CURRICULUM

POST GRADUATE & RESEARCH PROGRAMMES

M.Tech., M.Tech.(Research), M.Sc., M.C.A., M.B.A., Ph.D.

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA SURATHKAL
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2017

MOTTO

* Work is Worship

VISION

* To Facilitate Transformation of Students into- Good Human Beings, Responsible Citizens and Competent Professionals, focusing on Assimilation, Generation and Dissemination of Knowledge.

MISSION

* Impart Quality Education to Meet the Needs of Profession and Society and Achieve Excellence in Teaching-Learning and Research.

* Attract and Develop Talented and Committed Human Resource and Provide an Environment Conducive to Innovation, Creativity, Team-spirit and Entrepreneurial Leadership

* Facilitate Effective Interactions Among Faculty and Students and Foster Networking with Alumni, Industries, Institutions and Other Stake-holders.

* Practise and Promote High Standards of Professional Ethics, Transparency and Accountability.

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- 2017 –

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SECTIONS

REGULATIONS (General)

Common to all Degree Programmes

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Post Srinivasnagar, Mangalore - 575025, India.
2017

CONTENTS

REGULATIONS (General)
Common to all Degree Programmes

{also refer: REGULATIONS specific to the Degree Programmes}

G1. INTRODUCTION:

G1.0 The General Regulations that are common to all Degree Programmes of NITK Surathkal, are presented here. Specific aspects of the Regulations pertaining to a particular Degree Programme are given separately along with the corresponding Curriculum.

G1.1 The provisions contained in this set of Regulations govern the policies and procedures, on the admission of students, imparting instructions of courses, conducting of the examinations and evaluation and certification of students' performance leading to the said Degree Programme(s).

G1.2 This set of Regulations, on approval by the Senate, may supersede all the corresponding earlier sets of Regulations of the Institute, along with all the amendments thereto, and shall be binding on all students undergoing the said Degree Programme(s).

G1.3 This set of Regulations may evolve and get revised/refined or updated or amended or modified or changed through appropriate approvals from the Senate, from time to time, and shall be binding on all parties concerned, including the Students, Faculty, Staff, Departments, Institute Authorities.

G1.4 In order to *guarantee fairness and justice* to all the parties concerned, in view of the periodic evolutionary refinements, any specific issues or matters of concern shall be addressed separately, by the *appropriate authorities*, as and when found necessary.

G1.5 The effect of year-to-year (periodic) refinements in the Academic Regulations & Curriculum, on the students *admitted in earlier years*, shall be dealt with appropriately and carefully, so as to ensure that *those* students are not subjected to any unfair situation whatsoever, although they are required to conform to these revised set of Regulations & Curriculum, without any undue favour or considerations.

G1.6 The Senate may consider any issues or matters of concern relating to any or all the Academic Activities of the Institute, for appropriate action, irrespective of whether a reference is made (or the nature and extent of any reference if so present) here in this set of Regulations or otherwise.

G1.7 Whenever outside Experts need to be co-opted and/or invited for any of the Academic Committee Meetings, prior approval from the Chairman of the Senate/BOS shall be obtained, justifying the need, based on the agenda items of such Academic Committee Meetings. The outside experts shall be entitled for TA/DA/etc as per the prevailing Institute Rules.

G1.8 All disputes arising from this set of Regulations must be addressed to the Senate. The decision of the Senate is final and binding on all parties concerned. Further, any legal disputes arising from this set of Regulations shall be limited to the legal jurisdiction determined by the location of the Institute and not that of any other parties.

G2. DEFINITIONS: Unless the context otherwise requires –

- **"Institute"/"NITK"/"NITKS"** means, National Institute of Technology Karnataka, Surathkal.
- **"BOG"** means, the Board of Governors (BOG) of the Institute.
- **"MHRD"** means, the Ministry of Human Resources Development, GOI.
- **"JEE"** means, Joint Entrance Examination.
- **"GATE"** means, Graduate Aptitude Test in Engineering.
- **"Senate"** means, the Faculty Senate of the Institute.
- **"Director"** means, the Director of the Institute.
- **"BOS"** means, the Board of Studies of the Institute.
- **"Dean (A)"** means, the Dean (Academic).
- **"Dean (FW)"** means, the Dean (Faculty Welfare)
- **"Dean (P&D)"** means, the Dean (Planning and Development)
- **"Dean (R&C)"** means, the Dean (Research & Consultancy)
- **"Dean (SW)"** means, Dean (Students Welfare).
- **"Dean (AA&IR)"** means, Dean (Alumni Affairs & Institutional Relations).
- **"NITKS Hostels"** means, NITK-Surathkal Hostels.
- **"HOD"** means, the Head of the Department.
- **"Programme Co-ordinator"** means, a faculty in charge of an academic programme, particularly in case of PG and/or Research degree programmes.
- **"*D*egree *A*warding *D*epartment"** means, the department that offers the degree programme that a student undergoes, or the department to which the Research-Guide/Programme-Coordinator belongs.
- **"DAC" or "PAC"** means, the Departmental/Programme Academic Committee.
- **"DUGC"** means, the Departmental Under Graduate Committee.
- **"DPGC"** means, the Departmental Post Graduate Committee.
- **"PWEC"** means, the Project Work Evaluation Committee.
- **"DRPC"** means, Doctoral Research Programme Committee.
- **"RPAC"** means, Research Progress Assessment Committee.
- **"MTAC"** means Master's Thesis Assessment Committee.
- "**DTAC**" means, Doctoral Thesis Assessment Committee.
- **"DAAB"** means, the Departmental Academic Appeals Board.
- **"Faculty Advisor"** means the Faculty Advisor or the Panel of Faculty Advisors, in a Parent Department, for a group(admission-batch) of students.
- **"Course"** means, a specific *subject* usually identified by its *course-number* and *course-title*, with a specified *syllabus*/course-description, a set of *references*, taught by some *teacher*(*s*)/course-instructor(s) to a specific *class* (group of students) during a specific *academic-session*/semester.
- **"Course Instructor"** means, the teacher or the Course Instructor of a Course.
- **"Class/Course Committee"** means, the Class/Course Committee of a class/course.
- **"Project Guide"** means, the faculty who guides the Major Project of the student.
- **"Research Guide"** means, the faculty who guides the Research student/scholar, including the Additional Guide.
- **"He"** includes both genders he and she; similarly "his" and/or "him" includes "her" as well, in all the cases.
- **"Regulations"** means, this set of Academic Regulations.
- **"Curriculum"** includes the set of Academic Regulations, Course-Structure and Course-Contents.
- **"MOU"** means, Memorandum Of Understanding.

G3. ACADEMIC CALENDAR:

G3.1 The normal duration of the course leading to B.Tech degree will be *EIGHT* semesters.

G3.2 The normal duration of the course leading to M.Tech. degree will be *FOUR* semesters.

G3.3 The normal duration of the course leading to M.C.A. degree will be *SIX* semesters.

G3.4 The normal duration of the course leading to M.B.A. degree will be *FOUR* semesters.

G3.5 The normal duration of the course leading to M.Sc. degree will be *FOUR* semesters.

G3.6 Each academic year shall be divided into 2 semesters, each of *20 weeks* duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least *70 Teaching Days*, with at least 40 hours of teaching contact periods in a five-days session per week. The semester that is typically from Mid July to November is called the *ODD SEMESTER*, and the one that is from January to Mid-May is called the *EVEN SEMESTER*. Academic Session may be scheduled for the *Summer Session/Semester* as well.

G3.7 The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), approved by the Senate, and announced at least TWO weeks before the Closing Date of the previous Semester.

G3.8 The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra-curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

G3.9 Under any circumstances when any of the Teaching Days gets declared as a Holiday or otherwise when the classes get suspended, irrespective of whatsoever be the reasons, appropriate makeup for such loss shall be made by having the class/lab/teaching sessions conducted on a suitable Saturday by following the particular Class Time Table of that Teaching Day which was so lost.

G4. REGISTRATION:

G4.1 Every Student after consulting his Faculty-Advisor/Research-Guide is required to register for the approved courses with the DUGC/DPGC/DRPC of Parent Department at the commencement of each semester on the days fixed for such registration and notified in the academic calendar.

G4.2 **Lower and Upper Limits for Course Credits Registered in a Semester, by a Full-Time Student of a Degree Programme:**
A full time student of a particular degree programme shall register for the appropriate number of course credits in each semester/session, that is within the minimum and maximum limits specific to that degree programme as stipulated in the specific Regulations pertaining to that degree programme.

G4.3 **Mandatory Pre-Registration for higher semesters:**
In order to facilitate proper planning of the academic activities of a semester, it is essential for the students to *declare their intent to register* for an elective course well in advance, before the actual start of the academic session, through the process of Pre-Registration, which is mandatory for all students of second or higher semesters.

G4.4 All students (other than the freshly admitted students) intending to register for the next higher semester are required to have completed the *Mandatory Pre-Registration* of elective courses, at least TWO weeks before the Last Day of Classes in the current semester. To facilitate this Pre-registration all teaching departments shall announce the list of courses to be offered for the next higher semester, at least FOUR weeks before the Last Day of Classes in the current semester.

G4.5 PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply. Under Graduate students may be permitted to register for a few selected Post Graduate

courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

G4.6 ***Course Pre-Requisites:***

In order for a student to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior *earned credits* in, some specified courses. In such instances, the DUGC/DPGC/DRPC shall specify clearly, any such course pre-requisites, as part of the curriculum.

G4.7 Students who do not register on the day announced for the purpose may be permitted *LATE REGISTRATION* up to the notified day in academic calendar on payment of late fee.

G4.8 *REGISTRATION IN ABSENTIA* will be allowed only in exceptional cases with the approval of the Dean (A) after the recommendation of DUGC/DPGC/DRPC through the authorized representatives of the student.

G4.9 A student will be permitted to register in the next semester only if he fulfills the following conditions:

(a) satisfied all the Academic Requirements to continue with the programme of Studies without termination (refer Clause No: G10);
(b) cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
(c) paid all required advance payments of the Institute and hostel for the current semester;
(d) not been debarred from registering on any specific ground by the Institute.

G4.10 Medium of Instruction/Evaluation/etc. shall all be : English.

G5. EVALUATION SYSTEM:

G5.1 ***Course Credit Assignment:***

Every Course comprises of specific Lecture-Tutorial-Practical (L-T-P) Schedule. The Course Credits are fixed based on the following norms:

Lectures/ Tutorials :	One hour per week is assigned one Credit.
Practicals :	(i) a 3-hour session per week is assigned two Credits; OR (ii) a 2-hour session per week is assigned one Credit.

For example, a theory course with a L-T-P schedule of 3-1-0 will be assigned 4 credits; a laboratory practical course with a L-T-P schedule of 0-0-3 will be assigned 2 credits.

G5.2 The Academic Performance Evaluation of a Student shall be according to a ***Letter Grading System***, based on the ***Class Performance Distribution***, and *not* based upon any fixed apriori mappings or any absolute scale conversions from the Raw-Scores Scale (e.g. percentage-marks) to the Grade-Points Scale. The entire evaluation system (including these *Regulations) comprising of the Policies*, *Procedures*, *Mechanisms*, *Guidelines*, etc., have-been/shall-be designed, developed, evolved, implemented and adhered to, in order to meet the most fundamental/basic *quality* characteristics of being: fair/justifiable, objective/unbiased, reliable/precise, robust/resilient, while also being flexible/responsive and transparent/verifiable. It is equally essential to maintain appropriate level of *confidentiality* in terms of certain specific details, in order to achieve the above *quality* characteristics.

G5.3 The *double-letter grade* (AA, AB, BB, BC, CC, CD, DD, FF) indicates the level of academic achievement, assessed on a decimal (0-10) scale.

G5.4 ***Letter-Grades and Grade-Points****:*

LETTER-GRADE	GRADE-POINTS	REMARKS
AA AB BB BC CC CD DD	10 9 8 7 6 5 4	
FF	0	Fail due to poor performance
FA	0	Fail due to attendance shortage
I	-	Incomplete
U	-	Audited
W	-	Withdrawal
S	-	Satisfactory
N	-	Unsatisfactory

G5.5 The *double-letter grade* awarded to a student in a course other than a 0-0-P (Practical) course, for which he has registered shall be based on his performance in quizzes, tutorials, assignments etc., as applicable, in addition to one mid-semester examination and one end-semester examination. The distribution of weightage among these components may be as follows:

End-Semester Examination	: 40 to 50% (3 - 4 hours duration)
Mid-Semester Examination	: 20 to 25% (1 – 1½ hours duration)
Quizzes, Tutorials, Assignments, etc. (*continuous evaluation*)	: 25 to 40% (to make up for 100%)

Any variation, other than the above distribution, requires the approval of the pertinent DUGC/DPGC/DRPC.

G5.6 For any Undergraduate/ Postgraduate course offered to more than one section/ Department a common question paper, scheme of evaluation and grading has to be followed for both mid semester and end semester examinations. The respective DUGC/DPGC may decide about the weightage to be given to each individual component, viz tutorials, assignments, mid semester and end semester examination etc.

G5.7 The *double-letter grade* awarded to a student in a 0-0-P (Practical) course, is based on an appropriate continuous evaluation scheme that the course instructor shall evolve, with the approval of the pertinent DUGC/DPGC/ DRPC.

G5.8 The Course Instructor shall communicate clearly to the students, by announcements in the class, and/or by displaying prominently in the departments notice boards /website, and also report in writing to the DUGC/DPGC/DRPC the course plan and the details of the *Evaluation Scheme*, including the distribution of the weightage for each of the components, as well as the requirements for receiving a 'U' grade for auditing the course; within the first week of the semester in which the course is offered; so that there would be no ambiguities in this regard at the end of the semester while finalizing the grades.

G5.9 For courses offered exclusively for the PhD programme, the method of evaluation will be decided by pertinent DRPC. It may be similar to PG course evaluations, or it may be based on combinations of (a) Report submitted by the student (under the guidance of the Instructor for that course), (b) an open seminar, (c) viva-voce examination. An appropriate letter grade shall be awarded after the completion of the evaluation.

G5.10 ***Earned Credits***

This refers to the credits assigned to the course in which a student has obtained either 'S' grade, or any one of the *double-letter grades* 'AA', 'AB', 'BB', 'BC', 'CC', 'CD', 'DD' (but not 'FF' and 'FA').

G5.11 ***Cutoff Marks for 'AA' & 'FF' and the Scale-Differential:***

The *minimum cutoff* marks for 'AA' grade as well as the *maximum cutoff* marks for 'FF' grade will be decided by the Course Instructor based on the specific relevant details of the Class Performance Distribution (using appropriate class performance statistics parameters, like the Class-Mean, Class-Standard-Deviation, etc). However as a general guideline approved by the senate the minimum cutoff marks for 'AA' and 'DD' grade have been fixed as 70% and 20% respectively. Faculty members who intend to give a 'AA' grade to those students getting marks less than 70% and 'DD' grade for those students who get marks less than 20% are required to give justification for the same to the DUGC/ DPGC /DRPC of their respective department.

The *Scale-Differential* is defined as the difference between the minimum cutoff marks for the 'AA' grade and the maximum cutoff marks for the 'FF' grade (normally expressed as a multiple of the class-standard-deviation parameter).

An appropriate value for the Scale-Differential shall be decided by the Course Instructor after having studied the specific relevant details of the Class Performance Distribution.

The *minimum/maximum cutoff* marks for the intermediate grades are determined by appropriate *partitioning/clustering method* based on the specific relevant details of the Class Performance Distribution.

G5.12 ***Description of Grades:***

AA Grade:

An 'AA' grade stands for outstanding achievement, relative to the class, and the Course Instructor is supposed to take *utmost care* in awarding of this highest double-letter grade.

DD Grade:

The 'DD' grade stands for marginal performance and is the minimum passing double-letter grade.

FF and FA Grades:

The 'FF' grade denotes very poor performance, i.e. *failure* in a course due to poor performance and FA grade denotes poor attendance i.e. failure in a course due to attendance shortage (i.e. < 75%) and the Course Instructor is supposed to take *utmost care* while awarding these lowest double-letter grades. The students who have been awarded 'FF' grade in a course in any semester may be allowed to appear for a make-up end-semester examination. The make- up end- semester examination will be conducted possibly along with that arranged for those students who were awarded the 'I' grade, within the period announced in the academic calendar. If after considering make-up end-semester examination a student passes, then a minimum passing grade of 'DD' only be awarded, and if a student fails then a 'FF' grade will be awarded. Only regular registrants of a given course during a given academic semester who have obtained FF grade in the course will be permitted to appear for the makeup examination. Students who continue to have FF grade after the makeup examination are required to re- register for the course whenever it is offered subsequently. All the 'FF' (other than the courses for which 'DD' grade is obtained by the student in the make-up end-semester examinations conducted prior to the starting of next semester) and 'FA' grades secured in any course stay permanently on the grade card.

A student who obtains 'FA' grade in any course has to necessarily re-register for the course in the subsequent semesters/sessions whenever the course is offered until a passing grade is obtained. However, for an elective course in which 'FA' or 'FF' grade has been obtained, the student may either repeat the same course or register for any other elective course.

Only first year and final year courses may be offered during the summer session.

I Grade:

An 'I' grade denotes incomplete performance in any course due to absence at the end semester examination (see also Clause No: G8.3). When the 'I' grade is converted to a regular double-letter grade, a penalty of ONE Grade-Point is imposed, by awarding the double-letter grade that is immediately below the one that the student would have otherwise received.

U Grade:

This grade is awarded in a course that the student opts to register for audit. It is not mandatory for the student to go through the entire regular process of evaluation in an audit course. However, the student has to go through some process of minimal level of evaluation and also the minimum attendance requirement, as stipulated by the Course Instructor and approved by the corresponding DUGC/DPGC/DRPC, for getting the "U" grade awarded in a course, failing which that course will not be listed in the Grade Card.

W Grade:

A 'W' grade is awarded when the student withdraws from the course. Withdrawal from a course is permitted only under extremely exceptional circumstances (like medical emergencies, family tragedies and/or other unavoidable contingencies) and has to be recommended by the DUGC/DPGC/DRPC and approved by the Dean (Academic). However, no withdrawal is permitted after the finalization of the grades in the semester. Also, the 'W' grade once recorded remains permanently in the Grade Card.

S and N grades:

These grades are awarded for the Mandatory Learning Courses. The 'S' grade denotes satisfactory performance and completion of a course. The 'N' grade is awarded for non-completion of course requirements and the student will have to register for the course until he obtains the 'S' grade. The 'N' grade secured in a course stays permanently on the Grade Card.

G5.13 ***Evaluation of Performance:***

The overall performance of a student will be indicated by two indices: SGPA which is the Semester Grade Point Average and CGPA which is the Cumulative Grade Point Average.

SGPA for a semester is computed as follows:

$$\text{SGPA} = \frac{[\sum (\text{Course credits}) \times (\text{Grade Point})] \text{ for all courses with double-letter grades, including 'FF' and 'FA' (in that semester).}}{[\sum (\text{Course credits})] \text{ for all courses with double-letter grades, including 'FF' and 'FA' (in that semester).}}$$

CGPA is computed as follows:

$$\text{CGPA} = \frac{[\sum (\text{Course credits}) \times (\text{Grade Point})] \text{ for all courses with double-letter grades, including all 'FF' and 'FA' grades.}}{[\sum (\text{Course credits})^{*}] \text{ for all courses with double-letter grades, including all 'FF' and 'FA' grades.}}$$

***** Whenever a student reappears for a course in which he / she has been awarded 'FF' or 'FA' grade, the CGPA computations will not once again include the course credits for the failed courses in the denominator.

***** There is no equivalence between the CGPA scale and percentage. However, CGPA $\geq$ 6.5 can be considered as equivalent to first class and 5.5 $\leq$ CGPA $<$ 6.5 can be considered as

equivalent to second class. Notionally, CGPA may be multiplied by a factor of 10 to obtain the numerical percentage.

G5.14 ***Report of Marks, Grades and Class Performance Statistics:***

(a) The final grades shall be displayed for at least *ONE* working-day, during which period a student can approach the concerned course instructor(s) for any clarification. The process of evaluation shall be transparent and the students shall be made aware of all the factors included in the evaluation. In case of any correction, the course instructor shall have to incorporate the same before finalization of the grades.

(b) The course instructors shall submit the Report of Marks & Grades for each of the students in his course, along with the Summary Report of Marks & Grades containing the Class Performance Statistics, in the prescribed format, to the Chairman, DUGC/DPGC/DRPC by the stipulated date, for possible moderation (if and only when found necessary) and approval.

(c) The DUGC/DPGC/DRPC shall submit the final approved Report of Marks & Grades along with Summary Report of Marks & Grades containing the class performance statistics, in the prescribed format, to the office of the Dean (Academic) within the stipulated date.

(d) The Student Progress Report shall contain the Letter-Grade for each course; along with the SGPA, and the CGPA.

G5.15 ***Appeal for review of Grades:***

(a) The entire process of evaluation shall be made transparent, and the course instructor shall explain to a student why he gets whatever grade he is awarded, if and when required. A mechanism for review of grades is incorporated in the evaluation system. However, before appealing for such review, a student shall first approach the concerned Course Instructor and then the concerned DUGC/DPGC/DRPC, with the request to do the needful; and only in situations where satisfactory remedial measures have not been taken, the student may then appeal to the Departmental Academic Appeals Board (DAAB).

(b) In case of any such grievances about the grades, the student may appeal for review of grades to the Departmental Academic Appeals Board (DAAB) before the date specified in Academic Calendar.

(c) The fee for such an appeal will be decided by the Senate from time to time. If the appeal is upheld by DAAB, then the fee amount will be refunded to the student.

G6. ADD / DROP / cU -options:

G6.1 ***ADD-option:***

A student has the option to ADD courses for registration till the date specified for late registration in the Academic Calendar.

G6.2 ***DROP-option:***

On recommendation of the Teaching Department as well as the Parent Department, a student has the option to DROP courses from registration *until 2 weeks after the commencement of the classes in the semester*, as indicated in the Academic Calendar.

G6.3 ***cU-option:***

A student can register for auditing a course, or a course can even be converted from Credit to Audit or from Audit to Credit, with the consent of the Faculty Advisor and Course Instructor *until 2 weeks after the commencement of the classes in the semester as indicated in the Academic Calendar.* However, CORE Courses shall not be made available for audit.

G7. ATTENDANCE REQUIREMENTS:

7.1 All students must attend every lecture, tutorial and practical classes.

7.2 To account for approved leave of absence (eg. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a *minimum of 75%* of the classes actually conducted.

7.3 A student with less than 75% attendance in a course during a semester, in lectures, tutorials and practicals taken together as applicable, will not be permitted to appear in the End Semester Examinations of the course in which the shortfall exists, irrespective of his academic performance, and irrespective of nature of his absence . He shall be awarded 'FA' grade in that course .

7.4 The course instructor handling a course must finalise the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.

7.5 The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

G8. ABSENCE DURING THE SEMESTER:

G8.1 ***Leave of Absence:***

(a) If the period of leave is more than two days and less than two weeks, prior application for leave shall have to be submitted to the HOD concerned, with the recommendation of the Faculty-Advisor/Research-Guide stating fully the reasons for the leave requested, along with supporting documents.

(b) If the period of leave is two weeks or more, prior application for leave shall have to be made to the Dean (Academic) with the recommendations of the Faculty-Advisor/ Research Guide, HOD concerned stating fully the reasons for the leave requested, along with supporting documents. The Dean (Academic) may, on receipt of such application, grant leave or also decide whether the student be asked to withdraw from the course for that particular semester because of long absence.

(c) It will be the responsibility of the student to intimate the Course Instructors, and also the Dean (Students Welfare) as well as the Chief Warden of the hostel, regarding his absence before availing leave.

G8.2 ***Absence during Mid-Semester Examination:***

A student who has been absent from a Mid Semester Examination due to illness and other contingencies may give a request for make-up examination within two weeks after the Mid Semester Examination to the HOD with necessary supporting documents and certifications from authorized personnel. The HOD may consider such requests depending on the merits of the case, and after consultation with the course instructor, may permit the make up Mid Semester Examination for the concerned student.

G8.3 ***Absence during End-Semester Examination:***

In case of absence for an End Semester Examination, on medical grounds or other special circumstances, the student can apply for 'I' grade in that course with necessary supporting documents and certifications by authorized personnel to the HOD. The HOD may consider the request, depending on the merit of the case, and after consultation with the Course Instructor, permit the make up End Semester Examination for the concerned student (possibly arranged along with those students who were awarded the 'FF' grade). The student may subsequently complete all course requirements within the period announced in Academic Calendar (which may possibly be extended till first week of next semester under special circumstances) and 'I' grade will then be converted to an appropriate Double-letter grade, as per Clause No: G5.12 (Description of Grades: "I" Grade, above). All the particulars of such a decision with date of finalizing the grade shall be

communicated to Dean (Academic). If such an application for the 'I' grade is not made by the student then a double-letter grade will be awarded based on his in-semester performance.

G9. TRANSFER OF CREDITS

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges by students during their study period at NITK may count towards the credit requirements for the award of degree. The credits transferred will reduce the number of courses to be registered by the student at NITK. The guidelines for such transfer of credits are as follows:

a) B.Tech students with consistent academic performance and CGPA ≥7.5 can credit courses approved by the concerned DUGC of the program, in other Institutions during 3rd and 4th year and during summer breaks.

b) PG students with consistent academic performance and CGPA ≥7.5 can credit courses, approved by the concerned DPGC of the program in other Institutions during the summer vacation /project work.

c) Credits transferred will not be used for SGPA/CGPA computations. However, credits transferred will be considered for overall credits requirements of the programme.

d) Students can earn external credits only from IISC/IITs/NITs/IIMs and other Indian or foreign Universities/Institutes /Colleges with which NITK has an MOU (and that MOU must have a specific clause for provision of credit transfer by students)

e) Credits transfer can be considered only for the course at same level i.e UG, PG etc.

f) A student must provide all details (original or attested authentic copies)such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned departmental academic bodies (DUGC or DPGC)before giving approval. These academic bodies will then decide the number of equivalent credits the student will get for such course(s) in NITK. The complete details will then be forwarded to Dean (A) for approval.

g) The maximum number of credits that can be transferred by a student shall be limited to 20.

h) In case of major project for PG student, the External Guide will evaluate for only 50% credits (which will account for credits transfer)and the internal PWEC will evaluate for the remaining 50% credits.

i) A students has to get minimum passing grades/ marks for such courses for which the credits transfer are to be made.

j) Credits transfers availed by a student shall be properly recorded on academic record(s)of the student.

G10. WITHDRAWAL FROM THE PROGRAMME:

G10.1 ***Temporary Withdrawal:***

(a) A student who has been admitted to a degree programme of the Institute may be permitted to withdraw temporarily, for a period of one semester or more, on the grounds of prolonged illness or grave calamity in the family, etc., provided:

(i) He applies to the Institute stating fully the reasons for withdrawal together with supporting documents and endorsement from his parent/guardian;

(ii) The Institute is satisfied that, without counting the period of withdrawal, the student is likely to complete his requirements of the degree within the time specified (refer: "Degree Requirements") ;
(iii) There are no outstanding dues with the Departments / Institute / Hostels / Library / etc.;
(iv) Scholarship holders are bound by the appropriate Rules applicable to them.
(v) The decision of the Director of the Institute regarding withdrawal of a student is final and binding.

(b) Normally, a student will be permitted only one such temporary withdrawal during his tenure as a student and this withdrawal will not be counted for computing the duration of study.

G10.2 ***Permanent Withdrawal:***

Any student who withdraws admission before the closing date of admission for the Academic Session is eligible for the refund of the all the fees and deposits, after a deduction of a processing fee.

Once the admission for the year is closed, the following conditions govern withdrawal of admissions:

(a) A student who wants to leave the Institute for good, will be permitted to do so (and take Transfer Certificate from the Institute, if needed), only after clearing all the dues, if any. Also, all the fees and charges already paid will not be refunded on any account.

(b) Those Students who have received any scholarship, stipend or other forms of assistance from the Institute shall repay all such amounts in addition to those mentioned in Clause No: G10.2(a) above.

(c) The decision of the Director of the Institute regarding all aspects of withdrawal of a student shall be final and binding.

G11. CONDUCT AND DISCIPLINE:

G11.1 Students shall conduct themselves within and outside the premises of the Institute in a manner befitting the students of an Institution of National Importance.

G11.2 As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

G11.3 The following acts of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures:

(a) Ragging.
(b) Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus.
(c) Willful damage or stealthy removal of any property/belongings of the Institute/Hostel or of fellow students/citizens.
(d) Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.
(e) Mutilation or unauthorized possession of library books.
(f) Noisy and unseemly behavior, disturbing studies of fellow students.
(g) Hacking in computer systems (such as entering into other person's area without prior permission, manipulation and /or damage of computer hardware and software or any other cyber crime etc.)
(h) Plagiarism of any nature.
(i) Any other act of gross indiscipline as decided by the Senate from time to time.

Commensurate with the gravity of offense, the punishment may be: reprimand, fine, expulsion from the hostel, debarring from an examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.

G11.4 For an offence committed in (i) a hostel (ii) a department or in a class room and (iii) elsewhere, the Chief Warden, the Head of the Department and the Dean (Students Welfare), respectively, shall have the authority to reprimand or impose fine.

G11.5 Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Dean (Academic) for taking appropriate action.

G11.6 All cases of serious offence, possibly requiring punishment other than reprimand, shall be reported to the Director.

G11.7 The Institute Level Standing Disciplinary Action Committee constituted by the Director, shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.

G12. RESIDENCE:

G12.1 Institute is wholly residential and all full-time students shall be required to reside in the hostels.

G12.2 Under special circumstances, the Dean (Students Welfare) may permit a student to reside with his parent/guardian in the Institute campus or within a reasonable distance from the Institute.

G12.3 Students shall be required to abide by the Rules and Regulations of the NITKS Hostels as established by the Board of NITKS Hostels Management.

G13. GRADUATION REQUIREMENTS AND CONVOCATION:

G13.1 A student shall be declared to be eligible for the award of the degree if he has:
(a) Fulfilled Degree Requirements
(b) No dues to the Institute, Departments, Hostels, Library, CCC, and any other centers
(c) No disciplinary action pending against him.

G13.2 The award of the degree must be recommended by the concerned Departmental/Programme Academic Committee (DUGC/DPGC/DRPC) to the Senate, for approval and for further recommendation to the BOG.

G13.3 ***Convocation:***

Degrees will be awarded in person for the students who have graduated during the preceding academic year. Degrees will be awarded in absentia to such students who are unable to attend the Convocation. Students are required to apply for the Convocation along with the prescribed fee, after having satisfactorily completed all the degree requirements (refer "Degree Requirements") within the specified date in order to arrange for the award of the degree during convocation.

G14. COMMITTEES / FUNCTIONARIES:

The following committees shall be constituted common for the various degree programmes:

G14.1 ***Departmental Academic Appeals Board (DAAB):***

Constitution:

(a)	HOD of the teaching/parent Dept	…	Chairman
(b)	Three faculty members (1P + 1Asso.P + 1Asst.P)	…	Members
(c)	One Professor from outside the Department nominated by Dean (Academic)	…	Member
(d)	Faculty Advisor(s) of the Class from where the Appeal originates	…	Member(s)

Note:

- There shall be one DAAB for every department.
- The Chairman may co-opt and/or invite more members.
- Depending on the prevailing circumstances, a Senior Professor of the Department, nominated by the Dean (Academic), shall act as Chairman instead of Head of the Department.
- If the concerned instructor is a member of DAAB then he shall keep himself out of the Board during deliberations.

Functions (Highlights):

i. To receive grievance/ complaints in writing from the students regarding anomaly in award of grades due to bias, victimization, erratic evaluation, etc. and redress the complaints.

ii. To interact with the concerned course instructor and the student separately before taking the decision.

iii. The decision of the DAAB will be based on simple majority.

iv. The recommendations of the DAAB shall be communicated to the Dean (Academic) for further appropriate action as required.

G14.2 ***Class/Course Committee:***

Every Class (group of students registered for a course) of the Degree Programme shall have a Class/Course Committee, consisting of Faculty and Students.

Constitution:

(a)	One Faculty of the Parent/Teaching Department, not associated with the class; nominated by the HOD.	…	Chairman
(b)	Faculty Advisor(s) for the Class	…	Member-Secretary
(c)	Course Instructor(s)	…	Member(s)
(d)	*FOUR* to *SIX* students from the Class/Course to be chosen by the students amongst themselves	…	Members

Functions (Highlights):

i. The basic responsibilities of the Class/Course Committees are to review periodically the progress of the classes, to discuss problems concerning curriculum and syllabi and the conduct of the classes.

ii. Each class/course committee will communicate its recommendations to the HOD/DUGC/DPGC/DRPC of the Parent/Teaching Department.

iii. There shall be minimum one class committee meeting at the middle of every semester as indicated in the academic calendar. However additional class committee meetings may be convened as decided by DUGC/DPGC/Course Instructor.

iv. During beginning of the semester, the Course Instructors shall present the method of evaluation and distribution of weightages for the various components.

v. The minutes of each class/course committee meeting shall be recorded in a separate minutes register maintained in the Parent/Teaching Department.

vi. Any appropriate responsibility or function assigned by the DUGC/DPGC or the Chairman of the DUGC/DPGC.

G14.3 ***Faculty Advisor(s):***

The Faculty Advisor(s) will be appointed by the HOD of the parent department, who will be assigned a specific group (admission-batch) of students of the concerned parent department, and will be valid throughout their duration of study.

Functions (Highlights):

i. To help the students in planning their courses and related activities during their study period.

ii. To monitor, guide, advise and counsel the students on *all* academic matters.

iii. To coordinate the activities regarding mandatory learning courses.

G14.4 ***Course Instructor:***

Functions (Highlights):

i. He shall follow all the Regulations related to teaching of a course and evaluation of students.

ii. He shall be responsible for all the records (i.e., course registration, answer books, attendance, etc.) of the students registered for the course.

iii. He shall conduct classes as prescribed in the Academic Calendar and as per the teaching assignment time table issued by the HOD.

iv. He will arrange to distribute a course plan and the evaluation plan together with the course objectives, background materials to all the students within the first week of each semester.

v. He will prepare an evaluation plan showing details of how the student's performance will be evaluated in the course.

vi. He will properly document the students' performance and announce to the students (including on the notice board) as stipulated in the Regulations.

vii. He will report to the HOD on a periodic (*monthly*) basis, the potential cases of very poor academic performance as well as those of low attendance, that would possibly result in a 'FF' or 'FA' grade at the end of the semester.

G14.5 ***Departmental/Programme Academic Committee(s):***

Constitution:
The Departmental/ Programme Academic Committees are specific academic committees for each of the programmes/departments, like DUGC, DPGC, DRPC as given in the Regulations specific to such programmes/departments.

Functions (Highlights):

i. Specific functions as given in the Regulations specific to the concerned academic programme.
ii. Recommend to the BOS/Senate, appropriate measures to deal with the specific issues of concern, arising because of the effect of the year-to-year (periodic) refinements in the Academic Regulations & Curriculum, on the students *admitted in earlier years* (so as to ensure that *those* students are not subjected to any unfair situation whatsoever, although they are required to conform to these revised set of Regulations & Curriculum, without any undue favor or considerations) like the specific details of the credit requirements, etc., as and when such cases arise or need to be addressed, considering the nature and extent of the refinements, and implement the same with the appropriate approval of the BOS/Senate.

iii. Any appropriate responsibility or function assigned by the Senate or the Chairman of the Senate or the BOS or the Chairman of the BOS.

* * * * *

REGULATIONS

SPECIFIC TO

POST GRADUATE PROGRAMME

M.Tech. Degree

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Post : Srinivasnagar, Mangalore - 575025, India.
- 2017 -

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REGULATIONS
specific to
M.Tech. Degree Programme

{also refer: REGULATIONS (General) – Common to all Degree Programmes}

1. DEGREE PROGRAMMES:

1.1 Post Graduate M.Tech. Degree Programmes are offered in the following disciplines by the respective programme hosting departments listed below:

(a) Department of Civil Engineering		(CV)	
	i.	Structural Engineering	(ST)
	ii.	Geotechnical Engineering	(GT)
	iii.	Environmental Engineering	(EN)
	iv.	Transportation Engineering	(TS)
	v.	Construction Technology and Management	(CM)
(b) Department of Applied Mechanics and Hydraulics		(AM)	
	vi.	Marine Structures	(MS)
	vii.	Water Resources Engineering and Management	(WR)
	viii.	Remote Sensing and GIS	(RS)
(c) Department of Mining Engineering		(MN)	
	ix.	Rock Excavation Technology & Management	(RT)
(d) Department of Computer Science & Engineering		(CS)	
	x.	Computer Science and Engineering	(CS)
	xi.	Computer Science and Engineering – Information Security	(IS)
(e) Department of Electronics and Communication Engineering		(EC)	
	xii.	VLSI Design	(VL)
	xiii.	Communication Engineering	(CE)
(f) Department of Electrical and Electronics Engineering		(EE)	
	xiv	Power and Energy Systems	(PS)
(g) Department of Information Technology		(IT)	
	xv	Information Technology	
(h) Department of Mechanical Engineering		(ME)	
	xvi	Thermal Engineering	(TH)
	xvii	Manufacturing Engineering	(MF)
	xviii	Mechatronics	(MC)
	xix	Design and Precision Engineering	(DP)
(i) Department of Chemical Engineering		(CH)	
	xx	Chemical Plant Design	(PD)
	xxi	Industrial Pollution Control	(PC)
	xxii	Industrial Bio-Technology	(IB)
(j) Department of Metallurgical and Materials Engineering		(MT)	
	xxiii	Process Metallurgy	(PM)
	xxiv	Materials Engineering	(ML)
	xxv	Nanotechnology	(NT)
(k) Department of Mathematical and Computational Sciences		(MA)	
	xxvi	Computational Mathematics	(CMA)

1.2 The provisions of these Regulations shall be applicable to any new disciplines and/or that may be introduced from time to time and appended to the above list.

2. ADMISSION:

2.1 **Student Status:** There are six types of student status in the M.Tech. degree Programme:

(a) Full-time student on GATE-Scholarship
(b) Full-time sponsored student on QIP (AICTE)
(c) Full-time sponsored student from Industry or other Organizations including Educational Institutions
(d) Full-time, non-sponsored, non-scholarship student
(e) Internal Registrant - sponsored staff of NITK
(f) Internal Registrant –Selected as teaching Assistant of NITK

Note:

i. The full-time students are those who work on full-time basis at the Institute. The internal registrants are the faculty/staff of the Institute who work on part-time basis at the Institute.

ii. ***Duration:*** For full-time students, the duration of study shall be a minimum of FOUR semesters and a maximum of FOUR years. For internal registrants, the duration will be a minimum of FIVE semesters and a maximum of FIVE years.

iii. A student of type (a) will receive GATE-Scholarship for the duration of four semesters, which is subjected to the GATE-Scholarship rules of MHRD.

iv. Student of the type (c) shall be sponsored and financed by the sponsoring organization. He should produce a sponsorship-cum-clearance certificate in the given format of the Institute. The candidate must have a minimum of 2 years of Full-time work experience in the sponsoring organization, after completing the qualifying degree.

v. A non-sponsored non-scholarship (self-financed) student of type (d) will not receive any financial assistance from the Institute.

vi. An internal registrant (student) of type (e) shall produce a sponsorship-cum-clearance certificate from the Director, NITK.

vii. An internal registrant of type (f), selected as a Teaching Assistant, will be paid the Teaching Assistantship, and shall be governed by the *applicable rules* of the Institute. Total number of seats under this category may vary from year to year depending on the number of such Teaching Assistantships available.

viii. No student can receive scholarship/assistantship from more than one source.

2.2 Admissions will be made in accordance with the instructions received from MHRD from time to time. Seats are reserved for candidates belonging to Other Backward Classes (OBC) Scheduled Caste and Scheduled Tribes, Physically challenged candidates, children of defence personnel and other categories as per the guidelines issued by MHRD.

2.3 The minimum eligibility criteria for admission for the various M.Tech. Degree programmes shall be specified in the Institute Information Bulletin or the Prospectus. However, some general criteria are mentioned below.

2.4 The criteria for selection/admission for full-time students on GATE Scholarship will be based on GATE score. However the admission to other categories will be based on performance in qualifying exam, interview and other guidelines issued by the Senate from time to time. The prescribed qualifying examinations are given separately in the *Prospectus* or the *Institute Information Brochure* for each M.Tech. Programme.

2.5 Admission to a M.Tech. Programme shall be open to candidates who passed the prescribed qualifying examination, with a Cumulative Grade Point Average (CGPA) of at least 6.5 in the 0-10 scale grading system, OR not less than 60% marks in the aggregate (taking into account the marks scored in all the subjects of all the public/university examinations conducted during the entire prescribed period for the degree programme). However, this prescribed minimum shall be a CGPA of 6.0 OR 55% marks in the aggregate for SC/ST/PWD candidates.

2.6 A limited number of admissions is offered to Foreign Nationals and Indians Living Abroad in accordance with the rules applicable for such admission, issued from time to time, by MHRD.

2.7 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., this matter shall be reported to the Senate, recommending revoking the admission of the candidate.

2.8 Candidates have to fulfil the medical standards required for admission as prescribed in the *Institute Information Brochure* or the *Prospectus*.

2.9 The Institute reserves the right to cancel the admissions of any student and ask him to discontinue his studies at any stage of his study period on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.

2.10 The decision of the Senate regarding the admissions is final and binding.

2.11 Student Exchange Programmes and the Transfer of Credits in such cases shall be as per the corresponding MoU approved by Competent Authority.

2.12 Every Post Graduate student of the Institute shall be associated with *Parent Department*, offering the degree programme that the student undergoes, throughout his study period.

3. COURSE STRUCTURE;

3.1 The total course package for a M.Tech. Degree Programme will typically consist of the following components.

a) Programme Core Courses	Pc	≥ 20 Credits
b) Elective Courses	Ele	≥ 09 Credits
c) Major Project	MP	= 20 Credits
d) Mandatory Learning Courses	MLC	= 04 Credits

3.2 The Department Post Graduate Committee (DPGC) will discuss and recommend the exact credits offered for the programme for the above components, the semester-wise distribution among them, as well as the syllabi of all postgraduate courses offered by the department from time to time before sending the same to the Board of Studies (BOS). The BOS will consider the proposals from the departments and make recommendations to the Senate for consideration and approval.

3.3 **The Minimum Credit Requirement for the M.Tech. Degree is 60.**

3.4 ***Major Project:***

(a) The Major Project carries 20 credits and spreads over TWO semesters, normally during 3rd and 4th semesters (or as recommended by DPGC). The progress of the Project Work shall be monitored by the Project Guide.

(b) The method of evaluation, including intermediate assessment shall be evolved by the pertinent DPGC.

(c) The PWEC chairman (A faculty from the programme in the Department, nominated by the Chairman DPGC) should be identified in the third semester itself and the committee consisting of PWEC chairman and guide (s) shall evaluate the project in the Phase –I (third semester). Same chairman will continue for the phase –II of the project.

(d) The PWEC for the evaluation of the project in Phase II(end of fourth semester) shall consist of

i) PWEC Chairman

ii) Guide(s)

iii)External examiner (other than the External guide)/ Internal examiner (from NITK itself, but from outside the department). External examiner would be desirable

(e) BEFORE THE VIVA –VOCE EXAM: The student shall submit a copy of his/her thesis well in time (at least two weeks before the viva –voce exam) to all PWEC members and to chairman DPGC. The report of the Project Work to Chairman, DPGC, on or before the specified date. The Report shall be in the format prescribed by the Institute. For the effective assessment of the projects, all the M.Tech projects theses of the department shall be assessed and approved by the concerned PWEC before the Viva –voce examination.

(f) DURING THE VIVA VOCE EXAMINATION: Appropriate weightage shall also be decided by DPGC for oral presentation (preparation of slides) and for questions and answers.

(g) The date for submission of the thesis would be announced by the Dean (A) and will be announced in the academic calendar. However, the Dean (A) may permit the students to submit the thesis one week prior to the date announced on a case to case basis.

(h) The final evaluation is done by a Project Work Evaluation Committee (PWEC) constituted by the pertinent DPGC. There shall be an open seminar followed by a viva-voce examination as part of the final evaluation. After the final evaluation, appropriate double-letter grade is awarded, which will not however be considered for SGPA and CGPA calculations.

(i) Extension of time beyond the announced last date for submission of the Project Report may be granted by the Dean (A) on recommendation from the Chairman, DPGC.

(j) If in the opinion of the PWEC, the Project Report is acceptable with minor modifications for the passing grade 'DD', the PWEC shall value and instruct the candidate suitably to incorporate the necessary modifications and to resubmit it to the Chairman, PWEC. After such resubmission, the Chairman, PWEC will certify that the necessary modifications have been incorporated.

(k) The title of the Project Report shall be indicated in the Grade Card.

3.5 Students with CGPA <5.50 in course work will be permitted to register for a maximum of two make-up courses per semester along with the project work, to enable them to achieve the minimum CGPA requirements . In case, the student desires to register for more than two make-up courses per semester then the Course Work duration shall be extended by one or more semesters.

3.6 ***Mandatory Learning Courses:***

These are courses that must be completed by the student at appropriate time as suggested by the Faculty Adviser or the DPGC. The 'S' grade is awarded for satisfactory completion of the course and 'N' grade is awarded for non-completion of the course. In case 'N' grade is awarded the student has to re-register for the same course wherein he has no alternative

options. However, he can opt for other courses if he has been provided with multiple options. The 'S' and 'N' grades do not carry grade-points and hence not included in the SGPA, CGPA computations.

Courses that come under this category are the following:

(a) Practical Training / Minor Project:

This course is a 2-credit course. A full-time student will complete the Practical Training or the Minor Project at appropriate time stipulated by DPGC and register for it in the following Semester. The duration and the details, including the assessment scheme, shall be decided by the faculty advisor, with approval from DPGC.

(b) Seminar:

This course is a 2-credit course to be completed at appropriate time stipulated by DPGC. The student will make presentations on topics of academic interest.

4. DEGREE REQUIREMENTS:

4.1 The degree requirements of a student for the M.Tech. Degree programme are as follows:

(a) Institute Requirements:

(i) Minimum Earned Credit Requirement for Degree is 60.
(ii) Securing a CGPA of at least 5.50 in the Course Work.
(iii) Satisfactory completion of all Mandatory Learning Courses.

(b) Programme Requirements:

Minimum Earned Credit Requirements on all Core Courses, Elective Courses and Major Project as specified by the DPGC and conforming to Clause No: 3 (Course Structure) above.

(c) The Maximum duration for a student for complying to the degree requirement from the date of registration for his first semester, is FOUR years for full-time registration and FIVE years for internal registration.

5. TERMINATION FROM THE PROGRAMME:

A student shall be required to leave the Institute without the award of the Degree, under the following circumstances:

(a) If a student fails to earn the minimum credit specified below:

(i) Full-time student

Check Point	Credit Threshold
End of FIRST year	20

(ii) Part-time student

Check Point	Credit Threshold
End of FIRST year	10
End of SECOND year	20

Note: The period of temporary withdrawal is not to be counted for the above Credit Threshold.

(b) If a student is absent for more than 6(Six) weeks in a semester without sanctioned leave.

(c) If a CGPA of at least 5.50 is not secured in the course work.
{*in such cases the student is given the option of getting the P.G. Diploma instead of the M.Tech. Degree*}. However, students with CGPA>5.50 may opt for P.G.Diploma after the completion of the course work.

(d) Based on disciplinary action suggested by the Senate, on the recommendation of the appropriate committee.

NOTE: Under any circumstances of termination, the conditions specified in Permanent Withdrawal (refer: Clause No: G10.2) shall also apply.

6. COMMITTEES / FUNCTIONARIES:

The following committees shall be constituted for the Post Graduate Degree programme:

6.1 Board of Studies (BOS-PG):

Constitution:

(a)	Dean (A)	…	*Chairman*
(b)	Dean (FW)	…	Member
(c)	Dean (P&D)	…	Member
(d)	Dean (R&C)	…	Member
(e)	Dean (SW)	…	Member
(f)	Dean (AA&IR)	…	Member
(g)	Chairman of each DPGC/ his nominee	…	Member
(h)	BOG members representing the faculty	…	Members
(i)	Assistant Registrar (Academic)	…	*Convenor*
(j)	Dy. Registrar (Academic)	…	*Secretary*
(k)	TWO External Experts	…	Members

Note:

- There shall be one BOS-PG for the entire Institute.
- The Chairman may co-opt and/or invite more members including outside experts.
- The quorum of each meeting will be *NINE*.

Functions (Highlights):

i. To consider the recommendations of the DPGC on matters relating to postgraduate programme and to make suitable recommendations to the Senate.

ii. To approve curriculum framed/revised by DPGC for the postgraduate courses of study.

iii. To ensure that all norms and Regulations pertaining to postgraduate programme are strictly followed.

iv. To make periodic review of these Regulations pertaining to postgraduate programme and to recommend to the Senate any modifications thereof.

v. To review the academic performances and make suitable recommendations to the Senate regarding declaration of results, award of degrees etc.

vi. To recommend to the Senate, the award of stipends, scholarships, medals & prizes etc.

vii. To draw up general time table for the postgraduate course and finalise the PG academic calendar to be put up to the Senate for approval.

viii. To review the cases of malpractice in examinations and to recommend to the Director the punishment in such cases.

ix. To constitute a sub-committee for monitoring the implementation of the academic curriculum provided by the BOS and to provide guidance in curriculum assessment, evaluation process.

x. To conduct at least one meeting each semester and send the Resolutions to the Chairman of the Senate, and also to maintain a record of the same in the office of the Dean(A).

xi. Any appropriate responsibility or function assigned by the Senate or the Chairman of the Senate.

6.2 Departmental Post Graduate Committee (DPGC):

Constitution:

(a)	H.O.D. / Programme Co-ordinator	…	Chairman
(b)	Two Professors (by rotation for one year)	…	Members
(c)	Two Associate Professors (by rotation for one year)	…	Members
(d)	Two Assistant Professors (by rotation for one year)	…	Members

Note:

- There shall be one DPGC for every department that is involved in the teaching for any of the PG degree programmes.
- The Secretary (DPGC) shall be nominated by the Chairman on rotation basis for a period of one year.
- The Chairman may co-opt and/or invite more members including at most three outside experts.
- The quorum for each meeting shall be *FIVE*.

Functions (Highlights):

i. To monitor the conduct of all postgraduate courses of the department.

ii. To ensure academic standard and excellence of the courses offered by the department.

ii. To oversee the evaluation of the students in a class, for each of the courses.

iv. To evolve the methods of evaluation of major project including intermediate assessment

v. To develop the curriculum for postgraduate courses offered by the department, and recommend the same to the BOS.

vi. Moderation (only if and when found necessary) in consultation with the Course Instructor, and approval of the finalized grades, before submission of the same to the Academic Section of Dean (A).

vii. To consolidate the registration of the student and communicate to Course Instructors, and also to the Academic Section of the Dean (A).

viii. To conduct performance appraisal of Course Instructors.

ix To provide feedback of the performance appraisal to the Course Instructor and concerned authorities.

x. To consider any matter related to the postgraduate programme of the department.

xi. In cases where a course is taught by more than one faculty member, or by different faculty members for different sections of students, DPGC shall co-ordinate (only in case of need) among all such faculty members regarding the teaching and evaluation of such courses.

xii. To conduct at least two meetings each semester and send the Resolutions of the meeting to the Academic Section of the Dean (A), and also to maintain a record of the same in the department.

xiii. Any appropriate responsibility or function assigned by the Senate or the Chairman of the Senate or the BOS or the Chairman of the BOS.

6.3 Project Work Evaluation Committee (PWEC)

Constitution:

(a)	Chairman of DPGC or his nominee	…	Chairman
(b)	Project Guide(s)	…	Member(s)
(c)	One referee from outside the Department, selected by the DPGC	…	Member

Note:

- There shall be one PWEC for each PG project work.
- One external guide/referee, if any, invited as a member of PWEC, is entitled for TA/DA as per the Institute Rules.

Functions (Highlights):

i. To evaluate the PG project work and to award an appropriate letter grade. The chairman of PWEC shall submit the report, signed by all the members of the PWEC, to DPGC. The DPGC Chairman shall forward this report to the Academic Section of the Dean (A) without moderation.

6.4 Project Guide:

Functions (Highlights):

i. He will help the student under him in selecting the Project topic.

ii. He shall monitor the progress of the student working under him.

iii. He shall report to the DPGC the performance of the student from time to time.

iv. He will coordinate with the HOD/DPGC to arrange for facilities to carry out the project work.

REGULATIONS

SPECIFIC TO

POST GRADUATE PROGRAMME

M.Tech. (Research) Degree

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Post : Srinivasnagar, Mangalore - 575025, India.
- 2017 -

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REGULATIONS
specific to
M.Tech. (Research) Degree Programme

{also refer: REGULATIONS(General) – Common to all Degree Programmes}
{also refer: REGULATIONS(MTech) – Specific to M.Tech. Degree Programmes}

1. DEGREE PROGRAMMES:

1.1 Post Graduate M.Tech .(Research) Degree Programmes may be offered in the disciplines where a regular M.Tech. Degree Programme is already being offered or proposed to offer.

1.2 The provisions of these Regulations shall be applicable to any new disciplines and/or that may be introduced from time to time and appended to the above list.

2. ADMISSION:

2.1 **Student Status:** There are six types of student status in the M.Tech.(Research) degree Programme:

(a) Full-time student on GATE scholarship
(b) Full-time student - non-sponsored, non-scholarship
(c) Full-time student - sponsored from Industry or other Organizations including Educational Institutions.
(d) External Registrants sponsored from industry or other organization including Educational Institutions
(e) Internal Registrants - Sponsored Institute Staff or Project Staff of NITK.
(f) Internal Registrants- selected as Teaching Assistant of NITK.

Note:

i. The full-time students work at the Institute on full-time basis. The external registrants register at the Institute but work outside the Institute. The internal registrants are the Institute faculty/staff who work on part-time basis at the Institute.

ii. ***Duration:*** For full-time students, the duration of study shall be a minimum of FOUR semesters and a maximum of FOUR years. For Internal/External Registrants, the duration will be a minimum of FIVE semesters and a maximum of FIVE years.

iii. Student of the type (a) will receive GATE scholarship for the duration of four semesters, which is subjected to GATE scholarship rules of MHRD.

iv. Student of the type (c &d) shall be sponsored and financed by the sponsoring organization. He should produce a sponsorship-cum-clearance certificate in the given format of the Institute. The candidate must have minimum of 2 years of full-time work experience in the sponsoring organization, after completing the qualifying examination.

v. A non-sponsored non-scholarship (self-financed) student of type (b) will not receive any financial assistance from the Institute.

vi. An internal registrant of type (e) shall produce a sponsorship-cum-clearance certificate from the Director, NITK.

vii. An internal registrant of type (f), selected as a Teaching Assistant, will be paid the Teaching Assistantship, and shall be governed by the *applicable rules* of the Institute. Total number of

seats under this category may vary from year to year depending on the number of such Teaching Assistantships available.

viii. No student can receive scholarship/assistantship from more than one source.

2.2 Admissions will be made in accordance with the instructions received from MHRD from time to time. Seats are reserved for candidates belonging to Other Backward Classes, Scheduled Caste and Scheduled Tribes, Physically challenged candidates, children of defence personnel and other categories as per the guidelines issued by MHRD.

2.3 The minimum eligibility criteria for admission for the various M.Tech. (Research) Degree programmes shall be specified in the Institute Information Bulletin or the Prospectus. However, some general criteria are mentioned below.

2.4 The criteria for selection/admission will be based on performance in qualifying exam, interview and other guidelines issued by the Senate from time to time. The prescribed qualifying examinations for each M.Tech. (Research) Programme is given separately in the *Prospectus* or the *Institute Information Brochure*.

2.5 Admission to a M.Tech. (Research) Programme shall be open to candidates who passed the prescribed qualifying examination with a Cumulative Grade Point Average (CGPA) of at least 6.5 in the 0-10 scale grading system, OR not less than 60% marks in the aggregate (taking into account the marks scored in all the subjects of all the public/university examinations conducted during the entire prescribed period for the degree programme). However, this prescribed minimum shall be a CGPA of 6.0 OR 55% marks in the aggregate for SC/ST/PWD candidates.

2.6 A limited number of admissions is offered to Foreign Nationals and Indians Living Abroad in accordance with the rules applicable for such admission, issued from time to time, by MHRD.

2.7 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., the Dean (A) shall report the matter to the Senate, recommending revoking the admission of the candidate.

2.8 Candidates have to fulfil the medical standards required for admission as prescribed in the *Institute Information Brochure* or the *Prospectus.*

2.9 The Institute reserves the right to cancel the admissions of any student and ask him to discontinue his studies at any stage of his study period on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.

2.10 The decision of the Senate regarding the admissions is final and binding.

2.11 Student Exchange Programmes and the Transfer of Credits in such cases shall be as per the corresponding MoU approved by Competent Authority.

2.12 Every Post Graduate student of the Institute shall be associated with *Parent Department*, offering the degree programme that the student undergoes, throughout his study period.

3. PROGRAMME STRUCTURE:

3.1 The M.Tech.(Research) Degree Programme will typically consist of the following components.

a) Course Work ≥ 12 Credits (Courses carrying S/N grades shall not be counted)
b) MLC Course, HU800, Research Methodology
c) Research Thesis

3.2 The courses must be selected from the list of courses from the respective M.Tech discipline and must be completed *within the first THREE semesters* in case of Full-Time students, and *within the first SIX semesters* in case of Internal/External Registrants securing a CGPA of at least 5.50.

3.3 In case of external registrants, a minimum of one semester (preferably first semester) residential requirement to be completed during the completion of credit requirements. However the duration and number of visits to the institute after the course completion shall be decided by the research guide.

3.4 Students are required to undergo registration at the commencement of each semester on the days fixed for such registration and notified in the academic calendar.

4. RESEARCH GUIDE:

4.1 In each Department, applicants for M.Tech.(Research) programmes, will be given, at the time of selection, the details of research areas proposed by various faculty members, so that they will have an opportunity to discuss those areas with the respective faculty members and thereafter, indicate their choice in order of preference. The applicants shall then be interviewed by a committee constituted by the DPGC.

4.2 A permanent faculty of the Institute possessing a Ph.D. degree shall be recognised as the Research Guide.

4.3 One Research Guide, selected among the faculty of the Department in which he has registered, shall be allotted to each Research student by the HoD on the recommendations of DPGC at the time of admission, and the same shall be intimated to the Dean (A).

4.4 Depending on the research requirements, an additional faculty member of the institute may be included as an Additional Guide. However , the main Research Guide shall be from within the parent department . The inclusion of additional guide is allowed till the submission of the research proposal.

4.5 External Registrants may have an additional Research Guide from the organisation from which he is sponsored . The bio-data of intending Additional Guides from outside the Institute shall be scrutinized and recommended by the DPGC and approved by Dean (Academic).

4.6 Change of Research Guide(s) under exceptional circumstances shall be permitted on recommendation of the DPGC after obtaining the consent of (i) the Student (ii) the present Research Guide(s) and (iii) the proposed Research Guide(s).

5. EVALUATION SYSTEM:

5.1 Course Work Evaluation

The Course Work Evaluation shall be similar to that of other courses, and the details are given in the corresponding section in the Regulations (General) Common to all Degree Programmes (refer: Section G5).

5.2 Research Proposal Submission and Assessment

Every M.Tech. (Research) student is required to submit (within the first one year of joining the programme, his research proposal in the prescribed format, containing problem identification, state of the art technology, plan of research work etc. The RPAC shall assess the proposal through an open seminar and communicate the recommendation for approval or otherwise along with detailed comments to the Dean (A) through DPGC.

5.3 **Research Progress Assessment**

5.3.1 After approval of Research Work Proposal, half yearly assessments are made, through open seminars, to ensure satisfactory progress. The Research Scholar shall submit, through his Guide(s), a progress report of his research to the concerned RPAC twice a year. The RPAC will communicate to the DPGC about the periodic progress with detailedcomments. The DPGC shall forward the same to Dean (A).

5.3.2 The continuance of registration of all M.Tech.(Research) Students is subject to satisfactory progress made by them.

5.4 **Pre-Synopsis Seminar and Synopsis Submission**

5.4.1 Prior to the submission of the Synopsis of the Reseach Work, a comprehensive internal assessment of the research work should be made by RPAC by a Pre-Synopsis Seminar. The candidate can submit the Synopsis only if RPAC is satisfied about the quality of the work for submission as a M.Tech.(Research) Thesis.

5.4.2 Details of the Pre-Synopsis Seminar shall be notified well in advance, so as to enable interested staff members and students to attend the same.

5.4.3 The Chairman of the DPGC shall forward the RPAC's assessment report on the Pre-Synopsis Seminar to the Dean (A).

5.4.4 ONE printed copy and ONE soft copy of the Synopsis shall be submitted to the Dean (A), through Chairman of the DPGC, in the prescribed format consisting of a maximum of 15 pages including bibliography of research work.

5.5 **Thesis Submission and Assessment**

5.5.1 Prior to submission of thesis the scholar should a have at least one paper published preferably in refereed journal or in refereed conference proceedings.

5.5.2 THREE printed copies and one softcopy, in the prescribed format of the Thesis shall be submitted to the Dean (A), through Chairman of the DPGC, within THREE months from the date of submission of the Synopsis.

5.5.3 Along with the Thesis, the Research Scholar shall submit the requisite forms containing the authorization from the Research Guide(s) for submission of the Thesis and a certificate from Accounts Section that there are no dues against the Scholar.

5.5.4 The Thesis submitted by the student will be evaluated by MTAC constituted by Dean (A) by selecting two referees (one internal and one external) from the Panel submitted by DPGC.

5.5.5 If one of the examiners rejects the thesis, the thesis as it is has to be to be referred to a third referee selected from the Panel of referees.

5.5.6 If the thesis is rejected by two referees then it may be resubmitted after revision, incorporating the required modifications and / or alterations and / or additions etc in the light of referees' comments. Such re submission must be made not earlier than one month and not later than six months from the date of such intimation to the student by the Dean(A).The thesis so resubmitted may be examined either by the same referees or by new referees.

5.5.7 Rejection of the thesis so resubmitted will disqualify the candidate from further consideration for the award of M.Tech (Research) degree.

5.5.8 The copies of the referees' reports when received shall be confidently made available to the Research Guide (s) through Chairman, DPGC. The Research guide (s) shall send comments on these reports through DPGC for consideration by the Dean(A)

5.5.9 On the basis of the referees' report and the Research Guide (s) comments thereon, the Dean(A) will decide whether the Thesis be accepted for the viva –voce examination, or be rejected or referred again to a new referee.

5.5.10 The student, whose thesis has been recommended for the award of M.Tech (Research) degree, shall be required to defend his thesis at an viva-voce examination conducted by MTAC,. After satisfactory defense of the thesis , the MTAC will recommend the approval of the thesis to the Dean(A) through DPGC for further action towards the award of M.Tech (Research) degree.

5.5.11 The MTAC shall submit its report in the prescribed form to Dean (A) within ONE month after completion of viva-voce exam.

5.5.12 After satisfactory completion of the viva-voce examination, the M.Tech. (Research) degree may be conferred on the student, after approval by the Senate.

5.5.13 After successful completion of the viva-voce examination, the candidate shall submit Dean(A) ONE copy of his approved Thesis duly bound along with a soft-copy in the prescribed format.

6. DEGREE REQUIREMENTS:

The degree requirements of a student for the M.Tech.(Research) Degree programme are as follows:

(a) ***Institute Requirements:***

(i) Completion of Course Work of at least 12 Credits, and MLC course HU800, *within the first THREE semesters* in case of Full-Time students, and *within the first SIX semesters* in case of Internal/External Registrants.

(ii) Securing a CGPA of at least 5.50 in the Course Work.

(iii) Satisfactory defense of the M.Tech.(Research) Thesis.

(b) The Maximum duration for a student for complying to the degree requirement from the date of registration for his first semester is FOUR years for Full-time students and FIVE years for all other categories of students.

7. TERMINATION FROM THE PROGRAMME:

A student shall be required to leave the M.Tech. (Research) Degree Programme under the following circumstances:

(a) If the course work is not completed within the first THREE semesters in the case of full-time students, and within the first SIX semesters in case of internal/external registrants
(b) If a CGPA of at least 5.50 is not secured in the course work.
(c) If a student fails to submit satisfactory Research Proposal within one year of joining the program
(d) If the M.Tech.(Research) Thesis has not been accepted after *TWO submissions*.
(e) Based on disciplinary action on the recommendation of the appropriate committee.
(f) If a student is absent for more than 6 weeks in a semester without sanctioned leave

NOTE: Under any circumstances of termination, the conditions specified in Permanent Withdrawal (refer: Clause No: G10.2) shall also apply.

8. COMMITTEES / FUNCTIONARIES:

The following committees shall be constituted for the Post Graduate Degree programme:

8.1 Board of Studies (BOS-PG):
(Same as the BOS-PG mentioned in the M.Tech. Regulations)

8.2 Departmental Post Graduate Committee (DPGC):
(Same as the DPGC mentioned in the M.Tech. Regulations)

8.3 Research Progress Assessment Committee (RPAC):

Constitution:

(a) Guide	….	Chairman
(b) Co-Guide (if any)	….	Member
(c) At least One Faculty from the parent department of the M.Tech(R) scholar from the recommended panel, selected by Dean (A)	….	Member
(d) At least One Faculty from outside the parent department of the guide(s) from recommended panel, selected by Dean (A)	….	Member

Note:
- There shall be one RPAC for each M.Tech. (Research) Student
- The RPAC shall be constituted by the Dean (A) when the student submits the Research Proposal for assessment.

Functions (Highlights)

(i) To assess and approve the Research Proposal and Synopsis.
(ii) To communicate the half yearly assessment reports about the progress of the research work to DPGC.
(iii) To assess the Pre-Synopsis Seminar and communicate the results to the Dean (A) through the DPGC.

8.4 Master's Thesis Assessment Committee (MTAC):

Constitution:

(a)	Chairman DPGC or a Professor nominated by the Dean (A) on recommendation of DPGC	…	Chairman
(b)	Guide(s)	…	Member(s)
(c)	Two Referees	…	Members
(d)	At least one faculty from the parent department of the M.Tech(R) scholar from the recommended panel, selected by Dean (A)	….	Member
(e)	RPAC members	…	Invited Members

Note:
- There shall be one MTAC for each M.Tech. (Research) Student.
- The MTAC shall be constituted by the Dean (A) when the M.Tech. (Research) Student submits the M.Tech. Research Thesis for assessment.

- The TWO referees shall be selected by the Dean (A), from a panel of SIX referees (THREE from within the Institute and THREE from outside the Institute). These TWO Referees will be requested for an assessment of the M.Tech. Research Thesis, and one of these referees will be invited for the final *Thesis Defense and Viva-Voce Examination*.

Functions (Highlights):

(i) The TWO Referees will evaluate the M.Tech.(Research) Thesis and send the report to DPGC.

(ii) MTAC will evaluate the research work and the M.Tech.(Research) Thesis, based on the defense of the Thesis through an open seminar and viva-voce examination and send the report to Dean (A), through chairman, DPGC.

8.5 Research Guide:

Functions (Highlights):

i. He will guide the student to select a topic for research.

ii. He will suggest the courses for course work.

iii. He will monitor the progress of the student.

iv. He will suggest a Panel of Referees to the DPGC for constituting RPAC and MTAC.

v. He will approve and forward all the applications of the student.

vi. He will provide or arrange for facilities to carry out research work.

vii. In the event of leaving the Institute or away from the institute for a considerable period, he has to arrange for a Change of Research Guide as per Clause No: 4.6 above.

* * * * *

REGULATIONS

SPECIFIC TO

POST GRADUATE PROGRAMME

M.Sc. Degree

IN

CHEMISTRY / PHYSICS

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Post : Srinivasnagar, Mangalore - 575025, India.
- 2017 -

CONTENTS

REGULATIONS
specific to
M.Sc. Degree Programme
in
Chemistry / Physics

{also refer: REGULATIONS (General) – Common to all Degree Programmes}

1. DEGREE PROGRAMMES:

1.1 Post Graduate M.Sc. Degree Programmes are offered in the following disciplines by the respective programme hosting departments listed below:

i.	Chemistry	(CY)
ii.	Physics	(PH)

1.2 The provisions of these Regulations shall be applicable to any new disciplines and/or that may be introduced from time to time and appended to the above list.

2. ADMISSION:

2.1 **Student Status:** There is only one type of student status in M.Sc. degree programme, namely, full time.

2.2 **Duration:** The duration of study shall be a minimum of FOUR semesters and a maximum of FOUR years.

2.3 Admissions shall be made in compliance to the general guidelines received from MHRD from time to time. Seats are reserved for candidates belonging to Other Backward Classes, Scheduled Caste and Scheduled Tribes, Physically challenged candidates, children of defence personnel and other categories as per the guidelines issued by MHRD.

2.4 The admissions will be based on the performance in the Entrance Test and the performance in the qualifying examination.

2.5 Admission to M.Sc. Programme in Chemistry / Physics shall be open to candidates who have passed a Bachelor's degree in Chemistry /Physics with 60% (or cumulative Grade Point Average (CGPA) of at least 6.5 in the 0-10 scale grading system) of the aggregate in all the years of course of study in respective subjects and with 55% (Cumulative Grade Point Average (CGPA) of at least 6.0 in the 0-10 scale grading system**)** in respect of SC , ST and PWD candidates.

2.6 A limited number of admissions is offered to Foreign Nationals and Indians living abroad in accordance with the rules applicable for such admission, issued from time to time, by MHRD.

2.7 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., this matter shall be reported to the Senate, recommending revoking the admission of the candidate.

2.8 Candidates have to fulfil the medical standards required for admission as prescribed in the *Institute Information Brochure* or the *Prospectus*.

2.9 The Institute reserves the right to cancel the admissions of any student and ask him to discontinue his studies at any stage of his study period on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.

2.10 The decision of the Senate regarding the admissions is final and binding.

2.11 Student Exchange Programmes and the Transfer of Credits in such cases shall be as per the corresponding MOU approved by Competent Authority.

2.12 Every Post Graduate student of the Institute shall be associated with *Parent Department*, offering the degree programme that the student undergoes, throughout his study period.

3. COURSE STRUCTURE:

3.1 The total course credit requirement for the award of M. Sc. Degree will typically consist of the following components.

a) Core Courses	≥ 40 Credits
b) Elective Courses	≥ 12 Credits
c) Mandatory Learning Courses (Seminar)	≥ 03 Credits
d) M.Sc. Project	≥ 06 Credits

3.2 The Department Post Graduate Committee (DPGC) will discuss and recommend the exact credits offered for the programme for the above components, the semester-wise distribution among them, as well as the syllabi of all postgraduate courses offered by the department from time to time before sending the same to the Board of Studies (BOS). The BOS will consider the proposals from the departments and make recommendations to the senate for consideration and approval.

3.3 **The Minimum Credit Requirement for the M.Sc. Degree is 90**

3.4 ***Mandatory Learning Courses:***

These are courses that must be completed by the student at appropriate time as suggested by the Faculty Adviser or the DPGC. The 'S' grade is awarded for satisfactory completion of the course and 'N' grade is awarded for non-completion of the course. In case 'N' grade is awarded the student has to re-register for the same course wherein he has no alternative options. However, he can opt for other courses if he has been provided with multiple options. The 'S' and 'N' grades do not carry grade-points and hence not included in the SGPA, CGPA computations.

The Course that comes under this category is the following:

Seminar:

Each Seminar course is a 1-credit course. A student is required to register for three such Seminar Courses during his period of study for the M.Sc. Degree Programme, suitably arranged by the DPGC. The student is required to make presentations on topics of academic interest.

3.5 **M.Sc. Project**

(a) The M.Sc project will be undertaken during 4th semester. The progress of the Project work shall be monitored by the Project Guide.
(b) The method of evaluation, including intermediate assessment shall be evolved by the pertinent DPGC.

(c) A candidate shall submit 5 copies of the Report of the project work to Chairman, DPGC, on or before the specified date. The report shall be in the format prescribed by the Institute.
(d) The date of submission of report shall be announced by the DPGC after getting the approval by Dean(A)
(e) The final evaluation is done by a Project work Evaluation Committee (PWEC) constituted by the pertinent DPGC. There shall be an open seminar followed by a viva-voce examination as part of the final evaluation. After the final evaluation, appropriate double letter grade is awarded, which will not be considered for SGPA and CGPA calculations.
(f) Extension of time beyond the date for submission of the Project Report may be granted by the Dean (A) on recommendation from the Chairman, DPGC.
(g) If in the opinion of the PWEC, the Project Report is acceptable with minor modifications for the passing grade DD, the PWEC shall value and instruct the candidate suitably to incorporate the necessary modifications and to resubmit it to the Chairman, PWEC. After such resubmission, the Chairman, PWEC will certify that the necessary modifications have been incorporated.
(h) The title of the Project Report shall be indicated in the Grade Card.

4. DEGREE REQUIREMENTS:

4.1 The degree requirements of a student for the M.Sc. Degree programme are as follows:

(a) ***Institute Requirements:***
(i) Minimum Earned Credit Requirement for Degree 90.
(ii) Securing a CGPA of at least 5.50 in the Course Work.
(iii) Satisfactory completion of all Mandatory Learning Courses.

(b) ***Programme Requirements:***
Minimum Earned Credit Requirements on all Core Courses, Elective Courses and Project as specified by the DPGC and conforming to Clause No: 3 (Course Structure)

(c) The Maximum duration for a student for complying to the degree requirement from the date of registration for his first semester, is FOUR years.

5. TERMINATION FROM THE PROGRAMME:

A student shall be required to leave the Institute without the award of the Degree, under the following circumstances:

(a) If a student fails to earn the minimum credit specified below:

Check Point	Credit Threshold
End of FIRST year	20
End of SECOND year	40

Note: The period of temporary withdrawal is not to be counted for the above Credit Threshold.
(b) If a student is absent for more than 6 (Six) weeks in a semester without sanctioned leave.
(c) If a CGPA of at least 5.50 is not secured in the Course Work.
(d) Based on disciplinary action suggested by the Senate, on the recommendation of the appropriate committee.

NOTE: Under any circumstances of termination, the conditions specified in Permanent Withdrawal (refer: Clause No: G10.2) shall also apply.

6. COMMITTEES / FUNCTIONARIES:

6.1 Board of Studies (BOS –PG)

(Same as the BOS-PG mentioned in M.Tech Regulations)

6.2 Departmental Post Graduate Committee (DPGC):

(Same as DPGC mentioned in M.Tech Regulations)

6.3 Project Work Evaluation Committee (PWEC)

Constitution:

(a)	Chairman of DPGC or his nominee	…	Chairman
(b)	Project Guide(s)	…	Member(s)
(c)	One referee from outside the Department, selected by the DPGC	…	Member

Note:

- There shall be one PWEC for each PG project work.
- One external guide/referee, if any, invited as a member of PWEC, is entitled for TA/DA as per the Institute Rules.

Functions (Highlights):

To evaluate the PG project work and to award an appropriate letter grade. The chairman of PWEC shall submit the report, signed by all the members of the PWEC, to DPGC. The DPGC Chairman shall forward this report to the Academic Section of the Dean (A) without moderation.

6.4 Project Guide:

Functions (Highlights):

i. He will help the student under him in selecting the Project topic.
ii. He shall monitor the progress of the student working under him.
iii. He shall report to the DPGC the performance of the student from time to time.
iv. He will coordinate with the HOD/DPGC to arrange for facilities to carry out the project work.

REGULATIONS

SPECIFIC TO

POST GRADUATE PROGRAMME

Master of Computer Applications (MCA) Degree

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Post : Srinivasnagar, Mangalore - 575025, India.
- 2017 -

CONTENTS

REGULATIONS
specific to
M.C.A. Degree Programme

{also refer: REGULATIONS (General) – Common to all Degree Programmes}

1. ADMISSION

1.1 **Student Status** There is only one type of student status in the MCA degree Programme, namely, full-time.

1.2 **Duration** The duration of study shall be a minimum of SIX semesters and a maximum of SIX years.

1.3 Admissions will be made in accordance with the instructions received from MHRD from time to time. Seats are reserved for candidates belonging to Other Backward Classes Scheduled Caste and Scheduled Tribes, Physically challenged candidates, children of defence personnel and other categories as per the guidelines issued by MHRD.

1.4 The admissions will be on the basis of the performance in the prescribed Entrance Examination, and performance in the qualifying examination and interview. The prescribed qualifying examinations are given separately in the Institute prospectus for M.C.A. Programme.

1.5 Admission to M.C.A. Programme shall be open to candidates who have -

(a) passed the prescribed qualifying examination with a Cumulative Grade Point Average (CGPA) of at least 6.5 in the 0-10 scale grading system, OR not less than 60% marks in the aggregate (taking into account the marks scored in all the subjects of all the public/university examinations conducted during the entire prescribed period for the degree programme). However, this prescribed minimum shall be CGPA of 6.0 OR 55% marks in the aggregate for SC/ST candidates.

(b) a valid score in NITMCA Common Entrance Test (NIMCET)

1.6 A limited number of admissions is offered to Foreign Nationals and Indians Living Abroad in accordance with the rules applicable for such admission, issued from time to time, by MHRD.

1.7 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., this matter shall be reported to the Senate, recommending revoking the admission of the candidate.

1.8 Candidates have to fulfil the medical standards required for admission as prescribed in the *Information Brochure* or the *Prospectus*.

1.9 The Institute reserves the right to cancel the admissions of any student and ask him to discontinue his studies at any stage of his career on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.

1.10 The decision of the Senate regarding the admissions is final and binding.

1.11 Student Exchange Programmes and the Transfer of Credits in such cases shall be as per the corresponding MOU approved by Competent Authority.

2. COURSE STRUCTURE:

2.1 The total course package for a M.C.A. Programme will typically consist of the following components.

(a)	Programme Core Courses	Pc	≥ 60 Credits
(b)	Elective Courses	Ele	≥ 24 Credits
(c)	Major Project	MP	= 20 Credits
(d)	Mandatory Learning Courses	MLC	= 04 Credits

2.2 The Department Post Graduate Committee (DPGC) will discuss and recommend the exact credits offered for the programme for the above components, the semester-wise distribution among them, as well as the syllabi of all postgraduate courses offered by the department from time to time before sending the same to the Board of Studies (BOS). The BOS will consider the proposals from the departments and make recommendations to the senate for consideration and approval.

2.3 **The Minimum Credit Requirement for the M.C.A Degree is 120**.

2.4 ***Major Project:***

(a) The Major Project carries 20 credits and spreads over ONE semester, during 6th semester (or as recommended by DPGC). The progress of the Project Work shall be monitored by the Project Guide. No candidate will be permitted to submit the project report before the last day of the classes in the project work semester as per the Academic Calendar.

(b) The method of evaluation, including intermediate assessment shall be evolved by the pertinent DPGC.

(c) A candidate shall submit 5 copies of the Project Work to Chairman, DPGC, on or before the specified date. The dissertation shall be in the format prescribed by the Institute.

(d) The date for the submission of Report shall be announced by the DPGC after getting the approval of the Dean (A).

(e) The final evaluation is done by a Project Work Evaluation Committee (PWEC) constituted by the pertinent DPGC. There shall be an open seminar followed by a viva-voce examination as part of the final evaluation. After the final evaluation, appropriate double-letter grade is awarded, which will not however be considered for SGPA and CGPA calculations.

(f) Extension of time beyond the announced last date for submission of the Project Report may be granted by the Dean (A) on recommendation from the Chairman, DPGC.

(g) If in the opinion of the PWEC, the Project Report is acceptable with minor modifications for the passing grade 'DD', the PWEC shall value and instruct the candidate suitably to incorporate the necessary modifications and to resubmit it to the Chairman, PWEC. After such resubmission, the Chairman, PWEC will certify that the necessary modifications have been incorporated.

(h) The title of the Project Report shall be indicated in the Student Grade Card.

2.5 ***Mandatory Learning Courses:***

These are courses that must be completed by the student at appropriate time as suggested by the Faculty Adviser or the DPGC. The 'S' grade is awarded for satisfactory completion of the course and 'N' grade is awarded for non-completion of the course. In case 'N' grade is awarded the student has to re-register for the same course wherein he has no alternative options. However, he can opt for other courses if he has been provided with multiple options. The 'S' and 'N' grades do not carry grade points and hence not included in the SGPA, CGPA computations.

Course that comes under this category is the following:

Seminar:

This course is a 4-credit course to be completed at appropriate time stipulated by DPGC. The student will make presentations on topics of academic interest.

3. DEGREE REQUIREMENTS:

3.1 The degree requirements of a student for the M.C.A. programme are as follows:

(a) ***Institute Requirements:***

(i) Minimum Earned Credit Requirement for Degree is 120.
(ii) Securing a CGPA of at least 5.50 in the Course Work.
(iii) Satisfactory completion of all Mandatory Learning Courses.

(b) ***Programme Requirements:***

Minimum Earned Credit Requirements on all Core Courses, Elective Courses and Major Project as specified by the DPGC and conforming to Clause No: 2(Course Structure).

(c) The Maximum duration for a student for complying to the Degree Requirement from the date of registration for his first semester, is SIX years.

4. TERMINATION FROM THE PROGRAMME:

A student shall be required to leave the Institute without the award of the Degree, under the following circumstances:

(a) If a student fails to earn the minimum credit specified below:

Check Point	Credit Threshold
End of FIRST year	20
End of SECOND year	40
End of THIRD year	60

Note: The period of temporary withdrawal is not to be counted for the above Credit Threshold.

(b) If a student is absent for more than 6 (Six) weeks in a semester without sanctioned leave.
(c) Fails to get the minimum cutoff CGPA of at least 5.50 in the Course Work.
(d) Based on disciplinary action suggested by the Senate, on the recommendation of the appropriate committee.

NOTE: Under any circumstances of termination, the conditions specified in Permanent Withdrawal (refer: Clause No: G10.2) shall also apply.

5. COMMITTEES / FUNCTIONARIES:

The following committees shall be constituted for the Post Graduate Degree programme:

5.1 Board of Studies (BOS-PG):

(Same as BOS-PG Mentioned in M.Tech regulations)

5.2 Departmental Post Graduate Committee (DPGC):

(Same as DPGC mentioned in M.Tech regulations)

5.3 Project Work Evaluation Committee (PWEC)

Constitution:

(a)	Chairman of DPGC or his nominee	…	Chairman
(b)	Project Guide(s)	…	Member(s)
(c)	One referee from outside the Department, selected by the DPGC	…	Member

Note:

- There shall be one PWEC for each MCA project work.
- One external guide/referee, if any, invited as a member of PWEC, is entitled for TA/DA as per the Institute Rules.

Functions (Highlights):

i. To evaluate the MCA project work and to award an appropriate letter grade. The chairman of PWEC shall submit the report, signed by all the members of the PWEC, to DPGC. The DPGC Chairman shall forward this report to the Academic Section of the Dean (A) without moderation.

5.4 Project Guide:

Functions (Highlights):

i. He will help the student under him in selecting the Project topic.

ii. He shall monitor the progress of the student working under him.

iii. He shall report to the DPGC the performance of the student from time to time.

iv. He will coordinate with the HOD/DPGC to arrange for facilities to carry out the project work.

* * * * *

REGULATIONS

SPECIFIC TO

POST GRADUATE PROGRAMME

M.B.A. DEGREE

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Post : Srinivasnagar, Mangalore - 575025, India.
- 2017-

CONTENTS

REGULATIONS
specific to
M.B.A. Degree Programme

{also refer: REGULATIONS (General) – Common to all Degree Programmes}

1. ADMISSION

1.1 **Student Status** There is only one type of student status in the MBA degree Programme, namely, full-time.

1.2 **Duration** The duration of study shall be a minimum of FOUR semesters and a maximum of FOUR years.

1.3 Admissions will be made in accordance with the instructions received from MHRD from time to time. Seats are reserved for candidates belonging to Other Backward Classes Scheduled Castes and Scheduled Tribes, Physically challenged candidates, children of defence personnel and other categories as per the guidelines issued by MHRD.

1.4 The admissions will be on the basis of CAT/GMAT score and performance in the qualifying examination and interview. The prescribed qualifying examinations are given separately in the Institute prospectus for M.B.A. Programme.

1.5 Bachelor's Degree in any discipline from a Recognized University with not less than 50% marks (or Cumulative Grade Point Average (CGPA) of at least 5.5 in the 0-10 scale grading system) in the aggregate taking into account the marks scored in all subjects of all the University examination conducted during the entire prescribed period of the degree programme. However, this prescribed minimum marks shall be 45% (CGPA of at least 5.0 in the 0-10 scale grading system) in the case of SC/ST.

1.6 A limited number of admissions is offered to Foreign Nationals and Indians Living Abroad in accordance with the rules applicable for such admission, issued from time to time, by MHRD.

1.7 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., this matter shall be reported to the Senate, recommending revoking the admission of the candidate.

1.8 Candidates have to fulfil the medical standards required for admission as prescribed in the *Information Brochure* or the *Prospectus*.

1.9 The Institute reserves the right to cancel the admissions of any student and ask him to discontinue his studies at any stage of his career on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.

1.10 The decision of the Senate regarding the admissions is final and binding.

1.11 Student Exchange Programmes and the Transfer of Credits in such cases shall be as per the corresponding MoU approved by Competent Authority.

2. COURSE STRUCTURE:

2.1 The total course package for a M.B.A. Programme will typically consist of the following components.

(a)	Foundation Courses	≥ 20 Credits
(b)	Program Core(PC)	≥ 25 Credits
(c)	Advanced Courses	≥ 20 Credits
(d)	Elective Courses(Ele)	= 03 Credits
(e)	MLC	= 03 Credits
(e)	Major Project	= 08 Credits

2.2 The Department Post Graduate Committee (DPGC) will discuss and recommend the exact credits offered for the programme for the above components, the semester-wise distribution among them, as well as the syllabi of all postgraduate courses offered by the department from time to time before sending the same to the Board of Studies (BOS). The BOS will consider the proposals from the departments and make recommendations to the senate for consideration and approval.

2.3 The Minimum Credit Requirement for the M.B.A Degree is 90.

2.4 Summer Internship Project:

The Summer Internship Project of 8 weeks minimum duration shall be completed during vacation after second semester and carries 8 credits. The progress of the Summer Internship Project Work shall be monitored by the Project Guide.

(a) The Method of evaluation of the project work shall be evolved by the DPGC.

(b) A candidate shall submit 3 copies of the Summer Internship Project Work to Chairman, DPGC, on or before the specified date. The dissertation shall be in the format prescribed by the Institute.

(c) The final evaluation is done at the end of third semester by a Project Work Evaluation Committee (PWEC) constituted by the DPGC. There shall be an open seminar followed by a viva-voce examination as part of the final evaluation. After the final evaluation, appropriate double-letter grade is awarded, which will not however be considered for SGPA and CGPA calculations.

(d) If in the opinion of the PWEC, the Project Report is acceptable with minor modifications for the passing grade 'DD', the PWEC shall value and instruct the candidate suitable to incorporate the necessary modifications and to resubmit it to the Chairman, PWEC.

(e) The title of the Summer Internship Project Report shall be indicated in the Student Progress Report

2.5 Term Paper

The Term paper shall be undertaken by each student during the fourth semester and carries 3 credits. Each student will be attached to a faculty who would guide the student to take up a topic for self –study on any emerging area of interest related to the program.

(a) The method of evaluation shall be evolved by the DPGC.

(b) There shall be an open seminar followed by a viva -voce examination conducted by the concerned Faculty in-charge of the term paper for each student, as part of the final evaluation.

(c) After the final evaluation, appropriate double –letter grade is awarded, which will not however be considered for SGPA and CGPA calculations.

3. DEGREE REQUIREMENTS:

3.1 The degree requirements of a student for the M.B.A. programme are as follows:

(a) ***Institute Requirements:***
(i) Minimum Earned Credit Requirement for Degree is 90.
(ii) Securing a CGPA of at least 5.50 in the Course Work.

(b) ***Programme Requirements:***
Minimum Earned Credit Requirements on all Foundation Courses, Functional Courses, Elective Courses, Term Paper, MLC and Summer Internship Project as specified by the DPGC and conforming to Clause No: 2 (Course Structure).

(c) The Maximum duration for a student for complying to the Degree Requirement from the date of registration for his first semester, is FOUR years.

4. TERMINATION FROM THE PROGRAMME:

A student shall be required to leave the Institute without the award of the Degree, under the following circumstances:

(a) If a student fails to earn the minimum credit specified below:

Check Point	Credit Threshold
End of FIRST year	25
End of SECOND year	50

Note: The period of temporary withdrawal is not to be counted for the above Credit Threshold.

(b) If a student is absent for more than 6 (Six) weeks in a semester without sanctioned leave.

(c) Based on disciplinary action suggested by the Senate, on the recommendation of the appropriate committee.

(d) Fails to get the minimum cutoff CGPA of at least 5.50 in the Course Work

NOTE: Under any circumstances of termination, the conditions specified in Permanent Withdrawal (refer: Clause No: G10.2) shall also apply.

5. COMMITTEES / FUNCTIONARIES:

The following committees shall be constituted for the Post Graduate Degree programme:

5.1 Board of Studies (BOS-PG):
(Same as BOS-PG mentioned in M.Tech regulations)

5.2 Departmental Post Graduate Committee (DPGC):
(Same as DPGC mentioned in M.Tech regulations)

5.3 Project Work Evaluation Committee (PWEC)

Constitution:

(a)	Chairman of DPGC or his nominee	…	Chairman
(b)	Project Guide(s)	…	Member(s)
(c)	One referee from outside the Department,		

selected by the DPGC … Member

Note:

- There shall be one PWEC for each MBA project work.
- One external guide/referee, if any, invited as a member of PWEC, is entitled for TA/DA as per the Institute Rules.

Functions (Highlights):

i. To evaluate the MBA project work and to award an appropriate letter grade. The chairman of PWEC shall submit the report, signed by all the members of the PWEC, to DPGC. The DPGC Chairman shall forward this report to the Academic Section of the Dean (A) without moderation.

5.4 Project Guide:

Functions (Highlights):

i. He will help the student under him in selecting the Project topic.

ii. He shall monitor the progress of the student working under him.

iii. He shall report to the DPGC the performance of the student from time to time.

iv. He will coordinate with the HOD/DPGC to arrange for facilities to carry out the project work.

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REGULATIONS

SPECIFIC TO

DOCTORAL RESEARCH PROGRAMME

Ph.D. Degree

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Post : Srinivasnagar, Mangalore - 575025, India.
- 2017-

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REGULATIONS
specific to
Ph.D. Degree Programme

{also refer: REGULATIONS (General) – Common to all Degree Programmes}

1. DEGREE PROGRAMMES:

1.1 Doctoral (Ph.D.) Degree Programmes are offered in the various departments/disciplines/ programmes as listed below:

a) Department of Civil Engineering
b) Department of Applied Mechanics and Hydraulics
c) Department of Mechanical Engineering
d) Department of Electrical and Electronics Engineering
e) Department of Electronics and Communication Engineering
f) Department of Computer Engineering
g) Department of Chemical Engineering
h) Department of Metallurgical & Materials Engineering
i) Department of Mining Engineering
j) Department of Information Technology
k) Department of Mathematical & Computational Sciences
l) Department of Physics
m) Department of Chemistry
n) Department of Humanities, Social Sciences and Management

1.2 The provisions contained in these Regulations shall be applicable to any new Doctoral Research Programmes, either by any of the departments, or even possibly as inter (multi)disciplinary programmes, that may be introduced from time to time.

2. ADMISSION:

2.1 ***Student Status***: There are five types of student status in the Ph.D Degree Programme:

(a) Full-time student on Institute Scholarship
(b) Full-time sponsored student on QIP (AICTE)
(c) Full-time/External Registrant - sponsored student from Industry or other Organizations including Educational Institutions
(d) Full-time/External Registrant- non-sponsored, non-scholarship student
(e) Internal Registrant - sponsored Institute or Project staff of NITK

Note:

i. The full-time candidates are the registrants who work on full-time basis at the Institute. The external registrants are the candidates who register at the Institute but do research outside the Institute. The internal registrants are the Institute faculty/staff who work on part-time basis at the Institute.

ii. ***Duration:*** The duration of study shall be a minimum of TWO years and a maximum of SEVEN years for all categories of research scholars. Any student who concurrently registers for any postgraduate/research degree at another organization shall be automatically de-registered at the Institute. Also, a student, who has completed four years shall apply for extension of registration, in the prescribed format, every year till the submission of his thesis.

iii. A student of type (a) will receive Institute scholarship for a maximum duration of FOUR years of the Ph.D. programme, subjected to scholarship rules of the Institute.

iv. Student of the type (c) shall be sponsored and financed by the sponsoring organization. He should produce a sponsorship-cum-clearance certificate in the given format of the Institute.

v. A non-sponsored non-scholarship (self-financed) student of type (d) will not receive any financial assistance from the Institute.

vi. An internal student of type (e) shall produce a sponsorship-cum-clearance certificate from the Director, NITK. They may be converted to Full-time research scholars after the completion of the project with the recommendation from the respective DRPC.

vii. The status of research scholar should be maintained the same throughout the program. However, change of status from full-time to internal registration may be considered based on the recommendations of DRPC on a case to case basis. In general, the conversion from internal/external registration to full time will not be permitted.

viii. No student can receive scholarship/ fellowship from more than one source.

2.2 Admission to a Ph.D. Programme shall be open to candidates who passed the prescribed qualifying degree examination in relevant field with a Cumulative Grade Point Average (CGPA) of at least 6.0 in the 0-10 scale grading system, or not less than 60% marks in the aggregate (taking into account the marks scored in all the subjects of all the public/ university examinations conducted during the entire prescribed period for the degree programme). However, this prescribed minimum shall be a CGPA of 5.5 or 55% marks in the aggregate for SC/ST/PWD candidates.

2.3 As per UGC norms, students of type (a) must have passed GATE/ UGC-CSIR exam/ DAE-JEST/ or an exam conducted by the Institute to be admitted to Ph.D. Programme.

2.4 A limited number of admissions is offered to Foreign Nationals and Indians Living Abroad in accordance with the rules applicable for such admission issued from time to time by MHRD.

2.5 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., this matter shall be reported to the Senate, recommending revoking the admission of the candidate.

2.6 Candidates have to fulfil the medical standards required for admission as prescribed in the information bulletin.

2.7 The Institute reserves the right to cancel the admissions of any student and ask him to discontinue his studies at any stage of his career on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.

2.8 The decision of the Senate regarding the admissions is final and binding.

2.9 Every Ph.D. student/scholar of the Institute shall be associated with *Parent Department*, offering the degree programme that the student undergoes (or the department that his Research Guide belongs to), throughout his study period.

3. PROGRAMME STRUCTURE:

3.1 The Ph.D. Degree Programme Structure consists of the following stages:

(i) Ph.D. Course Work and Evaluation;
(ii) MLC: HU800 Research methodology
(iii) Research Proposal Submission and Assessment;
(iv) Research Progress Assessment;
(v) Pre-Synopsis Seminar and Synopsis Submission;
(vi) Ph.D. Thesis Submission and Assessment.

3.2 **The Minimum Course Credit Requirement is 12.**
(courses carrying 'S'/'N' grades shall not be counted).

Out of 12 credits required, only one self study course (900 level) with a maximum of 4 credits is permitted with the recommendation by the DRPC of the respective departments and approved by Dean (A).

3.3 The course work must be completed within the first TWO years, with a minimum CGPA of 5.50**.**

3.4 A minimum of one semester (preferably first semester) residential requirement is to be completed by all the external registrants during the completion of course credit requirements**.** However, the duration and the number of visits to the Institute after the course completion shall be decided by the Research Guide.

3.5 Every research scholar is required to undergo registration at the commencement of each semester on the days fixed for such registration and notified in the academic calendar.

4. RESEARCH GUIDE:

4.1 In each Department, applicants will be given at the time of selection the details of research areas proposed by various faculty members for Ph.D. programmes so that they will have an opportunity to discuss those areas with the respective faculty members and thereafter, indicate their choice in order of preference. The applicants shall then be interviewed by a committee constituted by the DRPC.

4.2 The faculty of the Institute who are appointed on permanent basis may be approved as Research Guide if they have Ph.D. degree or as and when they acquire Ph.D. A formal request in this regard may be made in the specified format for the approval of Dean (A) and the matter may be placed as reporting item in the BOS.

4.3 One Research Guide, selected among the faculty of the Department in which he has registered, shall be allotted to each Research scholar by the HOD of the parent department on the recommendations of DRPC at the time of admission. If the faculty is reaching superannuation and has less than 3 years of service in the Institute, an additional Research Guide from the parent department should also be assigned.

4.4 Depending on the research requirements, an additional faculty member or possibly an expert from outside the Department / Institute may be considered as a second Guide (additional-Guide). However, the *main* Research Guide shall be from within the *parent department*. In the case of external person applying for inclusion as an additional Research Guide for a specific research scholar, the application shall be scrutinized and approved by the BOS in order for a person to be recognized as an additional Research Guide. The list of approved guides will be reported to Senate.

4.5 The inclusion of additional guide is allowed till the submission of the research proposal seminar.

4.6 In case the Research guide is going to be away from the Institute for a period of more than one year then an additional guide from the Parent Department need to be identified and approved prior to leaving.

4.7 Change of Research Guide(s) under exceptional circumstances shall be permitted on recommendation of the DRPC after obtaining the consent of (i) the Research Scholar (ii) the present Guide(s) and (iii) the proposed Guide(s).

4.8 At any given time the number of Research Students/Scholars registered with a Research Guide shall not exceed FIVE(Excluding the numbers of students registered with the Guide in the case of funded projects). In this regard, being a co-guide for two Full-Time Research Scholars or being the sole Research Guide for two External/Internal Registrants (Research Scholars), is equivalent to being the sole Research Guide for one Research Scholar.

5. EVALUATION SYSTEM:

5.1 **Ph.D. Course Work Evaluation**

The Ph.D. course work evaluation shall be similar to that of other courses, and the details are given in the corresponding section in the Regulations (General) Common to all Post Graduate Degree Programmes (refer: Section G5).

5.2 **Research Proposal Submission and Assessment**

Every PhD student is required to submit his research proposal in the prescribed format, within 18 months after joining for the program. Chairman Senate is authorized to condone the delay upto 2 years. Beyond 2 years, approval by Senate is required up to two and a half years . If the delay is beyond two and a half years the registration is liable to be terminated. The Ph.D Research proposal must contain details including literature survey, problem identification, state of the art technology, plan of Research work, etc.. The RPAC will assess the proposal through an open seminar and communicate the recommendation along with detailed report for approval or otherwise to the Dean (A) through DRPC.

5.3 **Research Progress Assessment**

5.3.1 After the approval of Research Proposal, yearly assessments are made, through open seminars, to ensure satisfactory progress. The Research Scholar shall submit, through his Guide(s), a progress report of his research to the concerned RPAC every year. The progress seminars are to be presented within the first one month of every academic year as applicable to the scholar. Beyond four years the scholars are required to give half yearly progress seminars, (within the first month of every semester). In case of possible delay, prior permission should be obtained from Dean(A) at least 15 days before the due date. The RPAC will communicate to the DRPC a detailed report about the progress The DRPC will forward the RPAC Report to the Deputy Registrar (Academic) for filing in the appropriate records. Only those cases which require further action may be brought to the attention of the Dean (A) and/or the Director. If the research scholars fail to fulfill the above requirements, the registration is liable to be terminated.

5.3.2 (a) The continuance of registration of all research scholars is subject to satisfactory progress made by them. The progress seminars are to presented as per 5.3.1

(b) Ph.D registration is valid up to four years from the date of joining. Beyond four years, candidates should seek extension of registration by applying in the specific format within the stipulated date. Extension will be granted on yearly basis. The registration is liable to be terminated if the research scholars fail to obtain extension of registration

(c) For granting extension the following conditions must be fulfilled:

(i) For extension beyond 4 years – satisfactory progress (through a seminar) during the previous period and two conference papers.

(ii) For extension beyond 5 years –two half yearly progress seminars along with one journals publication and /or conference paper in the fifth year.

(iii) For extension beyond 6 years –two half yearly progress seminars along with one journals publication and /or conference paper in the sixth year.

5.3.3 Prior to Pre-synopsis seminar, the scholar is required to give at least TWO satisfactory Research Progress Assessment Seminars on the topic of his research, and have at least one paper published or accepted for publications preferably in a refereed journal or in a conference proceedings.

5.4 Pre-Synopsis Seminar and Synopsis Submission

5.4.1 Prior to the submission of the Synopsis of the Thesis, a comprehensive internal assessment of the research work should be made by RPAC by a Pre-Synopsis Seminar. The candidate can submit the Synopsis only if RPAC is satisfied about the quality of the work for submission as a Ph.D. Thesis.

5.4.2 Details of the Pre-Synopsis Seminar shall be notified well in advance, so as to enable interested staff members and students to attend the same.

5.4.3 The Chairman of the DRPC shall forward the RPAC's assessment report on the Pre-Synopsis Seminar to the Director.

5.4.4 ONE printed copy and ONE soft copy (PDF format) of the synopsis shall be submitted to the Dean(A) through Chairman of the DRPC, in the prescribed format consisting of maximum of 15 pages including bibliography of research work, with the following certificates

(a) Certificate from the Chairman, DRPC that the Pre-Synopsis Seminar has been completed satisfactorily.

(b) Declaration from the Research Scholar in a prescribed proforma, stating:

i. Bonafide nature of the work;
ii. that the thesis does not contain any work which has been previously submitted for the award of any degree, and
iii. the extent of collaboration, if any.

(c) Details of the courses studied (for all categories of research scholars) and also certificates with regard to the residential clause from the guide and Head of the Department (for external registrants).

5.4.5(a) Institute Scholars may be permitted to submit the thesis from outside only after submission of synopsis on recommendation of DRPC and approval by the Dean(A)

(b) QIP Scholars may be permitted to leave the Institute after 3 years and to submit the synopsis and thesis from outside, on recommendation of RPAC, DRPC and approval by Dean (A)

5.5 Ph.D. Thesis Submission and Assessment

5.5.1 Prior to the thesis submission, the scholar should have preferably two but at least one paper published or accepted for publication in a refereed journal.

5.5.2 THREE printed copies (soft-bound) and ONE soft copy (PDF format) of the thesis shall be submitted to the Dean(A), through Chairman of the DRPC, in the prescribed format, not later than three months from the date of submission of the Synopsis

(i) if the thesis is submitted after 3 months of submission of Synopsis, approval of the Chairman Senate is necessary for submission up to 6 months. However, a prescribed fine is to be paid by the scholar.

(ii) If the thesis is not submitted within six months after submitting the synopsis, the registration is liable be terminated.

5.5.3 Along with the Thesis, the Research Scholar shall submit the requisite forms containing the authorization from the Research Guide(s) for submission of the Thesis and a certificate from Accounts Section that there are no dues against the Scholar and the details on research publications.

5.5.4 The Ph.D. Thesis submitted by the scholar will be evaluated by DTAC constituted by Director by selecting two external referees (one will be invited for defense also) from the Panel submitted by DRPC.

5.5.5 The referees shall independently report to the Dean (A), preferably within six weeks from the date of their receipt of the Thesis. The referees will be requested to indicate their decision in a specific evaluation format supplied by the Institute and that their reports should include -

i. a critical survey and evaluation of the quality and quantity of the work as embodied in the thesis.

ii. questions, if any, to be asked or points to be clarified at the viva-voce examination, and

iii. a definite recommendation as to whether the Thesis is acceptable for the award of the degree of 'Doctor of Philosophy'.

5.5.6 If a referee in his report is not in a position to make a definite recommendation for the award of the degree, he should be requested to assist in deciding whether the candidate is required to make:

i. Substantial revisions involving rewriting of one or more chapters without, however, doing any further Research work.

ii. completely rewrite the thesis if the thesis, though not acceptable, in the present form, reveals sufficient quality and quantity of work to warrant the candidate being given an opportunity for further Research work and/ or reinterpretation of results.

5.5.7 The copies of the referees' reports when received shall be confidentially made available to the Research Guide(s) through Chairman, DRPC. The Research Guide(s) shall send comments on these reports through DRPC for consideration by the Dean (A).

5.5.8 On the basis of the referees' reports and the Research Guide(s)' comments thereon, the Dean (A) will decide whether the Thesis be accepted for the viva-voce examination, or be referred again to a new referee.

5.5.9 A thesis may be considered acceptable for holding the viva-voce examination if both the referees give positive recommendations. If one of them accepts and the other rejects; the Thesis as it is, shall be referred to a third referee chosen from the Panel of Referees by the Director.

5.5.10 Whenever a Thesis is referred to a third referee, the comments of the Research Guide point by point for the queries by the first two referees should also be reported to the Dean (A) along with the comments for the queries by the third referee.

5.5.11 If the referees recommend acceptance of the thesis subject to minor modifications only, the thesis can be resubmitted after incorporating the modifications in the light of the referees' comments, within a period of six months. The Thesis so resubmitted be preferably examined by the same referees. However ,a prescribed fine is to be paid by the scholar if the thesis is resubmitted after 6 months but within one year. If the thesis is not resubmitted within one year the registration is liable to be terminated.

5.5.12 A Thesis rejected by two referees may be re-submitted after revision, incorporating the required modifications and/or alterations and/or additions etc., in the light of the referees' comments. Such resubmission shall be made not earlier than three months and not later than one year from the date of such intimation to the Research Scholar by the Dean (A). The Thesis so resubmitted may be examined either by the same referees or by new referees.

5.5.13 Rejection of the thesis so resubmitted will disqualify the candidate from further consideration for the award of the Ph.D. degree, in the topic of research chosen by him.

5.5.14 A candidate, whose thesis has been recommended for the award of the Ph.D. degree, shall be required to defend his Thesis at an open viva-voce examination conducted by the DTAC. After satisfactory defense of the work, the DTAC will recommend the approval of thesis to the Director through DRPC for further action towards the award of the Ph.D. degree.

5.5.15 The DTAC shall submit its report in the prescribed form to the Director within ONE month after the completion of viva-voce exam. It is the responsibility of the Research Guide to see that all the necessary corrections are incorporated in the final version of the thesis before sending the DTAC report to the Director.

5.5.16 After satisfactory completion of the viva-voce examination, the degree may be conferred after approval by the Senate.

5.5.17 If a Thesis has been accepted but the candidate fails at the viva-voce examination, he may be permitted by the Director to re-appear for viva-voce examination again at a later date. The Recommendations of the DTAC conducting the viva-voce examination shall be considered by DRPC in taking a decision in this respect.

5.5.18 After successful completion of the viva-voce examination, the candidate shall submit to the DRPC the prescribed number of copies (one hard copy and a CD) of his approved Thesis (incorporating all the necessary corrections) in the prescribed format.

5.5.19 The abstracts of evaluation reports of PhD theses will be placed before the Senate as reporting item. The full original reports of all examiners will be placed before the Senate only in those cases of rejection by one of the examiners.

6. SCHOLARSHIP AND PAYMENT OF FEES:

6.1 The Institute Research Scholars will be paid scholarship at a rate in accordance with the directives from the appropriate authorities.

6.2 In case of institute scholarship holders, the continuance of scholarship beyond two years will be subject to satisfactory progress made by them as assessed by the pertinent RPAC and approved by DRPC

6.3 The PhD Research Scholars receiving scholarship or any other type of financial aid shall abide by the Scholarship Rules and/or other applicable Rules.

6.4 The Research Scholars need to pay the Institute fees till the submission of the Thesis.

7. DEGREE REQUIREMENTS:

The degree requirements of a scholar for the Ph.D Degree Programme are as follows:

7.1 Institute Requirements:

(i) Minimum Earned Credit in the Ph.D. Course Work of 12, with a minimum CGPA of 5.50, completed within the first TWO years (refer: Programme Structure, Clause No: 3.2 & 3.3 above).

(ii) Institute Residential Requirement (refer: Programme Structure, Clause No: 3.4 above).

(iii) Satisfactory completion of all the SIX stages of the Programme (refer: Programme Structure, Clause No: 3.1 above).

(iv) Satisfactory Defense of Thesis.

7.2 The Maximum duration for a student for complying to the degree requirement is SEVEN years from date of registration for his first semester for the Research Scholars of all categories.

8. TERMINATION FROM THE PROGRAMME:

A student shall be required to leave the Doctoral degree programme under following circumstances:

(a) If the student is absent for more than SIX (6) weeks in a semester without sanctioned leave

(b) Student fails to submit satisfactory Research Proposal within two and a half years of joining the programme.

(c) Student fails to give the research progress seminars within the stipulated time

(d) Student fails to register for each academic semester within the date specified

(e) The Research scholar fails to obtain extension of registration

(f) If the thesis is not submitted within six months after submitting the synopsis

(g) If the Thesis is asked for re-submission and not submitted within one year after asking for resubmission

(h) If the Ph.D Thesis has not been accepted after TWO submissions

(i) At the end of seven years of registration.

(j) Based on Disciplinary action, on recommendation by the appropriate committee.

NOTE: Under any circumstances of termination, the conditions specified in Permanent Withdrawal (refer: Clause No: G10.2) shall also apply.

9. COMMITTEES / FUNCTIONARIES:

The following committees shall be constituted for the Doctoral Research Degree programme:

9.1 Board of Studies (BOS-Research):

Constitution:

(a)	Dean (A)	…	*Chairman*
(b)	Dean (FW)	…	Member
(c)	Dean (P&D)	…	Member

(d)	Dean (R&C)	…	Member
(e)	Dean (SW)	…	Member
(f)	Dean(AA&IR)	…	Member
(g)	H.O.D of each department/his nominee	…	Member
(h)	BOG members representing the faculty	…	Member
(i)	Asst.. Registrar (Academic)	…	*Convenor*
(j)	Dy. Registrar (Academic)	…	*Secretary*
(k)	TWO External Experts	…	Members

Note:

- There shall be one BOS - Research for the entire Institute.
- The Chairman may co-opt and/or invite more members including outside experts.
- The quorum of each meeting will be *NINE*.

Functions (Highlights):

i. To frame and revise curricula for the courses of study.

ii. To consider the recommendations of the DRPC on matters relating to Ph.D. programme and to make suitable recommendations to the Senate.

iii. To ensure that all norms and Regulations pertaining to Ph.D. Programme are strictly followed.

iv. To make periodic review of ordinances, Regulations and instructions pertaining to Ph.D. Programme and to recommend to the Senate any modification thereof.

v. To scrutinize the Bio-data of the intending Research Guides and to recommend issue of registration letters to the competent persons.

vi. To recommend to the Senate, the award of stipends, scholarships, medals and prizes etc.

vii. To draw up general time table for the Ph.D. programme and finalise the Academic Calendar to be put up to the Senate for approval.

viii. To consider the cases of malpractice in examinations and to recommend to the Director the punishment for such cases.

ix. To conduct at least one meeting each semester and send the Resolutions to the Chairman of the Senate, and also to maintain a record of the same in the office of Dean (A).

x. Any appropriate responsibility or function assigned by the Senate or the Chairman of the Senate.

9.2 Doctoral Research Programme Committee (DRPC):

Constitution:

(a)	H.O.D. / Programme Co-ordinator or a Professor nominated by the Director	…	Chairman
(b)	All approved Ph.D. Guides associated with the Research Programme	…	Members

Note:

- There shall be one DRPC for every department that is involved in the Ph.D. degree programme, or for every inter (multi) disciplinary doctoral research programme.
- The Secretary (DRPC) shall be nominated by the Chairman on rotation basis for a period of one year.
- The Chairman may co-opt/invite more members including a maximum of three outside experts.
- The quorum for each meeting shall be THREE.

Functions (Highlights):

i. To monitor the conduct of all courses of the department for the PhD programme.

ii. To ensure academic standard and excellence of the courses offered by the department.

iii. To obtain the evaluation of each student in a course separately for Course Instructor's assessment, mid-semester tests and end-semester tests.

iv. To consolidate the grades of the students registered for various courses offered by the Department and submitted by the different Course instructors. The CGPA for each scholar should be computed up to the end of PhD Course Work and sent to the Academic Section of the Dean (A).

v. To take appropriate actions based on communication of RPAC and DTAC.

vi. To recommend the Panel of Members, as proposed by the Guide, for the formation of RPAC (three within Department, three outside the Department) to the Dean (A) for approval.

vii. To recommend the Panel of Referees in consultation with the Guide for formation of DTAC (TEN Referees, with FIVE drawn from India and FIVE from abroad) to the Director for approval, immediately after the acceptance of the RPAC's report on the Pre-Synopsis Seminar and along with the submission of the Synopsis to the Director.

viii. To consider any matter related to the Research programme of the department.

ix. To conduct at least two meetings each semester and send the proceedings of the meeting to Dean(A).

x. To maintain a separate register to record the minutes of all the meetings.

9.3 Research Progress Assessment Committee (RPAC):

Constitution:

(a)	Guide	….	Chairman
(b)	Additional -Guide (if any)	….	Member
(c)	At least One Faculty from the parent department of Ph.D Scholar ,selected by Dean (A), from the recommended panel.	….	Member
(d)	At least One Faculty from outside the parent department of the, Guides selected by Dean (A), from the recommended panel.	….	Member

Note:

- There shall be one RPAC for each Ph.D. scholar.
- The RPAC shall be constituted by the Dean (A) based on the recommendation of DRPC.
- Under special circumstances, members from outside the Institute may be co-opted with the prior approval of Dean (A).

Functions (Highlights)

(i) To assess and approve the Research Proposal and Synopsis.

(ii) To communicate the yearly assessment reports about the progress of the research work to DRPC.

(iii) To assess the Pre-Synopsis Seminar and communicate the results to the Director through the DRPC.

9.4 Doctoral Thesis Assessment Committee (DTAC):

Constitution:

(a)	Chairman DRPC or a Professor nominated by the Director on recommendation of DRPC	…	Chairman
(b)	Guide(s)	…	Member(s)
(c)	At least One Faculty from within the parent department of Ph.D scholar, selected by Dean (A)from the recommended panel.	…	Member
(d)	At least One Faculty from outside the parent department of the guides(s), selected by Dean(A) from the recommended panel	…	Member
(e)	Two External Referees	…	Members
(f)	RPAC Members	…	Invited Members

Note:

- There shall be one DTAC for each Ph.D. scholar.
- The DTAC shall be constituted by the Director when the scholar submits the PhD Thesis for assessment.
- The two external referees shall be selected by the Director, from a panel of TEN referees (Five from India and Five from abroad). These TWO External Referees will be requested for an assessment of the PhD Thesis, and one of these Referees will be invited for the final *Thesis Defense and Viva-Voce Examination*.

Functions (Highlights):

(i) The two external referees will evaluate the Doctoral Thesis and send the report to Director.

(ii) DTAC will evaluate the research work and the Doctoral Thesis, based on the defense of the Thesis through an open seminar and viva-voce examination and send the report to Director through DRPC

9.5 Research Guide:

Functions (Highlights):

i. He will guide the student to select a topic for research.

ii. He will suggest the courses for doctoral course work.

iii. He will monitor the progress of the student / scholar.

iv. He will suggest a Panel of Referees to the DRPC for RPAC and DTAC.

v. He will approve and forward all the applications of the student/scholar.

vi. He will provide or arrange for facilities to carry out research.

vii. In the event of leaving the Institute or away from the institute for a considerable period, he has to arrange for a Change of Research Guide as per Clause No: 4.5 above.

* * * * *

FORMS & FORMATS

Post Graduate and Research Programmes

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
Mangalore - 575025, India.
- 2017–

CONTENTS

COURSE REGISTRATION FORM
(Instructor Copy)

Course Code: Course Title: L.T.P: Credits:

Course Instructor(s): Teaching Dept.:

Sl. No.	Register No.	Name of the student	Semester	Branch	Signature	D/U/cU/W
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

D: Drop U: Audit cU: Credit-Audit Conversion W: Withdrawal

Note: The last column to be filled only if a student opts to drop / audit / credit-Audit conversion or withdrawal of the course.

Name & Signature of Course Instructor(s)
date

Name & Signature of HOD with
with date & Dept. seal

COURSE REGISTRATION FORM (FACULTY ADVISOR COPY)

Name of Faculty Advisor: **Dept.** **Semester:**

Sl. No.	Register No.	Name of the student	Course Number and Credits (Ex: CV372(3))										Signature
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
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16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

A: ADD D: DROP* U: Audit* cU: Credit-Audit Conversion* W: Withdrawal*

* Use separate card/s to enter D-U-cU-W options

Name & Signature of Faculty Advisor
Date:

Name & Signature of HOD
with Dept. Seal

COURSE REGISTRATION FORM [#]
(Student Copy)

Reg. No.: Dept.: Semester & Programme:

Name of the student: Fee Receipt No:

Sl. No.	Course No.	Course Title	Credits	Course Instructor's Name	Signature of Instructor
1					
2					
3					
4					
5					
6					
7					
8					

Signature of Student [*] Signature of Faculty Advisor [*] Signature of HOD [*]

Date: with seal

D / U / cU / W – Options

Sl. No.	Course No.	Course Title	Credits	D/U/cU/W	Signature of Faculty Adviser	Signature of Instructor
1						
2						
3						
4						
5						
6						
7						
8						

D: Drop U: Audit cU: Credit-Audit Conversion W: Withdrawal

Signature of Student [**] Signature of Faculty Advisor [**] Signature of HOD [**]

with seal

[#] It is mandatory for a student to preserve this card as a proof of his / her registration till the end of the programme.

[*] To be signed by the student as soon as he/she completes the registration of all the courses and by the faculty advisor, the HOD after the last day of late registration announced in the academic calendar.

[**] To be signed by the student, faculty advisor and the HOD at the end of each semester after verifying the options exercised by the student and to be returned to the student at the end of the semester.

Faculty Advisor has to ensure that the entries in the Faculty Advisor Copy, Course Instructor Copy, and Student Copy are matching.

STUDENT'S LEAVE APPLICATION

Name of the Student :

Reg. No./Admission-No./Roll-No.:

Programme / Branch / Semester / Class :

Period of Absence : From: To:

: Number-of-days of Leave =

Reason for Leave-of-Absence :

Supporting Documents Attached :

Signature of Student :

Number of days of Leave : already-availed | being-applied-now | still-available(un-availed)

Forwarded by Faculty Advisor :

Remarks by Chairman (DUGC/DPGC/DRPC) :

Recommendation : **Approval / No-approval**

Signature of the **Recommending Authority** :
with Date :

Decision : **Approved / No-approved**

Signature of the **Approving Authority** :
with Date :

NOTE:

(i) Chairman DPGC/DRPC can approve the leave up to 14 days.

(ii) If the leave is for more than 14 days, the leave application shall be forwarded to Dean (Academic) for approval.

Course Evaluation Form for Lecture Courses

PURPOSE: The objective of this feedback is to collect information for assessing and improving the course and the instructor's teaching effectiveness

Course Code: Course Title:

Type of Course: Core / Elective Class Size:

Academic Year: Semester & Programme:

Department: Instructor's Name:

(Mark ' √ ' in the appropriate box)

RATINGS						
5 - Strongly agree **4** - Agree **3** - Neither agree nor disagree **2** - Disagree **1**- Strongly disagree						
COURSE		5	4	3	2	1
1	The course plan provided sufficient information on the objectives and contents					
2	The distribution of marks (for tests, assignments, tutorials and exams) was clearly stated in the course plan					
3	I found the course materials (class notes, handouts, prescribed text books) useful					
4	The assignments, tutorials, quizzes etc. helped me to understand the course					
5	The tests and examinations covered to a large extent what was taught in the class					
6	I was satisfied with the course coverage					
7	The evaluation was fair and transparent					
8	The course helped me to acquire knowledge and skills					
9	This course motivated me to learn more					
10	Overall, the course was satisfactory					
INSTRUCTOR						
1	The instructor was generally well prepared for the classes					
2	The instructor presented the contents effectively					
3	The instructor generated interest in the subject					
4	The instructor delivered the lectures at an appropriate pace					
5	The instructor made use of appropriate teaching aids and methods					
6	The instructor encouraged students participation and interaction in the class					
7	The instructor provided timely and effective feedback regarding the assignments/tests/exams					
8	The instructor was available outside class hours for consultation					
9	The instructor was regular to the class					
10	Overall, the instructor was effective in his/her role as a teacher					

SUGGESTIONS / COMMENTS: Please turn over

Note: This course feedback form to be collected by any faculty member other than the course instructor and to be handed over to the concerned course instructor.
Please write below your suggestions/comments if any to improve the teaching-learning process:

Course Evaluation Form for Practical Courses

PURPOSE: The objective of this feedback is to collect information for assessing and improving the course and the instructor's teaching effectiveness

Course Code: Course Title:

Type of Course: Core / Elective Class Size:

Academic Year: Semester & Programme:

Department: Instructor's Name:

(Mark ' √ ' in the appropriate box)

RATINGS						
5 - Strongly agree **4** - Agree **3** - Neither agree nor disagree **2** - Disagree **1**- Strongly disagree						
LAB/PRACTICAL SESSIONS		5	4	3	2	1
1	The practical sessions/Experiments provided me an opportunity to understand the subject					
2	Handouts/laboratory manuals were available in advance					
3	Clear instructions to carry out the practical/Experiments were given in advance					
4	I was thoroughly prepared for all the practical/lab sessions					
5	The assistance given during the practical sessions was useful					
6	I was regular in submitting all my lab/practical reports					
7	The instructor's feedback on my report was prompt					
8	The instructor's feedback on my report was useful					
9	The evaluation was fair and transparent					
10	Overall, the lab/practical course was satisfactory					

SUGGESTIONS / COMMENTS: Please write below your suggestions/comments if any to improve the conduct of this lab/practical course

Note: This course feedback form to be collected by any faculty member other than the course instructor and to be handed over to the concerned course instructor.

SUMMARY REPORT OF MARKS and GRADES

Semester/Session & Year :

Course Number : Course Title : (L-T-P) Credits:

Name of the Instructor: Department:

CLASS PERFORMANCE DISTRIBUTION STATISTICS

Class – Size (No. of students) =
Class – Max. Mark (Xmax) =
Class - Min. Marks (Xmin) =
Class – Mean Marks (μ) =
Standard – Deviation (σ) =

A detailed **Histogram** of the Raw-Scores data is attached.

Grades	Cutoff Marks %		Number of Students
AA	=>		
AB	=>		
BB	=>		
BC	=>		
CC	=>		
CD	=>		
DD	=>		
FF	<=		
FA	**Attendance less than 75%**		

Course-Instructor(s)
Name & Signature with Date

Secretary-DPGC/DRPC
Name & Signature with Date

Chairman-DPGC/DRPC
Signature with Date & Dept-Seal

REPORT of MARKS and GRADES

Semester/Session & Year :

Course Number : Course Title : (L-T-P) Credits :

Course Category : BSc / Esc / HSc / Pc / Ele / MP / MLC / ?

Name of the Instructor : Department :

SL.No.	Reg. No.	Name	%Marks	Letter-Grade
1.				
2.				
3				
4.				
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30.				

BSc: Basic Science Core; **ESc:** Engineering Science Core; **HSc:** Humanities & Social Sciences Core;
Pc: Programme Core; **Ele:** Elective; **MP:** Major Project; **MLC:** Mandatory Learning Course

==========

Course-Instructor(s)
Name & Signature
with Date

Secretary-DPGC/DRPC
Name & Signature
with Date

Chairman-DPGC/DRPC
Signature with Date
& Dept-Seal

Permission to Carry out the M.Tech Project work outside the Institution

1	Name and Reg. No. of the student	
2	Department and Discipline	
3	Place where the work is planned to be carried out (attach copy of the offer letter)	
4	Duration (attach copy of the offer letter)	From (dd/mm/yyyy) To(dd/mm/yyyy)
5	Title of the project work(attach copy of the offer letter)	
6	Name and designation of the Guide from outside Institute	
7	Name and designation of the Guide from NITK	
8	Whether any financial assistance is received from the outside organization ? If yes, specify the nature and amount	

Signature of the **student** with date

Signature of the **Internal Guide** with date

Signature of **Chairman DPGC** with date

Permitted with GATE scholarship / Permitted without GATE scholarship / Not Permitted

*Note: A monthly attendance report of the student should be obtained duly signed by the **External Guide** with the seal and to be submitted to the Academic Office along with the signatures of the **Internal Guide** and **HoD**.*

Dean (Academic)

Panel Submission Form for constitution of PWEC

[DPGC → Dean (A)]

Department :

Programme : *MTech / MCA. / MSc / MBA*

Specialisation:

Sl. No.	Name and Reg. No. of the student	PWEC Chairperson	PWEC Members
1.			(a) Guide: (b)
2.			(a) Guide: (b)
3.			(a) Guide: (b)
4.			(a) Guide: (b)
5.			(a) Guide: (b)

(Please note that the Chairperson of PWEC shall be different from the Project Guide)

Secretary-DPGC
Name & Signature, with Date

Chairman-DPGC
Name & Signature, Date & Seal

[*Approval*]

Dean (Academic)

Request for Extension of Last Date for Submission of P.G. Project-Report / Thesis

[Student → Guide → DPGC Chairperson → Dean (A)]

Part I [To be filled-in by the Student]

Name: **Register No. :**

Date of Joining:

Department & Programme:

Name of Guide:

The last date currently specified:

Reasons for requesting the extension of time for submitting the project report/thesis:

Expected date of submission:

Declaration: I agree to pay the applicable fees for late submission as per the Institute Rules (semester fees as applicable to the degree programme).

Signature of the Student, with Date:

Part II [To be filled-in by the Guide]

Comments by the Guide:

Name: Signature: Date:

Part III [To be filled-in by the DPGC Chairperson]

Recommended / not-Recommended for extension of date for Report/Thesis submission.

Chairperson-DPGC
(Name & Signature, Date & Seal)

Part IV [To be filled-in by the Dean (A)]

Extension is (1) not granted (reason:)
(2) granted and the extended last date for submission of the project-report/thesis by the above student is_____

Dean (Academic)

Note: After getting the permission from the Dean, the student shall pay the applicable fees, if any, to the cash section and submit this form to the Examination Section along with the fee receipt.
If the student has already completed the maximum duration for complying the degree requirement from the date of registration of first semester, as per the Regulations, no more extensions shall be permitted.

D E C L A R A T I O N

by the P.G. (M.Tech /M.Tech(Research)/ MCA / MSc / MBA) Student

I hereby *declare* that the Report of the P.G. Project Work entitled

.....

.....

.....

which is being submitted to the National Institute of Technology Karnataka Surathkal, in partial fulfilment of the requirements for the award of the Degree of Master of ....

.....

in the department of ..... , is a *bonafide report of the work carried out by me*. The material contained in this Report has not been submitted to any University or Institution for the award of any degree.

.....
(Register Number, Name & Signature of the Student)

Department of .....

Place: NITK, SURATHKAL

Date:

Declaration to be signed by the student and incorporated as part of the P.G. Project Work Report

C E R T I F I C A T E

This is to *certify* that the P.G. Project Work Report entitled .....

.....

.....

submitted by ..... ,

(Register Number: .....) as the record of the work carried out by him/her, is *accepted as the P.G. Project Work Report submission* in partial fulfilment of the requirements for the award of degree of Master of.....

.....

in the Department of.....

External Guide (if any)
(Name and Signature
with Date and Seal)

Internal Guide
(Name and Signature
with Date and Seal)

Chairman - DPGC
(Signature with Date and Seal)

PWEC Report on P.G. Project Work Evaluation

[PWEC → DPGC → Dean (A)]

Part I [To be filled-in by the PWEC]

Name of the student : **Register No.:**

Programme : *M.Tech. / M.C.A. / M.Sc / M.B.A*

Specialization :

Name of Project Guide(s) :

Title of Major Project :

Date of open seminar & viva-voce examination:

Decision of PWEC : (1) Project Report is acceptable and the letter grade is _____
(2) Project Report has to be resubmitted.
(3) Project Report is not acceptable and the letter grade is "FF".

(*If the Report is not acceptable or if resubmission is required, specific reasons must be furnished by the PWEC, separately*)

Names & Signatures of PWEC chairperson & all the Members:

Name	**Signature**
1.	
2.	
3.	

Date:

Part II [To be filled-in by the DPGC]

The Project Work Evaluation Report by the PWEC is being forwarded to the Exam. Section.

Secretary-DPGC
(Name & Signature, with Date)

Chairman-DPGC
(Name & Signature, Date & Seal)

Note: The completed form (along with the photo copy of the cover page of the Project Report, where the Title and the name of the student are printed) has to be submitted, *in a sealed envelope,* to the Office of the Dean (A).

M.Tech.(Research) - RPAC Panel Submission Form

[Guide → RPAC → DPGC → . . . → Dean-A]

[*To be filled-in by the MTech.(Research) Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Name of Research Guide(s):

Research Area:

Signature of the Scholar, with Date:

[*Panel Proposed by the Research Guide*]

Panel for RPAC from the parent Department of the MTech (Research) Scholar

(1)

(2)

(3)

Panel for RPAC from outside the parent Department of the guide(s)

(1)

(2)

(3)

Note: Guide(s) have obtained the consent of the faculty before forwarding their names for RPAC panel.

Signature(s) of Research Guide(s)

[*Forwarding by the DPGC*]

The RPAC panel is being forwarded to |Dean(A)

Secretary-DPGC **Date** **Chairman-DPGC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Dean (Academic)

MTech(Research) Research Proposal Submission Form

[MTech.(Research) Scholar → Guide → RPAC → DPGC → . . . → Dean-A]

[*To be filled-in by the MTech(Research) Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Name of Research Guide(s):

Title of Research Proposal:

Signature of the Scholar, with Date:

[*Recommendation by the RPAC*]

Date of receiving the Research Proposal:

Date of Open Seminar: **Date of RPAC meeting:**

Decision of RPAC: *The research proposal is* ***acceptable / not-acceptable***
(if not acceptable, specific reasons must be furnished separately)

Names & Signatures of RPAC members:

(1)

(2)

(3)

[*Forwarding by the DPGC*]

The research proposal, along with the RPAC recommendations, is being forwarded to the Dean(A).

Secretary-DPGC **Date** **Chairman-DPGC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Research Proposal is ***approved / not-approved.***

Dean (Academic)

Note: (1) The details of research proposal such as literature survey, problem identification, state of the art technology, detailed plan of research work etc. must be attached as an annexure in a bound form.
(2) The detailed observations of RPAC is to be attached.

M.Tech.(Research) Research Progress Assessment Report

[MTech(Research) Scholar → Guide → RPAC → DPGC → . . . → Dean-A]

[*To be filled-in by the MTech(Research) Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Title of Research Report:

Signature of the Scholar, with Date:

[*Recommendation by RPAC*]

Date of receiving the Research Report:

Date of Open Seminar: **Date of RPAC meeting:**

Decision of RPAC: *The research progress is* ***satisfactory / not-satisfactory***
(if not satisfactory, specific reasons must be furnished separately)

Names & Signatures of RPAC members:

(1)

(2)

(3)

[*Forwarding by the DPGC*]

The research progress assessment report is being forwarded to the Dean(A).

Secretary-DPGC **Date** **Chairman-DPGC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Dean (Academic)

Note: 1.Progress report to be attached

(2) The detailed observations of RPAC, if any, may be attached.

(3) Research Progress Assessment shall be conducted on a half-yearly basis for research scholars beyond four years.

M.Tech (Research) Synopsis Submission Form

[MTech(Research) Scholar → Guide → RPAC → DPGC → . . . → Dean(A)]

[*To be filled-in by the MTech(Research) Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Name of research Guide(s):

Title of MTech(Research) Synopsis:

Signature of the Scholar, with date:

[*Recommendation by RPAC*]

Total course credits earned (must be at least 12)**:** **CGPA** (must be at least 5.50)**:**
(above requirements are applicable for students under credit system)

Date of Pre-Synopsis Seminar: **Date of RPAC meeting:**
Decision of RPAC: *The research progress is* ***acceptable / not-acceptable***
for submission of Synopsis of MTech(Research) Thesis.
(for non-acceptance, specific reasons must be enclosed)
Names & Signatures of RPAC members:
(1)

(2)

(3)

[*Forwarding by DPGC]*

The MTech(Research) Synopsis, along with the RPAC recommendations, is being forwarded to the Dean(A).

Secretary-DPGC **Date** **Chairman-DPGC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

The MTech(Research) Synopsis has been received and is ***accepted / not-accepted*** *for evaluation.*

Dean (Academic)

Note: The following documents must be enclosed:
1. ONE printed copy and ONE soft copy of the Synopsis.
2 . Details of the courses studied(copy of grade card to be enclosed)
3. Certificate regarding residential requirement.

M.Tech.(Research)Course Details and Residential Requirement

[MTech(Research) Scholar → Guide → RPAC → DPGC → . . . → Dean(A)]

[*To be filled-in by the MTech(Research) Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Title of Research Report:

Signature of the Scholar, with Date:

1. Courses studied

Sl. No.	Semester, year	Course code	Course Title	Grade

2. Residential period
From: **To:**

Guide(s)

[*Forwarding by the DPGC*]

Secretary-DPGC **Date** **Chairman-DPGC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Dean (Academic)

C O N F I D E N T I A L

M.Tech. (Research) – MTAC Panel Submission Form

INTERNAL/EXTERNAL REFEREES

[Guide → DPGC → . . . **(in sealed cover)** . . .→ Dean(A)]

Name of the Scholar:	**Register No. :**
Department:	**Date of joining:**
Name of Research Guide(s):	
Title of the Thesis:	

Panel of External Referees : Name, Address and Contact Details

(1)

(2)

(3**)**

Panel of Internal Referees: Name, Address and contact Details

1)

2)

3)

Signature(s) of Research Guide(s) with Date

Secretary-DPGC **Date** **Chairman-DPGC**

MTech. (Research) Thesis Submission Form

[MTech(Research) Scholar → Guide → DPGC → . . . → Dean(A)]

[*To be filled-in by the MTech(Research) Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Date of Synopsis submission:

Name of Research Guide(s):

Title of MTech(Research) Thesis:

Signature of the Scholar, with Date:

[*Recommendation by Research Guide*]

I/We authorize the above scholar to submit the MTech(Research) Thesis.

Name(s) of Guide(s) **Signature** **Date**

[*Forwarding by DPGC*]

The MTech(Research) Thesis is being forwarded to the Dean(A).

Secretary-DPGC **Date** **Chairman-DPGC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

The MTech(Research) Thesis has been received and ***accepted / not-accepted*** *for evaluation.*

Dean (Academic)

Note: The following documents must be enclosed:

1. Three printed copies and one soft-copy (CD) of the thesis
2. No Dues Certificate

C O N F I D E N T I A L

MTech. (Research) - MTAC Panel Submission Form (Internal)

(To be submitted after receipt of referees reports)

[Guide → DPGC → (In a sealed cover). . . → Dean-A]

Name of the Scholar:	**Register No. :**
Department:	**Date of joining:**
Name of Research Guide(s):	
Title of the Thesis :	

Panel of Internal Referees (within the Department):

Panel from the parent Department of the MTech (Research) Scholar

(1)

(2)

(3)

Note: Guide(s) have obtained the consent of the faculty before forwarding their names for MTAC panel.

Signature(s) of Research Guide(s)

[*Forwarding by the DPGC*]

Secretary-DPGC **Date** **Chairman-DPGC**

[Approval]

Dean (Academic)

Report of MTAC on M.Tech.(Research) Thesis Defense / Viva-Voce Exam

[M.Tech (Research) student → Guide → MTAC → DPGC . . . (**in sealed cover**) . . . → Dean (A)]

[*To be filled-in by the M.Tech.(Research) Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Title of Research Thesis:

Signature of the Scholar, with Date:

[*Recommendation by MTAC*]

Date of Thesis Defense/Viva-Voce Exam:
Date of MTAC meeting:
Decision of MTAC: *The Research Thesis is* ***satisfactory / not-satisfactory***
(if not satisfactory, specific reasons must be furnished separately)
Names & Signatures of MTAC members:

(1)

(2)

(3)

(4)

(5)

(6)

(Forwarding by DPGC)
MTAC report is being forwarded to Dean (A)

Secretary-DPGC **Date** **Chairman-DPGC**

[*Approval*]

Dean(Academic)

Note: The detailed observations of MTAC is to be attached

Request for extension of MTech (Research) Registration

[MTech(Research) Scholar → Guide → DPGC → . . . → Dean(A)]

[*To be filled-in by the MTech(Research) Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining**:

Name of Research Guide(s):

Currently specified last date:

Reasons for requesting the extension of Registration:

Declaration: *I agree to pay the applicable fees as per the Institute Rules - (semester fees as applicable).*

Signature of the Scholar, with Date:

[*Comments by the Research Guide, who is the Chairperson of RPAC*]

Comments:

Name(s) and Signature(s) with Date

[*Recommendation by the DPGC*

Recommended / not-Recommended for extension of registration.

Secretary-DPGC **Date** **Chairman-DPGC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Extension is (1) ***not granted*** **(reason:)**

(2) ***granted and the extended last date is*** _____

Dean (Academic)

Note: (1) At a stretch, extension of six months (i.e., one semester) may be approved for MTech(R)
(2) The scholar has to pay the applicable semester fees to the cash section after the extension is approved.
(3) If the scholar has already completed the maximum duration for complying the degree requirement from the date of registration of first semester, as per the Regulations, no more extensions shall be permitted.

Request for Recognition as Research Guide for Ph.D. Program

[Proposed Research guide (internal/external) with PhD → DRPC → Dean-A]

[*To be filled-in by the proposed Research Guide*]

Name : **Designation :**

Department: **Date of joining:**

Name of University from where Ph.D. is obtained:

Month & Year of obtaining Ph.D.

Title of Doctoral Thesis:

Signature with Date:

[*Recommendation by the DRPC*]

Date of DRPC meeting:
In the case of external research guide, the name & Reg. No. of the student for whom the research guide is proposed :

Decision of DRPC: *The request for recognition as research guide is* ***acceptable / not-acceptable***
(if not acceptable, specific reasons must be furnished separately)

Names & Signatures of DRPC members:

(1) (2)

(3) (4)

(5) (6)

[*Forwarding by the DRPC*]

The request for recognition as research guide, along with the DRPC recommendations, is being forwarded to the Dean (A).

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

The request for recognition as Research Guide is ***approved / not-approved****.*

Dean (Academic)

Note: In the case of external research guide, a brief bio-data with the copy of doctoral certificate is to be attached.

Ph.D - RPAC Panel Submission Form

[Guide → RPAC → DRPC → . . . → Dean-A]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Name of Research Guide(s):

Research Area:

Signature of the Scholar, with Date:

[*Panel Proposed by the Research Guide*]

Panel for RPAC from the parent Department of the PhD Scholar

(1)

(2)

(3)

Panel for RPAC from outside the parent Department of the guide(s)

(1)

(2)

(3)

Note: Guide(s) have obtained the consent of the faculty before forwarding their names for RPAC panel.

Signature(s) of Research Guide(s)

[*Forwarding by the DRPC*]

The RPAC Panel is being forwarded to Dean(A)

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Dean (Academic)

Ph.D Proposal Submission Form

[PhD → Guide → RPAC → DRPC → . . . → Dean-A]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Name of Research Guide(s):

Title of Research Proposal:

Signature of the Scholar, with Date:

[*Recommendation by the RPAC*]

Date of receiving the Research Proposal:

Date of Open Seminar: **Date of RPAC meeting:**

Decision of RPAC: *The research proposal is* ***acceptable / not-acceptable***
(if not acceptable, specific reasons must be furnished separately)

Names & Signatures of RPAC members:

(1)

(2)

(3)

[*Forwarding by the DRPC*]

The research proposal, along with the RPAC recommendations, is being forwarded to the Dean(A).

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Research Proposal is ***approved / not-approved.***

Dean (Academic)

Note: (1) The details of research proposal such as literature survey, problem identification, state of the art technology, detailed plan of research work etc. must be attached as an annexure in a bound form.
(2) The detailed observations of RPAC may is to be attached.

Ph.D Research Progress Assessment Report

[PhD → Guide → RPAC → DRPC → . . . → Dean-A]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Title of Research Report:

Signature of the Scholar, with Date:

[*Recommendation by RPAC*]

Date of receiving the Research Report:

Date of Open Seminar: **Date of RPAC meeting:**

Decision of RPAC: *The research progress is* ***satisfactory / not-satisfactory***
(if not satisfactory, specific reasons must be furnished separately)

Names & Signatures of RPAC members:

(1)

(2)

(3)

[*Forwarding by the DRPC*]

The research progress assessment report is being forwarded to the Dean(A).

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Dean (Academic)

Note : 1) Progress Reports to be attached

(2) The detailed observations of RPAC, to be attached.

(3) Research Progress Assessment shall be conducted on a half-yearly basis for research scholars beyond four years.

Ph.D. Synopsis Submission Form

[PhD Scholar → Guide → RPAC → DRPC → . . . → Dean(A)]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Name of research Guide(s):

Title of PhD Synopsis:

Signature of the Scholar, with date:

[*Recommendation by RPAC*]

Total course credits earned (must be at least 12)**:** **CGPA** (must be at least 5.50)**:**
(above requirements are applicable for students under credit system)

Date of Pre-Synopsis Seminar: **Date of RPAC meeting:**

Decision of RPAC: *The Pre-synopsis Seminar has been completed satisfactorily and research work is **acceptable / not-acceptable** for submission of Synopsis of PhD Thesis.*

(for non-acceptance, specific reasons must be enclosed)

Names & Signatures of RPAC members:

(1)

(2)

(3)

[*Forwarding by DRPC*]

The Ph.D. Synopsis, along with the RPAC recommendations, is being forwarded to the Director.

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

*The Ph.D. Synopsis has been received and is **accepted / not-accepted** for evaluation.*

Dean (Academic)

Note: The following documents must be enclosed:

1. ONE printed copy and ONE soft copy of the Synopsis.
2. Declaration by the Research Scholar [refer : Regulations–PG&R(PhD), Section5.4.4(b)]
3. List of papers presented/published/accepted for publication or presentation, in the prescribed format, and reprints of those papers.
4. Details of the courses studied (enclose copy of grade card)
5. Certificate regarding residential requirement.

Ph.D Course Details and Residential Requirement

[PhD Scholar → Guide → RPAC → DRPC → . . . → Dean(A)]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Title of Research Report:

Signature of the Scholar, with Date:

1. Courses studied

Sl. No.	Semester, year	Course code	Course Title	Grade

2. Residential period
From: **To:**

Guide(s)

[*Forwarding by the DRPC*]

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Dean (Academic)

List of Publications based on PhD Research Work

[to be filled-in by the Research Scholar and to be enclosed with Synopsis submission Form]

Sl. No.	Title of the paper	**Authors** (in the same order as in the paper. Underline the Research Scholar's name)	Name of the Journal/ Conference/ Symposium, Vol., No., Pages	Month & Year of Publication	Category *
1					
2					
3					
4					

* Category: 1 : Journal paper, full paper reviewed
2 : Journal paper, Abstract reviewed
3 : Conference/Symposium paper, full paper reviewed
4 : Conference/Symposium paper, abstract reviewed
5 : others (including papers in Workshops, NITK Research Bulletins, Short notes etc.)

(If the paper has been accepted for publication but yet to be published, the supporting documents must be attached.)

Research Scholar — Name & Signature, with Date

Research Guide — Name & Signature, with Date

C O N F I D E N T I A L

Ph.D. - DTAC Panel Submission Form (External)

(To be submitted along with synopsis)

EXTERNAL REFEREES (Indian) [Guide → DRPC → . . . **(in sealed cover)** . . .→ Director]

Name of the Scholar:	**Register No. :**
Department:	**Date of joining:**
Name of Research Guide(s):	
Title of the Ph.D. Thesis:	

Panel of External Referees (Indian): Name, Designation, Research area, Address and Contact Details

(1)

(2)

(3)

(4)

(5)

Signature(s) of Research Guide(s) with Date

Secretary-DRPC **Date** **Chairman-DRPC**

C O N F I D E N T I A L

Ph.D. - DTAC Panel Submission Form (External)

(To be submitted along with Synopsis)

EXTERNAL REFEREES (Foreign)

[Guide → DRPC → . . . **(in sealed cover)** . . .→ Director]

Name of the Scholar:	**Register No. :**
Department:	**Date of joining:**
Name of Research Guide(s):	
Title of the Ph.D. Thesis:	

Panel of External Referees (Foreign): Name, Designation, Research area, Address and Contact Details

(1)

(2)

(3)

(4)

(5)

Signature(s) of Research Guide(s) with Date

Secretary-DRPC **Date** **Chairman-DRPC**

Ph.D. Thesis Submission Form

[PhD Scholar → Guide → DRPC → . . . → Dean (A)]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Date of Synopsis submission:

Name of Research Guide(s):

Title of PhD Thesis:

Signature of the Scholar, with Date:

[*Recommendation by Research Guide*]

I/We authorize the above scholar to submit the Ph.D. Thesis.

Name(s) of Guide(s) **Signature** **Date**

[*Forwarding by DRPC*]

The Ph.D. Thesis is being forwarded to Dean(A).

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

*The PhD Thesis has been received and **accepted / not-accepted** for evaluation.*

Dean (Academic)

Note: The following documents must be enclosed:

1. Three printed copies and one soft-copy (CD) of the thesis
2. No Dues Certificate
3. Details on the Research Publications in the prescribed format with Reprints/Acceptance letter from the Journal editor

C O N F I D E N T I A L

Ph.D - DTAC Panel Submission Form (Internal)

(To be submitted after receipt of referees reports)

[Guide → DRPC → (In a sealed cover). . . → Dean-A]

Name of the Scholar:	**Register No. :**
Department:	**Date of joining:**
Name of Research Guide(s):	
Title of the Thesis :	

Panel of Internal Referees (within and outside the Department):

Panel from the parent Department of the PhD Scholar

(1)

(2)

(3)

Panel from outside the parent Department of the guide(s)

(1)

(2)

(3)

Note: Guide(s) have obtained the consent of the faculty before forwarding their names for DTAC panel.

Signature(s) of Research Guide(s)

[*Forwarding by the DRPC*]

Secretary-DRPC **Date** **Chairman-DRPC**

[Approval]

Dean (Academic)

Report of DTAC on Ph.D. Research Thesis Defense / Viva-Voce Exam

[PhD Scholar → Guide → DTAC → . . . (**in sealed cover**) . . . → Director]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Title of Research Thesis:

Signature of the Scholar, with Date:

[*Recommendation by DTAC*]

Date of Thesis Defense/Viva-Voce Exam:
Date of DTAC meeting:
Decision of DTAC: *The Research Thesis is* ***satisfactory / not-satisfactory***
(if not satisfactory, specific reasons must be furnished separately)
Names & Signatures of DTAC members:

(1)

(2)

(3)

(4)

(5)

(6)

[*Forwarding by the DRPC*]

DTAC report is being forwarded to the Director

Secretary-DRPC **Date** **Chairman-DRPC**

[*Approval*]

Director

Note: A brief, one page report with recommendation by the DTAC is to be attached with this form.

Request for extension of PhD Registration

[PhD Scholar → Guide → DRPC → . . . → Dean(A)]

[*To be filled-in by the PhD]*

Name of the Scholar: **Register No. :**

Department: **Date of Joining**:

Name of Research Guide(s):

Currently specified last date:

Reasons for requesting the extension of Registration:

Declaration: *I agree to pay the applicable fees as per the Institute Rules - (semester fees as applicable).*

Signature of the Scholar, with Date:

[*Comments by the Research Guide, who is the Chairperson of RPAC*]

Comments:

Name(s) and Signature(s) with Date

[*Recommendation by the DRPC*]

Recommended / not-Recommended for extension of registration.

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Extension is (1) ***not granted*** **(reason:)**

(2) ***granted and the extended last date is*** _____

Dean (Academic)

Request for permission to leave the Institute & Submit the thesis from outside

[PhD Scholar → Guide → DRPC → . . . → Dean(A)]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Date of submission of Synopsis:

Reasons for requesting the permission to leave the institute and submit the thesis from outside:

Declaration: *I agree to submit the thesis within the THREE months from the date of submission of Synopsis.*

[*Comments by the Research Guide, who is the Chairperson of RPAC*]

Comments:

Name(s) and Signature(s) with Date

[*Recommendation by the DRPC*]

Recommended / not-Recommended
(If not recommended, the reasons must be specified below)

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Permission is (1) ***not granted (reason:*** **)**
(2) ***granted to leave the Institute and submit the thesis from outside, within the stipulated period of THREE months from the date of synopsis submission.***

Dean (Academic)

Request for permission to leave the Institute after M.Tech./Ph.D. Viva-voce(For QIP)

[M.Tech / PhD Scholar → Guide → /DPGC/DRPC → . . . → Dean(A)]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Title of M.Tech/Ph.D. Thesis :

Declaration: *I have cleared all the Institute/Hostel dues pending against me.*

Signature of the Scholar, with Date:

[*Recommendation by the Research Guide*]

Date of M.Tech./Ph.D. viva-voce : Date of Relief sought:

Name(s) and Signature(s) with Date

[*Recommendation by the DRPC*]

Recommended / not-Recommended.
(If not recommended, the reasons must be specified below)

Secretary-DRPC **Date** **Chairman-DRPC/DPGC**

[*Verification of Records*]

The Records were verified and no dues are pending against the candidate.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Permission is (1) ***not granted (reason:*** **)**
(2) ***granted to leave the Institute from the above specified date***

Dean (Academic)

Note : Copy of 'No Dues' certificate to be enclosed

Request For Change of Research Guide *or* Inclusion of Additional-Guide

[PhD Scholar → Guide(s) → RPAC → DRPC → . . . → Dean(A)]

[*To be filled-in by the PhD Scholar*]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Research Area:

Name of present Research Guide:

Name of present Additional-Guide (if any):

Reasons for requesting change of Research Guide *OR* inclusion of Additional-Guide:
(to be stated clearly by the present Guide and/or additional-Guide if any)

Signature(s) of Research Guide(s) and Additional-Guide (if any)

	Name	Signature	Date
Ph.D. Scholar :			
Present Research Guide :			
Present Additional-Guide :			
Proposed Research Guide :			
Proposed Additional-Guide :			

[*Forwarding by the DRPC*]

Secretary-DRPC **Date** **Chairman-DRPC**

[*Verification of Records*]

The Records were verified and found to be in order.

Supdt. (Academic Section) **Asst. Registrar (Academic)** **DR (Academic)**

[*Approval*]

Dean (Academic)

D E C L A R A T I O N

by the Ph.D. Research Scholar

I hereby *declare* that the Research Thesis/Synopsis entitled

……

……

…… … ……

Which is being submitted to the National Institute of Technology Karnataka, Surathkal in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy in

…… … … … … … … …

…… … ……

is a *bonafide report of the research work carried out by me*. The material contained in this Research Thesis/Synopsis has not been submitted to any University or Institution for the award of any degree.

……
(Register Number, Name & Signature of the Research Scholar)

Department of ……

Place: NITK-Surathkal
Date:

Note: Declaration to be signed by the Scholar and incorporated as part of the Ph.D. Research Thesis /Synopsis

C E R T I F I C A T E

This is to *certify* that the Research Thesis/Synopsis entitled .....

.....

.....

.....

.....

submitted by ....., (Register Number: ....) as the record of the research work carried out by him/her, is *accepted as the Research Thesis/Synopsis submission* in partial fulfilment of the requirements for the award of degree of Doctor of Philosophy.

Research Guide(s)
(Name and
Signature with Date
and Seal)

Chairman - DRPC
(Signature with Date and Seal)

NO DUES CERTIFICATE

[for PhD/MTech Scholars]

Part I [To be filled-in by the Scholar]

Name of the Scholar: **Register No. :**

Department: **Date of joining:**

Name of research Guide(s):

Declaration

I hereby declare that in the event of any money being found due from me at a later date, I shall refund the same to the Institution without any loss of time.

Signature of the Scholar, with date:

Part II

Certified that no amount is due from the scholar :

(1) Department of _____ Head of the Department
(Signature with date and seal)

(2) Library Librarian
(Signature with date and seal)

(3) Hostel Hostel Superintendent
(Signature with date and seal)

(4) Central Computer Centre Systems Manager
(Signature with date and seal)

(5) Games & Sports Physical Director
(Signature with date and seal)

NO DUES CERTIFICATE

[for PhD/MTech Scholars]

(6) Students' Aid Fund	Section Superintendent (Signature with date and seal)
(7) Dispensary/Health Centre	R M O (Signature with date and seal)
(8) Cash Section	Cashier (Signature with date and seal)
(9) Accounts – I	Section Superintendent (Signature with date and seal)
(10) Academic Section	Section Superintendent (Signature with date and seal)

Based on certifications as above, it is hereby certified that no amount is due from the research scholar.

Dy. Registrar (Academic)
(Signature with date and seal)

NO DUES CERIFICATE

[for Internal registrants- PG/PhD Scholars who are regular employees of NITK]

Part I (To be filled-in by the Scholar)

Name of the Scholar: **Register No. :**

Department: **Date of Joining:**

Name of Research Guide(s):

Declaration

I hereby declare that in the event of any money being found due from me at a later date, I shall refund the same to the Institution without any loss of time.

Signature of the Scholar, with date:

Part II

Certified that no amount is due from the scholar.

Superintendent (Accounts I)
(Signature with date and seal)

Part III

Certified that no amount is due from the scholar.

Superintendent (Academic Section)
(Signature with date and seal)

Part IV

Based on certifications from the Accounts Section & Exam Section, it is hereby certified that no amount is due from the scholar.

Dy Registrar (Academic)
(Signature with date and seal)

Note: The Superintendents of the Accounts Section and Examination Section shall certify only after confirming that no amount is due from the scholar and that he/she has paid all the fees such as tuition fees and all other applicable fees and charges of the PG/PhD programme.

M.Tech. / M.Tech.(Research) / M.Sc. / MCA / MBA THESIS FORMAT

1.PRESENTATION

1.1 Precision and Consistency: Every effort must be made to avoid unwarranted repetitions, padding with irrelevant material. Further, the thesis must be self consistent in the use of symbols, abbreviations, spellings and punctuation. Once chosen, the same must be used throughout. Also, the pattern of presentation must be uniform in every detail right through the thesis. Above all, previous work must be clearly demarcated from that of the candidate. It is recommended that the thesis must be as brief and precise to the point.

1.2 Chapters: The basic material of the thesis shall be presented in the form of chapters, each carrying an appropriate and specific title which must convey the scope of its content. A separate chapter on Review of Literature is not mandatory. The chapters will be serially numbered using Arabic numerals.

1.3 Introduction: The first chapter shall be titled as Introduction which will (a) introduce the research problem presenting the current state of relevant knowledge (b) define the scope and objectives of the investigation and (c) describe the contents of the thesis preferably chapter-wise.

1.4 Last Chapter : It is strongly recommended, but not made obligatory that the last chapter of the thesis, or each part be devoted to conclusions and to highlight the specific contributions made along with the scope for further research. The summary of the work may also be combined with the conclusions.

1.5 Appendixes : It is important that the presentation must ensure utmost continuity in the theoretical discussions, in the description of experimental results and in their interpretations. Hence, lengthy derivations and voluminous tables, charts and figures which are likely to disturb the smooth flow for the reader must be presented in the appendixes.

1.6 Bio – Data: Contact address, qualification and list of publications

2. SEQUENCE

2.1 Title Sheet : The title sheet shall be the first page and it shall conform to the specimen.

2.2 Declaration: The declaration by the student as per specified format.

2.3 Certificate : The certification by the guide and the chairman, DPGC as per specified format.

2.4 Acknowledgement : The acknowledgement by the candidate for successfully carrying out the project work.

2.5 Abstract : It is the condensed version of the thesis, useful for documentation purpose. It should contain aim of the work, methods used, important results obtained and major conclusions. The write up should be self contained and list of references need not be there. The abstract should occupy maximum one page in A-4 size, typed in one-and-half space. The bottom line should contain key words which could be used for documentation.

2.6 Contents : The content shall follow the abstract and indicate the page numbers of the chapters, sections, sub-sections, appendixes and references. The numbers and titles of all the items must be clearly entered with the page numbers against them. It is not necessary to give separate lists of figures, tables etc.

2.7 Nomenclature : Nomenclature will follow the contents. Its purpose will be to define all the symbols, abbreviations, Greek or Latin letters, superscripts etc.

2.8 The Chapters : The chapter 1- Introduction shall follow the previous item. Chapter 2 and the subsequent chapters will follow in the usual sequence.

2.9 References : References shall follow the last chapter or the appendixes, if there are any. Research papers, reviews, treaties, web sources and books shall be listed therein in the alphabetical order. The text citation appears where the material to be cited is presented. They will be placed within the brackets appropriately in the text citing the author name and the year without a comma in between. Use the first author's name followed by "et al." in citations for publications with three or more authors. When the researcher is part of the sentence, only the year need to be put inside the brackets. A quick guide to common types of referenced material is as follows:

Journal References

Include year, volume, issue and page numbers

Stahl, D.C., Wolfe, R.W. and Begel, M. (2004). "Improved analysis of timber rivet connections." *J.Struct. Eng.*, 130(8), 1272-1279.

Books

Include author, book title, publisher, the publisher's location and chapter title and inclusive of page numbers (if applicable)

Zadeh, L.A.(1981). " Possibility theory and soft data analysis." *Mathematical frontiers of the social and policy sciences*, L. Cobb and R.M. Tharall, eds., Westview, Boulder, Colo., 69-129.

Cotton, F.A. (2003). *Chemical applications of group theory*, McMilan, London.

Conference Proceedings and Symposiums

Include the sponsor of the conference or publisher of the proceedings and the location-city and state or city and country.

Garrett, D.L. (2003). " Coupled analysis of floating production systems." *Proc., Int. Symp. on Deep Mooring Systems*, ASCE, Reston, Va., 152-167.

Reports

Same as for books, as above. For reports authored by institutions: spell out institution acronym on first use and follow with acronym in parentheses, if applicable. If subsequent references were also authored by that same institution, use only the acronym. For reports authored persons, include the full institution name and its location.

Web Pages

Include author, copyright date, title of "page", web address and date on which the material was downloaded.

Burkha, L.P. (1993). " A hypertext history of multi-user dimensions." *MUD history*, http://www.ccs.neu.edu (Dec. 5, 1994).

CD-ROM

Include authors, copyright date, titles, medium and producer/publisher and its location

Liggett, J.A. and Caughey, D.A. (1998). " Fluid statics." *Fluid mechanics* (CD-ROM), ASCE Press, Reston, Va.

Theses and Dissertations

Include authors, copyright date, title and the name and location of the institution where the research was

conducted. Note that some institutions use specific terminology; for example, " doctoral dissertation" rather than "Ph.D. thesis".

Sotiropulos, S.N. (1991). " Statis response of bridge superstructures made of fibre reinforced plastic. " MTech thesis, West Virginia Univ., Morgantown, W. Va.

Unpublished Material

Unpublished material is not included in the references but may be cited in the text as

follows: (John Smith, personal communication, May 16, 1983; J. Smith, unpublished internal report, February 2003).

3. TECHNICAL

3.1 Paper : The thesis (original + copies) should preferably printed on A4 size bond sheet on both sides of paper (back to back)

3.2 Typing : The typing shall be in standard letter size i.e. font size 12 of Times New Roman, with spacing of 1.5. The chapter number and title shall be three spaces between them. The number and title of a section in block capitals will be placed on the left. The number and title of a sub-section will not be in capital and placed on the left.

3.3 Margins : Each typed sheet will bear the margin shown here. For odd numbered pages Left 1.5", top 1.5", right 1" and bottom 1" and for Even numbered pages Left 1.0", top 1.5", right 1.5 and bottom 1.0

3.4 Binding : While submitting, the thesis will be bound through soft binding with blue cover and black font. After the defence and approval of the thesis, one hard copy and CD are to be submitted to the Institute which will go to the library. The front cover should be as per specimen A. The front cover will carry the title of the thesis in 22 font size gold letters properly centered at the top. In the middle, the full name of the candidate shall be typed in 16 font size gold letters. At the bottom, the name of the department, the Institute name, month and the year of submission, all in capitals and in separate lines and in 16 font gold letters.

3.5 Numbering System : The chapters will be designated by Arabic numerals, chapter 1, chapter 2 … etc. The sections of a chapter will be numbered using decimal type notations, e.g., 3.2 refers to the second section of chapter 3. Similarly, the sub-sections will be numbered using two digits after the decimal. Alternatively, the same may be numbered as 3.2.4. Decimal type notations will be used for numbering the figures/photos, charts, tables and drawings in a chapter. Equations may also preferably be numbered in decimal type notation within the brackets. Figure 3.2 refers to the second figure in chapter 3. Similarly, Table 4.2, chart 3.3 etc. Appendixes will be numbered with capital Roman numerals, e.g. Appendix I, Appendix II …..etc.

The pages carrying the Title sheet, Declaration, Certificate and Acknowledgements will not be numbered. One set of small Roman numerals (i, ii, iii…) will be used for numbering the pages of contents and nomenclature. These will be typed at the bottom centre of the page.

The pages of the chapters, the appendixes and the references will be designated by one set of Arabic numerals (1,2,3…etc). These will be typed on the bottom centre of the page. Pages carrying figures, charts, table etc. will carry appropriate page numbers. The page number of the first page of contents, the first page of each chapter including the conclusions need not be typed as is often the practice.

Specimen A : Title Sheet

T I T L E

(In capital letters)

Thesis

Submitted in partial fulfilment of the requirements for the degree of

MASTER OF TECHNOLOGY in

SPECIALIZATION

by

N A M E

(Register No.)

Emblem (1.5” x 1.5”)

DEPARTMENT

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA

SURATHKAL, MANGALORE -575025

Month, Year

PH.D. THESIS FORMAT

1.PRESENTATION

The doctoral thesis will naturally conform to the general practice adopted in the literature of the area in which the investigation is carried out. Each discipline has associated with it a mode of presentation of theoretical discussions, of experimental results and their interpretations. However, it is necessary to evolve a set of guidelines and rules common to all theses submitted to it.

1.1 Precision and Consistency: Every effort must be made to avoid unwarranted repetitions, padding with irrelevant material. Further, the thesis must be self consistent in the use of symbols, abbreviations, spellings and punctuation. Once chosen, the same must be used throughout. Also, the pattern of presentation must be uniform in every detail right through the thesis. Above all, previous work must be clearly demarcated from that of the candidate. It is recommended that the thesis must be as brief as possible and should be precise.

1.2 Chapters: The basic material of the thesis shall be presented in the form of chapters, each carrying an appropriate and specific title which must convey the scope of its content. A separate chapter on Review of Literature is not mandatory. The chapters will be serially numbered using Arabic numerals.

1.3 Parts: If the work comprises two or more mutually independent investigations, the thesis may be divided into two or more parts, each with an appropriate title. However, the numbering of chapters will be continuous right through, e.g. Part one may comprise Chapters 2-5, Part two chapters 6-9.

1.4 Introduction: The first chapter shall be titled as Introduction. If there are two or more parts, the Introduction shall be common to all of them and it will (a) introduce the research problem presenting the current state of relevant knowledge (b) define the scope and objectives of the investigation and (c) describe the contents of the thesis preferably chapter-wise.

1.5 Last Chapter : It is strongly recommended, but not made obligatory that the last chapter of the thesis, or each part be devoted to conclusions and to highlight the specific contributions made along with the scope for further research. The summary of the work may also be combined with the conclusions. The summary is the concise statement in which the candidate will define the problem, indicate the work carried out underlining the important conclusions reached. The summary is expected to provide sufficient information about the work contained in the thesis. It could be chapter-wise also and should be a maximum of six pages in one and a half space.

1.6 Appendixes : It is important that the presentation must ensure utmost continuity in the theoretical discussions, in the description of experimental results and in their interpretations. Hence, lengthy derivations and voluminous tables, charts and figures which are likely to disturb the smooth flow for the reader are to be presented in the appendixes.

1.7 Brief bio-data containing contact address, qualification and list of publications

2. SEQUENCE

2.1 Title Sheet : The title sheet shall be the first page and it shall conform to the specimen A.

2.2 Declaration: The declaration by the student as per specified format.

2.3 Certificate : The certification by the guide and the chairman, DRPC as per specified format.

2.4 Acknowledgement : The acknowledgement by the candidate for successfully carrying out the research work.

2.5 Abstract : It is the condensed version of the thesis, useful for documentation purpose. It should contain aim of the work, methods used, important results obtained and major conclusions. The write up should be self contain and list of references need not be there. The abstract should occupy maximum one page in A-4 size, typed in one-and-half space. The bottom line should contain key words which could be used for documentation.

2.6 Contents : The content shall follow the abstract and indicate the page numbers of the chapters, sections, sub-sections, appendixes and references. The numbers and titles of all the items must be clearly entered with the page numbers against them.

2.7 List of Figures, Charts, Tables : It is not necessary to give separate lists of these items. However, if the author considers it necessary to do so, he may place these immediately after the contents.

2.8 Nomenclature : Nomenclature will follow the contents. Its purpose will be to define all the symbols, abbreviations, Greek or Latin letters, superscripts etc.

2.9 The Chapters : The chapter 1- Introduction shall follow the previous item. Chapter 2 and the subsequent chapters will follow in the usual sequence. The un-numbered title page of a part will be placed before the first chapter of that part as in specimen B.

2.10 References : References shall follow the last chapter or the appendixes, if there are any. Research papers, reviews, treaties, web sources and books shall be listed therein in the alphabetical order. The text citation appears where the material to be cited is presented. They will be placed within the brackets appropriately in the text citing the author name and the year without a comma in between. Use the first author's name followed by "et al." in citations for publications with three or more authors. When the researcher is part of the sentence, only the year need to be put inside the brackets. A quick guide to common types of referenced material is as follows:

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The following must be printed in 16 font size gold letters one the spine of the thesis: Ph.D., full name of the candidate and the year.

3.5 Numbering System : Parts of a thesis will be designated by alphabetical numbers, e.g., Part one, Part two .. etc. The chapters will be designated by Arabic numerals, chapter 1, chapter 2 … etc. The sections of a chapter will be numbered using decimal type notations, e.g., 3.2 refers to the second section of chapter 3. Similarly, the sub-sections will be numbered using two digits after the decimal. Alternatively, the same may be numbered as 3.2.4. Decimal type notations will be used for numbering the figures/photos, charts, tables and drawings in a chapter. Equations may also preferably be numbered in decimal type notation within the brackets. Figure 3.2 refers to the second figure in chapter 3. Similarly, Table 4.2, chart 3.3 etc. Appendixes will be numbered with capital Roman numerals, e.g. Appendix I, Appendix II …..etc.

The pages carrying the Title sheet, approval sheet, acknowledgements and titles pages of parts will not be numbered. One set of small Roman numerals (i, ii, iii…) will be used for numbering the pages of contents, lists of figures, charts and tables and nomenclature. These will be typed at the bottom centre of the page.

The pages of the chapters, the appendixes and the references will be designated by one set of Arabic numerals (1,2,3…etc). These will be typed on the bottom centre of the page. Pages carrying figures, charts, table etc. will carry appropriate page numbers. The page number of the first page of contents, the first page of each chapter including the conclusions need not be typed as is often the practice.

Specimen A : Title Sheet

T I T L E

(In capital letters)

Thesis

Submitted in partial fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

by

N A M E

Emblem (1.5” x 1.5”)

DEPARTMENT

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA,

SURATHKAL, MANGALORE -575025

Month, Year

SPECIMEN B :

Note : This sheet is not designated by a page number

PART ONE

T I T L E

(In capital letters)

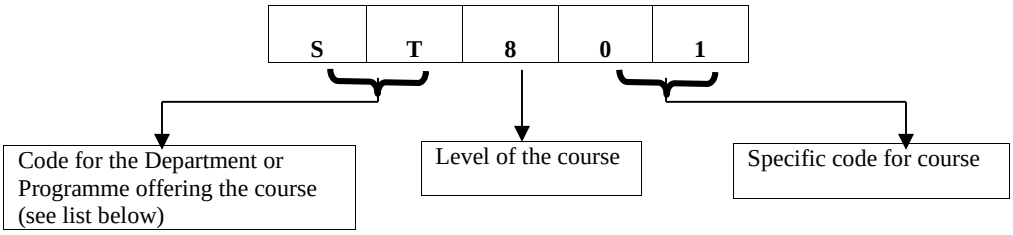
COURSE STRUCTURE – PG & R

Post Graduate & Research Programmes

Department	Programmes offered
Applied Mechanics and Hydraulics (AM)	● M.Tech. & MTech (R) (MS, WR, RS) ● Ph.D.
Civil Engineering (CV)	● M.Tech. & MTech (R) (EN, GT, ST, TS, CM) ● Ph.D.
Mining Engineering (MN)	● M.Tech.(R) (RT) ● Ph.D.
Computer Engineering (CO)	● M.Tech. & MTech (R) (CS, CS-IS) ● Ph.D.
Electronics & Communication Engineering (EC)	● M.Tech. & MTech (R) (CE, VL) ● Ph.D.
Electrical & Electronics Engineering (EE)	● M.Tech. & MTech (R) (PS) ● Ph.D.
Information Technology (IT)	● Ph.D.
Chemical Engineering (CH)	● M.Tech. & MTech (R) (PD, PC, IB) ● Ph.D.
Mechanical Engineering (ME)	● M.Tech & MTech (R). (MF, TH, MC, DP) ● Ph.D.
Metallurgical & Materials Engineering (MT)	● M.Tech. & MTech (R) (ML, PM, NT) ● Ph.D.
Chemistry (CY)	● M.Sc. (Chemistry) ● Ph.D.
Physics (PH)	● M.Sc. (Physics) ● Ph.D.
Mathematical & Computational Sciences (MA)	● M.Tech. & MTech (R) (CMA) ● M.C.A. ● Ph.D.
School of Management (HU)	● M.B.A. ● Ph.D.

Course Numbering Scheme

Course Numbers are denoted by character strings



Typically, courses whose three numerals are between 600 and 899 are taken by postgraduate and research students. Courses with numbers 900-999 are without standard L-T-P schedule, and are taken exclusively by Ph.D. students.

List of Codes for Departments and Programmes

Department Code	**Programme Code**
AM Applied Mechanics and Hydraulics	MS Marine Structures WR Water Resources Engg & Management RS Remote Sensing & GIS
CV Civil Engineering	EN Environmental Engg GT Geotechnical Engg ST Structural Engg TS Transportation Systems Engg CM Construction Technology & Management
MN Mining Engineering	RT Rock Excavation Technology & Management
CO Computer Engineering	CS Computer Science & Engg IS Computer Science & Engg – Information Security
EC Electronics & Communication Engg	CE Communication Engg VL VLSI Design
EE Electrical & Electronics Engg	PS Power & Energy Systems
IT Information Technology	IT Information Technology
CH Chemical Engineering	PD Chemical Plant Design PC Industrial Pollution Control IB Industrial Biotechnology
ME Mechanical Engineering	MF Manufacturing Engg TH Thermal Engg MC Mechatronics DP Design & Precision Engg
MT Metallurgical & Materials Engg	ML Materials Engg PM Process Metallurgy NT - Nanotechnology
CY Chemistry	-
MA Mathematical & Computational Sciences	CMA Computational Mathematics MCA Master of Computer Applications
PH Physics	-
HU School of Mangement	MBA Master of Business Administration

Contact Hours and Credits

Every Course comprises of specific Lecture-Tutorial-Practical (L-T-P) Schedule. The Course Credits are fixed based on the following norms:

Lectures/Tutorials - One hour per week is assigned one credit.
Practicals - 3-hour session per week is assigned 2 credits OR 2-hour session per week is assigned 1 credit.
For example, a theory course with a L-T-P schedule of 3-1-0 will be assigned 4 credits; a laboratory practical course with a L-T-P schedule of 0-0-3 will be assigned 2 credits.

In this booklet, the number of credits and contact hours per week are given after the course number and title.

Example: **ST801 Earthquake Engineering (3-0-0) 3**
It is 3 credit course consisting of : 3hr Lectures, 0hr Tutorial and 0hr Practical, per week.

M.Tech. in Water Resources Engineering and Management (WR)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	WR701	WR706	WR891/ WR897	WR899
2	WR702	WR707	WR898	
3	WR703	WR708		
4	WR704	WR890		
5	WR705	*Elective 2*		
6	*Elective 1*	*Elective 3*		
7	-------	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

WR701 Applied Hydromechanics (3-0-0) 3
WR702 Surface Water Hydrology (3-0-0) 3
WR703 Systems Approach & Optimization Techniques in Water Resources Engineering (3-1-0) 4
WR704 Ground Water Hydrology (3-0-0) 3
WR705 Hydrology & Hydraulics Lab (0-0-3) 2
WR706 Design of Hydraulic Systems (3-0-0) 3
WR707 Infrastructural Project Management (3-0-0) 3
WR708 Sustainable Water Management (3-0-0) 3

Elective (Ele) Courses

AM801 Finite Element Method Application to Hydraulic Structures (3-0-0) 3
AM802 Optimisation Techniques and Engineering Applications (3-0-0) 3
AM803 Numerical Methods for Civil Engineering Applications (3-0-0)3
AM804 Statistical Methods for Civil Engineering Applications (3-0-0)3
WR800 Irrigation Technology & Water Management (3-0-0) 3
WR801 Finite Element Applications to Flow Problems (3-0-0) 3
WR802 Computational Methods in Subsurface Flow (3-0-0) 3
WR803 Integrated River Basin Development (3-0-0) 3
WR804 Fluvial Hydraulics (3-0-0) 3
WR805 Selected topics in Water Resources Engineering & Management (3-0-0) 3
WR806 Geo-informatics Applications in Water Resources Engineering (3-0-0) 3
WR807 Water Quality Modelling & Management (3-0-0) 3
WR809 Soft Computing in Civil Engineering (3-0-0) 3
WR810 Applied Hydrology (3-0-0) 3
WR811 Hydrological Processes (3-0-0) 3
WR812 River Engineering and Sediment Transport (3-0-0) 3
WR813 Water Resources Systems Analysis (3-0-0) 3
WR814 Integrated Watershed Management (3-0-0) 3
CV801 Environmental Impact Assessment (3-0-0) 3
MA706 Probability & Statistical Applications (3-0-0) 3

Mandatory Learning Courses (MLC)

WR890 Seminar 2
WR891/WR897 Practical Training/Minor Project 2
(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

WR898 Major Project *(3rd sem.)* 6
WR899 Major Project (*4th sem.)* 14

M.Tech. in Marine Structures (MS)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	MS701	MS705	MS891/ MS897	MS899
2	MS702	MS706	MS898	
3	MS703	MS707		
4	MS704	MS890		
5	*Elective 1*	*Elective 3*		
6	*Elective 2*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

MS701 Wave Hydrodynamics (3-1-0) 4
MS702 General Oceanography & Coastal Engineering (3-1-0) 4
MS703 Marine Geotechnical Engineering (3-1-0) 4
MS704 Marine Structures Laboratory (0-0-3) 2
MS705 Port Planning & Development (3-1-0) 4
MS706 Analysis & Design of Marine Structures (3-1-0) 4
MS707 Coastal Engg. & Marine Geotech.Lab (0-0-3) 2

Elective (Ele) Courses

AM800 Coastal Erosion & its Mitigation (3-0-0) 3
AM801 Finite Element Method Application to Hydraulic Structures (3-0-0) 3
AM802 Optimization Techniques & Engineering Applications (3-0-0)3
AM803 Numerical Methods for Civil Engineering Applications (3-0-0)3
AM804 Statistical Methods for Civil Engineering Applications (3-0-0)3
MS800 Geo-informatics Applications in Coastal Engineering (3-0-0) 3
MS801 Numerical Modelling of Coastal Processes (3-0-0) 3
MS802 Offshore Engineering (3-0-0) 3
MS803 Foundation of Marine Structures (3-0-0) 3
MS804 Sedimentation & Dredging (3-0-0) 3
MS805 Integrated Coastal Zone Management (3-0-0) 3
MS806 Construction Planning and Operational Management of Marine Projects (3-0-0) 3
MS807 Selected Topics in Marine Structures (3-0-0) 3
MS808 Coastal Disaster Management (3-0-0) 3
MS809 Reliability analysis of Marine Structures (3-0-0) 3
MS810 Finite Element Application in marine Structures (3-0-0)3
MS811 Applied Elasticity (3-0-0)3
MS812 Experimental Methods in Stress analysis (3-0-0)3
MS813 Approximate Methods in Structural Mechanics (3-0-0)3
MS814 Thin Walled Structures (3-0-0)3
MS815 Experimental Methods and Measurements (3-0-0)3
MS816 Coastal Environmental Management (3-0-0)3
MS817 Dredging for Ports (3-0-0)3
MS818 Nonlinear Problems In Ocean Engineering (3-0-0)3
MS819 Mechanics Of Floating Bodies (3-0-0)3
MS820 Hydroelasticity (3-0-0)3
MS821 Offshore Renewable Energy (3-0-0)3
MS822 Computational Marine Hydrodynamics (3-0-0)3
MS823 Fundamentals of Submarine Hydrodynamics(3-0-03)3
MS824 Computational Hydrodynamics Lab (0-0-3)2
MS825 Foundation for Offshore Structures (3-0-0)3
MS826 Design of Offshore Structures (3-0-0)3
MA706 Probability & Statistical Applications (3-0-0) 3

Mandatory Learning Courses (MLC)

MS890 Seminar 2
MS891/MS897 Practical Training/Minor Project 2
(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

MS898 Major Project *(3rd sem.)* 6
MS899 Major Project (*4th sem.)* 14

M.Tech. in Remote Sensing & Geographic Information System(RS)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	RS701	RS705	RS891/ RS897	RS899
2	RS702	R706	RS898	
3	MA709	RS707		
4	RS703	RS708		
5	RS704	RS890		
6	*Elective 1*	*Elective 3*		
7	*Elective II*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

RS701	Introduction to Remote Sensing & Photogrammetry	(3-0-0) 3
RS702	Introduction to Geographic Information Systems	(3-0-0) 3
RS703	Remote Sensing Lab	(0-0-3) 2
RS704	GIS Lab	(0-0-3) 2
RS705	Satellite Digital Image Analysis	(3-1-0) 4
RS706	Advanced Geographic Information Systems	(3-0-0) 3
RS707	Satellite Digital Image Analysis Lab	(0-0-3) 2
RS708	Design Project	(0-0-3) 2
RS709	Applications of Unmanned Aerial Vehicles In Civil Engineering	(2-0-2)3
MA709	Database Management	(3-0-0) 3

Elective (Ele) Courses

RS801	Application of RS &GIS in Agriculture & Soil Science	(3-0-0) 3
RS802	Application of RS &GIS in Town & Country Planning	(3-0-0) 3
RS803	Application of RS &GIS in Forestry, Ecology & Environment	(3-0-0) 3
RS804	Application of RS &GIS in Earth Sciences	(3-0-0) 3
RS805	Selected Topics in RS & GIS	(3-0-0) 3
RS806	Aerial Photography and Digital Photogrammetry	(3-0-0) 3
RS807	Microwave Remote Sensing	(3-0-0) 3
WR702	Surface Water Hydrology	(3-0-0) 3
WR704	Ground Water Hydrology	(3-0-0) 3
WR707	Infrastructural Project Management	(3-0-0) 3
WR708	Sustainable Water Management	(3-0-0) 3
WR801	Finite Element Applications to Flow Problems	(3-0-0) 3
WR806	Geo-informatics Applications in Water Resources Engineering	(3-0-0) 3
MS800	Geo-informatics Application in Coastal Engineering	(3-0-0) 3
MS805	Integrated & Coastal Zone Management	(3-0-0) 3
CV801	Environmental Impact Assessment	(3-0-0) 3
MA706	Probability & Statistical Applications	(3-0-0) 3

Mandatory Learning Courses (MLC)

RS890	Seminar	2
RS891/RS897	Practical Training/Minor Project	2

(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

RS898	Major Project *(3rd sem.)*	6
RS899	Major Project *(4th sem.)*	14

M.Tech. in Environmental Engineering (EN)

Suggested Plan of Study:

Sl. No.	Semester I	II	III	IV
1.	EN701	EN704	EN891/ EN897	EN899
2.	EN702	EN705	EN898	
3.	EN703	CV801		
4.	MA704	EN890		
5.	*Elective 1*	*Elective 3*		
6.	*Elective 2*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	27
Elective Courses (Ele)	09
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

EN701 Environmental Quality & Monitoring (3-0-3) 5
EN702 Physico-Chemical Processes for Water & Wastewater Treatment (3-1-0) 4
EN703 Air, Noise & Solid Waste Management (3-1-0) 4
MA704 Numerical Analysis (3-0-0) 3
EN704 Biological Process Design for Wastewater Treatment (3-1-0) 4
EN705 Environmental Engineering Lab (0-0-6) 4
CV801 Environmental Impact Assessment (3-0-0) 3

Elective (Ele) Courses

EN801 Earth & Environment (3-0-0) 3
EN802 Transport of Water & Wastewater (3-0-0) 3
EN803 Air Quality Management (3-0-0) 3
EN804 Models for Water & Air Quality (3-0-0) 3
EN805 Solid & Hazardous Waste Management (3-0-0) 3
EN806 Environmental Systems Analysis (3-0-0) 3
EN807 Management of Water, Waste & Sanitation Utilities (3-0-0) 3
EN808 Membrane Processes for Water & Waste Treatment (3-0-0) 3
EN809 Industrial Waste Treatment (3-0-0) 3
EN810 Environmental Issues based on Case Studies (3-0-0) 3
EN811 Remote Sensing & GIS applications (3-0-0) 3
EN812 Selected topics in Environmental Engg. (3-0-0) 3
EN813 Ecotechnology (3-0-0) 3
EN814 Environmental Biotechnology (3-0-0) 3
EN815 Industrial Pollution Management (3-0-0) 3
EN816 Environmental Microbiology (3-0-0) 3
EN817 Environmental Management (3-0-0) 3
EN818 Environmental Toxicology (3-0-0)3
EN819 Environnemental Hydraulics (3-0-0)3
EN820 Modeling Waste Water Treatment Process & Plants (3-0-0)3
CV800 Environmental Geotechnology (3-0-0) 3
PC811 Industrial Microbiology (3-0-0) 3

Mandatory Learning Courses (MLC)

EN890 Seminar 2
EN891/EN897 Practical Training/Minor Project 2
(*to be completed during vacation between 2nd & 3rd sem.)*

Major Project (MP)

EN898 Major Project (*3rdsem.)* 6
EN899 Major Project (*4thsem.)* 14

M.Tech. in Geotechnical Engineering (GT)

suggested Plan of Study:

Sl. No.	Semester			
	I	**II**	**III**	**IV**
1	GT700	GT703	GT891/ GT897	GT899
2	GT701	GT704	GT898	
3	GT702	GT705		
4	MA704	GT706		
5	*Elective 1*	GT890		
6	*Elective 2*	*Elective 3*		
7	------	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

GT700	Basic Geomechanics	(3-1-0) 4
GT701	Shallow Foundations	(3-0-0) 3
GT702	Geotechnical Engineering Lab	(0-0-3) 2
GT703	Earth & Earth Retaining Structures	(3-0-0) 3
GT704	Pile Foundations	(3-1-0) 4
GT705	Ground Improvement Techniques	(3-0-0) 3
GT706	Computational Lab for Geotechnical Engineers	(0-0-3) 2
MA704	Numerical Analysis	(3-0-0) 3

Elective (Ele) Courses

GT801	Rock Mechanics	(3-0-0) 3
GT802	Soil Dynamics & Machine Foundations	(3-0-0) 3
GT803	Advanced Engineering Geology	(3-0-0) 3
GT804	FEM for Geotechnical Engineers	(3-0-0) 3
GT805	Earth & Rockfill Dams	(3-0-0) 3
GT806	Geotechnical Instrumentation	(3-0-0) 3
GT807	Selected Topics in Geotechnical Engineering	(3-0-0) 3
GT808	Soil Reinforcement & Geosynthetics	(3-0-0) 3
CV800	Environmental Geotechnology	(3-0-0) 3
ST801	Earthquake Engineering	(3-0-0) 3
TS701	Pavement Design	(3-0-0) 3
MS703	Marine Geotechnical Engineering	(3-1-0) 4
RT805	Tunnel Engineering	(3-0-0) 3
ST803	Soil-Structure Interaction	(3-0-0) 3

Mandatory Learning Courses (MLC)

GT890	Seminar	2
GT891/GT897	Practical Training/Minor Project	2

(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

GT898	Major Project *(3rd sem.)*	6
GT899	Major Project *(4th sem.)*	14

M.Tech. in Structural Engineering (ST)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	ST700	ST705	ST891/ ST897	ST899
2	ST701	ST706	ST898	
3	ST702	ST707		
4	ST703	ST708		
5	ST704	ST890		
6	*Elective 1*	*Elective 3*		
7	*Elective 2*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	27
Elective Courses (Ele)	09
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

ST700 Theory of Elasticity & Plasticity (3-0-0) 3
ST701 Finite Element Method (3-0-0) 3
ST702 Theory of Plates (3-0-0) 3
ST703 Structural Dynamics (3-0-0) 3
ST704 Computer Lab (0-0-3) 2
ST705 Advanced Design of Concrete Structures (3-1-0) 4
ST706 Advanced Design of Steel Structures (3-1-0) 4
ST707 Shells & Folded Plates (3-0-0) 3
ST708 Structures Lab (0-0-3) 2

Elective (Ele) Courses

ST800 Stability of Structures (3-0-0) 3
ST801 Earthquake Engineering (3-0-0) 3
ST802 Structural Optimization (3-0-0) 3
ST803 Soil-Structure Interaction (3-0-0) 3
ST804 Safety of Structures (3-0-0) 3
ST805 Offshore Structural Engineering (3-0-0) 3
ST806 Advanced Concrete Technology (3-0-0) 3
ST807 Wind Resistant Design of Structures (3-0-0) 3
ST808 Mechanics of Composite Laminates (3-0-0) 3
ST809 Advanced Bridge Engineering (3-0-0) 3
ST810 Analysis & Design of Substructures (3-0-0) 3
ST811 Computer Aided Design in Structural Engineering (3-0-0) 3
ST812 Selected Topics in Structural Engineering (3-0-0) 3
ST813 Repair and Rehabilitation of Structures (3-0-0) 3
ST814 Prefabricated Structures (3-0-0) 3
ST 815 Fracture Mechanics of Concrete (3-0-0)3
MA704 Numerical Analysis (3-0-0) 3

Mandatory Learning Courses (MLC)

ST890 Seminar 2
ST891/ST897 Practical Training/Minor Project 2
(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

ST898 Major Project *(3rd sem.)* 6
ST899 Major Project *(4th sem.)* 14

M.Tech. in Transportation Engineering (TS)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	TS701	TS704	TS891/ TS897	TS899
2	TS702	TS705	TS898	
3	TS703	TS890		
4	MA708	MA705		
5	*Elective 1*	*Elective 3*		
6	*Elective 2*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

TS701	Pavement Design	(3-0-0) 3
TS702	Urban Transport Planning	(3-1-0) 4
TS703	Transportation Engineering Lab	(0-0-6) 4
TS704	Traffic Flow Theory	(3-0-0) 3
TS705	Transportation Design Studio	(0-0-6) 4
MA705	Operations Research	(3-0-0) 3
MA708	Statistical Methods	(3-0-0) 3

Elective (Ele) Courses

TS800	Pavement Evaluation	(3-0-0) 3
TS801	Advanced Modeling Techniques in Transportation Engineering	(3-0-0) 3
TS803	Soil mechanics for Highway Engineers	(3-0-0) 3
TS804	Highway & Airport Geometric Design	(3-0-0) 3
TS805	Urban Mass Transport Systems	(3-0-0) 3
TS806	Traffic Engineering & Management	(3-0-0) 3
TS807	Air Transport Planning & Design	(3-0-0) 3
TS808	Highway Construction, Planning & Economics	(3-0-0) 3
TS809	Pavement Management Systems	(3-0-0) 3
TS810	Rural Roads	(3-0-0) 3
TS811	Road Construction Planning & Management	(3-0-0) 3
TS812	Road Safety & Traffic Management	(3-0-0) 3
TS813	Pavement Materials	(3-0-0) 3
TS814	Selected Topics in Transportation Engineering	(3-0-0) 3
TS815	Pavement Construction & Quality Control	(3-0-0) 3
TS816	Traffic Simulation And Modeling	(3-0-0)3
TS817	Public Transportation	(3-0-0)3
TS818	Characterization and Modeling of Asphalt Mixtures	(3-0-0)3
TS 819	Infrastructure Development – Programmes, Planning and Appraisal	(3-0-0)3
GT705	Ground Improvement Techniques	(3-0-0) 3
CV801	Environmental Impact Assessment	(3-0-0) 3
GT 700	Basic Geomechanics	(3-1-0)4
GT703	Earth & Earth Retaining structures	(3-0-0)3
ST809	Advanced Bridge Engineering	(3-0-0)3

Mandatory Learning Courses (MLC)

TS890	Seminar	2
TS891/TS897	Practical Training/Minor Project	2

(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

TS898	Major Project *(3rd sem.)*	6
TS899	Major Project (*4th sem.)*	*14*

M.Tech. in_Construction Technology and Management (CM)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	CM700	CM 704	CM 891/ CM897	CM899
2	CM701	CM 705	CM898	
3	CM702	CM 706		
4	CM703	CM707		
5	CM708	CM890		
6.	*Elective 1*	*Elective 3*		
7.	*Elective 2*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	24
Elective Courses (Ele)	**12**
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

CM700 Construction Planning & Control (3-0-0) 3
CM701 Construction Economics & Accounting (3-0-0) 3
CM702 Contracts &Specifications (3-0-0) 3
CM703 Construction Materials Lab (0-0-3) 2
CM704 Construction Methods & Equipment (3-0-0) 3
CM705 Construction Quality & Safety Management (3-0-0) 3
CM706 Organizational Behaviour (3-0-0) 3
CM707 Construction Software Lab (0-0-3) 2
CM708 Construction Personnel Management (2-0-0) 2

Suggested Elective (Ele) Courses

CM800 Repair & Restoration of Structures (3-0-0) 3
CM801 Operation Research & Decision Theory (3-0-0) 3
CM802 Maintenance & Rehabilitation of Structures (3-0-0) 3
CM803 Structural Systems & Design (3-0-0) 3
CM804 Valuation techniques in Engineering (3-0-0) 3
CM805 Contract Laws & Regulations (3-0-0) 3
CM806 Quality Control & Assurance (3-0-0) 3
CM807 Management Information Systems (3-0-0) 3
CM808 Functional Efficiency of Buildings (3-0-0) 3
CM809 Supervision of Field Operations (3-0-0) 3
CM810 Computer Aided Design in Civil Engineering (3-0-0) 3
CM811 Selected Topics in Construction Technology And Management (3-0-0) 3
CM812 Excavation Technology for Construction projects (3-0-0) 3
CM813 Global Business Management (2-0-0) 2
CM814 Sustainability in Built Environment (3-0-0) 3

CV801 Environmental Impact Assessment (3-0-0) 3
EN702 Physico-Chemical Process for Water & Waste Water Treatment (3-0-0) 3
EN803 Air Quality Management (3-0-0 3
EN805 Solid & Hazardous Waste Management (3-0-0) 3
GT705 Ground Improvement Techniques (3-0-0) 3
GT808 Soil Reinforcement & geosynthetics (2-0-0) 3
ST801 Earthquake Engineering (3-0-0) 3
ST806 Advanced Concrete Technology (3-0-0) 3
TS702 Urban Transport Planning (3-0-0) 3
TS815 Pavement Construction & Quality Control (3-0-0) 3
WR803 Integrated River Basin Development (3-0-0) 3
MS705 Port Planning and Development (3-1-0) 4
MS802 Offshore Engineering (3-0-0) 3
MS806 Construction Planning & Operational Management of Marine Projects (3-0-0) 3
MS817 Dredging in Ports (3-0-0) 3
RT700 Rock Excavation Technology (4-0-0) 4
RT805 Tunnelling Engineering (3-0-0) 3
PS702 Power Systems Modeling and Analysis (4-0-0) 4
PS750 Computer Control of Power Systems (4-0-0) 4
PS853 Renewable Energy Systems (3-0-0) 3
TH819 Design of Air-conditioning Systems (3-0-0) 3
MF804 Material Joining Processes (3-0-0) 3
MF812 Non-destructive Testing (3-0-0) 3
PM803 Advanced Welding Technology (3-0-0) 3

Apart from above, students may choose any 700/800 level courses as electives relevant to their degree with the consent of the faculty advisor, course Instructor and DPGC.

Mandatory Learning Courses (MLC)

CM890 Seminar 2
CM 891/CM897 Practical Training/ Minor Project 2
(to be completed during vacation between 2nd & 3rd sem)

Major Project (MP)

CM898 Major Project *(3rd sem.)* 6
CM899 Major Project *(4th sem.)* 14

M.Tech. in Rock Excavation Technology & Management (RT)

Suggested Plan of Study:

Sl. No.	Semester			
	I	**II**	**III**	**IV**
1	MA701	RT704	RT891/ RT897	RT899
2	RT700	RT705	RT898	
3	RT701	RT706		
4	RT702	RT890		
5	RT703	*Elective 3*		
6	*Elective 1*	*Elective 4*		
7	*Elective 2*			

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

MA701 Applied Statistics & Numerical Analysis (3-0-0) 3
RT700 Rock Excavation Technology (4-0-0) 4
RT701 Rock Mechanics (3-0-0) 3
RT702 Rock Mechanics Lab (0-0-3) 2
RT703 Design of Rock Structures (3-0-0) 3
RT704 Numerical Stress Analysis of Excavations (3-0-0) 3
RT705 Project Management (3-0-0) 3
RT706 Environmental Management in Rock Excavation Projects (3-0-0) 3

Elective (Ele) Courses

RT800 Rock Slope Engineering (3-0-0) 3
RT801 Rock Fragmentation Engineering (3-0-0) 3
RT802 Rock Reinforcement Engineering (3-0-0)3
RT 803 Rock Mechanics Instrumentation (3-0-0)3
RT 804 Underground space Technology (3-0-0)3
RT805 Tunneling Engineering (3-0-0) 3
RT806 Reliability Engineering (3-0-0) 3
RT807 Safety Engineering (3-0-0) 3
RT808 Industrial Engineering (3-0-0) 3
RT809 Structural geology & Discontinuities Analysis (3-0-0) 3
RS702 Introduction to Geo-informatics Systems (3-0-0)3
CV800 Environmental Geo-technology (3-0-0) 3

Mandatory Learning Courses (MLC)

RT890 Seminar 2
RT891/RT897 Practical Training/Minor Project 2 *(to be completed during vacation between 2nd & 3rd sem)*

Major Project (MP)

RT898 Major Project *(3rd sem.)* 6
RT899 Major Project *(4th sem.)* 14

M.Tech in Computer Science & Engineering (CS)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	CS700	CS702	CS891	CS899
2	CS701	CS703	CS898	
3	*Elective*	*Elective*		
4	*Elective*	*Elective*		
5	MA714	*Elective*		
6	CS704	CS890		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	21
Elective Courses (Ele)	15
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

CS700	Algorithms and Complexity	(3-0-2) 4
CS701	High Performance Computing	(3-0-2) 4
CS702	Database Engineering	(3-0-2) 4
CS703	Network Engineering	(3-0-2) 4
CS704	Mini Project	2
MA714	Mathematical Foundations of Computer Science	(3-0-0) 3

Elective Courses

CS800	Software Project Management	(3-0-0) 3
CS801	Software Quality Assurance	(3-0-0) 3
CS802	Software Architecture	(3-0-0) 3
CS803	Software Testing	(3-0-0) 3
CS810	Data warehousing & Data Mining	(3-0-0) 3
CS811	Information Retrieval	(3-0-0) 3
CS812	Distributed Database Systems	(3-0-0) 3
CS813	Topics in Data Management	(3-0-0) 3
CS820	Mobile Computing	(3-0-0) 3
CS821	Wireless Networks	(3-0-0) 3
CS822	Topics in Computer Networks	(3-0-0) 3
CS823	Network Management	(3-0-0) 3
CS830	Applied Algorithms	(3-0-0) 3
CS831	Optimization Algorithms	(3-0-0) 3
CS832	Distributed Algorithms	(3-0-0) 3
CS833	Topics in Algorithm Design	(3-0-0) 3
CS834	Network Optimization	(3-0-0)3
CS840	Compiler Optimization	(3-0-0) 3
CS841	Distributed Operating Systems	(3-0-0) 3
CS842	Knowledge Based Computer Systems	(3-0-0) 3
CS843	Power Aware Computing	(3-0-0) 3
CS850	Web Engineering	(3-0-0) 3
CS851	Service oriented Computing	(3-0-0) 3
CS852	Cloud Computing	(3-0-0) 3
CS853	Social Network Analysis	(3-0-0) 3

Open Group

CS860	Information Security	(3-0-0) 3
CS861	Elementary Number Theory	(3-0-0) 3
CS862	Cyber Law and Ethics	(3-0-0) 3
CS863	Security Policies	(3-0-0) 3
CS864	Advanced Image Processing	(3-0-0) 3
CS865	Topics in Speech Processing	(3-0-0)3
CS866	Interconnection Networks	(3-0-0)3
CS867	Data Science	(3-0-0)3

Mandatory Learning Courses (MLC)

CS890	Seminar	2
CS891	Practical Training *(to be completed during vacation between 2nd & 3rd sem)*	2

Major Project (MP)

CS898	Major Project (3rd Sem)	6
CS899	Major Project (4th Sem)	14

M.Tech in Computer Science & Engineering- Information Security (IS)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	CS700	CS702	IS891	IS899
2	IS701	IS703	IS898	
3	*Elective*	*Elective*		
4	*Elective*	*Elective*		
5	MA714	*Elective*		
6	IS704	IS890		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	21
Elective Courses (Ele)	15
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

CS700	Algorithms and Complexity	(3-0-2) 4
IS701	Number Theory & Cryptography	(3-0-2) 4
CS702	Database Engineering	(3-0-2) 4
IS703	Network Security	(3-0-2) 4
IS704	Mini Project	2
MA714	Mathematical Foundations of Computer Science	(3-0-0) 3

Elective Courses

IS800	Formal Methods	(3-0-0) 3
IS801	Secure Coding	(3-0-0) 3
IS802	Security Architecture: Design & Analysis	(3-0-0) 3
IS803	Information Security Audit	(3-0-0) 3
IS810	Security Administration	(3-0-0) 3
IS811	Security Threats & Vulnerability	(3-0-0) 3
IS812	Enterprise Security	(3-0-0) 3
IS813	Security in Computer System	(3-0-0) 3
IS820	Applied Cryptography	(3-0-0) 3
IS821	Cryptographic Protocols	(3-0-0) 3
IS822	Advanced Cryptography	(3-0-0) 3
IS823	Cryptanalysis	(3-0-0) 3
IS830	Database Security	(3-0-0) 3
IS831	Biometric Security	(3-0-0) 3
IS832	Web Application Security	(3-0-0) 3
IS833	Multimedia Security	(3-0-0) 3
IS840	Network Engineering	(3-0-0) 3
IS841	Distributed Systems Security	(3-0-0) 3
IS842	Internet Security	(3-0-0) 3
IS843	Mobile & Wireless Network Security	(3-0-0) 3
IS850	Cyber Forensics	(3-0-0) 3
IS851	Cloud Security	(3-0-0) 3
IS852	Ethical Hacking	(3-0-0) 3
IS853	Advanced Topics in Security	(3-0-0) 3
IS860	High Performance Computing for Security	(3-0-0) 3

Open Group

CS860	Information Security	(3-0-0) 3
CS861	Elementary Number Theory	(3-0-0) 3
CS862	Cyber Law and Ethics	(3-0-0) 3
CS863	Security Policies	(3-0-0) 3
CS864	Advanced Image Processing	(3-0-0) 3
CS865	Topics in Speech Processing	(3-0-0)3
CS866	Interconnection Networks	(3-0-0)3
CS867	Data Science	(3-0-0)3

Mandatory Learning Courses (MLC)

IS890	Seminar	2
IS891	Practical Training *(to be completed during vacation between 2nd & 3rd sem)*	2

Major Project (MP)

IS898	Major Project (3rd Sem)	6
IS899	Major Project (4th Sem)	14

M. Tech. in Communication Engineering (CE)

Suggested Plan of Study;

Sl. No.	Semester			
	I	II	III	IV
1	CE720	CE723	CE898	CE899
2	CE721	CE724		
3	CE722	CE725		
4	*Elective 1*	*Elective 3*		
5	*Elective 2*	*Elective 4*		
6	CE897	CE890		

Credit Requirements:

Category	Minimum Credits to be Earned
Program Core (Pc)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Program Core (Pc)

CE720 Digital Modulation & Spread Spectrum Systems (3-1-0) 4
CE721 Mathematical Foundations for Communication Engineering (3-1-0) 4
CE722 RF Circuits & Systems (3-1-0) 4
CE723 Light wave Communication (3-1-0) 4
CE724 Detection & Estimation Theory (3-1-0) 4
CE725 Advanced Digital Signal Processing (3-1-0) 4

Elective (Ele) Courses

(At least 2 electives must be chosen from CE Electives)

CE820 Digital Signal Compression (3-0-0) 3
CE821 Error Control Coding (3-0-0) 3
CE822 Wireless Communications & Networks (3-0-0) 3
CE823 Cryptography (3-0-0)3
CE824 Radar Signal Processing (3-0-0) 3
CE825 Optical Networks (3-0-0) 3
CE826 Image & Video processing (3-0-0) 3
CE827 Speech & Audio processing (3-0-0) 3
CE828 Multimedia Communications (3-0-0) 3
CE829 MIMO Communication Systems (3-0-0) 3
CE830 Information Theory (3-0-0) 3
CE831 Computer Communication Networks (3-0-0) 3
CE832 Advanced Antenna Theory (3-0-0) 3
CE833 Photonic Devices (3-0-0) 3
CE834 Active RF Devices and Circuits (3-0-0) 3
CE835 Soft Computing (3-0-0) 3
CE836 Adaptive Signal processing (3-0-0) 3
CE837 Time Frequency Analysis (3-0-0) 3
CE838 Topics in Medical Imaging (3-0-0) 3
CE839 Advanced Optical Communication Systems (3-0-0) 3
CE840 Advanced Communication Networks (3-0-0) 3
CE841 Internet of Things (3-0-0) 3
CE842 Algorithms for Parameter and State Estimation (3-0-0) 3
CE843 Multi Target Tracking and Multi Sensor Information Fusion (3-0-0) 3
CE844 Network Flow and its Optimization (3-0-0) 3
CE845 Signal Processing Techniques for Software Radios (3-0-0) 3
CE846 RF Transceiver System Design for Wireless Communication (3-0-0) 3
CE847 Principles of Communication Systems Simulation 3-0-0) 3
VL832 Digital Signal Processing Architectures (3-0-0) 3
VL834 Heterogeneous and Parallel Programming (2-0-2)3

Mandatory Learning Courses (MLC)

CE890 Seminar 2
CE897 Minor Project 2

Major Project (MP)

CE898 Major Project - I 06
CE899 Major Project - II 14

M. Tech. in VLSI Design (VL)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	VL720	VL723	VL898	VL899
2	VL721	VL724		
3	VL722	VL725		
4	*Elective 1*	*Elective 3*		
5	*Elective 2*	*Elective 4*		
6	VL890	VL897		

Credit Requirements:

Category	Minimum Credits to be Earned
Program Core (PC)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MLC)	20
Total	**60**

Program Core (Pc)

VL720	Digital IC Design	(3-0-2) 4
VL721	Analog IC Design	(3-1-0) 4
VL722	Advanced Computer Architecture	(3-1-0) 4
VL723	Advanced Mixed Signal Design	(3-1-0) 4
VL724	VLSI Design Automation	(3-1-0) 4
VL725	Digital VLSI Testing & Testability	(3-1-0) 4

Elective (Ele)Courses

(At least 2 electives must be chosen from VLSI Design Electives)

VL820	Logic Synthesis Techniques	(3-0-0) 3
VL821	Low Power VLSI Design	(3-0-0) 3
VL822	Modeling and Simulation	(3-0-0) 3
VL823	Submicron Technology	(3-0-0) 3
VL824	Advanced VLSI Design	(3-0-0) 3
VL825	Hardware Software Co-design	(3-0-0) 3
VL826	Sensor Technology and MEMS	(3-0-0) 3
VL827	Embedded Systems	(3-0-0) 3
VL828	VLSI Technology	(3-0-0) 3
VL829	Digital Design using FPGAs	(2-0-2) 3
VL830	Active Filter Design	(3-0-0) 3
VL831	RF Integrated Circuits	(3-0-0) 3
VL832	Digital Signal Processing Architectures	(3-0-0) 3
VL833	Reconfigurable Computing	(2-0-2) 3
VL834	Heterogeneous and Parallel Programming	(2-0-2)3
CE725	Advanced Digital Signal Processing	(3-1-0) 4
CE836	Adaptive Signal processing	(3-0-0) 3

Mandatory Learning Courses (MLC)

VL890	Seminar	2
VL897	Minor Project	2

Major Project (MP)

VL898	Major Project - I	06
VL899	Major Project - II	14

M. Tech. in Power and Energy Systems (PS)

Suggested Plan of Study:

Sl. no	Semester			
	I	II	III	IV
1	PS700	PS750	PS891/ PS897	PS899
2	PS701	PS751	PS898	
3	PS702	*Elective 3*		
4	PS703	*Elective 4*		
5	*Elective 1*	*Elective 5*		
6	*Elective 2*	PS890		

Credit Requirements:

Category	Minimum credits to be earned
Programme Core (Pc)	22
Elective Courses (Ele)	14
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

PS700	Computer-Aided Protection of Power Systems	(4-0-0) 4
PS701	Power Electronics: Modeling and Design	(4-0-0) 4
PS702	Power System Modeling and Analysis	(4-0-0) 4
PS703	Power System Modeling and Analysis Lab	(0-0-3) 2
PS750	Computer Control of Energy Systems	(4-0-0) 4
PS751	Control Systems	(4-0-0) 4

Elective (Ele) Courses

PS800	Fuzzy-Neural Control	(3-0-0) 3
PS801	EMI Testing and Design for Compatibility	(3-0-0) 3
PS802	Energy Management	(3-0-0) 3
PS803	Microcontroller-Based System Design	(3-0-0) 3
PS804	Electric Power Quality	(3-0-0) 3
PS805	Discrete Fourier Transforms and Digital Filter Design	(3-0-0) 3
PS806	Sensor Technology and Instrumentation Design	(3-0-0) 3
PS807	Optimization Techniques	(3-0-0) 3
PS808	Finite Element Methods and Applications	(3-0-0) 3
PS809	DC-AC System Interaction	(3-1-0) 4
PS810	Power System Transients and Overvoltages	(3-0-0) 3
PS811	Distribution System Automation	(3-0-0) 3
PS812	Energy Management Lab	(0-0-3) 2
PS813	Electric Power Quality Lab	(0-0-3) 2
PS814	Discrete Fourier Transforms and Digital Filter Design Lab	(0-0-3) 2
PS815	Power Electronics Design Lab	(0-0-3) 2
PS816	Distribution Automation Lab	(0-0-3) 2
PS817	Power System Operation under Deregulations	(3-0-0) 3
PS818	Advanced Semiconductor Devices	(3-0-0) 3
PS820	Analysis Of Faulted Power Systems	(4-0-0)4
PS850	FACTS and Custom Power Devices	(3-0-0) 3
PS851	High-Voltage Testing and Measurements	(3-0-0) 3
PS852	PV Power Systems	(3-0-0) 3
PS853	Renewable Energy Systems	(3-0-0) 3
PS854	Distributed Generation	(3-0-0) 3
PS855	Communication Networks for Power Systems	(3-0-0) 3
PS856	Application of Digital Signal Processing Techniques to Power Systems	(3-0-0) 3
PS857	Design of Embedded Controllers	(3-0-0) 3
PS858	Electric Drives	(3-0-0) 3
PS859	Computational Methods for Large Power System	(3-0-0) 3
PS860	Industrial Applications of HV and Fields	(3-0-0) 3
PS861	LabVIEW™ -based Data Acquisition and Instrumentation Lab	(0-0-3) 2
PS862	Computer Control of Energy Systems Lab	(0-0-3) 2
PS863	Power System Signal Processing Lab	(0-0-3) 2
PS864	Embedded Controllers Design Lab	(0-0-3) 2
PS865	High-Voltage Testing Lab	(0-0-3) 2
PS866	Gaseous Insulation & Gas Insulated System	(3-0-0)3
PS867	Power System Simulation Laboratory	(0-0-3) 2
PS868	Switched Electric Network - Power Electronics Perspective	(4-0-0) 4
PS869	Tensors	(4-0-0) 4
PS870	Tensor Analysis of Networks	(4-0-0) 4

Mandatory Learning Courses (MLC)

PS890	Seminar	2
PS891/ PS897	Practical Training / Minor Project *(to be completed during vacation between 2nd & 3rd sem.)*	2

Major Project (MP)

PS898	Major Project (*3rd sem.*)	6
PS899	Major Project (*4th sem.*)	14

M.Tech in Information Technology

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	IT700	IT703	IT891/ IT897	IT899
2	IT701	IT704	IT898	
3	IT702	MA712		
4	Elective 1	Elective 3		
5	Elective 2	Elective 4		
6	---	IT890		

Credit Requirements:

Category	Minimum Credits to be Earned
Program Core (PC)	24
Elective Courses (EL)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Program Core (PC)

IT700	Advanced Algorithms	(3-0-2) 4
IT701	Advanced Database Systems	(3-0-2) 4
IT702	Advanced Web Technologies	(3-0-2) 4
IT703	Advanced Network Security	(3-0-2) 4
IT704	Multimedia Systems Development	(3-0-2)4
MA712	Optimization Techniques and Random Processes	(4-0-0) 4

Elective Courses (EL)

IT800	Mobile Computing	(3-0-0) 3
IT801	Genetic Algorithms	(3-0-0) 3
IT802	Artificial Intelligence	(3-0-0) 3
IT803	Software Architecture	(3-0-0) 3
IT804	Artificial Neural Networks	(3-0-0) 3
IT805	Semantic Web Technologies	(3-0-0) 3
IT806	Distributed Computing Systems	(3-0-0) 3
IT807	Perceptual Audio and Speech Processing	(3-0-0) 3
IT808	Enterprise Resource Planning & Systems	(3-0-0) 3
IT809	Cyber Law & Intellectual Property Issues	(3-0-0) 3
IT810	Data Mining	(3-0-0) 3
IT811	E-Commerce	(3-0-0) 3
IT812	Web Services	(3-0-0) 3
IT813	Virtual Reality	(3-0-0) 3
IT814	Computer Vision	(3-0-0) 3
IT815	Cloud Computing	(3-0-0) 3
IT816	System Integration	(3-0-0) 3
IT817	Information Retrieval	(3-0-0) 3
IT818	Parallel Programming	(3-0-0) 3
IT819	Mobile Adhoc Networks	(3-0-0) 3
IT820	Wireless Sensor Networks	(3-0-0) 3
IT821	Intelligent Information Systems	(3-0-0) 3
IT822	Blind Signal and Image Processing	(3-0-0) 3
IT823	Information Technology for Healthcare	(3-0-0) 3
IT824	Perceptual Image and Video Processing	(3-0-0) 3
IT825	Advanced Computer Networks	(3-0-0) 3
IT826	Topics in Natural Language Processing	(3-0-2) 4
IT827	Topics in Soft Computing	(3-0-2) 4
IT828	Designing Internet of Things	(3-0-2) 4

Mandatory Learning Courses (MLC)

IT890	Professional Practice / Seminar	2
IT891 / IT897	Practical Training / Minor Project (To be completed during Vacation between 2nd & 3rd Sem.)	2

Major Project (MP)

IT898	Major Project I	6
IT899	Major Project II	14

M.Tech. in Chemical Plant Design (PD)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	CH700	PD703	PD891/ PD897	PD899
2	PD701	PD704	PD898	
3	PD702	PD705		
4	MA701	PD890		
5	*Elective 1*	*Elective 3*		
6	*Elective 2*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	27
Elective Courses (Ele)	09
Mandatory Learning Courses MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

CH700	Transport Phenomena	(3-1-0) 4
PD701	Process Equipment Design I	(3-1-0) 4
PD702	Process Dynamics & Control	(3-1-0) 4
PD703	Process Equipment Design II	(3-1-0) 4
PD704	Process Modeling & Simulation	(3-1-0) 4
PD705	Chemical Reactor Design	(3-1-0) 4
MA701	Applied Statistics & Numerical Analysis	(3-0-0) 3

Elective (Ele) Courses

CH800	Chemical Process Optimisation	(3-0-0) 3
CH801	Biochemical Engineering and Bioreactor Design	(3-0-0) 3
CH802	Selected Separation Processes	(3-0-0) 3
CH803	Computational Methods in Chemical Engineering	(3-0-0) 3
CH804	Advanced Chemical Engineering Thermodynamics	(3-0-0) 3
CH805	Risk & Safety Management in Process Industries	(3-0-0) 3
CH806	Process Energy Integration	(3-0-0) 3
CH815	Cavitation and its Applications in Chemical Engineering	(2-1-0)3
CH820	Mathematical Methods in Chemical Engineering	(3-0-0) 3
CH821	Multiphase Flow	(3-0-0) 3
CH822	Computational Fluid Dynamics (CFD)	(3-1-0) 4
PD807	Mechanical Design of Process Vessels	(3-0-0) 3
PD808	Integrated Process Design Flow Sheeting &Synthesis	(3-0-0) 3
PD809	Advanced Process Control	(3-0-0) 3
PD810	Polymerisation Reaction Engineering	(3-0-0) 3
PD811	Selected Topics in Chemical Plant Design	(3-0-0) 3

Mandatory Learning Courses (MLC)

PD890	Seminar	2
PD891/PD897	Practical Training/Minor Project	2

(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

PD898	Major Project *(3rd sem.)*	6
PD899	Major Project *(4th sem.)*	14

M.Tech. in Industrial Pollution Control (PC)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	CH700	PC703	PC891/ PC897	PC899
2	PC701	PC704	PC898	
3	PC702	PC705		
4	MA701	PC890		
5	*Elective 1*	*Elective 3*		
6	*Elective 2*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	27
Elective Courses (Ele)	09
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

CH700	Transport Phenomena	(3-1-0) 4
PC701	Industrial & Domestic Waste Water Treatment	(3-1-0) 4
PC702	Solid Waste Management	(3-1-0) 4
PC703	Air Pollution Control & Design of Equipment	(3-1-0) 4
PC704	Environmental Impact Assessment & Management Plan	(3-1-0) 4
PC705	Mathematical Modeling of Environmental Systems	(3-1-0) 4
MA701	Applied Statistics & Numerical Analysis	(3-0-0) 3

Elective (Ele) Courses

CH800	Chemical Process Optimisation	(3-0-0) 3
CH801	Biochemical Engineering & Bioreactor Design	(3-0-0) 3
CH802	Selected Separation Processes	(3-0-0) 3
CH803	Computational Methods in Chemical Engineering	(3-0-0) 3
CH804	Advanced Chemical Engineering Thermodynamics	(3-0-0) 3
CH805	Risk & Safety Management in Process Industries	(3-0-0) 3
CH806	Process Energy Integration	(3-0-0) 3
CH815	Cavitation and its Applications in Chemical Engineering	(2-1-0)3
CH820	Mathematical Methods in Chemical Engineering	(3-0-0) 3
CH821	Multiphase flow	(3-0-0) 3
CH822	Computational Fluid Dynamics (CFD)	(3-1-0) 4
PC807	Environmental Law	(3-0-0) 3
PC808	Waste Management using Eco Technology	(3-0-0) 3
PC809	Environmental Biotechnology	(3-0-0) 3
PC810	Industrial Pollution Prevention	(3-0-0) 3
PC811	Industrial Microbiology	(3-0-0) 3
PC812	Selected topics in Industrial Pollution Control	(3-0-0) 3

Mandatory Learning Courses (MLC)

PC890	Seminar	2
PC891/PC897	Practical Training/Minor Project	2

(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

PC898	Major Project *(3rd sem.)*	6
PC899	Major Project *(4th sem.)*	14

M.Tech. in Industrial Biotechnology (IB)

Suggested Plan of Study

SI No	Semester			
	I	**II**	**III**	**IV**
1	IB710	IB713	IB891/IB898	IB899
2	IB711	IB714	IB899	
3	IB712	IB715		
4	Elective 1	IB890		
5	Elective 2	Elective3		
6.	-	Elective 4		

Credit Requirements :

Category	Minimum Credits to be Earned
Core Courses	24
Elective Courses	12
Mandatory Learning Courses	04
Major Project	20
Total	60

Program Core (Pc)

IB710 Transport Phenomena (3-1-0)4
IB711 Enzyme Engineering and Technology (3-1-0)4
IB712 Fermentation Technology (4-0-0)4
IB713 Downstream Process Technology (3-1-0)4
IB714 Bioreactor Theory and Design (3-1-0)4
IB715 Environmental Biotechnology (4-0-0)4

Elective (Ele) Courses

IB800 Instrumental Methods of Analysis (3-0-0)3
IB801 Modeling, Simulation and Introduction to Bioinformatics (3-1-0)4
IB802 Biosensors (3-0-0)3
IB803 Immobilization Technology (3-0-0)3
IB804 Bioremediation Techniques (3-0-0)3
IB805 Animal Cell Biosystems and Immunotechnology (3-0-0)3
IB806 Bioinformatics (3-0-0)3
IB807 Quality Control in Biotechnology (3-0-0)3
IB808 Industrial Wastes Treatment and Management (3-0-0)3
IB809 Computer Aided Process Control (3-0-0)3
IB810 Total Quality Management and ISO 9000 (3-0-0)3
IB811 Protein Engineering (3-0-0)3
IB812 Genetic Engg. and Recombinant DNA Technology (3-0-0)3
IB813 IPR in Biotechnology (3-0-0)3
IB814 Cell Signaling and Systems (3-0-0)3
IB815 Molecular biology of bacterial and viral infections (3-0-0)3

CH807 Industrial and Environmental Epidemiology (3-0-0)3

Mandatory Learning Courses (MLC)

IB890 Seminar 2
IB891/IB898 Practical Training / Minor Project 2
(tobe completed during vacation between 2nd & 3rd Sem.)

Major Project (MP)

IB898 Major Project (3rd Sem.) 6
IB899 Major Project (4th Sem.) 14

M.Tech. in Thermal Engineering (TH)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	TH700	TH705	TH891/ TH897	TH899
2	TH701	TH706	TH898	
3	TH702	TH707		
4	TH703	TH890		
5	TH704	*Elective 3*		
6	*Elective 1*	*Elective 4*		
7	*Elective 2*	*Elective 5*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	21
Elective Courses (Ele)	15
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

TH700	Advanced Fluid Mechanics	(3-0-0) 3
TH701	Heat & Mass Transfer	(3-0-0) 3
TH702	Refrigeration & Cryogenics	(3-0-0) 3
TH703	Combustion	(3-0-0) 3
TH704	Thermal Engg Lab	(0-0-2) 1
TH705	Design of Renewable Energy Systems	(3-0-0) 3
TH706	Measurement in Thermal Systems	(3-0-0) 3
TH707	Thermal Computation Lab	(0-0-3) 2

Elective (Ele) Courses

TH801	Industrial Pollution Control	(3-0-0) 3
TH802	Solar Energy	(3-0-0) 3
TH803	Direct Energy Conversion	(3-0-0) 3
TH804	Design of Thermal System	(3-0-0) 3
TH805	Rocket Technology	(3-0-0) 3
TH806	Automobile Pollution & Control	(3-0-0) 3
TH807	Applied Computational Methods in Fluid Mechanics & Heat Transfer	(3-0-0) 3
TH808	Food preservation & Medical Refrigeration	(3-0-0) 3
TH809	Nuclear Engineering	(3-0-0) 3
TH810	Vacuum Engineering	(3-0-0) 3
TH811	Turbomachines	(3-0-0) 3
TH812	Steam & Gas Turbines	(3-0-0) 3
TH813	Applications of Microprocessors & Computers in Thermal Engineering	(3-0-0) 3
TH814	Design of Heat Transfer Equipments	(2-1-0) 3
TH815	Heat Transfer in Two-phase Flow	(3-0-0) 3
TH816	Advanced Thermodynamics	(3-0-0) 3
TH817	Theory & Design of I.C. Engines	(3-0-0) 3
TH818	Thermofluids	(3-0-0) 3
TH819	Design of Air Conditioning Systems	(3-0-0) 3
TH820	Computational Fluid Dynamics	(3-0-0) 3
TH821	Cryogenics Technology	(3-0-0) 3
TH822	Gas Dynamics	(3-0-0) 3
TH823	Materials for Nuclear Energy	(3-0-0) 3
TH824	Cogeneration &Energy Efficiency	(3-0-0) 3
TH825	Fuel Technology	(3-0-0) 3
TH826	Fusion Technology	(3-0-0) 3
TH827	Automotive fuels and Fuel Systems	(3-0-0) 3
TH828	Bio-Fuel in IC Engines	(3-0-0) 3
TH829	Pyrolysis and Torrefaction of Bio Mass	(3-0-0) 3
ME8xx	Courses	(3-0-0) 3

Mandatory Learning Courses (MLC)

TH890	Seminar	2
TH891/TH897	Practical Training/Minor Project	2

(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

TH898	Major Project (*3rd sem.*)	6
TH899	Major Project (*4th sem.*)	14

M.Tech. in Manufacturing Engineering (MF)

Suggested Plan of Study:

Sl. No.	Semester			
	I	**II**	**III**	**IV**
1	MF700	MF705	MF891/ MF897	MF899
2	MF701	MF706	MF898	
3	MF702	MF707		
4	MF703	MF890		
5	MF704	*Elective 3*		
6	*Elective 1*	*Elective 4*		
7	*Elective 2*	*Elective 5*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	21
Elective Courses (Ele)	15
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

MF700	Metal Removal Processes	(3-0-0) 3
MF701	Computer Integrated Manufacturing	(3-0-0) 3
MF702	Product Design & Rapid Prototyping	(3-0-0) 3
MF703	Robotics: Mechanics Control and programming	(3-0-0) 3
MF704	Manufacturing Systems Lab I	(0-0-3) 2
MF705	Metrology and Instrumentation	(3-0-0) 3
MF 706	Modern Machining Processes	(3-0-0) 3
MF707	Manufacturing Systems Lab II	(0-0-2) 1

Elective (Ele) Courses

ME800	Finite Element Method	(3-0-0) 3
MF801	Metal Casting Processes	(3-0-0) 3
MF802	Technology of Composite Materials	(3-0-0) 3
MF803	Theory of Material Forming Processes	(3-0-0) 3
MF804	Material Joining Processes	(3-0-0) 3
MF805	Industrial Drives	(3-0-0) 3
MF806	Micro Electro Mechanical Systems	(3-0-0) 3
MF807	Machine Tool Dynamics	(3-0-0) 3
MF808	Processing of Plastics & Composites	(3-0-0) 3
MF809	Concurrent Engineering	(3-0-0) 3
MF810	Optimization Methods	(3-0-0) 3
MF811	Automatic Control Engineering	(3-0-0) 3
MF812	Destructive/Non-destructive Testing	(3-0-0) 3
MF814	Industrial Tribology	(3-0-0) 3
MF815	Nanotechnology	(3-0-0)3
MF816	Material Selection in Mechanical design	(3-0-0) 3
MF817	Fracture Mechanics	(3-0-0) 3
MF818	Artificial Intelligence in Manufacturing	(3-0-0) 3
ME8xx	Courses	(3-0-0) 3

Mandatory Learning Courses (MLC)

MF890	Seminar	2
MF891/MF897	Practical Training/Minor Project	2

(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

MF898	Major Project *(3rd sem.)*	6
MF899	Major Project *(4th sem.)*	14

M.Tech. in Mechatronics Engineering (MC)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	MC700	MA713	MC891/ MC897	MC899
2	MC701	MC705	MC898	
3	MC702	MC706		
4	MC703	MC707		
5	MC704	MC890		
6	*Elective 1*	*Elective 3*		
7	*Elective 2*	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	26
Elective Courses (Ele)	10
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

MA713	Mathematical Methods for Engineers	(3-1-0) 4
MC700	Automated Manufacturing Systems	(3-0-0) 3
MC701A	Design and Manufacturing	(3-0-0)3
MC701B	Analog & Digital Electronics	(3-0-0) 3
MC702	Mechatronics Engineering	(3-0-0) 3
MC703	Web Based Manufacturing Systems	(3-0-0) 3
MC704	ADE & Microcontroller Lab	(0-0-3) 2
MC705A	Fluid mechanics & Heat transfer	(3-0-0)3
MC705B	Electro Mechanics & Motion Control	(3-0-0) 3
MC706	Micro-Electro-Mechanical Systems Design	(3-0-0) 3
MC707	FMS & Simulation Lab	(0-0-3) 2

Elective (Ele) Courses

MC800	Modeling & Simulation of Mechatronic Systems	(3-0-0) 3
MC801	Smart Structures & Materials	(3-0-0) 3
MC802	Power Drives	(3-0-0) 3
MC803	Intelligent Systems	(3-0-0) 3
MC804	Robotic Systems	(3-0-0) 3
MC805	Mechanical & Electrical properties of Materials	(3-0-0) 3
MC806	Rapid Manufacturing Technology	(3-0-0) 3
MC807	Nano Technology	(3-0-0) 3
MC808	Finite Element Analysis	(3-0-0) 3
MC809	Power Electronics	(3-0-0) 3
MC810	Digital Systems Design	(3-0-0) 3
MC811	Digital Signal Processing	(3-0-0) 3
MC812	Special Machines & Drives	(3-0-0) 3
MC813	Electro Magnetic Compatibility	(3-0-0) 3
MC814	Electro Magnetic Theory	(3-0-0) 3
MC815	Electronic Measurement and Instrumentation	(3-0-0) 3
MC816	Microprocessors	(3-0-0) 3
MC817	Embedded System Design	(3-0-0) 3
MA 702	Design & Analysis of Experiments	(3-0-0)3
ME8xx	Courses	(3-0-0)3

Mandatory Learning Courses (MLC)

MC890	Seminar	2
MC891/MC897	Practical Training/Minor Project	2

(to be completed during vacation between 2nd & 3rd sem.)

Major Project (MP)

MC898	Major Project (*3rd sem.)*	6
MC899	Major Project (*4th sem.)*	14

M. Tech. in Design & Precision Engineering (DP)

Suggested Plan of Study

Sl. No.	Semester			
	I	II	III	IV
1	DP701	MA713	DP891	
2	DP 702	DP705	*DP898*	DP899
3	DP703	DP706		
4	DP704	DP890		
5	*Elective 1*	*Elective 3*		
6	*Elective 2*	*Elective 4*		
7		*Elective 5*		

Credit Requirements

Category	Minimum Credits to be Earned
Programme Core	21
Elective Courses	15
Mandatory Learning Courses	04
Major Project	20
Total	**60**

Programme Core (Pc)

DP 701 Design Engineering (4-0-0) 4
DP 702 Mechanical Behavior of Engineering Materials (4-0-0) 4
DP 703 Principles of Precision Engineering (3-0-0) 3
DP 704 Design Engg Lab (0-0-2) 1
DP 705 Design Principles of Precision Systems (4-0-0) 4
DP 706 Precision Engg. Lab (0-0-2) 1
MA713 Mathematical methods For Engineers (3-1-0)4

Elective Courses (Ele) **(**3-0-0) 3
DP 800 Synthesis and Analysis of Mechanisms (3-0-0)3
DP 801 Design of Mechatronics Systems (3-0-0)3
DP 802 Industrial Tribology (3-0-0)3
DP 803 Optimization Methods in Engineering Design (3-0-0)3
DP 804 Experimental Stress Analysis (3-0-0)3
DP 805 Micro Electro Mechanical Systems (3-0-0)3
DP 806 Design of Fluid Power Systems (3-0-0)3
DP 807 Product Development & Rapid Prototyping (3-0-0)3
DP 808 Micromachining (3-0-0)3
DP 809 Materials Selection in Mechanical Design (3-0-0)3
DP 810 Applied Elasticity (3-0-0)3
DP 811 Vibration Analysis and Diagnostics (3-0-0)3
DP 812 Composites: Mechanics & Processing (3-0-0)3
DP 813 Theory of Metal Forming (3-0-0)3
DP 814 Modern Control Engineering (3-0-0)3
DP 815 Fracture Mechanics (3-0-0)3
MA 702 Design and Analysis of Experiments (3-0-0)3
ME8xx Courses (3-0-0)3

Mandatory Learning Courses(MLC)

DP 890 Seminar 2
DP 891 Practical Training/Minor Project/Internship 2

Major Project (MP)

DP 898 Major Project (3^{rd} Sem) 6
DP 899 Major Project (4^{th} Sem) 14

M. Tech. in Materials Engineering (ML)

Suggested Plan of Study;

Sl. No.	Semester			
	I	II	III	IV
1	ML700	ML705	ML891/ ML897	ML899
2	ML701	ML890	ML 898	
3	ML702	*Elective 1*		
4	ML703	*Elective 2*		
5	ML704	*Elective 3*		
6	MA702	*Elective 4*		

Credit Requirements

Category	Minimum Credits to be Earned
Core Courses	24
Elective Courses	12
Mandatory Learning Courses	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

ML700 Advanced Physical Metallurgy (3-1-0) 4
ML701 Materials Characterisation (3-1-0) 4
ML702 Plastics Engineering (3-0-0) 3
ML703 Mechanical Behaviour & Design of Materials (3-1-0) 4
ML704 Materials Engineering Lab (0-0-4) 2
ML705 Ceramics Engineering (3-1-0) 4
MA 702 Design & Analysis of Experiments (3-0-0) 3

Elective (Ele) Courses

ML800 Steels & Their Heat Treatment (3-0-0) 3
ML801 Composite Materials (3-0-0) 3
ML802 Electronic Properties of Materials (3-0-0) 3
ML803 Non-destructive Testing (3-0-0) 3
ML804 High Temperature Materials (3-0-0) 3
ML805 Fracture Mechanics (3-0-0) 3
ML806 Surface Engineering (3-0-0) 3
ML807 Science and Technology of Nanomaterials (3-0-0) 3
ML 808 Non-Equilibrium Materials and Processing (3-0-0) 3
ML809 Advanced Polymeric Materials and Technology (3-0-0) 3
PM803 Advanced Welding Technology (3-0-0) 3
PM804 Corrosion Engineering (3-0-0) 3

Mandatory Learning Courses

ML890 Seminar 2
ML891/ML897 Practical Training/Minor Project

(to be completed during vacation between 2nd & 3rd Sem.)

Major Project(MP)

ML898 Major Project (3rd Sem.) 6
ML899 Major Project (4th Sem.) 14

M. Tech. in Process Metallurgy (PM)

Suggested Plan of Study:

Sl. No.	Semester			
	I	II	III	IV
1	PM700	PM705	PM891/ PM897	PM899
2	PM701	PM890	PM 898	
3	PM702	*Elective 1*		
4	PM703	*Elective 2*		
5	PM704	*Elective 3*		
6	MA702	*Elective 4*		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	24
Elective Courses (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc)

PM700 Advances in Iron Making (3-1-0) 4
PM701 Advanced Metallurgical Thermodynamics (3-1-0) 4
PM702 Momentum and Thermal Transport Phenomena (3-1-0) 4
PM703 Experimental Techniques (3-0-0) 3
PM704 Process Metallurgy Lab (0-0-3) 2
PM705 Theory of Metallurgical Processes (3-1-0) 4
MA702 Design & Analysis of Experiments (3-0-0) 3

Elective (Ele) Courses

PM800 Advances in Steel Making (3-0-0) 3
PM801 Mechanical Processing of Steel (3-0-0) 3
PM802 Advanced Foundry Technology (3-0-0) 3
PM803 Advanced Welding Technology (3-0-0) 3
PM804 Corrosion Engineering (3-0-0) 3
ML800 Steels & Their Heat Treatment (3-0-0) 3
ML805 Fracture Mechanics (3-0-0) 3
PM806 Non Ferrous Extractive Metallurgy (3-0-0) 3
PM807 Advance Mineral Processing (3-0-0)3

Mandatory Learning Courses(MLC)

PM890 Seminar 2
PM891/PM897 Practical Training /Minor Project 2
(to be completed during vacation between 2nd & 3rd sem)

Major Projct(MP)

PM898 Major Project (3rd sem) 6
PM 899 Major Project (4th sem) 14

M. Tech. in Nanotechnology(NT)

Suggested Plan of Study:

Sl. No.	I	II	III	IV
1	NT700	Elective – 1	NT898	NT899
2	NT701	Elective – 2	NT897	
3	NT702	Elective – 3		
4	NT703	Elective – 4		
5	ML701	NT749		
6	NT748	NT890		

Credit Requirements:

Category	Minimum Credits to be earned
Programme Core (Pc)	24
Elective Course (Ele)	12
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**60**

Programme (Pc)

NT700 Introduction to Nanoscience & Nanotechnology (3-1-0) 4
NT701 Quantum Theory of Nanoscale Materials (3-1-0) 4
NT702 Synthesis Techniques for Nanomaterials (3-1-0) 4
NT703 Thermodynamics of Solids (3-1-0) 4
ML701 Materials Characterization (3-1-0) 4
NT748 Nanomaterials Synthesis Laboratory (0-0-3) 2
NT749 Materials Characterization Laboratory (0-0-3) 2

Elective Course (Ele)

NT750 Nanophotonics (3-0-0) 3
NT751 Nanoelectronics (3-0-0) 3
NT752 Surface Phenomena (3-0-0) 3
NT753 Carbon Nano Structures &Applications (3-0-0) 3
NT754 Nano Biotechnology (3-0-0) 3
NT755 Polymer Nanotechnology (3-0-0) 3
NT756 Nano Composites (3-0-0) 3
NT757 Chemistry of Nanomaterials (3-0-0) 3
NT758 Advanced Characterization Techniques (3-0-0) 3
NT759 Microstructure & Mechanical Properties of Nano-structures (3-0-0) 3
NT760 Nanomaterials for Energy Conversion (3-0-0) 3
NT761 Integrated Microelectronic Devices (3-0-0) 3
NT762 MEMS/NEMS Devices and Systems (3-0-0) 3
NT763 Nanotribology (3-0-0) 3
NT764 Computational Material Science (3-0-0) 3

Mandatory Learning Course (MLC)

NT890 : Seminar 2
NT897 : Minor Project (to be completed During the vacation between 2nd & 3rd sem 2

Major Project (MP)

NT898 : Major Project (3rd Sem.) 6
NT899 : Major Project (4th Sem.) 14

M.Tech. in Computational Mathematics (CMA)

Suggested Plan of Study:

Sl. No.	Semester I	II	III	IV
1	CMA701	CMA705	CMA891/ CMA897	CMA899
2	CMA702	CMA706	CMA890	
3	CMA703	CMA707	CMA898	
4	CMA704	Elective – 2		
5	Elective – 1	Elective – 3		
6	-----	Elective – 4		

Credit Requirements:

Category	Minimum Credits to be earned
Programme Core (PC)	24
Elective Courses (Ele)	12
Mandatory Learning Course (MLC)	04
Major Project (MP)	20
Total	**60**

Programme Core (Pc):

CMA701	Data Structures and Algorithms	(3-0-2)4
CMA702	Computational Combinatorics	(3-0-0)3
CMA703	Computational Linear Algebra	(3-0-0)3
CMA704	Computer Organization and Operating Systems	(3-0-2)4
CMA705	Theory of Computation	(3-0-0)3
CMA706	Stochastic Analysis and Applications	(3-0-0)3
CMA707	Numerical Algorithms and Analysis	(3-0-2)4

Elective (Ele) Courses:

CMA801	Computer Networks	(3-0-0)3
CMA802	Machine Learning	(3-0-0)3
CMA803	Software Engineering	(3-0-0)3
CMA804	Computer Graphics	(3-0-0)3
CMA805	Image Processing	(3-0-0)3
CMA806	Algorithmic Combinatorics	(3-0-0)3
CMA807	Cryptology	(3-0-0)3
CMA808	Selected Topics in Graph Theory	(3-0-0)3
CMA809	Distributed Computing Systems	(3-0-0)3
CMA810	Soft Computing	(3-0-0)3
CMA811	Combinatorial Optimization	(3-0-0)3
CMA812	System Modelling and Simulation	(3-0-0)3
CMA813	Database Systems	(3-0-0)3
CMA814	Linux and Network Programming	(3-0-0)3
CMA815	Internet Technology and Applications	(3-0-0)3
CMA816	General Systems Theory	(3-0-0)3
CMA817	Web Technology	(3-0-0)3
CMA818	Selected Topics in Computer Algorithms	(3-0-0)3
CMA819	Number Theory and Cryptography	(3-0-0)3
CMA820	Mobile Computing	(3-0-0)3
CMA821	Mathematical Modeling	(3-0-0)3
CMA822	Finite Element Methods	(3-0-0)3
CMA823	Nonlinear Programming	(3-0-0)3
CMA824	Selected Topics in Network Flow Modeling and Analysis	(3-0-0)3
CMA825	Collective Decision Making Process	(3-0-0)3
CMA826	Computational Fluid Dynamics	(3-0-0)3
CMA827	Design and Analysis of Experiments	(3-0-0)3
CMA828	Reliability Theory and Applications	(3-0-0)3
CMA829	Computational Number Theory	(3-0-0)3
CMA830	Pattern Recognition	(3-0-0)3
CMA831	Statistical Techniques in Data Mining	(3-0-0)3
CMA832	Mathematical Finance	(3-0-0)3
CMA833	Games Theory	(3-0-0)3
CMA834	Fuzzy Sets and Fuzzy Logic	(3-0-0)3
CMA835	Computational Graph Theory	(3-0-0)3

Mandatory Learning Courses (MLC)

CMA890	Seminar	2
CMA891/ CMA897	Practical Training/ Minor Project	2

(*to be completed during vacation between 2nd & 3rd Semester*)

Major Project (MP)

CMA898	Major Project (3rd Sem)	6
CMA899	Major Project (4th Sem)	14

Master of Computer Applications (MCA)

Suggested Plan of Study

Sl. No.	Semester					
	I	II	III	IV	V	VI
1	MCA601	MCA602	MCA611	MCA712	*Elective 5*	MCA899
2	MCA603	MCA704	MCA614	MCA721	*Elective 6*	
3	MCA604	MCA605	MCA711	*Elective 3*	*Elective 7*	
4	HU703	MCA606	*Elective 1*	*Elective 4*	*Elective 8*	
5	MCA607	HU612	*Elective 2*	MCA714	MCA725	
6	MCA608	MCA701	MCA617	MCA723		
7		MCA690	MCA713	MCA790		

Credit Requirements:

Category	Minimum Credits to be Earned
Programme Core (Pc)	72
Elective Courses (Ele)	24
Mandatory Learning Courses (MLC)	04
Major Project (MP)	20
Total	**120**

Programme Core (Pc)

MCA601 Computer Organization Architecture (4-0-0) 4
MCA602 Computational Mathematics (4-0-0) 4
MCA603 Discrete Mathematical Structures (4-0-0) 4
MCA604 Programming Concepts (4-0-0) 4
MCA605 Data Structures & Algorithms (4-0-0) 4
MCA606 Data Structures and algorithms Lab (0-0-3) 2
MCA607 Computer Architecture Lab (0-0-3) 2
MCA608 Programming Lab (0-0-3) 2
MCA611 Computer Oriented Statistical Methods (4-0-0) 4
MCA614 Operating Systems (4-0-0) 4
MCA617 Operating Systems Lab (0-0-3) 2
MCA701 Database Management Systems (4-0-0) 4
MCA711 Software Engineering (4-0-0) 4
MCA712 Computer Graphics (4-0-0) 4
MCA713 Software Engineering Lab (0-0-3) 2
MCA714 Computer Graphics Lab (0-0-3) 2
MCA721 Computer Networks (4-0-0) 4
MCA723 Computer Networks Lab (0-0-3) 2
MCA725 Computer Applications Lab (0-0-6) 4
HU612 Managerial Economics (4-0-0) 4
HU703 Accounting & Financial Management (4-0-0) 4
MCA704 Database Management systems Lab (0-0-3)2

Elective (Ele) Courses

MCA613 Microprocessors (3-0-0) 3
MCA615 Theory of Computation (3-0-0) 3
MCA616 Microprocessor Lab (0-0-3) 2
MCA702 Object Oriented Programming (3-0-0) 3
MCA705 Object Oriented Programming Lab (0-0-3) 2
MCA722 Internet Technology & Applications (3-0-0) 3
MCA724 Internet Technology & Applications Lab (0-0-3) 2
MCA801 Computer Algorithms (3-0-0) 3
MCA802 Fuzzy System Models (3-0-0) 3
MCA803 Management Information Systems (3-0-0) 3
MCA804 Operations Research (3-0-0) 3
MCA805 Optimization Techniques & Statistical Methods (3-0-0) 3
MCA806 Artificial Intelligence (3-0-0) 3
MCA807 Artificial Neural Networks (3-0-0) 3
MCA808 Computer Simulation & Modeling (3-0-0) 3
MCA809 Genetic Algorithms (3-0-0) 3
MCA810 Knowledge Management (3-0-0) 3
MCA811 Natural Language Processing (3-0-0) 3
MCA812 Network Optimisation (3-0-0) 3
MCA813 Object Oriented Analysis & Design (3-0-0) 3
MCA814 Performance Modeling (3-0-0) 3
MCA815 Stochastic & Queuing Systems (3-0-0) 3
MCA816 Unix & Network Programming (3-0-0) 3
MCA817 Advanced Client Server Computing (3-0-0) 3
MCA818 Adv Database Management Systems (3-0-0) 3
MCA819 Advanced Operating Systems (3-0-0) 3
MCA820 Cryptography & Network Security (3-0-0) 3
MCA821 Data Mining & Warehousing (3-0-0) 3
MCA822 Digital Image Processing (3-0-0) 3
MCA823 Distributed Computing System (3-0-0) 3
MCA824 Information & Coding Theory (3-0-0) 3
MCA825 Parallel Processing (3-0-0) 3
MCA826 Pattern Recognition & Scene Analysis (3-0-0) 3
MCA827 Web Design (3-0-0) 3
MCA828 Compiler Design (3-0-0) 3
MCA830 Object oriented programming with JAVA(3-0-0)3
SY828 Information Storage and Management (3-0-0) 3
SY829 Collective Decision Making Processes (3-0-0) 3

Mandatory Learning Courses (MLC)

MCA690 Seminar 1 2
MCA790 Seminar 2 2

Major Project (MP)

MCA899 Major Project 20

M.Sc. in Chemistry

Suggested plan of Study

Sl. No	Semester			
	I	II	III	IV
1	CY701	CY751	CY801	CY893
2	CY702	CY752	CY802	CY898
3	CY703	CY753	CY803	*Elective 3*
4	CY704	CY754	CY804	*Elective 4*
5	CY705	CY755	CY805	*Elective 5*
6	CY706	CY756	CY892	
7	CY707	CY757	*Elective 1*	
8		CY891	*Elective 2*	

Credit Requirements

Category	Minimum credits to be earned
Program Core (Pc)	63
Elective Courses (Ele)	15
Major project (MP)	9
Mandatory learning courses (MLC)	03
Total	**90**

Program Core (Pc) Courses **63**

CY 701 Analytical Chemistry I (3-1-0) 4
CY 702 Inorganic Chemistry I (3-1-0) 4
CY 703 Organic Chemistry I (3-1-0) 4
CY 704 Physical Chemistry I (3-1-0) 4
CY 705 Spectroscopy (3-1-0) 4
CY 706 Inorganic Chemistry Practical I (0-0-6) 3
CY 707 Organic Chemistry Practical I (0-0-6) 3
CY 751 Analytical Chemistry II (3-0-0) 3
CY 752 Inorganic Chemistry II (3-1-0) 4
CY 753 Organic Chemistry II (3-1-0) 4
CY 754 Physical Chemistry II (3-1-0) 4
CY 755 Spectroscopy-Applications in Chemistry (3-1-0) 4
CY 756 Inorganic Chemistry Practical II (0-0-4) 2
CY 757 Physical Chemistry Practical I (0-0-4) 2
CY 801 Inorganic Chemistry III (3-0-0) 3
CY 802 Organic Chemistry III (3-0-0) 3
CY 803 Physical Chemistry III (3-0-0) 3
CY 804 Organic Chemistry Practical II (0-0-4) 2
CY 805 Physical Chemistry Practical II (0-0-6) 3

Elective (Ele) Courses **15**

CY 860 Environmental Chemistry (3-0-0) 3
CY 861 Organometallic Chemistry (3-0-0) 3
CY 862 Bio-Inorganic Chemistry (3-0-0) 3
CY 863 Novel Inorganic Compounds (3-0-0) 3
CY 864 Chemistry of Nano-materials (3-0-0) 3
CY 865 Chemistry of Macro Molecules (3-0-0) 3
CY 866 Chemistry of Natural Products (3-0-0) 3
CY 867 Medicinal Chemistry (3-0-0) 3
CY 868 Synthetic methods in Organic Chemistry 3-0-0) 3
CY 869 Molecular Modeling & Drug design (3-0-0) 3
CY 870 Surface Chemistry (3-0-0) 3
CY 871 Chemical & Electrochemical Energy Systems (3-0-0) 3
CY 872 Bio-Physical & Photo Chemistry (3-0-0) 3
CY 873 Nuclear & Radiation Chemistry (3-0-0) 3
CY 874 Solid State Chemistry (3-0-0) 3
CY 875 Corrosion Science (3-0-0) 3
CY 876 Advanced Organic Synthesis (3-0-0) 3
CY 877 Biochemistry (3-0-0) 3
CY 878 Supra-molecular Chemistry (3-0-0) 3
CY 879 Green Chemistry (3-0-0) 3
CY 880 Computational Chemistry (3-0-0) 3
CY 881 Applied Organic Chemistry (3-0-0) 3
CY 882 Polymer Chemistry & Catalysis (3-0-0) 3

CY 898 Major Project (MP) **9**

Mandatory Learning courses (MLC) **3**

CY891 Seminar 1 1
CY892 Seminar 2 1
CY893 Seminar 3 1

M.Sc. in Physics

Suggested Plan of Study

S. No.	Semester			
	I	II	III	IV
1	PH701	PH751	PH801	Elective 2
2	PH702	PH752	PH802	Elective 3
3	PH703	PH753	PH803	Elective 4
4	PH704	PH754	Elective 1	PH899
5	PH705	PH755	PH893	
6	PH891	PH892	PH898	

Credit Requirements:

Category	Minimum Credit to be Earned
Program Core	52
Elective Courses	12
Seminars	06
M.Sc Project	20
Total	**90**

Program Core (PC)

PH701 Mathematical Physics – I (3-1-0) 4
PH702 Classical Mechanics (3-1-0) 4
PH703 Quantum Mechanics – I (3-1-0) 4
PH704 Electronics (3-1-0) 4
PH705 Physics Lab – I (0-0-6) 4
PH751 Condensed Matter Physics – I (3-1-0) 4
PH752 Atomic & Molecular Spectroscopy (3-1-0) 4
PH753 Statistical & Thermal Physics (3-1-0) 4
PH754 Electromagnetic Theory (3-1-0) 4
PH755 Physics Lab – II (0-0-6) 4
PH801 Condensed Matter Physics – II (3-1-0) 4
PH802 Nuclear Physics (3-1-0) 4
PH803 Physics Lab – III (0-0-6) 4

Elective (Ele) Courses

PH860 Cryogenics & Low Temp. Phys. (3-0-0) 3
PH861 Vacuum Technology & Thin Films (3-0-0) 3
PH862 Semicond. Device & Applications (3-0-0) 3
PH863 Materials Prep. Techniques (3-0-0) 3
PH864 Physics of Thin Films (3-0-0) 3
PH865 Crystallography (3-0-0) 3
PH866 Magnetism & Superconductivity (3-0-0) 3
PH867 Nanomaterials (3-0-0) 3
PH868 Charact. Techniques of Materials (3-0-0)3
PH869 Fiber Optics (3-0-0) 3
PH870 Lasers & Applications (3-0-0) 3
PH871 Nonlinear Optics (3-0-0) 3
PH872 Integrated Optics (3-0-0) 3
PH873 Optical Interferometry (3-0-0) 3
PH874 Optical Data Processing (3-0-0) 3
PH875 Quantum Mechanics – II (3-0-0) 3
PH876 General Theory of Relativity (3-0-0) 3
PH877 Mathematical Physics – II (3-0-0) 3
PH878 Experimental Techniques (3-0-0) 3
PH879 Physics of Low Dimensional Systems (3-0-0)3
PH 880 Nonlinear Dynamics And Chaos (3-0-0)3
PH 881 Computational Methods in Physics (3-0-0)3
PH 882 Density Functional Theory and its applications in materials science. (3-0-0)3

Mandatory Learning Courses (MLC)

PH891 Seminar 1 2
PH892 Seminar 2 2
PH893 Seminar 3 2

PH898 M.Sc. Project I (3rd sem) 8
PH899 M.Sc Project II (4th sem) 12

Master of Business Administration (MBA)

Suggested Plan of Study

Sl.No.	Semester			
	I	II	III	IV
1.	MBA711	MBA721	MBA731	MBA741
2.	MBA712	MBA722	MBA732	Elective V
3.	MBA713	MBA723	MBA733	Elective VI
4.	MBA714	MBA724	Elective I	Elective VII
5.	MA 715	MBA725	Elective II	Elective VIII
6.	MBA716	MBA726	Elective III	MBA748
7.	MBA718	MBA727	Elective IV	
8.	MBA719	MBA729	MBA 738	
9.			MBA 739	

Credit Requirements:

Category	Minimum Credits to be Earned
Foundation Courses	≥23
Functional Courses	≥29
Elective Courses	≥24
Mandatory Learning Courses (MLC)	03
Term Paper	03
Summer Internship Project	08
Total	**90**

Foundation Courses **Credits**

MBA711 Business Research (3-0-0)3
MBA712 Organization Behavior (3-0-0)3
MBA713 Financial Accounting (3-0-0)3
MBA714 Managerial Economics (3-0-0)3
MA 715 Statistics for Business Management (3-0-0)3
MBA716 Corporate Communication (3-0-1)3
MBA718 Spreadsheet Modeling for Business (2-0-2)2
MBA741 Ethics and Sustainability (3-0-0)3

Functional Courses

MBA721 Managerial Accounting (3-0-0)3
MBA722 Marketing Management (3-0-0)3
MBA723 Strategic Analysis (3-0-0)3
MBA724 Operations Management (3-0-0)3
MBA725 Financial Management (3-0-0)3
MBA726 Human Resource Management (3-0-0)3
MBA727 Business Analytics and Decision Making (3-0-0)3
MBA731 Strategic Management (3-0-0)3
MBA732 Corporate Information System (3-0-0)3
MBA733 Legal Environment (2-0-0)2

Mandatory Learning Courses (MLC)

MBA719 Seminar 1
MBA729 Seminar 1
MBA739 Seminar 1

Project

MBA738 Summer Internship Project 8
MBA748 Term Paper (0-1-2) 3

Elective Courses

Group 1 : Human Resource Management

MBA811 Organization Development and Management of Change (3-0-0) 3
MBA812 Industrial Relations (3-0-0) 3
MBA813 Compensation Management (3-0-0) 3
MBA814 Training & Development (3-0-0) 3
MBA815 Performance Management (3-0-0) 3
MBA816 Multicultural Workforce Management (3-0-0) 3

Group 2 : Marketing

MBA821 Advertising (3-0-0) 3
MBA822 Business-To-Business Marketing (3-0-0) 3
MBA823 Brand Management (3-0-0) 3
MBA824 Consumer Marketing (3-0-0) 3
MBA825 Marketing Research (3-0-0) 3
MBA826 Retail Marketing (3-0-0) 3
MBA827 Rural Marketing (3-0-0) 3
MBA828 Sales and Distribution Management (3-0-0) 3
MBA829 Services Marketing (3-0-0) 3

Group 3 : Finance

MBA831 International Financial Management (3-0-0) 3
MBA832 Banking, Financial Services and Insurance (3-0-0) 3
MBA833 Financial Derivatives (3-0-0) 3
MBA834 Corporate Taxation (3-0-0) 3
MBA835 Fixed Income Security (3-0-0) 3
MBA836 Security Analysis & Portfolio Management (3-0-0) 3
MBA837 Project Finance (3-0-0) 3
MBA838 Working Capital Management (3-0-0) 3

Group 4 : Operations

MBA841 Service Operations (3-0-0) 3
MBA842 Operations Strategy (3-0-0) 3
MBA843 Project Management (3-0-0) 3
MBA844 Six Sigma (3-0-0) 3
MBA845 Materials Management (3-0-0) 3

Group 5 : Analytics

MBA851 Customer Relationship Management (3-0-0) 3
MBA852 System Thinking and Strategic Modeling (3-0-0) 3
MBA853 Enterprise Resource Computing (3-0-0) 3
MBA854 Product Pricing (3-0-0) 3

Group G : General Electives

MBA8G1 Business Process Design and Reengineering (3-0-0) 3
MBA8G2 Contemporary Issues in Management (3-0-0) 3
MBA8G3 Economic Environment & Policy (3-0-0) 3
MBA8G4 International Business Management (3-0-0) 3
MBA8G5 Enterprise Risk Management (ERM) (3-0-0) 3
MBA8G6 Entrepreneurship Lab (3-0-0) 3
MBA8G7 E-Business (3-0-0) 3
MBA8G8 Management Control System (3-0-0) 3
MBA8G9 Merger and Acquisitions (3-0-0) 3
MBA8G10 Services Management (3-0-0) 3
MBA8G11 Supply Chain Management (3-0-0) 3
MBA8G12 Econometrics Theory and Applications (3-0-0) 3

Note : 1**)** Students shall select total 3 electives from any one group of specialization and remaining five from groups other than the specialization by selecting not more than two from a group .

COURSE CONTENTS - PG&R

DEPARTMENT OF APPLIED MECHANICS & HYDRAULICS

AM800 Coastal Erosion and its Mitigation (3-0-0) 3

Origin of Coasts, Sediment Transport and Budgeting, Coastal Erosion and Mitigation: Global Scenario and Indian Perspective, Coastal Processes, Planning and Design of Coastal Protection Works, Soft and Hard Options, Innovative Technologies, Performance of Coastal Protection Works in India, Coastal Zone Regulation, Integrated Coastal Zone Management, Coastal Pollution and Environmental Impact Assessment.

Bruun, P., Port Engineering, Vol. I &II.

Shore Protection Manual, U.S.Army Corps of Engineers, Coastal Engineering Research Center, U.S.Govt. Printing office, Washington D.C., Vol. 1 & 2. 1984.

Ippen A.T., Estuary and Coast line Hydrodynamics McGraw Hill, 1966.

AM801 Finite Element Method Application to Hydraulic Structures (3-0-0) 3

Direct approach. Basic structural elements. Plane elasticity problems. Galerkin weighted residual approach. Element properties. Linear and quadratic elements. Lagrange and Hermite shape functions. Isoparametric elements. Numerical integration using Newton-Cotes quadratures and Gauss-Legender quadratures. Finite element applications to hydraulic structures - breakwaters, gravity dam, earthen dam

Segerlind. L.T., Applied Finite Element Analysis, John-Wiley and Sons

Reddy. J.N. An Introduction to the Finite Element Method, McGraw-Hill Book Company.

AM 802 Optimization Techniques and Engineering applications (3-0-0) 3

Non-linear Optimization: Unconstrained and constrained optimization, Lagrange multipliers and Kuhn - Tucker conditions. Linear Programming (LP): Formulation of LP, Graphical solution, Simplex method, Finding a feasible basis Dual problem. Primal-dual relationship, Sensitivity analysis, Econonic interpretation of Duality, Interpretation of the Simplex method. Dynamic Programming (DP): Stage coach problem to resource allocation, Distribution of efforts problems , Scheduling problem. Network analysis: Transportation problems, Assignment Problems.

Hiller. F.S .and Liberman. G.J., Introduction to Operations Research.

Ravindran ,D.T.Philips and J.J.Solberg , Operations Research - Principles and Practice.

Hadly.G, Linear Programming(LP) Rao. S. S.,

Engineering Optimisation

AM 803 Numerical Methods for Civil Engineering Applications (3-0-0) 3

Numerical Solution of Non-linear Equations: Method of Bisection; Regula Falsi method; Secant method; Newton-Raphson Method; Fixed Point of a Function; Generalised Newton Raphson Method. Approximation of Functions; Numerical Differentiation: Richardson's Extrapolation Method; Approximation Formulas for Higher Order Derivatives. Numerical Integration: Newton-Cotes Rules; Compound Quadrature Rules; Gauss Quadrature Rules; Gauss Legendre Rules; Approximate Evaluation of Double Integrals. Numerical Solution of Differential Equations: Euler's method; Modified Euler method; Runge-Kutta Methods; System of Linear Equations*:* Direct methods; Iterative methods.

Application: Surface Gravity Wave Interaction with Floating Structure; Flow in Porous Media; Free Surface Flows.

S.C. Chapra and R.P. Canale, 2013. Numerical Methods for Engineers, McGraw Hill.

R.L Burden and J.D. Faires, 2011. Numerical Analysis, Clengage Learning, USA.

K. Atkinson, AN 1989. Introduction to Numerical Analysis, John Wiley & Sons, USA.

M.K. Jain, S.R.K. Iyengar and R.K. Jain, 1985.Numerical methods for Scientific and Engineering Computation, Wiley Eastern.

C.G. Koutitas & P.D. Scarlatos,2016. Computational Modelling in Hydraulic and Coastal Engineering, CRC Press, Taylor & Francis Group.

AM 804 Statistical Methods for Civil Engineering Applications (3-0-0) 3

Elements of Probability; Random Variables and Expectations: Random Variables and Distribution Function; Jointly Distributed Random Variables; Mathematical Expectation; Covariance and Variance; Moment Generating Function. Special Discrete and Continuous Probability Distribution: Discrete Uniform Distribution; Binomial Distribution; Multinomial Distribution; Geometric Distribution; Poisson Distribution; Normal Distribution; Exponential Distribution; Weibull Distribution; Gamma and Beta Distribution. *Correlation and Regression*: Method of Least

Square and Curve Fitting; Carl Pearson Coefficient of Linear Correlation; Rank Correlation and Spearman's Coefficient; Stochastic Processes.

Application: Statistical Approach in the Analysis of Random Waves; Fatigue Load Analysis.

G. Geoffrey Vining, Scott Kowalski, 2010. Statistical Methods for Engineers, Brooks/ Cole, Clengage Learning, USA.
H.C. Taneja, Statistical Methods for Engineering and Sciences, 2009. I.K International Publishing House, New Delhi.
M. S. Ross,2009. Introduction to Probability and Statistics for Engineers and Scientists, Wiley.
R.V. Hogg and A.T. Craig, 2005. Introduction to Mathematical Statistics McMillan.New York

MS 701 Wave Hydrodynamics (3-1-0) 4

General meteorology, Dynamic coastal environment, wave generation theories, statistical and spectral analysis of waves, directional spectrum, wave forecasting and hindcasting, small and finite amplitude wave theories, tsunami waves, wave transformations, wave-structure interaction.

Ippen A.T., Estuary and Coastline Wave Hydrodynamics
Bendat and Piersol, Random Data Analysis and Measurement Techniques.
Dalrymple. D.N.. Water Wave Mechanics for Scientists and Engineers.
Kanphuis A., Introduction to coastal Engineering and Management

MS702 General Oceanography & Coastal Engineering (3-1-0) 4

Properties of seawater, coastal resources and hazards, oceanographic instruments, types of ocean currents, tides and tide producing forces, oceanography of east and west coast of India, coastal processes, marine geology of Indian coast, coastal features, sediment transport, coastal engineering problems, solutions, coastal zone management.

George L. Pickard - Descriptive physical Oceanography.
Gross HG and E. Gross, Ocenography on view of Earth, Prentice Hall, New Jersey, USA, 1972.
Komar P.D., Beach processes and sedimentation
Horikawa. K .Introduction to coastal engineering
Pinet, PR, Invitation to oceanography, Jones and Bartlett Pub., Boston, USA, 2009
Silvestor R .Coastal Engineering. Weigel. Oceanography.

MS703 Marine Geotechnical Engineering (3-1-0) 4

Subsurface and Sub-Marine Explorations for On-Shore and Offshore structures: General planning of soil investigation programme, Boring and sampling in marine deposits. Mineralogy, and Chemistry of Marine Sediments: Morphology and genesis of marine sediments. Origin of clay minerals and their identification by the use of DTA. X-ray diffraction. and Electron microscope methods Engineering properties of Marine Sediments General failure theories - Lateral earth pressure - Rankine and Coulomb theories, Bearing capacity of deep and shallow foundations, Slope stability analysis.

Winter Korn and Fang - Foundation Engineering hand book
Tirant. P .L., Sea bed reconnaissance and offshore soil mechanics for installation of petroleum structures.
Ardus. D.A., Offshore site investigation

MS704 Marine Structures Lab (0-0-3) 2

Experiments on concrete materials and mix design.

MS 705 Port Planning and Development (3-1-0) 4

Economic importance, waterway transport, port development, classification of ports, traffic and hinterland studies, site investigation, queuing theory and its application, preparation of master plan for ports. Design and planning of break bulk, passenger, fishery, containers, dry and liquid bulk terminals, cargo handling facilities. Harbour tranquility, siltation in harbours. fundamentals of dredging, dredging execution.

Ernst G. Frankel, Port Planning and Developmen, John Wiley & Sons, USA, 1987.
UNCTAD Manual, Port Development, A Hand Book for Planner in Developing Countries
Per Bruun, Port Engineering Vol. I & II
PIANC publications. Hans Agerchou et.al., Design of Marine Terminals

MS706 Analysis & Design of Marine Structures (3-1-0) 4

Introduction - Design principles - Functional design - safety factors, General code provisions, Breakwaters, factors determining their selection. Rubble mound breakwaters - Design factors - Hydraulics of cover layer design. Design of structure cross section - stability of foundations. Vertical wall breakwaters - Types - Design factors .pilebreakwaters,

tandem breakwater and floating breakwaters and structures. Coastal protection measures against tsunami. Wharves, Piers, Bulkheads, Dolphins and Moorings - Types and factors controlling selection of type, Design considerations - Design of piled jetties and dolphins - mooring forces- Dock fenders. Dry docks, types of dock walls and floors - design factors. Locks, Slipways, Light houses.

US Army Corps of Engineers - Shore Protection Manual - 1984, C.E.M. - 2001
Quinn - Design of Ports and Harbour Structures Per
Bruun - Port Engineering Vol. I ,II, III.
Pilarczyk and & Zeidler - Offshore Breakwaters and Shoreline Control. John
Herbich - Hand Book of Coastal & Ocean Engg. Vol. I, II, III. Goda Y., Random
Seas & Design of Marine Structures.

MS707 Coastal Engineering & Marine Geotech. Lab (0-0-3) 2

Experiments on wave flume and marine soils.

MS 800 Geo-informatics Applications in Coastal Engineering (3-0-0) 3

The electromagnetic spectrum and atmospheric considerations, Spectral Characteristics , Sensors and platforms , Data Products , Image Interpretation and Analysis. GIS and GPS , Applications: Shore line change, Erosion , accretion area identification, Port Planning , Ocean Temperature Mapping, Ship routing.

Mischael Hord, "Remote Sensing Methods and Applications", John Wiley & Sons, New York, 1986.
Lillesand, T.M., R.W. Kiefer, and J.W. Chipman. 2004. Remote Sensing and Image Interpretation. 5 Edition,John Wiley & Sons.
Sabins, F.J. Jr. Remote Sensing: Principles and Interpretation. Third Edition. W.H. Freeman and Company, New York. 1996.
John R Jensen, Remote Sensing of the Environment An Earth Resource Perspective 2nd Edition,Dorling Kindersley India Pvt Ltd
Srinivas M.G. (Edited by), Remote Sensing Applications, Narosa Publishing House, 2001.

MS 801 Numerical Modelling of Coastal Processes (3-0-0) 3

Numerical Solution of Ordinary Differential Equations and Partial Differential Equations: Finite Difference Approach; Boundary Element Method. Sediment Transport Phenomenon: Physical Properties of Fluid and Sediments; Hydrodynamic Principle; Boundary Layer; Hydrodynamic Drag and Lift on Particle; Numerical Modelling of Sediment Transport; Long Wave Theory and Applications; Boussinesq Approximation; Mild-slope Approximation; Wavemaker Theory; Spectral and Statistical Analysis of Random Waves; Wave Forces on Offshore Structures; Modelling of Wave Energy Conversion Device; Programming using MATLAB.

C.G. Koutitas & P.D. Scarlatos, 2016. Computational Modelling in Hydraulic and Coastal Engineering, CRC Press, Taylor & Francis Group.
Horikawa K., 1978. Coastal Engineering: An Introduction to Ocean Engineering, University of Tokyo Press.
S. Dey, 2014. Fluvial Hydrodynamics: Hydrodynamic and Sediment Transport Phenomena, Springer-Verlag.
P.K. Banerjee, 1994. The Boundary Element Methods in Engineering, Mc-Graw Hill Book Company, London.
M.W. Dingemans, 1997. Water Wave Propagation over Uneven Bottom: Linear Wave Propagation, Part 1&II, World Scientific, Singapore.

MS802 Offshore Engineering (3-0-0) 3

The Ocean environment - Waves, Currents, Winds, Sea bed Geology, Earthquakes, Floating ice. Common Structural Systems - Jacket or Tension leg structures, Tower, Caissons, Concrete gravity platforms, Steel, Gravity platforms, FPSO spar platforms, Hybrids, Compliant structures, factors governing selection. Hydrodynamic loading of large offshore structures - Diffraction theory - Regions of validity - Application - Linear dynamic analysis. Foundations of offshore structures - Pile foundations, Prediction of axial pile capacity, Bearing capacity of footings, settlement of foundations. Offshore construction - Drilling techniques, logging methods, location of drill sites, Completion of walls, Marine survey, Welding, Checks on welding and codes, Corrosion and its prevention measures.

Dawson. T.H.- Offshore Structural Engineering
Det norske veritas, Rules for the Design, Construction and Inspection of Fixed Offshore Structures.
Recommended practice for Planning, Designing, and Construction of Fixed Offshore Structures- American Petroleum Institute.
Sarpakaya & Issacson, Fluid loading on structures.

MS803 Foundation of Marine Structures (3-0-0) 3

Soil structure interaction: Critical study of conventional methods of foundation design, Nature and complexities, advance techniques of analysis, relaxation and iteration for the evaluation of soil structure interaction for different types of structures under various types of loads and subsoil characteristics. Design of combined footing using soil

structure interaction. Analysis and design of pile foundations, bored piles, technique of offshore piling for various types of structures, pile behavior under cyclic lateral loads, development of p-y curves etc. Analysis and Design of Caissons & Well foundations.

Bowles J.E., Foundation analysis and design.
Polous & Davis, Pile foundation
Winter Korn and Fang, Foundation Engineering hand book

MS804 Sedimentation & Dredging (3-0-0) 3

Introduction : Port structures, dredging overview, environmental aspects, Geotechnical Information : Classification of soils and rocks, Geotechnical investigation for field test, Principle & methodology of dredging : Dredging process pretreatment, type of dredgers selection of dredgers, Dredging in Indian context, Drilling & Blasting environmental impact. Design of dredging works, Dredging for (i) navigation improvement. (ii) fill material, (iii)channel design &maintenance. Performance of dredging plant : Description and method of operation, production cycle and ancillary equipment for some important types of dredging and estimating their output. Use and disposal of dredged material: Reclamation fill, beach nourishment, disposal at sea, onshore disposal. Dredging costs and prices: Mobilization and demobilization, capital costs, running costs, building up a cost estimate.

Bray RN, Bates AD, Land J M - Dredging - A Hand book for Engineers - Published by Arnold London, 1997.
Journal of Indian Ports
Dredging - Journal
Solsbey, Dynamics of Marine Sciences.

MS805 Integrated Coastal Zone Management (3-0-0) 3

Estuaries - Classification, circulation pattern and sedimentation, determination of sediment yield from streams. Salt water intrusion. Marine environment pollution : Pollution of estuaries and seas and its implementations. Coastal erosion : Introduction, magnitude, consequences. Soft and hard options: various hard and soft options of coastal erosion mitigation. Innovative methods. Performance of hard and soft options. Environmental impact assessment of various mitigation measures, remedies. Coastal Zone Management : Principle, CRZ act, sustainable development, integrated CZM, issues, constraints. Implementation of ICZM : world scenario, Indian scenario - case studies. Risk analysis of coastal structures, Socio economic analysis, tourism. Territorial water, EEZ and contiguous zone. Living and non-living resources.

Fleming. C.A., Coastal Management, Putting policy into practice, Thomas Telford, London, 1996.
Mce Barett, Coastal Zone Planning and Management, Thomas Telford, London 1992. Barret.
M.G., Coastal Management, Thomas Telford, , London 1989.

MS806 Construction Planning & Operational Management of Marine Projects (3-0-0) 3

Project-definition, characteristics, life cycle phases, types. PER, TEFR and DPR. Project Economic and profitability analyses. Project Organisation, Work breakdown structure, Contracts, Disputes, Arbitration. Planning tools - Bar charts, Network analysis - Pert & CPM. Resources allocation, materials management and inventory control, equipment management, Decision analysis, EIA of projects. Special Construction Methods, Maintenance of Marine Structures, Corrosion and its prevention measures, Engineering & Economics.

Chaudhary. S., Project Management
Joy. P. K., Total Project Management
Chandra. P., Projects Planning Analysis.

MS807 Selected Topics in Marine Structures (3-0-0) 3

MS808 Coastal Disaster Management (3-0-0) 3

Types of Disasters, Earthquake, tsunami, flood, landslide, cyclones, forest fire, draught, coastal hazards, pollution, oils spill, erosion, Impact of Disasters, Forecasting, Role of Remote Sensing and Geographical Information System in Disaster Management, Vulnerability, Disaster Reduction Strategies and contingency planning, Multi Hazard Mapping, Financial Management, Losses from Global Disasters and Expenses in Reconstruction and Retrofitting of Structures, Role of NGOs, Government Bodies and Public, Social and Economic Development of Disaster Prone areas.

Proceedings of World Congress on Disaster Mitigation and Management, Inst. Engrs (India), New Delhi, 2004
Journal of Institute of Engineers
Report on Disaster Management Planning, NMPT 2001.

MS809 Reliability analysis of Marine Structures (3-0-0) 3

Concepts of structural safety; Basic statics and probability; Resistance parameters and distributions; Probabilistic

analysis of loads, live load and wind load; Determination of reliability; Monte Carlo study of structural safety; Level 2 reliability methods including advanced level 2 method; Reliability analysis of components; Reliability based design-determination of partial safety factors, code calibration; Reliability of structural systems; Applications to steel and concrete structures; Offshore structures etc.

Palle Thoft Christensen and M.J. Baker, Structural Reliability Theory and its Application, Springer-Verlag,1982.
Melchers. R.E., Structural Reliability Analysis and Prediction, Ellis Horwood, Chisester, England, 1987.
Ang. A.H.S. and. Tang. W.H, Probability Concepts in Engineering Planning and Design, Vol. II, John Wiley, New York, 1984.
Palle Thoft Cristensen and Murotsu. Y., Applications of Structural Systems Reliability Theory, Springer-Verlag, Berlin, 1986.

MS 810 Finite Element Applications in Marine Structures (3-0-0) 3

Review of various approximate methods – Variational Approach, Application to Structural Mechanics Problems. Governing equation and convergence criteria of finite element method. Bar elements, uniform section, mechanical and thermal loading, varying section, 2D and 3D truss element. Beam element - problems for various loadings and boundary conditions – 2D and 3D Frame elements - longitudinal and lateral vibration. Use of local and natural coordinates. Plane stress, Plane strain and axisymmetric problems. Derivation of element matrices for constant and linear strain triangular elements and axisymmetric element. Definitions, Shape function for 4, 8 and 9 nodal quadrilateral elements, Stiffness matrix and consistent load vector, Evaluation of element matrices using numerical integration. Derivation of element matrices for two dimensional problems, Torsion problems. Bandwidth- Elimination method and method of factorization for solving simultaneous algebraic equations.

Robert D Cook, David S Malkus, Michael E Plesha, 'Concepts and Applications of Finite Element Analysis', 4th edition, John Wiley and Sons, Inc., 2003,
Reddy J.N., An Introduction to Finite Element Method , McGraw Hill – 2000.
Rao. S.S., Finite Element Methods in Engineering, Butterworth and Heinemann, 2001

MS 811 Applied Elasticity (3–0–0) 3

Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants. Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams. Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy's stress function, Axi – symmetric problems, Introduction to Dunder's table, Curved beam analysis, Kirsch, Michell's and Boussinesque problems – Rotating discs. Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi-inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

Timoshenko, S., and Goodier, T.N., Theory of Elasticity, McGraw – Hill Ltd., Tokyo, 1990.
Bhaskar, K., and Varadan, T. K., Theory of Isotropic/Orthotropic Elasticity, CRC Press USA, 2009.
Barber, J. R., Elasiticity, Kluwer Academic Publishers, 2004

MS 812 Experimental Methods in Stress Analysis (3–0–0) 3

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages**,** Capacitance gauges, Laser displacement sensors. Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells. Two dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects, stress optic law, Transmission and Reflection polariscopes, calibration of photoelastic materials, Interpretation of fringe pattern, Compensation and separation techniques, calibration of photoelastic materials, Introduction to three dimensional photo elasticity. Introduction to Moiré techniques, Brittle coating methods and Holography.

Dally, J.W., and Riley, W.F., Experimental Stress Analysis, McGraw Hill Inc., New York 1998.
Hetenyi, M., Hand book of Experimental Stress Analysis, John Wiley and Sons Inc., New York, 1972.
Ramesh, K., Digital Photoelasticity, Springer, New York, 2000.

MS 813 Approximate Methods in Structural Mechanics (3–0–0) 3

Review of analytical methods for solving ordinary differential equations related to structural mechanics problems, boundary conditions, initial conditions, Need for approximate methods, closed form solutions: polynomial type, trigonometric type; Numerical integration. Weighted residual methods: Least square method, collocation method, sub-domain method, method of moments, basic Galerkin form and modified Galerkin form. Variational method: Elementary study on calculus of variation, Rayleigh Ritz method (strain energy method). Application to statically determinate and indeterminate structures: bar, beam, torsional member. Free vibration and stability analysis. Improvement of solution accuracy. Application to statically determinate and indeterminate structures: bar, beam,

torsional member. Free vibration and stability analysis. Numerical integration; Solving simultaneous equations: Various matrix methods; Code generation for structural mechanics problems using approximate methods.

Reddy, J. N., An Introduction to the Finite Element Method, McGraw-Hill, 2004.
Asghar Bhatti, M., Fundamental Finite Element Analysis and Applications: with Mathematica and MATLAB Computations, John Wiley & Sons Inc, 2005.
Tauchert, T.R., Energy Principles in Structural Mechanics, McGraw Hill,International Student Edition, 1989.

MS 814 Thin Walled Structures (3–0–0) 3

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized 'k' method, neutral axis method, principal axis method. Thin walled beams – concept of shear flow – the shear centre and its determination – shear flow distribution in symmetrical and unsymmetrical thin-walled sections – structural idealization – shear flow variation in idealized sections. Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion – shear flow distribution in thin-walled single & multi-cell structures subject to combined bending torsion – with walls effective and ineffective in bending – shear centre of closed sections. Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength estimation – thin-walled column strength – load carrying capacity of sheet stiffener panels – effective width.

Megson T M G , 'Aircraft Structures for Engineering Students', Elsevier Ltd, 2007
Peery, D.J., and Azar, J.J.,' Aircraft Structures', 2nd edition, McGraw – Hill, N.Y., 1999
Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCB-McGraw Hill, 1997

MS 815 Experimental Methods and Measurements (3-0-0) 3

Dimensional analysis with special reference to model studies in Hydrodynamics and Coastal Engineering problems. Design of models and fabrication. Hydrodynamic test facilities, wave makers, wave absorbers 2-D and 3-D wave generation. Static and dynamics load application methods with reference to model and prototype testing transducers and instrumentation for measurement of Force, Pressure, Strain, Displacement, vibration and Flow. Data acquisition systems. Measurement techniques for drag and inertia forces, cavitations. Water entry and exit problems. Wave, current and tide data collection methods. Field instrumentation for Geotechnical Engineering. Monitoring of Marine structural systems, Non destructive testing techniques and evaluation.

Dally, J.W., and Riley, W.F., Experimental Stress Analysis, McGraw Hill Inc., New York 1998.
Hughes. S. A., " Physical models and laboratory techniques in Coastal Engineering",1993.

MS 816 Coastal Environmental Management (3-0-0) 3

Pollution of Ocean Environment –Discharges from ships and offshore platforms, Pollution of coastal waters – discharge from industries, revering discharge and dredging; Pollution of Port waters – ballast water, ships discharge, cargo discharge (oil and ore); Environmental problems due to maritime construction on near shore areas, dismantling of maritime structures and ships; Occupational health and hazards. IMO and regulatory mechanism to check pollution; Quality systems for environmental control; Environmental maneuvering, maritime laws. Coastal erosion and related issues. Mangroves and its management.

North K., Environmental Management, ILO, Geneva
Sapru R.K., Environmental Management in India, Ashish Publishers, New Delhi.
Weber W. Jr., Environmental Systems and Processes, Wiley Interscience.

MS 817 Dredging for Ports (3-0-0) 3

Dredging, its necessity, requirements, Project implementation, Pre-Contract planning, Site investigation, Types of dredgers, Economics of dredging, Computing dredger output, Execution and utilization of dredged materials, drilling and blasting, types of explosivesSafety in blasting operations.

Ernst G. Frankel – Port Planning and Development, John Wiley &Sons , New York USA, 1987
Bray R N, Bates A D, and Land J M - Dredging – AHand Book for Engineers, Arnold, London, 1997

MS818 Nonlinear Problems In Ocean Engineering (3-0-0) 3

Conservative and non-conservative systems, Quadratic and cubic nonlinearities, Nonlinear damping, Forced oscillations, Sub and Super harmonic responses, Parametrically excited systems, Chaotic motion, System identification.

Nonlinear wave theories and wave loading, Nonlinear models of compliant platforms and soil-structure interaction, Risers and moorings, Nonlinear wave loading on large floating systems, Slow drift oscillation, Random response and statistical analysis.

Ali H. Nayfeh,andDean T. Mook, Nonlinear Oscillations, John Wiley

Subrata K.Chakrabarti, Handbook of Offshore Engineering, Elsevier
Y.Goda, Random seas and design of marine structure, World Scientific

MS819 Mechanics Of Floating Bodies **(3-0-0) 3**

Fluid pressure and centre of pressure – estimation of weight and centre of gravity – conditions of equilibrium – definition of meta-centre – hydrostatic particulars – stability at small angles of inclinations – problems of heel and trim-free surface effect – inclining experiment – stability at large angles

Dynamics

Equations of motion for SDOF systems, time and frequency domain solutions – oscillations of floating bodies, added mass and moment of inertia, and hydrodynamic damping – Exciting forces and moments due to waves – Strip theory for slender bodies – Introduction to random response theory – Random response of linear systems under wave loading, General motion analysis of floating bodies, time and frequency domain approaches.

C.B.Barrass and C.R.Derrett, Ship stability for Masters and Mates, Butterworth - Heinemann
Edward V. Lewis, Principles of Naval Architecture: Stability and Strength, Society of Naval Architects and Marine Engineers
Eric C.Tupper, Introduction to Naval Architecture, Butterworth - Heinemann
Rameswar Bhattacharyya, Dynamics of Marine Vehicles, John Wiley

MS 820 Hydroelasticity **(3-0-0) 3**

Introduction to Hydrodynamics and Structural mechanics; Unsteady hydroelasticity problems; Hull and its structural dynamic behaviour; Wave forces; Response of VLFS to waves; Statistical analysis of ship response - Flow-induced vibration; Transient loading seaquakes and Tsunamis; Analysis of floating structures on fluid base-stationary loads; Moving loads and critical speed.

Fluid structure interaction-structures in steady flow and structures in waves; Structural damping; Numerical methods associated with hydroelasticity problems - mode matching method, conjugate gradient method, finite element and boundary element methods; Application of hydroelasticity - Sloshing in vertical caisson, hydroelasticity of multi-module structures, wave ice interaction and wave interaction with floating and submerged structures, high speed vessel, very large hinged vessels, array of elastically connected cylinders, risers and pipelines.

R.E.D.Bishop and W.G.Price, "Hydroelasticity of ships"; Cambridge University Press, 1979.
S.K.Chakrabarti and C.A.Brebbia, "Fluid structure interaction", Southampton; Boston: WIT Press, 2001.
S.K.Chakrabarti and C.A.Brebbia, "Fluid structure interaction and moving boundary problems IV", Southampton: WIT Press, 2007.
S.K. Chakrabarti, "Handbook of offshore engineering", Amsterdam; London: Elsevier, 2005.
S.K. Chakrabarti, "Hydrodynamics of offshore structures", Southampton: Computational Mechanics; Berlin: Springer Verlag, 1987.

MS 821 Offshore Renewable Energy **(3-0-0) 3**

Wave Energy: Description of wave oscillation; Wave power and energy transport; Resonance absorption; Wave transport of energy and momentum; Description and operation of various wave energy converters for inshore and offshore application; Design of wave environment; Maximum power absorption from ocean waves, Hydrodynamic characteristics of wave energy converters, Response of floating structures; Time and frequency domain numerical methods.

Wind Energy: Design of offshore wind turbines; Mounting/mooring arrangements; installation; Design of wind environment; Aerodynamic characteristics of horizontal and vertical axis wind turbines; Aerofoil theory; Boundary element method; Momentum method; Boundary element momentum method.

Tidal Energy: Current stream devices; Barrage systems hydrodynamics characteristics of tidal devices; Wave and current effects. Energy storage: Transmission and distribution issues and solutions.

Joao Cruz, "Ocean Wave Energy: Current Status and Future Perspectives", Springer Verlag, 2007.
Johannes Falnes, "Ocean Waves and Oscillating Systems", Cambridge University Press, 2002.
John Twidell and Gaetano Gaudiosi, "Offshore Wind Power", Multi-Science Publishing Co-Ltd, UK, 2009.
Wei Tong, "Wind power generation and wind turbine design", WIT Press, 2010.
R.H. Charlier, C.W. Finkl., "Ocean Energy: Tide and Tidal Power", Springer Verlag, 2009.

MS 822 Computational Marine Hydrodynamics (3-0-0) 3

Numerical hydrodynamics: Averaged Navier-Stokes Equations; Pressure Equation for an Incompressible Fluid; Vorticity Equation; Inviscid Fluid Mechanics; Euler's Equation; Bernoulli Theorems for Inviscid Flow; Vorticity Dynamics and Kelvin's Circulation Theorem; Potential Flows and Mostly Potential Flows; Green Functions, Green's Theorem and Boundary Integral Equations; Kelvin-Neumann Problem; Kelvin-Neumann Green Function; Derivation of Gauss' Theorem; Froude-Krylov Surge Force on a Ship; Transport Theorem; Pressure Forces and Moments on an Object.

Numerical methods for scientific computation: Numerical solution to non-linear equation; Approximation of functions; Numerical solution to differential equation; Numerical solution to system of linear equation; Numerical Integration; Simpson's Rule; Euler's Method, Modified Euler's Method; Fourth Order Runge-Kutta Method; Predictor-Corrector Methods; Higher Order Differential Equations; Numerical Hydrodynamics Problems; Solution of Partial Differential Equation.

Boundary Condition of Perturbation Potential; Three Dimensional Flows; Two Dimensional Panel Methods; Two-Dimensional Steady Boundary Layer Equations; Boundary Layer Parameters; Sea Spectra; Fourier Transforms; Computational FFT and IFFT of Real Numbers; Simulation of Random Waves; Potentials and Boundary Conditions; Simulations of Ship Motions in Random Seas.

Hans-Gerhard Ramming**, "**Numerical Modelling of Marine Hydrodynamics: Applications to Dynamic Physical Processes", Elsevier, 2000.

O.M Faltinsen, "Sea Loads on Ships and Offshore Structures", Cambridge University Press, 1990.

Whitham, G.B. "Linear and Nonlinear Waves", John Wiley & Sons, 1974.

Kendall E. Atkinson**, "**An Introduction to Numerical Analysis", John Wiley & Sons, 2008.

MS 823 Fundamentals of Submarine Hydrodynamics (3-0-3) 3

Under Sea Environment; Submarine Controls; Hydrostatic and Stability: Static Control; Ballast Tanks; Stability when Surfacing and Bottoming; Manoeuvring and Control: Manoeuvring in Horizontal and Vertical Plane; Manoeuvring Limitation; Submarine Manoeuvring Trials; Resistance and Flow: Components of Resistance; Prediction of Submarine Resistance; Propulsion: Propulsor/Hull Interaction; Axisymmetric Hull with Single Propeller; Prediction of Propulsor Performance; Appendage Design: Forward Control Surfaces; Aft Control Surfaces.

N Bruggen and L. Wisedale, 1996. Model Submarine Technology: Radio Control Systems, Auxiliary Functions, Diving Techniques, Attitude Control, Traplet Publications Ltd.

P.R Franklin, 2015. Handbook of Submarine Operations, Frontier India Technology.

M. Renilson, 2015.Submarine Hydrodynamics, Springer, New York.

N. Friedman, 1984. Submarine Design and Development, Conway Maritime.

MS 824 Computational Hydrodynamics Lab (0-0-3) 2

Numerical Simulation for Coastal Erosion; Sediment Transport; Modelling of Tidal Hydraulics; Wind and Wave Generated Currents and Storm Surges using MIKE21.

Design and Analysis of Offshore Structures; Dynamic response due to Environmental Loads; Pile Structure Interaction using SACS.

Numerical Modelling using MATLAB.

MIKE 21 & MIKE 3, 2005. Flow Model, Hydrodynamic Module, DHI, Denmark.

SACS Bentley User Manual, USA.

R.K. Bansal, A.K. Goel & M.K. Sharma, 2009. MATLAB and its Applications in Engineering, Pearson.

MS825 Foundation for Offshore Structures (3-0-0) 3

Basic soil properties: correlation between engineering parameters, geotechnical investigation, bore log. Pile foundation: Jacket main piles, skirt piles, driven piles, drilled and grouted piles, steel and concrete piles, axial capacity, point bearing and skin friction, factor of safety, lateral load on piles, p-y, t-z and q-z curves, pile group effect, scour around piles, Seabed subsidence and design of piles against seabed movement, negative skin friction, cyclic degradation, main pile to jacket connections, skirt pile to jacket connections, API RP 2A provisions. Pile installation: Minimum pile wall thickness, pile handling stresses, static and dynamic stresses, pile stick up, stresses during stick up, wave and current loads, hammer selection, pile driving stresses, wave equation analysis, pile driving fatigue, API RP 2A provisions. Pile Testing: Working load test, ultimate load test, pile monitoring during driving, pile integrity Testing, high strain dynamic testing, rebound method. Special foundations: Mud-mats: bearing capacity, sliding stability,

overturning stability, short term and long Term settlements, factor of safety, bucket foundation, suction anchors, gravity foundation. Use of SACS software in the analysis and design.

Bowles, J.E.,2001. Foundation analysis and design, McGraw Hill.
Poulos, H.G and Davis, E.H., 1980. Pile Foundation Analysis and Design, John Wiley.
Winter Korn and Fang, 2001. Foundation Engineering hand book
Prakash S., 1981. Soil Dynamics, McGraw Hill.
API Recommended practice, 2000. 2A-WSD (RP 2A-WSD),
API Recommended practice, 2000. 2A-WSD (RP 2A-LRFD)

MS826 Design of Offshore Structures (3-0-0) 3

Loads on Offshore Structures: Wind Loads; Wave and Current Loads; Calculation based on Maximum base Shear and Overturning Moments; Design Wave heights and Spectral Definition; Hydrodynamic Coefficients and Marine growth; Fatigue Load Definition and Joint Probability distribution; Seismic Loads. Concepts of Fixed Platform Jacket and Deck: Jacket concepts, redundant framing arrangement; Launch and Lift jackets; Simple Deck configurations for Lift and float-over installations; In-service and Pre-service Loads and analysis. Steel Tubular Member Design: Principles of WSD and LRFD; Allowable stresses and Partial Safety Factors; Tubular Members, Slenderness effects; Column Buckling, Design for Hydrostatic pressure; Design for combined axial and bending stresses (API RP 2A guidelines). Tubular Joint Design for Static and Cyclic Loads: Simple tubular joints, design using allowable loads; stress concentration factors; S-N curves and fatigue damage calculations. Jackup Rigs: Configuration and operation of jackups; Simplified analysis; Spudcan Penetration and extraction; Spudcan – pile interaction; Design of jackup legs; Design against Accidental Loads (Fire, Blast and Collision): Behaviour of steel at elevated temperature; Fire Rating for Hydrocarbon fire; Design of structures for high temperature; Blast Mitigation-Blast walls; Collision of Boats and energy. Use of SACS software in the analysis and design.

Subrata K.Chakrabarti,2005. Handbook of Offshore Engineering, Elsevier.
Y.Goda, 2010. Random seas and design of marine structure, World Scientific.
Dawson, 1983. Offshore Structural Engineering, Prentice Hall.
A.S. Arya and J.L. Ajmani, 1996. *Design of steel structures*, Nem Chand Bros, Roorkee.
Johon E. Lothers 1999. Advanced Structural Design in Steel.
API Recommended practice, 2000. 2A-WSD (RP 2A-WSD)
API recommended practice, 2000. 2A-WSD (RP 2A-LRFD)

RS701 Introduction to Remote Sensing & Photogrammetry (3-0-0) 3

Principles of Remote sensing, Satellites and Sensors, Aerial Photography, Elements of photogrammetry, Satellite data products, Visual interpretation Colour concept, Multispectral , Thermal and Hyperspectral remote sensing. Microwave remote sensing- SAR and SLR, Laser Altimetry.

Sabins, Remote Sensing Principles and Interpretation, W. H. Freeman and Company, NY
Lillesand, Thomas & Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons
Avery & Belin Interpretation of Aerial Photographs, Bergess Minneapolis, Minn
Jensen, Remote Sensing of the environment - An Earth Resource Perspective, Pearson Education

RS702 Introduction to Geographic Information Systems (3-0-0) 3

Introduction to GIS principles , raster and vector-based GIS and data structures, Spatial data sources, Generation of thematic maps, Georeferencing, Digitization , Data Editing, Edge Matching and Mosaicing, Linking Spatial and Non Spatial Data, Errors and quality Control, Data Storage, Data formats, Geo-databases, Database concepts, Database management in GIS- Introduction to Visual Basic for applications , Data manipulations: attribute operations, area/distance calculations, overlay analyses. Map Projections: Global Positioning System

Chang, KT, Introduction to Geographic Information System, 4th Edition, Tata McGraw Hill.
Burrough & McDonnell, Principles of Geographical Information Systems, Oxford University Press
Yang, Snyder & Tobler, Map projection Transformation principles and applications, Taylor and Francis
Jan Van Sickle, GPS for land surveyors, Sleeping Bear Press

RS703 Remote Sensing Lab (0-0-3) 2

Familiarization with image annotations, Visual Interpretation -- Use of Procom II, Light Table, Dynascan , Digital Planimeter, Aerial Photo Interpretation - Stereoscopes, Parallax bar, GPS -- Distance measurement, Area Measurement , Ground truth Radiometer

RS704 GIS Lab (0-0-3) 2

Hands on experience on Commercial GIS software, ARC Info Master lab Kit, Arc GIS, Geomedia Professional and Geomedia Grid Open Source GIS Softwares.

RS705 Satellite Digital Image Analysis (3-1-0) 4

Introduction, Digital Analysis - Sources of error, Image rectification and restoration: Image Enhancement Multi-image manipulation. Image Classification, Supervised, unsupervised, Analysis of hyperspectral data, change detection studies.

Jensen, J.R.,Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall
ERDAS-Imagine 8.4, Tour Guide and Field Guide.
Lillesand, Thomas & Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons

RS706 Advanced Geographic Information Systems (3-0-0) 3

Statistical analysis, Measurement, Proximity analysis (buffering), Overlay analysis, Network analysis, Multicriteria analysis, site suitability analysis, Nearest neighbour analysis, Surface mapping, interpolation (including TIN), digital elevation model (DEM), Terrain classification- slope aspect, angle of incidence etc, Visibility analysis, Varigram and Kriging, Regression and correlation analysis, Gravity modelling, change detection, phystho Scripl

Chang, KT, Introduction to Geographic Information System, 4thEdition, Tata McGraw Hill.
Atkinson & Tate, Modelling Scale in Geographical Information Science, John Wiley & Sons
Shekhar & Chawla, Spatial Databases: A Tour, Prentice Hall

RS707 Satellite Digital Image Analysis Lab. (0-0-3) 2

Hands on Exercises with ERDAS, ENVI

RS708 Design Project (0-0-3) 2

Students will be given a topic for Design Project at the end of first semester. Evaluation of the project will be carried out at the end of second semester. The objective of this project is to address some applied or theoretical concepts in RS & GIS and to prepare a scientific report on it.

RS709 Applications of Unmanned Aerial Vehicles in Civil Engineering (2-0-2)3

Basics of Aerial Photogrammetry using unmanned Aerial Vehicles, Theory and Techniques of Orientation, Project Planning for Aerial Photogrammetry, georeferenced 2D maps and 3D models, 3D Point Cloud, Digital Surface & Terrain Model, Volume calculation, Contour line, 3D textured model and its applications in archelogy and mining, Thermography and multispectral imaging

P. Wolf and B. Dewitt 2014. Elements of photogrammetry, 3rd edition, , by, McGraw-Hill Book Co.
Manual of Photogrammetry, 2010. 5th edition, 2010 American Society of Photogrammetry.
F. Moffitt and E. Mikhail, 1980. Photogrammetry, 3rd edition, Harper & Row, Inc.
Valavanis, K., Vachtsevanos, George J. (Eds.) 2010. Handbook of Unmanned Aerial Vehicles (Volume 1).

RS801 Applications of RS & GIS in Agriculture & Soil Science (3-0-0) 3

Agricultural area mapping, Agricultural Planning, Suitability analysis of Agricultural land, Estimation & Forecasting of crop acreages and production, Identification of Optimal crop combination regions in different environments, Monitoring & Forecasting of crop health, Soil resources mapping, Soil classification on the basis of soil depth, color, texture, moisture content, chemical composition etc. through GIS.

RS802 Applications of RS & GIS in Town & Country Planning (3-0-0) 3

Land use/Land cover Analysis, Change detection in Land use/ Land cover, Site suitability analysis for residential, commercial, recreational, religious, medical, waste material disposal sites for Urban and Regional planning, Network Analysis for sewage, communicational, telecom, traffic flow in town and country planning, Parcel based studies for any ward of a town route networking, shopping complexes, parking space, sewage line, etc.,

Creation of databases of cities for municipal corporations, Urban population identification, control and management, Urban slums: Trend, pattern and management, Waste land mapping and management, Land

evaluation analysis, Generation of city information system

RS803 Applications of RS & GIS in Forestry, Ecology & Environment (3-0-0) 3

Forest mapping & classification, Study of Bio-diversity in different Biomes, Forest Fire: Identification, Control, Estimation of losses and management, Environmental Planning & Management, Study of Ecological imbalances and controls, Monitoring and forecasting of vegetation Health, Deforestation and Land degradation: Identification, control & management.

RS804 Applications of RS & GIS in Earth Sciences (3-0-0) 3

Geological mapping Lithology and structure, Geomorphological mapping Altimetric and Planimetric analysis, Oil and mineral exploration, Ground water and surface water potential mapping, Snow melt runoff forecasting, Natural Hazard and disaster (Earthquakes, Volcanic eruptions, Landslides, Avalanches, Flood, Drought, etc): Zone mapping, Forecasting, estimation of losses and management, Monitoring ocean productivity and coastal zone management.

RS805 Selected Topics in Remote Sensing and GIS (3-0-0) 3

RS 806 Aerial Photography and Digital Photogrammetry (3-0-0) 3

Principles and operation of GPS/DGP , Topographic maps and remote sensing images: map scale and content, image sources and interpretation methods, accuracy issues Introduction: aerial photography in the context of other remote sensing systems , Physics of light: principles of recording the image, Stereoscopy and parallax, Geometry: scale variation, relief displacement, tilts, Geometry of vertical aerial photographs: geometry, co-ordinate axes, scale, measurement, Softcopy photogrammetry, Digital elevation models, Air photo mosaics and orthophotos, Interpretation: principles and factors, Applied interpretation: geology, geomorphology, vegetation, soils, urban structures, Flight planning, API project management and implementation, Recent developments - digital aerial photographs, scanning existing photography.

Mikhail, Bethel and McGlone. 2001. Introduction to Modern Photogrammetry, John Wiley and Sons, Inc., New York.

Philipson (1997). 2nd edition, Manual of photographic interpretation, edited by American Society for Photogrammetry and Remote Sensing.

Kasser, Michael - Egels, Yves. Digital photogrammetry. London : Taylor & Francis, 2001

Wolf R.P , Elements of Photogrammetry McGraw-Hill, 2000

RS 807 Microwave Remote Sensing (3-0-0) 3

Electromagnetics:Fundamental background information., Electric and magnetic fields, waves,and dielectrics,Coordinate systems, and the divergence and Stokes' theorems., Faraday's law and the Maxwell-Ampere law., Maxwell's equations, time-harmonic form, Plane wave propagation, general relationship between E and H., Polarization, propagation in a lossy medium, propagation of electromagnetic power. Characteristics of antenna patterns. Radiometry: Passive microwave remote sensing, Polarized radiation, coherence, radiometry vs. radar. Fundamental radiometric units, source of brightness, and the Planck law. Irradiance, and absorptivity, emissivity, reflectivity, transmissivity. adiative transfer, simple examples, and atmospheric structure and composition.

Ulaby, F. T., R. K. Moore, and A.K. Fung, Microwave Remote Sensing: Active and Passive, Vol. I -- Microwave Remote Sensing Fundamentals and Radiometry, Addison-Wesley, Advanced Book Program, Reading, Massachusetts, 1981, 456 pages. Ulaby, F. T., R. K. Moore, and A.K. Fung, Microwave Remote Sensing: Active and Passive, Vol. II -- Radar Remote Sensing and Surface Scattering and Emission Theory, Addison-Wesley, Advanced Book Program, Reading, Massachusetts, 1982, 609 pages.

WR701 Applied Hydromechanics (3-0-0) 3

Basic concepts and equations of Ideal and Real fluid flow, stream & potential functions, Basic flow patterns of ideal fluid flow and their superposition, lift-drag. Laminar flow, Navier-Stokes equations, exact solutions, Boundary layer concepts and equations. Turbulent flow and theories of turbulence, Reynolds equations, Power, logarithmic velocity distribution, flow through pipes. Varied flow equation and methods of computation, methods for natural channels, flow over spillways, hydraulic jump, types of spatially varied flow, Demarchi's equation for side weirs.

H.R. Vallentine, Applied hydrodynamics

Raudkivi & Callander, Advanced Fluid Mechanics

French, Open Channel Hydraulics

WR702 Surface Water Hydrology (3-0-0) 3

Importance/Applications, Water Budget, Catchment hydrological cycle, hydrometeorology. Rainfall, interception, infiltration, soil moisture, evapotranspiration, runoff, groundwater (process description measurement spatio-temporal data analysis, estimation of each). Rainfall runoff modeling, Unit Hydrograph, Flow routing, Flood

estimation, Time series modeling.
Chow et al, Applied Hydrology
VM Ponce, Engineering Hydrology

WR 703 System Approach & Optimization Techniques in Water Resources Engg. (3-1-0) 4

Definition of a system, classification, steps in system design. Water resources systems, Concept of a system, Classification, systems analysis techniques, Issues in system approach, Advantages and limitations, Objectives of Water Resources development, steps in system design. Linear Programming: Formulation, Graphical method, Simplex method, Primal-dual relationship, introduction to sensitivity analysis, Application of LP. Dynamic Programming (DP) and applications in Water Resources Engineering. Network models -Transportation models , WR System as a network flow problem, Non-linear programming, Unconstrained and constrained Optimization, Lagrange multipliers method and Kuhn - Tucker conditions. Multi-objective models, Plan formulation and selection techniques.

D.P.Loucks et al., Water Resources Systems Planning and Analysis
Ravindran et al., Operations Research - Principles and Practice.
S.S.Rao, Engineering Optimisation
F.S.Hiller and G.J.Liberman, Introduction to Operations Research.
Y.Y.Haimes,Hierarchial Analysis of Water Resources Systems

WR 704 Groundwater Hydrology (3-0-0)3

Occurrence of groundwater, types of aquifers, formulation of governing equation for groundwater movement, groundwater budget, mechanics of well flow-solutions to unsteady flow to fully and partially penetrating wells in confined/unconfined, non-leaky aquifers, well design criteria, parameter estimation; Finite difference/finite element modeling for groundwater flow, Pollutant transport in groundwater, Seawater intrusion in coastal aquifers; Artificial recharge, water-logging, Stream-aquifer interaction, Conjunctive use management of surface and groundwater.

Mc Whorter, D.B. and D.K. Sunada. Groundwater hydrology and hydraulics, Water Resource Pub., Fort Collins, USA, 1977.
Fetter, CW. Applied hydrogeology, CBS Publishers, New Delhi, 2nd Edition, 1990. Todd, D.K. Groundwater hydrology, John Wiley, 1980.
Rushton, K.R. and Redshaw SC. Seepage and groundwater flow, Arnold, London,1976.
Karanth, K.R. Groundwater assessment, development and management, Tata McGraw Hill, New Delhi, 1987.

WR705 Hydrology & Hydraulics Lab (0-0-3) 2

Experiments on flumes and field hydrology problems

WR706 Design of Hydraulic Systems (3-0-0) 3

Objectives of hydraulic structures in Water Resources Systems. Preliminary investigation and preparation of reports. Design of water storage structures:1) High dams- Gravity dam (zonal method design), overflow & non overflow section 2)Low dams - weirs, earthen dam, vented dam (Barrage). Instrumentation and maintenance of dam structures. Collection and conveyance of water. Design of Intakes. Conveyance systems for irrigation, drinking and hydropower. Design of canal networks. Hydraulic design of pressure pipes, hydrostatic tests on pipes. Design of distribution system-pressure in distribution system. Nomographs, Hardy Cross & numerical methods. Computer aided design (application of CAD)

Creager, Justin & Hinds, Engineering for Dams, Vols. I, II, III
Varshney, Hydraulic & Irrigation Structures
Mays, Handbook of Water Resources

WR707 Infrastructural Project Management (3-0-0) 3

Project - definitions, characteristics, life cycle phases, types. Pre-feasibility, Techno-economic feasibility &Detailed Project reports. Project economics, Project economic evaluation. Project Risk - measures, types. Risk analysis - sensitivity analysis, scenario analysis, Monte Carlo simulation, Decision trees. Decision making under risk and uncertainty. Project organization, Work Breakdown Structure. Contracts, Tendering, Disputes, Arbitration. Construction Planning & Management, Scheduling tools - Bar charts, CPM, PERT (brief description only). Resources allocation - smoothening & leveling.Materials management and inventory control, Equipment/machinery management and economic analysis.

S Chawdary, Project Management
P.K. Joy, Total Project Management
P Chandra, Projects Planning Analysis.

WR 708 Sustainable Water Management (3-0-0) 3

Water resources management-purpose, water managers, sustainability, comprehensive framework for sustainable water management. Water and environmental law. Financial planning and management-economic analysis, benefit cost ratio, total economic value evaluation, water allocation. Reservoir operation- deterministic flow, reservoir sizing, sequent peak analysis, conjunctive use management- water budget, models, water harvesting.

Grigg, N.S., Water Resources Management, McGraw Hill, New York, 1996. A. S.
Goodman, Principle of Water resource Planning, Prentice Hall,1998.
Y. Heiman, Hierarchical analysis of water resources Systems, McGraw Hill, 2003.
Lorry W. Meyer, Water Resources Handbook, McGraw Hill,1993. James,
S. & Lee, W., Economics of Water Resources,1982.

WR800 Irrigation Technology & Water Management (3-0-0) 3

Basic soil physics- soil properties, soil water storage and movement in vadose zone. Climatic variables. Crop water requirements, irrigation water requirements. Irrigation scheduling. Types of irrigation schemes, methods of irrigation. Components of surface irrigation scheme, micro-irrigation methods (sprinkler, drip)- design features. Drainage system-components and design. Irrigation water quality, salt balance, soil salinity problems & remediation. Farm irrigation management schemes- conjunctive use, deficit irrigation, water allocation schemes. Socio-economic, institutional and environmental aspects of irrigation systems. Performance indicators- water production functions, economic productivity.

Larry James, Principles of farm irrigation system design
NH Rao, Irrigation scheduling with limited water supplies, CBIP Publ. 218 Smedema & Reycroft, Land Drainage, Batsford Academic

WR801 Finite Element Applications to Flow Problems (3-0-0) 3

Introduction to partial differential equations, numerical methods, initial and boundary value problems, weighted residual techniques. Galrekin finite element method, element families, formulation of element equations, global matrix, higher order elements, solution techniques application of Galerkin. FEM to various surface and subsurface flow problems.

P.S. Huyakern and G F Pinder, Computational methods in sub-surface flow, Academic Press, 1983
J.Donea, Finite Element methods for flow problems, Applied Publishers, 2003

WR802 Computational Methods in Subsurface Flow (3-0-0) 3

Partial differential equations in subsurface flow, initial and boundary value problems, solution methodology. Finite difference method -various schemes and their solution, simulation of single phase subsurface fluid flow. Finite element method - Galerkin method, element families, solution of steady and transient groundwater flow problems. Boundary element method - Basic concepts, application to one and two dimensional sub-surface flow problems. Method of characteristics and its applications, Analytical elements, infinite elements and applications.

P.S. Huyakern and G F Pinder, Computational methods in sub-surface flow, Academic Press, 1983
J.Bear and A.Verruijit, Modelling groundwater flow and pollution, 1988

WR803 Integrated River Basin Development (3-0-0) 3

Necessary conditions for river basin development Heceristic approach, sequential approach, components of river basin development, conjunctive use of surface water and groundwater, planning design and development of regional groundwater system in a river basin. Inverse modeling in regional GW system. Role of industries, NGO and VO in river basin development, Socio-economic factors rehabitation, concept of sustainable development, some typical case studies.

T.M.Chaturvedi, Water Resource Systems
W.G.Yeh, Groundwater Management

WR804 Fluvial Hydraulics (3-0-0) 3

Basic characteristics of river-beds and sediments. Sediment related problems. Sediment properties: physical, bulk, chemical. Modes of sediment movement and transport, Regimes of flow. Initiation of motion, Shields criteria, Critical velocity, Critical shear, Lift concept. Bed forms and resistance to flow, Suspended sediment transport, governing equations, measurement, computation. Bed load transport, computation of bed load, measurement. Total load computation. Design of stable channels, Critical Tractive Force approach.Reservoir sedimentation, aggradation and degradation of natural channels, Local Scour phenomenon, catchment erosion processes Graf, Sediment transport

Henderson FM, Open Channel Hydraulics
Garde & Rangaraju, Alluvial Stream Problems

WR805 Selected Topics in Water Resources Engineering & Management (3-0-0) 3

WR 806 Geo-informatics Applications in Water Resources Engineering (3-0-0) 3

The electromagnetic spectrum and atmospheric considerations, Spectral Characteristics, Sensors and platforms :Data Products , Image Interpretation and Analysis GIS and GPS , Applications: Land use/land cover, NDVI, Evaluation of surface and ground water resources, Watershed Management, flood inundation modelling and mapping.

Lillesand, T.M., R.W. Kiefer, and J.W. Chipman. 2004. Remote Sensing and Image Interpretation. 5th Edition. John Wiley & Sons.
Sabins, F.J. Jr. Remote Sensing: Principles and Interpretation. Third Edition. W.H. Freeman and Company, New York. 1996.
John R Jensen, Remote Sensing of the Environment An Earth Resource Perspective 2nd Edition, Dorling Kindersley India Pvt Ltd
M.G. Srinivas(Edited by), Remote Sensing Applications, Narosa Publishing House, 2001.
Mischael Hord, "Remote Sensing Methods and Applications", John Wiley & Sons, New York, 1986.

WR807 Water Quality Modelling & Management (3-0-0) 3

Water quality description, various characteristics of water, water quality criteria and standards, elements of reaction kinetics, spatial and temporal aspects of contaminant transport, transport mechanisms - advection, diffusion, dispersion. Rivers and streams, convective diffusion equation and its applications**.** Estuaries, estuarine hydraulics, estuarine water quality models. Lakes and reservoirs, eutrophication. Contaminant transport in unsaturated flow, solute transport models for conservative species, solute transport in spatially variable soils. Contaminant transport in groundwater, advection, dispersion, one dimensional transport with linear adsorption, dual porosity models, numerical models, biodegradation reactions. Water quality management, socio-economic aspects of water quality management, management alternatives for water quality control, waste load allocation process, lake quality management, groundwater remediation.

Thomann,& Mueller, Principles of Surface Water Quality Modeling and Control
Chapra Surface Water-Quality Modeling
Schnoor, Environmental Modeling
Thomann,. Systems Analysis and Water Quality Management

WR 809 Soft Computing in Civil Engineering (3-0-0)3

Fuzzy logic-Classical sets and fuzzy sets, fuzzy sets operations, fuzzy relations, Membership functions, de-fuzzification, fuzzy rule based systems, Applications. Artificial neural network-Model of a neuron, learning rules, activation functions, single layer perceptron networks, multilayer feed forward networks, back-propagation algorithm, Hopfield networks, Applications. Genetic algorithm-Fitness function, genetic algorithm operators-reproduction, crossover, mutation, schemata and schema theorem, Applications.

Ross T.J., Fuzzy logic with engineering applications-McGraw Hill, *1995*
Haykin S., Neural networks-a comprehensive foundation-Prentice Hall,2nd edition, 1998.
Goldberg D., Genetic algorithms- Addison-Wesley, 1st edition,1989.

WR 810 Applied Hydrology (3-0-0)3

Hydrologic cycle. Introduction to hydrologic models-deterministic, probabilistic, conceptual, parametric. Rainfall runoff transformation: unit hydrograph concepts, systems concept, response functions, SCS-CN method, rational method. Statistical treatment of hydrological data: PDF, frequency analysis of rainfall, low flow, flood, drought. Basic concept of stochastic hydrology. Flow routing; Hydraulic and hydrologic routing. Reservoirs: capacity, operation, sedimentation, rule curves. Urban hydrology

Chow. V.T.,.Maidment. D. R, and .Mays L. W, Applied Hydrology McGraw Hill,1988
Maidment. D. R, Handbook of Hydrology, McGraw Hill,1993

WR 811 Hydrological Processes (3-0-0)3

Introduction to the major hydrological processes and field measurement techniques. Elements of evaporation phenomena and plant growth: Weather Phenomena (solar radiation and energy balance on the earth's surface, air temperature, wind speed, humidity of air and transport of water vapor in the air). Evaporation from water bodies, bare soil, vegetation (transpiration) and methods of Evaporation estimation (Penman, Penman-Monthieth, Hagreaves, Turc, etc). Interception, throughfall, depression storage. Unsaturated (vadose zone) phenomena: Infiltration, water flow and retention in the unsaturated zone and method of estimations, (Horton's model, Holtan model, Darcy equation, Richards's equation, Green-Apt equations, etc) and other empirical methods.

Chow. V.T.,.Maidment. D.R, Mays L.W., Applied Hydrology,McGraw Hill,1988.
.Maidment. D. R, Handbook of Hydrology, McGraw Hill,1993.

WR 812 River Engineering and Sediment Transport (3-0-0)3

Watershed erosion and yield modeling concepts. Hydraulics of loose boundary channels; sediment transport (suspended load, bed load and total load); Dispersion and diffusion in channels and fluid transport of contaminants. Aggradations and degradation problems; local scour and its protection measures; special alluvial problems. Design of stable channels. River engineering: channel morphology, methods of river training.

Mays L.W., Water resources engg,John Wiley,USA,2001.
Chow. V.T., Open channel hydraulics, McGraw Hill,1959.
AndreRrobber.River processes:An introduction to alluvial dynamics,Arnold,London,1995.

WR 813 Water Resources Systems Analysis (3-0-0)3

Definition of system, System modeling and simulation, System planning model for hydropower,
Objective functions, constraints and resources input with reference to operation model of hydro-power systems, Simulation and search procedure, Linear programming and Dynamic programing, Hydropower project planning and economic analysis, hydropower components, Investment and socio-economic analysis/ costs, Economic profitability analysis, Optimization of water resources schemes.

Loucks. D.P., Stedinger. P.J.R., Haith D.A., Water resources systems planning and management, Prentice Hall, New Jersey,1987.
Hall A.K and Droup. J. A., Water resources systems engineering, Tata McGraw Hill, 1970.

WR 814 Integrated Watershed Management (3-0-0)3

Introduction and basic concepts of watersheds; Sustainable watershed approach & watershed management practices; Integrated watershed management- integrated approach, conjunctive use, rainwater harvesting; Watershed modelling-modelling approaches, system concept, hydrologic processes, rainfall, run-off, sub-surface flow; Socio-economic aspects, RS&GIS in watershed management; Water quality management – sources of pollution, water quality modelling, environmental guidelines; Flood and drought management; Principles of water conservation and recycling.

Murthy JVS 1998. Watershed management, New Age International, New Delhi.
V. Lazarova, and Akica Bahri 2004. Water re-use for irrigation. CRC Press, London.
Black Peter E. 1991. Watershed hydrology, Prentice Hall, London.
CWC Report 2005. General guidelines for water audit and water conservation. Ministry of Water Resources, New Delhi

DEPARTMENT OF CIVIL ENGINEERING

CV800 Environmental Geotechnology (3-0-0) 3

Perspectives of Environmental Geotechnology, Soil - Environment water Interaction, Mass transport, Energy Gradient & Conductivity, Sources of water, Contamination - under ground, ground water, Flow conditions, Contaminate migration, Disposal and Containment of Solid water, Remediation.

Donald P. Coduto, Geotechnical Engineering Principles and Practices, Prentice-Hall
Daniel, D. E. Geotechnical Practice for Waste Disposal, Chapman and Hall, London.
Reddi, L. N., and Inyang, H. F., Geoenvironmental Engineering- Principles and Applications, Marcel Dekker, Inc.

CV801 Environmental Impact Assessment (3-0-0) 3

Planning and Management of Environmental Impact Studies. Methodologies, Prediction and assessment of impacts, evaluation of alternatives. Case Studies. Sustainable development; Environmental policy.

Canter L.W., Environmental Impact Analysis, Mc. Graw Hill.
Srivastava A.K, Environmental Impact Analysis, APH Pub., New Delhi.

EN701 Environmental Quality & Mon (3-0-3) 5

Environmental Chemistry - Basic concepts from general chemistry, Acid -Base Equilibria, Solubility Equilibria, removal of heavy metals from complex water and wastewater systems, Oxidation-reduction Equlilibria, Water Stabilization, Water softening and neutralization. General principles of sample collection and data analysis.

Microbiology - The characterization, classification and identification of microorganisms, Pure cultures and cultural characteristics, Enzymes and their regulations, Microbial metabolism, Control of microorganisms. Microbiology of domestic water and wastewater, industrial microbiology. Epidemiology of infectious diseases, microbial agents of diseases.

Laboratory Practices : Gravimetric methods for solids analysis in water and wastewater, analysis of common cations and anions in water/wastewater, determination of nitrogen, phosphorus and chemical oxygen demand (COD). Titrimetric methods; Electrochemical methods; Spectrophotometric methods; Nephelometric methods; Atomic Absorption spectroscopy; Biochemical oxygen demand (BOD), MPN test for microbial pollution, plate counts; confirmatory tests.

Sawyer C.L, McCarthy, P.L and Parkin, G.F. Chemistry for Environmental Engineering. McGraw-Hill.
Pelczar M.J., Chan E.C.S. and Krieg, N.R. Microbiology. Tata McGraw-Hill.
Julia Levy, Campbell, J.J.R and Henry Blackburn, T., Introductory Microbiology, John Wiley and Sons.

EN702 Physico-Chemical Processes for Water & Wastewater Treatment (3-1- 0)4

Water Quality, Physical, chemical and biological parameters of water, Water Quality standards, Water quality indices. Water purification systems in natural systems, physical processes, chemical processes and biological processes. Primary, Secondary and tertiary treatment. Unit operations, unit processes. Aeration and gas transfer, Sedimentation, Filtration, Adsorption, Ion Exchange-processes, Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis, Disinfection

Weber, W.J. Physicochemical Processes for Water Quality Control, John Wiley and Sons.
Peavy, H.s, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw -Hill.
MetCalf and Eddy. Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, Tata McGraw-Hill.

EN703 Air, Noise & Solid Waste Management (3-1-0)4

Air pollutants, Sources, classification, emission, Effects on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects. Particulate emission control, and other removal methods like absorption, adsorption, precipitation etc., Air quality models. Noise Pollution- sources, mitigation. Municipal Solid Waste: Generation, Rate Variation, characteristics (Physical, Biological and Chemical); Management Options for Solid Waste, Waste Reduction at the Source, Collection techniques.

Wark Kenneth and Warner C.F, Air Pollution its Origin and Control. Harper and Row, Publishers, New York
Sincero A.P. and Sincero G.A. Environmental Engineering, Prentice Hall.
Manual of Solid Waste Management, Ministry of Urban Development, Govt. of India.

EN704 Biological Processes Design for Wastewater Treatment (3-1-0) 4

Waste waters-Sources, nature and characteristics, Process Kinetics, Enzyme reactions Reactor Analysis, Design of wastewater treatment systems, Activated Sludge and its process modifications, Biological Nitrification and denitrification, Aeration systems, Treatment Ponds and Lagoons, Attached Growth

Biological Treatment Systems, Anaerobic processes, Sludge Disposal, Waste water reclamation and reuse, Effluent disposal, Stream Sanitation, Biotechnological tools like bioremediation, genetically modified organisms etc. for environmental management.

Benefield, L.D and Randall C.W. Biological Processes Design for Wastewaters, Prentice Hall.
Quasim, S.R. Wastewater Treatment Plants Planning, Design and Operation, CBS Publishing.
Van Haandel A.C & Lettinga G. Anaerobic Sewage Treatment, John Wiley and Sons Ltd. Chichester

EN705 Environmental Engineering Lab (0-0-6) 4

Examination of Microorganisms. Reactor design and operation - demonstration, session: laboratory biochemical reactor, coagulation, chlorination of water, heavy metal removal, colour removal, Absorption studies using activated carbon. Estimation of suspended particulate matter and pollutants in air using high volume sampler.

American Public Health Association et al, Standard Methods for the Examinations of Water and Waste Water, APHA.
Aneja, K.R.,Experiments in Microbiology, Plant Pathology and Tissue Culture, Wishwa Prakashan, New Delhi. Manual of methods of General Bacteriology, ASM Publication.

EN801 Earth & Environment (3-0-0) 3

Understanding the Earth, atmosphere and processes governing environmental conditions; the geologic, tectonic, hydrological and biogeochemical cycles. Study and significance of natural resources; renewable biological resources, wildlife conservation/management, fisheries, forestry, energy resources, energy consumption, scarcity and conservation; mineral resources, mineral availability and recycling; air, water and soil resources. World food supply; ecological impacts of modern agriculture, organic farming. Major environmental concerns.

Heijungs, R. Environmental Life Cycle Assessment of Products. Center of Environmental Science, Leiden.

EN802 Transport of Water & Wastewater (3-0-0) 3

Transport of Water: Water Storage and Transmission: pumps and pumping units, Materials for pipes: Specification for pipes, pipe appurtenances, control devices. Distribution Systems : Principles of design, analysis of distribution networks, maintenance of distribution systems, Transport of Wastewater: Concept of model based design - hydraulic fundamentals of design models - Basic properties and model formulations for the design of wastewater of collection system - transitions in flow of sewage. Storm Drainage: rainfall data analysis - hydraulics. Equipment requirement for O & M; preventive maintenance - monitoring safety requirements.

Fair G.M. Geyer, J.C., Okun, D.A. Water and Wastewater Engg. Vol.I and II, John Wiley, New York, 1981

EN803 Air Quality Management (3-0-0) 3

Atmospheric diffusion of pollutants and their analysis, Transport, transformation and deposition of air contaminants on a global scale, Air sampling and pollution measurement methods, principles and instruments, Ambient air quality and emission standards, Air pollution indices, Air Act, legislation and regulations, control principles, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods. Biological air pollution control technologies; bioscrubers, biofilters, Indoor air quality

Wark Kenneth and Warner C.F, Air Pollution its Origin and Control. Harper and Row, Publishers, New York

EN804 Models for Water & Air Quality (3-0-0) 3

Introduction to Mathematical Models: Modeling approaches to water quality - classification of models - considerations in selecting models, Model requirements and limitations. D.O. Models for Streams, Models for Estuary and Lakes, Air quality models. Application of available softwares in water, air and distribution networks.

Thomann, R.V., and Mueller, A.J. Principles of surface water quality modelling and control, Harper and Row, New York.

EN805 Solid & Hazardous Waste Management (3-0-0) 3

Municipal Solid Waste : Generation, Rate Variation, characteristics; Management Options for Solid Waste, Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations and Disposal Techniques. Norms, Rules and Regulations. Economics of the on-site v/s off site waste management options. Integrated waste management. Introduction to Hazardous wastes, Definition of Hazardous waste, Risk assessment,

Transportation of hazardous waste, Current Management Practices: Environmental audit, Containment, remedial alternatives.

C.N. Haas and R.J. Vamos. Hazardous and Industrial Waste Treatment. Prentice Hall, Englewood Cliffs, New Jersey.
Freeman, H.W. Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw Hill, 1989

EN806 Environmental Systems Analysis (3-0-0) 3

Introduction to natural and man-made systems. Systems modeling as applied toenvironmental systems, the model building process, addressing to specific environmental problems. Strategies for analyzing and using environmental systems models. Application of optimization methods. Integrated management strategies

Weber W.J. Jr. Environmental Systems and Processes, Wiley Interscience.

EN807 Management of Water, Waste & Sanitation Utilities (3-0-0) 3

Introduction to management of Water and Sanitation, Development programmes, Feasibility planning. The role, objectives and techniques of project management to deliver effective and efficient infrastructure services, Project Appraisal, Contract management, Strategic Management, Change Management, Financial & Marketing management for non-financial water managers, Sustainable water and material flux management, Environmentally sound technologies for fresh water and wastewater management, Water quality surveillance programmes. The Emergence of Public Services Transnational Corporations and their Strategies in the Water Sector. Concept of Water Markets and the role of national and federal governments.

Mays, Urban Water Supply Handbook, McGraw Hill.

EN808 Membrane Processes for Water & Waste Treatment (3-0-0) 3

Introduction to membrane separation processes, Membrane filtration, dead and filtration, Cake filtration, Reverse osmosis, Nanofiltration, Ultrafiltration, Microfiltration, Membranes and modules, MF/UF experimental set up, Laws of MF/UF, Limiting Phenomena, Economic study, Applications, Case studies.

American Water Works Association Research Foundation, Water Treatment- membrane processes, McGraw Hill.

EN809 Industrial Waste Treatment (3-0-0) 3

Special nature of Industrial wastes, Sources and Characteristics, equalization/neutralization, treatment - based on specific case studies of major industrial processes like Food and dairy, distillery, fertilizers, pulp and paper, textiles, petrochemicals, power generation, electronics and IT etc.

Eckenfelder, Wesley W. Jr., Industrial Water Pollution Control, McGraw Hill.

EN810 Environmental Issues based on Case Studies (3-0-0) 3

Current issues of National Importance like River basin disputes, National/Inter National Environmental Policy, Global Conflicts etc. to be discussed.

EN811 Remote Sensing & GIS (3-0-0) 3

Fundamentals of Remote Sensing, Concepts, Sensors, Interpretation and Analysis Techniques, Indian Satellites, Applications of GIS.

Thomas N. Lilles and and Keifer - Remote Sensing and Image Interpretation, John-Wiley.

Anji Reddy - Remote Sensing and GIS- Anshan Pub.

EN812 Selected Topics in Environmental Engg. (3-0-0) 3

EN813 Ecotechnology (3-0-0) 3

Water budgeting, crop irrigation, Ecotechnology in crop plants, Sewage farming and utilization of waste water and solid wastes, wetlands and Root zones. Waste handling by Composting, Vermi compost other degradable biomass waste handling, Ecosanitation. Biodegradation: principle and ecorestoration. Green technology and green chemistry. Case studies about solid wastes from different industries and reuse.

Eco technology for Pollution Control and Environmental Management, R. K. Trivedi, Arvind Kumar, Enviromedia, Karad.

EN814 Environmental Biotechnology (3-0-0) 3

Concepts, Definitions, criteria, Bio treatment options for soil and ground water contamination, Bio accumulation, Bio fertilizers, agro technologies, Bioremediation and eco restoration using plants and microorganisms. Role of GMO in environmental biotechnology field with different examples.

Environmental Bio technology, Geeta bali et.al. APH Publishing, New Delhi.

EN815 Industrial Pollution Management (3-0-0) 3

Concepts, benefits, waste reduction, waste audit, environmental audit, ISO 14000, ISO 18000 series standard, Total quality management Life cycle design / assessment, process industries, cost benefit analysis, EIA and EMP, Good Management Practices, problems of small industries, case studies.

Industrial Pollution Prevention Handbook, Freeman H.M., McGraw Hill Inc.

EN816 Environmental Microbiology (3-0-0) 3

The Characterization, classification and identification of microorganisms, Pure cultures and cultural characteristics, Enzymes and their regulations, microbial metabolism, control of microorganismz. Microbiology of domestic water and wastewater, industrial microbiology. Epidemiology of infectious diseases, microbial agents of diseases.

Pelczar, M. J., Chan E.C. S. and Krieg, N. R. Microbiology. Tata McGraw-Hill Publishing Company Limited, New Delhi.

EN 817 Environmental Management (3-0-0) 3

Principles of Environmental Management, Policy and Legal aspects of Environmental Management, Environmental Management Techniques, Environmental Design, Environmental Economics, Case studies.

Kulkarni V and Ramachandra T.V., Environmental Management, Capital Publishing, Banglore
North K, Environmental Management, ILO, Geneva
Sapru R.K., Environment Management in India, Ashish Publishers, New Delhi. Kumor A., and Oti, Environment Management, APH Publishers, New Delhi.

EN818 Environmental Toxicology (3-0-0)3

Defintion branches Taxicology, role of Taxicologist, causes of toxicity, types of toxicity, occurence of toxciants, damage process and action of toxicants, factors afftecting xenobiotic action., defense responses to toxicants, aquate and environmental toxicity, aquatic toxicology tests & their types, environmental impact interpretation, some important terminologies in toxicology, recent advaces in toxicity analysis.

W.G Lands M.H Yu, Introduction to environmental toxicology, CRC press

EN819 Environmental Hydraulics (3-0-0)3

Basic equations for fluid flow analyses, Reynolds transport theorem, Fundamental Relationships for Flow and Transport, Diffusion and dispersion, Derivation of diffusion equation, Solution of diffusion equation, Advective diffusion, Turbulent diffusion, Transport Processes in Rivers, Modelling the movement of pollutants in ground water, Treatment Plant Hydraulics, Hydraulic profiles, Distribution networks.

Clark, M.M., Transport Modeling for Environmental Engineers & Scientists, John Wiley & Sons, 1996.
Martin J.L. and McCutcheon S.C. Hydrodynamics and Transport for Water Quality Modeling, CRC Press, 1999.
Chapra, S.C. Surface Water Quality Modeling McGraw Hill Book Co, 1997.
Ranga Raju K G, Flow through Open Channels, Second edition, Tata McGraw-Hill Company Ltd, 1997.
Singh, Vijay, Hager, Willi H. (Eds.), Environmental Hydraulics, Kluwer Academic Publishers, 1996.
Tsanis, I.K., Wu, J., Shen, H and Valeo, C. Environmental Hydraulics, Elsevier Publications, 2007.
Bhave P R, Analysis of Flow in Water Distribution Network, Technomic Publishing, 1996.

EN820 Modelling Waste Water Treatment Processes And Plants (3-0-0)3

Basis of wastewater modeling (kinetics, stoichiometry, mass balances, hydraulics, mixing and matrix notation) - An introduction of existing International water Association Quality (IWAQ) models (ASM1, ASM2, ASM3, ASM2d) - Selection of computer programs in which the models can be built in; Procedures for characterization of wastewater and sludge and the protocol for the development of calibrated activated sludge models- Case studies on modeling wastewater treatment plants. Applications of computer programs viz. ASIM, AQUASIM, SIMBA, WEST, SCADA as a tool of modeling wastewater treatment processes.

Henze, M., Gujer, W., Mino, T and M.C.M. van Loosdrech, Activated Sludge Models ASM1, ASM2, ASM2d and ASM3, IWA publishing, 2002
D. Brdjanovic, S.C.F Meijer, C.M. Lopez-Vazquez, C.M. Hooijmans, M.C.M. van Loosdrecht, Applications of Activated Sludge Models, IWA Publishing, 2014.
Leiv Rieger, Sylvie Gillot, Guenter Langergraber, Takayuki Ohtsuki, Andy Shaw, Imre Takacs, Stefan Winkler, Guidelines for Using Activated Sludge Models, IWA Publishing, 2012

GT700 Basic Geomechanics (3-1-0) 4

Concepts of failure and yield in soil, Failure theories, Effective stresses in soils, Microstructural considerations, Stress-path concepts and their applications. Shear Strength of soils and rocks, Mohr-Coulomb strength theory, Shear strength tests, Stress-deformation characteristics. Critical state concepts and their application, constitutive relationships. Deformation analysis, components of settlement, permissible settlements, consolidation settlements .Flow through soils.

Mitchell, J.K. Principles of Soil Behavior, John Wiley

Lambe, T.W. and Whitman, R.V. Soil Mechanics, Wiley Eastern.

GT701 Shallow Foundations (3-0-0) 3

Assessments of foundation loads, Choice of foundation types,Determination of bearing capacity by theoretical approaches, penetration tests and plate load tests, Proportioning of footings by conventional and uniform settlement methods,, Structural design(limit state) of shallow foundations, Expansive soils- Problems and remedial measures. Footings on layered soils and sloping grounds.

Bowles, J.E., Foundation analysis and design, McGraw Hill.
Swamisaran S., Design of substructures, Oxford and IBH publishers
Winterkorn and Fang, Foundation Engineering handbook, Von Nostran Reenhold Co.

GT702 Geotechnical Engineering Lab (0-0-3) 2

Identification of soils, Index properties, Hydraulic properties, Shear strength properties, Settlement characteristics, parametric studies. Rock testing, Demonstration of SPT and Pressuremeter.

Lambe, T.W.,Soil testing, Wiley International.
Relevant latest IS Codes.
Head,K.H., Manual of soil laboratory testing, Volumes 1-3.

GT703 Earth & Earth Retaining Structures (3-0-0) 3

Introduction, Rankine and Coulomb theories, Graphical method, Passive earth pressure by curved rupture surface, Stability analysis of gravity type, Cantilever type, Counterfort type retaining walls, Design of Soil reinforced retaining walls. Braced excavations, Analysis and design of sheet piles, Stability of slopes, Finite and infinite slopes, Swedish circle method, Taylor's modified Swedish circle method, Taylor's stability charts and Bishop's method of analysis.

Terzaghi K, and Peck,R.B., Soil Mechanics in engineering practice, McGraw Hill.
Bowles, J.E., Foundation analysis and design, McGraw Hill.

GT704 Pile Foundations (3-1-0) 4

Shallow vs. deep foundations, Classification of pile foundations, axial load carrying capacity of a single pile by different methods, negative skin friction, pile group efficiency, distribution of load to piles in groups, Design of piles and pile cap; settlement analysis of single pile and pile groups; Laterally loaded piles, batter piles, under-reamed piles; Construction of pile foundation, pile driving equipments and Pile load tests; durability and protection of piles, economics of pile foundations.

Tomlinson, M.J., Pile Design and Construction Practice, E and FN Spon.
Poulos, H.G and Davis, E.H., Pile Foundation Analysis and Design, John Wiley
IS 2911

GT705 Ground Improvement Techniques (3-0-0) 3

Introduction to engineering ground modification, need and objectives, Soil stabilization techniques; Mechanical modifications (shallow and deep compaction methods); Hydraulic modification, Dewatering systems, use of Geosynthetics and Prefabricated vertical drains, Preloading and Vertical drains; Chemical Modifications, Modification by admixtures, grouting, deep jet mixing methods, stabilization using industrial wastes; Modification by inclusion and Confinement.

Hausmann, M.R.,Engineering Principles of Ground Modification, McGraw-Hill.
Purushotham Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi.

GT706 Computational Lab for Geotechnical Engineers (0-0-3) 2

Slope stability analysis by different methods, Analysis and design of single pile and pile groups. Use of FEM software(Plaxis) to Geotechnical problems.

Bowles J.E, Foundation analysis and design, McGraw Hill.
Iqbal H. Khan , A text book of Geotechnical Engineering, Prentice-Hall

GT801 Rock Mechanics (3-0-0) 3

Engineering classification of rocks, Engineering properties of intact rocks, Determination of insitu properties - shear strength, deformation, insitu stress, strength of jointed rocks, stability of rock slopes, Bearing Capacity determination, Ground improvement techniques in rock masses, Rock blasting.

Jaegar and Cook, Foundation of rock masses.
Goodman, Introduction to rock mechanics, Wiley international

GT802 Soil Dynamics & Machine Foundations (3-0-0) 3

Dynamic loads, Types of machine foundations, Theory of free and forced vibrations, Dynamic soil properties, mass spring dash pot model, elastic half space model, damping in soils, Design of machine foundations, Foundations under reciprocating engines, Foundations for machines producing impact loads, Vibration Isolation.

Barkan, Dynamics of Bases and Foundations, McGraw Hill.
Richart R.E., Hall Ward Woods, Vibrations in soils and foundations, Prentice Hall.
Prakash S., Soil Dynamics, McGraw Hill

GT803 Advanced Engineering Geology (3-0-0) 3

Introduction, interior of the earth, weathering, Earthquakes, soils, mineralogy, petrology, study of igneous, sedimentary, metamorphic rocks, Engineering properties of rocks and their assessment, structural geology, geological structures, Dip and strike, folds, faults, joints, unconformities and their importance, clay mineralogy, stratigraphy, Hydrogeology, geophysical exploration, applied geology, geological investigations in dam projects, tunnel projects and in landslides, control measures.

Blyth, F.G.H & de Freitas, H.H., Engineering Geology, ELBS
Krynine & Judd, Principles of Engineering Geology and Geotechnics, McGraw Hill
Robert F. Legget, Geology and Engineering, McGraw Hill

GT804 FEM for Geotechnical Engineers (3-0-0) 3

Introduction; Single element - various shapes, displacement models, isoparametric elements, stresses and strains, stiffness matrices; The overall problem - an assemblage of elements; Techniques for nonlinear analysis; Application of FEM to soil and rock mechanics

Desai, C.S. & Abel, J.F., Introduction to Finite Element Method, CBS Publishers.
Gudehus, R.D., Finite Element in Geomechanics, John Wiley.

GT805 Earth & Rockfill Dams (3-0-0) 3

Introduction, site selection and exploration; Factors influencing design and design details; Treatment of rock foundations and abutments; Foundation treatment of Earth dams on pervious soils, controlling underseepage and relief wells; stability analysis; special design problems and details; measurements of porewater pressure and movements; Embankment construction procedures, equipments, quality control.

Sherard, J.C., Woodward, R.J., Gizienski, S.F. and Clevenger, W.A., Earth and Earth Rock Dams, John Wiley.
Sowers, G.P. and Sally, H.L., Earth and rockfill Dam Engineering, Asian Publ. House.

GT806 Geotechnical Instrumentation (3-0-0) 3

Requirements of a good instrumentation; Theory, Design, Methods of analysis of data; laboratory and field instrumentation; Planning an instrumentation program; transducers, hydrometers, strain measuring devices, load cells, LVDTs, pH meter etc, measuring rock and rock mass properties; settlement gauges, inclinometers, earth pressure cells, piezometers, instruments used in geophysical exploration methods, ground probing radar and instruments used in field tests such as SPT, SCPT, DCPT etc., nuclear moisture meter/densitometer, frequency analyzer, role of electronics in instrumentation; calibration, maintenance and installation of instruments, uncertainty analysis

Hanna, T.H., Field Instrumentation in Geotechnical Engineering, Trans-Tech Publ.
Bowles, J.E., Engineering Properties of Soils and their Measurements, McGraw Hill.

GT807 Selected Topics in Geotechnical Engineering (3-0-0) 3

Recent advances and current trends in Geotechnical Engineering

GT808 Soil Reinforcement & Geosynthetics (3-0-0) 3

Historical background, RCC, Vidalean concept of reinforced earth, Mechanisms, Types of reinforcements, Backfill soil properties, soil-reinforcement interaction studies, Internal and external stability criteria, Design principles of steep reinforced soil slopes, reinforced earth walls, MSE walls, reinforced soil footings, pavements, embankments on soft soils, geosynthetic clay liners, construction details; geosynthetic materials, functions, property characterization, testing methods for geosynthetics. Recent research & developments.

Koerner, R.M., Designing with geosynthetics, Prentice Hall Inc.
Jones, C.J.F.P., Earth Reinforcement and Soil Structures, Butterworths, Lodon.

ST700 Theory of Elasticity & Plasticity (3-0-0) 3

Elasticity : Definition and notation of components of stress and strain, Generalized Hooke's Law. Plane stress and plane

strains. Airy's stress function. Differential equations of equilibrium, Solution of two-dimensional problems using polynomials. Solution in rectangular and polar co-ordinates. Torsion of Prismatic, Circular and Rectangular bars. Prandtl's membrane analogy.

Plasticity : Introduction to plasticity, Criterion of yielding, Bending of prismatic beams, residual stresses, Plastic torsion.

S.P. Timoshenko and N.Godier, Theory of Elasticity, McGraw Hill
J. Chakrabarthy, Theory of Plasticity, McGraw Hill
Sadhu Singh, Theory of Plasticity, Khanna Publishers.

ST701 Finite Element Method (3-0-0) 3

Types of elements-Discretization of structures-Interpolation functions-Generalised and natural coordinates-Direct method of element formulation-Limitations-Variational method-Numerical integration-Timoshenko beam element-Plate bending elements-Mindlin element-Shell elements-Techniques for material and geometric non-linear problems.

C. S. Krishnamoorthy, Finite Element Analysis: Theory and Programming, Tata McGraw-Hill.
O. C. Zienkiewicz and R. L. Taylor, The Finite Element Method (vol. 1 and vol. 2), McGraw-Hill

ST702 Theory of Plates (3-0-0) 3

Thin and thick plates-deflection of laterally loaded plates-Navier and Levy's method-Energy and finite difference methods-Plate subjected to in-plane and lateral loads-Circular plate with symmetrical loading- Introduction to buckling of plates. Vibrations of Plates.

S. P. Timoshenko and S. W. Krieger, Theory of Plates and Shells, McGraw-Hill
S. P. Timoshenko and J. M. Gere, Theory of Elastic Stability, McGraw-Hill
A.W.Leissa, Vibration of Plates, NASA Special Publication

ST703 Structural Dynamics (3-0-0) 3

Types of dynamic problems. D'Alembert's principle, Equations of motion, degrees of freedom. SDOF systems - free and forced vibrations, support motion, vibration isolation, transmissibility, Duhamel's integral and its numerical evaluation. MDOF systems - Free vibrations, natural modes, orthogonality conditions, shear frame, matrix iteration for eigenvalues and eigenvectors, forced vibrations, mode superposition method, damping in MDOF systems. Vibrations of beams with different end conditions. Principles of earthquake resistant design, response spectrum and equivalent force concepts, Introduction to design code IS 1893.

Mario Paz, Structural Dynamics, CBS Publishers
Clough and Penzien, Dynamics of Structures, McGraw-Hill

ST704 Computer Lab (0-0-3) 2

Students should develop flow charts and programs for design and detailing of RC elements. Analysis of structures using available softwares.

ST705 Advanced Design of Concrete Structures (3-1-0) 4

Review of limit state design method. Design of floor systems, ribbed slabs, hollow cored slabs, grid floors, yield line analysis, strip method. Redistribution of moments, continuous beams and frames. Industrial buildings, purlins, crane gantry girders, precast roof systems, shell and folded plate elements, double pitched roof beams, trusses, columns, corbels, deep beams, R.C. walls. Storage structures, silos and bunkers, PSC pipes and water tanks. Raft and pile foundations.

Mark Fintel, Hand book of concrete engineering, ReinHold, New York 1995
N. Krishna Raju, Advanced reinforced concrete design, CBS Publishers 1996.
P. Purushothaman, Reinforced concrete structural elements Tata McGraw Hill 1994.

ST706 Advanced Design of Steel Structures (3-1-0) 4

Review of design of structural members and connections, Bolted and welded connections - Flexible, Semi-rigid and rigid connections. Design of Industrial buildings - Trussed bents, rigid frames, Vierendeel girders, open web structures and castellated beams, beams with openings. Multi storey framed structures, bracings, semi-rigid joints. Design of steel and concrete composite beams, columns, floors. Design of light gauge cold formed steel sections. Plastic design - beams, rectangular and gable frames. Limit state design - tension members, compression members and beams. Design of silos and bunkers.

Johon E. Lothers - Advanced Structural Design in Steel
Lynn S. Beedle - Plastic Design of Steel Frames
Handbook of Open-web Structures - CMERI - Durgapur

Teaching Resoruce for Structural Steel Design for Faculty of Civil Engg- INSDAG, Kolkatta

ST707 Shells and Folded Plates PREREQ: ST702 (3-0-0) 3

SHELLS - Classification of shells, Membrane and bending theory of circular cylindrical shells, Beam method for Cylindrical shells. Membrane theory of doubly curved shells - Pucher's stress function, Applications for spherical dome, Conical shell, Hyperboloid of revolution, Elliptic paraboloids, Conoids, Hyperbolic parabolids. Folded Plates - behaviour, Whitney's and Simpson's Methods, beam method.

Ramaswamy G.S, Design and Construction of shell roofs, CBS Publishers. K Chandrashekhara, Analysis of thin Concrete Shells, Tata McGraw-Hill.

ST708 Structures Lab (0-0-3) 2

Concrete Mix Design by different methods, Strain measurements using mechanical and electrical strain gauges. Study of Structural behaviour of beams and columns, Non-destructive testing of concrete.

ST800 Stability of Structures (3-0-0) 3

Concept of Stability, Bending of prismatic bars under simultaneous action of axial and lateral loads- Buckling of solid and open web columns, Critical loading on laced and battened columns, Lateral stability of beams-Analysis of beam columns-Instability of frames, Local buckling and post-buckling behaviour of plates and shells, Bifurcation buckling and limit-load analysis, Application of Energy methods, Numerical methods for solving elastic stability problems.

S. P. Timoshenko and J. M. Gere, Theory of Elastic Stability, McGraw-Hill
N.G.R.Iyengar, Structural Stability of Columns and Plates, East-west, Press.

ST801 Earthquake Engineering (3-0-0) 3

Earthquakes Magnitude and intensity, earthquake waves, seismic zoning maps, seismic risk and hazard, ground response spectrum, site amplification, liquefaction, selection of design earthquakes, peak ground acceleration. Earthquake analysis of structures, idealization, equivalent force concepts, response spectrum analysis, concepts of earthquake resistant design: ductility, lateral stiffness, strong column-weak beam design. Seismic retrofitting and repair. Concepts of base isolation and structural response control. Introduction to IS codes -IS 1893, IS 4326, IS 13935, IS 13920.

Newmar. N.. M. and Rosen Bluethe, Fundamentals of Earthquake Engineering, Prentice Englewood cliffs.
Dowrick D. J, Earthquake Resistant Design, A marval for Engineers & Architects, John Wiley.

ST802 Structural Optimization (3-0-0) 3

Classical optimization techniques, Linear Programming - Simplex method, Nonlinear programming Unconstrained optimization techniques - Steepest descent method, DFP Method, Constrained techniques - SLP and SUMT, Introduction to GA. Applications to structural design problems, computer implementation.

S.S. Rao, Optimization - Theory and Applications, Wiley Eastern Ltd.
Kalyanmoy Deb, Optimization for Engineering Design, Prentice Hall of India.

ST803 Soil Structure Interaction (3-0-0) 3

Soil-Foundation Interaction. Soil response model, Elasto-plastic behaviour, Time dependent behaviour. Beams on Elastic Foundations, Analysis of beams of finite length. Plates on Elastic medium, Infinite plates, thin and thick plates. Elastic analysis of piles, Analysis of pile groups, Interaction analysis.

A.P.S. Selva durai, Elastic Analysis of Soil-Foundation Interaction.
H.G.Poulos and E.H. Davis, Pile-Foundation Analysis and Design, John Wiley & Sons
R.F.Scott, Soil Mechanics and Engineering, McGraw Hill.

ST804 Safety of Structures (3-0-0) 3

Basic statistics and probability theory - Characteristics of random distributions, Levels of significance and confidence, Statistical distributions. Reliability theory, Structural reliability - level 1, 2 and 3. Characteristics of load and resistance - FOSM and AFOSM methods of assessment. Interpretation of safety. Determination of partial safety factors.

Ranganathan, Reliability Analysis and Design of Structures, GMH.

ST805 Offshore Structural Engineering (3-0-0) 3

Common offshore structures - jacket, gravity-type, hybrids, guyed towers, TLP, compliant structures. Environmental loadings - wind, waves, ice, buoyant, earthquakes, Diffraction theory and Morison equation approach for wave force. Static analysis - steel structures, concrete platforms, design stress criteria, Examination for dynamic

effects. Foundation analysis - piles, pile axial capacity, Bearing capacity of footings, Settlement of foundations. Dynamic analysis - governing equations for wave loadings, stress analysis, response to earthquake loadings.
Dawson, Offshore Structural Engineering, Prentice Hall

ST806 Advanced Concrete Technology (3-0-0) 3

Structure of Concrete - Concrete as a three-phase material - Strength Properties of Concrete - Compressive, tensile, shear, bi and tri-axial stresses; Deformation Characteristics of Concrete - elastic deformations, shrinkage, creep and thermal properties; Durability of Concrete - Permeability related problems, Alkali-aggregate reactions. Chemical and Mineral Admixtures, Concrete Mix Design Procedures, Testing and Quality Control of concrete - Conventional and non-destructive tests.
Mehta P.K. & Monteiro P.J.M, Concrete-Microstructure, Properties and Materials, Indian Cannet Intitute.
Neville A.M., Properties of Concrete, ELBS.
Sandor Popovics, Concrete Materials - Properties, Specifications and Testing , Standard publishers.

ST807 Wind Resistant Design of Structures (3-0-0) 3

Tall buildings - Structural concepts, wind effects, Lateral systems for steel buildings, concrete buildings and composite constructions - Shear walls and bracings; Gravity systems for steel buildings, concrete buildings and composite constructions. Analysis and design of Steel Transmission line towers, R.C. chimneys, R.C. cooling towers.
Bungale S. Taranath, Structural Analysis and Design of Tall Buildings, McGraw Hill. G.M.
Pinfold, Reinforced Concrete Chimneys and Towers, View point publisher. S.S. Murthy and
A.R. Santhakumar, Transmission line Structures.

ST808 Mechanics of Composite Laminates PREREQ: ST702 (3-0-0) 3

Types and Classification of composite materials. Composite Laminates, Lamina stress-strain relationship-Classification of laminates-Failure theories-Classical lamination theory-Stress strain variation in a laminate-Stress analysis-Intra and interlaminar stresses in laminates-First and higher order deformation theories-Bending, vibration and buckling analyses using the above theories-Equilibrium equations using PMPE-Boundary conditions-Solution methods.
R. M. Jones, Mechanics of Composite Materials, McGraw-Hill.
J. R. Vinson and R. L. Seierakowski, The Behaviour of Structures Composed of Composite Materials, Martinus Nijhoff Publ.

ST809 Advanced Bridge Engineering (3-0-0) 3

Review of IRC and IRS loadings. Effect of concentrated loads on deck slabs, load distribution methods for concrete bridges. Analysis and Design of superstructures -T beam and slab, bridge, Box girder bridge, Prestressed bridge, Balanced cantilever bridge, rigid frame, arch, bow, string girder. Steel plate girder and trussed bridges, Composite bridges, Cable-stayed bridges, Dynamics response of bridge decks.
D.J. Victor, Essentials of Bridge Engg., Oxford & IBH
N. Krishna Raju, Design of Bridges, Oxford & IBH M.S.
Troitsky, Cable Stayed Bridges, VNR.

ST810 Analysis & Design of Substructures (3-0-0) 3

Introduction, Bearing Capacity of shallow foundation, proportioning and designing of isolated footing, combined footing, strap footing and raft foundation. Pile foundations - Types of piles, Load carrying capacity of single pile and pile groups. Analysis design of pile group and pile cap. Analysis and design of various types of retaining walls.
Swamisaran S., Design of Substructures, Oxford & IBH
Bowles, J.E., Foundation Analysis and Design, McGraw Hill.
Tomlinson M J, Pile Design and Construction Practice, E & FN spon.

ST811 Computer Aided Design in Structural Engineering (3-0-0) 3

Computer Aided Design Concepts. Program planning and sequencing, Stages in structural design. Computer graphics, Artificial Intelligence, Knowledge-based expert Systems, Architecture and Applications of KBES, Principles of Neural Net works. Flow-charts and programs for design and detailing of RC Elements.
C.S.Krishnamoorthy and S.Rajeev, Computer Aided Design, Narosa Publishers.
H.B.Harrison, Computer Methods in Structural Analysis, Prentice Hall.
Adeli.H. and Balasubramanyan.K.V., Expert systems for Structural Design, Prentice Hall.

ST812 Selected Topics in Structural Engineering (3-0-0) 3

ST813 Repair and Rehabilitation of Structures (3-0-0) 3

Introduction, Deterioration process, Planning, Investigation and diagnosis, Testing techniques, Interpretation of results, Repair and renovation techniques, Repair materials, Surface coatings, Protection.

Allen, R.T.L. and Edwards, S.C., 'The repair of concrete structures'
Key, T., 'Assessment and renovation of concrete structures'
Emmons, P.H., 'Concrete repair and maintenance illustrated'

ST814 Prefabricated Structures (3-0-0) 3

Necessity, Advantages, Types of prefab elements, Modular coordination, Classification, Production techniques, Manufacture of precast and prestressing systems, Quality control aspects, Design aspects, Joints.

Bruggeling, A. S. G., ' Prefabrication with concrete'
Laszlo Mokk, 'Prefabricated concrete for industrial and public structures'

ST 815 Fracture Mechanics of Concrete (3-0-0)3

Introduction, failure of structures, Principles of Linear Elastic Fracture Mechanics, Nonlinear Fracture Mechanics, Structure and Fracture Processes in Concrete, Test methods for the Determination of fracture Parameters, Brittleness & Size Effect of Concrete Structure, Tension softening of the Concrete, Application of Fracture Mechanics to Concrete Structures.

Anderson T.L, Fracture Mechanics-fundamental and applications, CRC press
David Broek, Elementary Engineering Fracture Mechanics, Noordhoff
Surendra P Shah, Stuart E Swartz, Chengsheng Ouyang, Fracture Mechanics of Concrete, John Wiley & Sons.
Bhushan L Karihaloo, Fracture Mechanics & Structural Concrete, Longman Scientific & Technical.

TS701 Pavement Design (3-0-0) 3

Introduction to Pavement - types-factors affecting design and performance of pavements. Highway and Airport Pavements, Subgrade and climate, Stresses and deflections in Flexible Pavements, Flexible Pavement Design Methods for Highways and Airports, Stresses in Rigid Pavements, Rigid Pavement Design, Us**e** of advanced computer software for the design of flexible and rigid pavements

Yoder, E.J., Principles of Pavement Design, John Wiley & Sons
Yoder & Witczak, Principles of Pavement Design, John Wiley & So Sharma and Sharma, Principles & Practise of Highway Engg., Asia Publishing House.
Teng, Functional Designing of Pavements, McGraw , Hill.

TS702 Urban Transport Planning (3-1-0) 4

Transport Systems and Travel Demand: Overview of Major Transport Systems, Interactions with Industry, Transportation-System Components and Problems, Travel Demand, Demand Function, and forecasting. Transportation Planning Process: Trip Generation, Trip Distribution, Modal Split, and Trip Assignment. Land Use Transport Planning: Lowry Model, Garin-Lowry Model, Graph Theory, Entropy in Transportation, Commodity Flows, Urban goods movement.

Hutchinson, B.G., Principles of Urban Transport Systems Planning, McGraw Hill, London, 1974.
Bruton, Michael J., Introduction to Transport Planning, Hutchinson, London, 1970. Wilson, A..G., Entropy in Urban and Regional Modeling, Pion Ltd., London, 1970.

TS703 Transportation Engineering Lab (0-0-6) 4

Testing on Subgrade Soil, Testing on Road Aggregates, Tests on Bituminous Materials, Tests on Bituminous Mixes. Pavement evaluation: functional and structural evaluation.

Khanna, S.K. and Justo, C.E.G., Highway Material Testing, Nem Chand & Bros, Roorkee
I.R.C Specifications
I.S. Specifications

TS704 Traffic Flow Theory (3-0-0) 3

Traffic Studies and Surveys (Traffic Speed, Delay, Volume, and O-D Studies and Surveys, Time Mean Speed, Space Mean Speed and Lane Occupancy), Statistical Distributions in Traffic Engineering, Traffic Steam Models (Speed-concentration relationships, Flow-concentration relationship, Lighthill and Witham's Theory), Car Following Theory and Models, Queuing Theory and Applications, Vehicle Arrivals, Headways, and Gaps, and Simulation of Traffic.

Whol, Martin Traffic Systems Analysis for Engineers and Planners, McGraw Hill, London. Haight,
Frank A. Mathematical Theories of Traffic Flow, Academic Press, London.
Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi.

TS705 Transportation Design Studio (0-0-6) 4

Volume Studies, Speed and Headway Studies, Journey time and delay studies, Intersection delays, Parking Surveys, Driver characteristics, Interviews, Exercise on driver knowledge. Exposure to use of software such as TRANSYT

(for signal design), and MAAP (for accident analysis)
G.J. Pingnataro, Principles of Traffic Engineering, Mc Graw-Hill.
Wohl and Martin, Traffic System Analysis for Engineering and Planners, Mc Graw Hill.

TS800 Pavement Evaluation (3-0-0) 3

Structural and functional requirements of flexible and rigid pavements, pavement distress, different types of failures and causes, Pavement Surface Conditions- Pavement Slipperiness, Unevenness, ruts, Pot holes, cracks, Evaluation of Surface Conditions, Condition of Pavement Structures, Evaluation of Pavement Structural Condition, Model Pavements - Testing of model pavements under controlled conditions, test setup and instrumentation, Overlay design, Instrumentation in Pavement Testing

Babkov, Road Condition and Traffic Safety, Mir Publications
David Croney, The Design and Performance of Road Pavements, HMSO Publications

TS801 Advanced Modeling Techniques in Transportation Engineering (3-0-0) 3

Fundamentals of Artificial Neural Networks, and their applications, Basics of Genetic Algorithms and Simple Applications, Fuzzy-logic and its applications, Expert Systems and their Applications.

Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi.
Haykin, S. Neural Networks- A Comprehensive Foundation, NY: Macmillan. Press, 1994. George J.
Klir, and T. A. Folger., Fuzzy Sets, Uncertainty, and Information, Prentice Hall. Timothy J. Ross,
Fuzzy Logic with Engineering Applications, McGraw-Hill, Inc., 1995.
Harmon, P., and D. King., Artificial Intelligence in Business-Expert Systems, A Willey Press Book, J. Willey & Sons.

TS803 Soil Mechanics for Highway Engineers (3-0-0) 3

Functions of subgrade soil, importance of subgrade soil properties in highway engineering such as Design and performance of pavements, embankment foundations and slopes, Soil survey, Soil water, Detrimental matter in soils, Frost action in soil, Soil Compaction, Stress- Strain Relationships on Soils, Stress in Soils, Highway Embankments, Foundations, Stability Analysis.

RRL, DSIR, Soil Mechanics for Road Engineers, HMSO London
Leonards, Foundation Engineering, McGraw Hill Book Co.

TS804 Highway & Airport Geometric Design (3-0-0) 3

Design Controls and Criteria: Factors Influencing Functional Design of Highways, Design Controls and Criteria, Topography and Physical Features, Traffic, Impact of Vehicular Characteristics on Road Geometrics, Speed, and Safety. Cross-sectional Elements and Highway Geometrics: Cross-sectional Elements, Sight Distance, Horizontal Alignment, Vertical Alignment, Intersection Design, Parking and Other Facilities, Rotaries and Grade Separators.
Airport Design Standards, Airport Configuration and Planning

AASHO, A Policy on Geometric Design of Rural Highways and Urban Highways.
Khanna S.K., and Arora, M.G., Airport planning and Design, Nem Chand and Bros., Roorkee.
Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi.

TS805 Urban Mass Transport Systems (3-0-0) 3

Transit Classifications: Classes of Transit Modes, Modes, Technologies, Service Types, and routing. *Basic Transit* Management Activities: Service, Finance, Marketing, Maintenance, Demand Analysis, Transit Subsidies. *Transit* Terminals: Design, Functional Aspects, and Scheduling of Transit Units. Efficiency and Effectiveness Indicators for Transit Planning: System, Subsystem, and Route Level Analyses, Staff Utilization, Fleet Utilization and Productivity, Passengers Carried, Revenue, Operating Costs, and Break-Even Load, Capacity Utilization, Financial Performance indicators, Cost-Benefit Analysis. Bus transit operations: Planning, routing and scheduling, Location of loading and unloading platforms and transit terminals. Transport System Management Actions: Traffic management techniques for improving vehicular flows, preferential treatment for high occupancy modes, promoting non auto or high occupancy use, and transit and intermediate public transport service improvements. Demand management techniques for reduced traffic demand*:* staggered hours, and vehicle restrictions; Intersection management techniques: signal progression, optimization and computer controls; Small area Management: Management of Bicycles, Planning for pedestrians, and Planning for Parking.

Vukan, R. and Vuchic, A. Urban Public Transport Systems and Technology.
Morlok, E.K. Introduction to Transportation Engineering and Planning, McGraw Hill.
Transportation Systems Management: State of the Art, UMTA, US Dept. of Transport.

TS806 Traffic Engineering & Management (3-0-0) 3

Traffic Surveys and Traffic Flow: Traffic Survey and Analysis, Density speed and their relationships, Intersection maneuvers and operation; Level of Service: Highway Capacity and Level of Service Concepts, and Capacity under Heterogeneous Traffic Conditions; Accidents and Road Safety: Design of Traffic Control Signals - signal progression, optimization and computer controls. Traffic Demand Management: Traffic management techniques for improving vehicular flows, preferential treatment for high occupancy modes, promoting use of high occupancy transport modes, and improvements in transit and intermediate public transport services. Traffic demand management for reduced traffic demand: Staggered working hours, and vehicle restrictions; and Intersection Management Techniques.

Kadiyali, L.R.., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi
Pignataro, L., Traffic Engineering: Theory and Practice, John Wiley
Transportation Systems Management - State of the Art, UMTA, US Dept. of Transport.

TS807 Air Transport Planning & Design (3-0-0) 3

Airport Planning- Aircraft characteristics related to airport planning and design, airport master plan, site selection, planning surveys etc. Classification and Standards, Capacity and Delay, Terminal Facilities and Standards, The Demand Analysis, Optimal Route Frequency planning- Measure of air travel capacity, Approach to Demand Analysis, Microanalysis of Air Travel Demand, Calibration of Macromodels, Microanalysis of Air Travel Demand, Disaggregate Models of Air Travel Demand, Air travel Choice Models, Simultaneous Models of Demand and Supply. Optimal Route Frequency Planning, Air Traffic Controls.

Horonjeff, R and Mckelvey., The Planning and Design of Airports, McGraw Hill.
Kanafani, A., Transport Demand Analysis, McGraw Hill Book Company.

TS808 Highway Construction, Planning & Economics (3-0-0) 3

Equipment in Highway Construction, various types of equipment for excavation, grading and compaction-their working principle and advantages and limitations. Special equipment for bituminous and cement concrete pavement, stabilized soil road construction, Subgrade, Flexible Pavements : special materials, construction method and field control checks for various types of flexible pavement materials in sub-base , base, binder and surface course layers and their choice, Cement Concrete Pavements: Specifications, interlocking block pavements , joints etc., Soil Stabilised Pavement Layers, Drainage, Maintenance of roads, Hill roads

Peurifoy, R.L. Construction, Planning, Equipment and Method, McGraw Hill.
DSIR, Soil Mechanics for Road Engineers, HMSO London

TS809 Pavement Management System (3-0-0) 3

Components of Pavement Management systems, pavement maintenance measures, planning investment, research management, Pavement Performance Prediction: HDM and other models, Comparison of different deterioration Models, Functional Condition deterioration models, Unevenness prediction models and other models, comparison. Ranking and Optimization Methodologies, Design Alternatives and selection: Road Asset Management, Pavement Preservation Programmes, Techniques and Tools, Expert Systems and Pavement Management

Ralp Haas and Ronald W Hudson, Pavement Management System, McGraw Hill
Ralp Hass, Ronald Hudson and Zanieswki, Model Pavement Management, Kreiger Publications

TS810 Rural Roads (3-0-0) 3

Planning of rural roads, Location Surveys and Geometric Design, Pavement Materials: Soil Investigation, Properties and specifications of materials, Utilisation of locally available materials and waste materials in village road projects like fly ash, iron and steel slag, recycled and other waste materials etc., stabilized roads, road aggregates, materials for bituminous construction, cement concrete, special pavements. Pavement Design, Road Drainage, Construction and specifications, Maintenance of rural roads

HMSO, Soil Mechanics for Road Engineers, HMSO Office, London IRC,
Manual for Rural Roads, Indian Roads Congress.

TS811 Road Construction Planning & Management (3-0-0) 3

Various types of highway development projects in progress in India and their scope. Planning of new highway projects, consideration of alternative alignments, Planning different machinery for road project, their type, capacity and number, Optimum location of crushers, mixing plants, Planning various construction activities and their sequence. Application of CPM & PERT. Planning of road improvement and up-gradation projects, planning and construction method of road projects involving widening strengthening of existing road pavements, construction of new carriage-way for six - lane and four lane divided highway.

Peurifoy R.L., Construction, Planning Equipment Method, McGraw Hill
IRC Codes and MoTH Specifications

TS812 Road Safety & Traffic Management (3-0-0) 3

Road accidents, causes, scientific investigations and data collection, Analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, application of computer analysis of accident data, Safety in Road Design, Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists. Road safety issues and various measures for road safety. Traffic Management techniques

Babkov, V.F., Road Conditions and Traffic Safety, MIR Publications.
K.W. Ogden, Safer Roads: A Guide to Road Safety Engg, Averbury Technical, Ashgate Publishing Ltd., Aldershot, England.
Kadyali, L.R., Traffic Engineering and Transport Planning, Khanna Publications, New Delhi

TS813 Pavement Materials (3-0-0) 3

Aggregates : Origin, classification, requirements, properties and tests on road aggregates for flexible and rigid pavements, Importance of aggregate shape factor in mix design. Bitumen and Tar: Origin, Preparation, properties and tests, constitution of bituminous road binders, requirements, criterion for selection of different binders, Bituminous emulsions and Cutbacks: fillers, extenders, polymers, crum rubber and anti - stripping agents on pavement performance. Bituminous mixes, Cement Concrete for Pavement Construction

SRL, DSIR, Bituminous Materials in Road Construction, HMSO Publication
ISI and IRC Publications on relevant topics
Asphalt Institute, The Asphalt Hand Book

TS814 Selected Topics in Transportation Engineering (3-0-0) 3

TS815 Pavement Construction & Quality Control (3-0-0) 3

General Construction, Earth work, Construction of Earth, Gravel, WBM, WMM, Roads, Construction of Bituminous Pavements, Construction of Concrete Pavements, Roller Compacted Pavements, Joints Filler and Sealer, Reinforced Concrete Pavements, Prestressed Concrete Pavements, Maintenance of Flexible and Rigid Pavements, Quality control aspects of Various types of Flexible Pavements and Rigid Pavements.

Khanna, S.K. and Justo, C.E.G., Highway Engineering, Nemchand Bros, Roorkee, 2002
Yoder, E.J and Witezak, M.W.,(Second Edition) Principles of Pavement Design, John Wiley and sons

TS816 Traffic Simulation And Modeling (3-0-0)3

Introduction to Traffic Simulation; simple Probability Concepts; Different Probability Distribution (discrete and continuous distribution); Random Number Generation; Macroscopic Traffic Simulation: concepts of macroscopic models, first order traffic flow models (LWR Model), second order traffic flow models, Macroscopic Traffic Simulator: NETSIM; Mesoscopic Traffic Simulation: Concepts of mesoscopic models, application of mezzo models. Mesoscopic Traffic Simulator: DynaMIT; Microscopic Traffic Simulation: Concepts of microscopic models, Different types of car following models, lane changing and overtaking models, Different types of traffic simulation models; Microscopic Traffic Simulator: MITSIM, VISSIM; Traffic simulation models for mixed traffic conditions.

J. Barcelo, Fundamentals of Traffic Simulation, Springer, 2010.
A. M. Law and W. David Kelton, Simulation Modeling and Analysis, 4th edition, McGraw Hill, 2006
T. Toledo, Integrated Model of Driving Behavior, VDM Verlag Dr. Müller, Saarbrucken, Germany, 2008.
M. Treiber and A. Kesting, Traffic Flow Dynamics: Data, Models and Simulation, Springer, 2013

TS817 Public transportation (3-0-0)3

Modes of public transportation, comparison of transit modes and selection of technology for transit services. Bus transit operations. Efficiency and effectiveness indicators for transit planning: staff utilization. Fleet utilization, load factor, effective kilometer, earning per kilometer, cost per kilometer, fuel efficiency and profitability. Travel demand elasticity.

Performance evaluation of the public transportation system: Parametric and non-parametric methods, Benefit cost ratio, Analytical hierarchy process, Data envelopment method, Multivariate methods and related computations.

Vuchic A and Vukun R., Urban transit: operations, planning and economics, prentice hall, 2012
Morlok E.K., Introduction to transportation engineering and planning, McGraw hill,1978
Alvin C.Rencher and William F.Christensen,Methods of Multivariate Analysis, Wiley; 3 edition, 2012
Subhash C. Ray, Data envelopment analysis: theory and techniques for economics and operations research, Cambridge university press, 2012

TS818 Characterization and Modeling of Asphalt Mixtures (3-0-0) 3

Hot mix asphalt mix design concepts, classical methods, Superpave method. Modeling of asphalt concrete- Performance characteristics, future asphalt concrete modeling. Asphalt rheology – Mdoeling of asphalt binder rheology and its application to modified binders. Stiffness characterization –Comprehensive overview of stiffness, complex modulus characterisation of asphalt concrete. Constitutive models- viscoelastoplastic damage modeling of asphalt concrete. Models for rutting by simple shear tests, creep versus repeated loading, simple performance tests. Models for fatigue cracking and moisture damage. Models for low-temperature cracking in asphalt binders, mastics, and mixtures.

Y.Richard Kim, Modeling of Asphalt Concrete, ASCE PRESS, Mc Graw Hill, 2009.

E.Ray Brown, Prithvi S.Kandhal, Freddy L.Roberts, Y.Richard Kim, Dah-Yin Lee, Thomas W.Kennedy, Hot Mix Asphalt Materials, Mixture Design and Construction, Third Edition, NAPA Research And Education Foundation, Lanham, Maryland, 2009.

Relevant International Standards of ASTM, AASHTO, AI

TS 819 Infrastructure Development – Programmes, Planning and Appraisal (3-0-0) 3

Overview on infrastructure development polices of central and state governments in India. Programmes and initiatives for development of roads, railways, airports, and urban infrastructure in India. Planning of infrastructure projects-contexts, perspectives, and objectives. Project-wise studies and development of alternatives. Screening of alternatives and Master planning. Overview of various planning tools. Project appraisal by financial analysis, economic analysis, environmental and societal impact assessments. Concept of sustainable infrastructure development. Considerations to uncertainty and risk assessments.

Alvin S. Goodman and Makarand Hastak, Infrastructure Planning, Engineering, and Economics, Second Edition, McGraw-Hill Education, 2015.

CM700 Construction Planning & Control (3-0-0) 3

Principles of Project Management, Project Planning, Induction to Scheduling-work/project break down structures, Bar-Charts: principles of application of CPM and PERT; Precedence Method,; Updating; Time-cost tradeoffs, ResourceConstrained Scheduling; Resource Levelling Project Control; Performance Measurement, Earned Value; Multiple Construction Projects; Other Net Work Techniques; Project Management Software Packages

S. Chowdary, Project Management

P. K. Joy, Total Project Management

P. Chandra, Project Planning Analysis

Roy Pilcher, Principles of Construction Management Walker Antony, Project Management in Construction

CM701 Construction Economics &Accounting (3-0-0) 3

Economics-industrial development-Support matters of economy related to Engineering-Market Demand and Supply-quality control-quality production-Audit-economic law of production. Construction economics-Development in housing, transport and other infrastructure-Environment, Ecology Economics-Local Materials-Form and Functional Designs-Construction Workers-urban Problems-Poverty-Migration-unemployment-Pollution. Financing-Financial management-Types of Finance-long Term borrowing-Leasing-Equity Financing-Internal generation of Fund- External Commercial borrowings-Govt. Budgeting Support-International Finance Corporations-Analysis of Financial Statements-Balance Sheet-Profit and Loss Account-cash flow-Fund Flow Analysis-Ratio Analysis- Investment and Financing Decision-Financial Control-Job control-Centralized Management. Accounting-Cash

Basis-Accrual Basis-Percentage Completion Method-Completed Contract Method-accounting for Tax Reporting & Financial reporting purposes. Lending to Contractors-Loans-interim Financing-Risk and Security.

Kwaku A, Tena and Jose M Guevera, Fundamental of Construction Management and Organization

Halpin D W, Financial and Cost Concept for Construction Management

Warneer Z Hirsch, Urban Economics

CM702 Contracts & Specifications (3-0-0) 3

Construction Contracts - Elements of contracts- types of contracts - Design of contract documents - international contract document- Standard contract document . Tenders - Prequalification -bidding-accepting-evaluation of tender - potential contractual problems - World Bank procedures. Arbitration - Actions-laws-appointment of arbitrator-powers-rules of evidence. Legal requirements - Insurance-bonding-sale-purchase-land revenue codes-tax laws-income tax-sales tax-custom duties-influence on construction cost-legal requirement for planning-property law-agency law for approval-

statutory regulations.
Gajaria G. T., Laws relating to buildings and Engineering Contracts in India
Joseph T. Bockrath, Contracts and the Legal Environment for Engineers and Architects

CM703 Construction Materials Lab (0-0-3) 2

Study of properties of building materials; study of testing methods and standard specifications for strength and other properties of building materials; concrete mix design and testing; nondestructive testing methods; Studies on simple building system components

CM704 Construction Methods & Equipment (3-0-0) 3

Factors affecting selection of equipment and methods- Technical and economic; Construction Engineering fundamentals;Analysis of Production outputs and costs; Methods and equipment for Earthmoving, Lift and erection, Material Transport,Pile driving, Dewatering; Concrete Construction-batching, mixing, transport, placement, finishing, formwork, scaffolding;Steel Constructions-fabrication and erection.

CM705 Construction Quality & Safety Management (3-0-0) 3

Quality control, Accepting sampling, Statistical Quality Control: Total Quality Management(TQM)- Quality Function Development; Benchmarking, critical factors of TQM in Projects. Concepts of reliability- Types of failures, Component and System Reliability-Use of Redundancy - Interaction between Reliability and Maintainability - Replacement and Maintenance Policies -Design of Reliability. Safety Systems and Organization- Safety Laws- Hazard Analysis and Cost effectiveness- Logical Analysis of safety Systems- Organization, equipment Reliability Consideration - Fault- tree Analysis _ Statistical and Safety Analysis- Safety Information Systems -
Safety Budgeting
Jimmy W. Hinze, Construction Safety
Richard J Coble, Jimmy W. Hinze & Theo C Haupt, Construction Safety and Health Management.
John L Ashford, The Management of Quality in Construction

CM706 Organizational Behaviour (3-0-0) 3

Approaches to Organizational Behaviour; Overview of the Field of Organization Development: Individuals in Organizations: Motivation and behaviour; Motivation at work; Designing motivating jobs; Creating and individual decision making; Group Dynamics: Group behaviour, Inter-group relation and conflict; Communication; Leadership in Organizations. Characteristics of Organizations: Organization Structure and Design, Organizational change and Development; Organizational Culture and climate. Managing Innovation and Technology in changing environments. Case studies of OD interventions in mega-construction projects.
Gregery Moorhead, Ricky W. Griffin, Organizational Behaviour: Managing People and Organizations, 3rd Edition, Houghton Miffin Company, 2000
Stephen, P Robbins, Organizational Behaviour, 9th edition, Pearson Education Asia, New Delhi, 2001
Wendell L French, Cecil H. Bell, Jr., Organization Development: Behavioural Science Interventions for Organization Improvement, 6th edition, Pearson Education Asia, New Delhi, 2001.
Jit. S.. Chander, Organizational Behaviour, 3rd edition, Vikas Publishing House Pvt. Ltd.,, New Delhi, 2005.

CM707 Construction Software Laboratory (0-0-3) 2

Spreadsheet applications, Database applications, Project management software, Simulation software, Optimization Software, Visualization software- Construction applications

CM708 Construction Personnel Management (2-0-0) 2

Sources of lost time, productivity assessment tools such as productivity measurement system, work sampling, foreman delay survey; productivity improvement tools such as crew balance charts, process diagrams, Basic theories of motivation, leadership, communication and team behaviors adapted and applied to construction management; case studies.
Counter C., Coutler J. J., The Complete Standard Handbook of Construction Personnel Management, Prentice Hall, 1989
Loosemore M., Dainty A., Lingard, H., Human Resource Management in Construction Projects: Strategic and operational approaches, Spon Press Taylor & Francis Group, UK, 2003

CM800 Repair & Restoration of Structures (3-0-0) 3

Deterioration process in concrete structures, Construction and design defects. Diagnostic methods, Load testing and nondestructive testing. Causes and prevention of cracks in masonry structures, Corrosion in structures, process and

prevention, Fire damage of buildings. Repair materials, cement, aggregate, polymer and construction chemicals. Management of concrete for durability. Damage assessment and restoration techniques, case studies of restoration works, buildings, bridges, water retaining structures, marine structures.

Peter H Emmons, Concrete Repair and Maintenance Illustrated, Galgotia Publications Pvt. Ltd., New Delhi, 2001
R.T.L Allen ,S.C. Edwards, The Repair of Concrete Structures, Blackie & Sons Ltd., Glasgow, London, 1987
Tedkay, Asserssment and Renovation of Concrete Structures, Longman Scientific & Technical, Harlow, 1992.
R. Jagadisa, Structural Failures- Case Histories, Ocford & IBH Publishing Co. Ltd., New Delhi, 1995.
R.N. Raikar, Diagnosis and Treatment of Structures in Distress, R & D Centre Structural Designers & Consultants Pvt. Ltd., Vashi, New Bombay, 1994.

CM801 Operation Research & Decision Theory (3-0-0) 3

Phases of OR - Classifications; Linear Programming. Formulation & Graphical solutions; Simplex Algorithm; Quality & Sensitivity Analysis; Dual Simplex method. Transportation & Assignment problems; Games and their solution by Linear Programming; Network Analysis; Queuing Theory; Basic Structure of a queuing model. M/M/1 and M/M/S models.

Hamdy A Taha, Operations Research
Hiller and Liberman, Introduction to Operations Research.

CM802 Maintenance & Rehabilitation of Structures (3-0-0) 3

Performance of construction materials and components in services; Causes of deterioration; preventive measurements and maintenance; principles of assessment of weathering and durability; Characteristics of materials; Diagnosis of construction failures; dealing with cracks; Methods of repair in concrete, steel and timber structural components; Corrosion damage of reinforced concrete and its repair and prevention measures; Surface deterioration, Efflorescence causes, prevention and protection; Surface coating and painting; Water Proofing; Strengthening of existing Structures; Special repairs, maintenance inspection and planning, Budgeting and management.

Peter H Emmons, Concrete Repair and Maintenance Illustrated, Galgotia Publications Pvt. Ltd., New Delhi, 2001
R.T.L. Allen and S.C. Edwords, The Repair of Concrete Stuctures, Blacki & Sons Ltd., Glasgow, London, 1987.

CM803 Structural Systems & Design (3-0-0) 3

Structural Systems for buildings and spatial structures- concrete and steel. Analysis and design of typical grids, shells and folded plate roof structures, Information Technology and Industrial buildings, Prefabricated Structural Systems, Design of scaffolding and form work for different types of structures including spatial and industrial structures.

N. Subramanian, Principles of Space Structures, A.H. Wheeler &Co. (p) Ltd., Allahabad, 1995.
G.S. Ramaswamy, Design and Construction of Concrete Shell Roofs, Tata McGrawhill Publishing Co. Ltd., 1995.
Mark Fintel, Hand Book of Concrete Engineering, Reinhold, New York, 1995.
Perifov R.L., Form Work for Concrete Structures, Tata McGraw Hill Publishing Co. Ltd., New York, 1975

CM804 Valuation Techniques in Engineering (3-0-0) 3

Purpose of valuation- Different forms of values. Outgoings - Municipal & Govt. Taxes, insurance, Loss of rent, collection charges, sinking fund, Annual repairs & maintenance. Depreciation - Methods of calculation. Land value, Year's Purchase, Capitalised value, Obsolescence, Amortization. Methods of valuation - Open land valuation- factors affecting intrinsic values of land, Comparative method, Abstractive method, Belting method. Rent- definition, forms. Cost of structure - BIS rules for measuring plinth area and cubical contents. Valuation of land with buildings - Rental method, Land and building method, Valuation on profit basis, Direct comparison of capital value, Residual or Development method. Rights and Liabilities of Lessor & Lessee, Leasehold properties, freehold Properties. Easements - self imposed, legally created, Dominant and servient heritage - effect of easements on valuation. Market - Real Estate market and market value - fair market value, open market value - parameters affecting. Investments - Bonds, debentures, capital gains, Wealth Tax and Income Tax.

Banerjee, Principles and Practices of Valuation
Rao Gopinath C H, Valuation Practices of Immovable Properties. Mitra A K, Theory and Practice of Valuation. Shah N. A, Quality Surveying and Valuation.

CM805 Contract Laws & Regulations (3-0-0) 3

Construction Contracts - Elements of contracts- types of contracts - Design of contract documents - international contract document- Standard contract document. Tenders - Prequalification -bidding-accepting-evaluation of tender - potential contractual problems - World Bank procedures. Arbitration - Actions-laws-appointment of arbitrator- powers-rules of evidence. Legal requirements - Insurance-bonding-sale-purchase-land revenue codes-tax laws- income tax-sales tax-custom duties-influence on construction cost-legal requirement for planning-property law- agency law for

approval-statutory regulations.
Gajaria G. T., Laws relating to buildings and Engineering Contracts in India
Joseph T. Bockrath, Contracts and the Legal Environment for Engineers and Architects

CM806 Quality Control & Assurance (3-0-0) 3

Construction Organization-Types-Inspection-Control-Quality Management System-Quality Assurance-Control-Quality Circle-Architects-Engineers-contractors. Quality Policy-Objectives and Methods-Consumer Satisfaction-Ergonomics-Completion,Time-statistical,tolerance-Concepts-Codes-Standards-Contracts-Construction rogramming-Inspection Procedures-Processes and Products-Total QA/QC program and cost implication. Quality Assurance and Control-Objectives-Techniques-Needs-factors influencing-Failure Aspect, Analysis. Stability Methods-Optimum Design-Reliability Testing-Reliability Coefficient and Reliability prediction. Drawings-Detailing - specification-Standardization-Bid Preparation Construction Activity-safety-Environmental-Social-Natural Causes
Juran Frank, J M and Gryna F M, quality Planning and Analysis
Hutchins G, ISO 9000
John L Ashford, The Management of Quality in Construction

CM807 Management Information Systems (3-0-0) 3

Framework-business Models-Architecture of Information System-Evolution. Modern Information System-Development Life Cycle-Methodologies-Computer Based Methods-Structured Programming. Integrated Construction Management Information System-Project Management Information System-Finance-Marketing-Production-Personnel Levels-Types of Information Systems-Comparisons-Concepts-International Information System. Implementation and Control-Security Testing-Coding-Error Detection-validating-Cost-Benefit-Risk Information System. System Audit-. System methodology-Objectives-Time and Logic-Knowledge and human Dimension-Software Engineering Qualities-Design, Production, Service, Software Specification-Software Life Cycle Models-Verification and Validation.
Gordan B Davis, Management Information System: Conceptual Foundations
Joyce J Elam, Case Series for Management Information System
Ralph H Sprague and Huge J Watson, decision Support for Managers
Michael W Evans and John J Marciniah, Software Quality assurance and Management

CM808 Functional Efficiency of Buildings (3-0-0) 3

Environmental factors; Thermal performance of buildings; Comfort factors and measurements; climatic design; Solar control and shading devices, Louver design, ventilation; Introduction to lighting; units of light, colour lamps, luminaries, Daylight design of general lighting schemes; Energy management and lighting; acoustical design of auditoria and noise control in buildings

CM809 Supervision of Field Operations (3-0-0) 3

An overview of the principles of field supervision which includes leadership skill, problem solving, motivation techniques, problem solving process, communication methods, and useful supervisory aids for construction projects

CM810 Computer Aided Design in Civil Engineering (3-0-0) 3

Concepts of Computer Aided Design - Role of Computers in engineering process. Introduction to Hardware and Software Systems for Computer Aided Engineering. Software Tools for CAD: Programming paradigms - Object Oriented Programming - Introduction to C++ Computer modeling of engineering systems - Data Structures - pointers, arrays, structures and classes, Programming techniques for computer modeling of civil engineering problems. Computer Graphics - Basic principles, Transformations, Segmentation, Interactive graphics, Drafting - AutoCAD, Graphical User Interfaces - Windows. Graphics standards - Graphics Programming. Database Management System - Database models - Concepts of RDBMS - Engineering Database Management systems - Concepts of Database Programming. Artificial Intelligence and Expert Systems - Knowledge Representation -

Rules, Frames and Semantic networks - Inference Strategies. Process models - prototypes in Civil Engineering.

Development of CAE systems for different civil engineering applications such as in Building Technology and Construction Management, Geotechnical Engineering, Hydraulics and Water Resources Engineering, Structural Engineering, Transportation Engineering and Environmental Engineering.

Stephen Prata, Programming in C++.
Gary, J Bronsonenk S. and Lind N. C., Methods of Structural Safety.
C. S. Krishnamoorthy and S. Rajeev, Computer Aided Design, Software and Analytical Tools.
G. Enderle, K. Kansy and G. Pfaff, Computer Graphics Programming. C. J. Date, An Introduction to Database Management System (Vol.1).

C. L. Dym and R. E. Levitt, Knowledge Based Expert Systems in Engineering.

CM811 Selected Topics in Construction Technology & Management (3-0-0) 3

Recent Advances and Current Trends in Construction Technology & Management

CM812Excavation Technology for Construction Projects (3-0-0) 3

Scope of infrastructure industry, Role of excavation in construction projects. Typical case studies including construction of hydro- electric power projects, pipe line projects, tunneling projects, canal projects,dredging projects etc. Excavation methodology, Earth moving equipment, Production & productivity, Resources allocation, Contracting.

Chandra, P., 1995. Project planning analysis,selection, implementation and review. TMA New Delhi. Tatiya, R.R., 1995. Surface and underground excavations, Taylor and Francis.

Proc. Rapid excavation and tunneling conferences, 2006, 2007, 2008, Gale Group, Michigan

Stack, B.2008. Mining and tunneling machines, Muden Publishing Co.

CM813 Global Business Management (0-0-2) 2

Introduction to International Business - Globalization of World Economy - World Trade & Foreign Investment Trends -Technological Changes - Types of International Business - The Cultural Dimensions of International Business. The global trade and investment environment - Trading Practices - World Financial Environment - Tariff and Non-Tariff Barriers - WTO, Regional Blocks. Global financial environment - Determinants of exchange rates - International banks - Non-banking financial institutions. Global competitiveness: Export and Import Financing - Licensing and Joint Ventures - Research and Development in Global Market. Globalization with Social Responsibility - World Economic Growth and Environment - Negotiation in International Business - Multilateral settlements.

Hill Charles, International Business: Competing in the Global Marketplace, Irvin McGraw Hill.

Bhalla V. K. & Shivaramu S., International Business Environment and Business, Anmol, New Delhi.

CM814 Sustainability in Built Environment (3-0-0)3

Basic concepts: terminology, international developments, national developments, green building foundation and its systems, building assessment, building process and ecological design, sustainable sites and landscaping, building hydrologic system, indoor environmental quality, sustainable water use, economic analysis of green building, principles and practices of sustainable building design and construction, alternate building materials & technologies, energy conservation, waste utilization and waste management in construction sites.

Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, 2008.

Ann Marie VanDerZanden, Thomas W. Cook, Sustainable Landscape Management: Design, Construction, and Maintenance, John Wiley & Sons, 2010.

Craig, A. Langston., and Grace, K. C. Ding., Sustainability practices in Built environment, Springer, 2001.

Jagadish K S et al, Alternative Building Materials and Technologies, New Age International, 2011.

DEPARTMENT OF MINING ENGINEERING

RT 700 Rock Excavation Technology (4-0-0)4

Rock excavation by different methods and different machines. Mechanical cutting, Ripping, Drilling &Blasting etc. Selection of equipment and their maintenance. Material handling. Excavation in sensitive areas.

Chugh, C.P. Drilling technology hand book, Oxford &IBH, New Delhi, 1983.

Singh, B & Goel.R.K. Rock mass classification: A practical approach, Elsevier Science, 1999

Karunam, U.M.R & Misra. B. Principles of rock drilling, Oxford &IBH, New Delhi, 1998.

RT 701 Rock Mechanics (3-0-0)3

Stress- strain relationships and elastic constants, physico- mechanical properties of rocks. Measurement of rock loads and displacements, Failure criteria, Influence of anisotropy and discontinuity on rock behaviour. Stress distributions around single and multiple openings in rocks. Rock mass classifications. Rock mass damage criteria. Field instrumentation.

Obert L. and Duvell W. I. Rock Mechanics and design of structures in rock, Johnwiely, London, 1967

Bray and Brown. Rock Mechanics

RT 702 Rock Mechanics Laboratory (0-0-3) 2

Different experiments related to rock-mechanics

RT 703 Design of Rock Structures (3-0-0) 3

Design process for excavation in rocks- site characterization, planning and execution, stability analysis. Design methods in massive, stratified and jointed rock. Rock support and reinforcement.

Kidybinski A & Kwasniewski M. (Eds); Modeling of mine structures, A.A. Balkema, Rotterdam. 1988.

Obert L. and Duvell W. I. Rock Mechanics and design of structures in rock

RT 704 Numerical Stress Analysis of Excavations (3-0-0) 3

Concepts and mathematical derivations of Finite Element Method, Boundary Element Method and Finite Difference Method. Solutions of problems in rock excavation engineering using the above methods on computer.

Kidybinski A & Kwasniewski M. (Eds); Modeling of mine structures, A.A. Balkema, Rotterdam. 1988.

Kidybinski A. & Dubinski J. (Eds); Strata control in mines, A.A. Balkema. 1990

RT 705 Project Management (3-0-0) 3

Principles of project management, project planning. Introduction to scheduling work, project breakdown structure, bar charts, applications of CPM & PERT, precedence method, updating, time cost trade offs. Resource constrained scheduling, resource leveling, project control, performance measurement, earned value. Rock engineering project and other network projects. Economics of excavation projects. Project management softwares.

Chowdary, S. Project management, TMH, New Delhi, 1993.

Joy,P.K. Total project management, MacMillan, 1993.

Chandra,P. Project planning analysis, selection, implementation and review, TMA, New Delhi, 1995.

RT 706 Environmental Management in Rock Excavation Projects (3-0-0) 3

Environmental problems associated with rock excavations, air, noise, land pollution. Environmental effects of blasting, Heat and humidity in underground excavations. Ventilation, illumination in underground excavations. Environmental impact and assessment and environment management.

Dhar, B.B. Environmental management of mining operations, Ashish, New Delhi, 1990.

Chad- wick et al . Environmental impacts of coal mining and utilization, Pelgman & Oxford, 1987.

RT 800 Rock Slope Engineering (3-0-0) 3

Design of slopes and waste dumps. Factor affecting slope stability, Geological data collection. Rock slope rating. Mechanics of slope failure, Slope stability analysis. Monitoring of slope movements. Slope stabilization techniques. Slope stability analysis softwares.

Hoek, E. and Bray, J.W.Rock slope engineering, Inst. of Mining &Metallurgy, London, 1981.

Giani. Rock slope stability analysis, A.A. Balkema, 1992.

RT 801 Rock Fragmentation Engineering (3-0-0)3

Mechanisms of rock fragmentation due to blasting. Fragmentation prediction models. Fragmentation assessment methods. Explosives and initiation systems. Blast design, special techniques of blasting. Environmental effects and their control. Economic evaluation of blasting operations.

Sastry. V.R., Advances in drilling and blasting, Allied publishers, Bangalore, 1993.
Konya, C.G. Blast design, Prentice, New Jercy,1990.

RT 802 Rock Reinforcement Engineering (3-0-0) 3

Rock support and interaction. Classification of supports, temporary and permanent supports, Passive and active support systems. Pillars, fills, roof bolts and cable bolting as mass support systems, Design of support systems based on rock mass classification.

Biron, C. and Arioglu, E., Design of supports in mines, Wiley, NewYork, 1983. Mines,
Metals & Fuels (MMF) special issue on mine supports.

RT 803 Rock Mechanics Instrumentation (3-0-0)3

Introduction to rock mechanics instrumentation. Various types of deformation meters, strain gauges, LVDT's. Load cells. Photoelastic models, Ultrasonic monitors, geophones, seismographs, electro-magnetic velocity meters, accelerometers, high speed cameras, laser profilers. Field instrumentation for design of tunnels and underground structures. Rock slope and blast monitoring instruments.

Hunt, R.E., Geotechnical Engineering investigating manual.
Ervin, M.C., Insitu testing for geotechnical investigations, A.A. Balkema, 1983.

RT 804 Underground Space Technology (3-0-0)3

Design and construction of large underground excavation: rock conditions and initial state of stress, dimensions, shape, structural behavior methods and sequence of excavations. Power stations, storage caverns, metro railway. Large diameter trenches for communication, radioactive disposal and excavations for defense purpose. Stability analysis: structurally controlled instability, influence of size, in-situ stresses. Monitoring and back analysis. Dredging. Excavation for hydel projects. Excavation for other specific works**.**

Vutukuri V.S. and Lama R.D. Physico - mechanical properties of rocks, Transtech, Ohio, 1974.
Sarma, V.M. Underground space utilization, ISRMTT, 1998.
Tatiya.R.R. Surface and under ground excavations, Taylor & Francis, 1995 Sarma,
V.M. Underground space utilization, ISRMTT, 1998.

RT 805 Tunnelling Engineering (3-0-0)3

Types of underground excavations, methods of tunneling. Tunneling in soft ground. Tunneling by drilling &blasting, using TBMs. Excavation of large tunnels, hazards in tunneling. Ground treatment in excavation. Supports, ventilation, drainage and lighting in tunnels.

Vutukuri V.S. and Lama R.D. Physico - mechanical properties of rocks, Transtech, Ohio, 1974.
Proc. Rapid excavation and tunneling

RT 806 Reliability Engineering (3-0-0)3

Need for reliability evaluation of engineering systems. Concepts of Deterministic and Statistical Reliability. Statistical failure of components: failure distribution, system reliability evaluation using probability evaluation using probability distributions. Life testing. Reliability models: catastrophic failure model, stress strength model, Markov models. Reliability evaluation of maintained and non- maintained systems. Network modeling and evaluation of complex systems.

Billianton and Ronald N. Alian. Billianton and Ronald N. Alian. Reliability evaluation of engineering systems: Concepts and techniques
Klass B. Klasson and Jack C.L. Van Pepper. System reliability: concepts & applications Sinha.
S.K. Life testing and reliability estimation, Wiley, New Delhi, 1980.
Mishra. K.B. New trends in reliability evaluation, Elsvier, 1980.

RT 807 Safety Engineering (3-0-0)3

Classification of accidents, causes & prevention of various types of accidents, accidental enquiry- its significance and preparation of accident enquiry report. Accidental statistics- analytical and interpretation. Accidents costs, concepts of ZAP & MAP. Risk assessment and safety management. Aspects of human behavior in accidents application of loss control in safety, workers participation for promotion of safety. Crisis management and its role in safety.

Rakesh & Prasad. Legislation in Indian mines- A critical appraisal , Ashalatha, !992.
Proc. Of AICTE- ISTE short term training programme on "Recent trends in safety analysis and risk assessment in mineral based industries."

RT 808 Industrial Engineering **(3-0-0)3**

Time and motion study. Work and job design. Purchase, inventory and stores management. Quality control and management. Labor relations, wages and compensation. Industrial psychology.

Awate,P.G. Industrial Engineering, Vrinda, 1982.
Khurana, P.K. Industrial engineering, Khanna, New Delhi, 1994.

RT 809 Structural Geology and Discontinuities Aanalysis **(3-0-0)3**

Genetic rock structures and their significance. Effect of tectonic stresses on rock mass deformation. Effect of application of stress on petrographic constuents of rocks. Micro fabrics and its relation with strength of rocks. Foliation and lineation in rocks and their significance. Joints. Faults. Technologies used in investigation and mapping of geological structures**.**

Walter Wittke . Rock mechanics
Q. Zaruba & V. Mencl. Engineering Geology, Amsterdam, 1982.

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

CS700 ALGORITHMS AND COMPLEXITY (3-0-2) 4

Algorithmic paradigms: Dynamic Programming, Greedy, Branch-and-bound; Asymptotic complexity, Amortized analysis; Graph Algorithms: Shortest paths, Flow networks; NP-completeness; Approximation algorithms; Randomized algorithms and advanced data structures.

T.H. Cormen, C.E. Leiserson, R.L. Rivest, Introduction to Algorithms, McGraw Hill, 1994.
Dan Gusfield, Algorithms on Strings, trees and Sequences, Cambridge, 2005.
Sara Baase, Computer Algorithms: Introduction to Design and Analysis, Addison Wesley, 1998.
Michael T Goodrich & Roberto Tamassia, Algorithm Design: Foundations, Analysis & Internet Examples, John Wiley, 2002.

CS701 HIGH PERFORMANCE COMPUTING (3-0-2) 4

Overview and history of computing. Architectural Classification schemes. High performance computing, overview and performance quantification criteria, limits on performance Design of high performance architecture, parallel vs. pipeline architectures. Pipeline processing. Theory of pipeline scheduling and implementation. Hazards in Pipeline processors. Hazard detection and resolution techniques. Static and dynamic schedules. Evolution of RISC ISAs and pipeline hazards. Interconnection Networks. Topics of current research in High performance computing.

K. Hwang and F. A. Briggs, Computer Architecture and Parallel Processing, McGraw Hill, 1984.
John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, 3rd Edition, Morgan Kaufmann Publishers, 2002.

CS702 DATABASE ENGINEERING (3-0-2) 4

Distributed Databases: principles, Architecture, Design, Query Optimization, Transaction Processing, Concurrency control, Integrity and Security, Client/server architecture, Parallel Databases, Web databases, Current trends in database systems.

M.TamerÖzsu, Principles of Distributed Database Systems, Second Edition,
Raghu Ramakrishnan, Database Management Systems, McGraw-Hill, 2000
Ceri S and Pelagatti G, Distributed Databases Principles and Systems, Mc.Graw Hill, 1999.

CS703 NETWORK ENGINEERING (3-0-2) 4

Internetworking: Architectural principle, layering, names and addresses. Advanced topics in Transport Protocol, Congestion Control, Fair Queuing, Router design and router protocols. Network topologies, Peer-to-Peer networks. Application level protocols. Network management and access control.

Larry L. Peterson, Bruce S. Davie, *Computer Networks: A Systems Approach, Elsevier*
Richard Stevens, **TCP/IP Illustrated, Volume 1: The Protocols** *PHI, 2001.*
Behrouz Forouzan, TCP/IP Protocol Suite, 3/e, McGraw Hill

CS704 MINI PROJECT 2

Experimental Design / Implementation tasks of relatively minor intensity and scope as compared to the Major-project and in line with the guidelines formulated by DPGC (CSE).

MA714 MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE (3-0-0) 3

Divisibility, gcd, prime numbers, fundamental theorem of arithmetic, Congruences, Fermat's theorem, Euler function, primality testing, solution of congruences, Chinese remainder theorem, Wilson's theorem. Groups and subgroups, homomorphism theorems, cosets and normal subgroups, Lagrange's theorem, rings, finite fields, polynomial arithmetic, quadratic residues, reciprocity, discrete logarithms, elliptic curve arithmetic. Fundamental principles of counting, pigeonhole principle, countable and uncountable sets, principle of inclusion and exclusion, derangements, equivalence relations and partitions, partial order, lattices and Boolean algebra, generating functions, recurrence relations, solution of recurrences. Graphs, Euler tours, planar graphs, Hamiltonian graphs, Euler's formula, applications of Kuratowski's theorem, graph colouring, chromatic polynomials, trees, weighted trees, shortest path algorithms, spanning trees, the max-flow min-cut theorem.

Niven, H.S. Zuckerman and Montgomery, An Introduction to the Theory of Numbers, 3/e, John Wiley and Sons.
R. P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 3/e, Addison-Wesley
B. Kolman and R.C. Busby, Discrete Mathematical Structures for Computer Science, PHI, New Delhi.

CS800 SOFTWARE PROJECT MANAGEMENT (3-0-0) 3

Basic concepts of project management; Managing requirements; Software lifecycles; Software estimation; The project plan; Monitoring the project; Risk analysis; Managing quality and People problems, CMM & P-CMM Principles.

Joel Henry, Software Project Management, Pearson Education, 2003.
Kenneth R. Bainey, Integrated IT Project Management: A Model-Centric Approach, Allied Publishers.
Mario E. Moreira, Software Configuration Management Hand Book, Allied Publishers, 2004.

CS801 SOFTWARE QUALITY ASSURANCE (3-0-0) 3

Evaluation, Role, maturity in development, life cycle, models, maintenance issues, specification, object oriented design, management, testing, mechanisms, verification and validation, cost estimation, tools, debugging, simulators, ISO 9000 standards, Quality Assurance, Quality Standards: Quality Standards, Practices & Conventions- Software Configuration Management- Reviews and Audits- Enterprise Resource Planning software, Quality Metric System: Measurement Theory- Software Quality Metrics- Designing Software Measurement Programs- Complexity Metrics and Models- Organizational Learning- Improving Quality with Methodologies- Structured/Information Engineering.

Pankaj Jalote, An Integrated Approach to Software Engineering, Narosh Publication, 1995.
Capers Jones, Software Quality: Analysis & Guidelines for success International, Thompson press, 1997.
Achieving Software Quality through Teamwork, Isabel Evans, Allied Publishers, 2004.

CS802 SOFTWARE ARCHITECTURE (3-0-0) 3

Introduction to Software Architecture An Engineering Discipline for Software, Status of S/W Arch. Architecture Business Cycle, Where do Architectures Come from. Software Processes and the Architecture Business Cycle, Features of Good Architecture. Architecture Styles Pipes and Filters, Data Abstraction and Object Oriented organization, Even-based Implicit Invocation, Layered Systems, Registers, Interpreters, Process Control, Other Familiar Architectures, Heterogeneous Architectures.

Shared Information Systems Database Integration, Interpretation in Software Development Environments.

Len Bass, Paul Clements, and Rick Kazman, Software Architecture in Practice, 2nd ed, Addison-Wesley,
Garmus, Herros, "Measuring the Software Process: A Practical Guide to Functional Measure", PHI.
Florac, Carleton, "Meas. Software Process: Stat. Proce. Cont. for Software process Improvemnts", PEA.

CS803 SOFTWARE TESTING (3-0-0) 3

Software testing concepts & principles, Testing Strategies, Testability and Related Issues, Methods for developing the strategy, Life Cycle Testing, Installation Phase Testing and Various Phases of Testing; Tools and Techniques for Software Testing, Testing Object Oriented Software.

Glenford J. Myers, The Art of Software Testing, John Wiley & Sons, 1979.
Boris Beizer, Black Testing: Techniques for Functional Testing of Software and Systems, John Wiley & Sons, 1995
William Perry, Software Testing: Effective Methods for Software Testing, John Wiley, 1995
Cem Kaner, Jack Falk, Hung Quoc Nguyen, Testing Computer Software, 2nd Ed, Intl. Thomson Computer Press.

CS810 DATA WAREHOUSING & DATA MINING (3-0-0) 3

Data Warehousing: Data warehousing components and building data warehouse. Data Mining –Objectives, examples, data mining process, Data mining techniques, Generalization, Data mining knowledge representation.

Raph Kimball, Data Warehouse Toolkit, John Wiley & Sons Publications
Michael. J. Berry, Gordon Linoff: Data Mining Techniques: Marketing, Sales, Customer support.
John Wiley & Sons.

CS811 INFORMATION RETRIEVAL (3-0-0) 3

Introduction to Information Retrieval: unstructured and semi-structured text. Inverted index and Boolean queries. Text Indexing, Storage and Compression: Text encoding: Retrieval Models: Performance Evaluation: Text Categorization and Filtering: Text Clustering: Advanced Topics: Web Information retrieval.

Manning, Raghavan and Schutze, Introduction to Information Retrieval, Cambridge University Press.
Baeza-Yates and Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley.
Soumen Charabarti, Mining the Web, Morgan-Kaufmann.

CS812 DISTRIBUTED DATABASE SYSTEMS (3-0-0) 3

Distributed database architecture, distributed database design, distributed query processing, query decomposition and optimization of distributed queries, distributed transaction management and concurrency control, distributed DBMS reliability, distributed database operating systems, Distributed multi database systems, Client/Server database systems,Peer-to-Peer Systems, Location-based Applications, Parallel DBMS.

Principles of Distributed Database Systems, M.T. Ozsu and P. Valduriez, Prentice-Hall, 2nd Ed. 1999.
Ceri and Pelagatti, Distributed Database Principles and Systems, McGraw Hill. 2000
D. Bell and J. Grimson, Distributed Database Systems, Addison-Wesley, 1992.

CS813 TOPICS IN DATA MANAGEMENT (3-0-0) 3

Unstructured data management: limitations of structured data models, data management and information retrieval, Web-based data management: semi-structured data and querying XML, semantic Web data management, cloud computing and data management, Advanced networked information systems: pervasive and mobile data management, stream data management, sensor data management.

Sandro Fiore, Giovanni Aloisio. Grid and Cloud Database Management.2011.1st Edition
Evaggelia Pitoura and George Samaras . Data Management for Mobile Computing. 1998. Kluwer Academic Publishers.
Hara, T., Zadorozhny,V., Bachman, E. (Eds). Wireless Sensor Network Technologies for the Information Explosion Era. 2010. Springer

CS820 MOBILE COMPUTING (3-0-0) 3

Static & Mobile networking, Mobile IP, Pervasive Computing & Sensor network, mobile operating system, Distributed & Mobile Systems architecture, Mobile and Internet Protocols, Standards, Mobile applications.

Reza B' Far, Mobile Computing Principles, Cambridge, 2005.
Geoffrey Elliott & Nigel Phillips, Mobile Computing & Electronic business Technology & Applications, Pearson Education, 2003.
Ariel Pashtan, Mobile Web services, Cambridge, 2005.

CS821 WIRELESS NETWORKS (3-0-0) 3

Overview of wireless communications and networking. Transmission fundamentals, Communication networks, TCP/IP protocol stack overview, Basic wireless communication technology, channel uncertainties and countermeasures , Coding and error control. Mobile IP and wireless access protocol4. Cellular wireless networks, Overview of cellular systems (TDMA, GSM, CDMA, 3G/UMTS), Wireless LAN systems, Bluetooth, Zigbee and UWB standards, Erlang formulas

Rappaport, Theodore S., Wireless Communications, Principles and Practice, Prentice Hall, Inc, 2002, Kaveh Pahlavan, Prashant Krishnamoorthy, Principles of Wireless Networks, - A united approach - Pearson Education, 2002.

CS822 TOPICS IN COMPUTER NETWORKS (3-0-0) 3

TCP/IP Protocol Suite and Protocols in different Layers, QOS, Load Balancing, Traffic Engineering. Case study: Data center networks, Virtual networks, Mesh networks. Emerging concepts in next generation networks.

Mahbub Hassan, Raj Jain, High Performance TCP/IP Networking, Prentice Hall, 2004
Dennis Abts, John Kim, High Performance Data Center Networks: Architectures, Algorithms and Opportunities, Morgan and Claypool Publishers 2010.
Recent papers on advancement in Computer Networks

CS823 NETWORK MANAGEMENT (3-0-0) 3

Network management standards and models, network management protocols, SNMP. Management information base (MIB), Network Configuring Proto (NETCONF), Policy Management & Sharing of Data, approaches for sharing information. Heterogeneous Network and network security management, Network Management tools and applications.

John Strassner, Policy based Networking management, Morgan Kaufman/Elsevier, 2004
M. Subramanian, Network Management: Principles and Practice, Addson- Wesley, 2000
J. Burke, Network Management Concepts and Practice, A Hands-On Approach, Pearson Education,2000.

CS830 APPLIED ALGORITHMS (3-0-0) 3

Selected algorithms from areas such as graph and combinatorial algorithms, computational geometry, string processing algorithms, algebraic and number theoretic algorithms, linear programming and combinatorial optimization.

Dan Gusfield Algorithms on Strings, Trees and Sequences, Cambridge Univ. Press, 2005.

C. Papadimitrou and K. Steiglitz, Combinatorial Optimization, Prentice-Hall, 2000

CS831 OPTIMIZATION ALGORITHMS (3-0-0) 3

Basic OR techniques, requirements, networks, design, role and methods, databases, compilers, optimization and performance in web computing, internet application, performance measurement tools, case studies

K Kanth, Introduction to computer system performance evaluation, McGraw Hill, 1992

David K smith, Network Optimization in Practice, Ellis Horwood publications, 1982

CS832 DISTRIBUTED ALGORITHMS (3-0-0) 3

Distributed algorithms are algorithms designed to run on multiple processors, without tight centralized control. In general, they are harder to design and harder to understand than single-processor sequential algorithms. Distributed algorithms are used in many practical systems, ranging from large computer networks to multiprocessor shared-memory systems. They also have a rich theory, which forms the subject matter for this course.

Nancy & Lynch, Distributed Algorithms, Harcour Asia, 2001.

Gerard Tel. Introduction to Distributed Algorithms. Cambridge University Press, Cambridge, UK, 2ndedition, 2000.

CS833 TOPICS IN ALGORITHM DESIGN (3-0-0) 3

Overview and comparative study of various algorithm design techniques. Randomized algorithms, Algorithms in Computational Biology, Parallel Algorithms, Algorithms for the web**.**

R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995

Haralambos Marmanis and Dmitry Babenko, Algorithms of the Intelligent, Manning Publications, 2009

Wing-Kin Sung, Algorithms in BioInformatics: A Practical Introduction, Chapman and Hall, Boca Raton, Florida, 2010.

CS834 NETWORK OPTIMIZATION (3-0-0)3

Introduction, Mathematical preliminaries, Comparison of Label Setting and Label Correcting shortest path algorithms, Single Origin/Single Destination and Multiple Origin/Multiple Destination shortest path methods. The Max-Flow Problem: Cuts in a Graph, The Max-Flow/Min-Cut Theorem, The Maximal and Minimal Saturated Cuts, Price-Based Augmenting Path Algorithms. Multicommodity Flow Problems. Auction Algorithms for Min-Cost Flow: The Auction Algorithm for the Assignment Problem, Extensions of the Auction Algorithm, The Preflow-Push Algorithm for Max-Flow, The Auction/Sequential Shortest Path Algorithm. Simplex Methods for Min-Cost Flow.

Ravindra K Ahuja, , Thomas L. Magnanti, James B. Orlin, *Network Flows: Theory, Algorithms, and Applications, Prentice Hall, 1993*

Eugene Lawler, Combinatorial Optimization – Networks and Matroids, Dover Publication 2002

William J. Cook, William H. Cunningham, William R. Pulleyblank, Alexander Schrijver, *Combinatorial Optimization, Wiley 1997*

Michal Pioro, Deepankar Medhi, *Routing, Flow, and Capacity Design in Communication and Computer Networks, The Morgan Kaufmann Series in Networkin.*

CS840 COMPILER OPTIMIZATION (3-0-0) 3

Review of compiler fundamentals - lexical analysis, parsing, semantic analysis, error recovery and intermediate code generation; Runtime storage management; Code generation; Code improvement - peephole optimization, dependence analysis and redundancy elimination, loop optimization, procedural and inter-procedural optimization, instruction scheduling, optimization for memory hierarchy; Compilation for high performance architecture; Portability and retarget ability; Selected topics from compilers for imperative, object-oriented and mark-up languages, parallel and distributed programming and concurrency.

Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Compilers: Principles, Techniques and Tools, Addison-Wesley.

Michael L. Scott, Programming Language Pragmatics, Elsevier.

Andrew W. Appel, Modern Compiler Implementation in C/Java, Cambridge University Press.

CS841 DISTRIBUTED OPERATING SYSTEMS (3-0-0) 3

Introduction to Distributed Systems: Distributed systems: Goals Hardware Concepts Software - design Communication distributed systems: Layered Protocol: ATM Networks client server model - remote procedure call – group communication. Synchronization: Clock synchronization - mutual exclusion - election atomic transactions - dead locks. Process and Processors: Threads - System models processor allocation - scheduling fault tolerance - real time distributed systems. Distributed file systems: File system design and implementation - trends in distributed file systems. Shared Memory: Introduction - bus based multi processors ring based multiprocessors switched multiprocessors - NUMA comparison of shared memory systems - consistency models - page based distributed shared memory - shared variable distributed shared memory - object based distributed shared memory. Case studies: MACH and CHORUS

Andrew S. Tanenbaum, Maarten " Distributed Operating System, *Prentice-Hall , 2005*

R. Chow and T. Johnson, Distributed Operating Systems & Algorithms, *Addison-Wesley (1997)*

CS842 KNOWLEDGE BASED COMPUTER SYSTEMS (3-0-0) 3

Architecture of AI & KBCS Systems, Design Issues of KBCS, Introduction to Expert System, Introduction to fuzzy logic systems, Natural Language processing, Heuristic Search techniques, knowledge based systems AI for security systems

Nilson, Artificial Intelligence: A new Synthesis, 2001.

Taghi M. Khosgoftaar, Software Engineering with Computational Intelligence, Allied Publishers, 2004.

Soldek, Jerzy, Drobiazgiewicz, Leszek, Artificial Intelligence and Security in Computing Systems, Allied Publishers, 2004.

CS843 POWER AWARE COMPUTING (3-0-0) 3

Energy- efficient, power efficient and thermal aware computing and communication Newton's cooling model and basic thermodynamics and sustainability. Middleware Support for green computing: Power states Power states Voltage and frequency scaling ACPI support for Linux and, Voltage and frequency scaling, ACPI support for Linux and Windows, compiler optimization, virtualization and server consolidation. Tools for monitoring: Sensor networks, cooling equipment and their behavior. HPC computing: Hadoop, Map-Reduce, Dynamic thermal-aware scheduling, Resource Management in Virtualized Environment. Green Mobile, embedded computing and networking: Optimizing for minimizing battery consumption, Safe and Sustainable Cyber-physical systems (Medical devices). Management Frameworks Standards and metrics for green computing

K. Kant, Data center evolution - a state of the art issues and challenges, Elsevier Computer Networks

L. Barraso and Holzl, Case for Energy Proportional Computing, IEEE Computer Dec 2007

CS850 WEB ENGINEERING (3-0-0) 3

Perspectives on Web Engineering, Requirements specifications & web based system dev. Methodologies, migration of legacy systems to web environments-technology and solutions, web-based real time application development, Web engineering- the new paradigm with multi disciplinary facts, user-centered web design & applications, web metrics, HCI, Testing, verification and validation

Journal of Web Engineering, Rinton Press & IEEE and ACM publications on these areas.

Cato & John, User centered Web design, Pearson Education, 2001.

Zimmermann, Olaf; Tomlinson, Mark R.; Peuser, Stefan, Perspectives on Web Services, Allied Publishers, 2004.

CS851 SERVICE ORIENTED COMPUTING (3-0-0) 3

SOA Reference Model and Service Models, SOA Business Case, Service Design Principles, BPEL, Modeling SOA with CPN and OPNET, SOA, SOAP and REST, SOA Infrastructure, SOA Governance, Web Services, Identity and Security, Technologies, Tooling and Vendors.

Thomas Erl, Service-Oriented Architecture: Concepts, Technology and Design, 2006

Mark Hansen. SOA Using Java Web Services,

CS852 CLOUD COMPUTING (3-0-0) 3

Introduction to Cloud Computing, Cloud Computing Delivery Models, Open Source and Industry case Studies of cloud (Apache VCL, Amazon, IBM and Eucalyptus) Introduction to Map/Reduce and Apache Hadoop Programming models for cloud computing and examples/applications, Virtualizations as an enabler for cloud computing infrastructure.

George Reese Cloud Application Architectures", O'Reilly Publications, 2009

Tim Mather, Subra Kumaraswamy, Cloud Security and Privacy, O'Reilly, 2009

Tom White, The Hadoop – Definitive Guide, O'Reilly, 2009

CS853 SOCIAL NETWORK ANALYSIS (3-0-0) 3

Different sources of network data, types of networks, tools for visualizing network data, review of graph theory basics. Structural properties of networks: Notions of centrality, cohesiveness of subgroups, roles and positions, structural equivalence, equitable partitions, stochastic block models. Cascading properties of networks: Information/influence diffusion on networks, maximizing influence spread, power law and heavy tail distributions, preferential attachment models, small world phenomenon. Mining Graphs: Community and cluster detection: random walks, spectral methods; link analysis for web mining

Wasserman, Stanley, & Faust, Katherine. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press, 1994.

Scott, John. Social Network Analysis: A Handbook. 2nd Ed. 1994. Newberry Park, CA: Sage.

Robert Hanneman and Mark Riddle. Introduction to Social Network Methods, 2004.

CS860 INFORMATION SECURITY (3-0-0) 3

Information Security & cryptography - Basic concepts, Access control, Protection, Secure coding, Cryptography, Network security, Firewalls, Attack Techniques, IDS, Randomized algorithms, cryptography applications.

Goldrich, Foundations of Cryptography-Applications, vol-2, Cambridge Univ.Press, 2005

Blake, Seroussi & Smart, Advances in Elliptic curve cryptography, Cambridge, 2005.

CS861 ELEMENTARY NUMBER THEORY (3-0-0) 3

Elementary number theory, Finite fields, Arithmetic and algebraic algorithms, Secret key and public key cryptography, Pseudo random bit generators, Block and stream ciphers, Hash functions and message digests, Public key encryption, Probabilistic encryption, Authentication, Digital signatures, Zero knowledge interactive protocols.

Koblitz, N. Course on Number Theory and Cryptography, Springer Verlag, 1986

Menezes, A, et.al. Handbook of Applied Cryptography, CRC Press, 1996

Ivan Niven, Herbert S. Zukerman, Hugh L. Montgomery, An Introduction to the Theory of Numbers.

CS862 CYBER LAW AND ETHICS (3-0-0) 3

Cyber laws and rights in today's digital age; IT Act, Intellectual Property Issues connected with use and management of Digital Data The similar Acts of other countries Information Warfare: Nature of information warfare, including computer crime and information terrorism; Threats to information resources, including military and economic espionage, communications eavesdropping, computer break-ins, denial-of-service, destruction and modification of data, distortion and fabrication of information, forgery, control and disruption of information How, electronic bombs, and sops and perception management. Countermeasures, including authentication, encryption, auditing, monitoring, intrusion election, and firewalls, and the limitations of those countermeasures. Cyberspace law and law enforcement, information warfare and the military, and intelligence in the information age. Information warfare policy and ethical Issues.

Hon C Graff, Cryptography and E-Commerce - A Wiley Tech Brief, Wiley Computer Publisher, 2001.

Michael Cross, Norris L Johnson, Tony Piltzecker, Security, Shroff Publishers and Distributors Ltd.

CS863 SECURITY POLICIES (3-0-0) 3

General Overview of Policies, Policy Lifecycle, and Writing Security Policies, Information Classification and Privacy Policies, Network Security and Email Policies, Application, Operating System and Software Security Policy, Encryption and Key Management Policy, Security Policy: Audit and Compliance, Acceptable Use Policies and Training /Awareness, Security Policy: Enforcement and Effectiveness, Internet Censorship, Intellectual Property Protection, International Cooperation in Cyber Crime.

Scott Barman, Writing Information Security Policies, New Riders Publication.

Charles Cresson Wood, Information Security Policy made Easy.

CS864 ADVANCED IMAGE PROCESSING (3-0-0) 3

Basic concepts, Linear and nonlinear operations, Image Enhancement in the spatial and frequency domains, Important noise probability density functions, Estimation of signal and noise, medical image denoising, geometric transformations, image analysis, image segmentation, image registration, color image processing, image compression.

Rafael C. González, Richard E. Woods, "Digital Image Processing", 3rd Ed., PHI, 2007.

Anil K. Jain, "Fundamentals of Digital image Processing", Prentice Hall, US Ed., 1989.

Rafael C. González, Richard Richard Eugene Woods, Steven L. Eddins, *"Digital Image Processing using MATLAB", Pearson Education India, 2004.*
AL Bovik (Editor), "Handbook of Image and Video Processing", Academic Press

CS865 TOPICS IN SPEECH PROCESSING (3-0-0)3

Mathematical foundations of signal processing, Speech production and perception, Speech signal analysis: Short time speech analysis, Time domain analysis, Frequency domain analysis, LPC (Linear predictive coding) analysis; Issues in in speech processing: Speech synthesis, speech recognition, speaker identification, emotion analysis, language identification; Introduction to advanced topics in speech processing: pattern classifiers.

Speech Communications Human and Machines (Second Edition), Douglas O'Shaughnessy, Fundamentals of speech recognition, Rabiner and Juan.

CS866 INTERCONNECTION NETWORKS (3-0-0)3

Introduction to Interconnection Networks. Network Specifications. Traffic Patterns. Butterfly Networks, Torus, Mesh vs. Torus. Express Cubes. Non-Blocking Networks - Non-Blocking vs. Non-Interfering, Crossbars, Clos, Benes, Sorting Networks. Concentrators and Distributors. Slicing Multistage Networks. Routing Taxonomy, Deterministic Routing. Oblivious Routing. Randomized Routing, Adaptive Routing. Flow Control - Resources and Allocation Units, Bufferless Flow Control. Buffered Flow Control Packet-Buffer Flow Control, Flit-Buffer Flow Control, Buffer Management and Backpressure, Flit-Reservation Flow Control. Router Architecture, Router Datapath. Arbitration. Network Interfaces. Error Control Buses. Performance Analysis. Simulation of Interconnection Networks. Deadlocks, livelocks and starvation in Interconnection Networks. Deadlock and livelock detection strategies. The Turn Model for deadlock detection. Deadlock and livelock avoidance protocols. Deadlock free proofs of interconnection networks. Shared Memory networks in Chip Multiprocessors – Impact of Coherence Protocols, and Cache Hierarchy on Network Performance, Coherence Protocol Requirements for the On-Chip Network. Home Node and Memory Controller Design Issues. Miss and Transaction Status Holding Registers. Synthesized Network-on-Chips in Multiprocessor System-on-Chips. Network-on-Chips in 3D-Stacked ICs, Photonic Network-on-Chips, Wireless Network-on-Chips. Case Studies and Current NoC proposals in literature.

William Dally And Brian Towles, Principles And Practices Of Interconnection Networks. Morgan Kaufmann, 2004.
Jose Duato, Sudhakar Yalamanchili, Lionel Ni. Interconnection Networks - An Engineering Approach. MK, 2003.
John L Hennessy And David A Patterson, Computer Architecture A Quantitative Approach. Appendix F. 5th Edition, Morgan Kaufmann, 2012.
Li-Shiuan Peh And Natalie Enright Erger. On Chip Networks. Synthesis Lectures On Computer Architecture. Morgan And Claypool Publishers, 2009.
Recent Publications From NoCS, ISCA, MICRO And Other Leading Conferences.

CS867 DATA SCIENCE (3-0-0)3

Data collection and integration, data presentation, experimentation, longitudinal analysis, data products. Introduction to statistical inference, linear and logistic regression, variance and smoothing, analysis of variance, predictive modeling. Data types, statistical graphs, visualization of multi-dimensional data, maps and text, distance, clustering and dimensionality reduction. Managing Big Data, Map-reduce, the map tasks, grouping by key, the reduce tasks, combiners, extensions to map-reduce, workflow systems, recursive extensions to map-reduce. Statistical inference, statistical modeling, design of experiments, statistical graphics. Classification, decision trees, naïve bayes classifier, support vector machine, clustering, hierarchical clustering, k-means clustering, distribution-based clustering, ensemble learning and performance evaluation. Building the data pipelines, Map reduce, graph visualization, and storytelling

Michael Manoochehri, Data Just Right: Introduction to Large-Scale Data & Analytics, Addison-Wesley Data & Analytics Series, 2013
Foster Provost, Tom Fawcett , Data Science for Business: What you need to know about data mining and dataanalytic thinking, O'Reilly, 2013
Eric Siegel, Predictive Analytics,, 2013, Wiley, 2013
Drew Conway, John Myles White, Machine Learning for Hackers, O'Reilly, 2012
Ivan Idris, Python Data Analysis, Packt Publishing, 2014
Wes McKinney, Python for Data Analysis, O'Reilly, 2012

IS701 NUMBER THEORY & CRYPTOGRAPHY (3-0-2) 4

Elementary number theory, Finite fields, Arithmetic and algebraic algorithms, Secret key and public key cryptography, Pseudo random bit generators, Block and stream ciphers, Hash functions and message digests, Public key encryption, Probabilistic encryption, Authentication, Digital signatures, Zero knowledge interactive protocols, Elliptic curve cryptosystem

ms, Formal verification, Hard problems, Randomness and Pseudo randomness & Testing.

Koblitz, N. Course on Number Theory and Cryptography, Springer Verlag, 1986

Menezes, A, et.al. Handbook of Applied Cryptography, CRC Press, 1996

Ivan Niven, Herbert S. Zukerman, Hugh L. Montgomery, An Introduction to the Theory of Numbers.

IS703 NETWORK SECURITY (3-0-2) 4

Introduction - Attacks, services and mechanisms - Classical encryption techniques - DES -Block cipher - Design principles and modes of operation. Encryption Algorithms - Hash functions - Triple DES - RC5 - Key management – Public key cryptography - RSA algorithm - Digital signatures and authentication protocols. System Security - Backups - Integrity management - Protecting against programmed threats, viruses and worms - Physical security - Personnel security. Network Security - Protection against eavesdropping - Security for modems - IP security - Web security - Electronic mail security - Authentication applications. Security Tools - Firewalls - Wrappers - Proxies - Discovering a break-in - Denial of service attacks and solutions - Cryptographic security tools: Kerberos, PGP, SSH, SRP, OPIE.

William Stallings, "cryptography and network security – principles and practice", ii Edition, Pearson education, 2000

Steve Burnett, Stephene Paine, "rsa security's official guide to cryptography", TMH, 2001

E. Nemeth, g. Snyder, s. Seebass, t.r. Hein, "unix system administration Handbook", 3rd Ed., PEL

IS704 MINI PROJECT 2

Experimental Design / Implementation tasks of relatively minor intensity and scope as compared to the Major-project and in line with the guidelines formulated by DPGC (CSE-IS).

IS800 FORMAL METHODS (3-0-0) 3

Formal Methods in Computing Specification; Formal Description Techniques in Communication Software Systems; Formal Methods in Object Orientation and Software Engineering, Proof Methods and Techniques, Temporal and Model Logic

Jan Ven Lecuwen—Formal Model and Semantics, Elsevier-MIT Press, 1992

Arindama Singh—Logic for Computer Science, PHI, IEEE, 2003

Programming Perl. Larry Wall, Tom Christensen and Randal Schwartz.1996. O'Reilly & Associates, Inc.

IS801 SECURE CODING (3-0-0) 3

Buffer Overrun, Format String Problems, Integer Overflow, and Software Security Fundamentals , SQL Injection, Command Injection, Failure to Handle Errors, and Security Touch points, Cross Site Scripting, Magic URLs, Weak Passwords, Failing to Protect Data, Weak random numbers, improper use of cryptography, Information Leakage, ace Conditions, Poor Usability, Not Updating Easily, Executing with too much privilege , Failing to protect network traffic, improper use of PKI, trusting network name resolution.

Howard, LeBlanc, and Viega, 24 Deadly Sins of Software Security, ISBN: 978-0-07-162675-0

John Viega and Gary McGraw, Building Secure Software, Addison Wesley

Gary McGraw, Software Security: Building Security, Addison-Wesley

IS802 SECURITY ARCHITECTURE –DESIGN & ANALYSIS (3-0-0) 3

Secure systems – hardware, software and communication systems – design issues and analysis, Secure software architecture – models and principles, hardware design related security – smart cards and other security solutions, communication protocols and application systems associated with security.

Asoke Talukder, Manish Chaitanya, Architecting Secure Software Systems, CRC Press

IS803 INFORMATION SECURITY AUDIT (3-0-0) 3

Security Policy frameworks: practices, and procedures, business practice disclosures. Policy authority and practices, information security practices, personal and physical security practices, operation management practices, PKIs and key management schemes, key generation, key storage, backup, recovery and distribution, XML frameworks for security policy specification, certificate management life cycle. Output measurement approaches, benchmarking, function

points as measurement, estimation of software reliability, software metrics, software auditing, merits and auditing in outsourcing, SE1 & ISO based measurement, merits, CMM and P-CMM, Auditing Standards & groups, Audit Methods & Tools.

International Function Points user group, IT measurement, Person education, 2002
Encyclopedia of Software Engineering, John Wiley & Sons 1994.

IS810 SECURITY ADMINISTRATION (3-0-0) 3

Communication Security & configurations, Win 2003, Linux / Unix security & administration, Use of digital Signatures, SHHTP,SSL, Firewalls in organizational network and system administration, Backup, Viruses, SPAM and other security measures.

Lars Klander, Hacker Proof, Galgotia publications, 2002
Internet Security Professional Security – Techmedia publications, 2002

IS811 SECURITY THREATS & VULNERABILITY (3-0-0) 3

Basic security principles, principle of least privilege trust, trusted computing basics, reference monitors, inline reference monitors and access control, secure multi party computation, secure two party models. Mobile code security Digital Defense: Issues in Security, and Critical Infrastructure Protection: Threats of viruses, worms, malicious codes, etc. models of propagation and their epidemic spread, dos attacks, defenses against hacking. DDoS, design of scalable test beds for simulation of attacks against critical infrastructures, architectures for robust
and flexible Internet, ubiquitous, dependable and indestructible storage.

Ross Anderson , Security Engineering: A guide to Building dependable Distributed systems, John Wiley,
Raymond Panko, Corporate Computer and Network Security

IS812 ENTERPRISE SECURITY (3-0-0) 3

Enterprise security basics, enterprise access control and crypto system techniques, enterprise security systems: design concepts, network, software and database security. Network Recovery concepts in Enterprises.

Robert C. Newmann, Enterprise Security, Pearson Education, 2005.
Michael Cross, Norris L Johnson, Tony Piltzecker, Security , Shroff Publishers and Distributors Pvt. Ltd.
Jean & Mario, Network Recovery, Elsevier India, 2005.

IS813 SECURITY IN COMPUTER SYSTEM (3-0-0) 3

Basic concepts, Access control, Protection, Secure coding, Cryptography, Network security, Firewalls, Security on the Internet and the World Wide Web, Attack Techniques, IDS, Security in Windows, Linux, Social & Ethical issues of Information Security, Information Security management, Case studies & current topics.

Matt Bishop, Computer Security: Arts & Science, Pearson Education, 2004.
Michael Cross, Norris L Johnson, Tony Piltzecker, Security, Shroff Publishers and Distributors Pvt. Ltd.
Pieprzyk, Josef, Hardjono, Thomas; Seberry, Jennifer, Fundamentals of Computer Securiry, Allied Publ.

IS820 APPLIED CRYPTOGRAPHY (3-0-0) 3

Privacy-Enhancing Technologies, Privacy-Preserving Data Collection and Data Publishing, Privacy-Preserving Data Mining, K-Anonymity, Anonymous communications, Anonymous credentials, Group signatures, Privacy and anonymity in peer-to-peer architectures, Privacy-enhanced access control or authentication/certification, Advanced Crypto Algorithms and Protocols, Zero-knowledge proof, Oblivious Transfer, Secure Multiparty Computation Digital Cash, Secret Sharing, Threshold Cryptography, Identity-Based Encryption, Attribute-Based Encryption

B.Schneier, Applied Cryptography, John Wiley & Sons.
Alfred J. Menezes, Paul C. Van Oorschot, Scott A. Vanstone *Handbook of Applied Cryptography, CRC Press*
Jonathan Katz *and* Yehuda Lindell, *Introduction to Modern Cryptography, Chapman & Hall/CRCPress*

IS821 CRYPTOGRAPHIC PROTOCOLS (3-0-0) 3

Competitive strategies for the information economy, network economics; Technologies and applications of telecommunications systems with emphasis on LANs and Internet technologies. Selection of technologies and configurations necessary to support business applications. Competitive, economic, and political factors that influence technology innovation in public and private organizations, domestically and internationally. Management of research and development: project selection, resource allocation, technology planning, management of development projects. Quality, manufacturing, and intellectual properly issues. Concepts in communication security, security issues in layered architecture, components of security models, IPSec, Transport layer security, SHTTP, IP encapsulation, VPNs, open

PGP, Secret key & Public key cryptography , MD5, DES, Internet key Exchange, firewall & Internet Security protocols.

Huth, Secure communication systems: Design, analysis and implementation, Cambridge, 2005

Ross Anderson, Security Engineering: A Guide to Building Dependable Distributed Systems, John Wiley & Sons, 2001.

IS822 ADVANCED CRYPTOGRAPHY (3-0-0) 3

Objectives of cryptography, Symmetric Key Encryption- Stream ciphers & Block ciphers, Public-Key cryptography: RSA, Hash-functions, Discrete logarithm, Modular Squaring, Cryptographic Protocols: Key exchange & entity authentication, identification schemes, commitment schemes, electronic elections, Probabilistic algorithms, probably secure encryption & Digital signatures. Mathematical Models for Internet: Design and control communication networks that respond to: randomly fluctuating demands and failures by adapting rates, by rerouting traffic and by reallocating resources, stability and fairness of rate control algorithms for the Internet; economic issues, scalable models of simulation of such networks, Quantum Cryptography

Wenbo Mao, Modern Cryptography- Theory and Practice, Prentice Hall, 2004.

Susan Loepp & William K. Wooters, Protecting Information (Quantum Cryptography) Cambridge, 2005.

Hans DelFs & Helmutt Knebl, Introduction to cryptography: Principles & Application, Springer Verlag.

IS823 CRYPTANALYSIS (3-0-0) 3

Modern cryptography. Steganography, One-way functions; pseudo-randomness and random number generators; encryption; authentication, symmetric cryptography, asymmetric cryptography: public-key cryptosystem; digital signatures, message authentication codes, remote user authentication, notions of security; zero knowledge/ interactive proofs, multi-party cryptographic protocols, key exchange and applications; cryptanalysis of cryptographic primitives and protocols, such as by side-channel attacks, differential cryptanalysis, or replay attacks; and cryptanalytic techniques on deployed systems etc. Lattices in cryptography and cryptanalysis: Algorithmic aspects of the theory of point lattices and their applications to cryptography and cryptanalysis. Differential and Linear Cryptanalysis, side channel cryptanalysis.

Spillman & Richard J, Classical and Contemporary Cryptology, PHI International, 2004.

Han & Helmutt, Introduction to Cryptography: Principles and Applications, Springer Verlag 2002.

IS830 DATABASE SECURITY (3-0-0) 3

Design of Survivable and Dependable Distributed Systems: Issues in the design of distributed systems distributed OS, high-level protocols, distributed shared memory. OO distributed systems, distributed directory services, fault tolerance issues, issues of survivability, dependability, robustness. Distributed Systems and Fault Tolerance, Security Architecture for FT Systems, Security Architecture for Services, Algorithms, Techniques for Fault Tolerance and high integrity Services, Tools and Environments for building higher integrity service.

Ross Anderson, Security Engineering: A Guide to Building Dependable Distributed Systems, John Wiley & Sons, 2001.

Michael & David, Writing secure code, Microsoft Press, 2002.

IS831 BIOMETRIC SECURITY (3-0-0) 3

Security via biometrics. Spaced Domain based biometric and recognition techniques; Correlation based biometric, filters. Basic theory or Correlation filters; Design of advanced correlation fillers that offer tolerance to expected impairments; Methods to implement digital correlations; Applications of correlation filters.

Reid, Biometrics for Network Security, Pearson Education, 2004.

James L. Wayman , Anil K. Jain, Davide Maltoni, Dario Maio,*Biometric Systems: Technology, Design and Performance Evaluation , Springer*

Anil K. Jain, Ruud Bolle, Sharath Pankanti , *Biometrics: Personal Identification in Networked Society, Kluwer Academic Publishers*

IS832 WEB APPLICATION SECURITY (3-0-0) 3

Web safety and browser vulnerabilities, privacy concerns, issues with Java, JavaScript, ActiveX, and all things Web and security related. Various protocols and approaches to provide web services in as secure a manner as possible will be investigated, to include: digital certificates SSL (Secure Socket Layer), TLS (Transport Layer Security), host security, server access methods, and secure CGI/API.

D. Stuttard and M. Pinto. The Web Application Hacker's Handbook. Wiley. 2008.

Ivan Ristik. ModSecurity Handbook. Feisty Duck, Ltd. 2010.

Open Web Application Security Project. A Guide to Building Secure Web Applications and Web Services. http://www.owasp.org/index.php/Category:OWASP_Guide_Project

IS833 MULTIMEDIA SECURITY (3-0-0) 3

Introduction to digital rights management, Digital Watermarking-Basics, Theoretical Aspects, Schemes, Protocols, Media-specific watermarking. Steganography and Steganalysis, Finger Printing and Digital Forensics, Data Sanitization.

Ingemar Cox, Matthew Miller, Jeffrey Bloom, Digital Watermarking: Principles & Practice, The Morgan Kaufmann Series in Multimedia and Information Systems

Borko Furht, Darko Kirovski, Borivoje Furht, Multimedia Security Handbook (Internet and Communications), CRC Press, 2004

Bill Rosenblatt, Bill Trippe, Stephen Mooney, Digital Rights Management: Business and Technology, Wiley; 1st edition, 2001

IS840 NETWORK ENGINEERING (3-0-0) 3

Internetworking: Architectural principle, layering, names and addresses. Advanced topics in Transport Protocol, Congestion Control, Fair Queuing, Router design and router protocols. Network topologies, Peer-to-Peer networks. Application level protocols. Network management and access control.

Larry L. Peterson, Bruce S. Davie, *Computer Networks: A Systems Approach, Elsevier*

Richard Stevens, TCP/IP Illustrated, Volume 1: The Protocols *PHI, 2001.*

Behrouz Forouzan, TCP/IP Protocol Suite, 3/e, McGraw Hill

IS841 DISTRIBUTED SYSTEMS SECURITY (3-0-0) 3

Distribute systems concepts and design, Weak connectivity and update conflicts, GFS, Cryptographic Primitives, SSL, Reasoning formally about authentication, Software vulnerabilities and exploits, Software based fault isolation.

Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: Private Communication in a Public World, 2nd Edition, Prentice Hall, 2002

Abhijit Belapurkar, Anirban Chakrabarti*et. al, Distributed Systems Security: Issues, Processes and Solutions, Willey Publs.*

IS842 INTERNET SECURITY (3-0-0) 3

Business & legal principles, Information Security-Technological Solutions, Internet Security, Certificates Policies & Principles for E-business, non-repudiations-types & activities, PKI and its roles, examples & case studies.

Warwick Ford & Micheal Secure E-commerce, PH-PTR, 2001

Enrico Nardelli, Certification and Security in E-Services, Allied Publishers, 2004.

Gritzalis, Dimitris, Secure Electronic Voting, Allied Publishers, 2004.

IS843 MOBILE & WIRELESS NETWORK SECURITY (3-0-0) 3

Wired /wireless networks; Effect of mobility on networks, & systems; impact on IP stack from MAC layer and up; ad-hoc and sensor networks; wireless broadcast. II* broadcast. Satellite broadcast; issues of information capacity; distinction between wired and wireless networks from information theory; Issues of security in wireless; issues of 802.11 protocols; routing in wireless networks, design of secure protocols: key distribution for access control, source authentication of transmissions, and non-repudiation; Power management and selfishness issues, attacks in wireless networks; DOS and DDOS attacks, reaction to attacks, information processing for sensor networks

Perrig, Adrian; Tygar J. D., Secure Broadcast Communication in Wired and Wireless Networks, Allied Publishers, 2004.

Makki, S.K.; Reiher, P.; Makki, K.; Pissinou, N.; Makki, S. (Eds.), Mobile and Wireless Network Security and Privacy, Springer.

IS850 CYBER FORENSICS (3-0-0) 3

Industrial espionage and cyber-terrorism, principles of criminal law, computer forensic investigation, elements of personnel security and investigations, principles of risk and security management, conspiracy in computer crime, and computer fraud investigation. Introduction to Cyber Forensics: Computer Forensics and the law, Private & Public sector workplace practices, Cyber Crime examples: Defacements, DoS, Credit Card theft, Silent intrusion, internal attacks, investigative actions, Forensics analysis investigative action, Computer Forensic tools.

Jennifer Bayuk, *Cyber Forensics: Understanding Information Security Investigations, Springer*
Bill Nelson, **Amelia Phillips**, **Christopher Steuart** , *Guide to Computer Forensics and Investigations*

IS851 CLOUD SECURITY (3-0-0) 3

Introduction to cloud computing, Modular arithmetic background, concepts of security, how to assess security of a system, information theoretic security v/s computational security, Data security and storage in cloud, data dispersal techniques, High-availability and integrity layer for cloud storage, Encryption and key management in the cloud, Cloud forensics, Data location and availability, Data security tools and techniques for the cloud, Data distribution and information dispersal techniques Data encryption/decryption methodologies, Trustworthy cloud infrastructures, Cloud related regulatory and compliance issues

Mather, T., Kumaraswamy S., and Latif, S. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance. O'Reilly Media.
Stallings, W. Cryptography and Network Security: Principles and Practice, 5th Edition. Prentice Hall.
Menezes, A., Oorschot, P., Vanstone, S. Handbook of Applied Cryptography. CRC Press, Edition 1st

IS852 ETHICAL HACKING (3-0-0) 3

Hacking Fundamentals, Rconnaissance, Network, Server, Client, Web Application Penetration Testing, Structure of Penetration Testing, Programming and reverse engineering, Digital Foresnsics.

Ankit Fadia, An Unofficial Guide to Ethical Hacking, Macmillan India, 2006

IS853 ADVANCED TOPICS IN SECURITY (3-0-0) 3

Foundations of Crypto complexity and NP Completeness, Complexity classes, Elliptic Curve Cryptography, Emerging security concerns.

Brauer G R, Complexity Theory and Cryptology An Introduction to Cryptocomplexity, Springer 2005

Darrel Hankerson, Alfred Menezes, Scott Vanstone , *Guide to Elliptic Curve Cryptography, Springer*

IS860 HIGH PERFORMANCE COMPUTING FOR SECURITY (3-0-0) 3

Instruction Level Parallelism: Pipelining, Hazards, Compiler techniques for ILP, Branch prediction, Static and Dynamic Scheduling, Speculation, Limits of ILP. Multicore Memory Hierarchy: Cache tradeoffs, Basic and Advanced optimizations, Virtual Memory, DRAM optimizations. Multiprocessors: Symmetric and Distributed architectures, Cache coherence protocols - Snoopy and Directory based, ISA support for Synchronization, Memory Consistency Models. Security Architecture Design Methodology, Security policy models - Multi-Level Security, Multi-Lateral Security Policies. Example Symmetric key cipher architecture – Secure Processors, Cryptographic hash functions – Hardware trust anchors for confidentiality and integrity. Public Key Cryptography Architecture – Bastion.

John Hennessy and David Patterson. Computer Architecture - A Quantitative Approach. 5ed. Morgan Kaufmann.
Ruby B. Lee, Security Basics for Computer Architects. Mark Hill/Margaret Martonosi (eds.). Synthesis Lectures on Computer Architecture, Morgan and Claypool, 2013.
John P. Shen and Mikko H. Lipasti. Modern Processor Design - Fundamentals of Superscalar Processors. Tata McGraw Hill.
Important publications in secure processors, and high performance computing.

CE720 Digital Modulation and Spread Spectrum Systems (3–1–0) 4

Review of fundamental concepts and parameters in Digital Communications, Performance of Carrier modulation Schemes:Performance of BPSK and QPSK in AWGN channel, Performance of binary FSK and M-ary PSK in AWGN channel, Minimum Shift Keying (MSK) Modulation, GMSK, Continuous Phase Modulation(CPM) Schemes; Channel Characterization and Modeling: Optimum Receivers for AWGN channels, Equalization Techniques; Orthogonal Frequency Division Multiplexing (OFDM):Carrier Synchronization, Timing synchronization; Spread spectrum signals for digital communications: Introduction to Spread Spectrum Modulation, DSSS, FHSS, CDMA signals, Code Acquisition and Tracking, Spread Spectrum as a Multiple Access Technique; Multichannel and Multicarrier Systems; Digital Communications through Fading Multipath channels; Multi User Communications.

J. Proakis, Digital Communications, McGraw Hill, 2000

J. Viterbi and J. K. Omura, Principles of Digital Communications and Coding, McGraw Hill, 1979

Marvin K. Simon, Jim K Omura, Robert A. Scholtz, Barry K.Levit, Spread Spectrum Communications, 1995.

Andrew J Viterbi, CDMA Principles of Spread Spectrum Communications, Addison Wesley, 1995.

CE721 Mathematical Foundations for Communication Engineering (3–1–0)4

Introduction to Probability and Stochastic Processes: Notion of multiple Discrete and Continuous Random Variables, Stochastic Processes, Sum of Random Variables, Statistical Inference, Gaussian Q-function, Marcum Q-function; Linear Equations, Matrices, Vector Spaces, Basis and Dimensions, Linear Mappings, Matrices and Linear operators, Determinants, Eigen values and Eigen vectors; Groups, Rings and Fields, Vector Spaces and Modulus, Field Theory, Algebraic extensions; Introduction to Number Theory

R D Yates, D J Goodman, Probability and Stochastic Processes, John Wiley and Sons, 1999

H. Stark, J.W Woods, Probability and Random Processes, Pearson Education, 2002

K. Huffman, R. Kunze, Linear Algebra, Prentice Hall of India, 1998

CE722 RF Circuits and Systems (3–1–0) 4

Review of Basic Transmission Line Theory, Planar Transmission Lines - Stripline, microstrip line, suspended stripline and coplanar line; Parallel coupled lines in stripine and microstrip – Analysis, design and characteristics. Microwave Network Analysis - Microwave network representation, Impedance and admittance matrices, Scattering parameters, Typical two-port, three port, four port networks; Impedance Matching Techniques - Smith chart, Matching networks using lumped elements, Single- and double-stub matching, Quarter wave transformer, Multi-section transformers - Binomial and Chebyshev. Basic Passive Components -Lumped elements in MIC, Discontinuities and resonators in microstrip, Balun. Analysis and design of stripline/microstrip components- Directional couplers, Power divider, Hybrid ring. Switches and Phase Shifters - PIN diode– Equivalent circuit and Characteristics, Basic series and shunt switches in microstrip; SPST and SPDT switches, Switched line, branchline coupled and loaded line phase shifters in microstrip. Applications in phased arrays. MIC Filters - Lumped element filter design at RF. Impedance and Low pass scaling, Frequency transformation, High impedance/Low impedance low pass filter, Parallel coupled band pass filter, Spur line band stop filter, Realization in microstrip and suspended stripline Basics of MIC, MMIC and MEMS technologies - Substrates used. Fabrication process. Relative advantages. Examples- Realization of lumped elements and filters in MMIC, Realization of planar transmission lines and filters in MEMS.

M.M. Radmanesh, Radio Frequency and Microwave Electronics, Pearson Education Asia, 2001.

B. Bhat & S.K. Koul, Stripline-like Transmission Line for Microwave Integrated Circuits, New Age Intl. (P) Ltd.,1989.

D. K. Misra, Radio Frequency and Microwave Communication Circuits – Analysis and Design, John Wiley & Sons, 2001;

D. M. Pozar, Microwave Engineering, 2nd Edition, John Wiley & Sons, 1998.

CE723 Light Wave Communication (3–1–0) 4

Importance of OFC; Light wave propagation in dielectric slab waveguides, Ray Theory, Numerical aperture, SI and GI waveguides, channel waveguides. Optical fibers: Types, fabrication techniques, attenuation, dispersion, Modes in SI and GI , DSF, DFF, PM fibers, plastic fibers, fiber bundles, connectors, couplers, power splitters etc. Optical Sources and detectors: Review of PN junction diodes, LEDs, Laser Diodes, Noise sources; Photo-detectors: PIN and APD design, Noise characteristics, Modulation of LEDs/LDs, drive circuits for LDs & PDs., high speed operation. OFC Systems: Simple networks and their analysis, BER calculations, WDM principle and techniques. Optical TDM etc, long haul DWDM. EDFAs and their applications to OFC. Optical Fiber Sensors. Coherent detection in OFC

G.P. Agarwal, Fiber Optic Communication Systems, John Wiley 1997

Senior J., Optical fiber communications, Principles & Practice, PHI,1992
Keiser G., Optical fiber communications, McGraw-Hill, 1999
A Selvarajan, S.Kar, T Srinivas, Optical Fiber Communications, TMH, 2002
William B. Jones, Introduction to optical fiber communication systems, OUP, 1998

CE724 Detection and Estimation Theory (3–1–0) 4

Hypothesis Testing, Neyman Pearson Lemma, UMP test, Decision Theoretic framework, Multiple-Decision Problem. Parameter Estimation - Unbiasedness, Consistency, asymptotic normality, sufficient statistics, minimax estimation, decision theoretic framework, Rao-Blackwell theorem, Cramer – Rao inequality. Estimation: Minimum mean square linear estimation, Wiener filter, Kalman filter, Levinson – Durbin and innovation algorithms.

H. L. Van Trees Detection, Estimation and Modulation Theory, Part I, John Wiley, 1968.
Srinath, Rajasekaran and Viswanathan, Introduction to Statistical Signal Processing with applications, PHI, 1995.
Steven M. Kay, Fundaments of Statistical Signal Processing, Vol. I:Estimation Theory, Vol. II: Detection Theory, Prentice Hall International, 1993
Papoulis A., Probability Random Variables and Stochastic Processes, McGraw Hill, 2002
H. Stark and J. W Woods, Probability and Random Processes with applications to signal processing, Pearson Education, 2002.

CE 725 Advanced Digital Signal Processing (3-1-0) 4

2-D signals and systems, Analysis of 2D systems in spatial, frequency and transform domains; Short time Fourier Transform; Multirate Signal Processing: Decimation Interpolation, DFT filter banks, QMF filter banks, Multiresolution Signal analysis wavelets theory of sub band decompositions, Sub band codingand wavelet transforms, Application of wavelet transforms. Power spectral estimation; Higher order spectral estimation; Adaptive filters and applications. Recursive estimation and Kalman filters.

P.P. Vaidyanathan, Multirate systems and Filter banks, Prentice Hall, 1993.
S.J. Orfanidis, Optimum Signal Processing, McGraw Hill, 1989.
S. Haykin, Adaptive Filter Theory, Pearson, 1996

CE820 Digital Signal Compression (3–0–0) 3

Data Compression. Speech & image waveform characterization. Predictive coding. Transform coding. Subband coding, VQ based compression, Fractal coding of images. High quality video & audio compression for digital broadcasting. Standards for digital signal compression-data, speech, audio, image & video.

D. Salomon, Data Compression – the complete reference, Springer, 2000.
K. Sayood, Introduction to Data Compression, Pearson Education, 2000.
M.Nelson, The data compression book, BPB Publications, 2002.
Jayant & Noll, Digital coding of waveforms-Principles and applications to speech & video, PH, 1984.
Zi Nian Li, Fundamentals of Multimedia, Pearson Education, 2003.

CE821 Error Control Coding (3–0–0) 3

Coding for reliable digital transmission and storage. Groups, Rings, Vector Spaces, Galois Fields, Polynomial rings, Channel models, Linear Block codes, Cyclic codes, BCH codes, Reed Solomon Codes, Berlekamp-Massey and Euclid decoding algorithm, Decoding beyond the minimum distance parameter, Applications of Reed-Solomon codes, Convolutional codes, Decoding algorithms for Convolutional codes, Viterbi, Stack and Fano algorithms, Application of Convolutional codes. Codes based on the Fourier Transform, Algorithms based on the Fourier Transform, Trellis coded modulation, Combinatorial description of Block and Convolutional codes, Algorithms for the construction of minimal and tail biting trellises, Soft decision decoding algorithms, Iterative decoding algorithms, Turbo-decoding, Two-way algorithm, LDPC codes, Use of LDPC codes in digital video broadcasting, belief propagation (BP) algorithms, Space-Time codes.

Shu Lin and Danicl J. Costello Jr., Error Control Coding: Fundamentals and Applications, Prentice Hall, 2003.
S. B Wicker, Error Control Systems for Digital Communication and Storage, Prentice Hall International, 1995.
Blahut R. E, Theory and Practise of Error Control Codes, Addisson Wesley, 1983.
Blahut R.E., Algebraic codes for Data transmission, Cambridge University Press, 2003.
Johannesson R and Zigangirov K.S ,Fundamentals of Convolutional codes, IEEE press, 1999.
V. S Pless and W. C Huffman, A. Vardy, Trellis structure of codes, Chapter 24 of Handbook of Coding Theory.

CE822 Wireless Communications & Networks (3–0–0) 3

Radio Propagation Characteristics: Models for path loss, shadowing and multipath fading (delay spread, coherence band width, coherence time, Doppler spread), Jakes channel model, Digital modulation for mobile radio, analysis under fading channels: diversity techniques and RAKE demodulator, channel coding techniques, multiple access techniques used in wireless mobile communications. Space time propagation, wireless channel, channel as a space time random field, space time channel and signal models, capacity of space time channels, spatial diversity, space time receivers, space time coding with channel knowledge, space time OFDM. Wireless networks – WLAN, Bluetooth. Suitable mini-projects in the areas of Space-Time codes and OFDM. The cellular concept: Frequency reuse: The basic theory of hexagonal cell layout: Spectrum efficiency, FDM / TDM cellular systems: Channel allocation schemes, Handover analysis, Erland capacity comparison of FDM / TDM systems and cellular CDMA. Discussion of GSM and CDMA cellular standards, Signaling and call control: Mobility management, location tracking. Wireless data networking, packet error modeling on fading channels, performance analysis of link and transport layer protocols over wireless channels: mobile data networking (Mobile IP): wireless data in GSM, IS - 95 and GPRS.

Space time Wireless Communications

J.G. Proakis, Digital Communication, McGraw Hill, 2000.
G.L. Stuber, Principles of Mobile Communications, Kluwer Academic, 1996.
T.S. Rappaport, Wireless Communications: Principles and Practice, Prentice Hall, 2002.
Kumar, D. Manjunath and J. Kuri, Communication Networking, an Analytical Approach, Elsever, 2004
Paulraj, R. Nabar & D. Gore, Introduction to Space Time Wireless Communications, Cambridge Univ Press, 2003
C Sivarama Murthy and B S Manoj, Ad-Hoc Wireless Networks, Architectures and Protocols, PH, 2004.

CE823 Cryptography (3-0-0) 3

Elementary Number Theory, Finite series, Arithmetic and Algebraic Algorithms, Secrete key and Public key Cryptography, Pseudo Random bit generators, Block and Stream Ciphers, Hash functions and Message digests, Public key encryption, Authentication, Digital Signatures, Zero Knowledge Interactive Protocols, Elliptic curve cryptosystems, formal verification, Crypt analysis, Hard Problems.

Koblitz N., A Course on Number Theory and Cryptography, Springer Verlag, 1986.
Menezes A. et. all, Handbook of Applied Cryptography, CRC Press, 1996

CE824 Radar Signal Processing (3–0–0) 3

Radar and its composite environment, Review of Radar range performance computations, Detection Processes, Sequential and adaptive processes, Atmospheric effects, Sea and land Back scatter, Signal Processing concepts and waveform designs MTI & CW radars, phase coding techniques, FM pulse compression waveforms, Mateorogical radar and system performance analysis.

R.J Sullivan, Radar Foundations for imaging and Advanced Concepts, PMI, 2004.
F.E Nathanson, Radar Design Principles, Signal Processing and The Environment, PMI, 2004.
J.C. Toomay, Principles of radar, PMI, 2004.

CE825 Optical Networks (3–0–0) 3

Introduction to Optical Networks, Propagation of Signals in an optical fiber, Optical Components, Modulation and demodulation, Transmission system engineering, client layer of the optical layer, WDM network Elements, WDM network designing, DWDM networks

R. Ramaswami and K.N. Sivarajan, Optical Networks, A Practical Perspective, Harcourt Asia Pvt. Ltd., 2000.

CE826 Image & Video processing (3–0–0) 3

Digital image fundamentals – image acquisition, representation, visual perception, quality measures, sampling and quantization, basic relationship between pixels, imaging geometry, color spaces, Video spaces, analog and digital video interfaces, video standards. Two dimensional systems – properties, analysis in spatial, frequency and transform domains. Image transforms - DFT, DCT, Sine, Hadamard, Haar, Slant, KL transform, Wavelet transform. Image enhancement – point processing, spatial filtering, Image restoration – inverse filtering, de-blurring Video processing – display enhancement, video mixing, video scaling, scan rate conversion, Image compression – lossless and lossy compression techniques, standards for image compression – JPEG, JPEG2000. Video compression – motion estimation, intra and interframe prediction, perceptual coding, standards - MPEG, H.264 Image segmentation – feature extraction, region oriented segmentation, descriptors, morphology, Image recognition

R. C. Gonzalez and R E Woods, Digital Image Processing, Pearson Education, 2002
A K Jain, Fundamentals of Digital Image Processing, Pearson Education,1989
W Pratt, Digital Image Processing, Wiley, 2001

Al Bovik, Handbook of Image and Video, Academic Press, 2000
Keith Jack, Video Demystified, LLH, 2001

CE827 Speech & Audio processing (3-0-0) 3

Speech Production – human speech production mechanism, acoustic theory of speech production, digital models for speech production. Speech perception – human hearing, auditory psychophysics, JND, pitch perception, auditory masking, models for speech perception. Speech Analysis – Time and frequency domain analysis of speech, speech parameter estimation, Linear prediction. Speech compression – quality measures, waveform coding, source coders, Speech compression standards for personal communication systems. Audio processing – characteristics of audio signals, sampling, Audio compression techniques, Standards for audio compression in multimedia applications, MPEG audio encoding and decoding, audio databases and applications. Speech synthesis – text to speech synthesis, letter to sound rules, syntactic analysis, timing and pitch segmental analysis. Speech recognition – Segmental feature extraction, DTW, HMMs, approaches for speaker, speech and language recognition and verification

Douglas O'Shaugnessy, Speech Communication – Human and Machine, IEEE Press, 2000
L R Rabiner, Digital Processing of Speech Signals, Pearson,1978
T.F Quatieri ,Discrete-time speech signal processing: Principles and Practise Pearson,2002
Zi Nian Li, Fundamentals of Multimedia, Pearson Education, 2003

CE828 Multimedia Communications (3-0-0) 3

Representation of Multimedia Data, Concept of Non-Temporal and Temporal Media, Basic Characteristics of Non-Temporal Media, Images,Graphics,Text, Basic Characteristics of Temporal Media, Video, Audio, Animation, Basics of Morphing,Hypertext and Hypermedia, Multimedia Presentations, Synchronization. Compression of Multimedia Data, Basic concepts of Compression, Still Image Compression JPEG Compression, Natural Video Compression, MPEG-1&2 Compression Schemes,MPEG-4 Video Compression, Audio Compression Introduction to Speech and Audio Compression, MP3 Compression Scheme, Management of Coded Data ,Stream management in MPEG-4 , BIFS, DMIF Multimedia System Design, General Purpose Architecture for Multimedia Processing, Operating System Support for Multimedia, Data, Resource Scheduling with real-time considerations, File System, I/O Device Management, Delivery of Multimedia data, Network and Transport Protocols, QoS issues,RTP and RSVP,Video-conferencing and video-conferencing standards,Overview of Voice over IP, Multimedia Information Management, Multimedia Data base Design, Content Based Information Retrieval, Image Retrieval,Video Retrieval,Overview of MPEG-7.

Ralt Steinmetz and Klara Nahrstedt, Multimedia : Computing, Communication & Applications, Pearson Education Publications, 2004.

CE829 MIMO Communication Systems (3-0-0) 3

Overview of fundamentals of Digital Communications, The Wireless Channel, Detection, Diversity and Channel Uncertainty, Capacity of Wireless channels, Spatial Multiplexing and Channel modeling, Capacity and Multiplexing architectures, Diversity-Multiplexing tradeoff and Universal Space Time Codes, Multi-user Communication.

David Tse, Pramod Viswanath, Fundamentals of Wireless Communications, Cambridge University Press, 2005.
E. Biglieri, Coding for Wireless Channels, Springer, 2007
E. Biglieri et al., MIMO Wireless Communications, Cambridge University Press, 2007.

CE 830 Information Theory (3-0-0) 3

Entropy, Relative Entropy and Mutual Information, Asymptotic Equipartition Property, Entropy rate of a stochastic process, Data Compression, Channel Capacity, Differential Entropy, Gaussian Channel, Rate Distortion Theory, Information Theory and Statistics, Network Information Theory.

T. M Cover and Joy A Thomas, Elements of Information Theory, John Wiley 2006.
R.E Blahut, Principles and Practice of Information Theory, Addison Wesley, 1987.

CE831 Computer Communication Networks (3-0-0) 3

Overview of OSI and TCP/IP models; TCP/IP Networks: The TCP/IP Architecture, The Internet Protocol, IPv6, User Data gram Protocol, Transmission Control Protocol, Internet Routing Protocols, Multicast Routing, DHCP and Mobile IP, Internet Routing protocols, Multicast Routing; ISDN and ATM Networks: Overview of ISDN (ISDN Channels, User Access, ISDN protocols, Broadband ISDN), BISDN Reference Model, ATM Layer, ATM adaptation Layer, ATM Signaling, PNNI Routing; Network Security and distributed applications: Security requirements and attacks, Encryption, authentication, digital signatures, Ipv4 and Ipv6 security, ASN.1, SNMP, SMTP, MIME, HTTP; Advanced Network Architectures/Protocols: IP forwarding Architectures, Overlay Model, MPLS, Integrated services in the

Internet, RSVP, Differentiated Services, Real-Time Transport Protocol, Session Control Protocols; Queuing models, Little's Theorem, Markov chains – M/M/1, M/M/m, infinite server and m server loss systems, M/G/1, priority queuing, Networks of Queues Multiple Access Communication, Random Access Protocols. Scheduling: Stochastic Analysis: Stochastic traffic models, performance measures, Little's theorem, Brumelle's Theorem and applications, multiplexer analysis with stationary and Ergodic traffic, multi loop networks.

Leon Garcia and Widjaja., Communication Networks, Tata McGraw-Hill,2003
Stallings W. Data and Computer Communications. PHI, 2003
Kumar, D. Manjunath and J. Kuri. Communication networking, An analytical approach, Elsevier, 2004.
J.F. Hayes, Modelling and analysis of Computer Communications Networks, Plenum, 1984.
Bertsekas and Gallanger, Data Networks, PH, 1992

CE 832 Advanced Antenna Theory (3-0-0) 3

Planar Antennas - Microstrip rectangular and circular patch antennas- Analysis and design, Feeding methods; Circularly polarized microstrip antennas, Broadbanding techniques. Printed slot antennas. Array Theory – Linear array; Broadside and end fire arrays; Self and mutual impedance of between linear elements, grating lobe considerations. Planar array- Array factor, beamwidth, directivity. Example of microstrip patch arrays and feed networks. Electronic scanning. Broadband Antennas- Folded dipole, Sleeve dipole, Biconical antenna- Analysis, characteristics, matching techniques. Yagi array of linear elements and printed version, Log-periodic dipole array. Frequency Independent Antennas- Planar spiral antenna, Log periodic dipole array. Aperture Antennas- Field equivalence principle, Babinet's principle. Rectangular waveguide horn antenna, Parabolic reflector antenna. Antennas for mobile communication - Handset antennas, Base station antennas. Beam steering and antennas for MIMO applications. Active and smart microstrip antennas, Design and analysis of microstrip antenna arrays.

C. A. Balanis, Antenna Theory and Design, John Wiley & Sons, 1997.
J.D. Kraus, Antennas, McGraw-Hill, 1988.
R.A. Sainati, CAD of Microstrip Antennas for Wireless Applications, Artech House, 1996.
R. Garg, P. Bharhia, I. Bahl, and A. Ittipiboo, Microstrip Antenna design Handbook, Artech House.
J. R. James, P.S. Hall and C.Wood, Microstrip Antennas: Theory & Design, Peter Peregrinns , UK

CE 833 Photonic Devices (3-0-0) 3

Importance of optical/photonic devices and OEICs, Thin film or channel waveguides and their fabrication techniques; Electro-optic modulation; Acousto-optic modulation; Magneto-optic modulation. Optical processes in semiconductors:e-h pair formation and recombination;Franz-Keldish & Stark effect; Quantum well structures. LEDs and LDs: Structure, device performance, modulation Characteristics, drive circuits.Photo-detectors: pin &APDs(review);noise and sensitivity. High speed operation. Modulation and switching of LDs: SEEDs, Electro-optic modulators,QW modulators, Bistable devices. OEICs: fabrication, some specific OEICs(integrated LD,modulators,transmitter) Amplifiers: Semiconductor amplifiers, EDFA

Pallab Bhattacharyya, Semiconductor OE devices, PHI, 1995
A.K.Ghatak and K.Thyagarajan, Optical Electronics, Cambridge University Press, 1989
B. E. A. Saleh, M. C. Teich, Fundamentals of photonics, Wiley Inter science, 1991.
J. Singh, Optoelectronics: An introduction to materials & devices, McGraw Hill, 1996.
J. Wilson & J. F. B. Hawkes, Optoelectronics: An introduction, Prentice Hall India, 1992.

CE 834 Active RF Devices and Circuits (3-0-0) 3

Transistor Amplifiers - Types of amplifiers. S- parameter characterization of transistors; MESFETs - Equivalent circuit model. Single stage amplifier design- unilateral and bilateral cases, Amplifier stability, Constant gain and noise circles, DC bias circuits for amplifiers;Detectors and Mixers - Point contact and Schottky barrier diodes- Characteristics and equivalent circuit, Theory of microwave detection, Detector circuit design. Types of mixers. Mixer theory and characteristics. SSB versus DSB mixers. Single-ended mixer and single-balanced mixer- Design and realization in microstrip. Double balanced and image rejection mixers;Oscillators - Oscillator versus amplifier design, Oscillation conditions;Gunn diode – Modes of operation, Equivalent circuit. Design of Gunn diode oscillator in microstrip. FET oscillators. Frequency tuning techniques. Switches and Phase Shifters - PIN diode– Equivalent circuit and Characteristics, Basic series and shunt switches in microstrip; SPST and SPDT switches, Switched line, branchline coupled and loaded line phase shifters in microstrip. Applications in phased arrays. Oscillators - Oscillator versus amplifier design, Oscillation conditions. Gunn diode – Modes of operation, Equivalent circuit. Design of Gunn diode oscillator in microstrip. FET oscillators. Frequency tuning techniques.

D. K. Misra, Radio Frequency and Microwave Communication Circuits – Analysis and Design, John Wiley, 2004.
G. Gonzalez, Microwave Transistor Amplifiers – Analysis and Design, Prentice Hall, 1997.

D. M. Pozar, Microwave Engineering, John Wiley, 1998.
S.K. Koul and B. Bhat, Microwave and Millimeter Wave Phase Shifters, Vol.II- Semiconductor and Delay Line Phase Shifters, Artech House, 1991
G.D. Vendelin, A.M. Pavio and U.L. Rhode, Microwave Circuit Design using Linear and Non-linear Techniques, 1990.

CE835 Soft Computing (3–0–0) 3

Introduction to learning systems - Feed forward Neural Networks - Perception - Multilayer Perception. Propagation algorithm and its variants - Improving generalization by various methods. Recurrent Neural Networks Hopfield net Boltzmann machine and Mean field learning solving combinational optimization problems using recurrent Neural Networks. Unsupervised Neural Networks. Competitive learning Self-organizing maps Growing cell structures Principal component analysis. Basics of fuzzy sets. Genetic algorithms: Population based search techniques, evolutionary strategies, mathematical foundations of genetic algorithms, search operators, genetic algorithms in function and combinational optimization, hybrid algorithms, application to pattern recognition

S. Haykin, Neural Networks: A comprehensive foundation, Pearson, 1999
J. M. Zurada, Introduction to artificial neural networks, Jaico publishing, 1997.
B. Yejnanarayana, Artificial Neural Networks, PHI, 1999
C. Mohan and S. Ranka, Neural networks, Benram publications, 2004.

CE836 Adaptive Signal Processing (3-0-0) 3

Introduction to Adaptive Processing: General properties, filtering, prediction and smoothing, Applications in Communications: Equalisation, Echo cancellation, Noise cancellation. Optimal Signal Processing, Principles of orthogonality, minimum square error, Wiener Hopf equations, state space model, innovations process, Kalman filter equations. Linear Adaptive Equalisation, Gradient search and steepest descent adaptation algorithms, effect of eigenvalue spread on stability and rate of convergence, stochastic gradient descent using Least Mean Squares (LMS) algorithms, transient and steady state properties including convergence rate and mis-adjustment, least square estimation, normal equations, Recursive Least Squares (RLS) algorithms, relationship between RCS and Kalman filters. Introduction to Fast Recursive Algorithms for Equalization, Adaptive linear prediction, lattice filtering for RLS. Tracking time-varying systems, Nonlinear adaptive filtering

S.J. Orfanidis, Optimum Signal Processing, McGraw Hill, 1989.
S. Haykin, Adaptive FilterTheory, Pearson, 1996

CE 837 Time Frequency Analysis (3-0-0) 3

The need for Time-frequency analysis: introduction, simple analytic Examples, why spectra changes. Time and Frequency Description of Signals: duration and mean time in terms of the spectrum, bandwidth equations and AM and FM contributions to the bandwidth. Instantaneous Frequency and the Complex Signal: reasons for the complex signal, the analytic signal, physical interpretation of the analytic signal and density of instantaneous frequency. Densities and Characteristic functions: one and two dimensional density functions and their characteristic functions, relation between local and global averages. Fundamentals of Time-Frequency Distribution (TFD): Uncertainty principle and properties of TFD. Different Types of TFD: Short Time Fourier Transform, Wigner distribution, generalized TFD and prosperities of these distributions. Generation of TFD Using Kernal Methods. Kernel design for reduced interference in TFD. Positive Distributions Satisfying the Marginals. Applications of TFD in the fields of Radar, Speech, Sonar Signal Processing.

Leon Cohen, *Time-Frequency Analysis, Prentice-Hall PTR, Upper Saddle River, 1995.*
S. Mallat, *A wavelet tour of signal processing - The sparse way*, Elsevier, Third Edition, 2009
D. Gabor, "*Theory of communication*", Proceedings of IEE, pp. 429-457, 1946

CE 838 Topics in Medical Imaging (3-0-0) 3

Introduction to Image processing, X-ray tomography, emission computer tomography, magnetic resonance imaging systems and Optical Computed Tomography. X-ray tomography:X-rays, Interaction with matter, X-ray detectors, Projection and Fourier slice theorem, Translate and rotate, translate-rotate, rotate on a circular trajectory for 2-D imaging and helical or spiral scan trajectory for 3-D imaging. Fourier inversion algorithms, filtered back projection algorithms – reconstruction with non-diffracting sources, parallel projections and fan projections for 2-D and cone beam projections on circular and spiral trajectory for 3-D reconstruction. Computer implementation. MRI Imaging: Introduction, Physics of the transmitted signal, Interaction with tissue, Signal detection and detector, Imaging, Image quality Equipment, Clinical use. Ultrasound Imaging: Ultrasound imaging: Physics of acoustic waves, Generation and detection of ultrasound, Gray scale imaging, Doppler imaging, Image quality, Equipment, Clinical use. Optical tomography: Introduction to Optical tomography.

Kak A C, Slaney M, *Principles of Computerized Tomography, IEEE Press, New York , 1987*
Paul Suetens*, Fundamentals of Medical Imaging, Cambridge University Press, 2nd Edition, 2009.*

CE839 ADVANCED OPTICAL COMMUNICATION SYSTEMS (3-0-0) 3

Correlation properties and power density spectrum of shot noise process; Laser phase noise modeling and Lorentzian power spectrum of lasers; Coherent optical communication systems: Homodyne and heterodyne detection schemes, BER analyses - super-quantum and shot noise limits for homodyne PSK, Synchronous and asynchronous FSK, Impact of finite laser linewidth on BER, Polarization control and diversity schemes, Frequency alignment schemes; Review of optical amplifiers - Semiconductor amplifiers, Erbium-doped fibre amplifiers (EDFAs) and Raman amplifiers, Analytical modelling of gain saturation in EDFAs, Gain equalization in EDFAs, ASE noise in EDFAs, Amplifier cascades, Amplifier spacing penalty; BER analysis of lightpaths in WDM backbones in presence of ASE noise and switch crosstalks; Optical duobinary modulation: Spectral efficiency, Basic scheme, BER analysis, Impact of fibre nonlinearities; Advanced modulation schemes, Advanced detection schemes, Advanced Coding Schemes, Advanced optical networking, Optical Channel capacity and energy efficiency.

Milorad Cvijetic, Ivan Djordjevic, Advanced Optical Communication Systems and Networks, Artech House, 2013
J.E. Midwinter, Optical fibers for transmission, John Wiley, 1979.
S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
G.P Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.
G P. Agrawal, Fiber optic Communication Systems, John Wiley and sons, 1992.
Research Papers.

CE840 ADVANCED COMMUNICATION NETWORKS (3-0-0) 3

Overview of Internet-Concepts, challenges and history. Overview of high speed networks-ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.;Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.;Characterization of Traffic by Linearly Bounded arrival Processes (LBAP). Concept of (o,, p) regulator. Leaky bucket algorithm and its properties.;Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.;Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.;IP address lookup-challenges. Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms.;Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework.;IP switching and MPLS-Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS. [P control of Optical Routers. Lamda Switching, DWDM Networks.

Jean Wairand and Pravin Varaiya, High Perforamnce Communications Networks, Second Edition, 2000.
Jean Le Boudec and Patrick Thiran, Network Calculus A Theory of Deterministic Queueing Systems for the Internet, Springer Veriag, 2001.
Zhang Wang, Internet Qo,5, Morgan Kaufman 2001.
George Kesidis, ATM Network Performance, Kluwer Academic, 2000.
Research Papers.

CE841 INTERNET OF THINGS (3-0-0) 3

The IoT Networking Core , Technologies involved in IoT Development, Internet/Web and Networking Basics, OSI Model, Data transfer referred with OSI Model, IP Addressing, Point to Point Data transfer, Point to Multi Point Data transfer & Network Topologies, Subnetting, Network Topologies referred with Web, Introduction to Web Servers, Introduction to Cloud Computing.
IoT Platform overview: Overview of IoT supported Hardware platforms such as : Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards.

Network Fundamentals: Overview and working principle of Wired Networking equipment's, Router, Switches, Overview and working principle of Wireless Networking equipment's,Access Points, Hubs etc. Linux Network configuration Concepts: Networking configurations in Linux Accessing Hardware & Device Files interactions.
IoT Architecture:History of IoT, M2M, Machine to Machine, Web of Things, IoT protocols, Applications:Remote Monitoring & Sensing, Remote Controlling, Performance Analysis The Architecture, The Layering concepts , IoT Communication Pattern, IoT protocol Architecture, The 6LoWPAN, Security aspIoT Application Development: Application Protocols,MQTT, REST/HTTP, CoAP, MySQLects in IoT.
Back end Application Designing: Apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB Object type Database, HTML, CSS & jQuery for UI Designing , JSON lib for data processing, Security & Privacy during development, Application Development for mobile Platforms: Overview of Android / IOS App Development tools.
Case Study & advanced IoT Applications: IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments. Use of Big Data and Visualization in IoT, Industry 4.0 concepts. Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/Arduino).

Zach Shelby, Carsten Bormann, 6LoWPAN: The Wireless Embedded Internet, Wiley, 2009
Ovidiu Vermesan, Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013.
Jean-Philippe Vasseur, Adam Dunkels, Interconnecting Smart Objects with IP: The Next Internet, Morgan Kuffmann, 2010.
Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next Generation Pervasive Networked, Auerbach Publications, 2008.
Arshdeep Bahga, Vijay Madisetti, Internet of Things (A Hands on Approach), VPT, 2014 .
Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, Wiley, 2013.
Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill, 2010.
William Stallings; Data and Computer Communications, Pearson Education Pte. 6th Edition, 2014.

CE842 **ALGORITHMS FOR PARAMETER AND STATE ESTIMATION (3-0-0)3**

Maximum likelihood (ML) estimation, Maximum a posteriori (MAP) estimation, Least squares (LS) estimation, Minimum mean square error (MMSE) estimation, Linear MMSE (LMMSE) estimation. LS estimation for linear and nonlinear systems, modeling stochastic dynamic systems, the Kalman filter for discrete time linear dynamic systems with Gaussian noise. Steady state filters for noisy dynamic systems, adaptive multiple model estimation techniques. Nonlinear estimation techniques, computational aspects of discrete time estimation.

Y. Bar-Shalom, X. Rong Li and T. Kirubarajan, Estimation with Applications to Tracking and Navigation, John Wiley & Sons, 2001.
F. L. Lewis, Optimal Estimation, John Wiley & Sons, 1986.
R. G. Brown and P. Y. C. Hwang, Introduction to Random Signals and Applied Kalman Filtering, John Wiley & Sons, 1992.
http://www.ece.mcmaster.ca/~kiruba/ece771/ece771.html

CE843 MULTI TARGET TRACKING AND MULTISENSOR INFORMATION FUSION (3-0-0) 3

Target tracking, performance evaluation techniques, data association. Tracking with multiple sensors, out-of-sequence measurement, track initialization, track management. Probabilistic Data Association Filter (PDAF), adaptive gating for PDAF. Maximum Likelihood-PDA (ML-PDA). Joint Probabilistic Data Association Filter (JPDA). Multiple Hypothesis Tracking (MHT). Performance prediction, sensor management, track-to-track fusion. Nonlinear filters.

Y. Bar-Shalom, X. Rong Li, Multi Target Multi Sensor Tracking-Principles and Techniques, YBS Publishers, 1995.
Y.Barshalom, P K Willet and X Tin, Tracking and Data Fusion: A Hand book of algorithms , Yaakov Bar-Shalom, 2011.
Y.Barshalom, Multitarget-Multisensor Tracking: Applications and Advances v.2, Yaakov Bar-Shalom, 2000.
Y.Barshalom, Multitarget-Multisensor Tracking: Applications and Advances v.3, Artech House, 2000.
S.Blackman and R.Popoli, Design and Analysis of Modern Tracking systems published by Artech house.1999
Lecture Notes, Dr. R. Tharmarasa, McMaster University, Canada.

CE844 NETWORK FLOW AND ITS OPTIMIZATION (3-0-0) 3

Concepts and applications of Search methods, Convex sets, Linear, duality principles and Integer Programming. Static Maximum Flow, and Graph modeling of Networks. Multiple sources and sinks . The labeling method for solving

maximal flow problems Lower bounds on arc flows. Flows in undirected and mixed networks. Node capacities and other extensions. Flow value function of capacities. Case studies for optical networks and wireless sensor networks.

Ford and Fulkerson, Flow in Networks, Princeton University Press, 1962.

Dantzig G. B., Linear Programming and Extensions, Princeton University Press, 1963.

N. Deo, Graph Theory with Applications to Engineering and Computer Science, PHI, 1974.

R. Diestel, Graph Theory, Springer-Verlag, 2000.

M. Pior and, D.Medhi, Routing Flow and Capacity design in Communication and Computer Networks, Morgan Kaufmann Publisher, 2004

CE845 SIGNAL PROCESSING TECHNIQUES FOR SOFTWARE RADIOS (3-0-0) 3

Sampling and Discrete Time Systems: Sampling, Aliasing, Antialiasing filter, Nyquist criteria for ISI free communication, Sampling in frequency domain.

Numerical Computation of the Fourier Transform: Derivation of DFT and properties, FFT, Improving the resolution of the spectrum via zero padding, Spectral densities, z-transforms.

Digital Filters: Filter specifications, Filter design using windowing method, Equiripple filters, Nyquist and square root Nyquist filters.

Multirate Signal Processing: M-fold decimator and L-fold expander, sample rate conversion, noble identities, polyphase representations, interpolated FIR technique, CIC filters.

An Overview of Transceiver Systems: Baseband PAM transceiver, Eye patterns in PAM systems, QAM transceiver, Eye patterns in QAM systems, the impact of frequency offset and phase offset on the baseband equivalent of passband channels.

Adaptive Systems: Wiener filter, The LMS algorithm, The standard RLS algorithm, Sampling with AGC.

Phase Locked Loop: Continuous time PLL, Discrete time PLL, Maximum likelihood phase estimation, PLL with extended lock range.

Carrier Acquisition and Tracking: Non data aided carrier recovery techniques, Coarse carrier acquisition, Fine Carrier acquisition and tracking, Costas loop, Pilot aided carrier acquisition method, Data aided carrier tracking method.

Timing Recovery: Non data aided timing recovery methods and algorithms, Data aided timing recovery techniques, Muller and Muller's method, Decision directed method.

Channel Equalization: Continuous time channel model, Discrete time channel model, Symbol spaced equalizer, Fractionally spaced equalizer, Performance study of equalizers (Wiener- Hopf Equations), Adaptation algorithms, Cyclic equalization.

Behrouz Farhag, "Signal Processing Techniques for Software Radios", Second Edition, Lulu Publications, 2010.

Michael Rice, "Digital Communications: A Discrete Time Approach", First Edition, Pearson Education, 2009.

Richard Johnson, William Sethares, and Andrew Klein, "Software Receiver Design", First Edition, Cambridge University Press, 2011.

CE846 RF TRANSCEIVER SYSTEM DESIGN FOR WIRELESS COMMUNICATION (3-0-0) 3

An overview of wireless systems: Mobile communication systems, WLANs, Bluetooth, GPS, OFDM, MIMO, and UWB. Converge of system design.

System design fundamentals: Linear systems and transformation, Non-linear system representation and analysis approaches, Noise and random processes: Noise Figure, Noise Temperature, Noise PSD, Narrowband noise representation.

Elements of Digital Baseband Systems: Sampling theorem and sampling process, Jitter effect, pulse shaping and ISI, BER, SNR, CNR, EVM, eye diagram, scatter plot.

Radio Architectures and Design Considerations: Super heterodyne architecture, Direct conversion (or Zero IF architecture), Low IF Architecture, Band-pass sampling radio architecture. Discuss merits and demerits.

Receiver system analysis and design: Sensitivity, selectivity and Noise figure of receiver, Intermodulation characteristics, Single tone desensitization, Adjacent/Alternate channel selectivity and blocking characteristics, Receiver dynamic range and AGC system, System design and performance evaluation, Examples

Transmitter system analysis and design: Transmission power and spectrum, Modulation accuracy, Adjacent and Alternate channel power, Noise emission calculation, Some important considerations in system design, Examples.

Qizheng Gu, "RF System Design of Transceivers for Wireless Communications", First Edition, Springer Publication, 2005.

Kevin McClaning, "Wireless Receiver Design for Digital Communications", Second Edition, SciTech Publications, 2012.
Cornell Drentea, "Modern Communications Receiver Design and Technology", First Edition, Artech House, 2010.
William F. Egan, "Practical RF System Design", First edition, Wiley IEEE Press, 2003.

CE847 PRINCIPLES OF COMMUNICATION SYSTEMS SIMULATION (3-0-0) 3

The role of simulation and simulation methodology: examples of complexity, deterministic and stochastic simulation, software packages for simulation, performance estimation.
Sampling and Quantization: Reconstruction and interpolation, Sampling frequency, number of samples, Quadrature sampling, resolution.
Low pass Simulation models for Band pass Signals and systems: Complex envelope representation of band pass signals, multi carrier signals, nonlinear and time variant systems.
Filter Models and Simulation Techniques: FIR and IIR Filters, Synthesis techniques, representation, characteristics and analysis, raised cosine and square root raised cosine pulse example.
Phase Locked Loops and Differential Equation Methods: Basic PLL concepts, analog and digital models, solving differential equations using simulation, simulation of PLL characteristics (first and second order).
Generating and Processing random Signals: Stationary and ergodic processes, uniform random number generators, mapping uniform random variables to an arbitrary pdf, generating iid Guassian random numbers, generating correlated Gaussian numbers, establishing a pdf and psd, PN sequence generation and processing.
Monte Carlo Simulation of Communication Systems: Fundamental concepts, AWGN channel, Fading channel, examples, Semi analytic techniques.

Tranter, Sam Shanmugan, Rappaport and Kosbar, "Principles of Communication Systems Simulation with Wireless Applications", First edition, Prentice Hall, 2004.
Jeruchim, "Simulation of Communication Systems", Second Edition, Springer, 2011.
Won Y Yang, "MATLAB/Simulink for Digital Communication", Second Edition, YesDee Publishers, 2014.

VL720 Digital IC Design (3-0-2) 4

Introduction to MOSFETs. MOSFET logic circuits. CAD tools for VLSI design. MOSFET logic gates. Interfacing CMOS and Bipolar logic families. Circuit characterization and performance estimation – Resistance, Capacitance estimation – Switching characteristics – Delay models – Power dissipation – Packaging – Scaling of MOS transistor dimensions – Yield and Reliability. CMOS testing – Need for testing – Fault models – design strategies. CMOS subsystem design – Datapath operations – Addition, Multiplication, Counters, Shifters, Memory design. Interconnect design, Powergrid and clock design. Simulation exercises on MOSFET- characteristics and parameter extraction, logic gates, subsystems, timing and power dissipation.

Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic Digital Integrated Circuits – A design perspective, Pearson, 2003
S. M. Kang & Y. Leblebici, CMOS Digital Integrated Circuits, McGraw Hill, 1999.
David A Hodges, Horace G. Jackson and Resve Saleh, Analysis and Design of Digital Integrated Circuits, Mc Graw Hill, 2003
N. Weste and K. Eshrangian, Principles of CMOS VLSI Design: A systems perspective, Addison Wesley, 1993.

VL721 Analog IC Design (3 -1- 0) 4

Current mirrors – basic current mirror, Widlar, Wilson biasing, Cascoded current mirrors; Noise – Types, Representation of noise in circuits; Basic Single-stage amplifiers - CS, CD and CG amplifier; noise analysis; Differential amplifiers – current mirror load, current source load, CMR, CMRR, folded cascode amplifier, noise analysis, common-mode feedback circuits; Two-stage amplifiers – analysis, frequency response, stability, compensation; Band gap references; Constant–Gm biasing; Distortion in amplifiers; Introduction to switched capacitor circuits – MOSFET as a switch, charge injection and its cancellation, switched capacitor amplifiers

Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill International Edition, 2001
David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley, 2002
Phillip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press, 2003.

VL722 Advanced Computer Architecture (3– 1– 0) 4

Instruction set architectures of CISC, RISC and DSP Processors. CISC Instruction set implementation, Microprogramming approaches. Pipeline implementation of RISC instruction set. Implementation of DSP instruction

set. Instruction level parallelism – Dynamic scheduling, Dynamic hardware prediction, hardware based speculation, ILP through software approaches – VLIW, IA64 architecture as a case study, Memory hierarchy design, Multiprocessors, thread level parallelism and multi-core architectures, I/O buses. Arithmetic: Fixed point, Floating point and residue arithmetic, Multiply and Divide Algorithms, Issues in arithmetic system design Issues in the applications (optimizing the hardware – software interface), ASIP, reconfigurable computing, Future microprocessor architectures.

D. A. Patterson and J. Hennessy, Computer Architecture: A Quantitative Approach, Harcourt Asia, 2003.
D. A. Patterson and J. Hennessy, Computer Organization and Design, Harcourt Asia, 1998.
Flynn and Oberman, Advanced Computer Arithmetic Design, Wiley 2001
Behrooz Parhami, Computer Arithmetic Algorithms and Hardware Design, Oxford, 2000.

VL723 Advanced Mixed Signal Design (3-1-0) 4

Sample and Hold Circuits: Basic S/H circuit, effect of charge injection, compensating for charge injection, bias dependency, bias independent S/H. D/A Converter – General considerations, Static non-idealities and Dynamic non-idealities; Current-steering DAC – Binary weighted DAC, Thermometer DAC, Design issues, Effect of Mismatches. A/D converter – General considerations, static and dynamic non-idealities. Flash ADC – Basic architecture, Design issues, Comparator and Latch, Effect of non-idealities, Interpolative and Folding architectures. Successive Approximation ADC; Pipeline ADC. Over sampling ADC – Noise shaping, Sigma-Delta modulator

Behzad Razavi, Principles of Data Conversion System Design, Wiley-IEEE Press, 1995
Rudy J. van de Plassche, CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters, Springer, 2003

VL724 VLSI Design Automation (3-1-0) 4

Introduction to VLSI CAD: VLSI design methodologies, use of VLSI CAD tools, Algorithmic Graph Theory, computational Complexity and ROBDD; Partitioning and placement: KL algorithm, FM algorithm etc.; Floor planning: Sliced and non-sliced planning, Polish expression, Simulated annealing, partition based placement; Routing: Global routing, detailed routing, graph models, Line Search, Maze Routing, Channel routing; High Level Synthesis: Introduction to HDL, HDL to DFG, operation scheduling: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed scheduling, operator binding; Static Timing Analysis: Delay models, setup time, hold time, cycle time, critical paths, Topological vs logical timing analysis, False paths, Arrival time (AT), Required arrival Time (RAT), Slacks.

Sabih H. Gerez, Algorithms for VLSI Design Automation, John Wiley, 1998.
Majid Sarrafzadeh and C. K. Wong, An Introduction to VLSI Physical Design, McGraw Hill, 1996.
Naveed Sherwani, Algorithms for VLSI Physical Design Automation, Kluwer Academic Pub., 1999.

VL725 Digital VLSI Testing & Testability (3-1-0) 4

Overview of testing and verification, Defects and their modeling as faults at gate level and transistor level. Functional V/s. Structural approach to testing. Complexity of testing problem. Controllability and observability. Generating test for a signal stuck-at-fault in combinational logic. Algebraic algorithms. Test optimization and fault coverage. Logic Level Simulation – Delay Models, Event driven simulation, general fault simulation (serial, parallel, deductive and concurrent). Testing of sequential circuits. Observability through the addition of DFT hardware, Adhoc and structured approaches to DFT – various kinds of scan design. Fault models for PLAs, bridging and delay faults and their tests. Memory testing, Testing with random patterns. The LFSRs and their use in random test generation and response compression (including MISRs), Built-in self test.

M. Abramovici, M. A. Breuer, and A. D. Friedman, Digital Systems Testing and Testable Design, IEEE Press, 1994.
M. L. Bushnel and V. D. Agarwal, Essentials of Testing for Digital, Memory and Mixed – Signal VLSI Circuits, Kluwer Academic Publishers, 2000.
Ajai Jain, Learning Module for the course - VLSI Testing and Testability, IIT, Kanpur, 2001.

VL820 Logic Synthesis Techniques (3– 0 – 0) 3

Introduction to Computer aided synthesis and optimization. Hardware Modeling. Two level combinational logic optimization. Multiple level combinational optimization. Sequential logic optimization. Cell Library Binding. State of the art and future trends: System level synthesis and hardware software co-design.

Giovanni De Micheli, Synthesis and Optimization of Digital Circuits, McGraw Hill, 1994.
Srinivas Devadas, Abhijith Ghosh and Kurt Keutzer, Logic Synthesis", Kluwer Academic, 1998.
G. D. Hachtel and F. Somenzi, Logic Synthesis and Verification Algorithms, Kluwer Academic Publishers, 1996.
S. Hassoun and T. Sasao, (Editors), Logic Synthesis and Verification, Kluwer Academic publishers, 2002.

VL821 Low Power VLSI Design (3- 0 -0) 3

Introduction to Low Power VLSI. Modeling and Sources of Power consumption. Power estimation at different design levels. Power optimization for combinational circuits and sequential circuits Voltage scaling Approaches. Low energy computing using energy recovery techniques. Low Power SRAM architectures. Software design for low power. Computer Aided Design Tools. Case studies Recent trends in low-power design for mobile and embedded application.

Kaushik Roy, Sharat Prasad, Low-Power CMOS VLSI design, John Wiley, 2000.

Anantha P.Chandrakasan & Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer, 1995.

Gary K. Yeap, Practical Low Power Digital VLSI Design, Kluwer Academic Publications, 1998

VL822 Modeling and Simulation (3-0-0) 3

Introduction to Modeling and simulation concepts. Levels of simulation for digital, analog & mixed mode circuits. IC CAD Overview. Device Simulation. Electrical simulation techniques. Relaxation based simulation techniques. Gate level simulation, Switch level timing simulation. Mixed mode interface, simulation and implementation, analog multi-level simulation. Discrete time models, Event driven simulation, Logic simulation, timing verification in ICs,

R. Saleh, S. Jou & A.R.Newton, Mixed mode simulation and analog multilevel simulation, Kluwer, 1994.

V.Litovski & M. Zwolinski, VLSI circuit simulation & Optimization, Chapman & Hall publications, 1997.

J Baker, Li & Boyce, CMOS Circuit Design & Simulation, PHI, 2000.

VL823 Submicron Technology (3 -0- 0) 3

Review of basic device physics. MOS capacitor. Transistor theory. Scaling - Moore's law on technology scaling, MOS device scaling theory, Short channel effects, sub threshold leakage, Punch through, DIBL, High field mobility, Velocity saturation and overshoot. Reliability. Various definitions of channel length, Performance metric of digital technology, Transistor design trade-offs, Technology case studies, Silicon on Insulator (SOI) devices, Partially depleted and fully depleted SOI, Floating body effects, SOI for low power, Interconnects in sub micron technology, Foundry technology, International Technology Roadmap for Semiconductors (ITRS)

Yaun Taur, Tak H. Ning, Fundamentals of modern VLSI devices, Cambridge university press, 1998.

B. G. Streetman & S. Banerjee, Solid State Electronic Devices, Prentice Hall, 1999.

M. K. Achuthan and K. N. Bhat, Fundamentals of Semiconductor Devices, McGraw Hill, 2006

A. K. Dutta, Semiconductor Devices and Circuits, Oxford Univ. Press, 2008.

M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley, 1991

ITRS Road map - http://public.itrs.net/

VL824 Advanced VLSI Design (3– 0– 0) 3

Introduction to digital systems engineering, Modeling and analysis of wires; Circuits; Power distribution; Noise in digital systems; Signaling conventions; Advanced signaling techniques; Timing conventions; Synchronization; Signaling circuits; Timing circuits; Packaging of digital systems

Neil Weste and David Harris, CMOS VLSI Design : A Circuits and Systems Perspective, Addison Wesley, 2005

William J. Dallly and John W. Poulton, Digital Systems Engineering, Cambridge Univ. Press, 2004

VL825 Hardware Software Co-design (3–0– 0) 3

Codesign Overview, Models and Methodology of Embedded System Codesign, UML based modeling of reactive system behaviors, Modeling behaviors via transition systems, Temporal Logics for specifying system properties, Explicit state model checking, Hardware Software partitioning and Scheduling, Cosimulation, High level Synthesis (HW) and functional verification, Architecture Mapping, Hardware/Software Interfaces, reconfigurable logic and devices, System on Chip (SoC) and IP cores, Hardware/Software Codesign for application specific processor, Codesign tools and case studies.

G. Micheli, R. Ernst, and W. Wolf, , Readings in Hardware/Software Co-Design, Morgan Kaufman, 2002.

Balarin et al., Hardware-Software Co-Design of Embedded Systems: The POLIS Approach, Kluwer Academic 1997.

Wayne Wolf, Computers as components: Principles of Embedded Computing System Design, Harcourt India, 2001.

VL826 Sensor Technology and MEMS (3–0-0) 3

Sensor types and Classification – Mechanical, acoustic, magnetic, thermal, chemical, radiation and bio sensors; Micro-sensor; sensors based on surface acoustic wave devices; Micro-machining technology, bulk, surface and other micro-machining techniques' MEMS for automotive, communication, signal processing applications; Modeling and simulation of Micro-sensors and actuators; sensors and smart structures; micro-opto-electromechanical sensors.

Ristic L (Ed), Sensor Technology and Devices, Artech House, 1994.

Sze S.M. (Ed), Semiconductor Sensors, John Wiley, 1994.
Wise K.D., Integrated Sensors, Microactuators and Microsystems (MEMS), Special Issue of Proceedings of IEEE, Vol. 86, No. 8, August-1998.
Stephen D. Senturia, Microsystem Design, Kluwer Academic Press, 2001
Baltes et. Al (Eds.), CMOS – MEMs, Advanced micro and nano systems, Vol. 2, Wiley-VCH, 2005

VL827 Embedded Systems (3–0–0) 3

Introduction: Overview of embedded systems, embedded system design challenges, common design metrics and optimizing. Survey of different embedded system design technologies & trade-offs. Embedded microcontroller cores, embedded memories, Examples of embedded systems. Architecture for embedded system, High performance processors – strong ARM processors, programming, interrupt structure, I/O architecture, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, Digital signal processing, Sub-system interfacing, interfacing with external systems. Software aspects of embedded systems: real time programming languages and operating systems for embedded systems – RTOS requirements, kernel types, scheduling, context switching, latency, inter-task communication and synchronization, Case studies

Jack Ganssle, The Art of Designing Embedded Systems, Elsevier, 1999.
J.W. Valvano, Embedded Microcomputer System: Real Time Interfacing, Brooks/Cole, 2000.
David Simon, An Embedded Software Primer, Addison Wesley, 2000.
H. Kopetz, Real-time Systems, Kluwer, 1997
R. Gupta, Co-synthesis of Hardware and Software for Embedded Systems, Kluwer 1995.
Gomaa, Software Design Methods for Concurrent and Real-time Systems, Addison-Wesley, 1993.

VL 828 VLSI Technology (3-0-0) 3

Environment for VLSI Technology: Clean room and safety requirements. Wafer cleaning processes and wet chemical etching techniques. Impurity incorporation: Solid State diffusion modelling and technology; Ion Implantation modelling, technology and damage annealing; characterisation of Impurity profiles. Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultrathin films. Oxidation technologies in VLSI and ULSI; Characterisation of oxide films; High k and low k dielectrics for ULSI. Lithography: Photolithography, E-beam lithography and newer lithography techniques for VLSI/ULSI; Mask generation. Chemical Vapour Deposition techniques : CVD techniques for deposition of polysilicon, silicon dioxide, silicon nitride and metal films; Epitaxial growth of silicon; modelling and technology. Metal film deposition: Evaporation and sputtering techniques. Failure mechanisms in metal interconnects; Multi- level metallisation schemes. Plasma and Rapid Thermal Processing: PECVD, Plasma etching and RIE techniques; RTP techniques for annealing, growth and deposition of various films for use in ULSI. Process integration for NMOS, CMOS and Bipolar circuits; Advanced MOS technologies.

C.Y. Chang and S.M.Sze, ULSI Technology, McGraw Hill, 1996.
S.K. Ghandhi, VLSI Fabrication Principles, John Wiley Inc., 1983.
S.M. Sze, VLSI Technology, McGraw Hill, 1988.
M. K. Achuthan and K. N. Bhat, Fundamentals of Semiconductor Devices McGraw Hill, 2006

VL829 Digital Design using FPGAs (2-0-2) 3

Digital system design options and trade offs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral modeling and simulation, Hardware description languages, combinational and sequential design, state machine design, synthesis issues, test benches, Overview of FPGA architectures and technologies: FPGA Architectural options, granularity of function and wiring resources, coarse vs fine grained, vendor specific issues (emphasis on Xilinx and Altera), Logic block architecture: FPGA logic cells, timing models, power dissipation I/O block architecture: Input and Output cell characteristics, clock input, Timing, Power dissipation, Programmable interconnect - Partitioning and Placement, Routing resources, delays; Applications - Embedded system design using FPGAs, DSP using FPGAs, Dynamic architecture using FPGAs, reconfigurable systems, application case studies. Simulation / implementation exercises of combinational, sequential and DSP kernels on Xilinx / Altera boards.

M.J.S. Smith, Application Specific Integrated Circuits, Pearson, 2000
Peter Ashenden, Digital Design using VHDL, Elsevier, 2007
Peter Ashenden, Digital Design using Verilog, Elsevier, 2007
W.Wolf, FPGA based system design, Pearson, 2004
Clive Maxfield, The Design Warriors's Guide to FPGAs, Elsevier, 2004

VL830 Active Filter Design (3-0-0) 3

Butterworth, Chebyshev & Inverse-Chebyshev filter response and pole locations; LC ladder filter – prototype & synthesis; Frequency transformation of lowpass filter. Impedance converters; Gm-C filters – Gm-C biquad, Q-enhancement, Automatic Tuning; Active-RC filters – Comparison with Gm-C filter, Issues in realizing high frequency active-RC filters; Characterization of on-chip integrated continuous time filters.

R. Schaumann and M.E. Van Valkenburg, Design of Analog Filters, Oxford University Press, 2003.
P. V. Ananda Mohan, Current-Mode VLSI Analog Filters - Design and Applications, Birkhauser, 2003
M.E. Van Valkenburg, Analog Filter Design, Oxford University Press, 1995.

VL831 RF Integrated Circuits (3-0-0) 3

Basic concepts in RF Design – harmonics, gain compression, desensitization, blocking, cross modulation, intermodulation, inter symbol interference, noise figure, Friis formula, sensitivity and dynamic range; Receiver architectures – heterodyne receivers, homodyne receivers, image-reject receivers, digital-IF receivers and subsampling receivers; Transmitter architectures – direct-conversion transmitters, two-step transmitters; Low noise amplifier (LNA) – general considerations, input matching, CMOS LNAs; Downconversion mixers – general considerations, spur-chart, CMOS mixers; Oscillators – Basic topologies, VCO, phase noise, CMOS LC oscillators; PLLs – Basic concepts, phase noise in PLLs, different architectures.

Behzad Razavi, RF Microelectronics, Prentice Hall PTR, 1997
Thomas H. Lee, The design of CMOS radio-frequency integrated circuit, Cambridge University Press, 2006
Chris Bowick, RF Circuit Design, Newnes, 2007

VL832 Digital Signal Processing Architectures (3–0–0) 3

VLSI Architectures for DSP algorithms – Data flow representations, pipelining and parallel processing, retiming, unfolding, register minimization techniques, systolic architectures, algorithms for fast implementation of convolution, FIR, IIR and adaptive filters, DCT, analysis of finite word length effects, Low power design strategies; Architecture, programming and applications of general purpose digital signal processors (Emphasis on TI & AD processors); Application case studies: Speech coding, image and video compression, Viterbi decoding, wireless communication.

K.K. Parhi, VLSI Digital signal processing systems: Design and implementation, John Wiley, 1999.
Lars Wanhammar, DSP Integrated Circuits, Academic Press, 1999
S.M. Kuo, B.H.Lee, Real-Time Digital Signal Processing: Implementations, Applications, and Experiments with the TMS320C55X, Wiley, 2001

VL833 Reconfigurable Computing (2–0–2) 3

Reconfigurable computing systems- Introduction to fine grained reconfigurable systems such as field programmable gate arrays and coarse grained architectures and technology. Design and implementation - Algorithms and steps (design entry, functional simulation, logic synthesis, technology mapping, place and route, bit stream generation) to implement (map) algorithms to FPGAs. Temporal partitioning; Temporal placement; On-line communication; Designing reconfigurable applications on Xilinx Virtex FPGAs – dynamic reconfiguration of FPGA using Xilinx tools. Applications of reconfigurable computing - reconfigurable supercomputers, reconfigurable massively parallel computers and application domains such as distributed arithmetic, signal processing, network packet processing, control design, and cryptography

S.Hauck, A. DeHon, Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation, Elsevier, 2008

VL834 Heterogeneous and Parallel Programming (2-0-2) 3

Heterogeneous platform and GPU architecture. Introduction to OpenCL. OpenCL device architecture. Concurrency and execution model. Programming examples like vector addition, convolution and matrix multiplication. Application case studies.

Benedict R. Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry, Dana Schaa, *"Heterogeneous Computing with OpenCL" - Revised OpenCL 1.2 Edition, Morgan Kaufmann, 2013.*
Aaftab Munshi, Benedict R. Gaster, Timothy G. Mattson, James Fung, Dan Ginsburg, *"OpenCL Programming Guide", Addison-Wesley, 2012.*
David B. Kirk and Wen-mei W. Hwu, *"Programming Massively Parallel Processors - A Hands-on Approach", Second Edition, Morgan Kaufmann, 2013.*
AMD Accelerated Parallel Processing OpenCL User Guide, AMD, 2014.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PS700 Computer-Aided Protection of Power Systems (4-0-0) 4

Simulation methodologies of complex energy systems and transducers, Basic hardware scheme of a microprocessor based relay. Signal processing algorithms for energy system protection. Microprocessor- based protection of generators, transmission line, power transformer, and induction motors. Automatic testing of protective relays.

IEEE PES, Tutorial Course on Computer Relaying, IEEE Catalog 79EHC 148-7PWR, 1979.
IEEE PES, Tutorial Course on Microprocessor Relays and Protection Systems, IEEE Catalog 88EHO 269-1 PWR , 1988.
IEEE PES, Tutorial Course on Advancement in Microprocessor-Based Protection and Communication, IEEE Catalog 97TP120- 0, 1997.
A T Johns, S K Salman, Digital Protection of Power Systems, IEE.

PS701 Power Electronics: Modeling and Design (4-0-0) 4

Review of basics, modeling of devices, review of ac to dc converters, modeling and design of switch mode power converter circuits with hard switching such as dc to dc converters, isolated dc to dc converters, dc to ac converters and ac to ac converters. Design of magnetic circuits. Introduction to soft switching circuits, multilevel inverter topology and SVPVM algorithm. Applications to power systems and power quality issues.

Ned Mohan, Undeland, Robbins, Power Electronics 3rd edition, Part II & III, John Wiley.
M H Rashid, Power Electronics, Chapters 8, 6, 9 & 10 , 3rd edition, PHI (EEE) or Pearson Education.

PS702 Power System Modeling and Analysis (4-0-0) 4

Introduction to generalized theory of machines. Modeling of transformers, synchronous machines and induction machines to carryout dynamic analysis. Modeling and computational issues pertaining to power system stability analysis such as generator-driven and load-driven stability, and SSR analysis.

Charles V Jones, The Unified Theory of Electrical Machines, Butterworth and Co. Ltd.,1967.
P.W.Sauer, M.A. Pai, Power System Dynamics and Stability, Prentice Hall, NJ, 1998.
K.R.Padiyar, Analysis of SSR in Power Systes, Kluwer Academic Publishers, 1999
A.R.Bergen and V.Vittal, Power System Analysis, Pearson Education Asia, India, 2001

PS703 Power System Modeling and Analysis Lab (0-0-3) 2

Solution of differential-algebraic equations. Performance study of different numerical integration techniques and eigenvalue analysis in MATLAB®/SIMULINK® . Case studies: small and large signal stability analysis of power systems. EMTP-based simulation. Exercises and assignments to support PS702.

PS750 Computer Control of Energy Systems (4-0-0) 4

Optimal control of Power Systems : Economic load dispatch. Hydrothermal Co-ordination , Algorithms for Unit Commitment , Optimal Power flow. Load frequency Control : Issues related to operation of Multi-Area systems , Automatic Generation Control and Tie-line Control . Sources of Reactive power and Reactive power control. Study of algorithms for Security assessment , AC State Estimation algorithms. Operation of Power Systems under De-Regulated Environment.

S S Rao, Optimization Theory and Applications. Wilay Esatern Ltd 1979
Allen J Wood, Bruce F Wollenberg , Power Generation Operation and Control , Second Edition , John Wiley and Sons, 1996.
A Monticelli, State Estimation in Electric Power Systems :Generalized Approach, Kluwer Academic Publishers ,1999.
Leon K Kirchmayer, Economic Operation of Power Systems. John Wiley and Sons, 1958.
Leon K Kirchmayer, Economic Control of Interconnected Systems, John Wiley and Sons,
1959. Current Literature from relevant technical journals.

PS751 Control Systems (4-0-0) 4

Linear Systems, Dynamics, modeling of linear systems, state-space theory, state, state variables. Discrete systems, extension of state-space theory to discrete systems, stability theory. Review of control system analysis using state variable methods. Digital control - concepts of signal processing. Discrete time signals. Z-domain description of sampled continuous time plane. Implementation of simple digital controllers. Z-plane specifications of control system design. Digital compensator design using root locus plots and frequency response plots. State variable analysis of digital control systems - state description, solution of state difference equations, controllability and observability.

W Brogan, Modern Control Systems, Prentice-Hall, NY 1991.
Thomas Kailath, Linear Systems, IEEE Press.
G Gopal, Digital Control and State Variables, Tata McGraw-Hill, 1997.

PS800 Fuzzy-Neural Control (3-0-0) 3

Fuzzy Sets, Fuzzy Logic, Fuzzy Rule-Based Systems, Fuzzy Control Systems, Learning Processes, Single/Multi Layer Perceptrons; Neuro-Fuzzy Modeling and Control. Unified Approximate Reasoning Approach, BNN Network Based Fuzzy Controller with Self-Learning.

Junhong Nie , Derek Linkens, Fuzzy-Neural Control: Principles, Algorithms and Applications, PHI, 2005.
Timothy J Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.
Simon Haykin, Neural Networks - A Comprehensive Foundation, Second Edition, Prentice-Hall, 1999.

PS801 EMI Testing and Design for Compatibility (3-0-0) 3

Electromagnetic emissions: systems and appliances, Circuit model, Noise characteristics, Effects of Interference. Amplifier nonlinearity, modulation. Transients in power supply lines. Electromagnetic Interference: Radiation coupling, Conduction coupling. Open area testing and measurements: Test sites, Test Antennas, Anechoic chamber, TEM Cell, Reverberating Chamber, GigaHertz TEM Cell. Grounding: Principles and practice of Earthing, System grounding for EMC. Shielding: Shielding integrity and discontinuities, cable shielding, Electrical Bonding. EMC Components: EMI suppression cables, EMC connectors, EMC Gaskets. EMC Filters: Characteristics of filters, Power Line Filter Design. EMC Standards.

H W Ott, Noise Reduction techniques in Electronic Systems, Wiley Interscience.
C R Paul, Introduction to Electromagnetic Compatibility, Wiley Interscience.
R Morrison, W H Lewis, Grounding and Shielding in Facilities, John Wiley and Sons.
V P Kodali, Engineering Electromagnetic Compatibility, S Chand and Company, New Delhi.

PS802 Energy Management (3-0-0) 3

Principles of energy management, energy utilization. Energy conversion and thermodynamic principles. Semiconductor basics. Solar cells and photovoltaic systems. Electrochemical effects and fuel cells. Thermionic and thermoelectric systems. MHD generation. Energy Auditing : purpose, methodology, case studies of few selected industries, analysis of results and inference, different standards, instruments used in energy auditing.

S L Soo, Direct Energy Conversion, Prentice-Hall.
S W Angrist, Direct Energy Conversion, Allyn and Bacon.

PS803 Microcontroller - Based System Design (3-0-0) 3

Introduction to embedded systems, Microcontroller architecture, programming and interfacing: Study of 8-bit / 16-bit / 32-bit Microcontrollers / DSP Controllers. PWM, Timer, ADC interfacing, Interrupt processing, Communication interfaces, Development environments, Embedded / Real time O.S.

John Peatman, Design with Microcontrollers, McGraw-Hill, 1995.
Microcontroller / DSP controller User Manual / Reference Manual.
H Kopetz, Real-time systems, Kluwer, 1997.
Goman, Software Design Methods for Concurrent and Real Time Systems , Addison-Wesley, 1993.

PS804 Electric Power Quality (3-0-0) 3

Definition , Causes of Distortion , Quantification of Disturbance , Voltage Flickering, Frequently varying load , Measuring Devices , Voltage sensitive loads , Accepted standards of Power quality , Mathematical analysis of power Quality , effect of dynamic and static load, Minimization of disturbance , Voltage instability , Effect of OLTC, remedial measures.

G T Heydt, Electric Power Quality, Stars in a Circle Publication, 1991.
R C Dugan, Mark F McGranaghan, Surya Santoso, H W Beaty, Electrical Power Systems Quality, McGraw-Hill, Second Edition, 2002.
Math H J Bollen, Understanding Power Quality Problems , IEEE Press, 2000.
Recent publications in relevant journals and conferences

PS805 Discrete Fourier Transforms and Digital Filter Design (3-0-0) 3

Fourier transform : Discrete Time Fourier transform, Methods of obtaining DFT : Algorithms for obtaining FFT and DCT. Data Compression using DCT. Window functions : Their Properties , Application of windows in DFT computation. Digital filters :Designing techniques, IIR and FIR Filters : Different methods, Design of Digital Controllers. DSP architecture, Floating point and fixed point DSPs. Applications of Digital Signal Processing. Power Spectrum Analysis: Significance and Methods.

Roman Kuc, Introduction to Digital Signal Processing. Mcgraw-Hill, 1988
A V Oppenheim, R W Schafer, Discrete Time Signal Processing, PHI, 1994.
R G Lyons, Understanding Digital Signal Processing Prentice Hall, 2004

PS806 Sensor Technology and Instrumentation Design (3-0-0) 3

Sensor types and classification, Mechanical, Electrical, Acoustic, Magnetic, Thermal and Bio-sensors. Introduction to MEMS Technology, Modeling and simulation of Micro-sensors and actuators. Interfacing with digital controllers. Design of instrumentation using MEMS sensors.

Ristic L (Ed), Sensor Technology and Devices, Artech House, London, 1994.
Tai Ran Hsu, MEMS and Microsystems - Design and Manufacturing, Tata McGraw-Hill.
Wise K D (Guest editor), Integrated Sensors, Micro-actuators, and Micro-systems (MEMS), Special Issue of Proceedings of the IEEE, Vol.86, No.8, Aug 1998.

PS807 Optimization Techniques (3-0-0) 3

Linear Programming: Simplex method and extensions. Network models: Shortest path, maximum flow and minimum cost problems. Dynamic programming: resource allocation, production scheduling and equipment replacement problem. Non-linear programming: selected unconstrained and constrained non-linear programming algorithms like quasi Newton, reduced gradient and gradient projection methods. Penalty function methods, Quadratic programming.

Lueneburger , Linear and Non linear Programming, McGraw-Hill.
Fletcher, Optimization techniques, John Wiley and Sons.

PS808 Finite Element Methods and Applications (3-0-0) 3

Introduction, magnetic circuits, review of electromagnetic theory, application of finite element method to magnetic circuit design. CAD tools - SPEED™, MAXWELL™ and applications to magnetic circuit design.

SPEED™ Lab, Design Notes on Electric Machine Design, Glasgow University.
Chary, Finite Elements and Applications to Electromagnetics, John Wiley and Sons.

PS809 DC-AC SYSTEM INTERACTION (3-1-0) 4

Introduction to HVDC transmission systems, General aspects and comparison with AC transmission systems, HVDC configurations, components of HVDC transmission system, Converter and inverter circuit operation for HVDC system, Line Commutated and Capacitor commutated converters, HVDC control, Harmonic generation and their elimination, Converter faults and protections of HVDC systems, filter design, AC/DC load flow and stability analysis, Interaction between AC-DC systems, HVDC light system, Multi-terminal HVDC, Multipulse VSC/CSC based HVDC systems, New developments and recent trends in HVDC systems.

J Arrillaga, "High Voltage Direct current Transmission", Peter Peregrinus Ltd, UK.
E W Kimbark, "Direct Current Transmission", Wiley-Interscience, New York.
K R Padiyar, "HVDC Power Transmission Systems", Willey Eastern Limited, Second edition.
N Singh, "Electric Power Generation, Transmission and Distribution", PHI, New Delhi 2nd edition, 2008.

PS810 Power System Transients and Overvoltages (3-0-0) 3

Transients in power systems, Overvoltages, current chopping, capacitor switching, 3-phase capacitor bank switching, traveling waves, Bewley's lattice diagram, attenuation, distortion of waves, two-conductor system, multi-conductor system, Computation of transients. Transients in transformers: initial voltage distribution, winding oscillations. Protection form surges: ZnO arrestors. Insulation coordination principles and applications.

Allan Greenwood, Electrical Transients in Power Systems, Wiley Interscience.
Relevant IS Codes.

PS811 Distribution System Automation (3-0-0) 3

Introduction and Historical development of Distribution System Automation, Distribution Networks and Protection, Remote Control and Intelligent systems, Data Communications and Communication Protocols, SCADA systems,

Distribution System Automation Architectures, Practical applications and market overview.
H Lee Willis, Electrical Power Distribution Planning Reference Book , 2 Edition, Marcel Dekker Inc, 2004.
Cobus Strauss, Practical Electrical Network Automation and Communication Systems, Newnes Publications, 2003.

PS812 Energy Management Lab (0-0-3) 2

Laboratory exercises and assignments to provide additional support to PS802.

PS813 Electric Power Quality Lab (0-0-3) 2

Simulation of Electric Power Quality Problems, Familiarisation with the handling of Power Quality Instruments. Measurement of Power Quality Parameters . Report Preparation. To provide additional support to PS804.

PS814 Discrete Fourier Transforms and Digital Filter Desgin lab (0-0-3) 2

Application of Discreet Fourier Transforms for Power System Problems : Laboratory Exercises to design systems for the control of Active Power Filters, Implementation of Protection Algorithms. Design and implementation of Digital Filters and Controllers. To provide additional support to PS805.
MATLAB Signal Processing Toolbox Users Guide, Mathworks Inc.

PS815 Power Electronics Design Lab (0-0-3) 2

Laboratory experiments on design of power electronic circuits and systems, Hardware and simulation experiments to provide additional support to PS701.

Ned Mohan, Undeland, Robbins, Power Electronics, 3 Edition, John Wiley.
M H Rashid, Power Electronics, 2nd/3rd edition, PHI (EEE) or Pearson Education .

PS816 Distribution Automation Lab (0-0-3) 2

Algorithms for Distribution Automation, Database Management for Automation. Exercises and assignments to provide additional support to PS811.

PS817 Power System Operation under Deregulation (3-0-0) 3

Fundamentals of Deregulation, Restructuring Models and Trading Arrangements, Different Models of Deregulation, Operation and control, Wheeling charges and pricing, Role of FACTS Controllers and Distributed Generation in Restructured Environment, Developments in India, IT applications in restructured markets.
K. Bhattacharya,MH J Bollen and J.E. Daalder,"Operation of Restructured Power Systems", Kluwer Academic Pub, USA, 2001.
L. Philipson and H.L. Willis, "Understanding Electric Utilities and Deregulation", Marcel Dekker Inc. 1999.
M. Shahidehpour and M. Alomoush,"Restructured Electrical Power Systems:Operation, Trading and Volatility", Marcel Dekker Inc. 2001
Steven Stoff, "Power System Economics: Designing Markets for Electricity", John Wiley & Sons, 2002.
M. Ilic, F. Galiana and L Fink, "Power System Restructuring: Engineering and Economics", Kluwer Academic Pub., 1998.
L. L. Lie, "Power System Restructuring and Deregulation", John Wiley & Sons, UK, 2002.
S. Hunt and G. Shuttleworth, "Competition and Choice in Electricity", John Wiley & Sons, 1996.
Relevant research papers published in reputed journals and Conferences in India and aboard.

PS818 ADVANCED SEMICONDUCTOR DEVICES (3-0-0) 3

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating. BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power darlington - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor. Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT. Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers. Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types.

B.W Williams 'Power Electronics Circuit Devices and Applications'.
Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
Mohan, Undcland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.

PS820 Analysis Of Faulted Power Systems (4-0-0)4

Unsymmetrical faults on normally balanced 3-phase systems, simultaneous faults on symmetrical 3-phase systems. Ground faults and open conductors. Unsymmetrical 3-phase circuits.

Clarke E., "Circuit Analysis of AC Power Systems", Volumes I & II, John Wiley and Sons, 1943 & 1950.
Anderson P.M., " Analysis of Faulted Power Systems", Wiley/IEEE Press, 1995.

PS850 FACTS and Custom Power Devices (3-0-0) 3

Overview of Power Transfer issues in Transmission Systems and Power Quality issues in Distribution systems. Multilevel VSI configurations, modulation and control techniques, high-power, medium-voltage applications. FACTS Devices - Series, Shunt and Unified configurations and applications. Custom Power Devices - DVR, DSTATCOM and UPQC.

Math H J Bollen, Understanding Power Quality Issues, IEEE Press, 2005
N G Hingorani , L Gyugyi, Understanding FACTS, IEEE Press, 2001
IEEE Transactions, Proceedings and other related Journals.

PS851 High-Voltage Testing and Measurements (3-0-0) 3

Specification for High Voltage tests, Dielectric stress, Voltage stress, Insulation coordination, breakdown test of insulating oil, Transformer test with alternating voltage and impulse voltage. Insulation characteristics, types of insulation, types of stress used in high voltage testing. Laboratory test procedures. Testing with power frequency voltage. Partial discharge measurements, the basic PD test circuit, PD currents, PD measuring systems within the PD test circuit.

Dieter Kind, An Introduction to High-Voltage Experimental Techniques, Wiley Eastern Limited.
E Kuffel, W S Zaengal, J Kuffel, High Voltage Engineering Fundamentals, Newnes Publishers.
Kamaraju, Naidu, High Voltage Engineering, TMH.

PS852 PV Power Systems (3-0-0) 3

Large PV power systems, village power supply systems, PV-powered agricultural facility, micro-irrigation systems, remote applications, portable applications, PV power for domestic use. Design and economic considerations, cost analysis of PV power, issues in developing countries. Thermophotovoltaic system, satellite power system, photoelectrolytic cell, multi-cell systems.

C E Backus, Solar Cells. IEEE Process, 1976
P D Maycock, E N Stirewatt, Photovoltaics: Sunlight to Electricity in One Step, Brickhouse Publishers.

PS853 Renewable Energy Systems (3-0-0) 3

Energy Scenario. Solar, thermal and photovoltaic systems. Biomass and biogas. Wind energy systems. Geothermal, tidal and wave energy resources. Micro and mini hydros. Integrated renewable energy systems. Energy storage techniques.

R H Taylor, Alternative Energy Sources, Adam Hilger Limited.
Gary L Johnson, Wind Energy Systems, Prentice-Hall.

PS854 Distributed Generation (3-0-0) 3

Various technologies for distributed generation: Wind, Photovoltaic, Fuel cell based generation, Principles of reciprocating, stirling engines, Variable speed generators, doubly-fed generators, control and protection. Deregulation Policies, Economic issues of Distributed generation.

N Jenkins, R Allen, P Crossley, D Kirschen, G Strbac, Embedded generation, IEE, 2000.

PS855 Communication Networks for Power Systems (3-0-0) 3

Historic Developments in Data communication over Power lines, Remote energy metering protocols, Communication systems in Power stations, Modulation schemes for PLC, Communications in Power distribution grid.

Klaus Dostert, Power Line Communications, Franzis Verlag
IEC 62056, International Electricity Metering Protocol.

PS856 Application of Digital Signal Processing Techniques to Power (3-0-0) 3

Time frequency analysis, Time frequency distribution, Short time Fourier Transform. Multirate Signal Processing: Decimation, Interpolation, DFT filter banks, QMF filter banks. Multiresolution Signal analysis. Wavelet theory of sub-band decompositions, Sub-band coding and wavelet transforms, application of wavelet transforms. Homomorphic Signal Processing : Homomorphic system for convolution, properties of complex spectrum, Applications of homomorphic deconvolution. Multi Dimensional Signal Processing : Review of convolution and correlation. 2-D signals and systems. Linear estimation of Signals and applications : Random Signals , Linear prediction and applications (deconvolution, least square filters). Recursive estimation and Kalman filters. Adaptive signal processing: Adaptive filters and applications.

P P Vaidyanathan, Multirate Systems and Filter Banks, Prentice-Hall, 1993.
S J Orfanidis, Optimum Signal Processing, McGraw-Hill, 1989
Proakis, Manolakis, Introduction to DSP, PHI, 1994/ Pearson, 2002.
E C Ifeachor, B W Jervis, Digital Signal Processing: A Practical Approach.
Barrus, Gopinath, Guo, Introduction to Wavelet Transforms-- APrimer, Prentice hall
A K Jain, Image Processing. Prentice hall
A V Oppenheim, R W Schafer, Discrete Time Signal Processing, PHI, 1994.

PS857 Design of Embedded Controllers (3-0-0) 3

Review of Digital circuits fundamentals, Combinational and sequential circuits. Review of VHDL, Modeling of digital systems, synthesis and simulation,. Design of data acquisition circuits. Selection of A/D converters, minimum system requirements for the design of DSP/16bit processor based embedded controllers, Minimum system requirements for design of FPGA based embedded controllers.

Charles Roth, Digital system design using VHDL, Indian Reprint , Thomson Book
P Lapsley, DSP Processor Fundamentals -Architecture and Features, Chand Publications.

PS858 Electric Drives (3-0-0) 3

Drives fundamentals:, DC drives: Control of AC drives: space vectors, modeling and control of induction motor drive, v/f, vector control and DTC drives, rotor side control of induction motor drive. PMAC motor drives: modeling and control. Switched reluctance motor drives.

W Leonhard, Control of Electric Drives, Springer Verlag .
R Krishnan, Electric Drives, Pearson Education, 2003.

PS859 Computational Methods for Large Power (3-0-0) 3

Sparsity solutiontechniques: linear system solvers. Numerical Integration: multi step methods, solution of stiff tec systems. Methods to solve DAEs: application to power systems. Optimization techniques: OPF. Eigenvalue computations: small signal analysis and SSR analysis.

S A Soman, S A Khaparde, Shubha Pandit, Computational Methods for Large Sparse Power System Analysis, Kluwer, 2002.
J Arrillaga, C P Arnold, Computer Analysis of Power Systems, John Wiley and Sons, 1990.

PS860 Industrial Applications of HV and Fields (3-0-0) 3

Electrostatic precipitators and pollution controls using HV sources. Corona characteristics of precipitators. Charging, collection of dust particles. Xerography, Mineral separation using high voltages and fields, Electrostatic spray painting and applications. Testing of power systems components from the point of insulation, tests on insulators and material characteristics.

A D Moore (Ed.), Electrostatics and its Applications, John Wiley and Sons.
Dieter Kind, High Voltage Testing Techniques.
Technical papers of relevance.

PS861 LabVIEW™- based Data Acquisition and Instrumentation Lab (0-0-3) 2

LabVIEW™ Programming, Data Acquisition, Measurement and Automation, Instrument Interfacing, PXI system.

PS862 Computer Control of Energy Systems Lab (0-0-3) 2

Laboratory exercises and assignments to provide additional support to PS750. Exercises based on MATLAB®and

packages such as PSCAD™ , PowerWorld™, and SKM®.

PS863 Power System Signal Processing Lab (0-0-3) 2

Laboratory exercises and assignments to provide additional support to PS856.

PS864 Embedded Controllers Design Lab (0-0-3) 2

Laboratory experiments on DSP based embedded controllers, FPGA-based controllers to provide additional support to PS857.

PS865 High-Voltage Testing Lab (0-0-3) 2

Laboratory exercises and assignments to provide additional support to PS860/PS 851.

PS866 Gaseous Insulation & Gas Insulated Systems (3-0-0) 3

Gaseous insulation fundamentals, Insulation design, Interface with solids. Gas insulated substations (GIS), Compared with AIS, Typical features GIS: Layout, design, testing, specific problems / faults, diagnostics, maintenance, gas circuit breakers, other components of the substation.

Naidu, . Gas insulated substations, IK International Publishing House, New Delhi. 2007

Fujimoto, N., Boggs, S.A. and Chu, FY. Gas insulated substation technology & practice. Pergamon Press, New York 1985

Maller, V.N. and Naidu, M.S., Advances in high voltage insulation and are interruption in SF6 and vacuum. Pergamon Press, Oxford 1982z.

PS867 Pwer System Simulation Laboratory (0-0-3) 2

Laboratory exercises and assignments related to PS 859-Computational Methods for Large Power System: Developing computer programs related to some of the techniques/methods and its application to power system analysis: Gauss elimination and its variants, Sparse matrix solution techniques, Load flow or Power flow analysis, Three phase power flow, Transient stability analysis, Optimal power flow, State estimation, Eigen value and modal analysis.

PS868 Switched Electric Network - Power Electronics Perspective (4-0-0) 4

Electric network topology, modeling, and time domain analysis of switched electric-circuits. Natural frequency and choice of state-variables. Periodically switched networks with multi-part excitations.

References:

1. *Norman Balabanian and Theodore A. Bickart – Electrical Network Theory, John Wiley and Sons, Inc. 1969*
2. *Louis Weinberg – Network Analysis and Synthesis, McGraw-Hill Book Company, Inc. 1962*
3. *Ernst A. Guillemin – Introductory Circuit Theory, John Wiley and Sons, Inc. 1953*
4. *Robert W. Erickson – Fundamentals of Power Electronics, Chapman and Hall, 1997*

PS869 Tensors (4-0-0) 4

n-Way matrices, Generalisation postulates, Transformation Tensor, Singularity transformations, Examples of invariant transformations, Covariant and contravariant indices, geometrical interpretations, Compound tensors, Reduction formulae.

Reference:

Gabriel Kron – Tensor Analysis of Networks, John Wiley and Sons, Inc. 1939

PS870 Tensor Analysis Of Networks (4-0-0) 4

Review of Tensor Basics, Theory of groups, Reactance calculation of windings, Spinor transformations, Junction networks, Orthogonal networks, Interlinked electric and magnetic networks, the metric tensor, Compound networks, Symmetrical components, Multiple tensors, Analysis of networks.

References:

Gabriel Kron – Tensor Analysis of Networks, John Wiley and Sons, Inc. 1939

DEPARTMENT OF INFORMATION TECHNOLOGY

IT700 Advanced Algorithms (3-0-2) 4

Algorithmic paradigms: Dynamic Programming, Greedy, Branch-and-bound; Asymptotic complexity, Amortized analysis; Advanced Data structures for efficient manipulation of sets and partition, Efficient Graph algorithms: Depth first search; Strassen's matrix multiplication, Efficient algorithms: matrix inversion and LUP decomposition, Modular arithmetic, NP completeness/approximation algorithms, Randomized algorithms: min cut, primality testing; Online, Linear/Integer programming, Machine Learning Algorithms; Applications and Recent Trends.

Aho, Hopcroft and Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley, 1974.
Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 1985.
Baase S., Computer Algorithms: Introduction to Design and Analysis, Addison Wesley, 1998.
Michael T Goodrich & Roberto Tamassia, Algorithm Design: Foundations, Analysis & Internet Examples, John Wiley, 2001.
Dan Gusfield, Algorithms on Strings, Trees and Sequences, Cambridge, 2005.
Jon Kleinberg and Eva Tardos, Algorithm Design, Pearson/Addison Wesley, 2006.
T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3rd Edition, MIT Press, 2009.
Steven S Skiena, The Algorithm Design Manual, 2nd Edition, Springer-Verlag, 2010.

IT701 Advanced Database Systems (3-0-2) 4

Design of database kernels, Schema integration, Data warehousing, Distributed databases and Client Server architecture, Object-Relational databases, Emerging database technologies and applications, Application of conceptual and physical design to the real world database problems.

M. Tamer Özsu, Principles of Distributed Database Systems, Prentice Hall, 1999.
Ceri S and Pelagatti G, Distributed Databases: Principles and Systems, McGraw Hill, 2000.
T Connolly and C Begg, Database Systems: A practical Approach to Design, Implementation/Management, Pearson, 2002.
R. Elmasri and S. B. Navathe, Fundamentals of Database Systems, Addison-Wesley, 3rd ed., 1999.
R. Ramakrishnan and J. Gehrke, Database Management Systems, McGraw-Hill, 2nd ed., 1999.
M. Stonebraker and J. Hellerstein, Readings in Database Systems, Morgan Kaufmann, 3rd ed., 1998
M. Stonebraker, Object-Relational DBMSs, Morgan Kaufmann, 1996.
R. Mattison, Data Warehousing (Strategies, Technologies and Techniques), IEEE Press, 1998.

IT702 Advanced Web Technologies (3-0-2) 4

Introduction: Structure of the Web, Architecture and Components., *Web Engineering*: Fundamentals, Current challenges and new developments in the WWW; *Web Data Standards:* XML basics, Document Object Model, DTD and Schemas, XML Namespaces, XML for data representation and for display – XPath and XSLT, XML Manipulation; *Information Retrieval on the Web*: The Web and the problem of Search, Handling unstructured, semi-structured, structured data on the Web; Search Engines and search issues.; *Web as a Distributed computing platform:* Understanding Web Services technology, Service oriented Architecture and REST based web services (Resource Oriented Architecture); *The Web 2.0 phenomenon*: The Social Web, Social Network Analysis, Trends and research; *Web Intelligence:* The Semantic Web, principles, standards and technologies, Web of Services, Linked Open data and applications, Trends and research.

Anders Møller and Michael I. Schwartzbach, "An Introduction to XML and Web Technologies", (Addison-Wesley, 2006)
Gerti Kappel and Birgit Prýýll, "Web Engineering: The Discipline of Systematic Development of Web Applications", (Wiley Publishers, 2006)
Christopher Manning, Prabhakar Raghavan and Hinrich Schütze, "Information Retrieval", (Cambridge University Press, 2008).
Alonso, G et al, "Web Services - Concepts, Architectures and Applications Series: Data-Centric Systems and Applications", (Springer, 2004)
Robert A. Hanneman and Mark Riddle. "Introduction to social network methods", (University of California, Riverside, 2005)
Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, "Foundations of Semantic Web Technologies", (Chapman & Hall, 2009)

IT703: Advanced Network Security (3-0-2) 4

Basics of Network Security: Cryptography, Terminology, Mathematics (One way functions, Discrete Log problem, Integer Factorization), Background (App developers, Hosters, Listers, payloads, Attack life cycle), Authentication and Authorization, Defensive and Secure Programming, Threat Modeling and changes to SDL; Intranet Security: SPAM, Virus and Worms, Social Engineering, Network Management, Vulnerable Applications, Uneducated Users vs Spies, Firewall and DMZ, Piracy; Penetration Testing: Ethics, Moral, Legal values and repercussion, Procedures, Tools, Metasploit and Exploit db; Internet Security: Server side security (Webserver, Database server, Appserver, Compromised user accounts), Client side security (Browser security, Malicious Webserver and Victim Webserver, Malware and terms), Ecommerce (Internet Banking, E-shopping, Mobile Banking –Transactions & Reporting, Trading), Identity Theft (Password Stealing - Phishing/Keyloggers/Malware/Tab nabbing/Social Engg, Tools, Best Practices), Privacy (Introduction, Rights, Legal issues, Online services, Facebook, Google, Social web and Virtual Worlds), Cloud security, Mobile security (Challenges and Malware); Recent trends.

Yi Qian et al, Information Assurance – Dependability and Security in Networked Systems, Morgan Kaufmann, 2008.
William Stallings, Network Security Essentials, 4/e, Pearson Education, 2008.
Rolf Oppliger, Internet and Intranet Security, 2nd Edition, Artech House, 2007.
Nadia Nedjah et al, Computational Intelligence in Information Assurance and Security, Springer 2007.
Yang Xiao and Yi Pan, Security in Distributed and Networking Systems, World Scientific Publishing, 2007.
R Perlman, C Kaufman, M Speciner, Network Security: Private Commn in a Public World, Prentice Hall.
Applied Cryptography, Code Complete, Secure Programming, Articles and papers from http://securityresearch.in

IT704: Multimedia Systems Development (3-0-2) 4

Fundamental Concepts of Multimedia and Hypermedia; Media and Data Streams; Sound/Audio, Images/Graphics, Video and Animation, File Formats; Multimedia Compression Algorithms; Multimedia Networking: Multicasting, Quality of Service, Multimedia over IP; Interactive Multimedia Systems: Touch, Gesture, Marking, Speech and Audition, Virtual Humans: Overview of Virtual Humans, Face Cloning & Face Motion Capture and Analysis and Recent Research Trends.

Ze-Nian Li and Mark S. Drew, Fundamentals of Multimedia, Pearson Education, 2004.
N Magnenat-Thalmann and D Thalmann, Handbook of Virtual Humans, Wiley, 2004.
Steinmetz R and Nahrstedt K, Multimedia Systems, Springer-Verlag, 2004.
Yue-Ling Wong, Digital Media Primer, Pearson/Prentice Hall, 2009.
Fred Halsall and James F. Kurose, Multimedia Communications: Applications, Networks, Protocols & Standards, Pearson, 2004.

IT800: Mobile Computing (3-0-0) 3

Evolution of Wireless and Cellular Systems; Wireless Propagation: Encoding, Modulation, Multiplexing, and Error Handling Techniques; MAC Layer: Channel Allocation Techniques; Study of Mobile Communication Systems: Infrastructure, Registration and basic Call Establishment & Termination, Handoff, Roaming Support; Threat, Security & Privacy Issues; Ad-Hoc & Sensor Networks: Basic architecture/structure, terminology and Nomenclatures, Routing Protocols; IEEE 802.11 & 802.15; Recent Trends: Ultra-Wideband Technology, Sensor Networks, and Bluetooth;

Joschen Schiller, Mobile Communications, Pearson Education, 2003
Dharma Prakash Agarwal & Qing-An Zeng, Wireless & Mobile Systems, CENGAGE, 2nd Edition, 2006.
William Stallings, Wireless Communication & Networks, Prentice Hall of India, 2nd Edition, 2004.

IT801: Genetic Algorithms (3-0-0) 3

Robustness of traditional optimization and search techniques, Simple Genetic Algorithms, Similarity templates, goals of optimization, Schema Theorem of John Holland, Computer Implementation of genetic algorithms; Applications of genetic algorithms, advanced operators and techniques in genetic algorithms; Recent research Trends.

David Goldberg, Genetic Algorithms in search, optimizations and machine learning, Addition Wesley, 1999
Charles L Karr and L Michael Freeman, Industrial applications of Genetic Algorithms, CRC Press 1998.

IT802: Artificial Intelligence (3-0-0) 3

Problem Solving: Solving Problems by Searching, heuristic search techniques, constraint satisfaction problems, stochastic search methods. Game Playing: minimax, alpha-beta pruning. Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order logic, situation calculus. Theorem Proving in First Order Logic. Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks. Learning: Overview of different forms of learning, Learning Decision Trees, Neural Networks. Introduction to Natural Language Processing, Applications and Recent Research Trends.

Nilsson, Nils, Artificial Intelligence: A New Synthesis. Morgan Kaufmann Publishers, 1998.
Russell, Stuart J and Norvig Peter, Artificial Intelligence: A Modern Approach, Prentice Hall, 2003.
NPTEL Videos: Artificial Intelligence

IT803: Software Architecture (3-0-0) 3

Definition and overview of software architecture, The architecture business cycle: what influences software architects, Different Architectural styles, Architecture description language, Understanding and achieving quality attributes, Attribute-driven design, Documenting software architecture, Evaluating software architecture, Architecture reuse, Case studies and Recent Research Trends.

Mary Shaw, David Garlan, "Software Architecture", Prentice Hall India, 2000
Bass, Len; Paul Clements, Rick Kazman,. Software Architecture In Practice, Second Edition, Addison-Wesley, 2003.
Clements Paul et al, Documenting Software Architectures: Views and beyond, Addison-Wesley, 2003.

IT804: Artificial Neural Networks (3-0-0) 3

Introduction to Artificial Neural Networks , Artificial Neuron Model and Linear Regression, Gradient Descent Algorithm, Nonlinear Activation Units and Learning Mechanisms, Associative Memory Model, Statistical Aspects of Learning, Single-Layer Perceptions, Least Mean Squares Algorithm, Perceptron Convergence Theorem, Bayes Classifier, Back Propagation Algorithm, Multi-Class Classification Using Multi-layered Perceptrons, Radial Basis Function Network, Principal Component Analysis and Independent Component Analysis, Self Organizing Maps, Applications and Recent Research Trends.

Simon Haykin, "Neural networks - A comprehensive foundations", Pearson, 2004.
*Laurene Fausett: "**Fundamentals of neural networks: architectures, algorithms, and applications**", Prentice Hall.*
J A. Freeman, D M. Skapure: Neural Networks Algorithms, Applications & Programming Techniques, Addison-Wesley.
James A. Anderson, "An Introduction to Neural Networks", Prentice Hall of India.
Yegnanarayana: "Artificial Neural Networks", Prentice Hall of India, 2004.

IT805: Semantic Web Technologies (3-0-0) 3

Introduction to the Semantic Web – What is Semantics; Syntax, Structure and Semantics, Formal Languages, Semantic Web vision and Layered Cake Architecture, Vocabularies (Dublin Core, RSS, FOAF); Taxonomies - Descriptive Taxonomies, Navigational Taxonomies, Data Management Vocabulary, Roles of taxonomy in Content Management, Building and Maintaining taxonomies; Structured Web Documents and Resource Description Framework – Understanding content, Metadata, metadata standards, XML + metadata specification, RDF and metadata processing, Knowledge Organization Systems; Classification of organization systems; Relationship Models; Programming with RDF/XML; Web Ontology Language (OWL) - Ontology, Domain Modeling - Logic, Inferencing, Context; Programming with Ontology; Logic Reasoning for the Semantic Web - Classification and semantic metadata extraction techniques: statistical, statistical learning/AI, lexical and natural language, knowledge based; Linked Data, Role of Agents, Semantic Web and Intelligent Agents; Semantic Applications - demonstrating power of semantic technology for services, search, personalization, contextual directory and custom/enterprise applications; next generation semantic content management, Review of some of the active projects (e.g., SHOE, OntoBroker, InfoQuilt) and initiatives (OntoWeb, DAML); Contributions of IR, AI, Logic, and NLP to Semantic Web and Research Trends.

*P Hitzler, M Krötzsch, S Rudolph,Foundations of Semantic Web Technologies***,** Chapman & Hall, 2009.
K Breitman, M A Casanova, W Truszkowski, Semantic Web: Concepts, Technologies and Applications, Springer, 2010.
John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, Semantic Web ProgrammingWiley, 2009.
Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, 2nd Edition, The MIT Press, 2008.
Rajendra Akerkar, Foundations of the Semantic WebNarosa Publishing House, New Delhi, Oxford, 2009.

IT806: Distributed Computing Systems (3-0-0) 3

Basic concepts - Computer networks, Distributed systems and Computing, Design goals, Fundamental issues and transparencies in DCS, Ordering of events, Ordering of messagesand concerned protocols, Global state detection Process synchronization, Process communications, Load balancing techniques.

Mukesh Singhal and Niranjan G. Shivaratri, Advanced Concepts in Operating System, Tata McGraw Hill, 1994.
A.S Tanenbaum and M.V. Steen, Distributed Systems – Principles and Paradigms, PHI.
Randy Chow, Distributed Operating Systems and Algorithms, Addison Wesley.
G.F. Coulouies, J.D. Dollimore and T. Kindberg, Distributed Systems: Concepts & Design, Addison Wesley, 1994.

IT807: Perceptual Audio and Speech Processing (3-0-0) 3

Fundamentals of Audio and Speech Processing; Speech and Audio Analysis: Transforms – STFT, DCT, Wavelets and Gamma tone Filter banks; Audio and Speech Compression Standards: MPEG, AC-3, EAC-3 and AAC; Human Auditory Perception; Perceptual Audio Quality Metrics, Perceptual Audio Coding and Processing of Digital Speech; Speech and Audio Storage, Retrieval and Communication; Applications and Research Trends.

Jacob Benesty, M. Mohan Sondhi and Yiteng Huang, Handbook of Speech Processing, Springer-Verlag, 2008.
Andreas Spanias, Ted Painter and Venkatraman Atti, "Audio Signal Processing and Coding", Wiley-Interscience, 2007.
Soren Bech and Nick Zacharov, "Perceptual Audio Evaluation - Theory, Method and Application", Wiley, 2006.
Hugo Fastl and Eberhard Zwicker, "Psychoacoustics: Facts and Models", Springer, 3rd edition, 2006.
Marina Bosi and Richard E. Goldberg, "Introduction to Digital Audio Coding Standards", Springer, 2002.
Ben G. and Nelson M., "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", Wiley, 1999.

IT808: Enterprise Resource Planning and Systems (3-0-0) 3

Enterprise Resource Planning and Systems (ERP) – Introduction, ERP & Related Technologies, Customer Relationship Management (CRM), Human Resource Management (HRM), ERP Implementation Life Cycles, ERP Case Studies.

Alexis Leon- Enterprise Resource Planning.
V.K. Garg & N.K. Venkitakrishnan, ERP Ware: ERP Implementation Framework.
Garg & Venkitakrishnan, ERP: By Leon, ERP- Concepts and Planning.
Vinod Kumar G & N. K .Venkitakrishna, ERP - Concepts and Practice, PHI, 1998
Sunil C & Peter-SCM-Strategy and Planning and operation, Pearson Education, LPE, 2002

IT809: Cyber Law and Intellectual Property Issues (3-0-0) 3

The Right to Access, Anonymity, Data Protection, Malicious Code, Spam, Cyber-Hooliganism, Cyber-Stalking, Identity Theft, Cyber-Terrorism, Cyber-War, Distance Contracting, Obscene Publications, Digital Signatures, Civil Liberties, Civil Liability, Civil Remedies, Criminal Liability, Criminal Penalties, Sovereignty and Jurisdiction; Controlling Digital Goods: Copyright, Protection of Online Commercial Identity (Trade Mark, Domain Name), Controlling Online Business Methods: Patent, ICANN Dispute Resolution Policy and WIPO, Legal Position on Database protection in U.S, E.U and India, Protection of Multimedia works in cyber space, Copyright Infringement & Liability of Network Service provider.

Ahmed Kamal , The Law of Cyber Space , United Nations Institute of Training and Research , October 2005
Intellectual property issues in software published by National Academy Press, Washington D C 1991
Hahn, Robert W., Intellectual Property Rights in Frontier Industries: Software and Biotechnology, AEI Press, 2005.

IT810: Data Mining (3-0-0) 3

Basic concepts, KDD process, OLAP, Mining frequent patterns, Classification, Clustering, Database based mining, Graph mining, Web mining and Research Trends..

J. Han and M. Kambar, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers (Elsevier), 2008.
Oded Maimon, Lior Rokach, The Data Mining and Knowledge Discovery Handbook, Springer, 2005.
G. Piatetsky –Shapiro and W.J. Frawley (Editors), Knowledge Discovery in Databases, AAAI/MIT Press, 1991.
Sushmita Mitra and Tinku Acharya, Data Mining, Wiley- Interscience, 2004.

IT811: E-Commerce (3-0-0) 3

Infrastructure and Tools for E-Commerce, Current Trends in E-Commerce applications development, The Business of Internet Commerce, Enterprise level E-Commerce, Security and encryption, Electronic payment systems, Search engines, Intelligent agents in E-Commerce, On-line auctions, Data mining for e-commerce, Web metrics, Recommender systems, Knowledge management, Mobile e-commerce, Legal, ethical & social issues and recent trends.

Henry Chan et al., E-Commerce- Fundamental and applications, John Wiley & Sons, 2002
G.Winfield Treese and Lawrence C.S, Designing Systems for Internet Commerce, Pearson Education, LPE, 2002
Fensel, Dieter, Brodie M. L., Ontologies: A Silver Bullet for Knowledge Management & E-Commerce, Allied Publishers, 2004.
Zimmermann, Olaf; Tomlinson, Mark R.; Peuser, Stefan, Perspectives on Web Services, Allied Publishers, 2004.

IT812: Web Services **(3-0-0) 3**

Basic concepts, Enabling Infrastructure, Core functionality and standards, Service semantics, Web service composition, Service development, applications and research trends.

Alonso, G et al, Web Services -Concepts, Architectures and Applications Series: Data-Centric Systems and Applications2004.
Sanjiva Weerawarana et al, Web Services Platform Architecture: SOAP, WSDL, WS-Policy, WS-Addressing, WS-BPEL, WS-Reliable Messaging, and More, Prentice Hall, 2005.
Thomas Erl, Service-Oriented Architecture: Concepts, Technology, and Design, Prentice Hall, 2005.
J2EE Web Services, Richard Monson-Haefel, Pearson (LPE), 2005.

IT813: Virtual Reality **(3-0-0) 3**

Introduction to Virtual Reality Technology and its effectiveness in Real-Time Applications, Scientific Visualization, Input Devices: Trackers, Navigation and Gesture Interfaces; Output Devices: Graphics, 3D Sound and Haptic Displays; Computing Architectures for Virtual Reality, Modeling, Virtual Reality Programming, Human Factors in Virtual Reality; Virtual Humans: Overview of Virtual Humans, Face Cloning & Face Motion Capture/Analysis, Body Cloning & Body Motion Capture, Body Gesture Recognition and Action Response, Cloth Simulation and Research Trends.

Gerard Jounghyun Kim, Designing Virtual Reality Systems – The Structured Approach, Springer-Verlag, 2005.
N Magnenat-Thalmann and D Thalmann, Handbook of Virtual Humans, Wiley, 2004.
L J. Hettinger and M W. Haas, Virtual & Adaptive Environment: Applications and Human Performance, Lawrence Erlbaum, 2003.
Grigore C Burdea and Phillippe Coiffet, Virtual Reality Technology, John Wiley, 2003.

IT814: Computer Vision **(3-0-0) 3**

Concept of application of computer vision, functional architecture of a vision system visual sensony model and camera calibrative, processing tools, 3D vision, 3D representative schemes, High level vision and navigation.

Sonka M., Hlavac V., Boyle R., "Image Processing Analysis and Machine Design". PWS Publishers
Ballard D., brown C., "Computer Vision", Prentice Hall
Bratt W., "Digital Image Processing", John Wiley & Sons

IT815: Cloud Computing **(3-0-0) 3**

Introduction to Cloud Computing, Cloud Computing Delivery Models, Open Source and Industry case Studies of cloud (Apache VCL, Amazon, IBM and Eucalyptus) Introduction to Map/Reduce and Apache Hadoop Programming models for cloud computing and examples/applications, Virtualizations as an enabler for cloud computing infrastructure

George Reese,Cloud Application Architectures, O'Reilly Publications, 2009
Tim Mather, Subra Kumaraswamy,Cloud Security and Privacy, O'Reilly, 2009
Tom White, The Hadoop – Definitive Guide, O'Reilly, 2009.

IT816: System Integration **(3-0-0) 3**

Enterprise Integration Drivers, Requirements and Strategies: The Business Imperative for Enterprise Integration, Business Drivers and Requirements, Enterprise Integration Strategy; Enterprise Integration Architecture: Overview, Current Integration Architecture Assessment, Technical Integration Architecture, Service Integration Architecture, Information Integration Architecture, Process Integration Architecture; Enterprise Integration Solutions: Application Integration, Information Integration, Composite Application Integration, Process-Driven Integration, Best Practices for Enterprise Integration; Current trends.

B. G-Bernstein ,W. Ruh. Enterprise Integration: The Essential Guide to Integration Solutions. Addison-Wesley, 2005.
C. Britton , P. Bye, IT Arch & Middleware: Strategies for Building Large Integrated Systems, Addison-Wesley, 2004.

IT817: Information Retrieval **(3-0-0) 3**

Introduction: Basic IR Models, Basic Tokenizing, Indexing, and Implementation of Vector-Space Retrieval, Experimental Evaluation of IR,Query Operations and Languages, Text Representation, Web Search, Text Categorization and Clustering, Recommender Systems, Information Extraction and Integration.

C. D. Manning, P. Raghavan and H. Schütze,Introduction to Information Retrieval, Cambridge University Press, 2008.
Richardo & Bertheir, Modern Information Retrieval, Pearson Education, 2000

Korfhage Robert R, Information Storage and Retrieval, John Wiley & Sons, Inc, 1997.

IT818: Parallel Programming (3-0-0) 3

Introduction to Parallel Computer Architectures, Parallel Programming with OpenMP, Parallel Programming with MPI, Advanced concepts in MPI, Recent Advances in Parallel Programming techniques like Task, Parallelism using TBB, TL2, Cilk++ etc. and software transactional memory techniques. Advances programming on massively parallel processors like GPGPUs and APUs and introduction to compilers and tools on such machines.

J. Dongara, I. Foster, G. Fox, W. Cropp et al, "Sourcebook of Parallel Programming", Morgan Kaufmann.
Barbara Chapman, Gabriele Jost et.al, "Using OpenMP: Portable Shared Memory Parallel Programming", Scientific and Engineering Computation, MIT 2008.
B. Wilkinson and M. Allen, "Parallel Programming: Techniques and Applications", Prentice Hall.
S. Akhter and J. Roberts, "Multi-Core Programming–Performance through Multi-threading", Intel Press, 2006
David B. Kirk and Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands-on Approach (Applications of GPU Computing Series)", Elsevier Press, 2010.

IT819 Mobile Adhoc Networks (3-0-0) 3

Mobile ad hoc networking; imperatives, challenges and characteristics, Bluetooth networks, Routing approaches, Proactive and reactive protocols. Clustering and hierarchical routing, Multipath routing, Security aware routing, Energy efficient communication in ad hoc networks, Measuring energy consumption, Power save protocols, Maximum life time routing, Secure routing protocols, Intrusion detection, Security considerations in ad hoc sensor networks, Key management, Characterization of IP traffic, QOS classification, Self similar processes, Statistical analysis of non – real time traffic and real – time services and Recent trends.

C.S. Murthy & B.S. Manoj, AdHoc Wireless Networks, Pearson
T.Janevski, Traffic Analysis and Design of Wireless IP Networks, Artech House
Ozan K. Tonguz & Gianluigi, Adhoc Wireless Networks, Wiley.

IT820: Wireless Sensor Networks (3-0-0) 3

Introduction to wireless communication networks and wireless sensor networks, Network architecture and design principles, MAC and Link-layer protocols, Topology control in WSN, Routing protocols, information aggregation, information storage and query, localization, Security issues, Recent trends: multimedia sensor networks etc.

Wireless Sensor Networks: An Information Processing Approachby F. Zhao and L. Guibas, Elsevier/Morgan-Kaufmann, 2004
William Stallings, Wireless Communications and Networks, Prentice Hall, 2004.
P.Nicopolitidis, M.S.Obaidat, G.I. Papadimitria, A.S. Pomportsis, Wireless Networks, John Wiley & Sons, 2003.
K. Pahlavan, P. Krishnamoorthy, Principles of Wireless Networks, - A united approach - Pearson Education, 2002.

IT821: Intelligent Information Systems (3-0-0) 3

Emerging Technologies and applications with latest knowledge applied to customized logic systems, agent based approaches to modeling, and human-based models, multi-mobile agent systems, the product development process, fuzzy logic systems and ambient intelligent environment such as development of information and communication technologies, multimedia data hiding and watermarking algorithms for real world audio and video applications.

Xuan F. Zha,Artificial Intelligence and Integrated Intelligent Info Systems: Emerging Tech and Applications, IGI Global, 2006
Jialie Shen,Intelligent Music Information Systems: Tools and Methodologies, Idea Group Publishers, 2007
Pan, J.-S; Huang, H.-C; Jain, L.C.; Fang, W.-C; Intelligent Multimedia Data Hiding, Springer, 2007.

IT822: Blind Signal and Image Processing (3-0-0) 3

Introduction to Blind Signal and Image Processing: Principal Component analysis (PCA), Blind Source Separation (BSS) and Independent Component Analysis (ICA), BSS of Instantaneous and Convolutive Mixtures, Sequential Blind Signal Extraction, Robust BSS/ICA with noisy data; Learning Algorithms for Estimation of Sources; Applications: Audio, Speech, Image and Biomedical Signal Processing; Research Trends.

A.*Cichocki, S. Amari, Adaptive Blind Signal and Image Processing: Learning Algorithms & Applications, John Wiley, 2002*
Hyvarinen, J. Karhunen, E. Oja, Independent Component Analysis, John Wiley, 2001
C S. Roberts, R. Everson, Independent Components Analysis: Principles and Practice, Cambridge University Press, 2001

A. S. Bregman, Auditory Scene Analysis", MIT Press, 2nd Edition, 1999
Handbook on Speech Processing and Speech Communication, Springer, 2007.

IT823 Information Technology for Healthcare (3-0-0) 3

Evolution of IT Enhanced Healthcare, Internet Technologies in Telemedical Systems, Wireless Systems in E-Health, Decision Support Systems in Medicine, Health Telematics Networks, Computer Aided Diagnosis and Recent Trends.

Krzysztof Zielinski, Mariusz Duplaga and David Ingram, IT Solutions For Healthcare, Springer, 2006
Robert E Hoyt, Nora Bailey, Ann Yoshihashi, *Health Informatics, 5th Edition, Lulu Publishers, 2012*
Kevin Beaver, Healthcare Information Systems, Auerbach Publications, 2nd Edition, 2002.

IT824: Perceptual Image and Video Processing (3-0-0) 3

Fundamentals of Image and Video Processing; Image and Video Analysis: Image Transforms - DCT, Hadamard, Haar, KL and Wavelets; Image and Video Compression Standards: JPEG, JPEG2000, MPEG1, MPEG2, MPEG4 & MPEG7, H.264 and AVC; Image and Video Rendering and Assessment; Human VisualPerception; Perceptual Video Quality Metrics, Perceptual Coding and Processing of Digital Pictures; Image and Video Storage, Retrieval and Communication; Applications Image and Video Processing and Research Trends.

Perceptual Based Image Processing, Morgan & Claypool, 2009
Al Bovik, "Handbook of Image and Video Processing", Elsevier Academic Press, 2005
H. R. Wu and K. R. Rao, "Digital Video Image Quality and Perceptual Coding", CRC Press, 2005
R. C. Gonzalez and R E Woods, "Digital Image Processing", Pearson Education, 2002

IT825 Advanced Computer Networks (3-0-0)3

Overview of computer networks, seven-layer architecture, TCP/IP suite of protocols etc. MAC protocols for high-speed LANS, MANs, and wireless LANs. (For example, FDDI, DQDB, HIPPI, Gigabit Ethernet, Wireless Ethernet, etc.) Fast access technologies. (For example, ADSL, Cable Modem, etc.) IPv6: Why IPv6, basic protocol, extensions and options, support for QoS, security, etc., neighbor discovery, auto-configuration, routing. Changes to other protocols. Application Programming Interface for IPv6. Mobility in networks. Mobile IP. IP Multicasting. Multicast routing protocols, address assignments, session discovery, etc. TCP extensions for high-speed networks, transaction-oriented applications. Other new options in TCP.

W. R. Stevens, TCP/IP Illustrated, Volume 1: The Protocols, Addison Wesley, 1994.
G. R. Wright, TCP/IP Illustrated, Volume 2: The Implementation, Addison Wesley, 1995.
W. R. Stevens, TCP/IP Illustrated, Volume 3: TCP for Transactions, HTTP, NNTP, and the Unix Domain Protocols, Addison Wesley, 1996.
R. Handel, M. N. Huber, S. Schroeder, ATM Networks: Concepts, Protocols, Applications, Addison Wesley, 1998.
C. E. Perkins, B. Woolf, and S. R. Alpert. Mobile IP: Design Principles and Practices, Addison Wesley, 1997.

IT826 Topics In Natural Language Processing (3-0-2) 4

Introduction to Language Modelling, History and Applications, Text Processing Systems and architectures, N-grams, Lexical semantics and word-sense disambiguation, part of speech tagging, spelling correction, Text Classification – basics and process, tools, Naïve Bayes classifier, learning algorithms, Probabilistic Similarity Measures and Clustering, Sentiment Analysis, Generating and developing sentiment lexicons, learning lexicons, Information Retrieval, TF/IDF, Vector Space Models, Query analysis and processing, Information Extraction - Maximum Entropy models, Relation Extraction, Stochastic Tagging, and Log-Linear Models, Introduction to Semantics in NLP, Question Answering Models, passphrase analysis and answer generation, summarization, Emerging trends, research issues, challenges, interesting applications in various domains.

Christopher D. Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press, 1999
Daniel Jurafsky and James H. Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, Second Edition. Prentice Hall, 2008
Steven Bird. Natural Language Processing with Python, O'Reilly, 2009
James Allen, Natural Language Understanding. Benjamin/Cummings, 2ed, 1995

IT827: Topics in Soft Computing (3-0-2) 4

Fuzzy logic: Classical sets and fuzzy sets, fuzzy sets operations, fuzzy relations, Membership functions, defuzzification, fuzzy rule based systems. Artificial neural network: Model of a neuron, learning rules, activation

functions, single layer perceptron networks, multilayer feed forward networks, back-propagation algorithm, Deep learning. Genetic algorithm-Fitness function, genetic algorithm operators: selection, crossover, mutation. Swarm optimization techniques: Particle swarm optimization and global swarm optimization. Hybrid soft computing methods. Classification Methods: Naive Bayes, Decision tree, Support vector machine, K-nearest neighbor method. Clustering Techniques: Partitioning methods, Hierarchical methods, Density Based methods, Clustering high Dimensional data. Feature selection methods.

Vojislav Kecman, Learning and Soft Computing , Pearson Education (Asia) PTE, 2004
Ross T.J., Fuzzy logic with engineering applications-McGraw Hill, 1995
J. M. Zurada, Introduction to artificial neural networks, Jaico publishing, 1997.
Goldberg D., Genetic algorithms- Addison-Wesley, 1st edition,1989.
J. Han and M. Kambar, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers (Elsevier), 2008.
S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing 2nd edition, Wiley, 2011.
Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2017.
Shishir K. Shandilya, Smita Shandilya, Kusum Deep, Atulya K. Nagar, Handbook of Research on Soft Computing and Nature-Inspired Algorithms, IGI Global, 2017.

IT 828: Designing Internet of Things **(3-0-2) 4**

Introduction to Internet of Things: Technology drivers, Business drivers, Applications of IoT. Sensors and sensor nodes: sensing devices, sensors modules, nodes and systems. Connectivity and networks: Wireless Technologies for IoT, Edge connectivity and protocols, Wireless Sensor Networks. Communication technology for IoT, Design principles for Connected Devices, Internet principles, Prototyping embedded devices, Prototyping the physical design, Prototyping Online Components, Business models. Design of Semantic IoT, Cloud analytics and applications.

Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things : Key applications and protocols, Wiley publications 2015
Adrian McEwen And Hakim Cassimally, Designing Internet of Things, John Wiley and Sons 2014
Karin Breitman, Marco Antonio Casanova and Walter Truszkowski, Semantic Web: Concepts, Technologies, and Applications, Springer 2007
Charles Bell, Beginning Sensor Networks with Arduino and Raspberry Pi, Apress, 2013
Zhong, N., Ma, J., Liu, J., Huang, R., Tao, X. Wisdom Web of Things ,Web Information Systems Engineering and Internet Technologies Book Series, 2016
Rajkumar Buyya Amir Vahid Dastjerdi, Internet of Things - Principles and Paradigms, Morgan Kaufmann, 2016
Kai Hwang, Jack Dongarra,Geoffrey C Fox, Distributed and Cloud Computing: From Parallel Processing to the Internet of Thing, Morgan Kaufmann, 2012

DEPARTMENT OF CHEMICAL ENGINEERING

CH700 Transport Phenomena (3-1-0) 4

Introduction to general transport equations for momentum, energy and mass transfer in Cartesian, cylindrical and spherical coordinates, simplification of general equations with time and spatial coordinates for momentum, energy and mass transport, boundary layer concepts. Introduction to turbulent transport, formation of dimensionless groups by making use of general property balance equations. Interface transport in isothermal, non-isothermal and multicomponent systems. Macroscopic balances for isothermal, non-isothermal and multi component systems.

R.S.Brodkey and H.C.Hershey, Transport Phenomena- A unified approach, McGraw Hill, 1988.
R.B.Bird, W.E.Stuart and E.W.Lightfoot, Transport Phenomena- John Wiley, 1960.

CH800 Chemical Process Optimization (3-0-0) 3

Nature and organization of optimization problems, fitting models to data, formulation of objective functions. Optimization theory and methods. Non-traditional optimization methods. Applications of Optimization in process industries.

T.F.Edger and D.M.Himmelblau, Optimization of Chemical Processes, McGraw Hill, 1989.
Kalyanmoy Deb, Optimization of Engineering Design, Prentice Hall of India, 1995.

CH801 Biochemical Engineering & Bioreactor Design (3-0-0) 3

Microbiology. Characterization, Classification and enumeration of microorganisms, environmental and industrial microbiology, ecology, microbiology of soil and air, Laboratory techniques in microbial operations. Control of microorganisms by physical and chemical methods, biochemistry. Microbial metabolism. Mechanism and kinetics of enzyme catalyzed reactions. Enzyme technology. Bioreactor design.

J.E.Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill, 1977. S.
Aiba, Biochemical Engineering, Acadmic Press, 1965.

CH802 Selected Separation Processes (3-0-0) 3

Adsorption separation. Membrane separation processes. Surfactant based separations. External field induced separations. Supercritical fluid extraction- Physicochemical principles, thermodynamic modeling, process synthesis and energy analysis.

P.C.Wankat, Large Scale Adsorption and Chromatography, CRC Press, 1986.
R.W.Rousseau, Handbook of Separation Process Technology, John Wiley and Sons., 1987.

CH803 Computational Methods in Chemical Engineering (3-0-0) 3

Introduction to computational methods- matrix algebra. Finite difference methods. Partial differential equations-classification, solution of elliptic, hyperbolic and parabolic partial differential equations by finite difference equations, stability of different schemes. Variational methods.

D. Potter, Computational Physics, John Wiley, 1973.
C.A. Brebbia & A.J. Ferranta, Computational Methods for Solution of Engineering Problems, Pented Press., 1978.

CH804 Advanced Chemical Engineering Thermodynamics (3-0-0) 3

Fundamental concepts of classical and statistical thermodynamics, thermodynamic properties of multi-component multiphase systems from equations of state, inter molecular forces and potential energy functions, molecular theory of corresponding states, fugacities in gaseous mixtures, fugacities in liquid mixtures, theories of solutions, solubility of gases in liquids, solubility of solids in liquids, high pressure equilibria, generation of multi component phase equilibria data by computer calculations.

J.M. Prausnitz, R.N. Lichtenthaler & E. G. Azevedo, Molecular Thermodynamics of Fluid Phase Equilibria, 2nd Ed., Prentice Hall, 1986.
R.C. Reid, J.M. Prausnitz and B.E.Poling, The Properties of Gases and Liquids, 4th Ed., McGraw Hill, 1987.

CH805 Risk & Safety Management in Process Industries (3-0-0) 3

Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, ETA, FTA, Consequence analysis, Probit Analysis. Hazards in work places. Workers' exposures to hazardous chemicals. Hazards peculiar in industries. Guidelines for safeguarding personnel. Safety education and training-Safety managements, fundamentals of safety tenets, measuring safety performance, motivating safety performance, legal aspects of industrial safety, safety audits

F.P.Lees, Loss prevention in process industries, 2/e, Butterworth-Heinemann,. 1996
W.Handley, Industrial Safety hand book, 2/e, McGraw- Hill, 1977

CH806 Process Energy Integration (3-0-0) 3

Introduction and role of Thermodynamics. Heat exchanger Networks. Heat and Power Integration. Economic Evaluation. Applications and Problems.

B.Linnhoff, A User Guide on Process Integration for Efficient Use of Energy, UMIST. Robin Smith, Chemical Process Design, McGraw Hill.

CH815Cavitation and its Applications in Chemical Engineering (2-1-0) 3

Cavitation physics; hydrodynamic and acoustic cavitation; cavitation bubble dynamics – Rayleigh–Plesset equation; Cavitation assisted physicochemical and biological transformations – mixing, leaching and extraction, dyeing, waste water treatment, atomization, crystallization, coal washing, enzyme harvesting by cell disruption; Cavitation in nanotechnology – Production of nanomaterials; precision cleaning of surfaces.

Brennen Christopher), Cavitation and Bubble Dynamics, Oxford University Press, New York, 1996. ISBN: 0195094093

T.J. Mason, J.P. Lorimer, Applied Sonochemistry: Uses of Power Ultrasound in Chemistry and Processing, Wiley-VCH Verlag, 2002. ISBN: 3-527-30205-0

HaoFeng, Gustavo Barbosa-Cánovas, JochenWeiss (Editors) Ultrasound Technologies for Food and Bioprocessing, Springer,2011. ISBN-13: *978-1441974716.*

CH820 Mathematical Methods in Chemical Engineering (3-0-0)3

Vector and Vector spaces; Matrices, operators and transformations; Applications to Chemical Engineering Systems (homogeneous and non homogeneous); Partial Differential equations; Strum-Louiville Theory; Separation of variables and Fourier Transforms; Greens Functions; uniqueness conditions for linear and non-linear systems, Applications to models in Chemical Engineering.

S.Pushpavanam, "Mathematical Methods in Chemical Engineering", Prentice Hall of India Pvt Ltd(2004).

E.Kreszig, "Advanced Engineering Mathematics", Wiley, New York (2011).

CH 821 Multiphase flow (3-0-0)3

Homogeneous flow; Separated flow; Drift-flux model. Practical applications: Bubbly flow, Suspensions of particles in fluids , Slug flow, Annular flow, Drop flow, Bubble formation and bubble dynamics, hydrodynamics of solid-liquid and gas-solid flow, hydrodynamics of three phase flows, measurement techniques in multiphase flow

G. B. Wallis, "One-dimensional two-phase flow" , McGraw-Hill Book Company (1969).

R. Clift , J. R. Grace , M. E. Weber, "Bubbles, Drops and Particles", Dover Publications, US(2005).

G.F. Hewitt," Measurement of two phase flow parameters", Academic Press Inc (1978)

D.Butterworth and G.F Hewitt ,"Two phase flow and Heat transfer", Oxford University Press (1977)

G.Hetsroni , "Handbook of multiphase flow systems", Hemisphere Pub. Corp ,McGraw-Hill(1982), New York.

CH822 Computational Fluid Dynamics (CFD) (3-1-0)4

Mathematical description of physical phenomena; Discretization Schemes; Heat conduction, Convection and Diffusion; Calculation of the flow field; Solution of Navier-Stokes equations, Turbulence modeling, Applications to Chemical Engineering Systems.

S.V Patankar, "Numerical heat transfer and fluid flow", Taylor and Francies (1980).

J. H. Ferziger and M. Peric , "Computational Methods for Fluid Dynamics", Springer, Germany (2002).

David C. Wilcox," Turbulence Modeling for CFD", DCW Industries, Inc.(2006).

PC701 Industrial & Domestic Wastewater Treatment (3-1-0) 4

Introduction- Wastewater sources, components of wastewater flows, estimation of wastewater flows, analysis of wastewater flow rate data. Wastewater characteristics- physical, chemical and biological characteristics of wastewater. Wastewater treatment methods.

Metcalf and Eddy, Wastewater Engineering-Treatment, disposal & reuse, Tata McGraw Hill,1991

H.E.Babbilt and R.Baumann,Sewage and Sewage Treatment, 1986.

PC702 Solid Waste Management (3-1-0) 4

Introduction. Evolution of solid waste management. Generation of solid waste, Onsite handling, Storage and processing, Transfer and transport, Processing techniques and equipment. Recovery of resources- Conversion, Chemical and Biological methods. Disposal of solid waste. Hazardous waste and their management. Case studies on major industrial solid waste generation units.

Martell, Solid Wastes, John Wiley, NY, 1975.

George Tchobanuglour, H.Theisen and R.Eliassen, Solid Wastes.

PC703 Air Pollution Control & Design of Equipment (3-1-0) 4

Introduction. Air pollution laws and standards. Meteorological aspects of air pollution dispersion. Air pollution sampling and measurements. Air pollution control methods and design of equipments. Particulate emission control. Control of gaseous emissions. Air pollution control in specific industries. Acid rain, green house effects, important air pollution episodes.

Martin Crawford, Pollution Control Theory, McGraw Hill, NY. 1976.
Joe Ledbetter, Air Pollution Part A&B, Marcel Dekker, NY, 1972.

PC704 Environmental Impact Assessment & Management Plan (3-1-0) 4

Introduction and need for impact assessment. Methodologies. Application of Impact assessment methods in specific developmental projects. Ranking of impacts, environmental management plan. Legislation and pollution control acts and notifications. Environmental audits, waste audit, life cycle assessments, Industrial symbiosis. Clean Technology -options.

Peter Wathern, Environmental Impact Assessment-Theory and practice, Unwin Hyman Ltd, 1988.
Environmental Health and Safety Auditing Hand Book, McGraw Hill Inc, NY, 1994,

PC705 Mathematical Modeling of Environmental Systems (3-1-0) 4

Introduction to modeling of Environmental systems, physical phenomena, chemical phenomena, biological phenomena. Air pollutants- Modeling of dispersion of pollutants in air. Water Quality modeling-basic theory, estuary models, river model, lake models; models of treatment processes-thickening process, anaerobic digestion, activated sludge process, trickling filter process. Modeling of transport of pollutants in subterranean media- modeling of ground water pollution.

N.De Nevers, Air pollution control engineering, McGraw Hill, 1995. W.Licht,
Air pollution control engineering, Marcel-Dekker, 1988.

PC807 Environmental Law (3-0-0) 3

Historical Perspective. The regulation of environmental Protection. Town and Country Planning. Water Act. Air Act. Environmental Protection Act of 1986. Public Liability Insurance Act. Biomedical waste, Solid Waste management and Handling Rules. Chemical Emergency Rules. Case Studies.

Simon Ball and Stuart Bell, Environmental law, Blackstone Press Ltd., London, 1991. Julian
Gresser, Environmental Law in Japan, The MIT Press, London, 1981.

PC808 Waste Management Using EcoTechnology (3-0-0) 3

Sustainable development. Crop Irrigation. Vermiculture and Vermi Composting. Utilization of Solid waste from sewage treatment, fish farming in agriculture. Bio mass utilization. Sericulture. Root Zone Technology. Compost Techniques from crop residue. Case Studies about solid waste from industries.

Ecotechnology for Pollution Control and environmental Management, RK Trivedi, Arvind Kumar, Enviro Media, 1998

PC809 Environmental Biotechnology (3-0-0) 3

Concepts, Definitions, Criteria, Potable water quality, Biotreatment options for ground and water contamination, Bio accumulation of trace materials, Biodegradation of organic pollutants, biofertilizer, Immunocontraceptive biotechnology, agro technologies, phytoremediation and use of remote sensing technology.

Geeta bali et al., Environmental biotechnology, APH Publishing Corporation, New Delhi, 2002.

PC810 Industrial Pollution Prevention (3-0-0) 3

Concepts, Benefits, waste Reduction, Waste Audit, Environmental Audit, ISO 14000, ISO 18000 series standards, Total quality management, Life Cycle design/Assessment, Product labeling, Examples in Chemical Process Industries, Cost benefit Analysis, Role of Biotechnology.

Harry M. Freeman, Industrial Pollution Prevention Handbook, McGraw Hill Inc., 1995.

PC811 Industrial Microbiology (3-0-0) 3

Introduction, Industrial Fermentation Processes, Screening, Detection, Assay of Products, Stock Cultures, Innoculum Preparation, Media, Scale up Procedures, Typical Fermentation Process details, Antibiotics, Anaerobic, genetic Control, Hydrocarbon, Enzymes, Vitamins and Organic Acids.

Industrial Biotechnology, L.F. Casida Jr., New Age International Publishers, 1968.

PC812 Selected topics in Industrial Pollution Control (3-0-0) 3

PD701 Process Equipment Design I (3-1-0) 4

Detailed process design of Heat exchangers- Double pipe and Shell and Tube exchangers, Total condensers, partial condensers, vaporizers, reboiler, condenser-subcoolers, desuperheater-condensers, and Jacketed vessels. Detailed process design of Evaporators and Humidifiers

D.Q.Kern, Process Heat Transfer, McGraw Hill, 1950,
Coulson and Richardson, Chemical Engineering, Volume 6, Butterworth Heinemann, 199.,

PD702 Process Dynamics & Control (3-1-0) 4

Review of Stability analysis and controller design for linear time invariant systems. Advanced control techniques. Analysis of distributed parameter system dynamics. Multivariable process control. Sampled - data systems. Nonlinear control.

D.R. Coughanowr, Process Systems Analysis and Control, , McGraw Hill, 1995,
D.E. Seborg, T.F. Edgar and D.A. Mellichamp, Process Dynamics and Control, Jonh Wiley, 1989.

PD703 Process Equipment Design II (3-1-0) 4

Detailed process design of equipment for Absorption, Distillation, Multi-component absorption and distillation, Liquid-Liquid extraction, Leaching and adsorption.

Coulson and Richardson, Chemical Engineering, Volume 6, Butterworth Heinemann, 1996.
R.E.Treybal, Mass Transfer Operations, McGraw Hill, 1981.

PD704 Process Modeling & Simulation (3-1-0) 4

Introduction-Models and model building. Lumped parameter models (steady-state and unsteady-state). Distribution parameter models (steady-state and unsteady state) Stochastic models- discrete state/continuous state. Parameter estimation.

W.F.Ramirez, Computational Methods In Process Simulation, Butterworth, 1989.
R.E.Franks, Modeling and Simulation in Chemical Engineering, John Wiley, 1972.

PD705 Chemical Reactor Design (3-1-0) 4

Review of non-ideal reactor analysis. Non Isothermal reactor Design. Design of gas-liquid and liquid-liquid reactors. Design of plug flow type reactors-reactors for carrying out isothermal, adiabatic and non-isothermal operations involving homogeneous, heterogeneous, catalytic, non-catalytic reactions. Introduction to multiphase reactors-design concept for slurry reactors, trickle bed reactors, fluidized bed reactors.

J.M.Smith, Chemical Engineering Kinetics, McGraw Hill, 1970.
Octave Levenspiel, Chemical Reaction Engineering, Wiley Eastern Ltd., 1974.

PD807 Mechanical Design of Process Vessels (3-0-0) 3

General considerations in design of process vessels. Design of thin walled vessels under internal pressure. Compensation for openings and branches. Design of vessels subjected to external pressure. Design of vessels subjected to combined loadings. Design of vessels supports. Design of flanged joints and welded joints. Fatigue assessment of vessels and pressure tests.

Coulson and Richardson, Chemical Engineering, Volume 6, Butterworth Heinemann, 1996.
Brownwell and Young, Process equipment design -Vessel design, Wiley Eastern Limited., 1951.

PD808 Integrated Process Design Flow Sheeting & Synthesis (3-0-0) 3

Flow sheet synthesis. - Structural optimization of process flow sheets. Process synthesis concepts. Design and scheduling of batch processes- single product batch plants, multiple product batch plants, sizing of vessels in batch plants, inventories, synthesis of flowshop plants, optimal design and scheduling of multi product batch plants.

L.T.Biegler. I.E.Grossmann and Westerberg, Systematic methods of chemical process design, Prentice Hall Inc., 1997.
Robin Smith, Chemical process design, McGraw Hill Inc. 1995.

PD809 Advanced Process Control (3-0-0) 3

Linear multivariable control systems. Optimal control theory. Control of Distributed parameter systems. State estimation of Stochastic control. Optimal control of discrete data systems- linear quadratic Gaussian control, Kalman filter, Minimum variance control, Recursive least square identification and self tuning control.

Advanced Process Control, W.H.Ray, 1989, Butterworths.
Computer Controlled Systems, K.J.Astrom, Bjorn Wittenmark, 1990, Prentice Hall

PD810 Polymerization Reaction Engineering (3-0-0) 3

Classification of polymerization reactions. molecular weight distribution in batch and continuous reactors, average molecular weight and experimental determinations based on viscosity, osmotic pressure etc., semi-batch reactor operation, design of batch and continuous reactors. Heterogeneous poly-addition reactors. Polycondensation reactions.

Mechanism of Reactions, G.M.Burnett, 1954, Interscience.
Emulsion Polymerization, F.M.Bovey, A.J.Medalia, E.J.Meachan and I.M.Kolthoff, 1955, Interscience.

PD811 Selected Topics in Chemical Plant Design (3-0-0) 3

IB710 Transport Phenomena (3-1-0) 4

Introduction to general transport equations, cylindrical and spherical coordinates, simplification of general equations, energy and mass transport, boundary layer concepts, introduction to turbulent transport, formation of dimensionless groups, interface transport, microscopic balances for isothermal, non isothermal multi component systems, estimation of mass transfer, energetics of cell growth and product formation.

Transport phenomena- A unified approach, R.S.Brodkey and H.C.Hershey, 1988 Mc.Graw Hill
Transport phenomena by Bird, Stuart & Lightfoot, 1960, John Wiley

IB711 Enzyme Engineering and Technology (3-1-0) 4

Introduction: Nomenclature, specificity of enzyme action, monomeric and oligomeric enzymes; Kinetic and chemical mechanisms of enzyme catalysed reactions:bioenergetics, factors affecting rate of reaction, kinetics of uncatalysed reactions, initial velocity studies, nature of enzyme catalysis; Kinetics of single-substrate enzyme-catalysed reactions:Michaelis-Menten equations, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot etc.; Enzyme inhibition: reversible and irreversible inhibition.; Kinetics of multisubstrate enzyme-catalysed reactions; Chemical nature of enzyme catalysis: acid-base, electrostatic, covalent, enzyme catalysis.; Extraction and purification of enzymes; Immobilized biocatalysis: Reasons of immobilization, different types of carrier materials, immobilization methods, Kinetics.; Uses of enzymes in Industry: Starch industry, Milk processing, Cheese making, Brewing, Fruit juice productiondetrgent etc.

Enzymes-Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Affiliated East-west press ltd. New Delhi 2004.
Biocatalysis-Biochemical fundamentals and applications by Peter Grunwald, Imperial College press, London 2009.
Enzyme Technology, Preparation, Purification, Stabilization, Immobilization: Recent Advances (Biotechnology review) S.Torrey, Noyes Pubns ,1983
Enzyme Technology by HF Chaplin and C Bucke, Cambridge Univ. Press, 1990

IB712 Fermentation Technology (4-0-0) 4

Introduction: history, time line. Microbial growth kinetics: Batch, continuous and Fed-batch cultures. Micro organism: Isolation, preservation and strain improvement; Media for industrial fermentations: carbon sources, nitrogen sources, other ingredients, design, optimization. Sterilization: Design of batch and continuous sterilization, sterilization of fermentor. Inoculum development. Aeration and agitation: mass transfer considerations, K_La value determination, factors affecting K_La values. Process technology for the production of : Baker's yeast, ethanol, organic acids, microbial polysaccharides, industrial enzymes and antibiotics.

Principles of Fermentation Technology by Stanbury & Whataker, ,2nd edition,Elsvier,2005.
Comprehensive biotechnology by Murray Moo-Young, ,1st Edition, Pergamon , 1985
Bioprocess technology, Kinetics & Reactors by A.Moser, Springer Verlag 1981

IB713 Downstream Process Technology (3-1-0) 4

Characteristics of bio-product; stages in Bioseparation; Cell disruption: Homogenizer, bead mill, sonicator. Cell wall permeabilization; Filtration: Filter press, rotary drum filter. Centrifugation: Tubular & disc-stack centrifuges. Extraction: Solvent, Aqueous two-phase, super-critical fluid extraction. Precipitation: solvents, salts. Crystallization. Chromatographic separation and purification processes; membrane technology-Ultra filtration, Dialysis, electro dialysis.

Bioseparations: Downstream Processing by P.A. Belter, E.L. Cussler, and W-S. Hu, Wiley, New York 1988.
Separation process in Biotechnology by Juan A. Asenjo, , 1st Edition, CRC 1990
Separation process principles by Seader JD & Henley E.J, 2nd edition,Wiley 2005
Engineering Processes for Bioseparations by Laurence R. Weatherley, Butterworth-Heinemann 1994

IB714 Bioreactor Theory and Design (3-1-0) 4

Definition and basic principles of bioreactors. Bioreactor design: stirred tank, immobilized biocatalytic reactors, pneumatically agitated bioreactors, membrane reactors, animal cell bioreactors, plant cell bioreactors, photobioreactors, solid state fermentor, bioreactor operation modes and scale-up stretagies. Analysis of batch, continuous and fed batch bioreactors, non-ideal effects. Bioreactor support system: sterilization and containmenrt, system supplies. Instrumentation and control: measurement of process variables, control systems, computer applications.

Bioreactor system design by Juan-Asenjo, CRC press 1994. Biochemical Engineering Fundamentals by J.E.Bailey & D.F.Ollis2nd Ed., McGraw Hill 1986

Bioproce ss Engineering Basic concepts by Michael L Shuler, Fikret Kagrgi, Prentice Hall 1992

Biochemical Engineering by H W Blanck and DS Clark, Marcel Dekker, 1996.

IB715 Environmental Biotechnology (4-0-0) 4

Scope of environmental biotechnology, Qualitative and Quantitative characterization of wastes, waste disposal norms and regulations, waste water treatment-aerobic processes; anaerobic processes; design of integrated purification processes, biological means of stabilization and disposal of solid wastes, treatment of hazardous and toxic wastes, degradation of xenobiotic substances; bioremediation; bioleaching; micro-organisms for hostile environment, ecosystem health and biomonitoring .

Environmental Biotechnology by C.F.Froster & D.A.J.Wase, PHI 1987

Environmental Biology for engineers and Scientists by DA Vaccari et al. Wiley Interscience 2006.

Waste water Engineering, Treatment, Disposal & Reuse by Metcalf & Eddy,.

IB800 Instrumental Methods of Analysis (3-0-0) 3

Basics of analytical chemistry. Concept of Atomic absorption spectrophotometry, inductively coupled plasma(ICP), applications. Concept of Chromatography, Principles of working of gas chromatography, types of gas chromatography, different detectors used in Gas chromatography, principles and working of liquid chromatography, types of liquid chromatography, different types of detectors, concept of ion chromatography, applications of chromatography. Spectroscopic methods-UV, Vis, IR, Fluorescence, ORD, CD, & PAS), Automatic analyser, protein sequenator, peptide synthesizer and N.A. synthesizer. centrifugation and Rotors angle / vertical, zonal/continuous flow buoyant density centrifugation. Ultra centrifuge - principle and application,

Instrumental methods of Analysis Willard and Merit, CSS Publishers 1986

Standard methods of Biochemical Analysis by S R Thimmaiah, Kalyani Publications 1999

Principles of Instrumental Analysis, 5th edition by DA Skoog, FJ Holler and TA Nieman, 1998

Quantitative chemical analysis, 6th edition, by DC Harris, 2002

A practical guide to instrumental analysis, by E Pungor and G Horvai, 1994

Chemical analysis: Modern instrumentation methods and techniques, by F Rouessac and A Rouessac, 2000

IB801 Modeling, Simulation and Introduction to Bioinformatics (3-1-0) 4

Mathematical modeling of a process and its significance; different approaches to modeling; structured and unstructured models of cell growth; substrate utilization and product formation (e.g. Monod – Perret Model), Heterogeneous model like Shu's segregated model; two-and-three compartment models of Harder and Roeis; Genetically structured models; Case studies; modeling; controlling and monitoring of activated sludge process; lactic acid fermentation; Concept of simulation: simulation languages like mimic (CDC & UNIVAC), CSMP (IBM); etc. FORTRAN VI computer programs (INT and DYFLD); Dynamic Process simulation (PACER; FLOWTRAN; CHESS etc); Structure for simulation programme; General arrangement of main programme; Mathematical techniques like Newton – Raphson convergence, linear interpolation; first order and second order integration by Euler method, Mathematical modeling of bioreactors

Dynamics of Environmental Bioprocesses by J.B.Snape, I.J.Dunn & J.E.Prenosy, V & H Publishers 1995

Process computations in Biotechnology by Jasun K Ghosh, McGrawHill 1994

H.R. Bungay, Computer Games and Simulation for Biochemical Engineering, Wiley, 1985

IB802 Biosensors (3-0-0) 3

Introduction to biosensors, biological sensing elements and transducer systems, classification of biosensors, enzyme and whole cell based biosensors, affinity biosensors, amperometric biosensors, immuno sensors, ELISA, plant cell based biosensors, pesticide biosensors, flow injection analysis based biosensors, stability of biosensors, signal amplification, stabilisation and measurement, luminescence based biosensors

Yang, V.C. and T.T. Ngo. 2000. Biosensors and Their Applications. Kluwer Academic/Plenum Publishers, New York, NY.
Ligler, F.S. and Rowe Taitt, C.A. 2002. Optical Biosensors: Present & Future. Elsevier, The Netherlands
"Biosensors: Fundamentals and Applications" A.P.F. Turner, I. Karube, and G.S.Wilson, s.; Oxford Science Publications: Oxford, 1987.
"Enzyme and Microbial Biosensors: Techniques and Protocols" Ashok Mulchandani and Kim R. Rogers, Eds.; Humana Press, Totowa, NJ, 1998.
"Affinity Biosensors: Techniques and Protocols" Ashok Mulchandani and Kim R. Rogers, Eds.; Humana Press, Totowa, NJ, 1998

IB803 Immobilization Technology (3-0-0) 3

Classification of immobilization techniques, characteristics of solid matrices, effect of physico-chemical parameters on immobilized enzymes/whole cells, Immobilized enzymatic reaction kinetics, Modelling and simulation of immobilized whole cell systems, Design of advanced immobilized enzymes/whole cell systems, immobilization of plant cells; application of immobilized enzymes/whole cells systems.

In Situ Immobilization of Heavy-Metal-Contaminated Soils (Pollution Technology Review)G. Czupyrna, .D. Levy, A.I. Maclean, H. Gold,Noyes Publications 1989
Bio-immobilization: Technology, products, and markets ([Business opportunity report]) Philip Rotheim, Business Communications Co
Enzyme Technology, Preparation, Purification, Stabilization, Immobilization: Recent Advances (Biotechnology review) S. Torrey,Noyes Pubns ,1983

IB804 Bioremediation Techniques (3-0-0) 3

What is Bioremediation? Case Histories, Constraints and Priorities of Bioremediation, Bioaugmentation for Bioremediation, Bioreactors for Remediation Processes, Types of Bioremediation, Applications - Examples, Biotechnology and Oil Spills. Biotechnology for Hazardous Waste Management, Xenobiotic Compounds, Recalcitrance, Hazardous Wastes, Biodegradation of Xenobiotics, Biological Detoxification, Biotechnology to Hazardous Waste Management, Pesticide Industry: Tannery Industry and Biotechnology. Paper Industry and Biotechnology. Waste Treatment of Food and Allied Industries: Biological Treatment Methods, Air Pollution Abatement and Odor Control. Solid Waste Management. Novel Methods for Pollution Control: Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Aiming for Biodegradable and Ecofriendly Products.

Biodegradation and Bioremediation Martin Alexander, Academic Press ,1999
Handbook of Bioremediation Robert, Hinchee, Brown, McCarty, Semprini, Wilson,Lewis Pubs, Inc. ,1993
Bioremediation : Principles and Applications (Biotechnology Research) Ronald L. Crawford, Don L. Crawford, James Lynch,Cambridge University Press ,1996
Bioremediation Katherine H. Baker, Diane S. Herson, McGraw-Hill Professional ,1993

IB805 Animal Cell Biosystems and Immunotechnology (3-0-0) 3

Characteristics of animal cells and their implication on process design Nutritional requirements and serum free culture of mammalian cells Kinetics of growth and product formation. Reactor systems for large-scale production using animal cells. Production of Polyclonal antibodies with different types of antigens: antigen preparation and modification, adjuvants does and rute of antigen administration, collection of sera, purification of antibodies. Hybridoma technology – production and applications of monoclonal antibodies for diagnosis and therapy. Production of virus vaccines, specific vaccines. Production of cellular chemicals like Interferons, Interleukin, etc.Immunoassay procedures.

Essential Immunology by Ivan M Roitt, Blackwell Scientific Publication, 4th Edition, 1980
Basic Concepts in Immunology : A Student's Survival Guide. par John Jr. Clancy (Editor), James Morgan McGrawHill Text
Textbook of Immunology. 2nd ed. Constantin A. Bona, Francisco A. Bonilla. Harwood Academic Pub. 1996.
Fundamental Immunology. 4th ed. Livre & CD edition. William E. Paul (Editor). Lippincott-Raven Pub.

IB806 Bioinformatics (3-0-0) 3

Introduction to Bioinformatics, biological data banks, gene banks, sequence analysis, structure prediction, protein folding, Proteomics, emerging areas in Bioinformatics.

Bioinformatics and Functional Genomics Jonathan Pevsner,Wiley-Liss,2003
An Introduction to Bioinformatics Algorithms (Computational Molecular Biology) Neil C. Jones Pavel A.

Pevzner,Bradford *Books,2004*

IB807 Quality Control In Biotechnology (3-0-0) 3

General considerations in quality of bioproducts (enzymes/vaccines/insecticides/r-DNA product etc.) such as molecular identity, potency, purity and stability, toxicity, immunogenecity and consistency. Physical and biological containment, facilities for experiments dealing with recombinant cells and viruses. General scientific considerations for assessing possible risks of viral/bacterial insecticides and recombinant organisms in large scale particles.

Total Quality Environmental Management : An ISO 14000 Approach Vasanthakumar N. Bhat, Quorum Books,1998
ISO9000 for Better Business: Using ISO 9000 As a Foundation for Total Quality management Jack E. Small, Lanchester Press Inc,1996
Bioprocess Monitoring and Control (Hanser Series in Biotechnology) Marie-Noelle Pons,John Wiley & Sons Inc 1993

IB808 Industrial Wastes Treatment And Management (3-0-0) 3

Sources and characteristics of industrial wastes; effects on environment. Waste volume reduction, Waste strength reduction, Neutralization, Equalization and Proportioning. Removal of suspended and colloidal solids. Removal of inorganic and organic dissolved solids. Disposal of sludge solids. Mathematical models of water quality systems. Streams & Estuarine models for pollution control. Waste treatment methodologies for specific industries.

Waste water Engineering Treatment & Disposal & Reuse, Metcalf & Eddy
Waste water Management by Arceivala

IB809 Computer Aided Process Control (3-0-0) 3

Evolution of computer control; data logging; supervisory control and direct digital control; types of computer control; program control; optimizing and adaptive control; steady state and dynamic control; process identification, control ability and observability; state space representation of process; canonical forms; time optimal control; pontyagrains maximum principle; multivariable control system; process control computer; main frame and microprocessor systems; dedicated vs. Time sharing applications; computer hardware; analog subsystems; buffers; A/D; D/A; E/P and P/E interfaces; man/Machine interfaces case studies of computer process control.

Chemical Process Control: An Introduction to Theory and Practice, G. Stephanopoulos, PrenticeHall Inc., 1984.
Bioprocess Monitoring and Control, ed. Marie-Noelle Pons, Hanser (1992)

IB810 Total Quality Management & ISO 9000 (3-0-0) 3

Historical background, challenge of the 21st century, Quality (quality characteristics, variables and attributes defect, standard or specification quality of design conformance and performance); Quality control Benefits of quality control; Quality assurance, Total quality control (TQC), Tools and Techniques used in TQM. Responsibility for quality. Quality cost Measuring quality costs; Management for quality (planning, organising, staffing directing and controlling for quality); Quality and Productivity (effect on cost and market) ; 5S campaign; 4M checklist; Quality and Function Deployment (QFD) & just-in-time (JIT); Philosophy and their impact on quality (W. Edwards Deming and his contribution – comparison of the three philosophies) ; Malcolm Baldrige National Quality Award – Case studies on TQM.

Total Quality Environmental Management : An ISO 14000 Approach, Vasanthakumar N. Bhat, Quorum Books,1998
ISO 9000 for Better Business: Using Iso 9000 As a Foundation for Total Quality management Jack E. Small, Lanchester Press Inc, 1996
Measurement and Control in Bioprocessing (Elsevier Applied Biotechnology Series) K. G. Carr-Brion,Elsevier AppliedScience,1991

IB811 Protein Engineering (3-0-0) 3

Introduction: Design and construction of novel proteins and enzymes, Conformation of proteins in general and enzymes in particular, Effect of amino acids on structure of proteins, Energy status of a protein molecule, Structure function relations of enzymes, Physical methods such as x-ray crystallography for determination of protein structure, Site directed mutagenesis for specific protein function, Basic concepts for design of a new protein/enzyme molecule, Specific examples of enzyme engineering, -Tryesyl t RNAsynthetase, Dihydrofolate reductase, Subtilisin.

Protein Engineering : Principles and Practice Jeffrey L. Cleland, Charles S. Craik,Wiley-Liss Hardcover,1996
Introduction to Proteins and Protein Engineering Barry Robson, Jean Garnier, Elsevier Science Ltd,1988

IB812 Genetic Engineering and Recombinant DNA Technology (3-0-0) 3

Introduction to r-DNA technology, vectors: definition and types; construction and properties fo plasmid, phage,cosmid and phagemid vectors; restriction enzymes – properties and uses in cloning; gene cloning – genomic and cDNA cling;

impression of genes in recombinant cells, stability of recombinant cells, restriction mapping; DNA sequencing; gene mapping; polymerase chain reaction.

Genetic Engineering – A primer, WE Hill, Hard-Bead publishers, 2000
Principles of gene manipulation – RB Old and SB Primarose, Blackwell Scientific, 1992
Advanced topics in Molecular Biology – A Kumar and AK Srivastava, Horizon Press, 2001
Gene Probes – Principles –Protocols, MA deMuro and R Raples in Methods in Molecular Biology vol.179, Humana Press, 2002.
in Molecular Biology vol.179, Humana Press, 2002.

IB813 IPR in Biotechnology (3-0-0) 3

IPR in global economy, biodiversity related global IPR regime – TRIPS agreement, objectives and general principles, patents, trade secrets, UPOV convention, Plant variety rights, rights of traditional knowledge holders, etc. CBD, WTO, UNCTAD biotrade initiatives, nongovernmental initiated community IPR

Intellectual property rights, trade and biodiversity, G Dutfield, Earthscan publishers, 2000
Patents: A basic guide to patenting in biotechnology, RS Crespi, Cambridge Univ. Press, 1989
IPR in Biotechnology, K Singh, BCIL, New Delhi.

IB814 Cell Signaling and Systems (3-0-0)3

Introduction to cell signalling pathways and networks. Components of signalling pathways-receptors-protein phosphorylation-cyclic nucleotides-G-proteins- Inositol phosphate- reactive oxygen species-nitrogen species-toll like receptors-cytokine-receptors-apoptosis-innate immunity receptors. Systems biology-modelling of signalling networks-network motifs-feedback and feed forward systems.

Hancock J T. Cell signaling. Oxford University press. 2nd edition-2005.
Gomperts BD. Signal transduction. Academic press. 1st edition-2003.
Alone U. An Introduction to Systems Biology: Design Principles of Biological Circuits. Chapman and Hall/CRC.1st edition-2006.

IB815: Molecular biology of bacterial and viral infections (3-0-0) 3

Microbes and disease-establishing relationship - viral classification – Baltimore classification system -virus infectious cycle – viral structure – viral attachment and entry – RNA and DNA viral transcription and replication – reverse transcription, mechanisms of bacterial genetic modification-mobile genetic elements- pathogenic- islands-conjugation- transposons- virulence factors-molecular approaches- transposon mutagenesis- in vivo expression technology- genomic subtractive hybridization, respiratory-anatomy and histology- respiratory stem cells and regeneration- innate and adaptive immune system- antiviral innate immune system- interferon stimulated genes-bacterial defense strategies- quorum sensing- toxins-horizontal transfer of antibiotic resistant genes-vaccination, Case studies- staphylococcus aureus- heamophilus influenza- streptococcus pneumoniae – pseudomonas aeruginosa-influenza A virus- respiratory syncytial virus – HIV -Rhino virus – COPD and infections – cystic fibrosis and infections.

1. Norkin, L. C., (2010) Virology- molecular biology and pathogenesis, ASM Press, 1st Edition
2. Snyder L., et al., (2013) Molecular genetics of bacteria, ASM Press, 4th Edition
3. Flint, S. J., Racaneillo, V. R., Enquist, L. W., Skalka, A. M., (2009) Principles of virology, ASM Press, 3rd Edition
4. Knipe D. M., Howley P. M., (2007) Fields' Virology, Lippincott Williams and Wilkins, 5th Edition
5. Wilson, B. A., (2011) Bacterial pathogenesis a molecular approach, ASM Press, 3rd Edition
6. Kierszenbaum, A. L., Histology and Cell Biology: An Introduction to Pathology, 10th Edition

CH807 Industrial and Environmental Epidemiology (3-0-0)3

Basic principles and concepts of epidemiology relating to the design, analysis and interpretation of epidemiological studies. Epidemiologic methods for studying industrial and environmental determinants of disease. Estimating industrial workplace and environmental exposure, design experiments to understand the effects of exposure, analyse data from health reports and epidemiological studies. Specific health outcomes, including: cancer, non-malignant respiratory diseases. Introduction to statistical software ("R") for epidemiological studies.

Checkoway H, Pearce N, and Kriebel D. Research methods in occupational epidemiology. Oxford University press, 2nd eidition-2004.
Rothman J J. Epidemiology: An introduction. Oxford University press. 1st edition-2002.
Rothman J J, and Greenland S. Modern epidemiology. Lippincott Williams & Wilkins, 3rd edition-1998.

DEPARTMENT OF MECHANICAL ENGINEERING

TH700 Advanced Fluid Mechanics (3-0-0) 3

Recapitulation of fundamentals: Basic concepts. Navier Stokes equations, Potential flow theory and transformation flow around bodies, cylinders and aerofoils. Transformation of circle into aerofoil. Prediction of velocity and pressure distribution, boundary layer problems, laminar and turbulent boundary layers, separation criterion. Introduction to compressible flow, velocity of sound and mach number, Isentropic flow, flow with friction and heat transfer. Analysis of flows with normal and oblique shock waves. Supersonic flows. Unsteady flows.

Yuan, S. W., Fundamentals of Fluid Mechanics, Printice Hall, India.
S. M. Yahya, Compressible Fluid Flow, IIT, New Delhi.
A. H. Shapiro, The Dynamics and Thermodynamics of Compressible flow, Ronald Press. Nijaguna, Thermal Science/Engineering data Hand Book, KREC.

TH701 Heat & Mass Transfer (3-0-0) 3

Extended surface heat transfer with variable cross section. Numerical methods in solving two and three dimensional heat conduction problems. Boundary layer analysis. Heat transfer with phase change. Two-phase flow heat transfer with pure and mixed fluids. Pressure drop in two phase flow. Boiling crises in two phase flow. Design of heat exchangers. Special heat transfer processes. Radiation heat transfer. Radiation properties and laws. Electrical analogy. Radiation configuration factor. Radiation through gases and absorbing media. Introduction to mass transfer.

J.P. Holman, Heat Transfer, McGraw Hill, New York.
Frank Kreith, Heat Transfer, International Text Book Co.
Necati Ozisik M., Heat Transfer: A Basic approach, McGraw Hill Book Company, New York. Nijaguna B. T., Thermal Science/Engineering data Hand Book, KREC.

TH702 Refrigeration & Cryogenics (3-0-0) 3

Principles of vapour compression refrigeration system, cascade cycles, working fluids, compressors - reciprocating, rotary, scroll compressors, screw and centrifugal compressors. Heat exchangers, condensers, evaporators, dynamics of capillary and valve expansion devices, Design criteria for pipelines, absorption and adsorption refrigeration cycles, choice of working fluids, Thermoelectric refrigeration and Hybrid cycles. Introduction to Cryogenic technology-liquefaction of gases.

ASHRAE Hand books
R.B. Scott, Cryogenics Engineering, Van Nostrand.
R.F. Barron, Cryogenic Systems, McGraw Hill, New York.

TH703 Combustion (3-0-0) 3

Fuels and their properties, Review of basic thermodynamics and gaseous mixtures, combustion thermodynamics, stoichiometry, the First and Second Laws of Thermodynamics applied to combustion, composition of products in equilibrium, fundamentals of combustion kinetics, theory of thermal ignition, self ignition temperature, ignition delay, flame phenomena, deflagration and detonation, laminar flame propagation, flammability limits, flame quenching and minimum ignition energy, laminar burning velocity measurements, turbulent flame propagation, flame stabilization, diffusion flames: gaseous jet flames, burning of condensed phase, vaporization and combustion of liquid fuel droplet, spray combustion, combustion of solid fuels, Rocket motor systems.

Glassman I., Combustion, Academic Press, 1987
Kuo K.K. Principles of Combustion, John wiley & Sons, New York 1986
Stephen R.Turns, An Introduction to combustion, concepts and applications, 2e, McGraw Hill, 2000
Gary L. Borman and Kenneth W Ragland, Combustion Engineering, McGraw Hill,1998
R.M.Fristrom, Flame structure and processes, McGraw Hill, New York, 1995
Mukunda H.S., Understanding Combustion, Macmillan India Limited, Madras 1992
S.P Sharma and Chandermohan, Fuels and Combustion, Tata McGraw Hill

TH704 Thermal Engineering Lab (0-0-2) 1

1. Burning velocity measurement
2. Flame stability study
3. Determination of flow boiling heat transfer coefficient in conventional channel
4. Estimation of unknown parameters using inverse techniques from fin heat transfer
5. Inverse estimation of heat flux
6. Experiment on pool boiling heat transfer
7. Thin foil technique for film/jet cooling

8. Determine the performance parameters of Savonius water turbine.
9. Study of CRDI engine operated with open ECU

M.N. Ozisik, H.R.B. Orlande, Inverse Heat Transfer: Fundamentals and Applications, Taylor and Francis, New York, 2000.

Incropera F.P., DeWitt D.P., Fundamentals of Heat and Mass Transfer, fifth ed., John Wiley & Sons, Inc., New York, 2002.

Beck J. V., Blackwell B., Clair C. R., Inverse heat conduction – Ill posed Problems, Wiley, 1985.

Dwight Cooke, Satish G. Kandlikar, "Effect of open microchannel geometry on pool boiling enhancement", International Journal of Heat and Mass Transfer 55 (2012) 1004–1013.

TH705 Design of Renewable Energy Systems (3-0-0) 3

Biogas: Aerobic and anaerobic bio-conversion processes, raw materials, properties, properties of biogas (Calorific value and composition), biogas plant technology and status, Geothermal Energy: Hot springs and steam ejection, site selection, power plants, advanced concept, Solar energy: Principles, scope and applications, Fusion: Nuclear reactions, Fuels ignition temperature, Confinement schemes. Current status, Wind Energy: Wind energy potential measurement, aerofoil design, wind mill and wind electric generator, Mini and micro-hydel.

J.W.Twidell and A.D. Weer, Renewable energy sources, ELBS.
P.D. Dunn, Renewable energies: Sources, Conversion and Application.
S.Rao and B.B. Parulekar, Energy Technology, Khanna Publisher.
Desire LE Gourieres, Wind power plant: Theory and Design, Pergamon press.
B.T.Nijaguna, BiomassTtechnology, New Age International Publisher

TH706 Measurement in Thermal Systems (3-0-0) 3

Error Analysis in Experimental Investigations-Curve Fitting of Experimental Data. Methods of Measuring Temperature-Thermocouple, Error Estimation. Convective and Radiation Affects. Measurement of Unsteady Temperature-Optical Methods Shadowgraph, Schilieren and Interferometer, Spectroscopic Temperature Determination. Measurement of Pressure, Vacuum, Level etc. Heat Flux Sponsors, Transient Experimental Techniques for Surface Flux Rates. Measurement- Thermal Radiation, Volume Flow Rate, Velocity- Hot Wire and Hot Film Anemometer, Acoustic Methods. Measurement of Turbulence, Pollutants-Gas Chromatography.

E.G.R. Eckert and R.G. Goldstein, Measurement Techniques in Heat Transfer.
E.O. Doebelin, Measurement Systems: Application and Design.
T.P. Holeman, Experimental Methods for Engineers.
H.D. Young, Statistical Treatment of Experimental Data.

TH707 Thermal Computational lab (0-0-3) 2

1.FDM Codes for (i) 1D Parabolic PD equation-4 schemes (ii) 1D Hyperbolic PD Equation-4schemes. (iii)Convergence, stability and errors. 2. FDM computer codes for elliptic PD equation. 3. FDM computer codes for 2D steady Burgers equation. 4. FEM codes for (i) 1D steady state heat conduction/convection (ii) 1D transient heat conduction/convection (iii) 1D fluid flow between plates, ducts, annular cylinder 5. FVM codes for 1D steady and unsteady heat conduction/convection

Frank Krith & Bohn, Heat Transfer
J N Reddy, Introduction to finite Elements methods, TMH International
C A J Fletcher, Springer Verlag, Computational Techniques for Fluid Dynamic,Vol-1

TH801 Industrial Pollution Control (3-0-0) 3

Introduction: Man and the environment, Consequences of pollution growth, Impact on environment by industrial growth. Air, water and soil pollution. Energy generation and environmental degradation,, Noise and odour pollution ill effects of pollutants, Particulars, smoke, gaseous pollutants, formation and control, Meteorology, Plume dispersion studies, particulates,Waste water treatment, Legal aspects and pollution control.

C.S. Rao, Environmental Pollution Control Engineering, Wiley Eastern Ltd, 1994.
Henry C. Perkins, Air Pollution McGraw Hill W.L. Faith, Air Pollution control, John Wiley
Charles E.Baukal, Jr :Industrial Combustion Pollution and control, Marcel Dekker, Inc, N.Y. 2004
Arcardio.P.Sincero and Gregoric.A.Sincero, Environmental Engineering : A design Approach, Printice Hall. 1996

TH802 Solar Energy (3-0-0) 3

Solar radiation, direct and diffuse radiation, measurement and estimation, Flat plate collectors- design, short term and

long term performance. Water and air heating collectors. Concentrating collectors design procedure. Storage systems. Design of energy storage for various applications. Solar space heating and cooling and domestic water heating. Solar drying. Distillation of water and refrigeration. Conversion to mechanical energy; vapour turbines, engines, rotors operating on Rankine cycle. Sterling engine. Water pumping.

B.S. Magal, Solar power
Frank Freith and J.F. Kreider, principles of solar engineering Mc Graw Hill
Duffie and Beckman, Solar Energy thermal process, John Wiley.
S.P. Sukhatme, Solar Energy, Mc Graw Hill

TH803 Direct Energy Conversion (3-0-0) 3

Basics of energy conversion, Thermodynamic analysis. Thermoelectric, thermionic. Magneto hydrodynamic, Electrochemical, Photovoltaic effect, Solar cell: construction and operating characteristics, typical layout. Current developments.

Sheldon S.L. Chang, Energy conversion-; Prentice Hall
George W. Sutton, Direct Energy conversion, McGraw Hill
Archie W. Culp, Principle of Energy conversion, McGraw Hill
G.D. Rai, Non -conventional energy sources, Khanna Publishers

TH804 Design of Thermal Systems (3-0-0) 3

Engineering Design - Designing a Workable system - Economics -Equation Fitting - Modeling Thermal Equipment - System Simulation -Optimization - search methods - Dynamic Programming - Linear Programming - Geometric programming - Mathematical modeling -Thermodynamic Properties.

Stoker W. F., Design of Thermal Systems, McGraw Hill

TH805 Rocket Technology (3-0-0) 3

Reaction Principles, Essential factors of propulsive devices. Momentum theory, Ramjet engine, Design of propulsion and turbo jet engines. Performance of rocket vehicles. Design parameters, Solid propellant rocket motors. liquid propellant rockets, combustion mechanism, Testing of rockets, Introduction to nuclear and electrical rocket system.

M.J. Zucrow, Principles of Jet Propulsion and Rocket Systems, John Wiley. Mathur and Sharma, Gas Turbines and Jet Propulsion.
S.P. Sutton, Rocket Propulsion Elements.
M.J. Zucrow, Aircraft and Missile Propulsion, vol.- II, John Wiley.

TH806 Automobile Pollution & its Control (3-0-0) 3

Characterization of pollution control, Primary pollutants, Air pollution and health, Air pollution and the environment, Laws and regulation, Pollutants from SI and CI engines. Methods of characterization and analysis, ts. Mechanisms of pollutant formation in SI and CI engines, factors affecting emissions from engines engine modifications to control emissions, exhaust after treatment in SI and CI engines, influence of fuel properties, fuel specifications, alternative fuels and their emissions, driving cycles, emission standards and regulatory test procedures, Economic challenges.

Paul Degobert, Automobiles and pollution, Technip, Paris
Patterson D.J. and Henein N A. Emissions from combustion engine sand their control
Ann Arbor Science Publishers, Michigan 1972
John B Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Edition, Singapore, 1989
M.N Rao and H.V.N Rao, Air Pollution, Tata McGraw Hill.
Crouse William, Automotive Emission Control,(Gregg Division check), McGraw Hill.

TH807 Applied Computational Methods in Fluid Mechanics & Heat Transfer (3-0-0) 3

Modeling, Computers, and Error Analysis: Mathematical modeling of simple problems, Algorithm Design and software development process, Approximations and errors. Roots of Equations: Bracketing and open methods as applied to thermal engineering problems. Solution of linear and non-linear algebraic equations, Statistical description of thermal data, Modeling of data, Boundary value and initial value problems of heat transfer (conduction, convection and radiation) and fluid mechanics, Numerical solution of partial differential equations of heat transfer and fluid mechanics. Eigen value problems.

William H Press, Saul A Teukolsky, William T Vellerling and Brain P Flannery, Numerical Recipes in C, 2 ed., Cambridge university press.
E.V. Krishnamurthy and S. K. Sen, Numerical Algorithms, 2 ed., Affiliated east-west press.

TH808 Food Preservation & Medical Refrigeration (3-0-0) 3

Food Preservation - Refrigeration systems used in cold and frozen food storage. Factors affecting quality of food and

estimation of thermal properties of food materials. Freezing and thawing of foods. Evaluation of heat transfer coefficients in freezers. Study of quick freezing systems. Dehydration of foods. Tunnel drying of food materials. Tray and component driers. Freeze drying. Calculation of freeze drying time. Household freezing and storage equipments. Packing materials for frozen foods and refrigerated transport of frozen foods.

ASHRAE Hand books
Aurel Ciobanu et al. Cooling Technology in the Food Industry, Abacus press
Farrall A.W., Food Engineering Systems, Vol 1-Operations, AVI Publishing Co. Inc. Stuart Thorne, Development in food preservation, Applied Science Publications.
Heat transfer/Refrigeration/Thermodynamics data handbook

TH809 Nuclear Engineering (3-0-0) 3

Scope of Nuclear Power- Review of Nuclear Physics- Reactor Theory. Elements of Reaction Physics.
Thermodynamics Aspects of Nuclear Power, Fusion Process System. Thermal Reaction Type: PWR, CANDU, HTGCR. Fast Breeder: Fluid Fuelled, Organic Cooled Reactor, and Economics. Steady and Unsteady State- Calculation of Critical Size of Homogeneous And Heterogeneous Reactors. Elementary Idea of Reactor Instrumentation and Control. Reactor Materials, Shielding, Thermal Aspects of Nuclear Systems.

Richard Stephenson, Introduction to Nuclear Engineering, McGraw Hill.
Charles F. Bonilla, Nuclear Engineering, McGraw Hill.
K.S. Ram, Basic Nuclear Engineering, Wisely Eastern.

TH810 Vacuum Engineering (3-0-0) 3

Kinetic Theory of Gases, fluid flow in vacuum lines, transitional and molecular flows; Conductors of pipelines, fitting, pumps down line - Constructional materials for vacuum equipments and their out characteristics - Vacuum production techniques - Principles of operation of rotary, diffusion, turbo molecular, cryo vacuum production techniques - Principles of operation of rotary, diffusion, turbo molecular, cryo vacuum pumps - Mechanical and thermal design considerations - Selection of vacuum pump - Measurement of vacuum - Mcleod, thermal seals, valves, flanges and pipelines - Applications of vacuum technology for space, food preservation, manufacturing and Cryogenic applications.

Roth A., Vacuum Technology, North-Holland, 3rd Edition.
O'Hanlon J.F, A user's guide to vacuum technology, Wiley-Interscience, 2nd ed.
Hoffman D.M., Singh Band, Thomas J.H. (Eds)., Handbook of vacuum science and technology, Academic press

TH811 Turbomachines (3-0-0) 3

Dimensional analysis and principle of similitude, Energy transfer between fluid and rotor, Potential flow through cascades of blades. 3- dimensional viscous and compressibility effects. Principles of design and performance of different types of turbomachines. Equilibrium running diagrams, Principles of Mechanical design of different components of turbomachines and its auxiliary equipment, Regulation of turbomachines.

D.G. Shephard, Principles of Turbomachinery, McMillan Co., New York.
S.M. Yahya, Turbomachines, IIT, New Delhi.
H. Cohen and Rogers, Gas Turbines Theory, Longman Green Co., Ltd

TH812 Steam & Gas Turbines (3-0-0) 3

Steam turbines: power plant cycles, Cycle analysis and design , losses in steam turbine, Design of a stage, Design of multistage axial flow turbines, Vortex flow and lower pressure stage design , Performance at varying loads governing , Calculation of design point efficiency using cascade data. Gas Turbines - Performances of practical gas turbine cycles, Design point performance of simple and series flow cycles, factors affecting performance.

W.J. Kearton, Steam Turbine Theory and Practice.
Lee, Theory and design of Steam and Gas Turbine, Mc Graw Hill.
Cohen and Roger, Gas Turbine Theory; Longmans London.
Jennings and Rogers, Gas turbine analysis and Practice, Mc Graw Hill.

TH813 Applications of Microprocessors & Computers in Thermal Engineering (3-0-0) 3

Recapitulation of fundamentals - Numbering system, Boolean algebra, Binary arithmetic, Character representation, Logic gates, Flip flops - Types, Registers. BCD to seven segment display, LED and LCD, D/A and A/D converter principles. 8085 Microprocessor Architecture and Instruction sets. Microprocessor 8085 Assembly language programming, Data acquisition using C language. Use of C language to experimental data analysis. Demonstration of interface of microprocessor with stepper motor. Demonstration of data accusation using the C language directly to store on hard disk and display on the computer.

A.P. Mathur, Introduction to Microprocessor, Tata McGraw Hill, 1989.

Malvino and Leech, Introduction to Digital Electronics, TMH, New Delhi.
Laventhal, Introduction to Microprocessor Software, Hardware and Programming, PHI

TH814 Design of Heat Transfer Equipments (2-1-0) 3

Review of fundamental of heat transfer: Conduction, Convection, Radiation and Extended surfaces. Design of double pipe exchangers, Shell and tube heat exchangers, Design of condensers, evaporators, boilers, cooling towers, selection of materials, Inspection and testing procedure.
Donald Q. Kern, Process Heat transfer, McGraw Hill.
Heat Exchanger handbook, Heat exchanger theory, Hemisphere Publishing Corporation.

TH815 Heat Transfer in Two-phase Flow (3-0-0) 3

Pool boiling and condensation - boiling curve. Introduction to two-phase flow -Definition, Methods of analysis, Flow patterns. Flow models - Homogeneous, separated, Drift flux models. Flow through bends and restrictions, chocking in two-phase flow. Flow boiling and condensation: Introduction to convective boiling and condensation, flow pattern predictions, heat transfer and pressure drop in different flow patterns. Empirical correlations in two phase flow, Critical heat flux and interfacial phenomenon. Multi - component boiling and condensation - pool boiling.
G.B. Wallis, One Dimensional Two-phase Flow.
J.C. Collier, Convective Boiling and Condensation.
L. Stong, Boiling Heat Transfer and Two-phase Flow.

TH816 Advanced Thermodynamics (3-0-0) 3

Recapitulation of classical Thermodynamics, Thermodynamics potentials and criteria of equilibrium, Thermodynamics of chemical reaction, Advanced energy systems, Kinetic theory of gases and distribution of molecular velocities. Statistical thermodynamics and quantum mechanics. Irreversible thermodynamics. Transport processes in gases.
Michel M. Saad, Thermodynamics for Engineers, Prentice Hill
J.P. Holman, Thermodynamics, Mc Graw Hill
P.K. Nag, Basic and Applied Thermodynamics .
Lee & sears, Thermodynamics
Lee, Sears and Turcotti, Statistical thermodynamics, Addison-wasley

TH817 Theory & Design of I.C. Engines (3-0-0) 3

Constructional features of different engines, Combustion phenomena in SI engine, Combustion knock, Combustion chamber designs for SI engine, combustion phenomenon in the CI engine, Combustion chamber design for the CI engine, Delay period, and diesel knock, IC engine design principles, Design of engine components, Piston, connecting rod, crankcase, crankshaft, manifolds, valves, Design of cooling system, lubricating oil system and radiator fans, computer aided design of engine components, Engine balancing, recent advances.
Kolchin A and Demidov V, Design of Automotive Engines, Mir Publishers, Moscow, 1984
Charles Fayette Taylor, Internal combustion Engines in theory and practice. Vols I and II
The MIT Press Massachusetts Institute of Technology, USA, 1996
John Fenton, Engine Design, University Press Cambridge, Great Britain, 1986
Colin R.Ferguson, Internal Combustion Engine, Applied Thermosciences, John wiley and sons

TH818 Thermofluids (3-0-0) 3

Thermodynamic and Thremophysical properties of pure fluids,: Equilibrium properties such as vapour pressure, latent heats, critical constant and PVT behaviour. Transport properties such as viscositiy, thermal conductivity, diffusivity, surface tension estimation and correlation methods. Properties of multicomponent systems: V-L-E using equations and state and group contribution methods. L-L-E correlation and prediction.
International Journal of Refrigeration
ASHRAE Hand books
Reid et al, The Properties of Gases & Liquid, McGraw Hill
Heat transfer/Refrigeration/Thermodynamics data handbook

TH819 Design of Air Conditioning Systems (3-0-0) 3

Psychrometry. Air-conditioning calculations. Comfort scales. Solar radiation. Estimation of solar radiation from the solar angles. Cooling load and heating load calculations. Solar space heating and cooling. Passive cooling systems. Dehumidification and humidification equipment. Design of cooling towers, spray washers, air washers, cooling and dehumidifying coils. Design of air duct system. Room air distribution. Various types of air conditioning systems. Various types of system controls. Mass transfer by molecular diffusion and convection. Calculation of mass transfer

coefficients. Interface mass transfer. Application of air conditioning.
Arora C. P., Refrigeration and Air Conditioning, Tata McGraw Hill
Manohar Prasad, Refrigeration and Air conditioning, Wiley Eastern Limited, New Delhi.
Heat transfer/Refrigeration/Thermodynamics/Air conditioning data hand book.

TH820 Computational Fluid Dynamics (3-0-0) 3

A broad review in terms of historical background, application and purpose of study.Introduction to One-Dimensional Computation by FDM, FEM, FVM. Neumann boundary condition and Dirichlet boundary condition.Governing equation of Fluid Dynamics : Derivation, Discussion, Physical meaning and Governing equation forms suitable for CFD.Partial Differential Equation their mathematical behaviour.Finite Difference Methods. Derivation of FD equations, Solution methods of FD equation (elliptic equation, parabolic equation and hyperbolic equation).Incompressible Viscous Flow via FDM. Compressible Flows via FDM.Structured Grid Generation.Finite Element Methods: Introduction, FE Interpolation Functions. Linear Problems- Steady State problems, Transient problems. Solution of FE Equations.
Anderson John, D. Jr. Computational Fluid Dynamics-The Basics with Applications. McGrawHill Internation Edition, 1995.
Chung T. J. Computational Fluid Dynamics. Cambridge University Press (South Asian Edition 2003)
Andeson Dale A, John C, Tannehill & Richard H. Fletcher, Computational Fluid Dynamics & Heat Transfer. McGraw Hill 1984. Fletcher, C. A., Computational Techniques for Fluid Dynamics, Vol-1, Fundamental & General Techniques. Springer Verlag, Berlin 1988.

TH821 Cryogenics Technology (3-0-0) 3

Liquefaction of permanent gases, Methods of Air liquefaction, separation, storage and transport, Applications, Properties of solids and liquids at Cryogenic temperatures, cryogenic insulations vacuum technology, Cryo pumping, Cryogenic heat pipes, Cryo engines, Cryogenic instruments. Applications of cryogenic engineering in various fields.
R.B. Scott Cryogenics Engineering - Van Nostrand
R.F. Baroon "Cryoneic Systems, McGraw Hill New York
Arora C. P Refrigeration and Air conditioning "Tata McGraw Co. Ltd. New Delhi Refigeration / Thermodynamics/ Heat transfer / Air conditioning Data Hand book

TH 822 GAS DYNAMICS (3- 0- 0) 3

Kinetic theory of gases, molecular energies, transport phenomena, intermolecular forces, real gases, molecular collisions, energy transfer, control volume analysis, introduction to compressible flow, sonic velocity, mach number, varying area adiabatic flow, standing normal shocks, moving and oblique blocks, Prandtl- Meyer flow, Fanno flow, Rayleigh flow, real gas effects, Boltzmann equation, simple flows, flows induced by temperature fields, flows with evaporation and condensation
George Turrel, Gas Dynamics: Theory and Applications, John Wiley & Sons, 1997
Robert D Zucker and Oscar Biblaz, Fundamentals of Gas dynamics, John Wiley & Sons, 2002
Yoshio Sone, Molecular gas dynamics: theory, techniques and application,Birk Hauser, Boston, 2007
Ethirajan Rathakrishnan, Applied Gas Dynamics, John Wiley & Sons, 2010.

TH 823 MATERIALS FOR NUCLEAR ENERGY (3- 0- 0) 3

Structure of a nuclear power plant, requirements of reactor materials, fuel materials, plutonium, uranium and thorium and their alloys & compounds, core materials: beryllium, graphite, control and shielding materials, magnesium & its alloys, aluminum & alloys, zirconium & alloys, austinic stainless steel; materials for reactor vessel and other components, pearlitic steels ferritic chromium stainless steels, copper alloys, titanium and its alloys, coolants used in reactors: radiation embrittlement, corrosion of reactor materials, mechanical properties of materials.
V. Gerasimov & A Monakhov, Nuclear Engineering Materials, Mir Publishers, Moscow, 1983.
D.S Clark & W.R. Varney, Physical Metallurgy for Engineering, East West Press, New Delhi, 1987.
C. M, Srivastava & C. Srinivasan, Science of Engineering Materials, New Age International, 1997.

TH 824 COGENERATION AND ENERGY EFFICIENCY (3- 0- 0) 3

The concept of cogeneration, main design parameters for cogeneration, cogeneration alternatives, Bottoming and topping cycles, Steam turbine plants, Gas turbine plant, Diesel and gas engine plants, Thermodynamic evaluation, Combined cycle applications, Sterling engine, Industry / utility cogeneration, Trigeneration, Techno economic and Environmental aspects, Cogeneration in sugar, textile, paper and steel industry, Case studies.
David H. Thomas, Energy Efficiency Through Combined Heat and Power or Cogeneration (Energy Policies, Politics and Prices), NOVA, 2010

Guidebook on Cogeneration as a Means of Pollution Control and Energy Efficiency in Asia by Economic & Social Commission for Asia & the Pacific, United Nations Economic, Social Commission for Asia, and the Pacific, 2000.

TH 825 FUEL TECHNOLOGY (3- 0- 0) 3

Solid, liquid and gaseous fuels, Coal as a source of energy and chemicals in India, Coal preparation, Carbonization, Gasification and liquefaction of coal and lignite, principle of combustion, Petroleum and its derived products, Testing of liquid fuels, Petroleum refining processes, Inter-conversion of fuels, Natural gases and its derivatives, sources, potential, Gas hydrates, Combustion appliances for solid, liquid and gaseous fuels, Introduction to nuclear fuel, RDF, Bio-fuels, etc.

Himus-Fuels Technology, Leonard Hill Ltd., London, 2007

Shaha -Combustion Engineering and Fuels Technology –(Oxford &IBM), 2004.

R.J. Sarjant, *Efficient use of fuels – HMSO Publication, London.*

TH 826 FUSION ENERGY (3- 0- 0) 3

Fission and fusion, Need for plasma, Lawson criterion, Confinement problem, Laser driven fusion, Magnetic confinement, Plasma concept, Single particle motions in complex magnetic field geometries, Equilibrium and stability, Cross field transport, Important heating schemes, Tokamak and magnetic mirror, Reactor concepts, Current status.

Jeffrey P. Freidberg, Plasma Physics and Fusion Energy, Cambridge University press, 2008.

A. Harms, K. F. Schoepf, G. H. Miley, and D. R. Kingdon, Principles of Fusion Energy: An Introduction to Fusion Energy for Students of Science and Engineering, World Scientific, 2000.

TH827 AUTOMOTIVE FUELS AND FUEL SYSTEMS (3- 0- 0) 3

Conventional liquid HC fuels, Properties of conventional fuels, Alternative engines and fuels, including for racing, Fuel tanks and measurement of their contents, Transferring the fuel from tank to metering unit, Fundamental principles of carburetion, Elements of carburetors, Constant depression and fixed venture carburetors in practice, Induction manifold design, LPG fuel and mixing systems, Gasoline injection, Combustion and combustion chambers, Emissions and their control, Sampling and analysis of emissions, Crude oil delivered diesel fuel, Fuel quality and additives, Alternative fuels, Injectors and inline and unit injection pumps, Rotary and distributor type injection pumps. Test cycles, sampling and analysis of exhaust emissions, Optimizing air induction- variable valve timing and differences in approach for diesel and gasoline engines, Optimizing air induction- induction pipe tuning, Optimizing air induction- Turbo charging and supercharging, complex pressure wave charger, Introduction to alternate fuels, biomass combustion equipment, biomass fuel supply and purchasing, processing network, fuel switching feasibility study

T.K. Garret, Automotive fuels and fuel systems Vol. 1 & 2, John Wiley & Sons, 2008

Thomas McGowan, Biomass and Alternate fuel systems an engineering and economy Guide, John Wiley & Sons, 2009

TH828 BIO-FUELS IN IC ENGINES (3- 0- 0) 3

Introduction to global energy sources, Bio energy, Bio diesel-Introduction to biodiesel concept, physical and chemical properties, Production of biodiesel: primary raw materials- non edible, edible and waste frying oils, Processing of vegetable oils as biodiesel: transesterification process, batch processing, continuous processing, Basic plant equipments, and economic benefits of biodiesel. Bio diesel performance: Engine combustion process, engine performance tests and emissions with biodiesel blends. Ethanol and methanol: global market and future prospect, properties, production methods, Performance and emissions using ethanol and methanol blends in IC engines.

Ahindra Nag, Biofuels refining and performance, McGraw-Hill Professional, 2008.

Ayhan Demirbas, Biodiesel: a realistic fuel alternative for diesel engines, Springer, 2008.

Lucas Reijnders, Mark A. J. Huijbregts, Biofuels for road transport: a seed to wheel perspective, Springer, 2009.

Joshua Tickell, Kaia Tickell, from the fryer to the fuel tank: the complete guide to using vegetable oil as an alternative fuel, Biodiesel America, 2000.

TH 829 PYROLYSIS AND TORREFACTION OF BIO MASS (3- 0- 0) 3

Significance of pyrolysis and torrefaction of biomass, Pyrolysis methods for bimass and other organic waste materials generated in Industries, Municipality etc., to produce Biofuels, Vacuum pyrolysis, Processes involved for Biomass, Biochar, Torrefaction methods, process of torrefaction, pelletisation/briquetting processes, densification methods, biocoal production, gasification of biomass.

Bergman, P.C.A.; Kiel, J.H.A., Torrefaction for biomass upgrading", ECN report, ECN-RX—05-180,2005.

Bergman, P.C.A.; Boersma, A.R.; Zwart, R.W.H.; Kiel, J.H.A., Development of torrefaction for biomass co-firing in existing coal-fired power stations, ECN report ECN-C—05-013,2005.

Bergman, P.C.A., Combined torrefaction and pelletisation – the TOP process, ECN Report, ECN-C-05-073, 2005

Bergman, P.C.A.; Boersma, A.R.; Kiel, J.H.A.; Prins, M.J.; Ptasinski, K.J.; Janssen, F.G.G.J., 2005, Torrefied biomass for entrained-flow gasification of biomass,ECN Report ECN-C—05-026.

MF700 Metal Removal Processes (3-0-0) 3

Orthogonal and Oblique cutting, Machining parameters, Tool materials and Tool geometry, Mechanics, Tool wear and Tool life, Machinability, Economics of Machining, Surface Integrity, Measurement techniques, Modern Machining processes, USM, EDM, ECM, Mechanics and metal removal rates.

G Boothryod, Fundamentals of Metal cutting and Machining.
B L Juneja and Shekon G S, Fundamentals of Metal cutting and Machine Tools. Venkateshan, Experimental Techniques.
A.Bhattachary, Metal Cutting-Theory & Practice, New Central Book Agency, London

MF701 Computer Integrated Manufacturing (3-0-0) 3

Introduction to automation, Industrial control systems, Numerical controls and programming, PLC, Material handling, transport and storage systems. Manufacturing systems GT, FMS, Automated assembly and transfer lines, Concurrent engineering and DFM advanced manufacturing planning, Agile manufacturing, Data acquisition systems.

Mkell P. Groover, Automation, Production Systems, and Computer Integrated Manufacturing, Prentice Hall.
Jerome H Fuchs, The Illustrated handbook of Advanced Manufacturing methods, Prentice Hall.
P. Radhakrishna & S. subramanyan, CAD/CAM/CIM.
Ibrahim Zeid, CAD/CAM-Theory & Practice, McGrawHill Publ.

MF702 Product Design & Rapid Prototyping (3-0-0) 3

Generic process of Product Development, Concept generation, selection and Testing - CAD applications in Testing, CAD Hardware and software, Virtual Prototyping, Product Architecture, Industrial Design and Design for manufacturing, Design for assembly, Economic and Human Factors in Engg. Design for production- Metal and Plastic components, Optimum Design, Rapid Prototyping Technologies - Processes and Comparison, Details of Process constituents.

Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, McGraw-Hill, 2000.
A. K. Chitale and R. C. Gupta, Product Design and Manufacturing, PHI Pvt. Ltd., 2002
Chris McMahon and Jimmie Browne, CAD/CAM, Pearson Education Asia Pvt. Ltd., 2002

MF703 Robotics: Mechanics Control and Programming (3-0-0) 3

Introduction, Classification, specifications, work volume, control resolution, end effectors, Drives and transmission, Robot sensors, Robot layout, Robot kinematics and dynamics, Material handling systems.

Groover M P and et.al., Industrial Robotic Technology- Programming and Application, McGraw Hill
Koren Y, Robotics for Engineers, McGraw Hill
Ranky P G and Ho C Y, Robots modeling control and applications with software, Springer Verlag, Berlin.

MF704 Manufacturing Systems Lab I (0-0-3) 2

CAD Modeling, Assembly, Drafting of production drawing, Tolerance analysis of machine components like Screw jack, Drill Jig etc.

MF705 Metrology & Instrumentation (3-0-0) 3

Errors in measurement, Calibration , linear and angular measurements, quality control fundamentals, standard deviation, normal curve of variation, Comparators, control charts, limits and tolerances, statistical aspects of tolerances and setting of tolerances, tolerance charting, Surface finish terminology and measurement, measurement of screw thread and gear elements, acceptance test for machines.

ASTME Hand Book of Industrial Metrology, Prentice Hall, India
K.W.B Sharp Proctual Engineering Metrology,
Pitman Lander. K.J Hume, Engineering Metrology, Kalyani Publishers, India.
R.K. Jain, Engineering Metrology, Khanna Publishers.
Juran, Quality Central Hand Book, Mc Graw Hill.
Thomas G. Beckwith,Roy D Marangoni,John H Lienhard, Mecahnical Measurements, Peason Publ.

MF706 Modern Machining Processes (3-0-0) 3

Introduction to advanced machining processes – EDM, ECM, AJM, PAM, EBM,USM, LBM-Principles, Mechanism of material removal- material removal rate – Dynamics-process parameters-machining accuracy and finish,-Dynamics of ECM process-tool profile correction- Thermal Analysis of chemical machining, lon beam machining, modified conventional machining, hot machining-principle of restricted contact cutting, high production cutting tools for turning

and drilling, deep hole drilling, SPDT. Micro machining micro-turning, micro-milling, micro-drilling, micro EDM, micro-WEDM, micro ECM etc, ultra-precision machining, electrolytic in process dressing and grinding, high speed machining, nano surface generation, ductile cutting of silicon wafers, mechanism of ductile cutting, nanometric cutting, chip formation, recent developments.

Debarr & Oliver- Electrochemical machining – American Elsevier Publishing Company, Inc.
Bhattacharya, A., New Technology – The Institution Engineers(India)
Krasyuk, Electro-spark machining of metal, Consultants bureau, New York
P.C Pandy & Shan,Modern machining processes-Tata McGraw Hill publishing company, New Delhi
S.A Bahttacharya, Metal cutting Theory and practice, Central Book Publishers, Calcutta
Ghosh and Mallick-Manufacturing Science-Affiliated East-West Press Pvt. Ltd New Delhi
Vijay K. Jain Advanced Machining Process, Allied Publishing Pvt. Ltd, 2002

MF707 Manufacturing Systems Lab II (0-0-2) 1

CNC programming Manual and automated, Tool path generation and verification using CAM software Insight to simple structure analysis using FEA softwares.

ME 800 Finite Element Analysis (3-0-0) 3

Basic concepts, Finite elements formulation using elastic continuum displacement approach, Generalization of the finite element concepts-weighted residual and variational approaches. Element types, iso-parametric formulation, numerical integration, Automatic mesh generation schemes. Application to structural mechanics problems: plane stress and plane strains, Axi-symmetric stress analysis, three dimensional stress analyses, bending of beams and plates. Introduction to non-linear problems, finite element analysis of coupled problems.

Rao S. S. Finite Elements Method in Engineering, 4th Edition, Elsevier, 2006.
P Seshu, Textbook of Finite Element Analysis, PHI, 2004.
J.N.Reddy, Finite Element Method, McGraw -Hill International Edition.2004
Cook R. D., Concepts and Application of Finite Elements Analysis, 4th Edition, Wiley & Sons, 2003.

ME801 Finite volume method for computational Fluid Dynamics (3-0-0)3

Introduction, Conservation laws of fluid motion and boundary conditions. Turbulence and its modeling. Finite volume method for diffusion problem. Finite volume method for convection diffusion problem. Solution algorithm for pressure –velocity coupling in steady flows. Solution of the discretised equations. Finite volume method for unsteady flows.

Versteeg H K and Malalasekera W. An Introduction to computational fluid dynamics The finite volume method. Pearson Prentice Hall, 1995.
Date Anil W. Introduction to Computational Fluid Dynamics. Cambridge University Press. 2005
Patnakar Suhavs V. Numerical Heat transfer and Fluid Flow. Hemisphere Publishing corporation, Taylor and Francis Group, New York. 1980.

ME802 Nanofluids (3-0-0) 3

Introduction to microfluids and nanofluids, Synthesis of Nanofluids, Properties of nanofluids, Thermal fluid flow transport phenomena using nanofluids, Heat Transfer in Nanofluids: conduction, convection (natural & forced), Boiling of nanofluids, Advanced cooling device development using nanofluids. Applications and Future Directions.

Sarit K. Das, Stephen U. S. Choi, Wenhua Yu, T. Pradeep, Nanofluids, John Wiley and Sons Inc.
Roy Strandberg, Debendra K. Das, Heat Transfer Performance of Nanofluids, LAP Lambert Academic Publishing

ME 803 Wind Energy (2 0 2) 3

Introduction, Sources and characteristics of wind, Power in the wind; Wind resource assessment, Wind measurement, Classification of wind turbines, horizontal and vertical axis wind turbines, Wind turbine aerodynamics, Momentum theory, Blade element theory, Turbine airfoils and rotor wakes, Operational characteristics; Wind turbine design, Component design, Power control, Siting and wind farm design, Electric and control systems, Economic assessment, Environmental and social issues. Lab component: understand the operation of a low-speed wind tunnel, instrumentation for measuring force, velocity, and pressure, and various aspects of the flow around an airfoil, Pressure distribution over airfoil, measurement of the lift and the drag force, static pressure distribution, and wake velocity profile for a symmetric and asymmetric airfoil; flow visualization over a symmetric airfoil using smoke generator, the effects of adding a pair of "trip wires" to the asymmetric airfoil; compare the wind tunnel measurements with theory and other experimental data

J.F. Manwell, J.G. McGowan, and A.L. Rogers Wind Energy Explained, Theory, Design and Application, Second Edition John Wiley & Sons Inc. 2010
Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook, John Wiley & Sons, Ltd, 2001
Sathyajith Mathew, Wind Energy Fundamentals, Resource Analysis and Economics Springer-Verlag Berlin Heidelberg, 2006
Jewel B. Barlow, William H. Rae, Alan Pope Low-Speed Wind Tunnel Testing, 3rd Edition, John Wiley and Sons, 1999

ME804 Turbulent Flow (2-1-0)3

Introduction to stability of laminar flows. Linearized stability analysis using Orr-Sommerfeld equations. Transition to turbulence. General properties of turbulence. Introduction to mathematical analysis of turbulent flows. RANS equations. Turbulence modeling. Eddy viscosity/mixing-length models, application to free shear flows and wall-bounded flows. Two-equation models of turbulence: standard k-e and k-w model. Turbulent free shear flows. Turbulent wall bounded flows, Law of the wall, velocity defect law, law of the wake.

Jean mathien and Julian Scott, Introduction to Turbulent Flow, Cambridge Univ. Press
R.J. Garde, Turbulent Flow, New Age Science.
Stephen Bailey Pope, Turbulent Flow, Cambridge Univ. Press

ME805 Micro scale fluid flow and Heat transfer (3-0-0)3

Prerequisite ; Heat Transfer , Fluid MechanicsIntroduction: Fundamentals of kinetic theory-molecular models, scaling laws for micro-domains, Microscale gas flows: Wall slip effects and accommodation coefficients, flow and heat transfer analysis of microscale Couette flows, micro-Poiseuille flows, effects of compressibility, introductory concepts on gas flows in transitional and free molecular regimes. Microscale liquid flows, Introduction to nanofluidics, concepts of nano-fluids and their augmented transport characteristics, An introduction to bio-microfluidics.

Suman Chakraborty, Microfluidics and Microfabrication, Springer, 2010.
Stephane Colin, Microfluidics, John Wiley & Sons, 2010

ME806 Surface Treating and Finishing (3-0-0)3

Plating Processes, Diffusion Processes,Thin Film Coatings, Advanced Thermal spray Coatings, Characterization and Testing of Coatings, High-energy Surface Modifications, Plasma Surface Engineering of Plastics, Heat Treatment of Tool Steels, Heat treating solid solution strengthened Iron- Nickel- and Cobalt- base superalloys, Heat Treatment of Titanium and Titanium alloys, Heat Treatment of Cast Iron, Defects and Distortion in Heat Treated Parts

K.G. Budinski, Surface Engineering for Wear Resistances, Prentice Hall, Englewood Cliffs, 1988.
M. Ohring, The Materials Science of Thin Films, Academic Press Inc, 2005
ASM Handbook, Surface Engineering, Vol. 5, ASM Publication, Materials Park, Ohio, 2001.
ASM Handbook, Heat Treating, Vol. 4, ASM Publication, Materials Park, Ohio, 2001.
ASM Handbook, Materials Characterization, Vol. 10, ASM Publication, Materials Park, Ohio, 2001.
Jamal Takadoum, Materials and Surface Engineering in Tribology, John Wiley & Sons, Inc., 2008.
Rointan F. Bunshah, Handbook of Hard Coatings, Noyes Publications, U.S.A.,2001

ME807 Modal Analysis (3-0-0)3

Modal Testing – Introduction, Applications, Measurement Methods, Single DOF system - Theory and Properties of FRF data, Multi DOF system – Undamped, Proportional damping, Hysteric damping, viscous damping, characteristics of FRF data, Mobility Measurement System - Basic measurement system, structure preparation, transducers and amplifiers, Analyzers, Digital Signal Processing. Modal parameter extraction methods – Introduction, preliminary checks of FRF data, SDOF – Peak amplitude, circle fit, inverse method. Analytical and Numerical modal analysis of beam. Demonstration of modal analysis of simple structures.

Ewins D J, Modal Testing: Theory and Practice , John Wiley & Sons Inc., 1988
Nuno Manuel Mendes Maia et al,Theoretical and Experimental Modal Analysis, Wiley John & sons, 1997.
Zhi-Fang Fu and Jimin He, Modal Analysis, Butterworth-Heinemann Publisher, 2001.
Kenneth G McConnel and Paulo S Varoto, Vibration Testing: Theory and Practice, Wiley, 2nd Edition, 2008

ME808 Vehicle Dynamics (3-0-0) 3

Introduction to Automotive vehicles and Vehicle dynamics, Fundamental approach to modeling, Dynamic axle loads, Automobile - Principle Components, Working Principles and Construction details, Forces and couples on the wheel, Tractive and braking effort, Vehicle drag, power for propulsion, Air resistance, rolling resistance, grade resistance,

traction and tractive effort, distribution of effort, Stability of a vehicle on a slope, Front wheel drive, rear wheel drive and four wheel drive. Dynamics of a vehicle running on a banked and curved track, Vehicle Performance, Acceleration Performance, Braking Performance, Road Loads, Aerodynamics,Mechanics of air flow around a vehicle, Pressure distribution on a vehicle, Aerodynamic forces, Ride,Steady State Cornering, Roll Over, Electric Vehicles, Hybrid Electric Vehicles,Rail and off road vehicle dynamics

T.D. Gillespie, "Fundamentals of vehicle dynamics", Society of Automotive Engineers, Warrendale, PA, 1992.
N. K. Giri, "Automotive Mechanics", Khanna Publishers, Eighth edition
Ahmed A. Shabana, "Dynamics of Multibody Systems", Cambridge University Press; 2nd edition,1998.
Michael Blundell and Damian Harty, The Multibody Systems Approach to Vehicle Dynamics, Elsevier,2004.
M.Ehsani, Y.Gao and A.Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, Second edition, CRC Press.

ME809 Theory of Plates and Shells (3-0-0) 3

Review of equations of elasticity – Langrange equations, energy principles, Hamilton's principle, Principle of minimum , total potential energy, applications. Classical Theory of Plates – stress and moment resultants, bending of rectangular plates with various boundary conditions and loading, limitations of classical theory. Buckling Analysis of Rectangular plates - simply supported plates under compressive forces, Navier solution, Uni-axial and Bi-axial compression of a plate, Buckling of plates simply supported on two opposite edges, Levy's solution, buckling of plates with various boundary condition. Vibration of Plates – governing equations, simply supported plate, Levy's solution, Rayleigh-Ritz method, plates with general boundary condition. Shells of revolution – geometric properties, strain displacement, stress resultants, equation of motion, analytical solution, vibration of cylindrical shells.

Timoshenko, S. Theory of Plates and Shells 2e,2nd Edition, TataMcGraw Hill, 2010
Reddy,J.N., "Theory and Analysis of Elastic Plates & Shells", C.R.C.Press,NY,USA, 2nd Edition,2006.
Maan H Jawad, " Theory and Design of Plate and Shell Structures", Springer, 2012.
Eduard Ventsel, and Theodor Krauthammer, "Thin Plates and Shells Theory and Applications",CRC Press, 2001.
Wilhelm Flügge, "Stresses in Shells", Springer – Verlag, 1990.

ME810 Gas Turbines and Jet Propulsion (3-0-0) 3

Thermodynamic cycle analysis of gas turbines; open and closed cycles. Axial flow turbines; blade diagrams and design of blading, performance characteristics. Centrifugal and axial flow compressors, blowers and fans. Theory and design of impellers and blading. Matching of turbines and compressors. Fuels and combustion, effect of combustion chamber design and exhaust on performance. Basic principles and methods of heat recovery. Thermodynamic cycle analysis and efficiencies of propulsive devices. Thrust equation, classification and comparison of ram jets, turbojets, pulse jets and rockets. Performance of turbo-prop, turbo-jet and turbo-fan engines. Augmentation of thrust.

H. Cohen, G.E.C. Rogers and Saravanamutto, Gas Turbine Theory, Longman GroupLtd., 1980.
Anderson, J.D., Modern Compressible flow, McGraw Hill, 3rd Edition, 2003.
S.M. Yahya, fundamentals of Compressible Flow, New Age International (P) Limited,New Delhi, 1996.
V. Ganesan, Gas Turbines, Tata McGraw Hill Publishing Co., New Delhi, 1999

ME811 Technology of Engineering Materials (3-0-0) 3

Structure metals and alloys, polymeric materials, ceramic materials; properties of material, mechanical behavior, processing of materials, thermal spray processing of metals and ceramics; economics, environmental and social issues of material usage.

Thomas H.Courtney,Mechanical Behaviour of Materials , (2nd Edition), McGraw-Hill, 2000.
Mathew Philip, Bill Bolton, Engineering Materials, Butterworth-Heiremann, 2001.
Flinn, R.A. and Trojan, P.K., Engineering Materials and their Applications , (4th Edition), Jaico, 1999.
George E.Dieter, Mechanical Metallurgy , McGraw Hill, 1988.
ASM Handbook, Fatigue and Fracture, Vol. 19, ASM Publication, Materials Park, Ohio, 2001.
Jamal Takadoum, Materials and Surface Engineering in Tribology, John Wiley & Sons, Inc., 2008.

ME812 Analytic Combustion (3-0-0)3

Combustion and Thermochemistry, Chemical Kinetics, Chemical Reaction Mechanisms, Coupling Chemical and Thermal Analyses of Reacting Systems, Simplified Conservation Equations for Reacting Flows, Laminar Premixed Flames, Laminar Diffusion Flames, Droplet Evaporation and Burning, Introduction to Turbulent Flows, Turbulent Premixed Flames, Applications – impinging flame jets, CTARA experimental stove.

Anil W Date, Analytic Combustion, First edition, Cambridge University Press,2011..
Stephen R Turns, An Introduction to Combustion: Concepts and Applications, McGraw Hill, 2011.

D. P. Mishra, Fundamentals of Combustion, First edition, Prentice Hall of India, 2008.
Charles E.Baukal, Heat Transfer in Industrial Combustion, CRC Press 2000.

ME813 Laser Materials Processing (3-0-0) 3

Laser fundamentals, Basics of laser operation and types of lasers, Principles of laser material interaction, Laser welding, Laser cutting and drilling, Laser surface modification, Laser cladding, Laser solid freeform fabrication, Modeling of laser material processing.

W M Steen and J Mazumder, Laser Material Processing, 4th Edition, Springer, 2010.
E Kannatey-Asibu, Principles of Laser Materials Processing, , Wiley, 2009.
N B Dahotre and S P Harimkar, Laser Fabrication and Machining of Materials, Springer, 2008.
John C Ion, Laser Processing of Engineering Materials, , Elsevier, 2005.
Mvon Allmen and A Blatter, Laser-Beam Interactions with Materials, 2'nd Edition , Springer, 1998.

ME814 Design and Analysis of Reinforced Syntactic Foam (3-0-0) 3

Introduction, Fillers and Reinforcements, Processing and Microstructure of Syntactic Foams, Tensile Properties, Modeling and Simulation, Compressive Properties, Flexural Properties, Fracture Toughness, Dynamic Mechanical Properties, Summary and Future Challenges.

Nikhil Gupta, Dinesh Pinisetty and Vasanth Chakravarthy Shunmugasamy, Reinforced Polymer Matrix Syntactic Foams, SpringerBriefs in Materials, Springer, New York, 2013.
F. Shutov, Syntactic polymer foams in Advanced Polymer Science, Springer, New York, 1986.
B. D. Agarwal, L. J. Broutman, K. Chandrashekhara, Analysis and performance of fiber composites, Wiley, New York, 2006.
R. M. Christensen, Mechanics of composite materials, Dover Publications, Mineola, 1979.

ME815 Automotive Electronics (2:0:2)3

Automotive Mechanical Systems, Vehicle Systems, Power Train System, Transmission System, Braking System, Steering System, Need for Electronics in Automotive Systems, Overview of Vehicle Electronic Systems, Embedded Systems, Hardware Module, Software Module, Debug Interfaces, BDM and JTAG, Introduction to Embedded RTOS, Embedded System in Automotive Applications, Embedded System Communication Protocols, Vehicle communication protocols.

Laboratory: Experiments on open loop ECU using LABCAR, embedded controllers, actuators and sensors integration

Lack Erjavec Automotive Technology A systems approach, , 4th edition, Thomson Delmar Learning, 2005, USA;
Willliam B., Ribens Understanding Automotive Electronics, , 6-th Edit., An Inprint of Elsevier Science, USA, 2004;
Robert Bosch GmbH Diesel-Engine Management, 3th edition., Bentley Publishers, 2004;
Robert Bosch,GmbH Gasoline-Engine Management, 2nd edition., Bentley Publishers , 2004;
Robert Bosch GmbH,Automotive Handbook, 6th edition. Bentley Publishers, 2004;

ME816 Sustainable Energy Technologies (3-0-0)3

Sustainability Concept for Energy, Water and Environmental Systems, Efficient Production and Use of Energy, Sustainability indicators, Challenges in Energy system Design, Product innovation, Distributed Energy Generation, , Multi-Criteria Decision making in Energy Systems and Environment, Simulation tools, Biomass into Liquid Fuels, Energy from algae, Fuel Cell and Hybrid Systems, Carbon Emission Credits, Carbon Capture and Storage technology: status and future, Integrated Multi-generation Energy Systems, Advanced Steam Generator Concepts for Oxy-Fuel Processes, Climate change and thermal energy storage, Sustainable Nuclear Energy, Industrial Catalysis for Energy Production, Environmental impact of renewable energy systems. Energy Economics - Simple Payback Period, Time Value of Money, IRR, NPV, Life Cycle Costing, Cost of Saved Energy, Cost of Energy generated, Examples from energy generation and conservation, Energy Chain, Primary energy analysis, Life Cycle Assessment, Net Energy Analysis

Ibon Galarraga, Mikel González-Eguino, Anil Markandya (Editors), Handbook of Sustainable Energy, Edward Elgar Publishing Limited 2011
Ibrahim Dincer and Calin Zamfirescu, Sustainable Energy Systems and Applications, Springer Science+Business Media, LLC 2011
Ekko C. van Ierland and Alfons Oude Lansink (Editors), Economics of Sustainable Energy in Agriculture,Kluwer Academic Publishers , 2003
Fausto Cavallaro (Editor), Assessment and Simulation Tools for Sustainable Energy Systems Theory and Applications, Springer-Verlag London 2013

Halime O. Paksoy (Editor) Thermal Energy Storage for Sustainable Energy Consumption Fundamentals, Case Studies and Design, Springer,2007
Ronald E. Hester and Roy M. Harrison (Editors) Sustainability and Environmental Impact of Renewable Energy Sources, The Royal Society of Chemistry, Thomas Graham House, 2003
Nairn Harndia Afgan and Maria da Graca Carvalho, Sustainable Assessment Method For Energy Systems Indicators, Criteria and Decision Making Procedure, springer science+business media, LLC, 2000

ME817 Processes and Technologies for energy harvesting from waste (3-0-0)3

Abundance of Waste and Energy Scarcity, Biomass and Waste as Sustainable Resources, Anaerobic Digestion, Biomass and Waste Gasification, Digesters, Gasifiers and Biorefineries, Garbage to Electricity, Liquid Fuels , , MSW Processes to Energy, MSW Gasifiers and Process Equipment, Thermodynamic Approach to Design and Optimization of Biomass Gasifier, Modelling Waste Characteristics and WtE Plants as a Tool for Optimum Operation Conditions, Waste Incineration and Waste Prevention. Environmental and social impacts of waste to energy (WTE) conversion plants, Lifecycle assessment (LCA) and its application to sustainable waste management, Pollution control systems for waste to energy technologies, Fuel Cells in the Waste-to-Energy Chain, Molten Carbonate Fuel Cells, Solid Oxide Fuel Cells, Fuel Gas Clean-up and Conditioning, High-Temperature Fuel Cell Plants and Applications, Biomethane and Natural Gas, Prospects of Hydrogen as a Future Energy Carrier, Market and Feasibility Analysis of Non-conventional Technologies

Gary C. Young, Municipal Solid Waste to Energy Conversion Processes Economic, Technical, and Renewable Comparisons, John Wiley &Sons, Inc, 2010.
Industrial Plasma Technology Applications from Environmental to Energy Technologies , Edited by Yoshinobu Kawai, Hideo Ikegami, Noriyoshi Sato, Akihisa Matsuda,Kiichiro Uchino, Masayuki Kuzuya, and Akira Mizuno, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2010.
Waste to Energy Opportunities and Challenges for Developing and Transition Economies, Edited by Avraam Karagiannidis, Springer-Verlag London Limited 2012
Waste to energy conversion technology, Edited by Naomi B. Klinghoffer and Marco J. Castaldi, Woodhead Publishing Limited, 2013

ME818 Artificial Intelligence and its Applications (3-0-0)3

Computational Techniques for representing and solving problems; Perceptions; Representation, production system & search; Heuristics; Fuzzy Logic and control, Artificial Neural Networks techniques; Back propagation Algorithm,Adaptive Resonance Theory, Case studies in the field related to manufacturing, thermal, design and mechatronics applications.

George F. Luger, Artificial Intelligence, Pearson Pub.6th edition (2009)
VVS Sharma, B.Yajnanarayan and Deekshitalu, Artificial Intelligence & Expert System Technologies, Tata McGraw Hill.
Bart Kosko, Neural Networks and Fuzzy Systems.Prentice-Hall; Har/Dis edition (23 May 1991)
Stuart Russell, Peter Norvig Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall; December 11, 2009

ME819 Multiphase Flows (3-0-0)3

Introduction to multiphase flows, Properties of Dispersed flows, Concept of continuum, density and volume fraction, multiphase flow notations, Particle or droplet spacing, Response times, Stokes number, Phase coupling- mass, momentum and energy coupling, Size distribution and size distribution functions, Particle-Fluid interaction, one way coupling, two way coupling, Particle-flow turbulence interaction, Particle-Particle interaction, Atomisation, Sprays, Types of Spray formation- Ocean spray, Wind Shearing and Jet impingement methods. Droplets Atomization, Evaporation and spray combustion, Granular Flows, Particle erosion, Experimental methods, Numerical modelling of multiphase flows.

Clayton T Crowe, John D. Schwarzkopf, Martin Sommerfeld, Yutaka Tsuji ,Multi-phase flows with droplets and particles CRC Press, second edition, 2012.
Christopher E Brennen, Fundamentals of multi-phase flows, Cambridge University Press, 2005.
Nikolay Ivanov Kolev, Multiphase Flow Dynamics 1: Fundamentals, Springer 2007.
Nikolay Ivanov Kolev, Multiphase Flow Dynamics 2: Mechanical interactions, Springer 2011.
Nikolay Ivanov Kolev, Multiphase Flow Dynamics 3: Thermal interactions, Springer 2011.
Guan HengYeoh, JiyuanTu, Computational techniques for multiphase flows, Elsevier 2010.
Andrea Prosperetti and GretarTryggvason, Computational methods for multiphase flows, Cambridge university press 2007.

A.A. Mammoli and c.A.Brebbia, Computational methods in multiphase flows, Series Editors: WIT Press 2011.
Arthur H Lefebvre, Atomization and Sprays, Taylor and Francis, 1989.
Nasser Ashgriz, Handbook of Atomization and sprays: Theory and Applications, Editor: Springer 2011.

ME 825 Virtual Instrumentation (2-0-1)3

Introduction to virtual instrumentation and its evolution, Basics of graphical programming and Lab VIEW, Intodcutiona graphical system design, Basics of Data acquisition, Basics of Digital Signal processing and signal manipulation. Sensor, actuators and its characteristics, Advances in sensing technology and DAQ

Lab component:

Lab VIEW programming, Data collection from sensor inputs , Basic Digital signal processing of complex real world signals , Application of filters ; Implimentaion of Simple Control logics . Interfacing traditional instruments with Lab VIEW , Remote triggered experiments

Sanjay Gupta, Joseph John Virtual Instrumentation Using Lab VIEW Tata MaGraw-Hill (2005)
D Patranabis, Sensors and Transducers, Phl 2nd Edition (2003)
J.P. Holman Experimental Methods for Engineers McGrawHill, 6th Edition(2000)
Academic Resources from WWW.NI.COM

ME826 Experimental techniques in Vibration Analysis (2 -0- 2) 3

Review of basics Mechanical Vibration.. Idealization of complex real world system to SDOF, TDOF and MDOF. Vibration measurement and instrumentation. Determination of Impulse response of mechanical systems. Determination of harmonics excitation response mechanical systems. Method of vibration control

Lab Component

Experimental identification of natural frequency of simplified real world system, Experimental methods of system parameter identification . Estimation of damaging in a given system . Impuse response analysis of mechanical systems. Harmonic response of simplified real world mechanical systems. Signature analysis of roating machines. Passive semi active and active vibraton control.

Wilam T Thomson et.al, Theoryof vibration with applications, 5th edtion, Pearson Education
Leonard Meirovith , Elements of vibration analysis, 2nd Edition, McGrawHill Book Company
J.P Holman, Experimental methods of Engineers McGrawHill, 6th Edition.

ME827 Theory and practice of Sensors and Actuators (2- 0-2) 3

Physics of sensing, sensor specification & dynamics; experimental error analysis; measurement uncertainty, signal conditioning, Actuators and its control, modeling of sensing and actuation systems, Fundamentals of Signal processing. Lab components: Measurement of Temperature, RH, Pressure, strain, force, torque, displacement, velocity, Acceleration, rotation, and rpm – use of different sensors, signal conditioners, signal acquisition and digitization, Actuators: Solenoids, DC motor and its control, stepper motor and its control, servo motors PWM generation and control, Implementation of control systems using sensors and actuators

Sanjay Gupta, Joseph John Virtual Instrumentation Using Lab VIEW Tata MaGraw-Hill, 2005.
D Patranabis, Sensors and Transducers, Phl 3nd Edition, 2013.
J.P. Holman Experimental Methods for Engineers McGrawHill, 8th Edition, 2010.
James H McClellan, DSP First A Multimedia Approach , Printice Hall International , 1999.
Richard Crowder, Electric Drives and Electromechanical Systems: Applications and Control Elsevier, 2010.

ME 830 Convective Heat and Mass Transfer (3-0-0) 3

Fundamental Principles, similarity solution, scale analysis and integral momentum solution, Laminar boundary layer flow, laminar duct flow, external and internal natural convection, transition to turbulence, turbulent boundary layer flow, turbulent duct flow, free turbulent flow, convection with change of phase, mass transfer analysis, convection in porous media.

A. Bejan, "Convection Heat Transfer", Wiley student edition, 2013, ISBN 978-81-265-0934-8.
W. M. Kays, W. M. Crawford, "Convective Heat and Mass Transfer", McGraw Hill, 2004, ISBN-13: 978-0072468762
I. Pop and D. B. Ingham, "Convective Heat Transfer", Elsevier, 2001, ISBN 0-08-043878-4.

ME 835 Additive Manufacturing (3-0-0) 3

Introduction to Additive Manufacturing, AM Process Chain, Classification of AM Processes, AM Systems, Energy and Material Delivery in AM Processes, Materials Science for Additive Manufacturing, Mathematical Models for Additive Manufacturing, AM Process Selection, Applications and Case Studies

Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles and Applications, World Scientific, 2014.
Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publications, 2012.
Hod Lipson, Melba Kurman, "Fabricated: The New World of 3-D Printing", Wiley 2013.
Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.
D.T. Pham, S.S. Dimov, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling" Springer 2001.
Patri K. Venuvinod , Weiyin Ma, "Rapid Prototyping - Laser-based and Other Technologies", Kluwer Academic Publishers, 2003.

ME831Design and Optimization of Thermal Systems (3-0-0) 3

System Design – Introduction to design and specifically system design. Morphology of design with a flow chart.Discussion on market analysis, profit, time value of money, an example of discounted cash flow technique.Concept of workable design, practical example on workable system and optimal design.System Simulation - Successive substitution method, Newton Raphson method, Newton Raphson method, Gauss Seidel method, rudiments of finite difference method for partial differential equations, with an example. Regression and Curve Fitting - Concept of best fit and exact fit, Exact fit - Lagrange interpolation, Newton's divided difference, Least square regression - theory, examples from linear regression, Power law forms, Gauss Newton method for non-linear least squares regression - examples. Optimization - Formulation of optimization problems, Calculus techniques – Lagrange multiplier method – proof, Search methods – Concept of interval of uncertainty, reduction ratio, reduction ratios of simple search techniques like exhaustive search, dichotomous search, Fibonacci search and Golden section search, Method of steepest ascent/ steepest descent, conjugate gradient method, Geometric programming, Dynamic programming, Linear programming – two variable problem –graphical solution. New generation optimization techniques – Genetic algorithm and simulated annealing - examples.Introduction to Bayesian framework for optimization- examples.

Essentials of Thermal System Design and Optimization, C. Balaji, Ane Books, CRC Press, India
Design and Optimization of Thermal Systems, Y. Jaluria, MC Graw Hill, 1998.
Elements of Thermal Fluid System Design, L.C., Burmister Prentice Hall, 1998.
Design of Thermal System, W. F. Stoecker, MC Graw Hill, 1989.
Introduction to Optimum Design, J. S Arora, MC Graw Hill, 1989.
Optimization of Engineering Design – algorithms and examples, K. Deb, Prentice, 1995.

MF801 Metal Casting Processes (3-0-0) 3

Introduction, Carbon Dioxide and Shell Moulding, Die Casting, Squeeze casting, Design principles and methodologies, Gating and Risering, Modern Melting and Metal transfer practices, Computers and softwares in Foundries, Foundry Mechanization.

R W Hiene and P C Rosenthal, Principles of Metal Casting, TMH Publication
A J Clegg, Precession Casting Processes, Pergoman Press
P L Jain, Foundry Technology.

MF802 Technology of Composite Materials (3-0-0) 3

Definition and characteristics of composite materials, overview of advantages and limitations of composite materials, Significance and objectives, Types and classification of typical composite materials. Processing of Polymer Matrix, Metal Matrix and Ceramic Matrix Composite Materials, Testing of Composite Materials, Cutting, Machining and Joining of Composite Materials, Design of Composite Materials, Applications and Developments, Quality Assurance, Tribology of Composite Materials.

M.M.Schwartz, Composite Materials Handbook, McGraw Hill Inc., New York, 1992.
F.L. Matthews and R.D. Rawlings. Composite Materials- Engineering and Science, CRC Woodhead Publi., 1994.
Krishan K. Chawla, Composite Materials- Science and Engineering, Springer, New York, 1998.

MF803 Theory of Material Forming Process (3-0-0) 3

Introduction and classification, primary and secondary forming processes, Hot and Cold working, Friction and Lubrication in Metal Forming. Forming processes - selection and testing of stock materials, basic Forging operations, Technology of hammer forging, press forging and upsetting operations. Inspection and tolerance in forging. Extrusion

- parameters in hot and cold extrusion, metal flow, affect of friction - selection of press for extrusion. Wire Drawing - Principles parameters and operations. Sheet metal working - Shearing processes, techniques and tool design aspects for blanking, drawing etc. Die design principles. Near net shape manufacturing. Sheet materials and properties. Presses - classification. Plastic moulds, Jigs and Fixtures, Cutting tools.Die casting and forging dies - pressure die casting, die lubricants, die design, die casting allowances, steps in die design.Tool design for numerically controlled machine tools.

F.M. Wilson, Handbook of Fixtures Design.
F.M. Wilson, Die Design Handbook.
DonaldSon Leeain and Goold, Tool Design.
P. Pollukhin et.al., Rolling Mill Practice.
C. Peareson and R. Parkinson, Extrusion of metals.
J.A. Waller, Press Tools and Press Works.

MF804 Material Joining Processes (3-0-0) 3

Classification and characteristics of Welding. Equipment details and working of Gas Metal Arc Welding (TIG &MIG). Carbon Arc Welding. Ultrasonic welding. Plasma Welding. Under Water Welding. Physics and Metallurgy of Welding. Welding of Jigs and Fixtures, Inspection and testing of welds. Welding defects, residual stresses, welding distortion.

Parmer, Welding processes and Technology.
LITTLE, Welding Technology.

MF805 Industrial Drives (3-0-0) 3

Industrial Prime movers, System comparison, Definition of Terms, Electrical, Hydraulic and Pneumatic Drives, Motors and Generators - control aspects including stepper and servo control, Hydraulic and Pneumatic Basics, Hydraulic pumps, valves and actuators - Symbols for components, laying symbolic circuit for control - practical control problems, Displacement-step diagrams for Multi sensor and actuator controls, Pneumatic components and their symbols - Exercise problems, Safety and Maintenance aspects in Industrial Drives.

Andrew Parr, Industrial Drives, Butterworth-Heineamann, 2000
S. R. Majumdar, Oil Hydraulic Systems: Principles and Maintenance, Butterworth-Heinemann 1998
Andrew Parr, Hydraulics and Pneumatics, Butterworth-Heineamann, 1998

MF806 MicroElectroMechanical Systems (3-0-0) 3

MEMS - overview and working, Sensors, Transducers and Actuators, Design and manufacturing of electromechanical systems, Application of MEMS in automotive and Medical Electronics, Basics of MEMs Engineering, Scaling Laws, Materials for MEMS, Microsystem manufacturing - Photolithography, Bulk, surface and LIGA processes, Comparison of Processes, Wet and Dry Etching, Stiction, Method to Reduce Stiction, Microsystem Design, CAD applications in MEMS Design

Tai Ran Hsu, MEMS and Microsystems - Design and Manufacture, Tata McGraw-Hill, 2002
Marc J. Madou, Fundamentals of Microfabrication, The science of miniaturization, IEEE press
Stephen D Senturia, Microsystem Design, Kluwer Academic Pub, 2003

MF807 Machine Tool Dynamics (3-0-0) 3

Mechanical vibration theory - a review, Single degree, free, damped and forced vibration, multi degree freedom systems - specific example related to machine tool, dynamic modeling of machine tools. Theory of vibration measuring instruments. Machine tool chatter- dynamics cutting process, cause of chatter, general theory of machine tool chatter. Effect of flexible mounting on chatter, vibration absorber to avoid chatter.

W T Thomson, Theory of Vibration with application, Prentice Hall
S A Tobias, Machine tool vibration, Blachie &Sons Ltd
J D Smith, Machine Tool Dynamics: An Introduction, University Press.

MF808 Processing ofplastics and compites (3-0-0) 3

Review on the mechanical behaviour of composite materials, Reinforcements and Matrix materials, Processing methods for polymer matrix composites such as hand lay up, pultrusion, filament winding, reaction transfer moulding, autoclave curing of laminates, compression moulding, injection moulding and roll wrapping process, Processing methods for metal matrix composites such as diffusion bonding, squeeze casting, stir casting, liquid melt infiltration, spray co-deposition and unidirectional solidification, Processing methods for ceramic matrix composites such as sol-gel processing, vapour deposition techniques, lanxide process,liquid phase sintering,

Processing methods for carbon fibre composites , Non-destructive inspection, repair, assembly, recycling and CAD/CAM for composite material processing, future potential for composite materials.

F.C. Campbell, Manufacturing processes For Advanced Composites, Elsevier ,U.K.,2004 ASM Handbook, Volume 21, Composites, ASM International, Ohio, 2001.
Mel M. Schwartz, Composite Materials Handbook, Mc Graw-Hill, Inc.,New York,1992.
Sanjay K.Mazumdar,Composites Manufacturing-Materials, Product and Process Engineering, CRC Press, Florida, 2002. Krishan K. Chawla, Composite Materials-Science and Engineering, Springer, New York,1998.

MF809 Concurrent Engineering (3-0-0) 3

Definition & philosophy of concurrent engineering; Teamwork; Interfacing of manufacturing and design - Design for Manufacturability; Project Management; Life cycle based on concurrent engineering; Design for Assembly; Prototype tooling; Virtual Manufacturing; Activity based costing; Networking Technologies; Video Conferencing.

Syan,Channan S & Unny Menon, Concurrent Engineering:Concepts, Implementation & Practice, Chapman & Hall.
Ulrich, Karl T and Steven D Epipinger, Product Design & Development, McGraw Hill.
Ettlie, John E and Henry W Stoll, Managing the Design-Manufacturing Process, McGraw Hill

MF810 Optimization Methods (3-0-0) 3

Preliminary concepts, Unconstrained Minimization, LPP, Constrained Minimization, Duality-based Methods, Direct Search and dynamic Programming, Pareto Optimality, Finite Element based Optimization, New approaches to optimization like ANN, GI and Simulated Annealing, Optimization in fuzzy control

A. D. Belegundu and T. R. Chandrupatla, Optimization concepts and Applications in Engg.
C. Onwubiko, Introduction to Engineering Design Optimization, Prentice Hall, 2000
G. V. Reklatis, A. Ravindran, and K. M. Ragsdell, Engineering optimization: Methods and applications, Interscience 1983.

MF811 Automatic Control Engineering (3-0-0) 3

Transfer line concept and mass/production structure of automated plant. Automatic part handling. Automation of Assembly shop. Robot controls, Transfer function and Block diagram manipulation, Time and Frequency response. Nyquist stability criteria, Bode diagram and system compensation, Root locus method and Modern control theory

Harrison H L and Bollinger J G, Automatic controls International Text Book Co.
Murphy, Basic Automatic control, Van Nostrand Reven, Automatic control systems, McGraw Hill.

MF812 Destructive / Non Destructive Testing (3-0-0) 3

Introduction. Need, Tensile test, Fatigue test, creep test, hardness test, impact test, Basic elements of NDT, Magnetic particle test, liquid Particle test, ultrasonic test, Radiography, Acoustic Emission Test, Eddy current test, Leak test, New methods, reliability, case studies.

Geerge Dicter, Mechanical Metallurgy
Warren J. McGomnagle, Non Destructive Testing ASME Metals Hand Book. TMEH Hand Book.

MF 814Industrial Tribology (3-0-0) 3

Introduction-Historical background, Bearing concepts and typical applications. Viscous flow concepts-Conservation of laws and its derivations: continuity, momentum (N-S equations) and energy, Solutions of Navier-Strokes equations. Order of magnitude analysis, General Reynolds equation-2D and 3D (Cartesian and Cylindrical), Various mechanisms of pressure development in an oil film, Performance parameters. ; Boundary Layer Concepts-Laminar and turbulent flow in bearings, mathematical modeling of flow in high-speed bearings. Elastic Deformation of bearing surfaces-Contact of smooth and rough solid surfaces, elasticity equation, Stress distribution and local deformation in mating surfaces due to loadings, methods to avoid singularity effects, Estimation of elastic deformation by numerical methods-Finite Difference ; Method (FDM), Governing equation for evaluation of film thickness in Elasto-Hydrodynamic Lubrication (EHL) and its solution, Boundary conditions. Development of computer programs for mathematical modeling of flow in bearings, Numerical simulation of elastic deformation in bearing surfaces by FDM.

Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001.
Dudley D.Fulier " Theory and practice of Lubrication for Engineers", New York Company.1998
Moore "Principles and applications of Tribology" Pergamon press.
Radixmovsky, "Lubrication of Bearings - Theoretical principles and design" The Oxford press Company, 2000.
Susheel Kumar Srivasthava "Tribology in industry" S.Chand and Co.

MF 815 Nanotechnology (3-0-0) 3

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nano-sensors Imaging Sensors (Far-Field and Near-Field) - Position Sensors - Capacitive Sensors - Linear Variable DifferentialTransformer - Interferometric Sensors - STM Tips Based, Etc - Force and Pressure Sensors - Strain Gauges – Deflection Based -

AFM, Etc. - Visual Force Sensing - Bending Imaging Etc. - Capacitive Force/Tactile Sensors – Accelerometers– Gyroscopes - Chemical Sensors - Flow Sensors, Etc. ,nano-actuators, Piezoelectric Actuators - Thin-Film Type – ZnO, Etc. Films - Surface Acoustic Waves - PZT Actuators as also integrated Sensors - Electrostatic, Thermal, Ultrasonic, Electro, Magnetostrictive, and Shape Memory - Alloy Based Actuators - Polymer Actuators - Dielectric Elastomers - Carbon Nanotube (CNT) Actuators - Biomolecular Motors.nano manipulators,spm Probes and Micro/Nanogrippers,Carbon Nanotube Manipulation using Nanoprobes - Case Study: High Density Data Storage Usin Nanoprobes .Micro/Nanofabrication - Micro/Nano Assembly, Biomimetics and Design Strategy - Case Study: Roboflies: Biomimetic Micromechanical Flying Robots – Kinematics and Dynamics ,nanodevices, computational nanotechnology.

Charles P. Pode, Frank J Owens -Introduction to Nano Technology, John Wiley and Sons Ltd.,2003, Canada
William A Goddard III, Donald W Brenner, Sergey Edwart Lyschevski and Gerald J.Iafrate, "Handbook of Nanoscience Engineering and Technology", CRC Press, New York, 2003.
M. Elwenspoek and R. Wiegerink, Mechanical Microsensors, Springer-Verlag Berlin, 2001.
J. Israelachvili, Intermolecular & Surface Forces, Academic Press Ltd., 2nd Edition
William moreau "Semiconductor lithography Principles, Practices and Materials", Plenum Press,1988.
Robert Kelsall, iam Hamley and Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2005.

MF 816 Materials Selection In Mechanical Design (3-0-0) 3

Design Process-Introduction: materials - history and character; Organizing materials and processes; Matching material to design; Materials Selection Charts, Density and elastic moduli; Stiffness-limited design; Plasticity, yielding and ductility; Strength-limited design; Fracture and fracture toughness; Cyclic loading, damage and failure; Fracture-limited design; Friction and wear; Materials and heat; Using Materials at high temperatures; Conductors, insulators and dielectrics; Magnetic Materials; Materials for Optical Devices; Oxidation, corrosion and degradation; Manufacturing processes; Processing and properties; Materials, processes and the environment process, material and shape selection, the design of hybrid materials, 'eco' selection, and industrial design, Case Studies.

M.F. Ashby, Materials Selection in Mechanical Design, Butterworth Heinemann, 2010
Michael Ashby, Hugh Shercliff, and David Cebon, 2010,Materials: Engineering, Science, Processing and Design
M.F. Ashby and K. Johnson, Materials and Design, Butterworth Heinemann, 2nd edition, 2010
Ashby & Jones - Engineering Materials Vol 1& 2,*Butterworth Heinemann, 2000*

MF 817 Fracture Mechanics (3-0-0) 3

History of failure by Fracture; failure of structures, bridges, pressure vessels and ships, brittle fracture, development of testing for failure, identification of reasons for failure, existence of crack, Griffith crack and experiment, energy release rate and stress for failure in presence of crack. Stress Field around Crack Tip; revision of theory of elasticity, conformal mapping, Airy's stress function for crack tip stress field with crack emanating from straight boundary, stress state in crack tip vicinity, modes of crack face deformation, stress intensity factor and Irwin's failure criterion, fracture toughness. Determination of Stress Intensity Factor, different specimen configuration, numerical techniques- boundary collocation and boundary integral, finite element method, experimental method- reflection and refraction polariscopy, Determination of fracture toughness. Energy Consideration; potential energy, surface energy, plastic deformation around crack tip, energy release rate, compliance and correlation with fracture toughness, crack opening displacement (COD), COD as fracture criterion, experimental determination of COD, use of fracture toughness and COD as design criteria. Crack Propagation; law of fatigue crack propagation, life calculation when a crack is present and loaded, microscopic aspects of crack propagation, elastic crack and plastic relaxation at crack tip.

Engineering Fracture Mechanics –S.A Meguid Elsevier & Karen Heltan, introduction to fracture mechanics , Mc Graw hill
S.A Meguid , Engineering fracture Mechanics Elsevier Publications
Karen Hettan, Introducation to Fracture Mechanics, Mcgraw Hill Publications
Anderson, Fracture Mechanics-Fundamentals and Applications, . T.L CRC Press 1998
David Brock, Elementary Engineering Fracture Mechanics Noordhoff

MF818 Artificial Intelligence in Manufacturing (3-0-0)3

Computational Techniques for representing and solving problems; Perceptions; Representation, production system & search; Heuristics; Fuzzy Logic and control, Artificial Neural Networks techniques; Back propagation Algorithm, Adaptive Resonance Theory, Case studies in manufacturing.

George F. Luger, Artificial Intelligence, Pearson Pub.
VVS Sharma, B.Yajnanarayan and Deekshitalu, Artificial Intelligence & Expert System Technologies, Tata McGraw

Hill. Bart Kosko, Neural Networks and Fuzzy Systems. David braock , elementary engineering fracture mechanics noordhoft.

MC700 Automated Manufacturing Systems (3-0-0) 3

Automated machine tool like CNC milling, lathe, wire EDM, DNC, FMS, manufacturing cell, machine tool controllers, machining code generation manual and automated, in process sensing and control, cell controllers and system simulation, automated material handing systems

B. L. Juneja and Shekon G S Fundamentals of Machine tools
Yoren Koren Computer numerical control machines
Mkell P. Groover, Automation and production systems.

MC 701ADesign & Manufacturing (3-0-0) 3

Design Process, Mechanical Properties of Engineering Materials, Structure, Properties Relationship, Materials Selection in Mechanical Design, Selection of Materials, Shape, Processes; Design for Manufacture, Design for Environment, Computer Integrated Manufacturing, Principles of Mechanisms, Machine Dynamics, Primary & Secondary ,Manufacturing Processes, Casting, Metal Forming, Machining Processes, Press Working, Principles of Machine Tools, Automated Manufacturing

MC701B Analog & Digital Electronics (For Mechanical Engg Graduates) (3-0-0) 3

Operational amplifiers and their applications, analog signal processing, Digital electronics: combinatorial logic gates, sequential logic gates, microprocessors, memory devices, Analog to Digital conversion.

Ramakanth Gayakwad, OPAMPS and Linear Integrated Circuits, 4th Ed., Prentice Hall, 1997
Fletcher, B Engineering Approach to Digital Design, PHI, 1993
D.A. Bradley,D.Dawson, N.C.Burd & A.J.Loader: Mechatronics: Electronics in products & processing W.Bolten : Mechatronics David M Auslander & Carl J. Kempf: Mechatronics Mechanical System Interfacing.

MC702 Mechatronics Engineering (3-0-0) 3

Introduction to mechatronic components, sensors and transducers, signal conditioning, data presentation systems, Actuation systems, Basic system models, signal systems and controls, real time interfacing, applications and case studies. Mechatronis system design

Godfrey Onwubolu ,Mechatronics - Principles and Applications, Butterworth-Heinemann, 2005
David G. Alciatore, Michael B. Histand, David Alciatore Introduction to Mechatronics & Measurement Systems, McGraw-Hill; *2 edition, 2002*
Robert H. Bishop The Mechatronics Handbook CRC Press, 2002

MC703 Web based Manufacturing Systems (3-0-0) 3

Building blocks of automation, Mechanization of parts handling, automation of assembly Markov and queuing models, Petrinet models, various manufacturing systems, batch, mass, group, cellular systems, Process planning and CAPP. Shop floor control and automatic identification and assembly techniques, computer network for manufacturing, Integration of design and manufacturing, Design assignment and practice based on process planning and CAPP. Agent based manufacturing.

Mkell P Groover,Automation, Production systems, and computer integrated Manufacturing.
P. Radhakrishna & Subramanyan CAD/CAM/CIM
Jerome H Fuchs, The illustrated handbook of Advanced Manufacturing methods

MC704 Analog & Digital Electronics, Microcontroller Lab (0-0-3) 2

Laboratory exercises related to rectifiers, choppers, power opamps etc. Exercises related to digital IC's, logic gates, flip-flops, counters and latches, registers, few digital systems. Programming and interfacing experiments on target processor/ microcontroller. Exercises related to PLC programming and drive control using PLC

MC705A Fluid Mechanics & Heat Transfer (3-0-0) 3

Equation of Continuity, Euler's equations of motion – Navier Strokes equations. Hydrostatic, Analysis of fluid motion in integral form – Concept of a system and a control volume, Laminar & Turbulent Flows, Hydrodynamics, , Basic Thermodynamics, Air Standard Cycles, Diesel & Petrol Engines, Heat Transfer Fundamentals, Conduction, Convection, Radiation, Design of Heat Exchanger, Refrigeration & Air Conditioning

Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002
F.P.Incropera, and D.P.Dewitt, Fundamentals of Heat & Mass Transfer, John Wiley, Fourth Edition, 1998.

MC705B Electro Mechanics & Motion Control (For Mechanical Engg Graduates) (3-0-0) 3

Principles of electromechanical energy conversion, motion actuators: solenoids, stepping motors, DC motors, BLDC

motors, induction motors, synchronous motors, switched reluctance motors, Toroidal torque motors, servos and synchros, linearinduction motors, transformers for power, signal and pulse processing. Characteristics of machines : braking , four quadrant operation with power conditioners. Power amplifiers: linear and PWM , Power Operational amplifiers, Choppers, rectifiers, inverters and cycloconverters.

A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans : Electric machinery
G.K.Dubey : Fundamentals of Electric Drives, Narosa Publication
D.A. Bradley,D.Dawson,N.C.Burd and A.J.Loader: Mechatronics : Electronics in products and processing
W.Bolten : Mechatronics
Mechatronics : HMT limited, Bangalore
Mechatronics : The Integration of Engineering design: University of Dundee.

MC706 Micro Electro Mechanical Systems design (3-0-0) 3

MEMS overview and working, Design and manufacturing of electromechanical systems, Application of MEMS in automotive and medical electronics, Materials in MEMS, different manufacturing process and its comparison, Micro system design and CAD application in design.

Tai Ran Hsu, MEMS and Microsystems- Design and manufacturing Tata McGraw Hill
Marc J. Madou, Fundamentals of microfabrication

MC707 FMS & Simulation Lab (0-0-3) 2

Exercises related to automation design using Pneumatic and Electropneumatic systems, Exercises related to robot programming in FMS system, simulation of trajectories, interlocks, Exercises on CNC machining and system modeling and its stability simulation using simulation packages.

MC800 Modeling & Simulation of Mechatronics System (3-0-0) 3

Basic component models, system model and automated computer simulation, state space equation and analysis of linear systems, transducers, amplifiers and instruments, mechanical and thermofluidic systems, non linear system simulation.

Dean C. Karnopp, Donald L. Margolis, Ronald C. Rosenberg, System Dynamics : Modeling and Simulation of Mechatronic Systems Wiley-Interscience; 3 edition,1999
Ernest O. DoebelinSystem Dynamics: Modeling, Analysis, Simulation, Design Marcel Dekker 1998

MC801 Smart Structures and Materials (3-0-0) 3

Sensor and actuator techniques, signal processing for control of smart structures, smart amterials, models, and active sensory material systems , applications of smart materials primarily for vibration and pointing control, finite element models with piezoelectric elements use in sensor selection and actuators

Melschwartz, Encyclopedia of smart materials set,Wiley interscience, 2001
A D Srinivasan, D Michael Mcfarland, Smart structures analysis and design Cambridge univ press, 2000
B culshaw, smart structures and materials, Artec house pub, 1996

MC802 Power Drives (3-0-0) 3

Drives: Servo, stepper, DC and AC motors operation and selection, Electro-pneuamtic and hydraulic systems components, circuit design, position and velocity control.

Andrew Parr, Industrial drives, Butterworth -Heineamann
Andrew Parr, Hydraulics and Pneumatics, Butterworth -Heineamann

MC803 Intelligent Systems (3-0-0) 3

Concept of machine intelligence, intelligent agents, vision and image analysis, principles of decision making, fuzzy logic, decision trees, case-based reasoning, genetic algorithms, neural networks and expert systems.

George F Luger, Artificial Intelligence
Bart Kosko, Neural networks and fuzzy systems

MC804 Robotic Systems (3-0-0) 3

Components of robot systems, analysis and design of modern robotic and industrial control systems, hardware and software, computational methods and techniques used in vision- based robotics, real time embedded control, optimization techniques, matrix analysis and analytic 2D/3D geometry.

Koren Y, Robotics for Engineers, McGraw Hill
Ranky P G and Ho C Y, Robots modeling control and applications with software, springer verlog

MC805 Mechanical & Electrical Properties of Materials (3-0-0) 3

Structure and imperfections in materials, mechanical properties of metals and strengthening mechanisms, structure and properties of polymers, ceramics and composites. Conductors and semiconductor devices, dielectric, magnetic and optoelectronic materials superconducting materials. Their characteristics:breakdown strength. Magnetic properties of materials:Ferromagnnetic materials and ferrites.

A.J.Dekker :Electrical Engineering Materials.
CallisterW D, Mechanical Properties of Materials, John Wiley
L. Solymar, D. WalshElectrical Properties of Materials, Oxford University Press; 7th edition, 2004

MC806 Rapid Manufacturing Technology (3-0-0) 3

Generic process of product development, concept generation, selection and testing- CAD applications in testing, virtual prototyping, product architecture, industrial design and design for manufacturing, considerations, production and human factors. Rapid prototyping technologies- process comparison, detail of process constituents.

Karl T. Ulrich and Steven D. Eppinger, Product design and Development, McGraw-Hill 2000
A.K.Chitale and R.C. Gupta, Product design and manufacturing, PHI Pvt. Ltd., 2002 Chris McMohan and Jimmie Browne, CAD/CAM, Pearson Education Asia Pvt. Ltd.

MC807 Nano Technology (3-0-0) 3

Individual nano particles, properties, carbon nano structures, bulk nano structure materials, Molecular engineering, Nano machines and nano devices, Molecular machining, Manufacturing and computation.

K. Eric Drexier, Nano systems
C P Poole, F J owenf, Introduction to nano technology , wiley interscience, 2003
Editors at scientific America, understanding nano technology, warner books, 2002

MC808 Finite Element Analysis (3-0-0) 3

Methods of FEM, One-dimensional, two -diemensional formulation covering different types of elements, solution techniques, Field analysis of electric machines, finite element methods and its applications for the analysis of electric machines, MEMS problems any interested analysis related to mechatronics

J. N. Reddy, An Introduction to Finite Element Method, McGraw hill
Zienkiewicz O. C., Finite Element Method in Engineering Science, McGraw
Bathe K J and Wilson E L, Numerical Methods in Finite Element Analysis.

MC809 Power Electronics (3-0-0) 3

Power devices, simplified models, linear power supplies, acdc, dcdc, dcac, and acac, converter circuits: topologies and steady state operation. Detailed study of acdc, (controlled and uncontrolled) converters.Switching aid circuits, gated rive circuits and requirements.

Ned Mohan, Undeland and Robbins Power Electronics 3rd edition John Wiley
M.H.Rashid Power Eelctronics 2nd/3rd edition, PHI (EEE) or Pearson education

MC810 Digital System Design (3-0-0) 3

Review of combinational logic design using PLDs., Design of Synchronous Sequential logic systems, Introduction to VHDL, Design of system controllers, Design of systems using PLDs / FPGAs, Fundamentals of Data converters.

A.S. Sedra , K.C. Smith Microelectronics Circuits, 5th edition, Oxford University Press, 2003.
J. Millman, A. Grabel, Microelectronics, McGraw Hill, 2nd Ed., 19878.
J.F.Wakerly, Digital Design -PH publications, 3rd ed., 2001
W.Fletcher, An Engineering approach to digital design -PHI publication.
M.J.Sebastian Smith, Application Specific Integrated Circuits -Addison Wesley Pub.1999
C.H.Roth, Digital system design -PWS publications, 1997

MC811 Digital System Processing (3-0-0) 3

Fourier transform : Discrete Time Fourier transform, Methods of obtaining DFT : FFT and DCT. Digital filters designing techniques, IIR and FIR Filters , Power Spectrum Analysis: Different methods.DSP architecture, Floating point and fixed Point DSPs.Applications of Digital Signal Processing.

Roman Kuc, Introduction to Digital signal processing.
A.V. Opperhuim and R.W. SchaferDiscrete time signal processing.
R. G. Lyons, Understanding digital signal processing.

MC812 Special Machines & Drives (3-0-0) 3

Method of control and application of Brushless DC Motor, PMSM, Stepper Motor, A.C Servomotor ,Universal Motor. Electric Drive . Motor Rating , Heating effects, Electric braking. Modification of speed torque characteristic of Induction motor by V/f control, starting and braking. Synchronous motor Speed torque and torque angle

characteristics by V/f control, braking.
G.K.Dubey.Fundamentals of electrical drives -
A .E. Fitzerald ,C.Kingsley and S.D Umans, Electric Machinery -. Mc Graw Hill Int. Student edition. S.K.Pillai. A First course on electric drives -Wiley Eastern 1990.

MC813 Electro Magnetic Compatibility (3-0-0) 3

Review of EM theory. EMI from apparatus and circuits. EMI measurements. Shielding and grounding.EMI filters. Electrostatic discharge. EMC standards
Ott. H.W .Noise reduction techniques in electronic systems.
V. Prasad Kodali Engineering Electromagnetic Compatibility, S. Chand & Company.

MC814 Electro Magnetic Theory (3-0-0) 3

Static electric and magnetic fields. Time varing fields. Maxwell's equations. Boundary value problems.Propagation of plane waves in dielectric and conducting media. Introduction to computational methods in electromagneics.
William Hayt , Engineering Electromagnetics.
John D. Kraus. Electromagnetics.-
Jordan E.C and Balmain K.G , Electromagnetic waves and Radiating System.
Simon Ramo, John R. Whinnery and T.Van Duzer. "Fields and Waves in Communication Electronics.

MC815 Electronic Mesurement & Instrumentation (3-0-0) 3

Measurement Systems, Electromechanical Instruments, Bridges,Electronic Instrumentation, Oscilloscopes, Signal Analysis, Frequency, Time interval measurements, Physical Parameter Measurements, Transducers, Data Acquisition Systems.
B.H. Oliver and J.M. Cage, Electronic Measurements and Instrumentation, McGrawHill, 1975
Albert D. Helfrick, William D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, PHI

MC816 Microprocessors (3-0-0)3

Basics of Finite state machines, VonNeumann Architecture, Functional blocks of microcomputer, Architecture of 8bit / 16bit Microprocessors / Microcontrollers [viz. Intel 8051 family, MOTOROLA 68HXX, ARM core etc.. Programmers' of model of any one Microprocessor / Microcontroller chosen for detail study, Instruction set, Chip Configuration and programming, Use of development and debug tools, Interface applications. Laboratory exercises.
Intel 8bit Microcontroller Hand book
ARM core processor Hand book
John B. Peatman, Design with Microcontrollers McGraw Hill Publications, 1995.
Andrew N. Sloss, Dominic Symes,ARM System Developer's Guide : Designing and Optimizing System Software Chris Wright, John Rayfield, Elsevier Publication, 2004.

MC817 Embedded System Design (3-0-0) 3

Embedded controllers, basic requirements, design of embedded systems, system on chip concept. VLSI CAD application, Case study: DSP/microprocessor based or FPGA based system design
C.H.Roth Digital system design using VHDL,PWS 1998
User manual of Microprocessor /DSPs

DP701DESIGNENGINEERING (4-0-0)4

DesignProcess:MorphologyofDesign,Designdrawings,ComputerAidedEngineering,Designingofstandards,ConcurrentEngineering, Productlifecycle,TechnologicalForecasting,MarketIdentification,Competition Bench marking, Systems Engineering, Life Cycle Engineering, Human Factors in Design. Industrial Design, Design Methods: Creativity and Problem Solving. Conceptual design: Decision theory, Detail Design, Mathematical Modeling,Simulation,GeometricModeling.FiniteElementModeling,Optimization, GeometricProgramming, StructuralandShapeOptimization. MaterialSelection ProcessingandDesign:Economics,CostVsPerformance, WeightedpropertyIndex-ValueAnalysis,RoleofProcessingandDesign,Classification ofManufacturing Process Design forManufacture:Design forAssembly,Designforcastings,Forging,MetalForming,Machiningand Welding, Intellectualproperties&rights,ValueEngineering.
DieterGeorgeE., EngineeringDesign-AMaterialsandProcessingApproach,McGrawHill,InternationalEditionMechanicalEngg.,Series,1991.
KarlT.UlrichandStevenDeppinger,ProductDesignandDevelopment,McGrawHill,Edition2000.
Suh.N.P.,ThePrincipleofDesign,OxfordUniversityPress,NY.1990.

DP702MECHANICALBEHAVOIROFENGINEERINGMATERIALS (4-0-0)4

State-of-the-artofcomputationalmethodsforthemodelingandsimulation ofthemechanical responseofengineeringmaterials.Rangeofmaterialsbehavior:finitedeformationelasticity andinelasticity,contact,frictionandcoupled problems.Numericalformulation andalgorithms:Variationalformulation andvariationalconstitutiveupdates,finite elementformulation,Applicationtorealengineeringproblemsindesignandoptimization.

Marsden,J. E.,andT.J.R.Hughes.MathematicalFoundationsofElasticity,Prentice-Hall,1983. Malvern,L.E. IntroductiontotheMechanicsofaContinuousMedium. Prentice-Hall,1969.

Gurtin,M.E. AnIntroductionto ContinuumMechanics.AcademicPress,1981. Dover.Zienkiewicz, O. C., andR.L.Taylor.TheFiniteElementMethod.Mc-GrawHill,1989. Bathe,K.J.FiniteElementProcedures.PrenticeHall,1996.

DP703PRINCIPLESOFPRECISIONENGINEERING (3-0-0)3

IntroductiontoPrecisionEngineering:NeedforhavingaHighPrecision,FourClassesofAchievableMachiningAccuracy,PrecisionMachining,High-precision,Ultra-precisionProcessesandNanotechnology. ToolMaterialsfor PrecisionMachining: CoatedandLaminatedCarbides,Ceramics,Diamonds,CubicBoronNitride.Mechanicsof MaterialsCutting:TurningOperationandToolSignature&Mechanics.Ultra-Precision MachineElements:Guide-ways,DriveSystems,FrictionDrive,LinearMotorDrive,SpindleDrive. Hydrodynamic andHydrostaticBearings: Principle of Rolling Element Bearings, Design &Selection, Bearing Life, Constructionof Lubricated Sliding Bearings,PrincipleofHydrodynamic Bearings,HydrodynamicThrustBearings.DesignofHydrostaticBearings, HybridFluidBearingsGasLubricated Bearings:Aerostatic Bearings,Operation ofAerostatic Bearing Systems, AerostaticSpindles,HybridGasBearings.Micro-electro-Mechanical Systems:CharacteristicsandPrinciples, MaterialsandDesign,applicationofMEMS,FabricationandMicro-manufacturingProcesses,CleanRooms,Design andConstructionofCleanRooms.

V.C.Venktesh,PrecisionEngineering,TataMc.GrawHill,NewDelhi2007

KalpakjianS.,ManufacturingEngineeringandTechnology.3rdEd. Addision-WesleyPublishingCo.,NewYork,2001. NakzavawaH,PrinciplesofPrecisionEngineering,OxfordUniversityPress,1994.

DP704DESIGNENGINEERINGLAB (0-0-2)1

GeometricModelling&FEAnalysisof3Dofmachinetoolparts.Kinematicanddynamicsimulationofvariousmechanismsin machines,processsimulation,Synthesisofmechanisms,CNCprogramming-Manual andautomatic usingCAMsoftware.Simulation ofhydraulicandpneumaticsystems,2-Dstressanalysisusingstraingaugesand photoelasticty.

DP705DESIGNPRINCIPLESOF PRECISIONSYSTEMS (4-0-0)4

Introductiontoprecisionmachines,Principlesofaccuracy,repeatabilityandprecision.Errorsduetogeometry,kinematics, thermalexpansion,dynamicforcesandinstrumentation etc.Systemdesignconsiderations inprecision engineering.Rollingandslidingcontactbearings. Hydrostatic andmagneticbearings. Precisiongears,positioning mechanismsand drives.Electromagneticpiezoelectricandfluidactuators.Precisionmeasurementandcontroldevices. Threedimensionalco-ordinatemeasuringmachines.Surfacefinishmeasurement. Precisionmachiningandfinishing operations.Assemblyandtolerancing.Micromachining systems.Tribologicalvibrationsandnoiseconsiderations in highspeedmechanicalunits.

AlexanderSlocum-PrecisionMachineDesign,, PrenticeHall

Smith,S. T., Chetwynd,D.G.,FoundationsofUltra-precisionMechanismDesign,Taylor&Francis,1992

Evans,C.E.,PrecisionEngineering:AnEvolutionaryView,CranfieldPress,Bedford,UK,1989.

Blanding,D.L.,ExactConstraint:MachineDesignUsingKinematicPrinciples,ASME,NewYork,1999

DP706PRECISIONENGINEERINGLAB (0-0-2)1

Programmingand interfacingexperimentson target processor/microcontrollers,Precisionmeasurements,micro actuators,materialscharacterisation,useofSTM,SEM,AFM.MEMS,Micromachiningandsurfaceintegritystudies.Precisionmeasurements.

DP800SYNTHESISANDANALYSISOFMECHANISMS (3-0-0)3

MobilityAnalysis–degreeoffreedom,mixedmobility,total,partialandfractionalDOF,closedandopenchainsystems, structural analysis and synthesis of mechanisms. Alternative design solutions, coding, evaluation and selectionofoptimummechanism,Typesynthesis,numbersynthesisanddesignofmechanisms. Indexesofmerit,

graphical,algebraicandoptimizationtechniques,matrixmethodsofdesignandanalysis,designoffunction,pathand motiongenerators.Manipulators:Classification,actuationandtransmission systems,coordinatetransformation DH notations,inverseandforwardkinematics,manipulatordynamics.

KennethJ.WaldronandGaryJ.KinzelKinematics-Dynamics,andDesignof Machinery,SecondEdition,John Wiley&Sons,Inc.,2004
R.L.Norton-DesignofMachinery,FourthEdition,McGrawHill,2007
JosephE. Shigleyand JohnJ.Vicker,Jr-TheoryofMachinesandMechanisms,"SecondEd.,McGrawHill,1995
W.L.Cleghorn-MechanicsofMachines,OxfordUniversityPress,2005
ArthurG.ErdmanandGeorgeN.Sandor,MechanismDesign-AnalysisandSyntheses,Vol-1,PrenticeHall,NewJersey,1984

DP801DESIGNOFMECHATRONICSSYSTEMS (3-0-0)3

IntroductiontoMechatronicssystem,MechatronicsDesignprocess,AdvancedapproachesinMechatronics,Manmachinei nterface,Real-timeinterfacing:Elementsofdataacquisition andcontrol,Overview ofI/Oprocess,Analog signals,discretesignals,andFrequencysignals,Overframing.CasestudiesonDataAcquisition, Transducer calibrationsystemfor Automotiveapplications,SolenoidForce-Displacementcalibrationsystem,Rotaryoptical encoder.CasestudiesonDataAcquisition andcontrol:Temperature Controlsystem,Casestudiesofdesignof mechatronicproducts–MotioncontrolusingD.C.Motor&Solenoids,AdvancedapplicationsinMechatronics:Sensors forconditionMonitoring,MechatronicControlinAutomatedManufacturing–ArtificialintelligenceinMechatronics– FuzzyLogic, ApplicationsinMechatronics.

MechatronicsSystemDesign,Devdasshetty,RichardA. Kolk,ThomsonLearningPublishingCompany,Vikas publishinghouse,2001.
Bolton,-Mechatronics- ElectronicControlsystemsinMechanicalandElectricalEngineering- ,2ndEdition,AddisonWesleyLongmanLtd.,1999.
BrianMorriss,AutomatedManufacturingSystems- Actuators,Controls,SensorsandRobotics,McGrawHill,1995.
Bradley,D.Dawson,N.C.BurdandA.J.Loader,Mechatronics:ElectronicsinProductsandProcesses,ChapmanandHall,L ondon,1991.

DP802INDUSTRIALTRIBOLOGY (3-0-0)3

Introduction: Bearing concepts and typical applications. Viscous flow concepts-Conservation of laws and itsderivations:continuity,momentumandenergy,SolutionsofNavier-Strokes equations.Orderofmagnitudeanalysis, GeneralReynoldsequation,VariousmechanismsofpressuredevelopmentPerformanceparameters; BoundaryLayer Concepts-Laminar andturbulentflowinbearings,mathematicalmodelingofflowinhigh-speedbearings.Elastic Deformationofbearingsurfaces-Contactofsmoothandroughsolidsurfaces,elasticityequation,Stressdistribution and localdeformationin matingsurfaces,elasticdeformationbynumericalmethods-FiniteDifferenceMethod, GoverningequationforevaluationoffilmthicknessinElasto-Hydrodynamic Lubrication(EHL)anditssolution, Boundary conditions.Mathematicalmodeling offlowinbearings,Numericalsimulationofelasticdeformationin bearingsurfaces.IntroductiontoNanotribology,Nano-mechanicsandMaterialsCharacterization.

Mujamdar.B.C,IntroductiontoTribologyofBearing,WheelerPublishing,NewDelhi2001.
DudleyD.Fulier,TheoryandpracticeofLubricationforEngineers,NewYorkCompany.1998
Moore,PrinciplesandapplicationsofTribology,PergamonPress.1975
Radixmovsky,LubricationofBearings- Theoreticalprinciplesanddesign, TheOxfordPressCompany,2000.
SusheelKumarSrivasthava,Tribologyin industry",S.ChandandCo.2004
BhushanBharat,NanotribologyandNanomechanicsAnIntroduction,2nd ed.,2008,Springer

DP803OPTIMIZATIONMETHODSINENGINEERINGDESIGN (3-0-0)3

Optimizationproblemformulation-Designvariables,constraints,objectivefunctionandvariable;bounds.Single-Variable;SingleVariableOptimization Algorithm: Bracketing Melliotls ExhaustiveSearchMethodandbounding; PhaseMethod.;RegionElimination Methods:FibonacciSearchmethodandGoldensectionsearchmethod.Gradient based;methods,Newton-Raphson method,BisectionMethod,SecantMethod,andCubic SearchMethod.Computer programsforbounding phasemethodandgoldensectionsearchmethod; Multivariable OptimizationAlgorithms: Directsearchmethods.Simplex searchmethodandHooke- Jeevespatternsearchmethod.Gradient basedmethods, ConstrainedOptimizationAlgorithms- Kuhn-Tuckerconditions,penaltyfunction.Method,methodofmultipliers, cutting planemethod,GeneralizedReducedGradientmethod,computer programforpenalty functionmethod. Integer programming-penaltyfunctionmethod.Globaloptimizationusingthesteepestdescentmethod,geneticalgorithms andsimulatedannealing.

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DP804EXPERIMENTALSTRESSANALYSIS (3-0-0)3

Photoelasticity:Behaviorof Light,Polarized Light.PlanePolarizersand WavePlates,ArrangementofOpticalElementsinaPolariscopic,TheoryofPhotoelasticity:StressedModelinPlanePolariscopeandCircularPolariscope. AnalysisTechniques:Isochromatic andIsoclinicFringePatterns,Compensation Techniques,stressseparation Techniques, ThreeDimensionalPhotoelasticity:Stressfreezingtechnique,Interpretation FringePatterns,Effective Stresses.ShearDifferenceMethod. ElectricalResistanceStrainGauge:Strainsensitivity,GaugeConstruction, TemperatureCompensation,GaugeSelection,CorrectionfortransverseStraineffects,Semiconductor StrainGauges. RosetteAnalysis- threeelementrectangularRosette,DeltaRosettes,BrittleCoatingMethod:Coatingmethodsandstressanalysis,FailureTheories,CrackPatternsproducedbyDirectLoading, PatternProducedbyReleasingtheLoad,DoubleCrackPattern,CrackDetection,BiaxialstressField.

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Srinath,Lingaiah,Raghavan,Gargesa,etal-ExperimentalStressAnalysis,TataMcGrawHill,1991
Kuske,AlbrechtandRobertson-PhotoelasticStressanalysis-John Wiley &Sons.,1978
AS.Kobayassin(Ed),HandBookofExperimentalStressAnalysisSEMNCH,II edition.1974
SadhuSingh-ExperimentalStressAnalysis,Hannapublisher.1982

DP805 MICROELECTROMECHANICALSYSTEMS (3-0-0)3

Introduction,History,DevelopmentandneedofMicro-Electro-MechanicalSystems.OverviewofMEMStechnology,Differentelectro-physical processesusedformachining–dealingwithMEMSmaterials;relevantnon-conventional processes;IC fabricationprocessesused forMEMS;MEMSsensorsandactuators;Mechanicalprocesstechniquesand processmodelsformicromachining;Fabrication processesanddesignoftheprocesssequences;AgilePrototyping of designandmanufacturingprocessesin micro-machiningandcomputerbaseddesign;Reliabilityandprocesscontrolof micromanufacturingprocesses;Introductionandexposureto nano-technologyprocessesandsystems.

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RandyFrank,UnderstandingSmartSensors,seconded.,ArtechHouse,MA,2000.
IwaoFujimasa,Micromachines–A NewErainMechanicalEngineering,OxfordUniversityPress,NY,1996. S.M.Sze (ed.),SemiconductorSensors,John WileyandSons,Inc.,NY,1994.
SergejFatikowandUlrichRembold,MicrosystemTechnologyandMicrorobotics,SpringerVerlag,NY,1997.

DP806DESIGNOFFLUIDPOWERSYSTEMS (3-0-0)3

Introduction,Recentdevelopments,applications.BasictypesandconstructionsofHydraulicpumpsandmotors. Hydrauliccontrolelements– direction,pressureandflowcontrolvalves.Valveconfigurations,Seriesandparallelpressurecompensationflowcontrol valves.FlappervalveanalysisandDesign.Analysis ofvalvecontrolledandpump controlledmotor.Electro-hydraulic servovalves–specification,selectionanduseofservovalves.Electrohydraulic servomechanisms– Electrohydraulicpositioncontrolservosandvelocitycontrolservos.Nonlinearitiesincontrolsystems.Basicconfigurationso f hydraulicpowersupplies–BypassRegulatedandStroke RegulatedHydraulicPowerSupplies.Heatgenerationanddissipation inhydraulicsystems.Design andanalysisoftypicalhydrauliccircuits.Use ofDisplacement–TimeandTravel-Stepdiagrams; ynchronizationcircuitsandaccumulatorsizing.Meter-in, Meter- outandBleed-offcircuits;FailSafeandCounterbalancingcircuits.Components ofapneumaticsystem;Direction, flowandpressurecontrolvalvesinpneumaticsystems.Developmentofsingleandmultipleactuatorcircuits;Valves forlogicfunctions; Timedelayvalve;Exhaustandsupply airthrottling; Examples oftypicalcircuitsusing Displacement–TimeandTravel-Stepdiagrams,TraveldependentcontrolandTime-dependent control,Combined Control,ProgramControl,SequenceControl,Electro-pneumatic controlandair-hydrauliccontrol.Applicationsin Assembly,Feeding,Metalworking,materialshandlingandPlasticsworking.

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DP807PRODUCTDEVELOPMENT&RAPIDPROTOTYPING (3-0-0)3

Generic Product Development process, Concept generation – TRIZ, Concept selection and testing. ProductArchitecture, Design for Manufacturingand Assembly, Prototyping – Virtual and Physical, Rapid PrototypingTechniques–Detailsofprocessesandtheirapplications

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KevinOttoandKristinwood,ProductDesign,PearsonEducation,2001
Boothroyd,Dewhurstandknight,ProductPrototypingTechnology,MarcelDekker2001
PhamD.T.&DimovS.S.,RapidManufacturing,Springer-Verlag,2001

DP808MICROMACHINING (3-0-0)3

MicroMachiningProcesses-
Anintroduction,MolecularDynamicSimulationofMachiningattheAtomicScale,DiamondTurnMachining,AbrasiveJet MicroMachining,Magneto-Rheological Nanofinishingprocesses, Micro/NanoFinishingwithflexibleflow ofabrasives, Ultrasonic Micromachiningprocess,Micro-electricDischarge MicroMachining,LaserMicromachining processandtheirapplications,FocusedionBeamMachining, Electron BeamMicroMachining,ElectroChemicalMicroMachining,ChemoMechanicalPolishing.Metrology formicro machinedcomponents.

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JosephMcGeough,MicromachiningofEngineerignMaterials,MarcelDekkerInc,2002, FedrickJ R,UltrasonicEngineering,JohnWiely&Sons,NewYork,1985

DP809MATERIALSSELECTIONINMECHANICALDESIGN (3-0-0)3

DesignProcess-Introduction:materials-
historyandcharacter;Organizingmaterialsandprocesses;Matchingmaterialtodesign;MaterialsSelectionCharts,Densityandelasticmoduli;Stiffness-limited design;Plasticity,yieldingand ductility;Strength-limited design;Fractureandfracturetoughness;Cyclicloading,damageandfailure;Fracture-limiteddesign;Frictionandwear;Materialsandheat;UsingMaterialsathightemperatures;Conductors,insulators anddielectrics; MagneticMaterials;MaterialsforOpticalDevices; Oxidation,corrosion anddegradation; Manufacturing processes;Processing andproperties;Materials,processesandtheenvironmentprocess,material and shapeselection,thedesignofhybridmaterials,'eco'selection,andindustrial design,CaseStudies.

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MichaelAshby,HughShercliff,etal,Materials:Engineering,Science,ProcessingandDesign(2ndedition) 2010
M.F.AshbyandK.Johnson,Materialsand Design,ButterworthHeinemann,2ndedition,2010
Ashby&Jones- EngineeringMaterialsVol1&2, ButterworthHeinemann,2005

DP810APPLIEDELASTICITY (3-0-0)3

Introduction:Componentsof stresses,equationsof Equilibrium,Principalstressesand Mohr'sdiagramin threedimensions.Boundaryconditions.Stressinvariants,Octahedralstresses,Decomposition ofstateofstress,Stress transformation.IntroductiontoStrain: Deformation-StrainDisplacementrelations,Straincomponents,Thestateof strainatapoint,Principalstrain,Straintransformation,Compatibilityequations,Cubicaldilatation. Stress-Strain RelationsandtheGeneralEquationsofElasticity:GeneralizedHooke's.FormulationofelasticityProblems.Existence anduniqueness ofsolution,Saint-Venant's principle, Principleofsuperpositionandreciprocalthermo.Two DimensionalProblemsinCartesianCo-Ordinates:Airy'sstressfunction,investigationforbeamproblems.Useof Fourier series to solve two dimensional problems.Two Dimensional Problems in Polar Co-Ordinates:General equations,stressdistributionsymmetricalaboutanaxis,Purebendingofcurvedbar,Straincomponentsinpolarco-ordinates,Rotatingdiskandcylinder,Concentratedforceonsemi-infiniteplane,Stressconcentrationaroundacircular holeinaninfiniteplate. ThermalStresses:Introduction,Thermo-elasticstress-strainrelations.TorsionofPrismatic Bars:TorsionofCircularandellipticalcrosssectionbars,Soapfilmanalogy,Membraneanalogy,Torsionofthin walledopenandclosedtubes.ElasticStability:Axialcompressionofprismaticbars,Elasticstability,Bucklingload forcolumnwithconstantcrosssection.

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LS Srinath"AdvancedMechanicsofSolids"-TataMcGrawHillCompany.1982
Wang.C.T."AppliedElasticity"McgrawHill,1964.

DP811VIBRATIONANALYSIS& DIAGNOSTICS (3-0-0)3

ForcedVibrationwithnonharmonicandtransientexcitationofsingledegreefreedomsystems:Fourieranalysis,Responsetoarbitraryloading(Duhamel's Integral),Impulseresponse, Mechanicalshock,ParametricExcitation.Two degreeFreedom System,Multi-degreeFreedom systems,modalanalysis,MatrixiterationMethod,Transfermatrix Method,Myklestadt-ProhlMethod,Rayleigh'sminimumprinciple,Stodola'sMethod,Hoizer'sMethod.Vibrationsof Continuous systemsgovernedbywaveequationandEulerBernoulliequation,strings,membranes, rods,beams. Experimental MethodsinVibrationAnalysis,industrialapplications-rotorsandothersystems,vibrationstandards. Vibration Monitoring and analysis:Introduction, Machinery signatures, Selection of Transducers. Analysis Techniques,Machinefailuremodes,Measurement location,Vibrationseveritycriteria,Vibrationfrequencyanalysis. PermanentMonitoring,Casestudies.

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WilliamT.Thomson,MarieDillonDahleh,ChandramouliPadmanabhan,TheoryofVibrationwithApplication5thedition,PearsonEducation2008.

DP812COMPOSITES:MECHANICSANDPROCESSING (3-0-0)3

Principlesofcomposites,

micromechanicsofcomposites.Varioustypesofreinforcementsandtheirproperties.Roleofinterfaces.Fabricationofmetal matrixcomposites:in-situ,dispersionhardened,particle,whisker andfibre reinforced; composite coatings by electro deposition and spray forming. ; Fabrication of polymeric and ceramic matrix composites.Mechanicalphysicalpropertiesofcomposites,Mechanismsoffractureincomposites.Propertyevaluation andNDTofcomposites.Wearandenvironmentaleffectsincomposites.

AutarK. Kaw-Mechanicsofcompositematerials,CRCPressNewYork.2005

RoberM.Jones-MechanicsofCompositeMaterials,Mc-GrawHillKogakushaLtd.1998

MichaelW,Hyer-StressanalysisoffiberReinforcedCompositeMaterials,Mc-GrawHillInternational.2008

KrishanK. Chawla-CompositeMaterialScienceandEngineering,Springer.2001

DP813THEORYOFMETALFORMING (3-0-0)3

Definitionandscopeofthesubject,Briefreviewofelasticity,Octahedralnormalandshearstresses,Sphericalanddeviatricstress,Invarianceintermsofthedeviatoricstresses, idealisedstress-straindiagramsfordifferentmaterial models,Mathematicalrelationshipsbetweentruestressandtruestrains,Cubicaldilation,finitestrainsco-efficients Octahedralstrain,Strainrateandthestrainratetensor. Yieldcriteriaforductilemetal,VonMises,Tresca,Yield surfaceforanIsotropicPlasticmaterials, Stressspace,ExperimentalverificationofYieldcriteria, Yieldcriteriaforan anisotropicmaterial.Stress-StrainRelations, Plasticstress-strainrelations,PrandtlRoeussSaintVenant,Levy-Von Mises, Experimental verification of the Prandtl-Rouss equation, Yield locus, Symmetry convexity, Normality rule.Upperandlowerboundtheoremsandcorollaries.Applicationtoproblems:Uniaxialtensionandcompression, bendingofbeams,Torsion ofrodsandtubes,Simpleformsofindentationproblemsusingupperbounds. Problemsof metalforming:Extrusion,Drawing,RollingandForging. Problemsofmetalforming:Extrusion,Drawing,Rollingand Forging.Sliplinetheory,Introduction,Basicequationsforincompressibletwodimensionalflow,continuityequations, Stressesinconditionsofplainstrainconventionfor slip-lines,Geometryofsliplines,Propertiesofsliplines.

EngineeringPlasticity- Theoryand ApplicationtoMetalFormingProcess-R.A.C..Slater,McMillanPress,1977

JohnsonandMellor-PlasticityforMechanicalEngineers,Vannostrand,1970

Sluzalec,Andrzej-TheoryofMetalFormingPlasticity,Springer,1985

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DP814MODERNCONTROLENGINEERING (3-0-0)3

StateVariableAnalysisofDynamicsystems,StateEquations,SISOandMIMOSystems.

StateModelofPhysicalSystems:Signalflowgraphs,RelationbetweenTransferfunctionandStateequation.TimeResponse: StateTransition

Matrix,Timeresponse.StatevariableFeedback:Stability,ControllabilityandObservabilityofsystem.Digital Control Systems:Overview ofZtransforms,StabilityAnalysis inz-plane,PerformanceCalculation, Rootlocus,Response Characteristics. StateSpacemodel:Discreteequations,Statemodel,Performancecomputation,Stabilityanalysis. NonlinearControlSystems**:**NonlinearSystemBehaviors.ContinuousandDiscontinuousNonlinearities**:** Saturation, Deadzone,AbsoluteValueDetector,IdealandPracticalRelays,Quantization, Hyterisis,BacklashandFriction. Linearization**:**SISOandMIMO(StateSpace)Linearisedmodel.Describing Functions-PrincipleandMethods.Phase

PlaneAnalysis:PrincipleandMethods**.**Stability:LyapunovDirectmethod,LyapunovFunctionsand Applications.

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R CDorfandR HBishop,ModernControlSystems,PrenticeHallInternational,NJ.2001
BurnsR.S.,AdvancedControlEngineering,ButterworthHeinemann,2001.

DP815FRACTUREMECHANICS (3-0-0)3

HistoryoffailurebyFracture;failureofstructures,identificationofreasonsforfailure,existenceofcrack,Griffithcrackandex periment, energyreleaserateandstressforfailureinpresenceofcrack.StressFieldaroundCrackTip; revisionoftheoryofelasticity,conformalmapping,Airy'sstressfunctionforcracktipstressfield withcrack emanatingfromstraightboundary,stressstateincracktipvicinity,modesofcrackfacedeformation, stressintensity factorandIrwin'sfailurecriterion,fracturetoughness.Determination ofStressIntensityFactor,differentspecimen configuration,numericaltechniques-boundarycollocationand boundaryintegral,finiteelement method,experimental method-reflectionandrefractionpolariscopy,Determination offracturetoughness.EnergyConsideration; potential energy,surfaceenergy,plasticdeformation aroundcracktip,energyreleaserate,compliance andcorrelationwith fracturetoughness,crackopeningdisplacement(COD),CODasfracturecriterion,experimentaldeterminationof COD,useoffracturetoughnessandCODasdesigncriteria.CrackPropagation;lawoffatiguecrackpropagation,life calculationwhenacrackispresentandloaded,microscopic aspectsofcrackpropagation, elasticcrackandplastic relaxationatcracktip.

TLAnderson,FractureMechanicsFundamentalsand Applications,CRCPress.2009
STRolfeandJMBarson-Fractureand FatigueControlinStructure;PrenticeHall.1999
ASTetelmanandAJMcEvily,FractureofStructuralMaterials;John Wileyandsons.1967
F.Jacobs:"StereolithographyandotherRP&MTechnologies",SME,NY1996..
DavidBroek,ElementaryEngineeringFractureMechanics,Sithoff &NoodhoffInternationalPublishers,Netherlands,1978

DEPARTMENT OF METALLURGICAL & MATERIALS ENGINEERING

ML700 Advanced Physical Metallurgy (3-1-0) 4

Thermodynamics, phase diagrams, classification of transformation, diffusion, high diffusivity path, applications; nucleation and growth kinetics, TTT diagram, precipitation hardening, spinodal decomposition, strengthening mechanisms, dispersion strengthening, eutectoidal transformation, order - disorder transformation, recovery and recrystallisation.

D. A. Porter and K. E. Esterling, Phase transformation in metal and alloys, Chapman Hall, 1992.
V. Raghavan, Solid state phase transformation, PHI of India Pvt. Ltd., New Delhi, 1987.

ML701 Materials Characterisation (3-1-0) 4

X-RD techniques: Single crystal orientation, Texture studies, Lattice parameter, Chemical analysis, Stress analysis. TEM: Theories of contrast in crystal, electron diffraction, SAD patterns, lattice defects, precipitates, second phases, specimen preparations. SEM: Electron - specimen interactions; modes of working, X-ray, auger induced conductivity, high resolution scanning transmission microscopy. Field ion and field emission microscope

P. G. Grundy and G. A. Jones, Electron Microscopy in Study of Materials, Edward Ernold, 1976.
B. D. Cullity, Elements of X-ray Diffraction, Addison - Wesley Publications, 1978.
P. E. J. Flewitt & R. K. Wild, Physical Methods of Materials Characterization, IOP, 1994 Publishing Ltd,
1994 Metals Hand Book, Vo.10, ASM, Metals Park, Ohio, 1986

ML702 Plastics Engineering (3-0-0) 3

General properties of plastics - introduction, polymeric materials, plastics available to the designer, selection of plastics. Mechanical behaviour of plastics - introduction, viscoelastic behaviour of plastics, short term testing of plastics, long term testing of plastics, design method for plastics using deformation data, mathematical models of viscoelastic behaviour, fracture behaviour of unreinforced plastics, creep failure of plastics, fatigue of plastics, Impact behaviour of plastics. Processing of plastics - introduction, extrusion, injection moulding, transfer moulding.

R. J. Crawford, Plastic Engineering, 2nd edn. Pergamon Press, 1987, Reprinted in 1989.
William J. Patton, Plastic Technology, D. B. Taraporevala Sons and Co. Pvt. LTd., 1981.
Peter C. Powell, Engineering with Polymers, Chapman & Hall, 1983.

ML703 Mechancial Behaviour & Design of Materials (3-1-0) 4

Atomic and molecular bonds, classification of materials, their properties with respect to the types of bonds present in them as a class. Dislocations and plastic deformation, slip, torsion, CRSS, slip systems, strain hardening, recrystallization. Tensile behaviour and testing, temperature and strain rate effects, compression behaviour and testing, hardness testing, torsion testing, impact testing & transition temperature. Failure under combined stresses (triaxial), design against failure. Failure behaviour and fracture toughness testing. Fatigue behaviour of materials, design against fatigue failures. Creep behaviour and testing: design against creep failures. Failure analysis: a few case studies.

G. I. Dieter, Mechanical Metallurgy, Sl metric edition, McGraw Hill, 1988.
J. A. Collins, Failure of Materials in Mechanical Design, Wiley Interscience Publication, 1981.
Metals Handbook, Vol.11, 9th edition, ASM, 1986.

ML704 Materials Engineering Lab (0-0-4) 2

Experiments in quantitative metallography, X-ray diffraction, diffusion, phase transformations and properties of materials.

ML705 Ceramics Engineering (3-1-0) 4

Structure of ceramics: bonding, Pauling's rules, oxide structures, carbide and nitride structures, structure of glasses, Zachariasen rules, silicate structures. Ceramic phase diagrams, microstructure of ceramics. Defects in ceramics: thermodynamics approach; structure, formation and properties of glasses. Processing of ceramics: general route - traditional ceramics, advanced ceramics. Powder production: leaching, thermal decomposition, spray drying, sol-gel synthesis, Forming - die compaction, slip casting, tape forming process, Consolidation - sintering, grain growth, HIP. Properties and testing of ceramics: mechanical, thermal, magnetic, ferroelectric, dielectric, optical, ceramic, fibres, Toughening mechanisms.

References:

Michel W. Barsoum, Fundamental of Ceramics, International Edition,1997
W. D. Kingery, Introduction to Ceramics, 2nd Edition, John Wiley & Sons, 1991
Alan G. King, Ceramic Technology and Processing, Noyes Publications, New York, 2002
Jhon B. Watchman, Mechnical Properties of Ceramics, Jhon Wiley & Sons, 1996.
A. O. Surendranathan, An Introduction to Ceramics and Refractories, CRC Press, 2014.

ML800 Steels & Their Heat Treatment (3-0-0) 3

Iron and its solid solutions, iron - carbon equilibrium diagram, plain carbon steel, influence of alloying elements in Fe-C alloys, low alloy steels, heat treatment of steel, formation of martensite, bainite reaction, concept of hardenability, tempering of martensite, thermomechanical treatment, surface hardening, stainless steels, tool steels, embrittlement and fracture of steels, Cast irons: characteristics, applications.

R.W. K. Honeycombe, Steels - Microstructure and Properties, Edwards Arnold, 1995
W. C. Leslie, The Physical Metallurgy of Steels, McGraw Hill Book Company, New York, 1982
F. B. Pickering, Physical Metallurgy and the Design of Steels, Applied Science Publishers ,1978

ML801 Composite Materials (3-0-0) 3

Introduction, their characteristic features, interfaces, wettability, bonding. Important reinforcements fibers, whiskers, short fibers and particles, production. Properties, and applications of polymer matrix composites: metal matrix composites, ceramic matrix composites, carbon /carbon composites, intermetallic matrix composites, mechanics, laminate composites, short fiber composites, toughness of composites - thermal, fatigue and environmental effects, joining of composites, designing with composite materials.

K. K. Chawla, Composite materials, Springer - Verlag Press, 2001.
Mathews F. L. and Fawlings R. D., Composite Materials: Chapman Press.
Bryan Harris, Composite Materials, Institute of Materials, London 1996.

ML802 Electronic Properties of Materials (3-0-0) 3

Introduction: Brilluion Zone Theory; Fermi level, Band theory. Thermal Properties: specific heat, thermal expansion & thermal conductivity. Electrical properties: conductors, insulators, intrinsic semiconductors, extrinsic semiconductors. Single crystal growth, zone refining, producion of PNP, NPN transistors, intergrated circuits. Dielectrical - materials and applications, electrostriction, magnetostriction. Ultrasonic transducers: piezoelectric materials and applications, ferroelectric materials and applications. Magnetic Properties: soft magnetic materials, hard magnetic materials, ferrites, garnets, ESD magnets, magnetic tapes, films, ferromagnetic materials, antiferromagnetic materials, materials for computer memories. Neutron diffraction. Superconductivity: Type I, Type II superconductors, hard and soft superconductors, Meissener effect, high temperature superconductors, Applications of superconductors, photoconducting applications. Optical Properties: lasers, gas laser, He-Ne laser, N_2CO_2, Ar, H_2-Cd lasers, liquid lasers, dye lasers, solids laser, ruby, Nd - YA glass lasers, semiconductor diode laser, applications of laser. Optical storage, optical computing, optical fibres.

R. E. Hummmel, Electronic Properties of Materials, Navona, 1995
J. Wulff, Electronic Properties, Edition of1964.
C. M. Srivastava & C. Srinivasan, Science of Engineering Materials, NewAge International Pvt. Ltd., India. 1999,

ML803 Non-Destructive Testing (3-0-0) 3

Ultrasonic Inspection: ultrasonic waves, variables, attenuation, inspection methods, pulse echo, transmission methods, inspection standards, standard reference blocks, practical applications. Radiography Inspection: radiographic inspection principles, radiation sources, image quality, radiographic sensitivity, geometric unsharpness, image intensifiers, X-ray films, exposure, penetrameters, inspection standards, neutron radiography, gamma radiography. Other techniques: visual inspection, insitu metallography, dye penetrant inspection, magnetic particle inspection, eddy current method, acoustic emission method, holography, computed tomography.

Barry Hull & Vernon John, Non-destructive Testing, ELBS edn., Macmillan, London, 1989.
R. Halmshaw, Non-destructive Testing, 2nd edn., Edward Arnold, London, 1991.
McGonnagle W. J., Non-destructive testing, Gordon & Beach Science, New York, 1983.

ML804 High Temperature Materials (3-0-0) 3

Materials composites and structure, Fe based super alloys, Ni base super alloys, Co base super alloys, titanium and its alloys, refractory metals and alloys, high temperature ceramic materials, cermets, cemented carbides, creep resistance, fatigue resistance, corrosion resistance, oxidation resistance, formability, weldability, fluidity; application of superalloys, titanium alloys, refractory metals and alloys, cermets, cemented carbides, ceramics.

Donachie, A technical guide on Super alloys, A.S.M. Ohio, 2002
C. T.Sims & N. C. Hagel, super alloys, JohnWiley Publishers, 1972
Betteridge, The Nimonic Alloys - Edward Arnold Publishers Ltd., London, 1959

ML805 Fracture Mechanics (3-0-0) 3

Failure analysis, conventional design concepts & its limitations, mechanics of fracture - fracture toughness, determination of fracture toughness - ASTM standards, Brittle and ductile fractures, cleavage fracture, cleavage cracks, crystallographic mechanism, designing and testing for fracture resistance, design, improved toughness in ceramics, composites, case studies in failure anaysis.

D. Boreck, Elementary Engineering Fracture Mechanics, Marines Nijhoff, Dordredet (1986).
E. J. F. Knott Fundamentals of Fracture Mechanics, Butterworths (1973)
S. Teteleman and A. J. MCEvily, Facture of Structural Materials, John Wiley and Sons, (1961)

ML806 Surface Engineering (3-0-0) 3

Surface Cleaning: Classification and Selection of Cleaning Processes Finishing Methods: Classification and Selection of Finishing Processes; Topography of Surfaces; Microstructural Analysis of Finished Surfaces Plating and Electroplating: Electrodeposition Processes: Copper Plating; Nickel Plating; Zinc Plating; Zinc Alloy Plating; Selective (Brush) Plating; Electroforming. Nonelectrolytic Deposition Processes: Eletroless Nickel Plating; Electroless Alloy Deposition Dip, Barrier and Chemical Conversion Coatings: Batch Hot Dip Galvanized Coatings; Phosphate Coatings; Chromate Conversion Coatings; Rust Preventive Compounds; Painting; Ceramic Coatings and Linings; Anodizing. Vacuum and Controlled - Atmosphere Coating and Surface Modification Processes: Thermal Spray Coatings; Chemical Vapor Deposition of Nonsemiconductor Materials; Chemical Vapor Deposition of Semiconductor Materials; Plasma - Enhanced Chemical Vapor Deposition; Growth and Growth - related Properties of Films Formed by Physical Vapor Deposition; Vacuum Deposition, Reactive Evaporation, and Gas Evaporation; Sputter Deposition; Ion Plating; Ion-Beam-Assisted Deposition; Arc Deposition; Ion Implantation; Diffusion Coatings; Pulsed - Laser Deposition. Testing and Characterization of Coatings and Thin Films: Film Thickness Measurements Using Optical Techniques; Corrosion Testing; Evaluation of Mechanical Properties of Thin Films.

P. K. Dutta & I. S. Gray, Surface Engineering, Vol. I - III, Royal Society of Chemistry, 1993.
ASM Hand Book, Vol.5, ASM International, Metals Park, Ohio, 1999.
Kenneth G. Budinsk, Surface Engineering for wear resistance, Prentice Hall, NJ1988.

ML807 Science and Technology of Nanomaterials (3-0-0) 3

Introduction: Definitions, classification, fundamental principles, fullerences, nanoparticles, nanoclusters, nanowires, nanotubes, nanolayers, nanopores, supramolecules. Properties: Size dependence of properties such as electrical, physical, optical and chemical. Synthesis: Top-down and bottom-up approaches, plasma arcing, chemical vapor deposition, electrodeposition, sol-gel synthesis, high energy milling/ball milling, nanolithography, self assembly, Langmuir-Blodgett films. Characterization: Scanning tunneling microscopy, transmission electron microscopy and atomic force microscopy. Application: Nanomachines and nanodevices, impact of nanomaterials in the areas of materials manufacturing, health care,data storage, clean energy etc. Society and nanotechnology: Challenges and fears, impact on health and environment.

ML 808 Non-Equilibrium Materials and Processing (3-0-0) 3

Thermodynamics of equilibrium and non-equilbrium processes. Effect of fine structures on equilibrium, Suppressing of equilibrium structures, Melt quenching, Laser based processing, Ion based processes, High energy milling, Sputtering systems, ECAPs, Roll bonding, Friction based processes like friction welding, friction stir processing, friction surfacing. Use of shock energy for non-equilibrium processing.Metallic glasses, Quasicrystals, High entropy alloys. tomic crystals and their reactivity.Non-equilibrium phases in Fe based, Cu based, Al based alloys.Properties of Non-equilibrium synthesized materials.

Rajiv Mishra, Friction stir processing and Applications: Elsevier publications, 2005.
Lecture notes
D J Paulo Tribology in manufacturing technology, (ed)Springer, 2012.
B S Yilbas, S Z Shuja Laser surface processing and model studies,, Springer, 2013.

S Hosamani An introduction to surface alloying of metals, 2011

ML 809 Advanced Polymeric Materials and Technology (3-0-0) 3

Specialty Polymers:High temperature and fire-resistant polymers,Liquid crystalline polymers,Dendrimers,Drag reduction,Polymer Cement ,Ion-Exchange Resins and Anchored Catalysts,Photoactive Materials,Organometallic polymers, adhesives

Biopolymers: Polymeric bio-implants,Contact lenses,Surgical sutures,Artificial organs,Drug DeliveryBiopolymers,Tissue Engineering

Polymers for Advanced Technologies:Conducting polymersMembrane Science and Technolog, Applications in Electronics and Energy, photonic Polymers, Sensor Applications.

Smart polymers:Self healing polymers, Polymer actuators, Shape memory polymers, Magnetorheological polymers, Piezoelectric polymers , Electroactive polymers

Chanda, S. K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, 1st Edn, CRC Press, USA, 2009.

J. R. Fried, Polymer Science and Technology, 3rd Edn, Prentice Hall,SA,2014

.B.D.Ratner et al., Biomaterials Science: an Introduction to Materials in Medicine, 3rd Edn, Academic press, USA, 2012.

J. Park, R.S. Lakes, Biomaterials: an Introduction, 3rd Edn, Springer, USA, 2007.

A. K. Bhowmick, Ed., Current Topics in Elastomers Research, CRC Press, USA. 2008

PM700 Advances in Iron Making (3-1-0) 4

Different and emerging methods of Ironmaking, Modern developments in Ironmaking in the blast furnace, Preparation of inputs, Physico-chemical study of the reduction of iron ores and oxides, Deposits of coal and the developments in coke making process, Study of processes inside an iron blast furnace, Study of blast furnace slags, Heat exchange zones in blast furnace, Stoichiometry, Material and Heat Balance and introduction to Mathematical Modelling Recent trends in the operation of blast furnaces. Gas based DRI making by HyL, Midrex and fluidized bed processes, Coal based DRI making by rotary kiln, vertical retort and rotary hearth, Electric pig iron furnace; Corex and other SR processes. Production of ferroalloys.

Making, Shaping and Treating of Steel, 10th Edition, Edited by United States Steel, 1985; or 11th Edition, Edited by the Association of Iron and Steel Engineers, 1999.

A. Ghosh and A. Chatterjee, Ironmaking and Steelmaking; Theory and Practice, PHI Learning (P) Ltd., New Delhi 2008.

A. K. Biswas, Principle of Blast Furnace iron making, SBA Publications, Calcutta, 1981

Strasburger, Brown, Stephenson & Dancy, B. F. Theory and Practice, Vol.I & II, 1969, Gordon & Reach, New York.

Robert L. Stephenson, Direct reduced Iron – Technology & Economics of production and use, 1980, Iron & Steel Society of AMIE.

PM701 Advanced Metallurgical Thermodynamics (3-1-0) 4

Review of heat capacity, enthalpy, entropy and free energy concept, fugacity, activity, activity coefficient and the equilibrium constant, solutions - Raoult's law and Henry law, properties of Raoultian ideal solution, non-ideal solution, binary Gibbs-Duhem equation and its application to activity and activity coefficient determination, study of thermodynamic properties of metallurgical systems with special emphasis on liquid metals and slags, quasichemical theory, excess thermodynamics functions, regular and sub regular models of metallic solutions, interaction parameter and interaction coefficient, ternary Gibbs-Duhem integration, theory of ideal mixing of silicates, tubular representation of thermodynamic data and the free energy function.

R. T. Dehoff, Thermodynamics in Materials Science, McGraw Hill, 1993

D. R.. Gaskell, Introduction to Thermodynamics of Materials, McGraw Hill, 1981

R. A. Swalin, Thermodynamics of solids, John Wiley, 1972

PM702 Momentum and Thermal Transport Phenomena (3-1-0) 4

Momentum Transfer in Metallurgical Processes - Viscous properties of fluids, Laminar flow and the momentum equation, Turbulent & complex flows, Energy balance applications, Problems in compressible flow, Sonic velocity and supersonic jets, production of vacuum, Differential models of turbulence for bulk convecting flows, Electromagnetically driven flows, Physical & computational models, Recent advances in metallurgical fluid dynamics: Advances resulting from physical and mathematical modeling. Heat Transfer in Metallurgical Processes - Unsteady state conduction of heat, Differential thermal energy balance in fluids, Forced and Natural convention of heat, The heat transfer coefficient, Heat Transfer Correlations, Radiant heat transfer between black - body surfaces, gray - body

surfaces, radiation through emitting and absorbing media, Heat transfer in continuous casting, welding and quenching, Inverse heat conduction problem - solution and applications. Process Modelling - Introduction, types of models, similarity criteria, development of process models, model implementation.

D. R. Poirier & G. H. Geiger, Transport Phenomena in Materials Processing, TMS, Warrendale, 1994.
R. I. L. Guthrie, Engineering in Process Metallurgy, Oxford Science Publications, 1989
M. A. Glinkov & G. M. Glinkov, A General Theory of Furnaces, Mir, Moscow, 1980
Nobuo Sano, W. K. Lu & P. V. Ribound: Advanced Physical Chemistry for Process Metallurgy, Academic Press, London 1997
N. J. Themelis, Transport and Chemical Rate Phenomena, Gordon Breach, New York, 1995.

PM703 Experimental Techniques (3-0-0) 3

Introduction to metallurgy – crystal structure, defects & phase diagram. experimental determination of phase diagrams including TTT and CCT diagrams, Elements of Optical, Scanning & transmission electron microscopy, Mechanical properties tensile, creep & fatigue, fracture toughness testing, x-ray methods - qualitative and quantitative chemical analysis by diffraction, absorption and fluorescence, stress analysis, texture.

V. Raghavan, Physical Metallurgy, Principles and Practice, Prentice Hall of India Private Ltd., New Delhi, 1985.
G. E. Dieter, Mechanical Metallurgy, 1986, McGraw Hill, New York.
B. D. Gullity, Elements of X-ray Diffraction, Addison - Wesley, New York., 1956

PM704 Process Metallurgy Lab (0-0-4) 2

Experiments in extractive metallurgy, Metallography optical & scanning microscopy techniques, quantitative metallography, x-ray diffraction.

PM705 Theory of Metallurgical Processes (3-1-0) 4

Review of various rate theories, Gibbs and Langmiuir isotherms, diffusion in solids, liquids and gases, mass transfer: concept of mass transfer coefficients, mass transfer correlations, mass transfer models, interfacial phenomenon interfacial turbulence, electrocapillary effects, enhanced vaporization; process analysis, staged operations, impinging jets and submerged jets, continuous flow systems, analysis of single particle reactions, correlation with packed beds and fluidized beds.

F. D. Richardson, Physical Chemistry of Melts in Metallurgy, Vols.1 & 2, 1974, Academic Press, London. J. Szekely & N. Themelis, Rate Phenomenon in Process Metallurgy, Wiley International, 1971
L. Coudrier et al, Fundamentals of Metallurgical Processes, 1978, Pergamon

PM800 Advances in Steel Makeing (3-0-0) 3

Review of the development in steelmaking processes, Physico - Chemical and Thermodynamic Principles of important reactions in steelmaking, deoxidation of steel. Basic oxygen steelmaking processes, developments in L.D. converter, Bottom oxygen process and combined blowing, energy optimizing furnace (EOF) process. Steelmaking in electric arc furnaces, principles and practice adopted for stainless steel production, recent developments in stainless steel making, recent developments in electric arc furnace practice. Steelmaking in electric arc furnace, recent developments. Conarc process, steel making in induction furnace. Secondary steel making processes, ladle furnace method, injection metallurgy, vacuum treatment of liquid molten steel, Non - metallic inclusions in steel – Mechanism of formation and removal, Principles and practice adopted for stainless steel production, recent developments in stainless steel making. Electro-slag refining and vacuum Arc Re-melting, vaccum induction melting, plasma melting, electron beam melting and microwave melting. Continuous casting of steel, fluid flow in the tundish, moulds used for continuous casting, use of casting powder, electro-magnetic stirring, defects in continuous casting products, Introduction to mathematical modeling of continuous casting process.

Making, Shaping and Treating of Steel, 10th Edition, Edited by United States Steel, 1985; or
11th Edition, Edited by the Association of Iron and Steel Engineers, 1999
A. Ghosh and A Chatterjee, Ironmaking and Steelmaking: Theory and Practice, PHI Learning (P) Ltd., New Delhi, 2008
A. K. Chakravarty, Sttelmaking, PHI (P) Ltd., New Delhi, 1007
R. H. Tupkary, Modern Steel Making, 1982, Khanna Pub. New Delhi, 2008
C. Bodsworth, Physical Chemistry of Iron and Steel manufacture , Longmans, Green, 1963,or 2nd edition, prentice Hall Press:1972
T. Rosenqvist, Principles of Extractive Metallurgy, 2nd edition, Mcgraw-Hill, 1974, Mcgraw-Hill, 1983, Tapir Academic Press, 2004.

PM801 Mechanical Processing of Steel (3-0-0) 3

Review of stress and relationship for elastic behaviour, elements of the theory of plasticity, effects of various factors on the plastic deformation of polycrystalline aggregates, fundamentals of metal working, effects of various factors on forming processes, mechanics of metal forming, work of plastic deformation, formability tests and evaluation, friction in forming operations, experimental techniques of forming analysis, detailed analysis of the various hot and cold working processes with special reference to steels based on the following points: Classification of processes, equipment, deformation forces and geometrical relationship variables, defects, residual stresses, theories of the forming process, power requirements, lubrication problems, recent developments, heating for mechanical working, soaking pit practice, control methods and computer simulation. CAD, CAM, FEM. Numerical Problems Design Aspects.

G.E. Dieter, Mechanical Metallurgy, S. I. Metric McGraw Hill, 1988.
T. Altan, S. Oh. H. Gegel, Metal Forming - Fundamentals and Applications, ASM, Ohio, 1983.
Making, Shaping & Treating of Steel, 10th Edition, USS, 1985.

PM802 Advanced Foundry Technology (3-0-0) 3

Liquid, solid and solidification; shrinkage nucleation and growth, segregation, mechanism of solidification of ferrous alloys, flow of metals in gates, heat transfer during solidification, melting furnaces and processes for the production of cast irons and steel castings, special problems in heat treatment to ferrous castings, sand practice for iron and steel casting production, modern trends, engineering design of castings, sources of fluctuation in properties, influence of form and environment. Numerical problems and computers in foundry.

J. Campbell, Castings, Butterworth, 1991, London
Heine and Rosenthal, Principles of Metal Casting, 1955, McGraw Hill, NY.
Solidification of Metals, W. C. Winegard, Institute of Metals 1964.

PM803 Advanced Welding Technology (3-0-0) 3

Introduction to conventional welding process, energy source for fusion welding, heat flow and fluid flow for fusion welding, fluxes for fusion welding, slag/metal interaction, solid state transformation, cracking phenomena, gases in welds. Special welding processes: TIG, ESW, plasma, ultrasonic, laser, electron beam welding, surface hardening, weldability of metals and alloys, stresses in welds, welding of carbon steels, low alloy steels, stainless steels. Cast iron, welding of non-ferrous and composite materials, numerical aspects of modeling the welds, weld design, weld tests. Computers in Welding.

ASM Handbook, vol.6: Welding Brazing and Soldering, 1994
Welding Handbook: American Welding Society, 1991
J.F. Lancaster, Metallurgy of Welding, 2007

PM804 Corrosion Engineering (3-0-0) 3

Definition of corrosion, corrosion damage, standard expressions for corrosion rate, classification of corrosion, electrochemical aspects, electrochemical reactions, Pourbaix diagrams, mixed potential theory, polarization, Evan's diagrams, passivity, effects of environment - oxygen and oxidizers, temperature, corrosive concentration, cathode/anode area ratio, galvanic coupling using mixed potential theory. Forms of corrosion - uniform, galvanic, crevice, intergranular, pitting, selective leaching, erosion, stress corrosion, corrosion fatigue, fretting. Corrosion rate measurements - Tafel and linear polarization, AC impedance, small - amplitude cyclic voltammetry. Corrosion testing. Interpretation of results, Corrosion protection: materials selection, alternative environment, design, cathodic and anodic protection, coatings, High - temperature corrosion: mechanisms and kinetics, high - temperature materials.

Mars G. Fontana, Corrosion, McGraw - Hill Book Company 1986.
David Talbot and James Talbot, Corrosion Science and Technology, CRC Press, NewYork, 1998
Denny A. Jones, Principles and Prevention of Corrosion, Maxwell Macmillan 1992
Metals Handbook, Vol.13, Corrosion, ASM Metals Book, Ohio1987.

PM 806 Non Ferrous Extractive Metallurgy (3-0-0)3

Basics of Extractive metallurgy,Extraction of metals from oxide sources,Basic approaches and special features of specific extraction processes,Extraction of Aluminum (Bayer process, Hall-Heroult process, modern refining processes of Alumina ProductionExtraction of metals from sulphides ore sources (Pyro-metallurgy and hydro-metallurgy)Production of copper, zinc (conventional and advanced routes),*Extraction of gold Extraction of titanium.*
Extraction of nonferrous metals, H.S. Ray, R. Sridhar and K.P. Abraham Affiliated East West Press Pvt Ltd., New Delhi (2007).F. Habashi, Principles of Extractive Metallurgy, Vol.1-4, Gordon and Breach, New York,T. Rosenqvist,

Principles of Extractive Metallurgy, McGraw Hill, New York (1983)R.D. Pehlke, Unit processed in extractive metallurgy, Elsevier, Amsterdam (1982)H.S. Ray and A. Ghosh, Principles of extractive metallurgy, Wiley Eastern Ltd., New Delhi (1991)E-books and open sources

PM807 Advance Mineral Processing (3-0-0) 3

Introduction: Economic Justification, Economic Benefits; Crushing Technique and Fine Grinding; Classification: Factor influencing settling rates, free settling and hindered settling, air Classifiers and concentrate by classification; Metallurgical accounting and simulation: Mass balance method and mass balance on complex circuits, Particle size analysis; Dewatering: Thickeners, Filtering, Type of Filters; Flotation: Application of flotation, wettability, bubble column concentration, cell type; Working principle of advance magnetic separator such as vertical pulsating high gradient magnetic separator, multi stage magnetic separator, hybrid magnetic separator. Electrostatic Separator, electrodynamic separator; Gravity concentration: Shaking table, Jigs, spiral, Heavy media Separator, Particle Dynamics in shaking table, spiral, jigs and spirals; Recycling of E-waste: Purpose of recycling, Treatment method and processing.

D.V. Subba Rao, Mineral Beneficiation: A Concise Basic Course, 2011, CRC Press.

B. A. Wills Mineral Processing Technology: An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery, 7 edition, 2006, Butterworth-Heinemann.

Charles Burroughs Gill, Materials Beneficiation, Materials Research and Engineering, 1991, Springer-Verlag New York, Inc.

Nam S&t, Minerals Processing and Beneficiation 2015, Daya Publishing House.

NT700 Introduction to Nanoscience & Nanotechnology (3 -1 - 0) 4

Miniaturization of devices, need for nanoparticles; Fundamentals of structure and energetic of nanomaterials; Size effects, surface energy; Thermodynamic laws governing equilibrium properties; Relating macroscopic behavior to molecular models of materials; Heat capacities, Phase transformation, Electronic properties, Magnetic properties, diffusion; Structure of nanocrystalline, crystalline and liquid crystalline states; Tensor properties of materials; Point, line and surface imperfections; Environmental impact; Real world examples such as materials for fuel cells/batteries, engineered materials, nano-electronic and nano-photonic devices, MEMS and NEMS devices, ionic and network solids, polymers and biomaterials.

C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley Interscience 2003.

C.N.R. Rao, Achim Muller and A.K. Cheetham, The Chemistry of Nanomaterials,Vol I & II, Wiley VCH, 2004.

B.Rogers, S.Pennathur and J.Adams, Nanotechnology: Understanding small systems, CRC Press, 2008.

A. Nouailhat, An instriduction to nanoscience and nanotechnology, John Wiley & Sons, 2008.

Dieter Vollath, Nanomaterials: An introduction to synthesis, properties & applications, Wiley-VCH, 2008.

T. Pradeep, Nano: The Essentials – Uncerstanding Nanoscience and Nanotechnology, Tata McGraw Hill

H.S. Nalwa, Encyclopedia of Nanotechnology, ASP, 2011

NT701 Quantum Theory of Nanoscale Materials (3 – 1 – 0) 4

Introduction to quantum mechanics, Schrodinger equation, uncertainty principle, bound states of 3–D potential wells and periodic potentials, angular momentum, quantum statistics; perturbation theory, electronic band structures in semiconductors, metals, organic materials and nanostructures; vibrational properties of solids; light-matter interaction; electronic bonding; electronic, optical and magnetic properties of nanomaterials.

B.Rogers, S.Pennathur and J.Adams, Nanotechnology: Understanding small systems, CRC Press, 2008.

Dieter Vollath, Nanomaterials: An introduction to synthesis, properties & applications, Wiley-VCH, 2008.

M.F.Ashby, P.J.Ferreira, D.L.Schodek, Nanomaterials, Nanotechnologies and design, Elsevier, 2009.

NT702 Synthesis Techniques for Nanomaterials (3 – 1 – 0) 4

Physical Methods: Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and other variants, Electrodeposition. Chemical Methods: Metal nanocrystals by reduction, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Nanocrystals of semiconductors and other materials by arrested precipitation, Thermolysis routes, Sonochemical routes, Liquid-liquid interface, Hybrid methods, Solvated metal atom dispersion, Post-synthetic size-selective processing. Sol- gel, Micelles and microemulsions, Cluster compounds. Biological Methods: Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis. Lithographic

Techniques: AFM based nanolithography and nanomanipulation, E-beam lithography and SEM based nanolithography and nanomanipulation, Ion beam lithography, oxidation and metallization. Deep UV lithography, X-ray based lithography.

H.S. Nalwa - Encyclopedia of Nanotechnology, 2011
Leon L.Shaw(Ed), Processing & properties of structural nanomaterials,2010
C.N.R. Rao, Achim Muller and A.K. Cheetham, The Chemistry of Nanomaterials,Vol I & II, Wiley VCH, 2004.
G. Cao, Nanostructures & Nanomaterials Synthesis, Properties & Applications, Imperial College Press, 2004

NT703 Thermodynamics of Solids (3 – 1 – 0) 4

Laws of thermodynamics, relations between thermodynamic quantities; Thermodynamics of chemical reactions, magnetism, polarizability and elasticity; Phase transformation, partial molar and excess quantities; Multi-phase equilibria and their phase diagrams, free energy of binary systems; Electrochemical equilibria; Thermodynamics of surfaces and interfaces; Macroscopic equilibrium phenomena.

Dieter Vollath, Nanomaterials: An introduction to synthesis, properties & applications, Wiley-VCH, 2008.
R.A.Swalin, Thermodynamics of solids, John Wiley, 1972
M.F.Ashby, P.J.Ferreira, D.L.Schodek, Nanomaterials, Nanotechnologies and design, Elsevier, 2009.

NT748 Nanomaterials Synthesis Laboratory (0 – 0 – 4) 2

Synthesis of nanostructured metals and metal oxides (ex. Ag, Cu, Sn, As, ZnO, SnO_2, oxides of iron, etc) by hydrothermal, microwave, and ultrasonic methods under varying conditions; surface functionalization .

NT749 Materials Characterization Laboratory (0 – 0 – 4) 2

Characterization of nanomaterials by powder XRD, study of size distribution and variation; Study of morphology of nanomaterials by Optical microscopy, SEM and TEM; metallographic specimen preparation.

NT750 Nanophotonics (3 – 0 – 0) 3

Nanophotonics: Background, Maxwell's equations, optical modes, 1D, 2D and 3D photonic crystals and light propagation in them, Photonic Properties of Nanomaterials; Photon Absorption, Emission & Scattering; Permittivity & free Electron Plasma of metals, Extinction Coefficient of Metal particles; Gold & silver particles for nanophotonic devices, bandgap engineering of nanoscale devices, Thin films, Quantum wires and dots, photonic crystal fibers, Quantum Confinement based light sources and detectors, optical tweezers, photonic crystal devices, nonlinear optics in nano and microstructures.

B.Rogers, S.Pennathur and J.Adams, Nanotechnology: Understanding small systems, CRC Press, 2008.
H. Rigneault, J.M. Lourtioz, C. Delalandeand A. Levenson, ISTE Ltd., 2007.
A. Nouailhat, An instriduction to nanoscience and nanotechnology, John Wiley & Sons, 2008.
Dieter Vollath, Nanomaterials: An introduction to synthesis, properties & applications, Wiley-VCH, 2008.
G.L. Hornyak, J.J. Moores, H.F. Tibbals and J. Dutta, Fundamentals of Nanotechnology, CRC Press, 2009.

NT751 Nanoelectronics (3 – 0 – 0) 3

Semiconductors: Tuning the Band gap of Nanoscale Semiconductors, Excitons, Semiconductor nanowires- Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanosprings; Quantum dot, Single electron devices, molecular electronic devices; Metal-insulator transition, Nanostructured ferromagnetism, effect of bulk nanostructuring of magnetic properties, dynamics of nanomagnets, Nanocarbon ferromagnets, Giant & colossal magnetoresistance, Nanopore containment of magnetic particles,

B.Rogers, S.Pennathur and J.Adams, Nanotechnology: Understanding small systems, CRC Press, 2008.
A. Nouailhat, An introduction to nanoscience and nanotechnology, John Wiley & Sons, 2008.
Dieter Vollath, Nanomaterials: An introduction to synthesis, properties & applications, Wiley-VCH, 2008.
G.L. Hornyak, J.J. Moores, H.F. Tibbals and J. Dutta, Fundamentals of Nanotechnology, CRC Press, 2009.

NT752 Surface Phenomena (3 – 0 – 0) 3

Thermodynamics of surfaces; Reactivity of surfaces; Atomic models of crystal surfaces; Electron diffraction from surface layers; Surface diffusion; Physical and chemisorptions of gases on surfaces; Chemical reactions at surfaces; Nucleation on surfaces and bulk phases.

Dieter Vollath, Nanomaterials: An introduction to synthesis, properties & applications, Wiley-VCH, 2008.
G.L. Hornyak, J.J. Moores, H.F. Tibbals and J. Dutta, Fundamentals of Nanotechnology, CRC Press, 2009.

NT753 Carbon Nano Structures & Applications (3 – 0 – 0) 3

Carbon nanostructures and types of CNTs, growth mechanisms, synthesis of CNTs by flame, CVD, laser ablation and electric arc processes, purification and characterization methods, mechanical reinforcements, solid disordered carbon nanostructures, nanostructured crystals, electrical, vibrational, mechanical properties of CNTs, optical properties, Raman spectroscopy of CNTs, carbon clusters and fullerenes, decoration of CNT by nano metals/oxides, lithium and hydrogen adsorption and storage, fuel cell applications and energy storage, sensor applications of CNTs. Applications to nanoelectronics, nanocomposites, nanowires and drug delivery.

C.N.R. Rao, Achim Muller and A.K. Cheetham, The Chemistry of Nanomaterials, Wiley Interscience, 2005.

A. Jorio, G. Dresselhaus and M.S. Dresselhaus, Carbon Nanotubes – Advanced Topics in the Synthesis, Structure, Properties and Applications, Springer 2008.

A. Loiseau, P. Launois, P. Petti, S. Roache, J.P. Salvetat, Understanding Carbon Nanotubes - From basics to applications, Springer 2006.

NT754 Nano Biotechnology (3 – 0 – 0) 3

Biosynthesis of nanosized materials using microbes, bioconjugation of biomaterials (enzyme) with nanoparticles, different types of inorganic materials used for synthesis of hybrid nano- bio-assemblies, nanoprobes for analytical applications – a new methodology in medical diagnostics and biotechnology, synthesis of nanomedicines and its behavior in biological systems. Synthesis of nanodrug carriers (soft, hard), applications of nanomaterials to cancer detection and treatment, Lab on Chip, DNA Micro-array, Protein Micro-array, Bioelectronics, Biobatteries, Biorobotics, Molecular motors.

A.K. Bandyopadhyay, Nanomaterials, New Age Publishers.

T. Pradeep, Nano: The Essentials – Uncerstanding Nanoscience and Nanotechnology, Tata McGraw Hill,2007

NT755 Polymer Nanotechnology (3 – 0 – 0) 3

Processing of Nanoparticles - Binding mechanisms in Nanoparticles, Dispersion of Nanoparticles, Stabilization of Nanoparticles. Processing and fabrication of polymer nanocomposites - Melt blending, Solvent casting, In-situ polymerization, Solution polymerization, Template synthesis, High shear mixing. Homogenoeous/heterogeneous nucleation, plasma promoted nucleation, Cold Plasma Methods, Atomic layer deposition fundamentals, Laser ablation, Vapour – liquid – solid growth, particle precipitation aided CVD. Polymer nanocomposites with structural, gas barrier and flame retardant properties, carbon fiber reinforced polymer composites, elastomer and thermoplastic elastomer nanocomposites for propulsion systems, water borne fire-retardant Nanocomposites, hybrid composites for cosmetics, protective and decorative coatings. Polymer based optical, electronic and magnetic materials. Nanoelectronics. Molecular Electronics Components. Characterization of polyphenylene based switches and complex molecular devices. Molecular rectifying diode switches,

Chung, Deborah D. L., Composite Materials: Science and Applications, Spinger International Edition, Springer-Verlag, London (2004)-Indian Edition 2006

B. T. Astrom, Manufacturing of Polymer Composites, Chapman and Hall, London 1995

T. G. Gutowski, Advanced Composites Manufacturing, John Wiley and Sons, New York 1997

K. Goser, Peter Glösekötter, Jan Dienstuhl, *Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices. Springer Berlin, 2004*

NT756 Nano Composites (3 – 0 – 0) 3

Introduction to nanocomposites, composite materials, mechanical properties of nanocomposite materials, stress –strain relationship, toughness, strength, plasticity, cermic-metal nanocomposites, ceramic based nanoporous composites, metal matrix nanocomposites, polymer based nanocomposites, carbon nanotubes nanocomposites, natural nano-biocomposites, bio-mimetic nanocomposites and biologically inspired nanocomposites, nanocomposites for hard coatings, DLC coatings, thin film nanocomposites, modeling of nanocomposites, synthesis of various nanocomposite materials, Sputtering, mechanical alloying, sol-gel synthesis, thermal spray synthesis, nano-indentation, processing of polymer nanocomposites, properties of nanocomosites, salt infiltration, powder mixing, intrusion method, exfoliation and interaction, gel-casting impregnation techniques.

P.M. Ajayan, L.S. Schadler and P.V. Braun, Nanocomposite Science and Technology, Wiley-VCH, 2003

C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley Interscience 2003.

H.S. Nalwa, Encyclopedia of Nanotechnology, 2004

Chung; Deborah D. L., Composite Materials: Science and Applications, Spinger International Edition, Springer-Verlag, London (2004)-Indian Edition 2006

NT757 Chemistry of Nanomaterials (3 – 0 – 0) 3

Nanomaterials, size effects, general methods for preparation, sol-gel, solvothermal, sonochemistry and other novel methods of synthesis, properties and uses of nanomaterials, growth of nanocrystals in solutions, structure, energy bands, methods of measuring properties, particle size determination, metal and semiconductor nanocrystals, oxide nanoparticles, nanotubes and nanowires, nanostructured polymers and composites, nanoporous materials, nanocatalysis, industrial applications.

C.N.R. Rao, Achim Muller and A.K. Cheetham, The Chemistry of Nanomaterials,Vol I & II, Wiley VCH, 2004.
C.N.R. Rao, Achim Muller and A.K. Cheetham, Nanomaterials Chemistry, Wiley VCH, 2007
C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley Interscience 2003.

NT758 Advanced Characterization Techniques (3 – 0 – 0) 3

Compositional and structural characterization techniques: XPS, X-topography, Electron probe microanalysis, Electron diffraction, Electron probe microanalysis, SIMS and RBS, AFM, STM, Raman spectroscopy, Photoluminescence spectroscopy, Hall measurement, dynamic and static I-V characteristics, C-V measurement, EBIC, SQUID, VSM, MFM, neutron diffraction, DSC, TGA, DMA.

C. Suryanarayana, A practical approach to X-ray diffraction analysis,1998
Z.L. Wang, Characterization of Nanostructured materials,2003
J.I. Goldstein, Scanning Electron Microscopy and X-ray microanalysis,2003
E.Smith and G. Dent, Modern Raman Spectroscopy: A practical approach,2005

NT759 Microstructure & Mechanical properties of Nano-structures (3 – 0 – 0) 3

The phenomenological, mechanistic and micro-structural aspects of the mechanical properties of materials are developed, with particular emphasis on the similarities and differences among various material systems including metals, ceramics and polymers. Phenomenological aspects of the three-dimensional characteristics of stress and strain, various yield criteria, elastic behavior, viscoelastic behavior, plastic behavior, statistical aspects of brittle fracture and fracture mechanics are presented. Mechanistic and micro-structural topics include edge and screw dislocation behavior, slip systems, critical resolved shear stress, dislocation multiplication and interactions, barriers to motion, polymer chain conformation and entropy.

C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley Interscience 2003.
H.G.Rubahn, Basics of Nanotechnology, Wiley-VCH, 3rd ed., 2008.
Dieter Vollath, Nanomaterials: An introduction to synthesis, properties & applications, Wiley-VCH, 2008.
G.L. Hornyak, J.J. Moores, H.F. Tibbals and J. Dutta, Fundamentals of Nanotechnology, CRC Press, 2009.

NT760 Nanomaterials for Energy Conversion (3 – 0 – 0) 3

Fundamentals of thermodynamics, chemistry, and transport applied to energy systems. Analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance, and environmental impact. Applications to fuel reforming and alternative fuels, hydrogen, fuel cells and batteries, solar cells, combustion, catalysis, combined and hybrid power cycles using fossil, nuclear and renewable resources. CO_2 separation and capture. Biomass energy.

C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley Interscience 2003.
H.G.Rubahn, Basics of Nanotechnology, Wiley-VCH, 3rd ed., 2008.
Dieter Vollath, Nanomaterials: An introduction to synthesis, properties & applications, Wiley-VCH, 2008.
G.L. Hornyak, J.J. Moores, H.F. Tibbals and J. Dutta, Fundamentals of Nanotechnology, CRC Press, 2009.

NT761 Integrated Microelectronic Devices (3 – 0 – 0) 3

Semiconductor fundamentals, p-n junction, metal-oxide semiconductor structure, metal-semiconductor junction, MOS field-effect transistor, and bipolar junction transistor. Emphasis on physical understanding of device operation through energy band diagrams and short-channel MOSFET device design. Issues in modern device scaling outlined. Includes device characterization projects and device design project.

R.S. Muller, T.I. Kamins and M. Chan, Device Electrnics for Integrated Circuits, 3rd Ed., John Wiley, 2002.
S.M. Sze, Physics of Semiconductor Devices, Wiley Interscience, 2nd Ed., 1981.

NT762 MEMS/NEMS Devices and Systems (3 – 0 – 0) 3

MEMS & NEMS – overview, sensors, transducers and actuators designing, Basics of MEMS engineering, scaling laws, materials for MEMS and NEMS; microsystem manufacturing: photolithography, bulk, surface and LIGA

processes, comparison of wet and dry etching, striction, methods to reduce striction, microsystem design, CAD applications in MEMS design, Applications of MEMS and NEMS in automotive, aircraft, medical electronics, and sensor systems.

Tai Ram Hsu, MEMS and micrsystems – Design and Manufacturing, Tata McGraw Hill, 2002.
M.J. Madou, Fundamentals of microfabrication – the science of miniaturization, IEEE Press,
S.D. Senturia, Microsystems Design, Kluwer Academic Publishing, 2003.

NT763 Nanotribology (3 – 0 – 0) 3

Nanotribology, nanomechanics, surface forces, nano-rheology of molecular thin films, interfacial forces, spectroscopic study of confined fluids, friction and wear on atomic scale, nanomechanical properties of solid surfaces and thin films, computer simulation of nanometer scale indentation and friction, mechanical properties of nanostructures, scale effects in mechanical properties and tribology, nanoscale boundary lubrication studies, bio-mimetics, lotus effect, superhydrophobic surfaces, measurement techniques, scanning probe microscopy, noncontact AFM, and related topics.

Bharat Bhushan (Ed.), Nanotribology and Nanomechanics, 2nd Ed., Springer XXXIV, 2008.

NT764 Computational Materials Science (3 – 0 – 0) 3

Theory and application of atomistic computer simulations to model, understand, and predict the properties of real materials. Energy models: from classical potentials to first-principles approaches. Intermolecular forces and potentials, Density-functional theory and the total-energy pseudopotential method. Many body model potentials, Atom site stress field, Errors and accuracy of quantitative predictions. Thermodynamic ensembles: Monte Carlo simulation methods, Computation for few particles, Markov process, molecular dynamics simulations, Numerical integrations of equations of motion, Systems in contact with heat bath, Free energies and phase transitions. Fluctations and transport properties. Coarse-graining approaches and mesoscale models.

G. Ali Mansoori, Principles of Nanotechnology, World Scientific, 2006.
K.Ono, K.Esfarjani and Y. Kawazoe, Computational Materials Science, From Ab-initio to Monte-Carlo, Springer Series in Solid State, New York, 1999.
D.C. Rapaport, The Art of Molecular Dynamics Simulation, CUP, 2004.
W.H. Press, S.A. Teukolsky, W.T. Wetterling and B.R. Flannery, Numerical Recipies, The Art of Parallel Scientific Computing, CUP, 1996.

MT800 Metallurgical Process Design (3-0-0) 3

Design and its significance. Modern trends, fluid flow and heat transfer principles applicable to design. Furnaces, classifications, Glinkove theory. Burners. Principles of chimney design. Fuel economy. Design features of electric arc furnaces, induction furnaces, reheating furnaces and soaking pits. Refractories for furnaces.

A. Glinkove, A general Theory of Furnaces, Min Publishers Moscow, 1980
G. E. Dielw, Engineering Design, 2nd Edition, McGraw Hill, 1990

MT801 Mass Transfer & Chemical Kinetics (3-0-0) 3

Review of various rate theories, Gibbs and Langmiuir isotherms, diffusion in solids, liquids and gases. Mass Transfer: interfacial phenomenon-significance, interfacial turbulence, electrocapillary effects, enhanced vaporization electro-chemical theory of smelting and refining. Process analysis, impinging jets and submerged jets. Continuous flow systems. Analysis of single particle reactions - correlation with packed beds and fluidised beds.

N. J. Thumelis, Transport and Chemical Rate Phenomena, Gordon Breach, New York, 1995

MT802 Thermodynamics of Solids (3-0-0) 3

First law of thermodynamics, the second law of thermodynamics, some relations between thermodynamic quantities, thermodynamics of phase transformation and chemical reactions. Partial molar and excess quantities.

Thermodynamic properties of alloy system - equilibrium between phases of variable composition. Free energy of binary system. Thermodynamics of surfaces and interfaces. Classification of defects in the crystal, defects in the metals, defects in elemental semiconductors, defects in nearly stoichiometric compound, defects in non - stoichiometric compound.

R. A. Swalin, Thermodynamics of solids, John Wiley.

MT803 Solidification of Metals (3-0-0) 3

Heat flow in solidification, plane front solidification of single phase alloy, cellular solidification, plane front solidification of polyfront alloy, solidification of castings and ingots, solidification of polyphase alloy. Fluid flow,

thermodynamics of solidification, nucleation and interface kinetics growth. Processing and properties: homogenization, mechanical properties of equiaxed cast structure, properties of columnar structure, aligned composites, effect of working.

M.C. Flemings, Solidification Processing, McGraw Hill, 1974
W. Kurz, D. J. Fischer, Fundamentals of Solidification, Trans Tech, 1984.

MT804 Materials Science & Engineering (3-0-0) 3

Introduction, atomic structure and bonding, crystal structure and crystal geometry, solidification, crystal imperfections and diffusion in solids, electrical properties of materials, mechanical properties of metals, polymeric materials, phase diagrams, engineering alloys, ceramic materials, silicate structure, processing of ceramics, electrical, mechanical, thermal properties of ceramics. Magnetic materials, corrosion, composite materials, optical properties, superconducting materials.

E. Reed Hill, Introduction to Physical Metallurgy, Van Nostrand, East west Press, New Delhi, 1973.

MT805 Plastic Deformation (3-0-0) 3

Interatomic forces, metallic crystals and their elastic properties, elementary theory of structural imperfections in crystals, plastic deformation of single crystals, plastic deformation of polycrystals. Deformation textures, characteristics and driving forces of softening process in deformed crystals. Fracture, resistance of metal to plastic deformation, ductility and deformability of metals and alloys, thermo-mechanical treatment, superplasticity and its applications.

G. E. Dieter, Mechanical Metallurgy, McGraw Hill, 1988.

MT806 Structure & Properties of Alloys (3-0-0) 3

Structure of pure metal, properties of pure metal, solidification, solid solution, working and annealing, two phase alloy, Aluminum alloys and age hardening, magnesium and beryllium, theory of heat treatment of steels, steels for structural applications, carbon and alloy tool steels, stainless steels, cast iron, reactive and refractory metals for high temperature applications, failure of materials, non-destructive testing.

MT807 Alloy Design (3-0-0) 3

Introduction, structure property correlation, electron basis of structure, composition control, phase diagrams, second phase particles, grain boundary modification, strengthening mechanisms, mechanical working, texture, behaviour of second phase particles, design for creep resistance, high temperature materials, super alloys, design for fracture resistance, design for fatigue resistance, fatigue - fracture, creep fatigue interaction, superplastic forming. HSLA steels, TRIP steels, maraging steels, stainless steels. Aluminium alloys, titanium and its alloys, zirconium and its alloys, magnesium based alloys, quasicrystals.

MT808 Heat Transfer (3-0-0) 3

Modes of heat transfer, one dimensional, steady state conduction, transient conduction, external flow (convection), internal flow (convection), free (natural, buoyant) convection, boiling and condensation, radiation, radiation exchange between surfaces.

J. P. Holman, Heat Transfer, 9th Edition, McGraw Hill, 2002.

DEPARTMENT OF CHEMISTRY

CY701 Analytical Chemistry I (3-1-0) 4

Analytical Chemistry: Basic concepts, statistical treatment of errors. Sampling in analysis: Various techniques of sampling, statistical criteria, storage of samples. Gravimetric analysis: Basic concepts, conditions of precipitation, co- & post-precipitation. Volumetric analysis: acid-base, redox, precipitation, complexometric titrations. Electroanalytical methods: conductometry, potentiometry, Ion selective electrodes in potentiometry,,potentiometric titrations, Polarography and voltammetry, DC & AC polarography, Rapid scan polarography, Pulse polarography, Square wave polarography, Cylic voltammetry, Chronopotentiometry, Stripping analysis, Amperometric titrations, Coulometry, Thermal methods of analysis: TG, DTG, DTA and DSC, Nuclear methods of analysis. Nephelometry, Turbidometry

S.M. Khopkar, Basic Concepts of Analytical chemistry, 2002.

D. A. Skoog and D. M. West, Principles of Instrumental Analysis, Holt Rinahart Winston, New York, 1988.

D.A. Skoog, F.J. Holler, S.R. crouch, Instrumental Analysis, 2008.

R.D. Braun, Introduction to Instrumental Analysis, Parma Book, 2006.

G.H. Jeffery, J. Bassett, J. Mendhem, R.C. Denney, Vogel's Textbook of quantitative Chemical analysis, ELBS, 5th Edn, 1989.

CY702 Inorganic Chemistry - I **(3-1-0) 4**

Modern Periodic Table: Periodic properties, trends and underlying principles. Chemical Bondings: Ionic bond, Lattice energy. Covalent bond: Molecular orbital theory for diatomic and polyatomic molecules, hybridization, VSEPR theory. Metallic bond: Band theory, semiconductors and insulators. Hydrogen bond. Structure of solids: Symmetry in crystal systems, radius ratio, shapes of crystals, solid state defects, physical properties of solids. Symmetry of molecules: Elements of symmetry and symmetry operations.

F. A. Cotton & G. Willkinson, 6th edn., Advanced Inorganic Chemistry, Willey Eastern, 1977.

H. T. Huheey, 3 rd Edition, Inorganic Chemistry, Principles of Structure and Reactivity, 2002.

M. F. C. Ladd, Structure and bonding in solid state chemistry, Chickester, Ellis, Horwood, 1974.

CY703 Organic Chemistry – I (3-1-0) 4

Basic concepts: Review of inductive, electromeic, resonance, hyperconjugative and field effects, tautomerism. H-bonding, EDA complexes, inclusion compounds, Crown ethers, Catenanes, Rotaxanes. Hammett & Taft equations. Aromaticity: Huckel's rule, Organic acids and bases, factors affecting. Reaction mechanisms, structure and reactivity, organic reactions & reagents. Kinetic and thermodynamic control, transition states, Hammond postulate, kinetic isotope effect. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, nitrenes, carbenes, benzynes. Determination of reaction mechanism. Aliphatic/aromatic nucleophilic, electrophilic, substitution reactions, types & mechanisms, Additions to C-C and Carbon-Heteroatom multiple bonds, Elimination reactions, Free radical reactions, Formation and hydrolysis of esters, Base catalyzed condensation reactions. Photochemistry: Jablonski diagram & quantum yield, Photochemical synthesis.

F. A. Carey & R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 3rd edition, Plenum Press, New York, 1990.

J. March, Advanced Organic Chemistry, Reactions, Mechanism & Structure, 4th edition, Wiley Interscience, 1994

R. H. Lowry and K. S. Richardson, Mechanism and Theory in Organic Chemistry, 2nd edition, Harper and Row Publishers, New York, 1981.

P. Sykes, A Guide book of Mechanisms in Organic Chemistry, Orient-Longman, 1985.

I. L. Finar, Volume 1, The Fundamental Principles, 6th edition, ELBS, England, 1989.

N. S. Isaacs, Physical Organic Chemistry, ELBS, Longman, UK, 1987.

I. Ninomiya, T. Naito, Photochemical Synthesis, Academic Press, New York, 1989.

CY704 Physical Chemistry – I (3-1-0) 4

Quantum Chemistry: de-Broglie concept, uncertainly principle, Schroedinger equation, Solution of Schroedinger wave equation for exactly solvable problems. Chemical Thermodynamics: Combined form of 1st and 2nd laws, Maxwell's relations. Third law of thermodynamics, Gibbs-Duhem equation Quantitative treatment of Le-Chatelier principle. Chemical Dynamics: Transition state theory and the Arrhenius equation. Marcus theory of electron transfer. Reactivity and selectivity principles. Lindemann, Hinshelwood and RRKM theories. Fast reaction Techniques, Complex reactions, Opposing, parallel, consecutive reactions. reactions in solution: Ionic reactions-kinetic salt and solvent effects. Substituent effects on the rates of reactions-Hammett and Taft equations, linear free energy relationships. Isokinetic temperature. An introduction to kinetic isotope effect. Theories of reaction rates: Collision theory of reaction rates, steric factor, activated complex theory and its applications to reactions in solution. Phase equilibria.

G.M. Barrow-Physical Chemistry (V Edition) McGraw Hill international Series 1988.

A.W. Atkins Physical Chemistry ELBS (IV Edition) Oxford University Press, Oxford 1990.
J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, Shobanlal Nagin Chand Co. 1986.
Donald A Mc Quarrie, Quantum Chemistry, University Science Books, Mill Valley, California, 1983.
A.K. Chandra, Introductory Quantum Chemistry (Tata MeGraw Hill) 1994.
K.J. Laidler, Chemical Kinetics. (Harper and Row) 1987.
S.K. Jain, Kinetics of Chemical Reaction (Vishal Publications) 1982.

CY 705 Spectroscopy (3-1-0) 4

Atomic and Molecular Spectroscopy: Interaction of electromagnetic radiation with matter, absorption and emission spectroscopy, molecular spectra, quantization of energy levels and transitions. Microwave-Spectroscopy: Spectra of diatomic & polyatomic molecules, rigid and non-rigid rotator models, isotope effects, Stark effect, instrumentation. IR spectroscopy: Vibrational frequency, modes of vibration, instrumentation, FTIR. Raman spectroscopy: Basic principles, Raman Spectroscopy. Electron transition spectroscopy: Beer-Lambert's law, chromophores, oxochromes, instrumentation. Molecular luminescence spectroscopy, Chemiluminescence, Fluorescence, and phosphorescence, Atomic absorption spectroscopy. X-ray diffraction techniques: X-ray structural analysis.

D. A. Skoog and D. M. West, Instrumental methods of Analysis, Holt Rinahart Winston, New York, 1988.
C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, Tata-McGraw Hill, 1994.
Barrow, Introduction to Molecular Spectroscopy.
Drago, Physical Methods in Inorganic Methods.
Walker & Straughan, Spectroscopy, Vol I and II.
J. M. Hollas, Modern Spectroscopy, Wiley Chichester, 1992.

CY706 Inorganic Chemistry Practicals – I (0-0-6) 3

Qualitative analysis salts/salt mixture of less familiar elements – semimicro analysis. Analysis of commercially important ores, alloys, limestone, cement. Instrumental methods, pH-metry, potentiometry, polarography, amperometry, spectrophotometry, turbidimetry, flame photometry, atomic absorption spectrometry, fluorometry, coulometry, and electrogravimetry. Statistical analysis of data.

G. Srehla, Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, Orient Longman, New Delhi, 1982.
J. Basset, R.C. Denny, C.H. Jeffery and J. Mendham, Vogel's Textbook of Quantitative Inorganic analysis, including Elementary Instrumental Analysis, ELBS, London, 1978.

CY707 Organic Chemistry Practicals – I (0-0-6) 3

Separation of binary mixture & their qualitative analysis. Quantitative determination of sugars, amino acids, phenols, carboxylic acids, amides, amines, esters, aldehydes, ketones, alcohols, enols, unsaturation, urea. Single step organic synthesis involving isolation, purification and characterization of organic compounds with an emphasis on reactions like alkylation, acetylation, nitration, halogenations, sulphonation, cyclization, diazotization, condensation, oxidation, reduction, hydrolysis, dehydration, elimination etc. with stress on different techniques set-up (air-sensitive, moisture sensitive etc).

B. S. Furniss et al., Vogel's Text Book of Practical Organic Chemistry including Qualitative Organic Analysis, Longman-ELBS, London, 1989.
F .G. Mann and B. C. Saunders, Practical Organic Chemistry, ELBS, England, 2001.
Cheronis et al, Semimicro Qualitative Organic Analysis, Wiley-Eastern, New Delhi, 1964
R. L.Shriner, The Systematic Identification of Organic Compounds-A Lab. Manual, Wiley, 1969.
In-house laboratory manual with the experimental procedures and relevant literature.

CY 751 Analytical Chemistry II (3-0-0) 3

Surface analysis: Electron spectroscopy, XPS, Augur electron spectroscopy, Photo acoustic spectrometry. SEM, TEM, Scanning probe microscopy – AFM, SECM, SCM and SMFM Separation methods: Solvent extraction, Chromatography – theoretical concepts, migration parameters, column efficiency, separation factor, Paper and thin layer chromatography, Partition chromatography, Gas chromatography, HPLC, Exclusion chromatography, Gel permeation chromatography, Super critical fluid chromatography & Extraction capillary electrophoresis.

D.A. Skoog, F.J. Holler, S.R. crouch, Instrumental Analysis, 2008.
R.D. Braun, Introduction to Instrumental Analysis, Parma Book, 2006.
G.H. Jeffery, J. Bassett, J. Mendhem, R.C. Denney, Vogel's Textbook of quantitative Chemical analysis, ELBS, 5th Edn, 1989
Ray F. Egerton, Physical principles of electron microscopy- An introduction to TEM, SEM and AEM, Springer

Publicatons, 2005.
Wells O. C, Scanning Electron Microscopy, McGraw-Hill, New York 1974.
Weilie Zhou, Robert P. Apkarian, Zhong Lin, Wang, and David Joy, Fundamentals of Scanning Electron Microscopy, Springer publications, 2004.

CY752 Inorganic Chemistry – II (3-1-0) 4

s-Block elements: General discussions, synthesis and properties of their compounds. Alkali and alkaline earth metal complexation, cyclic and crown ethers, cryptands and calixeranes, biological significance. p-Block elements: Chemistry of non metals: B, Si, P & S, E-H, E-X, E-O & E-N bond types in different molecules, Chemistry of boranes, silanes, phosphanes and sulphanes, borazine, boron and silicon nitrides. P-N & S-N rings: synthesis, structure, bonding and reactions of N3P3Cl6 & S4N4. Halogen and noble gas chemistry: Inter halogens, pseudo halogens, ionic oxy halogen species. Organometallics of s- and p- block elements Specific reagents of main group elements: synthesis, structure and reactions Industrial Chemicals: Urea and poly phosphates, production, structure, property, analysis and uses.

F.A.Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th edn., J. Wiley. New York, 1999.
D.F.Shriver, P.W. Atkins and C.H. Lingford, Inorganic Chemistry, ELBS, 1990
W.L. Jolly, Modern Inorganic Chemistry, Mcgraw-Hill, 1985.
N.N.Greenwood and E.A. Earnshaw, Chemistry of Elements, Pergmann Press, 1984.
H. T. Huheey, 3rd edition, Inorganic Chemistry, Principles of Structure and Reactivit, 2002.

CY753 Organic Chemistry - II (3-0-0) 4

Stereochemistry: Molecular symmetry, optical activity, enantiomers, absolute configurations, threo & erythro isomers, resolution, diastereomers, stereospecific, stereoselective, asymmetric synthesis, chiral reagents, Cram's and Prelog's rules. Optical activity in biphenyls, allenes, spiranes. Stereochemistry of N, S & P compounds. Conformational analysis: Cycloalkanes and decalins, Winstein-Eliel equation, Curtin-Hammett principles, CD, ORD, Cotton effect. Geometrical Isomerism: monocyclic compounds, fused ring systems, determination of configuration. Classification & general mechanistic treatment of nucleophilic, electrophilic & free radical rearrangement reactions. Mechanism, stereochemistry & applications of importantnamed reactions.Pericyclic reactions: Woodward-Hoffmann correlation approach, FMO approach, cycloadditon reactions. Photochemistry: Principles, photo-dissociation, -reduction, -isomerization, -cyclization. Norrsih type-I & Type-II reactions. Photochemical cells.

E.L.Eliel, Stereochemistry of Carbon Compounds, Tata McGraw Hill, New. Delhi, 1994.
D.Nasipuri, Stereochemistry of Organic Compounds -Principles and Applications, Second edition, Ch-2-6, Wiley Eastern, New Delhi, 1994.
J. March, Advanced Organic Chemistry-Reactions, mechanisms & structure, Wiley, NY, 2000.
K. K. Rohatgi-Mukherjee, Fundamental of Photochemistry, New Age International (P) Ltd, New Delhi, 1986.
P.S.Kalsi, Stereochemistry, Conformation and Mechanism, Wiley Eastern, New Delhi, 1993.
F.J.Carrey & R.J.Sundberg, Advanced Organic Chemistry-IV-Ed. Part A & B, Kluwer Academic/Linum publishers, 2001.
N.Carruthers, Modern Methods of Organic Synthesis, Cambridge University, 1996.

CY754 Physical Chemistry – II (3-1-0) 4

Quantum Chemistry: Need of approximate methods in quantum chemistry. Approximate methods of solving Schroedinger equation for problems of chemical interest, Introduction to SCF methods. Born-Oppenheimer aproximations. Statistical Thermodynamics: Concept of distribution. M-B, B-E and F-D statistics. Partition functions, Irreversible Thermodynamics:. Entropy production. Electrokinetic phenomena. Photochemistry: Quantum yield and its determinations, experimental methods in photochemistry, Frank- Condon principle, hotophysical pathways- Jablonski diagram, Radiationless transitions and selection rules. Flourescence and phosphorescence- theory and applications. Applications in synthesis, solar energy utilization and atmospheric chemistry.

B.C. McClelland, Statistical Thermodynamics, Chapman and Hall, London 1973.
M.C. Gupta, Statistical Thermodynamics, Wiley Eastern Limited 1993.
N. D. Smith, Elementary Statistical Thermodynamics, Plenum Press, New York 1982.
Donald A Mc Quarrie, Quantum Chemistry, University Science Books, Mill Valley, California, 1983.
P.W. Atkins, Molecular Quantum Chemistry Mechanics, 2nd edition, Oxford University Press, 1983.
I. N. Levine, Quantum Chemistry, 5rd edition, Allyn and Bacon, Boston, 2000.
A.K. Chandra, Introductory Quantum Chemistry (Tata MeGraw Hill) 1994.
K.K. Rohatgi Mukherjee, Fundamentls of Photochemistry, Wiley Eastern Ltd., New Delhi, 1978.

***CY755 Spectroscopy, Applications in Chemistry* (3-1-0) 4**

Electronic transitions, spectra of conjugated systems, complexes. Woodward–Fieser rules, H-bonding & solvent effects. IR spectroscopy: fingerprint region, functional group analysis, H-bonding & solvent effects, overtones, Fermi resonance, analysis of organic & coordination compounds. Raman spectroscopy and its applications. NMR spectroscopy: ^{1}H NMR, Zeeman splitting, δ, spin-spin coupling, Instrumentation & experimental techniques. J values, 1st& 2nd order patterns. AB, AX & ABX systems, stereochemical assignments. 2D NMR, MRI. ^{13}C NMR: Theory & applications. NMR of B, Al, Si, F & P nuclei-structure and dynamics of inorganic molecules. ESR spectra of organic free radicals, metal complexes, spin traps. NQR spectroscopy: Townes-Dailey theory, techniques, instrumentation, applications. Mass spectroscopy: Instrumentation, molecular ions, meta-stable, isotope abundance, fragmentation types & rules. McLafferty rearrangement. ESI-MS & MALDI-MS. Single crystal X-ray analysis.

Silverstein, Bassler&Monnill, Spectrometric Identification of Organic Compounds, Wiley, 1981.

W.Kemp, Organic Spectroscopy-3rd Ed. Pagrave Publishers, New York, 1991.

P.S.Kalsi, Spectroscopy of Organic Compounds-3rd Ed. New Age, New Delhi, 2000.

E.A.V. Ebsworth, D.W.H.Ranklin and S.Cradock: Structural Methods in Inorganic Chemistry, Blackwell Scientific, 1991.

J. A. Iggo: NMR Spectroscopy in Inorganic Chemistry, Oxford University Press, 1999.

D. H. Williams, I. Fleming, Spectroscopic methods in organic chemistry, Tata McGraw Hill. 1988.

Jack D. Dunits, x-ray analysis & the structure of organic molecules, Wiley-VCH; 2 edition, 1996.

Lund A., Shiotani M., Principles and Applications of Electron Spin Resonance, Springer Verlag, 2008.

CY756 Inorganic Chemistry Practicals – II (0-0-4) 2

Preparation and analysis of metal complexes, characterization by spectroscopic, magnetic, thermal and x-ray diffraction methods. Instrumental methods, pH-metry, potentiometry, polarography, amperometry, spectrophotometry, turbidimetry, flame photometry, atomic absorption spectrometry, fluorometry, coulometry, and electrogravimetry. Solvent extraction and Chromatography.

G. Pass and H. Sutcliffe, Practical Inorganic Chemistry, Chapman-Hall, London, 1974.

D.M. Adams and J.B. Raynor, advanced Practical Inorganic Chemistry, John Wiley and Sons, New York, 1967.

G. Brauer (Ed.) Handbook of Preparative Inorganic Chemistry, 2nd Edition, Vols. I and II, Academic Press, New York, 1963.

CY757 Physical Chemistry Practicals – I (0-0-4) 2

Experiments involving Thermodynamics, Kinetics, Electrochemistry, Spectroscopy, Crystal structure analysis, Photo chemistry, Refractometry and Polarimetry.

D.P. Shoemaker and C.W. Garland, Experiments in Physical Chemistry, McGraw-Hill, New York 1962.

F. Daniels, J.W. Williams, P. Bender, R.A. Alberty and C.D. Cornwell, Experimental Physical Chemistry, McGraw-Hill 1962.

J. B. Yadav, Advanced Practical Physical Chemistry, 1989.

CY801 Inorganic Chemistry – III (3-0-0) 3

Chemistry of transition and inner transition metals. Co-ordination Chemistry: Theories of metal ligand bonding-Valence Bond Theory, crystal field theory, spectrochemical series. Jahn-Teller distortion. Pi-bonding and molecular orbital theory. Spectral properties of complexes, term symbol of d^n ions. Orgel and Tanaber-Sugano diagrams. Charge transfer transitions. Magnetic properties - types of magnetic behavior, crystal field and M.O. interpretation, spin-orbit coupling, Gouy and Faraday methods.Isomerism in complexes. Kinetics and Mechanism of Ligand displacement and addition reactions in octahedral and square planar complexes. Coordination Chemistry of Inner transition Metals. Metal ions in biological systems.

S.F.A. Kettle, Coordination Chemistry, ELBS & NELSON, 1969.

F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd Edn., Wiley Eastern, 1977.

J.E. Huheey, Inorganic Chemistry, Principles of Structure and Reactivity, 4th Edn., Harper & Row, 1978.

H.J. Emeleen and A.G. Sharpe, Modern Aspects of Inorganic chemistry, 4th Edn.,ELBS & Roultedge of Kegan Paul, 1978.

P. Powell, Principles of Organometallic Chemistry, ELBS, Chapman and Hall, London, 1988.

CY802 Organic Chemistry – III (3-0-0) 4

Carbohydrates:Configuration & conformation, derivatives of monosaccharides-ethers, esters, acetals, ketals, deoxysugars, structure of disaccharides-maltose, cellobiose and sucrose, structures of cellulose, chitin, starch, glycogen & their degradation. Amino acids, peptides & proteins: peptide bond synthesis, solid phase peptide synthesis-Merrifield

method. Structure of proteins. Lipids:Classification, structure, properties and synthesis of fatty acids. Heterocyclic compounds: Classification, nomenclature, structure, reactivity, synthesis and reactions of three, four, five and six membered heterocycles, fused heterocycles and bridged heterocycles. Mesoionic compounds. Synthesis of bases of nucleic acids. Structural elucidation caffeine. anthocyanins & flavones. Natural products: Alkaloids - isolation and methods of structural determination, physiological activity, taxonomy, biogenesis. Terpenoids – isolation, isoprene rule, structural elucidation. Carotenoids. Steroids. Vitamins - B-complex & K group.

J. Joule & G. Smith, Heterocyclic Chemistry, Van-Nostrand, ELBS, 1978.
Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, Wiley –Eastern, 1987.
Katritzky & Rees, Comprehensive Heterocyclic Chemistry, Vol-I-VI Ed. Pergamon, 1984.
O.P.Agarwal, Chemistry of Natural Products – Vol-I & II, Goel Gorakhpur, 1985.
I. .L.Finar, Organic Chemistry-Vol-I-II, Longmann ELBS London, 2000.

CY 803 Physical Chemistry – III (3-0-0) 3

Ionics-Ion-solvent interactions, ion–dipole theory of solvation, ion-ion interaction, Debye-Huckel theory, Mass transport in solution. - Fick's laws of diffusion, Limiting current density, Einstein relation between diffusion coefficient and ionic mobility, Electrodics-electrical double layer, electrode-electrolyte interface. Thermodynamics of electrified interfaces, electrocapillary curves, Lipmann equation, surface excess, structure of electrified interfaces: Helmholtz-Perrin, Guoy-Chapman and Stern models. Applications of electrochemistry in supercapacitor study, Corrosion and corrosion prevention- Thermodynamics and kinetics of corrosion, methods of prevention to corrosion, theories of overvoltage, mixed potential theory, polarization, exchange current density, Pourbaix diagram, Buttler-Volmer equation, kinetics of electron transfier, Stearn Geary equation, Tafel equation, Linear polarization, Electrochemical impedance spectroscopy and its applications.

J. O'M Bockris and AKN Reddy, Modern Electrochemistry- Vol. I & II, Plenum Press, N.Y.
Nestor Perez, Electrochemistry and Corrosion, Kluwer Academic Publishers, 2001.
Jones, D.A., Principles and prevention of corrosion, Prentice Hall, New York. (1996).
Mars G Fontana, Corrosion engineering, McGraw Hill Book Co., New York, Third edition(1987).
Bard, A. J., and Faulkner, L. R., Electrochemical Methods, second edition, Wiley, New York

CY804 Organic Chemistry Practicals – II (0-0-4) 2

Separation of ternary mixtures. Quantitative determination of nitrogen, carbon, hydrogen, sulphur of an organic compound. Multi-step organic synthesis involving dyes, polymers, drugs etc. Isolation and characterization of natural products like caffeine, vitamin C, casein, lipase etc. Extraction of oil from oil seed and characterization of oil. Purification of organic compounds by column and TLC, steam distillation, fractional distillation etc. Protein analysis and antimicrobial studies.

P. R. Singh et al, Experimental Organic Chemistry–Vol. I & II TMH New Delhi, 1981.
Dey & Sitaraman, Laboratory Manual in Organic Chemistry, Allied-New Delhi, 1992.
B. S. Furniss et al., Vogel's Text Book of Practical Organic Chemistry including Qualitative Organic Analysis, Longman-ELBS, London, 1989.
F .G. Mann and B. C. Saunders, Practical Organic Chemistry, ELBS, England, 2001.
Cheronis et al., Semimicro Qualitative Organic Analysis, Wiley-Eastern, New Delhi, 1964.
In-house laboratory manual with the experimental procedures and relevant literature.

CY805 Physical Chemistry Practicals – II (0-0-6) 3

Experiments involving instruments like Electrochemical work station, IR spectrometer, UV-Visible spectrophotometer, NMR spectrometer, TGA and DSC, Stripping analysis, Ionometers, Cyclic voltammetry experiments, Surface area analysis.

D.P. Shoemaker and C.W. Garland, Experiments in Physical Chemistry, McGraw-Hill, New York 1962.
F. Daniels, J.W. Williams, P. Bender, R.A. Alberty & C.D. Cornwell, Experimental Physical Chemistry, McGraw-Hill 1962.
Journal of Chemical Education, latest issues.

CY860 Environmental Chemistry (3-0-0) 3

Environmental segments, hydrological, oxygen, nitrogen, phosphate and sulphur cycle. Atmosphere: Composition, structure and evolution. Chemical and photochemical reactions in the atmosphere. Water resources, complexation in natural and waste water, microbially mediated aquatic reactions. Composition of Lithosphere, water, air, organic and inorganic components in soil. Nitrogen pathways, NPK, wastes and pollutants in the soil. Air pollutants: CO, NO_X, Hydrocarbons, Photochemical smog, SO_2, acid rain, particulates, radioactivity. Tropospheric chemistry. Water

pollution, aquatic environment, water pollutants, pesticides insecticides, detergents, sediments , radioactive materials and thermal pollution. Wastewater treatment. Water quality parameters and standards, sampling, monitoring techniques and methodology, pH, Conductivity, DO, NH_3, Cl^-, F^-,CN^- , S^{2-}, SO_4^{2-}, PO_4^{3-}, B, Si, metals and metalloids, hardness, COD,BOD,TOC, phenols, pesticides, surfactants, tannin, lignin and E.coli. Chemical toxicology: Toxic chemicals in the environment, Biochemical effects of As, Cd, Pb, Hg, CO, NOx, SO_2,O_3, PAN,CN, pesticides and carcinogens.

A. K. De, Environmental Chemistry, New Age Intl.(Pvt) Ltd.,1998.
C.N.Sawyer, P.L.McCarty and G.F. Parkin, Chemistry for Environmental Engineering, McGraw-Hill, 1990.
S.E.Manahan, Environmental Chemistry, Lewis Publishers, 2001.
JO'M – Bockris (ed), Environmental Chemistry, Plenum Press, New York, 1977.

CY861 Organometallic Chemistry (3-0-0) 3

Organometallic compounds: Classification, nomenclature, and characteristics. General properties, 18-electron rule, Organometallic compounds of main group elements: Preparative routes, structural aspects, multiple bonded silicon and arsenic organometallics, cyclopentadienyl complexes. Organometallic compounds of transition elements: Synthesis and structural properties, reactivity. Transition metal pi-complexes with unsaturated organic molecules: Preparation, properties and structural features. Applications of organometallics in oxidative addition, oxidative coupling, reductive elimination, insertion and deinsertion reactions, hydrogenation, carbonylation, hydroformylation, isomerization, aasociative substitution, dissociative substitution, activation of C-H bond, polymerization of olefins, Fischer-Tropsch process, Water Gas Shift reaction. Biological applications and environmental aspects.

R. C. Mehrotra and A.Singh: Organometallic Chemistry, New Age International, 1999.
J. P. Collman, L. S. Hegedus, J.R.Norton and R.G.Finke: Principles and Applications of Organotransition Metal Chemistry, University Science Books, 1987.
F.A.Cotton and G.Wilkinson: Advanced Inorganic Chemistry (5^{th} Ed.), Wiley,1991.
R.H.Crabtree: Organometallic Chemistry of Transition Metals, Wiley, 1998.

CY862 Bioinorganic Chemistry (3-0-0) 3

Metal ions in biology, their vital role in the active-site structure and function of metallo-proteins and-enzymes. Heme and non-heme systems with one, two or multi-metal centers, photosynthesis and photosystem II. Peptide and nucleotide hydrolytic enzymes, metal environment, electronic, magnetic and redox properties; functions such as electron-transfer, O_2-binding, reduction to O_2^-, O_2^{2-} and O^{2-}species their utilization of hydroxylation and epoxidation, fixation of N_2, water – oxidation (Oxygen Evolving Complex) reactions. Synthetic models: design and strategy in the synthesis of ligand-metal complexes, redox potentials, reactivity of O_2, CO, NO, N_2; mechanistic aspects, high-valent metal-oxo systems. Interaction of metal ions with nucleotides and peptides, hydrolysis of phosphate and amide groups and related mechanistic aspects. Metal based drugs, environmental applications and toxic effects (Cd, Hg, Cr) of metal ions. Physical techniques in bioinorganic chemistry: Spectrophotometry X-ray crystallography, paramagnetic, NMR and EPR spectroscopy, magnetic susceptibility, electrochemistry.

Lippard, S.J. and Berg, J.M. Principles of Bioinorganic Chemistry, University Science Books, 1994.
Fenton, D.E., Biocoordination Chemistry (Chemistry Primer 26), Oxford University Press, 1996.
Bertini, 1., Gray, H.B.; Lippard, S.J.; Valentine, J.S.,Bioinorganic Chemistry, University Science Books, 1994.
Siegel, H. and Spiro, T.G. Metal ions of Biological Systems, Mercel-Dekker, 1980 to present.
Lehniger, A.L., Principles of Biochemistry, New York, Worth, 1982.

CY863 Novel Inorganic Compounds (3-0-0) 3

Acylic & cyclic systems from the periodic table - Inorganic homo-& heterocycles, saturated and unsaturated ring systems, π-electron precise and rich rings, synthesis, structure and reactivity. Metallocycles - Chemistry of individual rings. Cages & clusters of Elements, structural variety, properties and implications of borides, carbides, silicides, nitrides, phosphides, oxides and sulphides of transition elements, multiple bonds and cluster variety of transition metals. Higher boranes, carboranes and metalloboranes. Inorganic polymers, definition, variety and merits, P, Si, S, N & O based polymers. Polyphosphazenes, polythiazenes, poly siloxanes and poly silanes.

D.M.P. Mingos and D.J.Wales, Introduction to Cluster Chemistry, Prentice Hall, New Jersey, 1990.
N.N. Greenwood and E.A. Earmshaw, Chemistry of Elements, Pergamann Press, 1984.
F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley, New York 1988.
I. Haiduc & D.B. Sowerby (Eds,), Inorganic Homo-and Heterocycles, Vols. 1 & 2, Acad. Press, (NY), 1987.
J.E. Mark, R. West & H.R. Allcock, Inorganic polymers, Acad. Press, (NY) 1992.

CY 864 Chemistry of Nano-Materials (3-0-0) 3

Nanomaterials, size effects, general methods of preparation, sol-gel, solvothermal, sonochemistry and other novel methods of synthesis, properties and uses of nanomaterials. Growth of nanocrystals in solution, structure, energy bands, methods of measuring properties, particle size determination. Characterization techniques, metal and semiconductor nanocrystals, oxide nanoparticles, nanotubes and nanowires, nanostructured polymers and composites, nanoporous materials, nanocatalysts, industrial applications.

C.N.R. Rao, A. Muller and A.K. Cheetham,(Eds.), The Chemistry of Nanomaterials, Vol I & II, Wiley – VCH, 2004.
C.N.R. Rao, A. Muller and A.K. Cheetham,(Eds.), The Chemistry of Nanomaterials, Wiley – VCH, 2004.
Charles P Poole Jr and Frank J Owens, Introduction to Nanotechnology, Wiley Interscience, 2003.

CY865 Chemistry of Macromolecules (3-0-0) 3

Classification, nomenclature, molecular weights, glass transition, degree of crystallinity, morphology, and viscosity, structure-property relationship. Mechanisms and methods of polymerization – mechanism of step polymerization, reactivity. Chain polymerization, radical polymerizations (INIFERTER, ATRP, RAFT, SET). Living polymerizations. Ziegler-Natta & metathesis polymerizations. Polymer characterization. Polymer degradation. Polymer membranes. Conducting polymers. Liquid crystal polymers. Polyelectrolytes. Polymer adhesives. Hydrogels. Polymers for high temperature applications. Biodegradable polymers. Drug delivery polymers. Polymers for electronics.

R. J. Young and P. A. Lovell, Introduction to Polymers, 2nd Edition, Chapman and Hall, 2002.
F. W. Billmeyer, Textbook of Polymer Science, 3rd Edition, John Wiley, 1994.
G. Odian, Principles of Polymerization, Fourth edition, Wiley-Interscience, 2004.
L. H. Sperling, Introduction to Physical Polymer Science, Wiley- Interscience, 1986.
M. Rubinstein and R. A. Colby, Polymer Physics, Oxford University Pres
J.R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Dehli, 1999.

CY866 Chemistry of Natural Products (3-0-0) 3

Alkaloids: Detailed study of structural elucidation, stereochemistry, rearrangement, synthesis & biogenesis of alkaloids - Papaverine, Adrenaline, Ephedrine, Piperine, Cinchonine, Quinine, Morphine and Reserpine. Terpenoids: Structural elucidation & synthesis of terpenoids - Geraniol, Menthol, α-pinene, Camphor; Farnesol, Zingiberene and α-Santonin. Diterpenoids: Abietic and Pimaric & Gibberillic acid;.Triterpenoids: Squalenes Steroids: Blanc's rule, Barbier-Wieland degradation. Chemistry of Cholestrol, Ergosterol, Vitamin-D & bile acids. Steroidal hormones: Oestrone, esterdiol, estriol & their relationship. Progesterone, androsterone & testosterone, Synthesis of cortisone, cortisol & aldosterone. Transformations in steroids and hormones. Porphyrins: Synthesis, structure and degradation products of Hemoglobin and Chlorophyll.

G.R.Chatwal, Natural Products Chemistry Vol-I & II. Himalaya Bomba), 1990.
O.P.Agarwal, Chemistry of Natural Products – Vol-I & II, Goel Gorakhpur, 1985.
I.L.Finar, Organic Chemistry-Vol-I-II, Longmann ELBS London, 2000.

CY867 Medicinal Chemistry (3-0-0) 3

Concepts, definitions, pharmacophores, pharmacodynamics and pharmacokinetics, drug targets: proteins, enzymes, receptors, nucleic acids, miscellaneous targets. Enzymes & receptors. ADMET of drugs: Factors affecting ADMET. Drug discovery, design and development, drug optimization, structure-activity relationships, strategies in drug design. QSAR and combinatorial synthesis. Optimization of drug-target interactions and access to drug targets. Pro-drugs and drug delivery systems. Illustration of drug development through specific examples. Drug resistance, Drug synergism and combination therapy. General anesthetics, anticonvulsants, antipyretic, analgesic, cardiovascular, NSAIDs, antfertility, anticancer & antiviral drugs.

Ashutoshkar, Medicinal Chemistry, New Age Int. Publications, 2005.
G.R.Chatwal, Medicinal Chemistry, Himalaya Publishing House, 2002.
Patric, G. L., An Introduction to Medicinal Chemistry. 3rd ed.; Oxford University Press: 2005.
Silverman, R. B., The Organic Chemistry of Drug Design and Drug Action. 2nd ed.; Academic Press: 2004.
Williams, D. A.; Lemke, T. L., Foye's Principles of Medicinal Chemistry. 5th ed.; Wolters Kluwer Health (India) Pvt. Ltd.: 2006.

CY868 Synthetic Methods in Organic Chemistry (3-0-0) 3

Oxidation: oxidation of alcohols & ketonic compounds, oxygen addition at C=C, oxidative cleavage of C=C bonds, transition metal oxidants. Ozonolysis. Reduction: catalytic, metal hydride and electron transfer reductions, hydrogenolysis. Retrosynthetic analysis: Principles & terminology, disconnection approach, C-X disconnections, one

group C-C & two group C-C disconnections. Protecting groups: protection & deprotection of hydroxy, carboxyl, carbonyl, carboxy amino groups & carbon-carbon multiple bonds. Organometallic reagents: Organolithium, organo magnesium, organo zinc, organo cadmium & organo mercury compounds. Silicon and boron containing reagents. Peterson reaction. Hydroborations, organoboranes. Organotin compounds: synthesis & utility of organostannanes.

F. A. Cary and R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th Edition, Springer, 2009.
S. Warren, Organic Synthesis, The disconnection Approach, John Wiley & Sons, 2004.
J. Tsuji, Palladium Reagents and Catalysts, New Perspectives for the 21st Century, John Wiley & Sons, 2003.
Advanced Organic Chemistry- Reaction Mechanisms, Reinhard Bruckner, (Academic press, USA), 2005.
N.Carruthers, Modern Methods of Organic Synthesis, Cambridge University, 1996.

CY869 Molecular Modelling & Drug Design (3-0-0) 3

Computational programming. Use of standard analysis softwares to solve chemistry problems. Structure & dynamics of bio-molecules, protein folding, free energy, molecular simulation, dielectric continuum method, empirical approaches, rate constants, docking, elucidation of enzyme structure & mechanism, kinetic, spectroscopic, isotopic & stereo-chemical studies. Molecular modeling, conformational analysis. Chemical models & mimics for enzymes, receptors, peptides, carbohydrates, nucleic acids & other bioactive molecules, catalytic antibiotics. Design, synthesis & evaluation of enzyme inhibitors. Structure based drug design, physical & chemical based factors associated with biological activities. Computer aided drug design: Captopril, substrate based drug design of protease inhibitors. Qualitative and quantitative structure-activity relationships.

Richard B. Silvermann, The Organic Chemistry of Drug Design and Drug Action, Academic Press, 1992.
O. M. Dean, Molecular Foundations of Drug-Receptor interactions, Cambridge Univ. Press, Cambridge, 1987
T. A. Clark, A Handbook of Computational Chemistry, Wiley, New York 1985.
D. DeCamp, R. Ogden, I. Kuntz and C. S. Craik in: Protein Engineering Principles and Practice (Eds J. L. Cleland and C. S. Craik) Wiley-Liss Inc New York, 1996.

CY870 Surface Chemistry & Catalysis (3-0-0) 3

Basic concepts Surface vibrations, General aspects Surface reactions, co-adsorption, poisoning and promotion effects, model reactions, Chemistry of bimetallic surfaces, surface alloys, surface segregation and faceting. Surface modification. Techniques for surface investigation. BET theory of adsorption. Determination of surface area (BET equation). Surface films on liquids (Electro-kinetic phenomenon) Catalytic activity at surfaces. Preparation of catalyst and their behavior: Role of supports, preparation & structure of supports, silica, alumina, silica-alumina, zeolities, carbon manufacture, catalyst size & shape, pre-treatments. Deactivation process, sintering, poisoning & catalyst fouling. Definition of performance criteria of catalysts: Activity, selectivity, temperature response, catalyst life. Homogeneous and heterogeneous catalysis, mechanisms and applications ocillatory reactions, autocatalysis.

A.W. Adamson, Physical Chemistry of Surfaces, 6th ed., New York, Wiley, 1997.
John. C. Vickerman(ed.), Surface Analysis: The principal Techniques, John Wiley & Sons, New York, 1997.
G.A. Somorjai, Introduction to Surface Chemistry and Catalysis. , John Wiley, New York, 1994.
K. Christmann, Introduction to Surface Physical Chemistry, (Topics in Physical Chemistry Vol. l), Springer-Verlag, 1991.
R. Pearce and W.B. Patterson, Catalysis and Chemical Process: (Blackie & Sons.), 1981.

CY871 Chemical & Electrochemical Energy Systems (3-0-0) 3

Available energy options, their advantages and disadvantages. Fossil fuels petroleum natural gas and coal-Origin, processing and production of value added products-available current conversion technologies. Nuclear Energy Principles of Fission – Fission reactors. Electrochemical power sources-theoretical background on the basis of thermodynamic and kinetic considerations. Primary electrolyte cells, Secondary electrolyte cells- classification based on electrolyte type temperature of operation on the basis of electrodes. Fuel cells-classification-chemistry of fuel cells. Solar energy conversion devices-photovoltaic cells-photoelectrochemical cells-semiconductor electrolyte junctions photocatalytic modes for fuel conversion process-photobiochemical options. Hydrogen as a fuel production (Thermal, electrolysis, photolysis and photo-electrochemical) storage and applications of hydrogen storage. Other methods of energy conversion processes especially in the form of storage as chemical energy.

C.A. Vincent Modern Batteries, Edward Arnold, 1984.
R. Narayan and B. Viswanathan, Chemical and Electrochemical Energy systems, University Press 1998.
K. Sriram, Basic Nuclear Engineering, Wiley Easter, 1990.
D. Linden Hand book of batteries and fuel cells, McGraw Hill Book Company 1984.
T. Ohta, Solar Hydrogen energy systems, Peragamon Press, 1979.

CY872 Biophysical & Photochemistry (3-0-0) 3

Bioenergetics, Biopolymer Interactions: Forces involved in biopolymer interactions-electrostatic changes and molecular expansions, hydrophobic forces, dispersion force interactions. Thermodynamic of Biopolymer solutions: Osmotic pressure, membrane equilibrium muscular contractions and energy generation in mechano-chemical system. Cell Membrane and Transport, Photochemical region and energy associated with uv-vis region, laws of photochemistry, Stem Volmer analysis, photofragmentation, photoaddition, type I and type II cleavages, photosubstitution, cycloaddition, Paterno-Buchi reaction, isomerization and rearrangement reactions, photoreduction and photooxidation reactions, singlet oxygen and chemiluminescence, Photoinduced electron transfer reactions (PET), application to solar energy conservation and artificial photosynthetic systems. Photochemical substitution in transition metal complexes.

K.K. Rohatgi Mukherjee, Fundamentls of Photochemistry, Wiley Eastern Ltd., New Delhi, 1978
N.j. Turro, Modern Molecular Photochemistry, The Benjamin Cummings Publishing Co. Ltd. Menlo Park 1978.
J. Clavert and J. Pitts, Photochemistry, John Wiley, New York 1965.
D.O. Ccowan and R.L. Drisko, Elements or Organic Photochemistry Plenum Press, New York 1976.
I. Ninomiya and T. Naito, Photochemistry Synthesis, Academic Press, New York 1989.

CY873 Nuclear & Radiation Chemistry (3-0-0) 3

Nuclear chemistry: Basic concepts, Radioactivity and Nuclear Decay- Radioactive decay modes of natural and artificial nuclides, Radiation Detection and Measurement: Experimental techniques in the assay of radioactive isotopes. Radiation Detectors-Gas filled (ion chambers, proportional and GM counters), scintillation and semiconductor detectors (Nal-Tl and Ge(Li), HPGe solid state detectors)- important features of detectors. Nuclear Reactions and Radiosotopes ,Nuclear reactos-Power(types and basic features) and breeder reactors. Production and separation methods of radioisotopes and labeled compounds, Szilard-Chalmer process , Radiation Sources and Dosimetry-units, radiation dose, radiation chemical yield and primary dosimeters, Health and Safety Aspects: Biological effects of radiation, Hazards in radiochemical work. Radiation protection, permissible exposure doses, radioactive waste management.

Friedlander, Kennedy Macias & Miller, Nuclear and Radiation Chemistry, Wiley, 1985.
H J. Amikar, Essential of Nuclear Chemistry, Wiley Eastern, 1987.
Spinks and Woods, An Introduction to Radiation Chemistry, Wiley, New York, 1990.
Farhataziz and Rodgers, Radiation Chemistry: Principles and Applications, VCH, Weinheim.
G. F. Knoll,Radiation Detection and Measurement, John Wiley, New York, 1989.

CY874 Solid State Chemistry (3-0-0) 3

Crystal Structure: Crystalline solids, crystal systems space groups: methods of characterising crystal structure-Powder x-ray diffraction, electron and neutron diffraction; Types of close packing-hcp and ccp. Packing efficiency, radius ratios; structure types-NaCl, ZnS, Na_2O, $CdCl_2$, wurtzite, nickel arsenide, CsCl, Cdl_2, rutile and Cs_2O, perocskite ABO_3, K_2NiF_4, spinels. Thermal analysis, microscopy and spectroscopy as tools of characterization,Development of free electron theory to band theory of solids-metals and their properties; semiconductors-extrinsic and intrinsic, Hall effect; Insulators-Dielectric, Ferroelectric, Pyroelectric and Peizoelectric properties and the relationship between them. Magnetic properties: Dia, para, ferro, ferri, antiferro and antiferri magnetic types- selected magnetic materials such as spinels, garnets and perovskites. Superconductivity, Amorphous materials-glasses and refractories. New Materials - Zeolites, Fullerenes. Defects-color centers-reactivity.

A.R. West, Solid State Chemistry and its applications John Weley & Sons, Singapore 1984.
Lesley Smart and Elaine Moore, Solid State Chemistry-An Introduction Chapman & Hall, London,1992.
H.V. Keer, Principles of the Solid State, Wiley Eastern Limited, New Delhi, 1993.
D.K. Chakrabarty, Solid State Chemistry, New Age Publication, 1996.
L.Azaroff, An Introduction to Solids. McGraw Hill, 1985.

CY 875 Corrosion Science (3-0-0) 3

Introduction to corrosion,vation and diffusion controlled corrosion, potential-pH diagrams, passivity, different forms of corrosion, Theories of corrosion, Environmental aspects, Atmospheric corrosion monitoring methods, corrosion testing by NDT. Electrochemical AC and DC techniques, Electrochemical noise study, Corrosion control methods, Design aspects in corrosion control, corrosion resistant materials, corrosion inhibitors, Electrochemical methods – cathodic and anodic protection, protective coatings, organic, inorganic and metal coatings. Corrosion control methods in fertilizer, petrochemical and chemical industries.

S.N. Banerjee, An Introduction to Corrosion and Corrosion Inhibition, Oxonian Press Ltd., 2000.
L.L. Shrier, Corrosion Vol I & II, George Nownons Ltd, London, 2nd Edn.,1998.

M.G. Fontana, and N.D. Greens,Corrosion Engineering, McGraw Hill, New York, 3rd Edn., 2004.
H.H. Uhlig, Corrosion and Corrosion Control, Wiley-Interscience, 2002.
D. A. Jones, Principles and Prevention of Corrosion, Prentice-Hall, 2nd Ecn., 1996.

CY 876 Advanced Organic synthesis (3-0-0) 3

Alkylation of enolates & other carbon nucleophiles, control of enantioselectivity, the nitrogen analogs of enols & enolates, enamines & imine anions, reductive amination. 1,3-Dipolar cycloaddition. Modern methods of reduction & oxidation reactions. Organometallic reagents in organic synthesis: Pd, Rh, Ru & Ni based reagents, Suzuki, Stille, Sonogoshira, Heck & Negeshi couplings. Modern methods: Baylis-Hillman, Henry, Nef, Kulinkovich, Ritter, Sakurai, Tishchenko and Ugi reactions. Brook rearrangement. Tebbe olefination. Stereoselective & stereospecific reactions, stereochemical control in acyclic, cyclic & other bicyclic systems. Controlling geometry of double bonds, determination of stereochemistry. Asymmetric synthesis: chiral pool strategy, chiral auxiliaries, chiral reagents and catalysts.

R.E.Ireland, Organic Synthesis, Prentice Hall India, 1969.
Anand, Bindra & Ranganath, Art in Organic Synthesis, Wiley New Delhi, 1970.
M. B. Smith, Organic Synthesis, 2nd Edition, 2005
P.S.Kalsi, Organic Reactions and their mechanisms, New Age, New Delhi, 1996.
S. Warren, Organic Synthesis, The disconnection Approach, John Wiley & Sons, 2004.
I. Ojima, Catalytic Asymmetric Synthesis, 2nd edition, Wiley−VCH, New York, 2000.

CY 877 Biochemistry (3-0-0) 3

Cell structure and functions: Overview of metabolic processes, ATP- the biological energy currency, ETS, metabolism of glucose, amino acids and lipids, Digestion. Biological membranes, Fluid mosaic model of membrane structure. Enzymes: Types, specificity, mechanism & conjugated proteins. Hemoglobin & its function. Carbohydrates: Polysaccharides.. Nucleic acids: Flow of genetic information, nature of genetic code, replication of DNA, transcription and translation, regulation of gene expression. Biochemical reactions of TPP, PLP, Lipoic acid, Vitamins: A, B, C, D, E, K. Coenzyme A. Recombinant DNA technology. Bioinformatics.

Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, Principles of Biochemistry 6th edition, W.H. Freeman & Co., 2006.
D. L. Nelson & M. M. Cox. Lehninger, Principles of Biochemistry 5th edition, W. H. Freeman &Co. 2008.
Outlines of Biochemistry 5th edition 2001- Conn, E.E., Stumpf, P. K. Bruening, G. and Doi, R.H. (John Wiley and Sons).
R.K. Murray et al., Harper's Illustrated Biochemistry, McGraw Hil.
D. Voet et al., Fundamentals of Biochemistry, 2006.

CY 878 Supramolecular Chemistry (3-0-0) 3

Definition. Binding interactions: ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-p, anion-p, p-p, and van der Waals interactions. Synthesis of crown ethers, lariat ethers, podands, cryptands, spherands, calixarenes, cyclodextrins, cyclophanes, cryptophanes, carcerands & hemicarcerands. Host-Guest interactions, pre-organization & complimentarity, lock and key analogy. Crystal engineering: Role of weak interactions. Self-assembly molecules: Design, synthesis & properties, self assembling by H-bonding, metal-ligand interactions & other weak interactions, metallomacrocycles, catenanes, rotaxanes, helicates & knots. Molecular electronic devices, molecular-wires, -rectifiers, -switches, -logic. Supramolecular chemistry to enzyme mimics, ion channel mimics, supramolecular catalysis etc.

J. M. Lehn, Supramolecular Chemistry-Concepts and Perspectives Wiley-VCH, 1995.
P. D. Beer, P. A. Gale, D. K. Smith; Supramolecular Chemistry Oxford University Press, 1999.
J. W. Steed and J. L. Atwood; Supramolecular Chemistry Wiley, 2000.

CY 879 Green Chemistry (3-0-0) 3

Importance, principle and scope. Green reagents-Dimethyl carbonate, polymer supported reagents, peracids, chromic acid. Green catalysts-acid catalysts-oxidation catalysts, basic catalysts, polymer supported catalysts & phase transfer catalysts. Ionic liquids: Reactions in acidic & neutral ionic liquids. Synthetic organic transformation under RT. Microwave assisted reactions in water- Hoffmann elimination, hydrolysis, oxidation, saphonification reactions, Microwave assisted reactions in organic solvents-esterification, Fries rearrangement, Deils-Alder reactions, decarboxylation. Ultrasound assisted reactions. Aqueous reactions: Aldol & Benzoin condensations, Diels-Alder & Knovenegol reactions, Solid state reactions- without solvents, solid supported synthesis.

Paul T. Anastas, John Charles Warner, Green Chemistry: Theory & Practice ISBN13:9780198506980.

V.K. Ahulwalia & M. Kidwai, New trends in green chemistry. ISBN 1-4020-1872-X Anamaya publishers.
Clark, James & Macquarrie, Duncan, Handbook of green chemistry & technology, Blackwell Publishing ISBN 0-632-05715-7.

CY 880 Computational Chemistry (3-0-0) 3

Basic structure and functioning of computers. Principles of programming. algorithms and flow charts. ORIGIN, SIGMA PLOT, CHEM SKETCH etc. & solve physical/organic/polymer chemistry related problems. Plotting curves. Writing the structures, chemical equations, determining molecular parameters such as bond lengths, bond angles, dihedral angles etc. Bound-state *ab initio* quantum mechanical & density functional calculations, understanding of basis set types & sizes, computational scalability, Hartree-Fock and Post-Hartree-Fock calculations for determining electronic energies & associated molecular properties, electronic structure & thermochemical properties, geometry optimization, study of reaction mechanism, transition-state optimizations. Computer aided drug design. Molecular docking.

Franck Jensen, Introduction to computational chemistry, 2nd Ed., John Wiley & Sons Ltd. 2007.
Ramesh Kumari, Narosa, Computers and their applications to Chemistry.
Mc graw Hill, Theory and Problems of Programming with Basic, NY, 1987.
Ram Kumar, Programming with Fortran 77, Tata McGraw Hill, 1989.
K. J. Johnson, Marcel Dekker, Numerical methods in chemistry, NY, 1980.

CY 881 Applied Organic Chemistry (3-0-0) 3

Manufacture, properties & applications of Polyethene, Polypropylene, PVC, Polystyrene & Acrylic polymers, Teflon, Phenol-formaldehyde, Urea-formaldehyde, Nylon, Polyesters, Caprolactums. Dyes: Colour and constitution, methods of applying. Azo dyes, orange –II, mordant brown, congo red and methyl orange; triphenyl methane dyes- malachite green, rosaniline, crystal violet and phenolphthalein; cyanin dyes - cyanin blue and quinaldine; reactive dyes and optical brightners. Pigments: Fast violet, lake red and orange R. Pesticides and Insecticides: Classification. Nicotine, pyrethrins, rotenone and allethrin, DDT, methoxychlor, BHC, aldcin, malathion and parathion. Fumigents and repellants. Soap & detergents. Production of acetic acid, formic acid, acetone, methanol etc., Pharmaceuticals.

Heinrich Zollinger, Color Chemistry: Synthesis, properties & applications of synthetic organic dyes & pigments, Helvetica chemical acta, 2003.
K.M. Dunn, Scientific soap making: The chemistry of the cold process, Amezon.com.
W.B. Weeler, Pesticides in agriculture and the environment, Amezon.com, 2002.
R.W. Dyson et. al, Speciality polymers, Chapman & hall, New-York, 1987.

CY 882 Polymer Chemistry and Catalysis (3-0-0) 3

Monomers, Polymerisation Process, Kinetics of Polymerisation, Polymer Molecular weights, Stereochemistry of polymers, Analysis and Identification of polymers: X-ray diffraction, thermal analysis and microscopy. Phase transitions in polymers. Polymers in solution. Catalysis: Homogeneous catalysis-equilibrium and steady state treatments, activation energies of catalysed reactions. Kinetics of enzyme catalysed reactions-Michaelis-Menten equation. Effect of pH, temperature & inhibitors. Surface reaction kinetics:BET equation and its application in surface area determination. semiconductor catalysis, n-and p-type. Mechanism of surface reactions. Uni-& bi-molecular reactions. Industrial application of catalysts.

F.W. Billmeyer, Text book of Polymer Science: (Wiley)
Gowariker, viswanathan and Sreedhar, Polymer Science: (Wiley Eastern)
J.R. Fried, Polymer science and Technology, (Prentice Hall)
K.J. Laidler, Chemical Kinetics. (Harper and Row) 1987.
Puri and Sharma, Principles of Physical Chemistry, Vishal Publications, 2010.

DEPARTMENT OF PHYSICS

PH 701 Mathematical Physics-I (3 1 0) 4

Vector calculus, Kronecker delta, Levi-Civita tensor; Curvilinear coordinates. Gradiant, Divergence, Curl, Laplacian. Linear Vector spaces. Bra-Ket notationorthogonality, Gram-Schmidt orthonormalization, Linear operators. Hilbert space. Differential equations - singular points, Frobenius method, examples. Orthogonal functions. Legendre, Bessel, Laguerre and Hermite differential equations and their solutions, Legendre, Bessel, Laguerre and Hermite functions and their properties, Spherical Harmonics. Beta and gamma functions. Properties of beta and gamma functions. Fourier Series, Fourier integral; Laplace transform. Solving differential equations using LT. Fourier Transform, Convolution Theorem, Solving differential equations using FT. Green's function technique to solve differential equations. Functions of complex variables: Analytic functions, power series, Taylor series, poles, Cauchy's theorem, Cauchy's integral formula and simple applications of calculations of residues.

G. Arfken & H. J Weber -"Mathematical Methods for Physicist", Acad. Press 6thedition (2005)

E. Kreyszig -"Advanced Engineering Mathematics, Wiley Eastern, 5th edition (1991)

K. F. Riley, M.P. Hobson and S. J. Bence, Mathematical methods for physics and engineering",; Cambridge University Press. (2004)

Jon Mathews and R.L.Walker, Mathematical Methods of Physics", second edition, , Addison-Wesley Publishing Com. (1969)

PH702 Classical Mechanics (3 1 0) 4

Mechanics of a particle, Mechanics of a system of Particles, Constraints, D'Alembert's Principle and Lagrange's Equation, Velocity Dependent Potentials and the Dissipation Function, Variational Principles and Lagrange's Equation- Hamilton's Priciple, Conservation Theorems and Symmetry Properties. The Central Force Field Problem-Reduction to Equivalent One Body Problem, The Virial Theorem, The Kepler Problem – Inverse Square Law Force, Scattering in a Central Force Field. The Hamilton Equation of Motion – Legendre Transformations and the Hamilton Equations of Motion, Cyclic Coordinates and Conservation Theorems, The Principle of Least Action. Canonical Transformations. Poisson's Brackets and Other Canonical Invariants. Hamilton – Jacobi Theory and Action Angle Variables- The Hamilton Jacobi Equation for Hamilton's Principle Function. Special theory of relativity. Lorentz transformation equations, length contraction, time dilation, velocity addition formula, mass-energy equivalence, invariance of spherical wave.

Herbert Goldstein, Charles Poole and John Safco,. Classical Mechanics by (Third Edition) Pearson Education.

Arthur Beiser, Concepts of Modern Physics by (sixth edition).

David Morin,Introduction to Classical Mechanics with Problems & Solutions, Cambridge Univ. Press, 1st Ed. 2009.R.G. Takwale and P.S. Puranik, Introduction to Classical Mechanics, , Tata McGraw Hill, 8th reprint 1987.

PH703 Quantum Mechanics-I (3 1 0) 4

Introduction to Quantum Mechanics. Planck's radiation law, Photoelectric effect, Compton effect, Stability of atoms and Atomic spectra, Wave particle duality: matter waves. de Broglie's hypothesis, Wave packets. Uncertainty Principle. Concept of wave function, Probability density function and statistical interpretation. Expectation values. General formalism of Quantum Mechanics : Fundamental postulates of wave mechanics. Commutation relations. Operators. Degeneracy, Dirac-delta function. Schrödinger wave equation. Applications of Schrödinger's time-independent wave equation : Bound states of a particle in a square well potential ($E < 0$) and non-localized states ($E > 0$) with Examples. Barrier problems and Tunnel effect. (STM) (Qualitative). Exactly soluble eigen value problems : Simple harmonic oscillator. Angular momentum and parity. Schrödinger Wave Equation in three dimensions. The Hydrogen atom, Separation of variables and quantum numbers. Energy spectrum. Space quantization, Electron probability density. Variational method. WKB Approximation.

P. M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill (1977).

R. Shankar, Principles of Quantum Mechanics, Plenum Press, New York, 1980.

A. K Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Macmillan India Ltd (1984).

PH 704 Electronics (3 1 0) 4

Network theorems. Mesh and node analysis, Star-Delta conversion.Passive Circuits. Diode Circuits. rectifier circuits, diode clipping and clamping circuits, Zener diodes, DC power supplies. Bipolar JunctionTransistors: transistor as an amplifier, CB, CE and CC configuration and characteristic curves, limits of operation**.** BJT Biasing circuits: Operating (Q-point), load-line analysis, fixed bias, emitter stabilized bias, voltage divider bias, bias stabilization. BJT Small signal analysis: Two port analysis of a transistor amplifier, h-parameter and r_e parameter model. Field Effect Transistors (FETs): Construction and characteristics of JFETs, pinch-off voltage, I-V characteristics, FET small signal model, FET biasing, common-source and common drain low-frequency amplifiers. MOSFETs. Operational Amplifiers: Difference amplifier, basic operational amplifier and its features, inverting and non-inverting amplifier, summer, integrator, differentiator, comparator. Introductory Digital Electronics: Boolean theorem and identities, OR, AND, NOT, NOR, NAND, Ex-OR/Ex-NOR gates, de Morgan's theorem.

David A. Bell, Electronic Devices and Circuits, Oxford Univ. Press, 5th Ed (2008).

Jacob Millman & Christos Halkias, Integrated Electronics, Tata McGraw Hill, 6th Reprint.

Nashelsky & Boylstad, Electronic Devices & Circuit Theory, Prentice Hall India, 7th Ed.

A.P. Malvino, Electronics Principles, McGraw Hill, 6th Ed.

PH705 Physics Lab -1 (0-0-6)4

PH 751 Condensed Matter Physics – I (3 1 0) 4

Crystal structures : Space Lattice, Unit Cell & Lattice Parameters, Crystal Systems, Bravais Lattices, Crystal Structure & Packing Fraction, Planes in Crystals.Reciprocal lattice, Diffraction of X-rays by Crystal Planes, Bragg's Law, Structure Factor, Principle of diffraction Techniques, Brillouin zones. Lattice vibrations: The 'Balls and Springs' Model of a Harmonic crystal, Normal Modes of a One-dimensional Monatomic Chain: The Periodic Boundary Condition, Salient Features of the Dispersion Curve. Normal Modes of One-dimensional Diatomic Chain. Atomic cohesion and crystal binding. Classical Free Electron Theory of Metals, Theory of Thermal conductivity. Franz law. Quantum Free Electron Theory, Optical properties of solids. Exitons, Polarons, Color Centers, Luminescence and Photoconductivity. Imperfections in Crystals. , Point Defects, Thermodynamics of Point Defects, Schottky Defects, Frenkel Defects, Line Defects. Dislocations.

Ali Omar, Elementary Solid State Physics, Addison Wesley.

C. Kittel, Introduction to solid state physics, Wiley Eastern Edition, 5/e, 1998.

L.V. Azaroff, Elements of X-ray crystallography, McGraw Hill publication, 1986.

A.J. Dekker, Electrical Engineering Materials, Prentice Hall of India, 1990

PH 752 Atomic and Molecular Spectroscopy (3 1 0) 4

Absorption and emission of radiation, Basic elements of practical spectroscopy. Microwave spectroscopy : The rotation of molecules, The rigid diatomic molecule. Intensity of spectral lines, Effect of isotopic substitution. Non-rigid rotator. Rotational spectra and Analysis. Infrared Spectroscopy : The vibrating diatomic molecule, The diatomic vibrating rotator,. Raman spectroscopy : Introduction pure rotational Raman spectra, Polarization of light and the Raman Effect, Vibrational- Raman spectra, Structure determination from Raman and Infra-red spectroscopy. Electronic spectroscopy of atoms : Electronic angular momentum, Many-electron atoms, The angular momentum of many-electron atoms, Photoelectron spectroscopy, Zeeman effect, The influence of nuclear spin. Elements of Spin Resonance Spectroscopy. Nuclear magnetic resonance spectroscopy (NMR), Electron spin resonance spectroscopy

J. Michael Hollas, Basic Atomic and Molecular Spectroscopy, RSC, Cambridge, UK, 2002

Colin N. Banwell and Elaine McCash, Fundamentals of Molecular Spectroscopy (Fourth Edition) Tata McGraw – Hill Pub. Co. New Delhi (1994)

Gerhard Herzberg, Atomic Spectra and Atomic Structure, Dover publications, New York, 1945

PH 753 Statistical & Thermal Physics (3 1 0) 4

Probability -Discrete and continuous probability distribution,mean, variance, **r**andom walk problem Binomial,

Gaussian, Poisson distribution functions. Review and statistical basis ofThermodynamics:Macroscopic and Microscopic systems, Phase Space, laws of Thermodynamics, Entropy, Specific heat, Thermodynamic potentials-Helmholtz free energy, Gibbs free energy, chemical potential, Maxwell's equations.Ensembles, Partition Function and Applications. Classical and quantum mechanical distribution functions:Equilibrium distribution, properties of distribution functions. Quantum statistical mechanics-postulates of Quantum statistical mechanics, Phase space, Density matrix, Liouvllie's theorem. Black body thermal radiation:Bose-Einstein statistical distribution function, Density of states for photons in a cavity.Fermi-Dirac distribution function: Fermi gas in metals, Fermi energy, Thermal properties of solids - Specific heat. Application to degenerate Fermi-gas. Elements of Phase Transitions.Phase diagram, Van der Waals gas, I and II order phase transitions, formation of

R K Pathria,Statistical Mechanics, Butterworth-Heinemann,Indian Edition
F. Rief, Fundamentals of Statistical and Thermal Physics, Tata-McGraw Hill
Palash B. Pal, An Introductory Course of Statistical Mechanics, Narosa, 2008
C. Kittel and Kroemer Thermal Physics

PH 754 Electromagnetic Theory (3 10) 4

Electrostatics: Review of vector calculus, Calculation of E-field, Calculation of electrostatic potential, Laplace and Poisson's equation, Multipole expansion of potential, Magnetostatics: Ampere's law and Biot-Savart's law, Computation of magnetic fields, Vector & scalar potentials, Magnetic dipole, Magnetostatics: Ampere's law and Biot-Savart's law, Computation of magnetic fields, Vector & scalar potentials, Magnetic dipole, Electrodynamics: Maxwell's equations, Wave equations and its solutions, Reflection & Refraction at a plane boundary, Potential formulation; Scalar and vector potentials, Waveguides: Rectangular waveguides, Modes of propagation, Resonant cavities and their modes, Dipole radiators, Covariant formulations of Maxwell's equations.

David J. Griffiths, Introduction to Electrodynamics, Prentice Hall, 3rd Ed.
John D. Kraus, Electromagnetics, McGraw Hill, 4th Ed.
M.N. O. Sadiku, Elements of Electrodynamics, 2nd Ed., Oxford Univ., 1995.
R.P. Feynman, Lectures on Physics, Vol. 2, Narosa Publ. Pvt. Ltd. 2002.

PH755 Physics Lab –II (0-0-6)4

PH 801 Condensed Matter Physics-II (3 1 0) 4

Band theory of solids: Bloch theorem, Kronig - Penney Model, Energy Bands of Solids, The Motion of Electrons in One Dimensions according to the Band Theory. Effective Mass of Electron. Dielectric properties: Polarization in static field – static dielectric constants, polarization mechanisms, Monatomic gases, polyatomic gases, the Internal Field (local field) in dense dielectrics, Clausius - Mosotti equation, ferroelectric materials, polarization catastrophe, hysteresis, Domain theory, Applications, pyroelectric, piezoelectric materials, Behavior of Dielectrics in alternating fields, complex dielectric constant, Dipolar relaxation, Dielectric loss and loss angle. Magnetism – Classification of Magnetic Materials Dia, Para, Ferro, Antiferro and Ferri Magnetic Materials, Weiss molecular field theory. Superconductivity : Meissner effect, type I and II superconductors, Theoretical interpretation of BCS Theory. High temperature superconductors and Applications.

Ali Omar, Elementary Solid State Physics, Pearson Education
C. Kittel, Introduction to Solid State Physics, Wiley Eastern edition, 1998.
A. J. Dekker, Electrical Engineering Materials,Prentice Hall of India, 1990.
B D Culity & CD Graham, Introduction to Magnetic Materials, Wiley

PH 802 Nuclear Physics (3 1 0) 4

General properties of Nuclei-Nuclear radius, charge distribution, Deuteron problem- Nuclear force, Nuclear binding energy, Electric and magnetic moments, Nuclear models, Radioactivity and Nuclear decay-Alfa decay-Gamow's theory, Beta decay-Fermi's theory, Gamma decay, Nuclear Reactions. Scattering theory (Qualitative)-Rutherford scattering, Nucleon-nucleon scattering, partial wave analysis, Cross section, Optical theorem. Experimental Nuclear Physics-Detectors-Gas and solid state detectors, Mass spectroscopy, Particle accelerators. Particle physics-Elementary particles, classification, Quark model.

Kenneth Krane, Nuclear Physics, John Wiley and Sons, latest edition

Griffith, Introduction to Elementary Particles
R.D. Evans, Atomic Nucleus
Kaplan, Nuclear Physics

PH803 Physics Lab-III (0-0-6)4

PH 860 Cryogenics & Low Temperature Physics (3 0 0) 3

Low temperature production and measurement, liquefaction of gases, Joule-Thomson effect, Heat transfer mechanisms, Cryostats, Superfluidity, B-E Condensation, Quantum Hall effect, Superconductivity, BCS theory, High Tc Superconductors, Josephson effect, SQUIDS, Metal insulator transitions, Superconducting magnets for Accelerators, NMR and Detectors, Laser cooling,

M.S.Thyagi, Electronic devices and circuit theory, Prentice Hall India, 1991 ,54/e.
S.M.Sze, Semiconductor Devices - Physics and Technology, John Wiley,200.

PH861 Vacuum Technology and Thin Films (3-0-0) 3

Behaviour of gases at low pressures, sources of gas release into vacuum systems – adsorption and desorption, diffusion, permeation, dynamic gas balance and ultimate pressure obtainable in vacuum system. Production of vacuum – different pumps, rotary pump, diffusion pump, turbomolecular pump. Sorption pump, cryopump, getter pumps. Measurement of reduced pressures – McLeod's gauge, thermal conductivity gauges, thermo couple gauge and pirani gauge, ionization gauges – triode gauge, Bayard-Alpert gauge, Klopfer gauge, Helmer gauge, Lafferty magnetron gauge, Penning gauge, Redhead gauge. Thin films – Methods of preparation- vacuum evaporation, sputtering electro deposition, chemical methods, liquid phase epitaxy, molecular beam epitaxy. Measurement of film thickness – optical interference technique, gravimetry, quartz crystal oscillator, other magnetic and electrical methods.

Maissel L.I and Glang R: Hand book of thin film technology, McGraw Hill Publications
*Brunner Jr.W.F and Batzer T. H : Practical vacuum techniques, Reinhold Publication*s.

PH 862 Semiconductor Devices and Applications (300)3

p-n junction – basic fabrication steps, abrupt junction and linearly graded junction, varactor diode, heterojunction. Breakdown – zener and avalanche breakdown, applications. Bipolar transistor, static characteristics, CE amplifier, frequency response and switching of BJT, hetero-junction bipolar transistors. Field effect transistor – JFET characteristics, MOSFET fundamentals, MOS memory structures – DRAM, SRAM and non volatile memory, Power MOSFET. Microwave diodes – Tunnel diode, IMPATT diode, transferred electron devices, quantum effect devices, hot electron devices. Photonic devices – Light emitting diodes, visible and infra-red LEDs, organic LED, semiconductor laser, photo-detector, solar cells.

Sze S.M : Semiconductor Devices – Physics and Technology, John Wiley Publication 2002
Tyagi M.S : Introduction to Semiconductor Materials and Devices, John Wiley Publication 2003

PH 863 Materials Preparation Techniques (3-0-0) 3

Crystal growth equilibrium, classification of growth processes, growth from solution, growth by chemical reaction, growth from meta stable phases, kinetics of crystal growth, crystal growth by solid-solid equilibria, liquid-solid equilibria, zone melting techniques, other crucible-less techniques, other liquid-solid methods, dendrite growth,crystal growth by vapour-solid equilibria, growth from liquid solution-aqueous-solution growth, hydrothermal growth, molten-salt growth, composite growth methods, vapour-liquid-solid-growth

R.A. Laudise,The Growth of Single Crystals - Prentice Hall, 1970. Crystal
J.C.Brice, Crystal Growth Processes - John Wiley, 1986.

PH 864 Physics of Thin Films (3 0 0) 3

Thin film deposition and Layered structures, Surface energies, diffusion in solids, stress in thin films, Surface Kinetic Processes, Homo-epitaxy : Si and GaAs, Hetero-epitaxy and Super-lattices, Electrical and Optical Properties of hetero-structures, Quantum wells, Schottky Barriers and Interface Potentials, Inter-diffusion, Thin film reactions, Morphological changes in thin films.

King-Ning Tu, James W. Mayer and Leonard C. Feldmann, Electronic Thin Film Science for Electrical Engineers and Materials Scientists, Macmillan Pub. Co, New York, 1987

PH 865 Crystallography (3 0 0) 3

Production and properties of x-rays, the characteristic spectrum, detection of x-rays, Geometry of crystals, Crystal systems, Symmetry in crystals, Crystal structure, Diffraction, Bragg's Law, Intensities of diffracted beam, Structure Factor, Lorentz Factor, Absorption Factor, Intensities of Powder Pattern Lines, Measurement of X-ray Intensity, Laue method, Rotating Crystal method. Moving Film method, Powder method, X-ray Diffractometer.

B.D. Cullity. Elements of X-ray Diffraction
Leonid.V.Azaroff. Elements of X-ray Crystallography,

PH 866 Magnetism & Superconductivity (3 0 0) 3

Introduction to Magnetism : Magnetic fields, Magnetic Forces and Magnetic materials. Diamagnetism, Langevin's theory of Diamagnetism, Quantum theory of Paramagnetism. Ferromagnetism and antiferromagnetism- Ferromagnetic order, Curie point and exchange integral, Magnons, Neutron Magnetic Scattering, Neutron Diffraction, Magnetic storage Devices. Nanomagnets- multi domain and single domain particles, super paramagnetism. Magnetic superlattices, Giant Magnetoresistance, Hysteresis Measurement-Vibrating sample magnetometer(VSM), Magnetic Force Microscopy(MFM). Introduction to Superconductivity, Properties of Superconductors, thermodynamics of superconducting transition, London Equations, Coherence Length, BCS theory. Flux Quantization, Types of Superconductors, High Temperature Superconductors, DC and AC Josephson effect, Quantum Interference, Superconducting Quantum Interference Device(SQUID)

C. Kittel, Introduction to solid state physics, Wiley Eastern Edition
David Jiles, Introduction to Magnetism and Magnetic Materials Taylor & Francis.
B D Cullit,y Introduction to Magnetic Materials, Wiley

PH 867 Nanomaterials (3 0 0) 3

Introduction to Nanoscience and Nanotechnology. Scaling laws. A few Examples from mechanics, electricity and magnetism, optics, etc. Size dependence of particles. Excitons. Electron confinement, quantum wells, quantum wires and quantum dots. Preparation of quantum nanostructures. Semiconductor heterostructures, Confining excitons. Single electron tunneling phenomena. Photonic properties of nanomaterials. Quantum dot lasers. Optical tweezers. Methods of synthesis, properties and characterization of nanomaterials. Applications.

Charles P. Poole Jr. & Frank J. Owens, Introduction to Nanotechnology, Wiley, Interscience (2003)
Rogers, Pennathur and Adams, Nanotechnology :Understanding small system. CRC Press, Taylor and Francuis Group, New York. (2008)

PH 868 Characterization Techniques of Materials (3 0 0) 3

Metallographic techniques, Optical microscopy, X-ray diffraction, Crystal size, lattice parameter measurements, Phase diagram determination, Electron microscopy – TEM, SEM, STEM, Thermal analysis, Electric and Dielectric measurements.

Edington J., Practical electron microscopy, Vol – 1
B.D. Cullity, Elements of X-ray diffraction

PH 869 Fiber Optics (3 0 0) 3

Optical fiber types, Ray propagation in optical fibers, Fiber fabrication, Modes of propagation in optical fibers, Dispersion and attenuation in optical fibers, Fiber couplers and power splitters, fiber interferometers, PM fibers, Fiber Bragg gratings, Fiber amplifiers, Nonlinear effects in optical fibers.

A.K.Ghatak and K.Thyagarajan, An Introduction to Fiber Optics, McGraw Hill
G.P.Agrawal, Nonlinear Fiber Optics, Academic Press

PH 870 Lasers and Applications (3 0 0) 3

Electromagnetic interaction of matter; spontaneous absorption and emission, Einstein's coefficients. Process, techniques and properties of stimulated emission, concept of population inversion and techniques. Properties of laser radiation, coherence length and coherence time. Line broadening mechanisms, Doppler broadening, spectral hole burning. Optical resonators, resonator configuration, stable and unstable resonators, laser threshold and gain equations. Laser Models - Two level, three level and four level lasers, rate equations. Types of lasers: Gas lasers (He-Ne, CO_2, Ar, N_2, etc.) Types of lasers: Solid-state lasers (Ruby, Nd:YAG, Erbium –doped lasers, etc.). Semiconductor lasers;

single and multiple quantum well lasers, VCSELS, Semiconductor laser amplifiers. Dye-lasers and their properties. Q-switching and Mode-locking in lasers. Applications of lasers: Scientific and Technical, Commercial, Industrial, Military, Medical, etc. Classification of lasers and laser safety.

A. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge Univ. Press (1989)

J. T. Verdeyen, Prentice Hall, 2nd Ed. (1993)

A. Yariv, Photonics : Optical electronics in Modern Communications, Oxford University (2006)

PH 871 Nonlinear Optics (3 0 0) 3

Introduction to nonlinear optics and description of the nonlinear optical processes. Review of wave propagation in isotropic and anisotropic media; index ellipsoid. Nonlinear susceptibility of classical anharmonic oscillator; time domain descriptions of Optical Nonlinearities. Wave description of nonlinear optical interactions; coupled wave equations, phase matching, material requirements. Quasi-phase matching, sum-frequency generation, second harmonic generation (bulk and powder-SHG). Difference frequency generation, optical parametric amplification and oscillation. Laser induced damage assessment in materials. Nonlinear optics of interfaces. Third order nonlinear optical processes; optical phase conjugation; Intensity dependent refractive index; nonresonant electronic nonlinearities, nonlinearities due to molecular orientation, optical bistability and power limiters. Nonlinear optical properties of liquid crystals and conjugated polymers. Nonlinear optical effects in optical fibres. Stimulated Brillouin scattering, Stimulated Rayleigh scattering. Stimulated Raman scattering, Ultrafast optics.

R.W. Boyd, Nonlinear Optics, Academic Press, Press (2006)

Saleh & Teich, Fundamentals of Photonics, Wiley Interscience 2nd Ed., (2007)

PH872 Integrated Optics (3 0 0) 3

Maxwell's equations, plane waves in dielectric, Poynting vector, Wave propagation in isotropic and anisotropic media. Reflection and refraction of light at a single interface. The slab waveguide: metal waveguide, dielectric slab waveguide, weak-guidance approximation, symmetric and asymmetric waveguide analysis. Waveguide mode orthogonality. Fabrication techniques of optical waveguides and case studies. Optical characterization of waveguides, material and modal dispersion. The channel waveguide – fabrication and methods of analysis of channel waveguides. Channel waveguide integrated optic devices. Coupled mode devices – couplers and waveguide gratings, other coupled mode interactions. Semiconductor optoelectronics. Crystal optics, electrooptic effect, linear and quadratic electrooptic effect, transverse and longitudinal electrooptic effect, amplitude and phase modulators. Acousto-optic effect, Bragg diffraction and acousto-optic modulators

A. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge Univ. Press (1989)

R. Syms and J.Cozens, Optical Guided Waves and Devices; McGraw Hill (1992)

PH 873 Optical Interferometry (300)3

Theory of partial coherence, auto- and cross-correlation functions, Michelson Interferometer, Length and density measurement, Jamin's interferometer, measurement of RI of gases, Fabry-Perot interferometer, Interference spectroscopy, Multi-layer mirrors, Sagnac interferometers, Optical Gyroscopes.

M.Born and Wolf, Principles of Optics, Pergamon Press

Ajoy Ghatak, Optics, 3rd ed.,Tata McGraw Hill, 2005.

E.Hecht, Optics, 2nd ed., Addison Wesley Publ. Co.,1987.

PH 874 Optical Data Processing (3-0-0) 3

Diffraction theory of image formation; Fresnel and Fraunhofer Diffraction, Fourier transforming and Imaging properties of lenses, Frequency analysis of optical imaging systems, spatial frequency filtering, Spatial light modulators, Diffractive optical elements, Optical data processing, Analog optical processors.

J W Goodman, An Introduction of Fourier Optics McGraw Hill M.Born and Wolf, Principles of Optics, Pergamon Press.

PH 875 Quantum Mechanics- II (3 0 0) 3

Orbital and spin angular momentum. Eigen states and eigenvalues of angular momentum. Clebsch-Gordon coefficients. Irreducible tensor operators and the Wigner-Eckart theorem. Perturbation Theory: Time independent first order and

second order perturbationtheory (non degenerate case). Degenerate case-removal of degeneracy. Stark effect. Variational method. Time dependent approximation, Fermi-Golden rule. Adiabatic and sudden approximations. Systems of identical particles. Second quantization, occupation number representation. Non-relativistic scattering theory. Scattering amplitude and cross section. Born approximation. Partial wave analysis. The optical theorem. Elements of relativistic quantum mechanics. The Klein-Gordon equation. The Dirac equation. Dirac matrices, spinors. Positive and negative energy solutions, physical interpretation. Nonrelativistic limit of the Dirac equation.

J.J. Sakurai, Modern Quantum Mechanics, Benjamin / Cummings (1985).
P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill(1977).
R. Shankar, Principles of Quantum Mechanics, 1984, Plenum Press, New York.

PH 876 General Theory of Relativity (3 0 0) 3

Theory of Gravitation: Review of the special theory of relativity and the Newtonian theory of gravitation. Non-Euclidean space time. General Relativity and gravitation, desirable features of gravitational theory. Principle of equivalence and principle of covariance.Tensor Analysis. Christoffel symbols, covariant derivative of tensors, intrinsic derivative, covariant derivative of second order, Curvature tensor and its symmetric properties, Riemann Christoffel tensor, Ricci Theorem, Ricci tensor, Einstein tensor, Local inertial coordinate system, Bianchi identities, Contracted Bianchi identities. Geodesic and Field Equations.Riemannian metric. The LeviCivita tensor, Dual tensor. Parallel transport and Lie derivative. The first integral of geodesic and types of geodesics. Geodesic deviation and geodesic deviation equation. Einstein field equation and its Newtonian approximation, Energy momentum tensor of perfect fluid. Crucial Tests of General Relativity, Schwarzschild Solution.Einstein field equations under spherical symmetry, Schwarzchild Space time

Weinberg. S, Gravitation and Cosmology Wiley, 1972
Wald R. M, General Relativity, University of Chicago Press, 1984.
J V Narlikar, Lectures on General Relativity and Cosmology, McMillan, 1978
R Adler, M. Bazin and M Schiffer, Introduction to General Relativity, McGraw Hill,1975.

PH 877 Mathematical Physics-II (3 0 0) 3

Complex variables : Laurent series. Branch points and Branch cuts and Integrals involving them; analytic continuation. Contour integrals. Principal value integrals, Hilbert transforms. Greens functions and applications to electromagnetic fields. Integral equations, Volterra and Fredholm. Transforming and an ODE into an integral equation; method of successive approximation and Nueman series, resolvent kernel. Group theory: Representation of a group – reducible and irreducible. Discrete groups, Schur's Lemma, Orthogonality theorem; Lie algebra and groups, Examples of SU(2) and O(3). Vectors and Tensors: Rotations, Lorentz transformations and General coordinate transformations, Covariant and Contravariant objects.

G. Arfken & H. J Weber, "Mathematical Methods for Physicist", Acad. Press 6th edition,(2005)
E. Kreyszig,"Advanced Engineering Mathematics, Wiley Eastern, 5th edition (1991)
K. F. Riley, M. P. Hobson and S. J. Bence , Mathematical methods for physics and Engineering", Cambridge University Press.(2004)
Jon Mathews and R. L. Walker, Mathematical Methods of Physics", Second Edition, Addison-Wesley Publishing Com. (1969)

PH 878 Experimental Techniques (3 0 0) 3

An Introduction to Absorption and Emission Spectroscopy - Ultraviolet and Visible Absorption Methods, Fluorescence and Phosphorescence Spectrophotometry, Flame Emission and Atomic Absorption Spectrometry, Atomic emission spectroscopy, Infrared Spectrometry, Raman Spectroscopy, X-Ray Methods, Radiochemical Methods, Chemical analysis of surfaces, Thermal Analysis.

Willard, Merritt, Dean & Settle, Instrumental Methods of Analysis- (Sixth Edition) CBS Publ. & Distrib., New Delhi.

PH 879 Phyics of low dimensional Systems (3 0 0) 3

Introduction to low dimensionalsystems: length and energy scale, overview of fabrication techniques (M.B.E MOCVD, etc) and possibilities, applications of low – dimensional physics, examples, top-down vs bottom –up Density of states in ID,2D and 3D, growth of heterostructures and their electronic properties, strained layers, quantum wires and dots, quantum wells

in heterostructures , band diagrams,two dimensional electron gas (2 DEG) system, occupation of subbands. Electrons in high maganetic fields : Hall effects, Landau levels, Landauer-Buttiker formalism, Shubnikov- de Haas oscillations, quantum Hall effect, edge states. Transport through OD quantum dots, Coulomb blockade, resonant, tunneling . Charge and spin transport in quantum point contact : quantizd conductance. Optical properties ; optical processes in low dimensional semiconductors. Graphene as a two – dimensional system :transport properties and its divice applications .

J.H.Davies , The \phyiscs of low - dimensional semiconductors : an introduction (Cambridge University Press 1998)
Kelly M J, Low – dimensional semiconductors ; Materials, Phyiscs, Technology , Devices , (Clarendon Press 1996),
S. Dutta, Electronic tansport mesoscopic systems (Cambridge University Press, 1997)

PH 880 Nonlinear Dynamics And Chaos (3-0-0)3

Linear and nonlinear systems, Discrete time dynamical systems, the logistic map and period doubling, bifurcations, two dimensional maps, graphical iteration, Qualitative analysis of fixed points, Chaos, Feigenbaum's number, Representations of dynamical systems, vector fields of nonlinear systems, phase plane analysis, linear stability, limit cycles, the Lorenz equation, bifurcations in continuous time dynamical systems, the Rossler equation and forced pendulum, the Chua's circuit, introduction to fractals, Mandelbrot sets and julia sets, lyapunov exponent, frequency spectra of orbits, dynamics on a torus, control of chaos, introduction to floquet theory.

S Strogtaz, Nonlinear dynamics and chaos: with applications to physics, biology, chemistry, and engineering, Westview Press, 2001
F C Moon, Chaotic Vibrations, Wiley & Sons, 2004
Alligood, Sauer, Yorke, and Crawford, Chaos- An Introduction to Dynamical Systems, Springer, 1996

PH 881 Computational Methods in Physics (3-0-0)3

Basics of computers; Brief introduction to Python and iPython notebooks; Computing with formula, example: trajectory of a ball; Solving matrix equations, matrix decomposition; Interpolation; Iterative equations, population growth models; Ordinary differential equations, numerical error and error propagation, numerical instabilities, Euler's method, implicit and explicit schemes, Runge-Kutta methods, Examples: linear and nonlinear oscillators; Partial differential equations, finite difference schemes, relaxation techniques, the diffusion equation; Examples: heat wave, E-M wave; Random numbers, Distribution function, Monte Carlo methods, Ising model.

A B Downey, Think Python: An introduction to software design (available online)
D Potter, Computational Physics, Wiley Newyork NY, 1973
W.H. Press, S.A. Teukolsky, W.T. Vettering, and B.R. Flannery, Numerical Recipes in C: the art of scientific programming, Cambridge University Press, Cambridge UK, 1992.

PH 882 Density Functional Theory and its applications in materials science. (3-0-0)3

Introduction of many body problem (interacting and non-interacting wave-functions for N number of electrons, probability densities) Overview of electronic structure methods and DFT. Mathematical tools (Functionals, one and two-body operators and their expectation values, variational principle, Hellman-Feynman principle, virial theorem), Hartree-Fock theory and Correlation, The Uniform Electron Gas Hohenberg-Kohn Theorem, Kohn-Sham Scheme. Exchange and Correlation Energy, Adiabatic Connection, Properties of Functionals, Local Density Approximation, Gradient Expansion and Generalized Gradient Approximations, Hybrids Functionals, their performance and Challenges, Time-Dependent Density Functional Theory: The Runge-Gross Theorem, Linear Response and Excitation Spectra. Applications (metallic alloys, organic semiconductors, semiconductor nano particles)

Robert G. Parr and Weitao Yang, "Density Functional Theory of Atoms and Molecules",(Oxford University Press, 1994).
Reiner Dreizler and E. K. U. Gross, "Density Functional Theory" (Springer 1990)
John P. Perdew and Stefan Kurth: "Density Functionals for Non-Relativistic Coulomb Systems", in "A Primer in Density Functional Theory" Ed. C. Fiolhas, F. Nogueira, and M. Marques (Springer Lectures Notes in Physics, v.620, 2003).
Important journal articles in this area (will be provided during the lecture)

DEPARTMENT OF MATHEMATICAL & COMPUTATIONAL SCIENCES

CMA701 Data Structures and Algorithms (3-0-2)4

Abstract data structures and their implementations: arrays, list, stack, queue.Tree data structures: Binary trees, Height balanced trees, priority queues, Tree traversal algorithms.Dynamic Data structures: 2-3 trees, Red-black trees, binary heaps, binomial and Fibonacci heaps, Skip lists, universal hashing.Graphs and algorithms: Breadth first search and Depth First Search, Shortest paths, minimum spanning trees.Introduction to analysis of algorithms: Big Oh, Omega and Theta notations. Basic algorithm design techniques: Dynamic programming and divide-and-conquer, Sorting algorithms with analysis.

T.H Cormen, C.E Leiserson, R.L. Rivest, C. Stein, Introduction to algorithms, Third edition, PHI, 2009.
Algorithm Design, Michael T. Goodrich, Robert Tamassia, John Wiley& Sons, 2006
Ellis Horowitz, Sartaz Sahni, S. Rajasekaran, Fundamentals of computer Algorithms, Second edition, University Press (India) Limited, 2008.

CMA702 Computational Combinatorics (3-0-0)3

Combinatorics: Generating Permutations and Combinations, Relations, Recurrence Relations and Generating Functions. Lattice Theory: Lattices and their properties, Duality Principle, New Lattices – Lattice Homomorphisms, Product Lattices, Modular and Distributive Lattices, Boolean Algebras/ Boolean Lattices, Boolean Polynomial. Graph Theory: Different classes of graphs, Digraphs and their fundamental properties, Representations of graphs, Trees, Connectivity, Traversability, Planarity and Colorability.

Ralph P. Grimaldi, Discrete and Combinatorial Mathematics – An applied introduction, Pearson Addison Wesley, 5th Edition, 2004.
Richard A. Brualdi, Introductory Combinatorics, China Machine Press, 5th Edition, 2009.
J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with applications to Computer Science, McGraw Hill
Jonathan L. Gross and Jay Yellen, Handbook of Graph Theory, CRC Press.
Geir Agnarsson and Raymond Greenlaw, Graph Theory – Modeling, Applications and Algorithms, Pearson Education, 2007.

CMA703 Computational Linear Algebra (3-0-0)3

Matrix multiplication problems: Basic algorithms and notations, exploiting structure, block matrices and algorithms, vectorization and re-use issues.Matrix analysis: basic ideas from linear algebra, vector norms, matrix norms, finite precision matrix computations, orthogonality and SVD, projections and the CS decomposition, the sensitivity of square linear systems. General linear systems: Triangular systems, the LU factorization, roundoff analysis of Gaussian elimination, pivoting, improving and estimating accuracy.Special linear systems: The LDM^T and LDL^T factorizations, positive definite systems, banded systems, symmetric indefinite systems, block systems, vandermonde systems and the FFT, Toeplitz and related systems.

Gene H. Golub nad Charles F. Van Loan, Matrix Computations, Third Ed, Hindustan book agency, 2007.
A.R. Gourlay and G.A. Watson, Computational methods for matrix eigenproblems, John Wiley & Sons, New York, 1973.
W.W. Hager, Applied numerical algebra, Prentice-Hall, Englewood Cliffs, N.J, 1988.
D.S. Watkins, Fundamentals of matrix computations, John Wiley and sons, N.Y, 1991.
C.F. Van Loan, Introduction to scientific computing: A Matrix vector approach using Mathlab, Prentice-Hall, Upper Saddle River, N.J, 1997.

CMA704 Computer Organization and Operating Systems (3-0-2)4

Introduction to basic digital electronic circuits: Combinational and sequential circuits, flip-flops, registers, memory, counters.Computer organization: Design of basic computers, hardwired and micro programmed control, programming a basic computer, instruction formats and addressing modes, stack organization.Computer architectures: RISC and CISC architectures, Parallel processing.Operating system: Introduction to operating system, functionalities of an operating system. Process management: creation, scheduling and termination of a process, light-weight process, Inter process communication, Deadlocks handling, process synchronisation.Memory management: static and dynamic memory, memory allocation methods. Input output management: Handling interrupts, Disk scheduling algorithms.File Management: File and Directory structures, allocation methods, free space management, UNIX file structure.System Security and protection methods.

Morris Mano, Computer system architecture, third edition, PHI, 2007.

V. Carl Hamacher, Zvonko G. Vranesic, Safwat G. Zaky, Computer organization, McGraw-Hill, 2002
A. Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts, John Wiley & Sons, 2012.

CMA705 Theory of Computation (3-0-0)3

Introduction, Abstract Models for Computation and their relationship with formal languages and Theory of Recursive Functions; Computational and Representational System Models: Finite Automata; Push-down Automata; Linear Bounded Automata; Turing Machines; Formal Language Models; Regular Expressions, Context free Languages, Context Sensitive Languages, Recursively, Enumerable Languages, Generative Grammars, Recognition Procedures; Finite Representation for formal languages, Chomsky Hierarchy; Normal Forms; Derivation Graphs; Pumping Lemma; Undecidability; Recursive Functions and Computability; Computational Effectiveness, Complexity Measures, Reducibility; Complexity Classes.

Hopcroft and Ullman, Introduction to Automata Theory; Languages and Computation, Narosa.
Gyorgy E. Revesz, Introdution to Formal Languages, Dover.
Aho, Hopcraft & Ullman, Automata, Languages and Computation, Narosa, 1986.
Mishra and Chandrashekar, Theory of Computer Science, Prentice Hall of India, 1999.

CMA706 StochasticAnalysisand Applications (3-0-0)3

Overviewof probability, randomvariables, probability functions, functions of r.v.s, some important probability distributions,stochasticprocesses,basicconcepts, classification,Markovchains,C-Kequations,ergodicchains, steady statebehaviour, Poisson processes, birthand deathprocesses,queuingsystems,basicconcepts,M| M| 1 and M| M| s queues, Reliability, definitions,conceptof hazard,bath-tub curve, systemreliability forvarious configurations.

J. Medhi,StochasticProcesses,NewAgeInternationalPublishers.
K.S.Trivedi,ProbabilityandStatisticswithReliability,QueuingandComputerScienceApplications,PHI.

CMA707 Numerical Algorithms and Analysis (3-0-2)4

Errors and Approximations: Order/Rate of convergence of an Iterative method-Solution of Algebraic, Transcendental and Polynomial equation-Newton-Raphson method, Extension of Newton-Raphson method for finding multiple roots and to solve system of non-linear equations. Mullers method, Chebyshev's methods. Interpolation: Newton's Divided difference method. Hermite's interpolation. Cubic spline interpolation. Errors in interpolation. Numerical Differentiation: Finite difference operator techniques. Richardson's extrapolation technique and differentiation of interpolating polynomials. Numerical Integration: Method of undetermined coefficients. Errors in integration formulae. Iterative solution of linear equations. Numerical solution of ordinary different equations: Initial value problems. Single step and multistep methods for solving first and second order Initial value problems. Solution of Boundary value problems by finite difference method and shooting method. Numerical solution of partial differential equations: Solution of elliptic partial differential equations by 5-point and 9-point schemes. Solution of hyperbolic partial differential equations by explicit and implicit schemes. Error Analysis.

Jain M K, Iyengar S R K and Jain R K, Numerical Methods for Scientific and Engineering Computation, 4th Edn, New Age International Pvt Ltd (2005)
Jain M K, Numerical Solutions of Differential Equations, 2nd Edn, John Wiley and Sons Ltd (1984)
S S Sastry, Introductory Methods of Numerical Analysis, 5th Edn. Prentice Hall of India.

CMA801 Computer Networks (3-0-0)3

Introduction: Uses of Computer Network, Network hardware, Network software, Hierarchical Reference Models; Physical Layer: The theoretical Basis for Data Communication, Transmission media. Wireless transmission, The Telephone system, Data Link Layer: Data Link Layer Design Issues, Error correction and detection, Elementary data link layer protocols; Sliding Window Protocols, Protocol Specification and verification, Medium Access Sublayer: The channel allocation problem, Multiple Access Protocols, IEEE 802 standards for LANs and MANs, Bridges. Network Layer: Network Layer Design issues, Routing algorithms, congestion control algorithms, internet working. Transport Layer: Transport services, transport protocols. Application layer Application layer protocols, Cryptography.

Jim Kurose and Keith Ross Computer Networking- Top Down approach, 5th edition, Pearson Education, 2010
Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, 5th edition, Morgan Kaufmann, 2011
Behrouz A. Forouzan , Data Communications & Networking, 4th edition, Tata McGraw-Hill Education, 2006
Douglas E.Comer, The Internet Book, 4th edition, Prentice Hall, 2007

CMA802 Machine Learning (3-0-0)3

Introduction to machine learning, Concept Learning and the General-to-Specific Ordering, Decision Tree Learning, Artificial Neural Networks, Dimensionality reduction, linear discrimination, Evaluating Hypotheses, Bayesian Learning , Computational Learning Theory, Instance-Based Learning, Genetic Algorithms, Learning Sets of Rules, Analytical Learning, Combining Inductive and Analytical Learning, Reinforcement Learning.

Ethem Alpaydin, "Introduction to machine learning", second edition, PHI publication, 2010.
Tom Mitchell , "Machine Learning", McGraw Hill, 1997
Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

CMA803 Software Engineering (3-0-0)3

Introduction to software engineering. Generic view of Process, Process models. System Engineering: Business Process Engineering, Product Engineering, Requirements Engineering, Building Analysis model, Design Engineering, Creating an Architectural Design, Modeling component – level Design, Software Testing: Testing strategies, Testing tactics Product metrics, Managing Software Projects: Project management. Metrics for process and projects. Estimation, projects scheduling, Risk management, Quality management, change management.

Roger S. Pressman, Software Engineering – A practitioner's Approach, 7th Edn, MacGraw-Hill
Ian Sommer ville, Software Engineering, 9th Edn, Addison-Wesley
Rajib Mall, Fundamentals of Software Engineering, 3rd Edn, Prentice-Hall India(PHI) Learning Pvt Ltd.

CMA804 Computer Graphics (3-0-0)3

Graphics hardware: Display devices, Input devices; Basic raster graphics algorithms: line and circle drawing algorithms; Windowing and 2D/ 3D clipping: Cohen and Sutherland line clipping, Cyrus Beck clipping method; 2D and 3D Geometrical Transformations: scaling, translation, rotation, reflection; Viewing Transformations: parallel and perspective projection; Curves and Surfaces: cubic splines, Bezier curves, B-splines, Parametric surfaces, Surface of revolution, Sweep surfaces, Fractal curves and surfaces; Hidden line/surface removal methods; illuminations model; Shading: Gouraud, Phong; Introduction to Ray-tracing; Animation; Programming practices with standard graphics libraries like openGL.

Foley, Van dam, Fundamentals of Interactive Computer graphics, Addison Wesley.
Hearn D. Baker, Computer graphics, PHI.
Rogers D.F. and Adams J., Mathematical Elements for Computer Graphics, McGraw Hill.

CMA805 Image Processing (3-0-0)3

Introduction to image processing, Image acquisition, sampling and quantization, Image transforms: Discrete Fourier transform, Discrete cosine transform, Discrete sine transform and wavelet transform, Image restoration: Image degradation models, blurs and noise models, restoration methods, Weiner filter and regularization filters, Image enhancement: Enhancement in Spatial and frequency domain, unsharp masking and high-boost filtering, Image segmentation: Image thresholding, region based segmentation methods, region growing, region merging & splitting and active contour models, Image Compression : lossy/lossless compression methods, Image Analysis, Introduction to image processing tool box in Matlab, Applications of image processing to various imaging systems.

R.C. Gonzalez, R.E. Woods, "Digital image processing using MATLAB", Prentice Hall, Second edition, 2003.
Henri Maitre, "Image Processing",first edition, Wiley, 2008.
T.F. Chan, J.H. Shen, "Image processing and analysis", SIAM,First edition, 2005.
Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing" , Addison-Wesley, 2nd edition, 2002.
Anil K. Jain , Fundamentals of Digital Image Processing, Prentice Hall, 1992.

CMA806 Algorithmic Combinatorics (3-0-0)3

Fundamental Notions Related to Enumerative Combinatorics (Lists/Permutations, Sets/Combinations, Special Bijections, etc.), The Twelve-fold Way of Counting, Integer Partitions, Finite Group Actions, The Cauchy-Frobenius Lemma, Structures and Algorithms, Analysis of Algorithms, Complexity Classes, Integer Partitions, Set Partitions, Bell and Stirling Numbers, Labeled Trees, Catalan Families, Backtracking Algorithms, Permutation Groups

Donald L. Kreher, Douglas R. Stinson, Combinatorial Algorithms: Generation, Enumeration, and Search, Series: Discrete Mathematics and its applications, CRC Press, 1998
Tucker A. , Applied Combinatorics, 2nd edn, John Wiley, 1984
R. Graham, D. Knuth, and O. Patashnik, Concrete Mathematics,Addison-Wesley, 1994
R. Stanley, Enumerative Combinatorics, Volumes I and II, Cambridge UniversityPress, 2001

CMA807 Cryptology (3-0-0)3

Introduction to Cryptocomplexity, Foundations of Computer Science and Mathematics, Algorithmics, Formal Languages and Recursive Function Theory, Algebra, Number Theory and Graph Theory, Probability Theory.Foundations of Cryptology, Tasks and Aims of Cryptology, Some Classical Cryptosystems and Their Cryptanalysis, Perfect Secrecy.RSA Cryptosystem, Primality, and Factoring, Other Public-Key Cryptosystems and Protocols: Diffie-Hellman and the Discrete Logarithm Problem, ElGamal's Protocols, Rabin's Public-Key Cryptosystems, Arthur-Merlin Games and Zero-Knowledge, Merkle and Hellman's Public-Key Cryptosystem, Rabi, Rivest, and Sherman's Protocols.

Rothe, Jorg: Complexity Theory and Cryptology- An Introduction to Cryptocomplexity, Springer, 2005.
Paar,Christof and Pelzl, Jan: Understanding Cryptography, Springer International Edition, 2010.

CMA808 Selected Topics in Graph Theory (3-0-0)3

Graphs – An Introduction, Classes of graphs, Distances in graphs, Domination, Labelling, Coloring – Introduction & Types of coloring – Complete Colorings, Colorings and Distance: T-Coloring, $L(2,1)$-Coloring, Radio Coloring, Hamiltonian Coloring, Critical Concepts, Independence, Matching and Covering, Chordal graphs, Perfect graphs, Interval graphs, Planar graphs, Graph Operations, Graph Partition, Probability on graphs – Random graphs, Hyper graphs, Algebraic concepts in graph theory, IP & LP formulation of selected graph problems, Graph Models.

Douglas B. West, Introduction to Graph Theory, 2nd Edition, PHI Learning Pvt. Ltd., 2012.
Haynes, T.W., Hedetniemi, S.T. and Slater, P.J., Fundamental of Domination in graphs, Marcel Dekker, Inc.,New York 1998.
Gary Chartrand and Ping Zhang, Chromatic Graph Theory, CRC Press.
Tommy R. Jensen and Bjarne Toft, Graph Coloring problems, John Wiley & sons.
Michael Stiebitz, Diego Scheide, Bjarne Toft and Lene M. Favrholdt, Graph Edge Coloring, Wiley.
Random Graphs – Béla Bollobás, 2nd Edition, Cambridge University Press.
Haynes, T.W., Hedetniemi, S.T. and Slater, P.J., Domination in graphs – Advanced Topics, Marcel Dekker, Inc.,New York 1998.

CMA809 Distributed Computing Systems (3-0-0)3

Introduction:Computer Networks and Multi-processor systems, Evolution of modern operating systems, Design Goals, transparencies and fundamental issues in Distributed systems, Temporal ordering of events, Global state detection, Physical clocks, Mutual Exclusion Algorithms, Interprocess Communication, Deadlocks in distributed systems, Load balancing techniques, Distributed databases. Security in distributed systems.

Shivarathi & Shingal, Advanced Operating Systems
Randy Chow, Distributed Operating Systems and Algorithms
George Couloris et al, Distributed Systems - concepts and design, Pearson Education, 2002
A.S. Tanenbaum and M.V. Steen, Distributed Systems - Principles and Paradigms, Pearson Education 2003.
Wolfgang Emmerich, Engineering Distributed Objects, Wiley, 2000.
Gerald Tel, Introduction to Distributed Algorithms, 2/e, Cambridge, 2004.

CMA810 Soft Computing (3-0-0)3

Learning and Soft Computing: basic tools of Soft Computing, Learning and Statistical Approaches to Regression and Classification.Neural Networks: Mathematical Models of Neurons, ANN Architecture, Learning Rules, Learning Paradigms – Supervised, Unsupervised, and Reinforced Learning. ANN Training Algorithms. Multi Layer Perception Model, Hopfield Networks, Associative Memories, Application of Artificial Neural Networks. Fuzzy Logic : Classical and Fuzzy Sets, Membership Function, Fuzzy Rule generation. Operations on Fuzzy sets, Fuzzy Arithmetic, Fuzzy Logic, Uncertainty Based Information: Combination of Operations, Aggregation Operations.Fuzzy numbers, Linguistic variables, Arithmetic Operations on Intervals and Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.Classical Logic, Multi Valued Logic, Fuzzy Propositions, Non Specificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy sets. Neuro-Fuzzy Systems, Applications of Fuzzy Logic in Medicine, Economics, Genetic Algorithms in Problem Solving.

Vojislav Kecman, Learning and Soft Computing , Pearson Education (Asia) PTE, 2004
Anderson J A, An Introduction to Neural Networks, PHI, 1999
S Haykin, Neural Networks: A Comprehensive Foundation ", Pearson Education, 2003
Hertz J, Krogh, R. G. Palmer, Introduction to the Theory of Neural Computation, Addition-Wesley, 1991
G.J. Klir and B Yuan, Fuzzy Sets and Fuzzy Logic", PHI 2001
Melanie Mitchell, An Introduction to Genetic Algorithms , PHI, 1998

CMA811 Combinatorial Optimization (3-0-0)3

Algorithms for optimization of combinatorial optimization problems. Integer Programming and Network Optimization algorithms, combinatorial problems on Graphs or Networks, Polyhedral Combinatorics, Complexity of Problems such as linear programming and the traveling salesman problem. NP-Completeness, approximation algorithms, worst case and probabilistic analysis of algorithms and local search.

C.H. Papadimitriou and K. Steiglitz, Combinatorial Optimization, Algorithms and Complexity, Prentice Hall, 1982.
E. L. Lawler, Combinatorial Optimization – Networks and Matroids, Holt, Rinehart and Winston, 1976
C. Berge, Principles of Combinatorics, Academic Press, 1971
Tucker, Applied Combinatorics, 2nd edn, John Wiley, 1984
L. R. Ford Jr. and D. R. Fulkerson, Flows in Networks, Princeton, Univ. Press, 1952.
Pardalos, Panos; Du, Ding-Zhu; Graham, Ronald L., Handbook of Combinatorial Optimization, Springer, 2013
Lex Schrijver, Combinatorial Optimization: Polyhedra and Efficiency, 3-Volume book, Springer-Verlag 2003

CMA812 System ModellingandSimulation (3-0-0)3

Basicsimulation Modeling:The nature of simulation,definition ofsystems,models andsimulation.Structure of simulation models; advantages and disadvantages of simulation, steps in a simulation study. Classification of simulation models;Discrete-Event simulation: Selecting Input Probability Distributions, Random-number Generators, GeneratingRandom variables forstandard distributions,Output Analysisfora singlesystem.System Software: GPSS;general description, facilities,storages, Queues,transfer blocks,controlstatements, variablelogic switches,Booleanvariables,functions,concept of userchains,facilitypreemption,matching Introductiontoother simulationlanguagessuchas MATLAB, TUTSIM ModelingandSimulation of ContinuousSystems.

G.Gordon,SystemSimulation,PHI.
A. M.LawandW.D.Kelton,simulation,modelingandanalysis,McGrawHill.
J.A.Payne,Introductionto simulation,ProgrammingTechniquesandmethodsofanalysis.
ThomasJ. Schriber,SimulationUsingGPSS,JohnWileyandSons.
Mariyansky,DigitalComputerandSimulation,CBSPublishers,NewDelhi.

CMA813 Database Systems (3-0-0)3

The Database system, structure of a database, three level Architecture of databases and its importance. The Relational model, the Entity Relationship model, conversion of ER diagram to Relational Database. The concepts of integrity, referential integrity, functional dependency, the normal forms. Sequential file organization, indexes, index and B tree, multi key file organization. The structured Query Language: data definition and manipulation commands, views, nested queries, examples. Transactions, concurrency related problems and control, locks, two phase locking, deadlock. Database recovery techniques, security and integrity, authorization, data access control. The need and advantages of the distributed and client server database systems, data replication and fragmentation, distributed queries.

Avi Silberschatz, Henry F Korth, S. Sudarshan, Database System Concepts, 6th Edn, McGraw-Hill
Hector Garcia- Molina, Jeffrey D. Ullman, Jennifer Widom, Database Systems: The Complete Book, 2nd Edn,
Coronel/Morris/Rob, Database Systems Design, implementation and Management,10th Edn
C.J. Date, An Introduction to Database Systems, 8th Edn
Raghu Ramakrishnan, Johannes Gchrhe, Database Management Systems, 3rd Edn

CMA814 Linux and Network Programming (3-0-0)3

Overview of LINUX OS, File I/O, Files and directories, Standard I/O library, System data files and information. Processes: Process relationships, Terminal I/O, Advanced I/O, Threads. Interprocess communication, Message passing,Synchronization, Shared memory, Sockets: Name and address conversions. Applications: TCP echo client server, UDP echo client server.

W Richard Stevens, Advanced programming in the UNIX environment, Addison Wesley,1999.
W Richard Stevens, UNIX Network Programming Volume 1 and 2, Prentice Hall, 1998.
N.Matthew, R.Stones, Beginning Linux Programming, 4th Edition, ,Wrox, Wiley India Edition,rp-2008

CMA815 Internet Technology and Applications (3-0-0)3

History of Internet, Internet addressing,TCP/IP. DNS and directory services, Internet resources and applications.,SMTP, FTP, TELNET and HTTP, WWW Overview, HTML, Javascript, ASP and JSP, Advanced java programming, Applet Programming, N/w programming, JDBC. Servlet programming.

Douglas Comer, The Internet Book, 4th edition, Prentice Hall, 2007

Deitel & Deitel, Internet & World Wide Web, How to program, Prentice Hall, 2000
D Norton and H Schild, Java2: The complete reference, Tata McGraw-Hill Education, 2000

CMA816 General Systems Theory (3-0-0)3

Boundary, interface, structure, behaviour and description of a system; state transitions. General systems approach to problem solving; Primary dimensions in systems studies. Problem Classification: Analysis; Design; Optimization; Control; Simulation; etc. System Models; Modeling of system uncertainties; parametric uncertainties.

G.M. Weinberg, General Systems Thinking-An Introduction, Dorset House
H.A. Simon, The Sciences of the Artificial, MIT Press
http://pespmc1.vub.ac.be/CYBSYSTH.html
http://systemtheory.net/
http://www.well.com/abs/
http://www.er.ele.tue.nl/sweiland/ssyst.htm

CMA817 Web Technology (3-0-0)3

The Web Design Environment; Designing for a variety of Browsers, Designing for a variety of displays, Web design principles for print designer, beginning guide for the server; HTML: HTML Overview, Structural HTML Tags, formatting text, creating links, adding image and other page elements,Tables, Frames, forms, Image mapping, cascading style sheets; Using Web design Tools like MS Front page, Flash Dreamweaver, coreldraw, Photoshop; Multimedia and Client side scripting: Audio on the web, Video on the web, DHTML, Introduction to java script, Java Applets. Server-side scripting: Active Server Pages, XML.

Hiroshi Maruyama, Kent Tamura, XML and Java Developing Web Applications., Naohiko Uramoto.
Thomas Powell, Fritz Schneider, Javascript, the complete reference, Tata McGraw Hill, 2002.
David Crowder, Rhonda crowder, Web design, IDG books of India Pvt. Ltd., 2001.
Jennifer Neiderst, Web design in a nutshell, Orielly Publications.

CMA818 Selected Topics in Computer Algorithms (3-0-0)3

Computational geometry: Convex Hull, Polygon triangulation, Voronoi diagram. String processing algorithms: KMP algorithm, Boyer-Moore algorithm. Algebraic and number theoretic algorithms: Modular arithmetic, Chinese remainder theorem.Linear programming and combinatorial optimization: LPP formulation, simplex method
NP-completeness and Approximation: Polynomial time reduction, NP-complete proofs

De Berg, Mark and Cheong, Otfried and van Kreveld, Marc and Overmars, Mark}, Computational geometry, Springer, 2008.
Charras, Christian, and Thierry Lecroq. Handbook of exact string matching algorithms. King's College Publications, 2004.
T.H Cormen, C.E Leiserson, R.L. Rivest, C. Stein, Introduction to algorithms, Third edition, PHI, 2009.
Jon Kleinberg Eva Tardos, Algorithm Design, Pearson, 2006

CMA819 Number Theory and Cryptography (3-0-0)3

Elementary Number Theory Congruences, applications to Factoring. Finite fields, Quadratic residiues and reciprocity. Simple cryptosystems, public key cryptography, RSA, Discrete logs. Primality and Factoring, the rho method, Fermat factorization, continued fraction and Quadratic Sieve methods.

N. Koblitz., A Course in Number Theory and Cryptography, Springer, 1994.

CMA820 Mobile Computing (3-0-0)3

Mobility:Issues, challenges, and benefits; Review of mobile andcellular communication technology; Review of distributed/networkoperating systems, ubiquitous computing.Network Programming:Process communication techniques, remotelogin, ftp, socket programming, RPC, RMI, client-server programming.Process Migration:Steps, advantages, application taxonomy,alternatives, case study of DEMOS/MP.Mobile Computing:Physical mobility, challenges, limits andconnectivity, mobile IP and cellular IP in mobile computing, case studyof CODA. Wireless LANs:Introduction to IEEE 802.11, Bluetooth and IrDAtechnologies and standards.Mobile Adhoc Networks:Hidden and exposed terminal problems;Routing protocols: DSDV, DSR, AODV.Wireless Sensor Networks:Motes, smart dust, TinyOS, routingprotocols.Handheld Devices and OS:Palm, HP; PalmOS, WindowsCE,Windows Mobile.Mobile Internet and WAP:WWW programming model, WAPprogramming model, gateways.Mobile agents:Aglets, Tcl, PMADE.

Hansman, U. and Merck, L., Principles of Mobile Computing, 2nd Edition., Springer.

Jochen Schiller, Mobile Communications, second edition, Addison-Wesley, 2004
Milojicic, D., Douglis, F. and Wheeler R., Mobility Processes, Computers and Agent, Addison Wesley. 2000
Lange, D. B. and Oshima, M., Programming and Deploying JavaMobile Agents with Aglets, Addison Wesley. 1998

CMA821 Mathematical Modeling (3-0-0)3

Introduction: Mathematical modeling through ordinary differential equations and systems of ordinary differential equations of first order, Mathematical modeling through difference equations, Modeling using partial differential equations, Mathematical modeling through graphs.

J.N. Kapoor, Mathematical Modeling, Wiley Eastern, 1988.
R. Aris, Mathematical Modeling Techinques, Pitman, 1978.

CMA822 Finite Element Methods (3-0-0)3

Introduction to finite element Method, Physical Interpretation, Variational Interpretation, Generalised Interpretation, Elements & Interpolation functions, Applications: General field problems, Fluid mechanics and Heat transfer problems, Boundary Conditions, Mesh Generation and other Practical Considerations.

K.H.Huebner, D.L. Dewhirst, D.E.Smith, T.G. Byron, The finite element method for engineers, John Wiley & Sons.
J.N.Reddy, An Introduction to the finite Element Method, Mc Graw Hill.
K.J.Bathe, Finite element Procedures, Cambridge, MA.

CMA823 Nonlinear Programming (3-0-0)3

Convex sets and functions, Unconstrained and Constrained optimization problems, Optimality conditions, Lagrange multipliers, The Fritz John conditions, The Karush-Kuhn-Tucker conditions, Constraint qualifications, Lagrangian Duality, Quadratic Programming, Wolfe's method, Newton's method, Conjugate gradient methods.

M. S. Bazaraa, H. D. Sherali and C. M. Shetty, Nonlinear Programming: Theory and Algorithms, Wiley, 2006.
N. Andreasson, A. Evgrafov and M. Patriksson, An introduction to continuous optimization, Overseas press, 2006.
E. K. P. Chong and S. H. Zak, An introduction to optimization, Wiley 2004.
S. G. Nash and A. Sofer, Linear and Nonlinear Programming. McGraw-Hill, 1996.
S. Chandra, Jayadeva and A. Mehra, Numerical optimization with applications, Narosa, 2009.

CMA824 Selected Topics in Network Flow Modeling and Analysis (3-0-0)3

Representation and analysis network structures. Painted Network Algorithms and applications. Representation and analysis of flows in networks. Max Flow Min Cut Theorem. Feasible Distributor Problem. Flow Rectification Problem. Tucker Representation of Circulation Space and Differential Space. Extremal Representation Problem. Matching and Assignment Problems. Bottleneck Optimization Problems. Potentials and Spans. Max Tension Min Path Theorem. Feasible Differential Problem. Tension Rectification Problem. Routing Problem. Optimal Differential Problem. Optimal Distribution Problem. Network Flow Duality Theorem. Network Simplex Method for Flows. Thrifty Adjustment algorithm. Out-of-Kilter Algorithm. Optimal Flows and Potentials. Characteristic Curves. Network Flow Equilibrium Conditions. Boundedness of Optimizing Sequences. Linear Systems of Variables. Generalized Circuits & Cuts. Painted Index Theorem and Algorithm. Extremal Representation Theorem. Extremal Solutions.

R. T. Rockafellar, Network Flows and Monotropic Optimization, Wiley Interscience.
Ford and Fulkerson, Flows in Networks, Princeton Univ. Press

CMA825 Collective Decision Making Process (3-0-0)3

Decision Making Processes, Individual Preferences, Collective Outcomes, Process Influence, Arrow's Theorem, Sen's Theorem, Voting Profiles, Voting Paradoxes and their resolution through refinements in axioms, Binary Independence, Transitivity, Monotonicity, General Aggregation Processes.

Donald G. Saari, "Chaotic Elections – A Mathematician Looks At Voting", AMS.
Donald G. Saari, "Decisions and Elections – Explaining the Unexpected", Cambridge Univ. Press.
Donald G. Saari, "Geometry of Voting", Springer – Verlag.
Kenneth J.Arrow "social Choice and Individual Values", Yale Univ. Press.

CMA826 Computational Fluid Dynamics (3-0-0)3

Philosophy of CFD, Governing Equations of Fluid Dynamics - Derivation, Physical Interpretation, Forms of Governing Equations suitable to CFD, Mathematical behavior of Partial differential Equations. Finite differences,

Error & Stability Analysis of numerical schemes, Grid generation with appropriate transformations, CFD techniques - Lax – Wendroff technique, MacCormack's technique. Numerical Solutions to some one and two -dimensional flows.
J. Anderson, Computational fluid dynamics: The basics with applications, McGraw Hill.
C.A.J. Fletcher, Computational techniques for fluid dynamics vol 1& 2,Springer – Verlag.
H.K. Versteeg, W Malalasekera, An Introduction to Computational Fluid Dynamics, Longman Scientific & Technical.

CMA827 Design and Analysis of Experiments (3-0-0)3

Introduction to probability, one-dimensional random variables, two and higher dimensional random variables, probability distributions, Samplingtheory,moments, mgf andtheir properties, parameter estimation, point estimation,intervalestimationofmeansandvariances,Hypothesistesting,Goodnessoffittests,analysisof varianceofone-wayandtwo-wayclassifieddata,experimentaldesign.
DouglasMontogomery, Design andAnalysis of Experiments, John Wiley
Sheldon M. Ross,IntroductiontoProbabilityandStatistics forEngineersandScientists,John Wiley
Hogg R.V., & Craig A.T.,Introduction to MathematicalStatistics,McMillan

CMA828 Reliability Theory and Applications (3-0-0)3

Reliability,conceptsanddefinitions,causesoffailure,conceptofhazard,failuremodels,bathtubcurve,MTTF, MTBF,systemreliabilityforvariousconfigurations,reliabilityimprovement,redundancy,reliability-costtrade-off, maintainabilityandavailabilityconcepts,systemsafetyanalysis,FTA,FMEA.
E.E.Lewis,IntroductiontoReliabilityEngineering,JohnWiley.
KS.Trivedi,ProbabilityandStatisticswithReliability,QueuingandComputerScienceApplications,PHI.

CMA829 Computational Number Theory (3-0-0)3

Elementary Number Theory: Theory of Divisibility, Diophantine Equations, Arithmetic Functions, Congruences, Arithmetic of Elliptic Curves. Computational Number Theory: Introduction, Algorithms for Primality Testing, Integer Factorization, Discrete Logarithms. Quantum Number Theoretic Algorithm. Miscellaneous Algorithms in Number Theory. Cryptography and Information Security
Song Y. Yan, Number Theory for Computing, 2nd Ed. Springer, 2002.
Richard Crandall and Carl Pomerance , Prime numbers: a Computational perspective, Springer, 2001.
Henri Cohen, A course in Computational Algebraic Number Theory, Springer, 2000.

CMA830 Pattern Recognition (3-0-0)3

Introduction to pattern recognition, Classification, Non-Metric methods, Maximum-Likelihood and Bayesian Parameter Estimation, Supervised learning, Nonparametric Techniques, Linear Discriminant Functions, Feature extraction and selection, Multilayer Neural Networks, Algorithm-Independent Machine Learning, Unsupervised Learning and Clustering, Comparison of classifiers.
Richard O. Duda, Peter E. Hart, David G. Stork , "Pattern Classification", 2nd Edition, Wiley, 2001.
Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
Geoff Dougherty, Pattern recognition and classification an Introduction, Springer, 2013.

CMA831 Statistical Techniques in Data Mining (3-0-0)3

Overviewofdataminingtechniques,Taxonomyofdataminingtasks,Stepsindataminingprocess,Predictive modeling,Associationrules, Statistical perspective,Clustering, Regression analysis, Time series analysis, Bayesianlearning,Datawarehousing,Dimensionalmodeling,Performanceissuesandindexing,Developmentlife cycle,Casestudies.
JiaweiHan,MichelineKamber,DataMining ConceptsandTechniques,MotganKaufmannPublishers.
UsamaMFayyad,GregoryPiatetsky-Shapiro,PadhraiSmythandRamasamyUthurusamy,Advancesinknowledge discoveranddatamining,TheM.I.T.press.

CMA832 Mathematical Finance (3-0-0)3

Introductionto Stochastic Processes, Poisson process,BrownianMotion,Martingales. PresentValue Analysis, InterestRateAnalysis,MarketModelSpecificationProblems.ArbitageTheorem, Multi-PeriodBinomialModel, Block-Scholesformula,ValuingInvestmentsbyExpectedUtility,PortfolioSelectionProblem,CapitalAssets PricingModel,RatesofReturn,SinglePeriodandGeometricBrownianMotion,Mean-VarianceAnalysisofRisk- Neutral-Priced CallOptions,AutoregressiveModelsandMeanRegression,OtherPricingOptionsandApplications
S. M. Ross, An Elementary Introduction to Mathematical Finance, CUP.
Thomas Mikosch, Elementary Stochastic Calculus with Finance in view, World Scientific.

Mark S. Joshi, The Concepts and Practice of Mathematical Finance, CUP.

CMA833 Game Theory (3-0-0)3

Introduction: Definition of Games. Actions, Strategies, Preferences, Payoffs. Examples**.** Strategic Form Games: Strategic form games and examples: Prisoner's Dilemma, Bach or Stravinsky. Dominant Strategy Equilibrium:Strongly dominant strategies, weakly dominant strategies, dominant strategy equilibrium; Examples of Prisoner's Dilemma and Vickrey Auction. Two Player Zerosum Games (Matrix Games): Maxminimization and Minmaximization. Saddle points. Nash equilibrium in matrix games. Minimax theorem. Solution via linear programming. Examples. Bayesian Games: Motivational Examples. Definition of a Bayesian Game and Bayesian Nash Equilibrium and examples.

Martin Osborne. An Introduction to Game Theory. Oxford University Press, 2003.
Y. Narahari. Game Theory and Mechanism Design. IISc Press and World Scientific, 2014.
Philip D. Straffin, Jr. Game Theory and Strategy. The Mathematical Association of America, January 1993.
Ken Binmore, Fun and Games : A Text On Game Theory, D. C. Heath & Company, 1992.

CMA834 Fuzzy Sets and Fuzzy Logic (3-0-0)3

Characteristics of Fuzzy System Models, Classification, Problems; Examples, Modeling of system uncertainties; parametric uncertainties; scope and validity of results. From Classical (Crisp) Sets to Fuzzy Sets: A grand Paradigm shift, Fuzzy Numbers, Fuzzy Arithmetic, Fuzzy Measures, Operations on Fuzzy Sets, Fuzzy Relations, Multi-valued Logic, Fuzzy Logic; Uncertainty and information, Uniqueness of Uncertainity Measure; Possibility Theory; Approximate Reasoning; Fuzzy Decision Making.

Klir and Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India.
Klir and Folger, Fuzzy Sets, Uncertainty and Information, Prentice Hall of India.
T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw Hill.
Zimmermann, Fuzzy Set Theory and its applications, Kluwer Academic Publishers.
C. V. Negoita, Fuzzy Systems, Abacus Press.

CMA835 Computational Graph Theory (3-0-0)3

Graph Enumerations, Distances in Graphs, Matchings, Coverings, Independence and Factorizations. Fundamental algorithmic techniques for solving graph problems – Traversal and Search Techniques, Greedy Approach, Dynamic Programming, Backtracking, Branch and Bound Techniques and their applications to various graph problems, Network Flow Algorithms, Classification of graph problems: P, NP-Hard and NP-Complete. Spanning Trees and Optimization: Basics of Minimum Cost Spanning Trees, Optimal Routing Trees, Optimal Communication Trees.

Fred Buckley and Frank Harary, Distances in Graphs, Addison Wesley, 1990.
Gary Chartrand and Ping Zhang, Introduction to Graph Theory, Tata McGraw Hill, 2006.
Geir Agnarsson and Raymond Greenlaw, Graph Theory – Modeling, Applications and Algorithms, Pearson Education, 2007.
Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 2nd Edition, 2009.
T. H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, Prentice Hall of India, 2nd Edition, 2005.
Wu Bang Ye and Kun-Mao Chao, Spanning Trees and Optimization Problems, CRC Press, 2004.

MCA 601 Computer Organization and Architecture (4-0-0) 4

Data Representation, Number systems, Logic design, Addressing modes, Assembly Language programming, Memory organization, Arithmetic: Adders, Carry Look ahead Adder, CSA, Fast multipliers, Booth multiplier, Floating point representation and operations, CPU architecture and organization, Microprogramming, Hardwired control unit, Instruction Formats I/O architecture. Multiprocessing, RISC vs., CISC Architectures, Pipelining and superscalar machine, Parallel processing.

VC Hamachar, ZG Vranesic and SG Zaky, Computer Organization, McGraw Hill
1996 Moris Mano, Computer System Architecture, Prentice Hall, 1992

MCA 602 Computational Mathematics (4-0-0) 4

Numerical solution of algebraic and Transcendental equations, Solution of system of linear algebraic equations by direct and iterative methods, Interpolation - Finite differences, Curve fitting by least Square Principle, Numerical Differentiation and Integration, Numerical solution of ordinary differential equations, Solution of boundary value problems in ordinary differential equations, Solution of partial differential equations.

S S Sastry: Introductory methods for Numerical analysis, 3rd edition, 2000, Prentice Hall.

M K Jain, S R K Iyengar and R K Jain, Numerical methods for Scientific and Engineering computation, Wiley Eastern, 1985
M K Jain, Numerical solution of Differential equations, Wiley Eastern, 1984

MCA 603 Discrete Mathematical Structures (4-0-0) 4

Fundamentals of logic: Propositional and predicate calculus, Graph Theory: trees, Representation of graphs, Spanning Tree and shortest path algorithms, Planarity, Connectivity, Traversability, Colorability, Network flow algorithms, Search procedure, Recurrence relations and generating functions, Group Theory: Groups, Subgroups, Lagrange's Theorem, Cyclic groups, Permutation groups, Normal subgroups, Lattice Theory: Order relations, Partial order, Linear order, Lattices, Boolean lattices, Boolean algebra.

J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with applications to Computer Science, McGraw Hill. Judith L. Gerstring, Mathematical Structures for Computer Science, Freeman, 5th edn.
Ralph P. Grimoldi, Discrete and Combinatorial Mathematics, An applied introduction, Pearson Education, 4th edn.

MCA 604 Programming Concepts (4-0-0) 4

Introduction to Algorithms, Flow charts, Procedure oriented Programming concepts, Data types, Operators and Expression, I/O functions, composite Data types (Arrays, Structs, Union) Queues (FIFO), Stacks (LIFO), Pointers, Dynamic Memory Allocation, Linked lists: - Single and doubly linked list, Introduction to Object oriented Paradigms:- Encapsulation, Data hiding, Polymorphism (Operator and Function overloading), Inheritance, Data abstraction, Introduction to Object Oriented Design.

B. Kernighan and D. Ritchie, The C Programming Language, Prentice Hall, 1990
E. Balagurusamy, Programming in ANSI C, Tata Mc.Graw Hill 2004
Hilbert Schilds, C++ complete Reference 1999.

MCA 605 Data Structures & Algorithms (4-0-0) 4

Introduction to analysis of algorithms: asymptotic notations, big-oh, big-omega, theta, small-oh, small-omega notations, worst-case and average-case analysis, solving recurrences. Abstract data types, Linear Data Structures and their sequential storage representation: stacks, queues, priority queues, and their applications. Pointers and linked storage representation: singly linked list, circular linked list, doubly linked lists and their application, skip lists. Nonlinear data structures: trees, storage representation of binary trees, operations on binary trees: tree traversals, insertion, deletion, searching, trees, applications of trees, AVL trees. Graphs: representation of graphs, breadth first search and depth first search, shortest path problem, minimum cost spanning trees, applications of graphs. Sorting: selection sort, bubble sort, insertion sort, merge sort, heap sort, quick sort, radix sort. Searching: sequential search, binary search, search trees, hash tables.

T.H. Cormen, C.E. Leiserson, R.L. Riverst, C.Stein, Introduction to Algorithms, Prentice -Hall of India, 2003
A.V. Aho, J.E. Hopcraft and J.D. Ullman, Data Structures and Algoriths, Pearson Education, 2003
J.P. Tremblay and P.G. Sorenson, An Introduction to Data Structures with Application. Tata McGraw-Hill 1991.

MCA 606 Data Structures and Algorithms Lab (0-0-3) 2

MS-DOS editor commands. Unix commands. Simple programs using I/O. Implementation of programs using control statements, Functions, Arrays, Pointers, Structures, Unions, File handling, Graphics function and animation.

Brian W.Kernigham and Pike R., The Practice of Programming, Addison Wesley, 1999.

MCA 607 Computer Architecture Lab (0-0-3) 2

MCA 608 Programming Lab (0-0-3) 2

C programming: - Data types, Operators, Functions, Arrays, Structures, Unions, Dynamic Allocation, Linked list
C++:- Class, Inheritance, Overriding Function and Operator Overloading.

MCA 611 Computer Oriented Statistical Methods (4-0-0)4

Introduction of probability, total probability theorem, conditional probability, Baye's theorem, one and two dimensional random variables, functions of random variable, probability distributions, discrete and continuous cases, marginal and conditional distributions, independence of random variables, expectation and variance of a random variable, correlations, sampling theory, sampling distributions, weak law of large numbers, central limit theorem and applications, methods of estimation, parameter estimation, tests of statistical hypothesis.

Meyer P.L., Introduction to Probability and Statistical Applications, Oxford & IBH, 1979.
RV Hogg and AT Craig, Introduction to Mathematical Statistics McMilan, 1975.

HU 612 Managerial Economics (4-0-0) 4

Business Objectives and Business Decisions - Nature and scope of managerial economics, Economic theories, Firms Objectives, Profit maximization, Entrepreneurship, Manager role, Managerial decisions. Demand Analysis, Forecasting and Market Structure - Demand determinants, types of demand, Demand function, Demand Elastictiy's, Demand forecasting -methods, market structure, type of competitions, price and output decisions under perfect and imperfect competition. Monopoly, Monopolistic, Oligopoly competitions, safeguarding competition and anti-trust lanes. Production, Pricing and Profit Management - Production theory, Determinants of price, Pricing structure, Price discrimination, Pricing of joint products, Pricing methods, statutory price fixation in India, Price discounts and differentials, Nature of profit, profit policy, measurement, planning and forecasting. Decision Techniques and Capital Budgeting - Optimization, Resource allocation, Evaluation alternatives, formulation of linear programming problem, marketing decision concepts, Introduction to capital budgeting, Types and evaluation of investment decisions. Data of Macroeconomics - National income, Aggregate demand and expenditure, saving and Investment, Trade cycle and control, International trade, Balance of payments and Foreign exchange. Money System - Market for money, Interest rates, the capital market - banks, stock exchange, multiplier and accelerator. Case Studies.

Mote V.L Paul Samuel and Gupta G.S. "Managerial Economics", McGraw -Hill, 1985
Craig Petersen H. and Cris Lewis W., "Managerial Economics", Prentice Hall of India, 2000 Dwivedy D.N., "Managerial economics", Vikas Publishing House, 1995.
Mcguigam, "Managerial Economics Applications Strategy and tools", South Western, 2002. N. Gregory Mankiw. "Principles of Economics", (3rd Ed) Thomson, 2002.

MCA 613 Microprocessors PREREQ MCA601 (3-0-0) 3

Introduction to microprocessors. Architecture of 8086/8088. Assembly language programming. Addressing modes of 8086. Instruction set. Subroutines. Modular programming. Macros and conditional assembly. Interrupt processing. Hardware architecture of 8086/8088. Memory System Design and peripherals. Introduction to 80386, 80486. Hardware details of PENTIUM.

BB Barry, The Intel Microprocessors, Prentice Hall of India,1996.
Liu and Gibson, Microcomputer System, the 8086/8088 family, Prentice Hall 1989.

MCA 614 Operating System (4-0-0) 4

Operating System Functionalities, Types of Operating System- Multi programming, Multi tasking, Multi processing and Realtime Operating system, Processes and threads, Process Management (learning fork system call), Inter process communication (using shared memory, Message Queues,. Pipes etc.), CPU scheduling, Process synchronization Mechanism (Semaphores in Unix), Dead locks - Prevention, avoidance and recovery techniques, Memory Management (Paging, Segmentation and Swapping), Virtual Memory (Dynamic Paging Techniques and Page replacement Algorithms), File Systems Management, IO Management, Protection and Security

Silberschatz, Galvin, Gagne Operating System Concepts (Sixth Edition), John Wiley 2008
Mourice J. Bach, The Design of the Unix Operating System PHI 2002

MCA 615 Theory of Computation PREREQ MCA603 (3-0-0) 3

Finite automata. Moore and Melay machines. Regular Expressions. Pumping lemma. Minimizing the automata. Formal Languages. Regular languages. Context free languages (CFL). Chomsky and Greibach Normal forms. Pushdown automata (PDA). Equivalence of PDA and CFL. Turing machines. Theory of recursive functions. Complexity theory. NP-completeness.

Aho, Hopcraft & Ullman, Automata, Languages and Computation, Narosa,1986
Mishra and Chandrashekar, Theory of Computer Science, Prentice Hall 1998.

MCA 616 Microprocessor Lab (0-0-3) 2

MCA 617 Operating Systems Lab (0-0-3) 2

Unix Operating System familiarization, UNIX shell scripting, Implementation of IPC Using Shared Memory, Pipes, Files, Message queues etc., Process synchronization using Semaphores (Reader writer and Dining Philosopher Problem), Disc scheduling Algorithms.

MCA 701 Database Management Systems (4-0-0)4

Files versus database systems, Three-level architecture of databases, Data Models, ER-diagram, EER-model, Relational model, ER-Relational mapping, Relational algebra and calculus. Query languages, SQL, Embedded SQL, Relational database design algorithms, Normalization, Physical database organization, Indexing and hashing,

Transaction processing, Concurrency control techniques, Database recovery techniques, Database security and authorization.

Ramez Elmasri, Shamkant B Navathe, Fundamentals of database system, Addison Wesley, McGraw-Hill, 2000.
Silberschatz Korth and Sudarshan, Database System Concepts, McGraw Hill.
Ramakrishnan, R., Gehrke, Database Management Systems, Third edition McGraw Hill.

MCA 702 Object Oriented Programming PREREQ MCA604 (3-0-0) 3

Key concepts of Object Oriented Programming. Overview Of C++, Classes,Inheritance. Polymorphism, Overloading. Virtual functions, Templates, Exception handling, I/O stream. File I/O, Java Programming

Herbert Schild, C++ The complete References, 1999.
HM.Deitel and PE Deitel, Java How to Program, Prentice Hall, 1998.

HU 703 Accounting and Financial Management (4-0-0) 4

Principles of Accounting - Concepts - Conventions - Principles. Accounting Systems as source of Financial Information for Decision Making. Financial Accounting - Financial Statements - Ratio Analysis. Inventory Management - Depreciation Policy. Cost Accounting - Classifications. Management Accounting - Cost for Profit Planning and Decision Making. Financial Decisions. Accounting Systems for Planning Control and Decision Making. Budgeting and Budgetary Control.

I.M. Pandey, Elements of Management Accounting. Vikas Publishing House. Khan and Jain, Financial Management, Tata McGraw Hill Publication.
Prasanna Chandra, Financial Management, Tata McGraw Hill Publication. Van Horne James C., Financial Management Policy, Prentice Hall of India.
Anthony & A. Alkinson, Robert S. Kaplan & S. Mark Young, Management Accounting 4th Ed.
Ther Robert S. Kalpan Series in Management Accounting.

MCA 704 Database Management Systems Lab (0-0-3) 2

Creation of tables, Views, Insertion, Modification and deletion of elements. Implementation of queries. Implementation of joins. Implementation of PL/SQL, triggers, cursors and sub programs. Implementation of database connectivity through front end tools. Database design and implementation. Mini project.

MCA 705 Object Oriented Programming Lab PREREQ MCA606 (0-0-3) 2

Simple C++ Program. Dynamic memory allocation. Constructor/Destructor, Friend function, Function overloading, Operator overloading. Inheritance. Virtual functions and Dynamic binding. Templates. File Handling. Exception handling. Simple Java programs. Inheritance. Event handling programs.

MCA 711 Software Engineering (4-0-0) 4

Software engineering paradigms, Planning, Cost estimation, Organization structure, Software project scheduling, Risk analysis and management, Requirements and specification, Rapid prototyping, Software design, Software metrics, Software testing and maintenance, Software configuration management and case tools, OO modeling, OO software development process, OOT concepts, Unified software development process, Development Phases, UML, structural and behavioral modeling, architectural modeling.

Roger S. Pressman, Software Engineer: A Practitioner Approach, McGraw Hill, 1999
L Sommerville, Software Engineering, Addision Wesley, 1996
Grady Booch "OO Analysis and Design with Applications" Pearson Education Asia
Jacobson, Booch and Rambaugh, "The unified software Development process" Pearson Education Asia

MCA 712 Computer Graphics (4-0-0) 4

Graphic Hardware, Display Devices: line and point plotting algorithms, I/O Devices, Display processors, Color display Techniques (Shaddow masking & Penetration CRT), Coordinates (Screen and User), 2D and 3D transformation, Curves, Surfaces and solids, Hidden line and surface elimination, illumination and shading, Color Models (RGB, HIS etc), Animation techniques.

Hearn D and Baker MP, Computer Graphics, PHI, 2002
Roger DF, Procedural Elements of Computer Graphics, McGraw Hill, 2002, Gonzalez C and Woods RE, Digital Image Processing, Addison Wesley, 2000.

MCA713 Software Engineering Lab (0-0-3) 2

MCA 714 Computer Graphics Lab (0-0-3) 2

Line and Point Drawing Algorithms, 2D 3D Transformations, Clipping and Windowing, Animation

MCA 721 Computer Networks (4-0-0) 4

Introduction :Uses of Computer Network, Network hardware, Network software, Types of networks, topology, Hierarchical Reference Models OSI and TCP/IP Models. The theoretical basis for Data Communication, Transmission media. Physical Layer. Bit signal transformation, Bit rate control, Multiplexing, Circuit switching, Line coding, Data Link Layer, Data Link Layer Design issues, Addressing, Error correction and detection, Flow control, Medium Access control, Framing, Network Layer Network Layer Design issues, IP addressing, Subnetting, NAT IP v6, DHCP, ICMP, ARP, Routing algorithms, IP datagram and fragmentation, Internetworking devices Transport Layer Transport layer services, Addressing, Connection control, transport protocols such as UDP and TCP, congestion control algorithms, Quality of service. Application layer: Application layer protocols SMTP, DNS, FTP, HTTP, Introduction to Network Security, Introduction to wireless network and Mobile Ad-hoc Networks

AS Tannenbaum, Computer Networks, Prentice - Hall 2003.
William Stallings, Data and Computer Communication, PHI, 1997
James F. Kurose and Keith W Rose, Computer Networking Pearson Education, 2003

MCA 722 Internet Technology & Applications (3-0-0) 3

History of Internet. Internet addressing. TCP/IP. DNS and directory services. Internet resources and applications. WWW Overview. Advanced java programming. Applet Programming. N/w programming, JDBC. Servlet programming.

Deitel & Deitel, Internet & World wide Web, How to program, Prentice Hall 2000.
D Norton and H Schild, Java2: The complete reference, TMH 2000.

MCA 723 Computer Networks Lab. (0-0-3) 2

Implementation of Datalink, Network, Transport, Application layer protocols techniques based on computer networks. Client/server programming. Internetworking of LANs. File transfer using TCP/IP Remote command execution UNIX socket programming.

MCA724 Internet Technology & Applications LabPREREQ MCA705 (0-0-3) 2

Client and Server Side Scripting Programs. Use of Components. Creating dynamic web pages. Experiments with ASP/ACTIVEX / JAVA Server Pages. Socket programming and applications. Java servlets. On-line transactions. Database connectivity. Mini project.

MCA725 Computer Applications Lab (0-0-6)4

MCA801 Computer Algorithms PREREQ MCA605 (3-0-0) 3

Mathematical Background. Design and Analysis of algorithms. Complexity measures. Worst-case and average-case complexity. Sorting and selection. Searching and set manipulation. Hashing. Union-Find problem. Design techniques: Divide and conquer, Dynamic programming, Greedy method, Backtracking, Branch & bound. Graph and parallel algorithms. Algebraic problems. String processing. NP-completeness.

A Aho, J Hopcroft, and J Ullman, The design and analysis of computer algorithms, Pearson Education 2001.
Thomas H. Cormen, Charles E Leiserson, and Ronald L. Rivest, Introduction to Algorithms, Prentice Hall 1998.

MCA802 Fuzzy System Models (3-0-0) 3

Classical (Crisp) sets versus fuzzy Sets. Fuzzy Numbers. Fuzzy arithmetic. Fuzzy measures. Operations on fuzzy sets. Fuzzy relations. Multi-valued logic. Fuzzy logic. Uncertainty and information. Uniqueness of uncertainty measure. Possibility theory. Approximate reasoning. Fuzzy decision making.

Klir and Folger, Fuzzy Sets, Uncertainty and Information, Prentice Hall 2001.
Klir and Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India 2001.

MCA803 Management Information Systems (3-0-0) 3

Definition of management information systems. Information systems for decision making process. Information-based support systems. Information system requirements. Planning, designing and implementing MIS. Case study.

GB Davis and MH Olson, Management Information Systems, Mc-Graw Hill, 1984.
Murdick RG and Ross JE, Information systems for modern management, Prentice Hall.

MCA804 Operations Research (3-0-0) 3

Linear Programming. Formulation and graphical solutions. Simplex Algorithm. Quality and sensitivity analysis. Dual simplex method. Transportation and assignment problems. Games and their solution by linear programming. Network

Analysis. Queuing Theory. Basic structure of a queuing Model. M/M/1 and M/M/S models and their variants.
Hamdy A Taha, Operations Research, Prentice Hall of India, 1997.
Hiller and Liberman: Introduction to Operations Research, Prentice Hall 1995.

MCA805 Optimization Techniques & Statistical Methods (3-0-0) 3

Linear programming problem. Simplex method. Two-Phase method. Duality theory. Transportation problem. Assignment problem. Reliability. Concepts of hazard, Bath-tub curve, MTTF , MTBF. System reliability for series, parallel and mixed configurations. Data Analysis. Time series analysis, Time series models, Method of moving averages. Seasonal movements, Cyclical movements.
Kanthi Swarup, PK Gupta and Man Mohan, Operations Research, Sultan chand & Sons, 1978.
J Medhi, Statistical Methods, Wiley Eastern, 1987.

MCA806 Artificial Intelligence PREREQ MCA603 (3-0-0) 3

Foundation and history of AI. AI Problems and techniques. Heuristic search techniques. Knowledge representation. Reasoning under uncertainty. Planning and learning. Genetic algorithms. Applications of AI. Principles of natural language processing. Expert systems. Current trends in intelligent systems. AI programming languages. Introduction to LISP and PROLOG.
Elain Rich and Kevin Knight, Artificial Intelligence, Tata McGraw Hill Publishing Company Limited, 1995.
Stuart Russel and Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 1995.

MCA807 Artificial Neural Networks PREREQ MCA721 (3-0-0) 3

Introduction to artificial neural network. Learning process. Single layer and multilayer perceptrons. Back propagation algorithm. Convolution network. Radial basis function network. Kernel regression and its relation to RBF network. Learning strategies. Support vector machines. Linearly separable patterns. Non-separable patterns. SVM for nonlinear regression. Principal component analysis. Pattern classification. Hierarchical vector quantization.
Simon Haykin, Neural Networks: A comprehensive Foundation, Prentice-Hall International, New Jersey, 1999. B Yegnanarayana, Artificial Neural Networks, Prentice-Hall of India, New Delhi.

MCA808 Computer Simulation & Modeling PREREQ MCA611 (3-0-0) 3

Components of a system. Models of system. Random number generation. Probabilistic distribution. Simulation languages. Applications
Jerry Banks and John Carson. S, Discrete Event System Simulation, PHInc, 1984.
Gotifried B, Elements of Stochastic process simulation, PHInc, 1984.

MCA809 Genetic Algorithms PREREQ:MCA605 (3-0-0) 3

Robustness of traditional optimization and search techniques, Goals of optimization, A simple genetic algorithm, Similarity templates, Mathematical Foundations, Computer Implementation of Genetic Algorithms, Advanced operators and techniques in genetic algorithm search. Industrial application of genetic algorithms.
David Goldberg, Genetic Algorithms in search, optimization and machine learning, Addision Wesley International,1999.
Charles L Karr and L Michael Freeman, Industrial applications of Genetic Algorithms, CRC Press, 1998.

MCA810 Knowledge Management (3-0-0) 3

Introduction to knowledge Management. Types of knowledge within an organization. Intellectual capital. KM Architecture and Tools. ERP for KM. Knowledge sharing tools. Data ware housing. Knowledge strategy creation. KM practices. KM Process. Integrating knowledge sharing and learning. The chief knowledge Officer (CKO) and his/her job. Training programmes for organization. Wide learning. Making KM work across various segments of industry and business firms. Case studies of KM practices in successful companies, Future challenges in KM.
Ratnja Gogula (Ed), Knowledge Management: A New Down., The Institute of Hartered Financial Analysts of India, Hyderabad 2002.

MCA811 Natural Language Processing PREREQ MCA603 (3-0-0) 3

Issues and difficulties in NLP. Language understanding systems. Types of NLP Systems. Grammars and parsing. Semantic Interpretation. Language communication. Typical Systems. Current trends in NLP.
James Allen, Natural Language Understanding, Benjamin / Cummings Publishing Co, 1995.
Ronald Hausser, Foundations of Computational Linguistics, Springer-Verleg, 1999.

MCA812 Network Optimization PREREQ MCA603 (3-0-0) 3

Net work models. Minimal spanning trees. Shortest route problem. Matching and coloring problems. Max flow min- cut theorem. Capaciated network model. Network simplex method. PERT and CPM. Resource analysis in network scheduling. Precedence planning. Resource allocation and scheduling.

CH Papadimitriou and K Steiglitz, Combinatorial optimization: Algorithms and Complexity, Prentice Hall,1982.
Hamdy A Taha, operations research, PHI, 1997.

MCA813 Object Oriented Analysis & Design PREREQ MCA702 (3-0-0) 3

Object oriented design fundamentals. OOSD life cycle. Object oriented analysis. UML. Object oriented design methods. Design patterns and frameworks. Object oriented development. Coding, Testing, Maintenance. Case studies in object oriented development.

Grady Booch, James Rumbaugh and Ivar Jacobson, The Unified Modeling Language User Guide, Addison Wesley Long man, 1999.
Erich Gamna, Design Patterns, Addison Wesley, 1994.

MCA814 Performance Modeling PREREQ MCA611 (3-0-0) 3

Performance evaluation methods. Analytical versus simulation modelling. Performance measurement and benchmarking. Workload modelling. Random variables. Commonly used distributions. Stochastic processes. Markov chain models of computer systems. Queuing models. Discrete event simulation. Simulation Languages. Confidence intervals. Variance reduction techniques. Case studies of analytical and simulation studies of computer systems.

Raj Jain, The Art of Computer Systems Performance Analysis, John Wiley and Sons, New York, USA, 1991.
KS Trivedi, Probability and Statistics with Reliability, Queuing and computer science, PHI, 1982.

MCA815 Stochastic and Queuing Systems PREREQ MCA611 (3-0-0) 3

Probability concepts. Random variables. Functions of random variable. Distributions. Moment generating function. Stationary process. Markov process. Binomial process. Poisson process. Birth and death process. Renewal process. Markov chains. Chapman-Kolmogorov equations. Transition probabilities. Series and parallel systems. Reliability and Availability of Markovian systems. Maintainability. Preventive maintenance. Markovian queuing models.
Little's formula. Multi-server queues. M/G/1 Queues. Pollaczek-Khintchine formula. Decision theory and games.

Trivedi KS, Probability and Statistics with reliability, Queuing and Computer Science Applications, Prentice-Hall 1984.
J Medhi, Stochastic process, Wiley eastern 1987.

MCA816 UNIX and Network Programming PREREQ MCA615 (3-0-0) 3

Overview of UNIX OS. File I/O. Files and directories. Standard I/O library. System data files and information. Processes. Process relationships. Terminal I/O. Advanced I/O. Threads. Interprocess communication. Message passing. Synchronization. Shared memory. Sockets. Name and address conversions. Applications: TCP echo client server, UDP echo client server.

W Richard Stevens, Advanced programming in the UNIX environment, Addison Wesley,1999.
W Richard Stevens, UNIX Network Programming Volume 1 and 2, Prentice Hall, 1998.

MCA817 Advanced Client Server Computing PREREQ MCA614, MCA721 (3-0-0) 3

Development of Client/Server computing. Architecture of client/server. Three tired architecture. Client characteristics and tools. Use of GUI and local processing with examples. Services like file, database, communication and security. Platforms: LAN, WAN and enterprise wide services. Network operating system. Connectivity: SWMP, NFS, SMPT, IPC. Services: pipes, semaphores, shared memory, DDE, RPC, OLE. Application development. Management and risk issues.

Robert Orfalietall, Essential Client/Server Survival guide.
Larry T. Vaughn, Client /Server System Design & Implementation.

MCA818 Advanced Database Management Systems PREREQ MCA701 (3-0-0) 3

Basic concepts. Architecture for data sharing, Federated DBMS. Distributed databases. Client/server architecture. Multimedia databases. Object oriented data bases. Data mining and knowledge discovery. Pattern clustering abstraction and similarity. Clustering for data mining. Data mining using neural networks and genetic algorithms. Discovery of association rules. Frequent episodes in event sequences. Applications of data mining.

Ramez Elmasri, Shamkant B Navathe, Fundamentals of Database Systems, Addison Wesley, 2000.
Stefano Ceri & Giuesppe Pelagatti, Distributed Databases - Principles and Systems, McGraw Hill 1987.

MCA819 Advanced Operating Systems PREREQ MCA614 (3-0-0) 3

An overview of operating system functions. Distributed operating systems. Design issues. Distributed shared memory. Scheduling algorithms. Recovery. Protection and Security. Cryptography. Architecture of multiprocessor operating systems. Database operating systems.Transaction processing. Serializibility. Concurrency control algorithms. Object oriented operating systems. Case studies: UNIX, LINUX, Windows.

Mukesh Singhal Niranjan, G.Shivorothri, Advanced concepts in Operating Systems, Tata Mc-Graw Hill, 1994.
Andrew S Tenanbaum, Modern Operating Systems, PHI, 1995.

MCA820 Cryptography and Network Security PREREQ MCA721 (3-0-0) 3

Conventional encryption. Introduction to Finite Fields. Contemporary symmetric ciphers. Confidentiality using conventional encryption. Public-Key Encryption. Hash Functions. Introduction to Number Theory. Public-Key Cryptography. Message authentication. Hash and Mac algorithms. Digital signatures and authentication protocols. Network security. System security.

William Stallings, Cryptography and Network Security, Pearson Education India 2002.
RE Smith, Internet Cryptography, Pearson Education India.

MCA821 Data Mining and Warehousing PREREQ MCA701 (3-0-0) 3

Overview of data mining techniques. Taxonomy of data mining tasks. Steps in data mining process. Predictive modeling. Association rules. Statistical perspective. Clustering. Regression analysis. Time series analysis. Bayesian learning. Data warehousing. Dimensional modeling. Performance issues and indexing. Development life cycle. Case studies.

Jiawei Han, Micheline Kamber, Data Mining : Concepts and Techniques, Motgan Kaufmann Publishers, 2000.
Usama M Fayyad, Gregory Piatetsky-Shapiro, Padhrai Smyth and Ramasamy Uthurusamy, Advances in knowledge discover and data mining, The M.I.T. press, 1996.

MCA822 Digital Image Processing PREREQ MCA712 (3-0-0) 3

Digital image fundamentals. Elements of visual perception. Colour models. Mathematical preliminaries of 2D systems. Image transforms. Image enhancement and restoration. Image compression. Image segmentation.

Gonzalez C and Woods RE, Digital image processing Addition Wesley, 2000.
Anil K Jain, Fundamentals of digital image processing, PHI, 1997.
William. K Pratt, Digital image processing, Wiley International, 2000.

MCA823 Distributed Computing System PREREQ MCA701 , MCA721 (3-0-0) 3

Introduction to distributed Systems. Design Goals. Fundamental issues in distributed systems. Basics of networking, Temporal ordering of events. Lamport's logical Clocks. Vector clocks. Global state detection. Physical clocks. Process Synchronization. Distributed mutual exclusion. Performance matrix. Interprocess communication. RPCs. Deadlocks in distributed systems. Load balancing techniques. Distributed databases.

GF Coulouries, JD Dollimore and T Kindberg, Distributed Systems: Concepts and Design, Addison Wlesley, 1994.
Mukesh singhal and Niranjan G.Shivaratri, Advanced concepts in Operating system, Tata McGraw Hill 1994.

MCA824 Information and Coding Theory PREREQ MCA611 (3-0-0) 3

Entropy and its characterizations. Huffman codes. Shannon-Fano coding. Information measure-noiseless coding. Fundamental theorem of information theory. Error correcting codes. Minimum distance principles. Hamming bound. General binary code. Group code. Covolution encoding. Algebraic structure. Gilbert bound. Threshold decoding. Cyclic binary codes. BCH codes. Decoding. Optimum codes. Concepts of non-cyclic codes.

R Ash, Information theory, Interscience publication, Singapore, 1965.
N Abrahamson, Information theory and coding, Mc Graw Hill, 1963.

MCA825 Parallel Processing PREREQ MCA 601, MCA613 (3-0-0) 3

Theory of Parallelism. Multiprocessors and Multicomputer. Conditions for Parallelism. Data and resource dependencies. Hardware and software Parallelism. Program Flow Mechanisms. Control Flow versus data flow. Hardware technologies. Instruction set Architectures, CISC, RISC. Scalar Processors, Memory Hierarchy and Virtual Memory. Cache Memory organizations. Hardware synchronization mechanisms. Vector processing principles.

K Hwang & Briggs FA, Computer Architecture and Parallel Processing, McGraw Hill,
1985. Kai Hwang, Advanced Computer Architecture, McGraw Hill 1993.

MCA826 Pattern Recognition & Scene Analysis PREREQ MCA611 (3-0-0) 3

Pattern and features. Pattern recognition approaches. Discriminant functions. Statistical pattern recognition. Gaussian model. Parametric estimation. Bayesian parameter estimation. Pattern classification by distance functions Cluster

analysis. Syntactics pattern recognition. Features extraction and recent advances.
Earl Gose, Richard Johnsonbaugh, Steve Jost, Pattern Recognition and Image Analysis, Prentice Hall 1999.
Duda RO and Hart PE, Pattern Classification and Scene Analysis, Wiley, 1973.

MCA827 Web Design PREREQ MCA702 (3-0-0) 3
HTML overview. HTML tags. Formatting text. Cascading style sheets. DHTML. Web design tools. MS Front page. Dreamviewer Multimedia. Client side scripting. Introduction to java script. VB script. Server side scripting. Active server pages. Java server pages. Database connectivity. Web applications.
Thomas powell, Fritz Schneider, Java script:The complete reference, Tata Mc Graw Hill, 2002.
David crowder, Rhonda crowder, Web design, IDG books India Pvt. Ltd., 2001.

MCA828 Compiler Design PREREQ MCA605 (3-0-0) 3
Phases of a compiler. Lexical analysis. Syntax analysis. LEX and YACC utility. Syntax directed translation. Run time Environments. Intermediate code generation. Code optimization. Code generation.
AV Aho, Ravi Sethi, and JD Ullman, Compilers: Principles, techniques and tools, Pearson education Asia, 2001.

MCA830 Object oriented programming with JAVA (3-0-0)3
Introduction to Programming, and Java: Primitive Data Types and Operations: Selection Statements, Loops, Methods, Arrays, Strings and Text I/O; Exceptions and Assertions, Objects and Classes; Inheritance and Polymorphism; Getting Started with GUI Programming: Creating User Interfaces; Event Driven Programming; Java Database Programming; Remote Method Invocation; Java Server Pages; Multithreading; Networking; Advanced Swing Models; Menus, Toolbars, Dialogs; Containers, Layout Managers, and Borders.
References:
Y. Daniel Liang, Introduction to Java Programming Comprehensive version, Tenth Edition, Pearson publishers, 2015.
Herbert Schildt, Java: The Complete Reference, Ninth Edition, Oracle press (Mc. Graw Hill), 2014.
Bruce Eckel, Thinking in Java fourth edition, Prentice Hall, 2005.

MA701 Applied Statistics & Numerical Analysis (3-0-0) 3
Introduction to probability, probability distributions, Sampling theory, Hypothesis testing, Analysis of variances of one-way and two way classified data, Numerical solutions of ordinary differential equations, Numerical solution of partial differential equations, Introduction to finite element methods.
Sheldon Ross M., Introduction to Probability and Statistics for Engineers and Scientists, John Wiley. Hogg R. V., Craig A. T., Introduction to Mathematical Statistics McMillan.
Smith G. D., Numerical Solution of Partial Differential Equations, Oxford University Press.

MA702 Design & Analysis of Experiments (3-0-0) 3
Introduction to Probability, one - dimensional random variables, two and higher dimensional random variables, probability distributions, Sampling theory, moments, mgf and their properties, Parameter Estimation, point estimation, interval estimation of means and variances, Hypothesis testing, goodness of fit tests, Analysis of variances of one-way and two way classified data, experi*mental* design.
Douglas Montogomery, Design and Analysis of Experiments, 3 Edition, John Wiley.
Sheldon Ross M., Introduction to Probability & Statistics for Engineers & Scientists, John Wiley
Hogg R. V., Craig A. T., Introduction to Mathematical Statistics, 4th Edition, McMillan

MA703 Linear Algebra (3-0-0) 3
Finite dimensional vector spaces, Algebra of transformations, matrix algebra, solution sets of linear system of equations, eigenvectors, Real symmetric / Complex Hermitian matrices, Algebra of polynomial matrices, Inner product spaces, singular value decomposition, polar decomposition, Applications of linear algebra in signal processing, coding theory and control theory. *rd*
Gilbert Strang, Linear Algebra and Its Applications, 3 ed., Brooks/Cole, 1998.
David C. Lay, Linear algebra and its applications, 2nd ed., Pearson, 2000.

MA704 Numerical Analysis (3-0-0) 3
Solution of algebraic transcendental and polynomial equations, Interpolation, Numerical differentiation, Numerical Integration, Integration over infinite intervals, Error analysis, Numerical solution of ordinary differential equations, Numerical solution of partial differential equations, Introduction to finite elements

Jain M.K., Iyengar S.R.K., Jain R.K., Numerical Methods for Scientific and Engineering Computation
Jain M.K., Numerical Solutions of Differential Equations
Mitchell A.R., Wait R., Finite Element Method in Partial Differential Equations

MA705 Operation Research (3-0-0) 3

Introduction and formulation of models: simplex method, duality in LP, Dual Simplex method, sensitivity analysis, transportation and assignment problems, Integer programming, Classical optimization methods, Lagrangian Multipliers and Khun-Tucker Conditions, quadratic programming.
Hamy A. Taha, Operations Research: An Introduction, PHI.

MA706 Probability & Statistical Applications (3-0-0) 3

Probability & Statistics: Introduction, one - dimensional random variables, two and higher dimensional random variables, marginal and conditional distributions, independence of random variables, variances and correlations, Distributions: Sampling Theory. Parameter Estimation: Hypothesis testing, goodness of fit tests, Data Analysis, Linear regression.
Meyer P.L. Introduction to Probability & Statistical Applications -, Amerind Publishing Co
Sheldon Ross M., Introduction to Probability & Statistics for Engineers & Scientists, John Wiley

MA707 Random Processes (3-0-0) 3

Overview of Probability, Random variables, Probability functions, Functions of Random variables, some important probability distributions, sequence of random variables, limit theorem, Random Correlation function, power spectral densities, linear systems with random inputs, Gaussian and Poisson process.
Gray R.M. and Davisson L.D., An Introduction to Signal Processing
Papoulis A, Probability, "Random variables and Stochastic Processes". McGraw Hill, 1984.

MA708 Statistical Methods (3-0-0) 3

Probability and Statistics, Introduction , One dimensional random variables, Two and higher dimensional, random variables, marginal and conditional distributions, independence of random variables, variances and correlations. Distributions: Sampling theory. Parameter estimation: Hypothesis testing, Goodness of fit tests. Data Analysis, Linear regression.
Meyer P.L. Introduction to Probability & Statistical Applications -, Amerind Publishing Co
Sheldon Ross M., Introduction to Probability & Statistics for Engineers & Scientists, John Wiley

MA709 Database Management (3-0-0) 3

Introduction to database systems, relational data model, Relational databases- SQL, Database design- Entity relationship data model- normal Forms, Storage and file organization, access methods, Data warehouses and Data mining.
Elmasri, Ramex, Shamkant B Navathe : Fundamentals of database systems
Ullman J. D : Principles of database systems
Date C. J.: An Introduction to database system Vol I,II,III Addison Wesley
Prakash, Naveen : Introduction to Database management : Tata McGrawHill

MA710 Applied Mathematics for Surveyors (3-1-0) 4

Tracing of curves, Overview of methods of Integration. Applications of Integration to area, arc length, volume and surface of revolution. Multiple Integrals. Line Integrals, Surface Integrals, Volume Integrals. Numerical Integration : Trapezoidal and Simpson Rule's. Numerical double Integration. Projection: Projection of a point, line segment on a line, projection of planes and surfaces. Spherical Trignometry
K. A. Stroud, Advanced Engineering Mathematics, Palgrove Macmillan 4 edition
Thoma 7 Finney, Calculus and Analytical Geometry
B.S. Sastry, Higher Engineering Mathematics, Khanna Publishers. S.S.Sastry, Introductory methods of Numerical Analysis.

MA711 Statistics for Management (3-0-0)3

Applications of statistics in managerial decision making – Primary and secondary data collection methods, drafting of questionnaire – Classification and tabulation of data – sampling method – Probability and Non-Probability Methods – Simple Random Sampling Method – Stratified Random Sampling – Cluster random Sampling – Measurement and Scales of Measurement – Data Analysis – Compilation and Tabulation of Data – Graphical Representation of the Data – Summary Statistics – measures of Variation –measures of Co-Variation – Estimation – Interval Estimate –

Testing of Hypothesis –Null and Alternative – Types of Errors – Type I and Type II Errors – Concept of Size and Power of a test Hypothesis. Correlation analysis – Regressions analysis – Business forecasting and time series.

Gupta S.P., Statistical Methods, 33rd Edition, Sultan Chand and Sons, 2004.
Daniel W. W. and J.C. Terrell, Business Statistics for Management and Economics, Houghton Mistlin Co 1992.

MA712 Optimization Techniques and Random Processes (4-0-0) 4

Deterministic Models: Introduction and formulation of models, Linear Programming, Graphical Solution, Simplex method, Two-phase method, Big-M method, Duality in LP, Transportation problems and Assignment problems.

Probabilistic Models: Overview of Probability, Random Processes, Classification, Markov Chains, C-K equations, Ergodic chains, Poisson Processes, Birth and Death Processes, Queuing Theory, Basic concepts, M/M/1 and M/M/S queues, Reliability Theory, Concept of Hazard rate function, Bath-tub curve, MTTF and MTBF, System reliability for Series, Parallel and Mixed configurations.

H. A.Taha, Operations Research - An Introduction, 8thedition,2007,PHI.
F. S. Hillier and G.J. Lieberman, Introduction to Operations Research, Concepts and Cases, 8th edition, 2010, TMH.

MA713 Mathematical Methods For Engineers (3-1-0)4

Revision of Linear Algebra – Linear Transformations, Range and Kernel, Isomorphism, Matrix of transformations and Change of basis

Partial Differential Equations: Second order PDEs, Classifications, Formulation and method of solutions of Wave equation, Heat equation and Laplace equation.

Tensor Calculus: Line, area and volume integrals, Spaces of N-dimensions, coordinate transformations, covariant and mixed tensors , fundamental operation with tensors, the line element and metric tensor, conjugate tensor, Christoffel's symbols , covariant derivative.

G. Hadley, Linear Algebra, Narosa, 2002.
A. N. Kolmogorov & S. V. Fomin, Elements of the Theory of Functions and Functional Analysis, 2001.
Sokolnikoff and Redheffer – Mathematics of Physics and Engineering, 2nd edition, McGraw Hill, 2006.
S. Sokolnikoff, Tensor Analysis, Wiley, New York, 2006.
Marsden, Ratiu, Abraham, Manifolds, Tensor Analysis, and Applications, Springer, 2001.
J. L. Synge, Tensor Calculus, Dover Publications (July 1, 1978)
L.A.Pipes and L.R. Harwill: Applied Mathematics for Engineers and Physicists, McGraw Hill, 2004.

MA714 Mathematical Foundations of Computer Science (3-0-0) 3

Divisibility, GCD, Prime Numbers, Fundamental Theorem of Arithmetic, Congruences, Fermat's Theorem, Euler Function, Primality Testing, Solution of Congruences, Chinese Remainder Theorem, Wilson's Theorem

Groups and Subgroups, Homomorphism Theorems, Cosets and Normal Subgroups, Lagrange's Theorem, Rings, Finite Fields

Polynomial Arithmetic, Quadratic Residues, Reciprocity, Discrete Logarithms, Elliptic Curve Arithmetic

Fundamental Principles of Counting, Pigeonhole Principle, Countable and Uncountable Sets, Principle of Inclusion and Exclusion, Derangements, Equivalence Relations and Partitions, Partial Order, Lattices and Boolean Algebra, Generating Functions, Recurrence Relations, Solution of Recurrences

Graphs, Euler Tours, Planar Graphs, Hamiltonian Graphs, Euler's Formula, Applications of Kuratowski's Theorem, Graph Coloring, Chromatic Polynomials, Trees, Weighted Trees, Shortest Path Algorithms, Spanning Trees, The Max-Flow Min-Cut Theorem.

Niven, H.S., Zuckerman and Montgomery, An Introduction to the Theory of Numbers, John Wiley New York, 1992
Grimaldi, R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994
Kolman, B. and Busby, R.C., Discrete Mathematical Structures for Computer Science, PHI, New Delhi, 1994

MA715 Statistics for Business Management (3-0-0) 3

Role of Statistics in Decision Making, Collecting & Tabulating Data-Measure of Central Tendency and Dispersion in Frequency Distribution, Probability Theory: Classical, Objective & Subjective Approach-Addition, Multiplication & Bayes Theorem –Applications-Binomial, Poisson and Normal - Decision Making Under Certainty, Uncertainty and Risk -Sampling and Sampling Distribution: Types of Sampling - Random Sampling-Concept of Standard Error Central Limit Theorem. Testing of Hypotheses, Significance Level-Type I & Type II Error- One-Two Tail Tests - Hypothesis Testing of Means, Variance & Proportions -Chi-Square Tests- Goodness of Fit, Independence of attributes, Correlation and Regression Analysis

Levine, Stephan, Krehbiel, Berenson, Statistics for Managers, Using Microsoft Excel, PHI New Delhi, 2011.
Daniel, Terrell, Business Statistics, For Management and Economics, 6th Edition, Houghton Mifflin Company, 1992.

Richard I. Levin and David S. Rubin, Statistics for Management, Prentice Hall of India, 1999.
Srivatasava, Shenoy and Sharma, Quantitative Techniques for Managerial Decision Making, Wiley Eastern, 1998

MA801 Dynamical Systems (4-0-0) 4

Discrete and Continuous dynamical systems, Damped and Undamped Dynamical systems, Autonomous and non-autonomous systems, Phase- Space analysis, Local and global Stability, Limit cycles, Critical Point Analysis, Lorentz Model, Deterministic Chaos, Bifurcation Theory, Saddle Node Bifurcation, Period Doubling and Hopf Bifurcation, Hamiltonian Systems

Ferdinand Verhulst (1996), Non-Linear Differential Equations and Dynamical Systems, Springer
Wiggins, S. Introduction to Non-Linear Dynamical Systems, Springer , 1990
Lawrence Perko, Differential Equations and Dynamical Systems, 3rd Edition, Springer.
M.W.Hirsch,S. Smale,R.L.Devaney, Differential Equations , Dynamical Systems and An Introduction to Chaos, Elsevier, 2nd Ed.

MA802 Modern Algebra (4-0-0) 4

Groups, Permutation groups, Sylows theorems, Simple groups, solvable groups, Direct Products of groups and structure of finite Abelian groups. Rings: Prime and Maximal Ideals, Euclidean and Principal ideal rings, Unique factorization domains and Polynomial rings. Fields: Extension fields, Prime fields, Algebraic and Transcendental extensions. Roots of polynomials, splitting fields, finite fields, Separable and Inseparable extensions, Perfect and Imperfect fields. Simple extensions, Galois theory, Solvability of polynomials by radicals, Abel's theorem.

I.N. Herstein, Topics in Algebra
J.B. Fraleigh, A First course in Abstract Algebra
J.A. Gallian, Contemporary Abstract Algebra

MA803 Approximation Theory & Numerical Methods (4-0-0) 4

Fundamentals : The approximation problem, general approach to the approximation problem, L_p norms, Tchebycheff norm and the Polya algorithm. Least squares and Orthogonal functions, Tchebycheff approximation. Approximation in the L_1 norm. The Weierstrass theorem and degree of convergence, Computational Methods.

J.R.Rice, The Approximation of Functions, Vol. 1, Addison - Wesley.

MA804 Computational Combinatorics (4-0-0) 4

Generating functions, Recurrence relations, Generalised Permutations and Combinations, Inclusion-Exclusion, Inversion formulae, The Van-der Waerden Conjecture, Partitions, Projective and Combinatorial Geometries, The Burnside -Frobenius Theorem, Group theory in Combinatorics, Permutations Groups and their Cyclic Indices, Polya's Enumeration Theorem;(0-1) Matrices, Latin Squares, Hadamard Matrices, Reed-Muller Codes

B.Bollobas, Combinatorics, Cambridge University Press
I.Anderson, Combinatorics of Finite Sets, Dover

MA805 Fluid Mechanics (4-0-0) 4

Navier-Stokes equations, boundary layer flows, similarity transformations, wave propagation and shocks, methods of characteristics; basic equations of hydromagnetic flows, Hartman flow, Reynolds equations for turbulent flows, statistical theory, empirical velocity profiles.

MA806 Formal Languages & Theory of Computation (4-0-0) 4

Finite automata: Moore and Melay machines, Regular Expressions, Pumping lemma, Minimizing the automata, Formal Languages: Regular languages. Context free languages (CFL), Chomsky and Greibach Normal forms. Pushdown automata (PDA), Equivalence of PDA and CFL, Turing machines, Theory of recursive functions,Complexity theory,NP-completeness.

Aho, Hopcraft & Ullman, Automata, Languages and Computation, Narosa, 1986
Mishra and Chandrashekar, Theory of Computer Science, Prentice Hall of India, 1998.

MA807 Mathematical Logic & Applications (4-0-0) 4

Propositional calculus. The notions of truth and proof, adequacy, truth functions and decidability. Predicate calculus, interpretation, proof substitution, soundness, the deduction theorem. Adequacy and compactness. First order theories, consistency, completeness, categoricity, models. The Lowenheim-Skolem theorem. Turing machines. Godel numbers. The undedidability of the predicate calculus.

MA808 Numerical Solution of Ordinary Differential Equations (4-0-0) 4

Initial value problem for systems of ODEs. Single-step methods, explicit and implicit, R-K methods. Linear multistep methods; convergence, order consistency and zero-stability, weak stability theory. Predictor-corrector methods. First

order systems and the problem of stiffness. LMM for special second-order ODEs.
Two point boundary value problems for ODEs, Finite difference methods; deferred correction and extrapolation. Numerical methods for Sturm-Liouville problems. Computer implementation of different, algorithms.

MA809 Optimization Techniques (4-0-0) 4

Linear programming, simplex method, duality, transportation and assignment problems, Reliability, definitions, concept of hazard, bath-tub curve, system reliability for various configurations, data analysis: correlation and regression of data, simple linear regression, time series analysis: definitions, characteristic movements, measurement of trend, secular trend, seasonal movements, cyclical movements.
H.A. Taha, Operations Research, Prentice Hall India
J. Medhi, Statistical Methods, Wiley Eastern.

MA810 Algorithmic Graph Theory (4-0-0) 4

Introduction to graphs Max-flow Min-cut theorem. Algorithms for computing maximum s-t flows in graphs. Algorithms for computing the minimum cut in a graph. Edge and vertex connectivity of graphs and menger's theorem. Maximum matching, Hall's theorem, algorithms for computing maximum matching in weighted and unweighted graphs. Arborescences and algorithm for computing minimum arborescence. Edmonds theorem for disjoint arborescences. Planar graphs and algorithms for checking for planarity. Edge and vertex coloring of graphs. Independent sets and perfect graphs. Extremal graph theory.
G Chartrand and O.Oellermann, Applied and Algorithmic Graph Theory, McGraw Hill, 1993
A Gibbons, Algorithmic Graph Theory, Cambridge University Press, 1985

MA811 Computational Fluid Dynamics (4-0-0) 4

Basic concepts and equations of fluid dynamics, non-dimensional forms, boundary layer equation, grid generation, grid refinement, adaptive grids, finite difference methods, explicit and implicit methods, fundamentals of fluid flow modeling, upwind scheme
Yuan S.W., Fluid Mechanics, PHI
Patankar S.V., Numerical Heat Transfer, McGraw Hill
White F.M., Viscous Fluid Flow, McGraw Hill

MA812 Design & Analysis of Experiments (4-0-0) 4

Introduction to probability, one-dimensional random variables, two and higher dimensional random variables, probability distributions, Sampling theory, moments, mgf and their properties, parameter estimation, point estimation, interval estimation of means and variances, Hypothesis testing, Goodness of fit tests, analysis of variance of one-way and two-way classified data, experimental design.
Douglas Montogomery, Design and Analysis of Experiments, 3rd Edition, John Wiley
Sheldon Ross M., Introduction to Probability and Statistics for Engineers and Scientists, JohnWiley
Hogg R.V.,Craig A.T.,Introduction to Mathematical Statistics, 4th Edition, McMillan

MA813 Special Topics in Mathematics (4-0-0) 4

The contents will depend on the topic chosen and will be announced before the course is offered.Sample Course titles are: i)Mathematical Theory of Chaos and Fractals; ii) Fuzzy Sets and Applications; iii) Nonlinear Dynamics

MA814 Number Theory & Cryptography (4-0-0) 4

Elementary Number Theory. Congruences, applications to Factoring. Finite fields, Quadratic residues and reciprocity. Simple cryptosystems, public key cryptography, RSA, Discrete logs. Primality and Factoring, the rho method, Fermat factorization, continued fraction and Quadratic Sieve methods.
N. Kobltiz, A course in Number Theory and Cryptography, Springer, 1994.

MA815 Finite Element Methods (4-0-0) 4

Introduction to calculus of variations, Approximate methods, Finite Elements, nodes classifications, approximate functions, Solution of Boundary value problems of second order differential equations, Finite element equations for the heat conduction equation, vibration equation elliptic problems using Galerkine and Ritz methods.
M.K. Jain, Numerical Solution of Differential Equations, PHI Ltd.
A.R. Mitchell and R. Wait, Finite Element methods in Partial Differential Equations, John Wiley, 1997.

MA816 Mathematical Modeling (4-0-0) 4

Introduction: Mathematical modeling through ordinary differential equations and systems of ordinary differential

equations of first order, Mathematical modeling through difference equations, Modeling using partial differential equations, Mathematical modeling through graphs

J.N. Kapoor, Mathematical Modeling, Wiley Eastern, 1988. R.
Aris, Mathematical Modeling Techniques,Pitman, 1978.

MA817 Reliability Theory & Applications (4-0-0) 4

Reliability, concepts and definitions, causes of failure, concept of hazard, failure models, bath tub curve, MTTF, MTBF, system reliability for various configurations, reliability improvement, redundancy, reliability-cost trade - off, maintainability and availability concepts, system safety analysis, FTA, FMEA.

E.E. Lewis, Introduction to Reliability Engineering, John Wiley.
K S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, PHI

MA818 Statistical Quality Control (4-0-0) 4

Sampling theory: random samples, statistic sampling distributions, central limit theorem, concept of Quality, types of variations, process control and product control, control charts for variables and attributes, concept of acceptance sampling, by attributes, O.C., AQL, LTPD, AOQL, ATI etc, types of sampling plans, Reliability, definitions, concept of hazard, bath-tub curve, system reliability for various configurations.

E.L. Grant, Statistical Quality Control, Mc Graw Hill.
D C Montgomery, Introduction to Statistical Quality Control, John Wiley.

MA819 Combinatorial Optimization (4-0-0) 4

Polynomial Boundedness; network optimization problems; Greedy algorithms; Matroid theory; Matroid Intersections; Matroid Partitions; Primal weighted Intersection algorithm; Duality Theory; Matroid polyhedra; Primal-Dual weighted Intersection Algorithm; Matroid Parity; Generalizations.

MA820 Nonlinear Programming (4-0-0) 4

Linear Inequalities and Theorems of the Alternative; Convex sets; Convex and concave Functions; Saddle Point Optimality criteria of Nonlinear Programming without Differentially; Differential convex and concave Functions; Optimality criteria of Nonlinear Programming with differentiability; Duality in nonlinear Programming; generalizations of convex functions; Quasi convex, strictly quasi convex; Pseudoconvex; Optimality and Duality of generalized convex and concave Functions; Optimality and Duality in the presence of equality constraints.

MA821 Modeling & Simulation (4-0-0) 4

Components of a system. Models of system. Random number generation. Probabilistic distribution. Simulation languages. Applications.

Jerry Banks and John Carson S., Discrete Event System Simulation, PHInc., 1984
Gotifried B., Elements of Stochastic Process Simulation, PHInc, 1984

MA822 Statistical Techniques For Data Mining (4-0-0) 4

Overview of data mining techniques. Taxonomy of data mining tasks. Steps in data mining process. Predictive modeling. Association rules. Statistical perspective. Clustering. Regression analysis. Time series analysis. Bayesian learning. Data warehousing. Dimensional modeling. Performance issues and indexing. Development lifecycle. Case studies.

Jiawei Han, Macheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 2000
Usama M Fayyad, Gregory Piatesky-Shapiro, Padhari Smyth and Ramasamy Uthurusamy, Advances in Knowledge Discover and Data Mining, The MIT Press, 1996

MA823 Mathematical Finance (4-0-0) 4

Introduction to Stochastic Processes, Poisson process, Brownian Motion, Martingales. Present Value Analysis, Interest Rate Analysis, Market Model Specification Problems. Arbitage Theorem, Multi-Period Binomial Model, Block- Scholes formula Valuing Investments by Expected Utility, Portfolio Selection Problem, Capital Assets Pricing Model, Rates of Return, Single Period and Geometric Brownian Motion, Mean- Variance Analysis of Risk- Neutral-Priced Call Options, Autoregressive Models and Mean Regression, Other Pricing Options and Applications

S.M.Ross, An Introduction to Mathematical Finance, Cambridge University Press,1999.
A.J.Prakash, R.M. Bare, K. Dandapani, G.L.Ghai, T.E.Pactwa and A.M.Parchigari, The Return Generating Models in Global Finance, Pergamon Press, 1998.
S.M.Ross, Applied Probability Models with Optimization Applications, Holden- Day, 1980.

SCHOOL OF MANAGEMENT

MBA711 Business Research **(3-0-0) 3**

Introduction to Research, Research and Scientific Method, Research Ideas and Literature Review, Research Proposal, Language of Research, Ethics in Research, Research Process, Sampling Design: Probability and Non Probability, Data Collection, Analysis and Interpretation, Ethics in Business Research, Research Design and Approaches: Descriptive, Exploratory, Causal, Qualitative Research, Observation Studies, Surveys, Experiments, Measurements and Scales, Questionnaires, Data Analysis: Presentation, Exploring and Examining, Presenting Findings: Written and Oral Reports, Referencing.

Donald R. Cooper and Pamela S. Schindler, Business Research Methods, TMH, New Delhi, 9th Edition, 2006.
Earl Babbie, The Basic of Social Research, Wadsworth- Thomson Learning, 2nd Edition, 2002.

MBA712 Organization Behaviour **(3-0-0) 3**

Concept of Management, Leadership, Skills of Manager, Organizations as Social Systems, Effective Human Skills, Motivation and Behaviour, Theories of Motivation, Organizational Behaviour - Nature of Organizations, Organizational Effectives, Interdisciplinary Focus, Approaches to OB. Foundations of Individual Behavior, Personality, Perception, Learning, Attitudes, Values, Job Design, Socio-technical Systems, Work Stress. Group and Interpersonal Behavior, Group Dynamics, Power, Conflict, Organizational Process, Organizational Designs.

Stephen P. Robbins, Timothy A. Judge, Seema Sanghi, Organizational Behavior, Pearson Education.
Steven L Mc Shane, Mary Ann Von Gilnow and Radha R. Sharma, Organizational Behaviour, TMH
Fred Luthans, Organizational Behavior, McGraw Hill International

MBA713 Financial Accounting **(3-0-0) 3**

Financial Accounting — Concepts – Principles – Accounting Systems – Preparation of Financial Statements. Indian Accounting Standards – Creative . Accounting, Annual Report, Presentation and Analysis of Audit Reports and Directors Report. Human Resource Accounting – Fixed Assets and Depreciation Accounting – Inventory Valuation (Basic). - U.S.GAAP Framework and Indian Accounting Standards Framework -. Analysis of Financial Statements –Funds Flow Analysis – Ratio Analysis – Cash Flow Analysis - Cost Accounting – Cost classification Marginal Costing – Performance Budgeting – Cycle Costing – Strategic Cost Management.

Lyrich: Accounting for Management, Tata McGraw-Hill, New Delhi, 2001.
Maheswari S. N, Cost and Management Accounting, Sultan Chand and Co., New Delhi, 6th Edition 2001.
Narayan Swamy, R. Financial Accounting: A Managerial Perspective, PHI

MBA714 Managerial Economics **(3-0-0) 3**

Introduction, nature and scope of managerial economics. Business objectives and decision making. Demand analysis, law of demand, elasticity of demand, demand forecasting, supply analysis, supply elasticity. Production analysis and production function, cost concept and analysis. Market equilibrium, average revenue concept and market structure. Perfect and imperfect competition, pricing strategy. National income dynamics, theories of profit. Decision techniques and capital budgeting. Macroeconomic facts, money system and case studies.

Craig Petersen and Chris Lewis W, Managerial Economics, Prentice-Hall of India, 2000
Mcguigam, Managerial Economics Applications Strategy and tools, South Western, 2002.
Mankiw N. Gregory , Principles of Economics, Thomson, 2002.

MBA716 Corporate Communication **(3-0-0) 3**

Importance of Communication, Nature of Communication, Communication Process and Flow; Communication Channels and their Use; Communication Climate; Communication, Culture and Work; Verbal and Non-Verbal Communication, Interpersonal Communication, Interview Skills – Principles, Planning and Conducting Interviews; Group Dynamics; Presentations, Persuasive Presentations; Keys to Functional Writing, Business Correspondence, E-Communication.

Ronald B. Adler and Jeanne Marquardt Elmhorst, Communicating at Work: Principles and Practices for Business and the Professions, McGraw-Hill, 2008

MBA718 Spreadsheet Modelling for Business **(2-0-2) 2**

Introduction to Spreadsheet- Functions of Spreadsheet- Spreadsheet Uses and Limitations- Entering Formulas into Excel- Control-Flow Statements-Charts in Excel- Dash Board- Sensitivity Analysis- Creating Tornado Diagrams- Pivot Tables and Charts- Modeling with IFPS and VBA- Matrix Operations - Regression Analysis- Macros - Recording and Editing- Lookup and Reference Functions- DCF-NPV and IRR Functions- Data Tables- Database Manipulation- Workbook Sharing & Merging- Customizing Toolbars And Menus- User-Defined Functions- Matrix Operations In Excel- Auditing Tools

MBA721 Managerial Accounting **(3-0-0) 3**

Organizations and accounting - Differences between Financial Accounting and Management Accounting - Understanding Financial Statements - Interpreting Financial Statements Financial Statement Analyses – Horizontal and Vertical Analyses – Value Chain

Analysis - Significant Accounting Policies, Accounting Standards - Features of Corporate Accounting - Creative Accounting - Cash Flow and Fund Flow Techniques - Costs - Cost Estimation - Estimating Product Costs and Activity-Based Costing - Product Planning Decisions - Cost-Volume-Profit Analysis - Budgets and Budgeting - Cost Allocations - Traditional Absorption Costing Systems - Management Accounting in a Changing Environment.

Horngreen and Sundlem - Introduction to Management Accounting, PHI
Manmohan & Goyal - Principles of Management Accounting, Sahitya Bhawan Publications, 1998
Maheshwari S. N., Management Accounting and Financial Control, Sultan Chand & Sons

MBA722 Marketing Management (3-0-0) 3

Introduction to Marketing - Marketing Process - Marketing Environment - Marketing Research - Demand Forecasting - Competition - Marketing Strategy - Consumer Behaviour- Industrial Marketing -Customer Satisfaction - Segmentation - Targeting, Positioning Developing New Market Offerings - Product Life Cycle - Designing Global Market Offerings - Product and Branding Strategy - Designing and Managing Services - Developing Pricing Strategy - Advertising Strategy - Media Planning - Marketing Channels - Retailing - Marketing Communication –Advertising.

Philip Kotler and Kevin Lane Kelle,rMarketing Management, Pearson, 12th Edition, 2006.
Philip Kotler andGary Armstrong, Principles of Marketing, Prentice Hall, 13th Edition, 2009.
Philip Kotler, Kevin Lane Keller , Abraham Koshy and Mithileshwar Jha , Marketing Management: A South Asian Perspective, Pearson Education; 12th Edition, 2007.
Tapan K Panda Marketing Management: Indian Context , Excel Books, 2008

MBA723 Strategic Analysis (3-0-0) 3

Strategy in context- strategic thinking-case study in achieving profitable growth- core differentiation strategies- vision mission and values- strategic map model. competitive edge- defining investment priorities- competitive position- environmental changes. presenting the change plans pulling everything together into a plan- leading people through change.

Arthur A Thomson and A J Stickland, Strategic Management, Tata McGraw Hill
John A.. Pearce and Richard B. Robinson, Strategic Management - Strategy Formulation and Implementation , AITBS Publishers and Distributors.
Charles W. L. Hill and Gareth R. Jones, Strategic Management Theory , Integrated Approach, All India Publishers & Distributors.

MA724 Operations Management (3-0-0) 3

Operations Functions, Types of Operations, Time Series Analysis- Function of Production Planning and Control. Aggregate Planning - Guidelines. Operation Scheduling - Assignment Model – 'n' jobs to be Produced in 'm' machines - Run Out Time Method - Network Scheduling. Quality Control: Purpose of Inspection and Quality Control - Process Control - Control Charts for Variables- Control Charts for Fraction Defectives - Control Charts for Defects - Sampling Plan - Single Sampling Plan, OC Curve, AQL, AOQL, LTPD. Inventory Control - Deterministic Models - Probabilistic Models. Maintenance and Replacement- Breakdown Vs. Preventive Maintenance - Group vs. Individual Replacement. Just in Time Production. Simulation, Monte Carlo Simulation.

Buffa E.S. and Sarin R.K., Modern Production / Operations Management, John Wiley & Sons, 8th Ed., New York, 1990
Chary S.N., Production & Operations Management, TMH, New Delhi, 1992

MBA725 Financial Management (3-0-0) 3

General Financial Environment – Introduction – Capital, Secondary and Money Markets, Basics, Instruments, Financing and Rating Institutions, and legal environment. - Corporate Financial Objectives and Functions - Financial Analysis, Ratio analysis, Common size statement analysis, Trend analysis, Sickness prediction - Funds Flow analysis - Risk and Return Portfolio Theory - Sources of Funds , Types, Issuing and Pricing, Valuation of Stocks and bonds - Dividend Policy - Capital Structure Decision, Capital Structure Theories - Valuation Of The Firm - Evaluation Techniques, Evaluation Of Lease Contracts - Corporate Restructuring, Mergers And Acquisitions - Financial Restructuring, - Working Capital Management

Van Horne James C., Financial Management Policy, Prentice of India, (9th Edition)
Pandey I.M., Financial Management, Vikas Publications House, (7th Edition)
Chandra, P., Fundamentals of Financial Management, TMH

MBA726 Human Resource Management (3-0-0) 3

Overview Of HRM, Strategic HRM, HR Planning, Job Analysis, Recruitment And Selection, Human Resource Development, Performance Assessment And Management, Compensation System, Incentives And Benefits, Safety And Health, Labour Relations, Multinational HRM, Role Of Culture, Legislations Pertaining To Labour Acquisition, Compensation And Maintenance, Emerging Issues In HRM.

Michel Armstrong, Human Resource Management, 5th Edition, 2006
V S P Rao, Human Resource Management, PHI, 7th Edition, 2004
Cynthia D. Fisher, Human Resource Management, Biztantra, 5th Edition, 2004.
Flippo Edwin B., Principles of Personnel Management- McGraw Hill – Kogak.

MBA727 Business Analytics and Decision Making (3-0-0) 3

Analytical decision making: emerging business environment- analytical competition-embedding analytic in business process- reporting / descriptive analytics, modeling or predictive analytics, data-driven strategies- analytics and business performance-

building analytical culture- industry trends in analytics-review techniques and tools. Business contexts-stages of enhanced analytics capabilities-defining metrics- categories and levels of metrics- defining KPIs- linking strategic outcomes and KPIs- KPI directories for different industry segments- aligning technologies in analytics domain. Blue printing a solution framework: identifying core KPIs- sourcing data- using high. Analysis & interpretation: gathering and reporting-use of dashboards and other visualizations tools- interpretations of analysis- suggesting strategic and tactical programs. Project development: industry inputs- validation of models- frameworks- data analytics .

Davenport Tom, Harris Jeanne G., Morison Robert, Analytics at Work: Smarter Decisions, Better Results, (February 2010)
Davenport Thomas H., Harris Jeanne G., Competing on Analytics: The New Science of Winning, (March 2007)

MBA731 Strategic Management (3-0-0) 3

Strategic management process, firm and environment: environmental analysis – macro- micro and relevant environment – models for environmental analysis – SWOT analysis- BCG matrix- GE's stoplight matrix. strategy and resources. Pyramid of business policy. Types of strategies: dependency – generic strategies. Generation of strategic alternatives – strategic information systems. Organizational level strategies: franchising- licensing- sub contracting- diversification- concentric diversification- conglomerate expansion. strategy implementation – evaluation and control. Matching structure and control, global issues of 21st century--strategic audit-issues in non-profit organizations

Arthur A Thomson and A J Stickland, Strategic Management, Tata McGraw Hill
John A.. Pearce and Richard B. Robinson, Strategic Management - Strategy Formulation and Implementation - , AITBS Publishers and Distributors.
Jauch Lawrance R. & Glueck William F., Business Policy and Strategic Management- McGraw Hill (5t h Edition).
Johnson Gerry & Scholes Kevan, Exploring Corporate Strategy- Prentice Hall of India (4t h Edition).

MBA732 Corporate Information System (3-0-0) 3

Managerial overview of information systems, information needs and management process- information system- data information system to problem solving- data information and its attributes - level of people and information needs - types of decisions and information information system - stages in system analysis - classification of information system, technical foundations of information systems: hardware, software, telecommunications and networks, database, client server computing; business applications of information systems: DSS, EIS, artificial intelligence, expert systems, neural network, office automation, business information systems, systems analysis and design, tools for information system development, managing information resources, securities concerns - network securities.

James A O'Brien ,George M Marakas, Ramesh Behl, Management Information Systems , TMH Education Pvt. Ltd , 2010.
Uma G. Gupta, Management Information Systems, A Managerial Perspective, Galgotia Publications, 1998
Kenneth J Laudon, Jane P. Laudon, Management Information Systems, Pearson/PHI, 10/e
W. S. Jawadekar, Management Information Systems, Tata McGraw Hill Edition, 3/e

MBA733 Legal Environment (2-0-0) 2

Nature of contract requirements & classifications – discharge of contract – remedies for the breach- quasi contract – contingent contract. Sale of goods act - sale, agency, negotiable instruments act, nature and requisites instruments, transfer of negotiable instruments, holder in due course special rules for cheques banks, discharge of negotiable instruments. Partnership act - nature of the companies, kinds of companies – formation and incorporation of a company, memorandum of association, Articles of Association and prospectus ,company management, company meetings (board and general), majority rule and minority protection , compromises, arrangements. Reconstruction and amalgamation – winding up. Competition, / FEMA, consumer protection, right to information act. Special economic zones, environment & business, business and the ip regime, wto.

Kapoor, N.D. , Mercantile Law, Sultan Chand & Sons, 28th Ed.
Majumdar, A.K. and Kapoor, G.K., Company Law and Practice, Taxmans Publications, New Delhi, Revised 2000.

MBA741 Ethics and Sustainability (3-0-0) 3

Evolution- management structure for corporate governance-board structure-building responsive boards - issue and challenges-effectiveness of board- board committees and audit committee- legal compliance committee and stakeholders' relationship committee-appraisal of board performance- transparency and disclosure- internal control system and risk management-corporate governance in various countries – investor protection and institutional investors-corporate social responsibility -various corporate governance forums - CACG ,OECD , ICGN , NFCG organization perspectives- ethical principles in business – codes and innovations-concept of stakeholders' organization- activity analysis- process-business ethics as a strategic management tool-stakeholders' protection-sustainability reporting -stakeholder engagement-corporate sustainability management systems-legal framework- conventions and treaties on environmental- health and safety and social security issues-principle of absolute liability .

Taxmann , Corporate Governance , ICSI& Taxmann Publication
Adrian Cadbury, Corporate Governance and Chairmanship – A personal View - Publication: Oxford University Press.
Sanjiv Agarwal, Corporate Governance: Concept & Dimensions, Published by Snow White Publication.

MBA811 Organization Development and Management of Change (3-0-0) 3

Introduction to OD- organisations as systems, dimensions of organisational design, the evolution of organisational theory and design, role of organization theory and design, change management -nature of planned change, designing interventions, recruitment

and selection, leading & managing change, evaluating and institutionalizing OD. Change and HR strategies- implementation and impact of change, role of HR strategies in implementing change. Structure and strategic change, HR implications of structural choice and change interpersonal group processes , organization process approaches , restructuring organizations , employee involvement , organization transformation , organizational development in global settings OD in healthcare, schools, and public sector organizational culture.

Richard H. Hall, Organizations-structures, Processes and Outcomes, 8th edition, PHI, 2002
Richard L.Daft, Organization Theory and Design, 7th edition Thomson south western. 2002
Harold Koontz and Heinz Weihrich, Essentials of Management, Tata McGraw Hill, 9th Edition, 2012.
Pradip N. Khandwalla, Corporate Creativity, Tata McGraw Hill.2005

MBA812 Industrial Relations (3-0-0) 3

An overview of historical background of industrial relations (IR). Labour movement theories. Legislations related to labour laws, attitudes and approaches. Industrial conflict. Collective bargaining. Workers' participation in management. Governments' labour policy. India and ILO.

Agnihotre V., Industrial Relations in India.
Agarwal R. D., Dynamics of Industrial Relations in India.
Srivastava S.C., Industrial Relations and Labour Law, New Delhi, Vikas 1994

MBA813 Compensation Management (3-0-0) 3

Conceptual and theoretical understanding of economic theory related to compensation management (wage concepts and wage theories). Employees satisfaction and motivation issues in compensation design. Establishing internal, external and individual equally. Strategic importance of variable day-determination of inter and intra industry compensation differentials. Individual and group incentives. Dearness allowance concept-emergence & growth in India. Role of fringe benefits in reward systems retirement plans including VRS/golden handshake schemes. Executive compensation. Compensation systems in multinational companies and it companies including ESOP. Collective bargaining strategies-long term settlements-cases of productivity settlements-exercises on drawing up 12 (3) and 18(1) settlements. Emerging trends in IR due to LPG.

Relevant Bare Acts

MBA814 Training & Development (3-0-0) 3

Introduction to training design & implementation -needs analysis and needs assessment, performance analysis, job analysis, task analysis, learner analysis, context analysis and skill gap analysis. Training objectives-training deliverables and instructional strategies, training design budgets and schedules, training project management, design blue prints and proto types. Drafting training materials- developing tests/assessments, quality control issues . Train the trainer programmes- classroom delivering of training, non class room delivering techniques. Evaluation- role of evaluation, evaluation techniques- Kirkpatrick model, CIRO model, cost benefit analysis- evaluating reactions and learning, evaluating transfer of training- learning – principles and theories, social learning.

Donald J. Ford , Bottom-Line Training, PHI, 1999 .
Craig R.L. Training and Development Hand book: A guide to Human Resource Development, New York, NY:McGraw Hill 1996.
McGrath, Training for Life and Leadership in Industry, Prentice Hall of India, New Delhi.
Blanchard, P Nick, and James W. Thacker, Effective Training-Systems, Strategic and Practices,Pearson Education, New Delhi

MBA815 Performance Management (3-0-0) 3

Introduction- performance appraisal vs. performance management- PFM theatre- planning for manager's performance and development-monitoring and mentoring- annual stocktaking- appraisal for recognition and reward- organizational effectiveness-high performing teams.

Michael Armstrong & Angela Baron, Performance Management: The New Realities, Jaico Publishing House, New Delhi, 2002.
T.V.Rao, Appraising amd Developing Managerial Performance, TV Rao Learning Systems Pvt Limited, Excel Books, 2003.
David Wade and Ronad Recardo, Corporate Performance Management, Butter Heinemann, New Delhi, 2002.

MBA816 Multicultural Workforce Management (3-0-0) 3

Concept of culture, Gert Hoofstede model. comparative human resource (HR) practices: power distance, individualism, masculinity, implications for Indian manager. HR issue for the international manager: international staffing; MNC training; MNC performance appraisal; compensation and benefits; international unions. Cross cultural management approach: organizational structure and intercultural management- conventional organizational structures of global organizations; intercultural communication. . core values as for bonding between employees and corporate across the globe. Global strategy and local adaptation. Conflict resolution strategies to handle: environmental turbulence; different attitudes to corporate culture and ethics. Cultural conflict and management style. Expatriate management.

Nina Jacob., Intercultural Management (MBA Master Class series). Kogan Page, New Delhi 2004
Peter J. Dowling, International Human Resource Management, South Western – Thomas Learning.
Heinz Weihrich, Mark V. Cannice and Harold Koontz , Management, Tata McGraw Hill, 13th Edition, 2012.
Evans, Pucik, Barsoux, The Global Challenge, Tata McGraw Hill, 2010.

MBA821 Advertising (3-0-0) 3

Introduction to Integrated Marketing Communications-Evaluating the Economic-Social and Regulatory Aspects of Advertising and Promotion-The Role of Ad Agencies and other Marketing Communication Organizations-Consumer Behavior-The Communication Process- Communications Mix. Creative Strategy- Pre Testing and Post Testing- Media Mix- Media Planning- Challenges in Media Planning. Developing the Media Objectives- The Message. Developing the Media Strategy- Media Scheduling, Calculating the Cost Efficiency. Steps in Campaign Planning-Role of Research in Advertising. Appropriation of Advertisement Budget.

Belch E. George & Belch A. Michael, Advertising and Promotion, Tata McGraw Hill, New Delhi, 2001.
Parameswaran, Brand Building Advertising: Concepts and Cases, Tata McGraw Hill, New Delhi, 2002.
William F Arens , Contemporary Advertising, Tata McGraw Hill, NewDelhi, 2008

MBA822 Business-To-Business Marketing (3-0-0)3

Fundamental of Business Markets. - Organisational Buying Process. - Org. Buyer Behavior - Differences Between Consumer Marketing and Industrial Marketing - Classification of Industrial Products - Nature of Demand - Industrial Marketing System-Models - Buying Situation -Buying Centre Concept. Demand Estimation -Industrial Marketing Segmentation. Managing Industrial Products -Strategies Involved PLC Concepts and Industrial Products. Pricing Strategies - Competitive Bidding - Negotiation. Distribution Channels - Influencing Factor. Industrial Marketing Communications - Industrial Marketing Research - Differences between Consumer Marketing Research and Industrial Marketing Research. Marketing Strategy Formation - Key Account Selling.

Michael D. Hutt, Thomas W. Speh, Business Marketing Management, Thomson, 9th Edition, 2007.
Hill- M Richard- Alexander S. Ralph- Cross James S, Industrial Marketing, AITBS, New Delhi, 4th Edition, 1991.
Dwyer, F. Robert & Tanner, John F. Jr., Business Marketing,McGraw-Hill, 4th Edition, 2009

MBA823 Brand Management (3-0-0) 3

Introduction To Brand Management and Crafting of Brand Elements - Consumer Brand Knowledge , Product Management – Role of a Product Manager, Organizing The Brand Management System, Brand Positioning and Values – Customer Based Brand Equity Model, Brand Identity, Brand Image, -Managing Brand Architecture and Brand Portfolios - Corporate Branding and Tools for Building Brand Equity - Measurement of Brand Equity, Brand Marketing Programs –Designing Marketing Programs to Build Brand Equity, Integrating Marketing Communication to Build Brand Equity. Measuring and Interpreting Brand Performance – Capturing Customer Mindset, Capturing Market Performance, Co-Branding

Kevin Lane Keller, Strategic Brand Management- Building, Measuring And Managing Brand Equity, Pearson, 2nd Edition, 2006.
Jean-Noel Kapferer, Strategic Brand Management, Free Press, 1st Edition, 1994.
Subrato Sengupta, Brand Positioning, McGraw Hill, 2nd Edition, 2005.

MBA824 Consumer Marketing (3-0-0) 3

Nature of Consumer Behaviour- Model of Consumer Decision Making — Its Implications on Consumer Behaviour-Major Models in Consumer Behavior. Individual Psychological Factors-Perception Attitudes Learning Personality and Motivation - Implications of Not Achieving the Goal. Group Factors in Consumer Behaviour - References Group Concepts - Opinion Leadership Aspects - Usage of these Concepts in Marketing Communications. Decision Process, Diffusion of Innovation in Consumer Behaviour - Its Implication on Consumer Behavior. Concepts of Customer Satisfaction - Concept of Cognitive Dissonance-Cultural Aspects in Consumer Behavior- Consumer Research

Della & Bitta, Consumer Behaviour: Concepts & Applications, Tata McGraw Hill, NewYork, 1993.
Schiffman G.Leon and Kanuk Leslie Lazar, Consumer Behaviour, 9th Edition, Prentice Hall of India Private Ltd, New Delhi, 9th Edition, 2007.
Roger D Blackwell, Paul W Miniard and James F Engel, Consumer Behavior South-Western College Pub, 10th Edition, 2005.

MBA825 Marketing Research (3-0-0) 3

Nature and Scope of Marketing Research- Conceptual Aspects Involved in Marketing Research- Marketing Information System, Marketing Research Process- Basic Research Designs, Applicability of Research Designs, Data Collection Procedures and Methods. Scaling Concepts, Scaling Techniques, Questionnaire Design and Development. Concept of Sampling, Sampling Types, Multivariate Analysis Applications in Cluster Analysis, Conjoint Analysis, Multidimensional Scaling, Factor Analysis, Discriminant Analysis , Exposure to Statistical Packages. Product Research, Advertising Research, Market and Sales Analysis Research.

Carl Mcdaniel and Roger Gates, Contemporary Marketing Research, South Western College Publishing, Singapore, 4th Edition,1999.
Tull, D.S. and Hawkins D.J., Marketing Research – Measurement and Method, Prentice Hall, New Delhi., 6th Edition, June2000.
Donald R. Lehmann, Sunil Gupta, and Joel H. Steckel, Marketing Research, Addison-Wesley Educational Publishers Inc., 1998.

MBA826 Retail Management (3-0-0)3

Introduction to Retailing – Retailing in India - Retail Formats and Theories-Understanding the Retail Consumers, Overview of Retailing Environment and Management, Strategic Planning, Structural Change, Market Structure, Retail Planning, Development and Control. Learning, Attitude. Motivation and Perception. Situational Analysis, Retail Institutions By Store-Based Strategy-Mix, Web, Nonstore-Based and other Forms of Non Traditional Retailing. CRM, Promotional Strategies Used in Retailing .Choosing a Store Location- Managing Retail Business- Service Characteristics, Branding, Perceptions of Service Quality, Retail Information Systems, Merchandise Management Retail Pricing, Development and Implementing Plans, Internationalization and Globalization.

Michael Levi M and Barton Weitz , Retailing Management, Tata McGraw Hill, 5th Edition,2008.
Dunne Patrick M., Lusch Robert F. and Griffith David A – Retailing, Cengage Learning, 4th Edition,2010.
Barry Berman, Joel R Evans, Retail Management- A Strategic Approach, Pearson, 10th Edition, 2009.
Newman A.J. and Cullen P, Retailing: Environment and Operations, Vikas, 1st Edition

MBA827 Rural Marketing (3-0-0) 3

Issues In Rural Marketing And Characteristics Of Rural Markets -Understanding Consumers -Researching Rural Markets -Creating And Delivering Value -Communicating And Positioning In Rural Markets -Communication And Diffusion Process : An Approach To Accelerate Consumer Acceptance -Distribution In Rural Markets -Non Conventional Methods Of Reaching Rural Markets -Developing Marketing Strategy For Rural Markets.

T.P. Goplalaswamy, Rural Marketing, Excel Books,2nd Edition, 2003.
Pradeep Kashyap & Siddhartha Raut, The Rural Marketing Book, Biztantra Publications, 2006.
Sanal Kumar, Rural Marketing, Sage Publications, 2002.

MBA828 Sales and Distribution Management (3-0-0) 3

Conceptual Understanding of Sales Management, Importance of Sales Force Management in the Indian Context. Personal Selling Process- Prospecting, Pre Approach, Approach Presentation, Planning Sales Calls, Motivating a Sales Force and Sales Force Compensation, Sales Force Expenses and Transportation, Sales Meeting and Sales Contest, Sales Records and Reporting Systems Forecasting Sales and Developing Sales Budgets, Designing and Organizing Sales Territories. Sales Organisations, Relations with other Departments. Profiling and Recruiting Sales People- Distribution Management- The Vertical and Horizontal Marketing Systems. Wholesaler, Retailing and Retailer Marketing Decisions. Physical Distribution-Logistics & Participants in Physical Distribution Process,

Richard R. Still , Edward W. Cundiff and Norman A. P. Govoni,Sales Management – Decision, Strategies & Cases; PHI./Pearson Education, 1988.
Krishna K Havaldar and Vasant M Cavale, Sales and Distribution Management , Tata McGraw Hill, 2nd Edition, 2011.
S.L.Gupta, Sales and Distribution Management , Excel Books, 2002.
Spiro, Stanton, Rich, Management of Sales Force, Tata – McGraw Hill, New Delhi,7th Edition, 2003.

MBA829 Services Marketing (3-0-0) 3

Services Marketing – Nature, Need, Classification of Services, Barriers and Issues in Services Marketing in the Indian Context. Gaps Model of Service Quality, Expectations and Perceptions, Measuring Service Quality- SERVQUAL, Building Customer Relationships and Service Recovery. Relationship Marketing, Positioning, Service Development and Designing Services, Service Blue Printing, Quality Function Deployment, Adding Value, Physical Evidence and Services Cape. Pricing Strategies for Services, Creating and Managing Service Delivery, Balancing Demand and Capacity, Waiting Lines and Reservation. Integrated Services Marketing Communication, Services Advertising Strategies, Integrated Model of Services Quality.

Christopher Lovelock, Services Marketing – People, Technology, Strategy, Addison Wesley Longman (Singapore), Pearson Education Asia, 4th Edition, 2001.
Roland T. Rust, Anthony J. Zahorik and Timothy L. Keiningham, Services Marketing, Harpercollins, 1996.
Valarie A.Zeithmal and Mary Jo Bitner, Services Marketing – Integrating Customer Focus Across the Firm, Tata McGraw-Hill, New Delhi, 2nd Edition, 2002.
Christopher H. Lovelock and Jochen Wirtz, Services Marketing, 7th Edition. Prentice Hall, 2010.

MBA831 International Financial Management (3-0-0) 3

Introduction – Introduction to Foreign Exchange Markets – Supply And Demand Conditions and Demand Factors of Currency – Exchange Rate Theories. International Financial Systems: Exchange Systems –IMF And World Bank — Capital Account Convertibility. International Financial Markets – Euro Banking and Euro Currency Market — Term structure in International Capital Markets. - International Financing — Depository Receipts – International Financing Decision - Funding And Risk Management Aspects - International Credit Instruments — International Credit Syndication Mechanism — Risk Factors Of International Financing. International Capital Budgeting– Foreign Direct Investments –Valuation of International Cash Flows – Cash Management – International Portfolio Investing.

Levi Maurice D., International Finance, McGraw Hill (3rd Edition).
Apte P. G., International Financial Management, Tata McGraw Hill.
Shapiro, A., Multinational Financial Management, Wiley India Edition

MBA832 Banking, Financial Services and Insurance (3-0-0) 3

Indian Banking System - Banking Structure and Performance Measurement - Financial Statement Analysis and Bank Performance Measurement - Banking Regulations Organisation - Bancassurance and Universal Banking - Financial Innovations - Factoring, Securitisation and Take Out Finance - International Banking Services of Custodians-Central Depository, Systems, Mutual Funds, Commercial Paper, Financial Journalism, Portfolio Management, Investment Management. Nature Of Insurances –Values And Costs Of Insurance – Basis Of Recovery. Property And Liability Loss Exposure – Life, Health And Income Exposures – Types Of Life Insurance – Channels of Distribution

Pond Keith, Lipscombe Geoffrey, The Business of Banking: An Introduction to the Modern Financial Services Industry, Financial World Publishing
Vaughan Emmet J. & Vaughan Therese M., Fundamentals of Risk and Insurance, Wiley Finance, 10th Edition

MBA833 Financial Derivatives (3-0-0) 3

Introduction - Forward Contracts, Future Contracts, Options, Swaps And Other Derivatives; Operation Of Margins; Sources Of Financial Risk: Foreign Exchange Risk, – Options Warrants And Convertibles. – Futures - Future Contracts; Future Markets - Clearing House, Margins, Trading, Future Positions And Taxation; Future Prices And Spot Prices; - Currency Derivatives- Interest Rate Derivatives- Term-Structure and Pricing Principles, Trading Strategies. - Managing Market Risk - Hedging Schemes - Portfolio Insurance. - Derivatives Market In India

Chance, Don M: An Introduction to Derivatives, Dryden Press, International Edition.
Chew, Lilian: Managing Derivative Risk, John Wiley, New Jersey.
Hull, J.: Options: Futures and other Derivatives, Prentice Hall, New Delhi.

MBA834 Corporate Taxation (3-0-0) 3

General Principles Guiding And Direct And Indirect Taxes. Corporate Tax Structure - Direct And Indirect Treatment Of Various Items Of Receipt And Payment - Items Of Deductions. Special Provisions – Service Tax And Value Added Tax. Tax Planning For Corporate – Assessment Procedure. Case Laws Discussion.

Ahuja Girish and Gupta, Ravi, Systematic Approach to Income Tax, Service Tax and VAT, Bharath's Students' List of Publications, 19th Edition, 2008
Singhania Vinod, Taxmann students guide to income tax with service tax value added tax Taxmann, 38th Edition, 2008

MBA835 Fixed Income Security (3-0-0) 3

Fixed Income Markets, Government Securities Market - Bond Valuation, Time Value Of Money, Price And Yield Conventions, Understanding Market Linkages, Bonds And Money Market Instruments, MIFOR Curve - Risk Identification In Bonds - Yield Curve Analysis - Treasury Securities - Bond Indexing, Index Return Comparison - Portfolio Construction - Global Bond Markets - Fixed Income Derivative Markets – Interest Rate Options, Caps & Floors Pricing - Markets For Asset Backed Securities, Prime And Subprime Mortgage-Backed Securities - Fixed Income Investing.

Fabozi Frank J., The Handbook of Fixed Income Securities, McGraw Hill
Dun & Bradstreet, Fixed Income Securities, Tata McGraw Hill
John C. Hull, 2005. Options, futures, and other derivative securities. Pearson Education, Sixth edition.

MBA836 Security Analysis & Portfolio Management (3-0-0) 3

Investment Environment – Stock Exchanges – Bond Analysis – Derivative Instruments – Technical Structures And Valuation. Theoretical Framework For Investment Decisions –Analysis Of Risk & Return, Asset Pricing Models. Fundamental Analysis – Technical Analysis – Random Walk Hypothesis – Efficient Market Hypothesis. Portfolio Management – Portfolio Theory – Capital Market Theory – Utility Analysis – Portfolio Revision – Performance Analysis Of Managed Portfolios.

Fischer Donald E. & Jordan Ronald J., Security Analysis and Portfolio Management, Prentice Hall of India.
Elton Edwin J. & Gruber Martin J., Modern Portfolio Theory and Investment Analysis, John Wiley & Sons.

MBA837 Project Finance (3-0-0) 3

Characteristics - Technology Selection, Assessment Of Technical Collaborator - Market Analysis - International Competitiveness And SWOT Analysis - Assessing The Project Cost - Means Of Financing Projects - Cash Flow Valuation For Assessing Projects - Financial Analysis Common Risks In Projects - Risk Mitigation Methodologies In Projects - Securitization - Project Planning - Network Techniques For Project Implementation - Disbursement, Supervision And Follow Up Of Project By Lender - Monitoring And Follow-Up Of The Project

Vinter, G.D., Project Finance, Sweet & Maxwell Ltd., 6th Edition
Finnerty, J.D., Project Financing – Asset Based Financial Engineering, Wiley Finance
Yescombe, E.R., Principles of Project Finance, Academic Press

MBA838 Working Capital Management (3-0-0) 3

Meaning, Concepts, Classification And Importance,. Excess Or Inadequate Working Capital, Working Capital Financing - Determining The Working Capital Financing Mix - New Trends In Financing Of Working Capital By Banks - Management Of Cash - Receivables Management –Inventory Management – Classification, Codification And Valuation Of Inventories.

Rangrajan and Mishra, Working Capital Management, Excel Publications
Periasamy, P, Working Capital Management –Theory & Practice, Himalaya, 2007
Pandey, I.M., Financial Management Vikas, 9th Edition

MBA841 Service Operations (3-0-0)3

Introduction, the service concept, customer and relationships, customer expectations and satisfactions, managing supply relations, service processes, service people, resource utilization, network technology and information, performance measurement, linking

operations decisions to business performance, driving operational improvement, service strategy, service culture, operational complexity

Robert Johnston and graham clark, Service Operations Management,2nd Edition, Pearson.
Bill Hollins & Sadie Shinkings, Managing service operations design and implementation.

MBA842 Operations Strategy (3-0-0) 3

Strategic context : strategic management, business environment, strategic design, operations strategy : role of operations management, the concept of an operations strategy, designing an operations strategy, analysis for strategy design, implementing the strategy. Strategic decisions in operation: products and innovation, quality management, process planning and improvement, capacity management, structure of supply chain, movement of materials

Donald Walters, Operations strategy, Thompson Publications.

MBA843 Project Management (3-0-0) 3

Entrepreneurship – generation of project ideas – portfolio models of planning – screening of project ideas. Market opportunity analysis – systematic market appraisal – demand forecasting methods. Technical feasibility – technology development / acquisition – decision on appropriate technology – determination of plant capacity – material inputs and sourcing, structure and civil works. environment appraisal for projects. financial feasibility – estimation of the cost of project – working capital requirement – projected cash flow statement and balance sheet – project appraisal techniques – social cost benefit analysis – Projecting scheduling – tools used in projects scheduling, PERT and CPM, resource allocation in projects – projects control – budgetary control, standard costing and other control measure in project implementation – project abandonment analysis. – organization structure for project implementation – preparation for project reports, methods and techniques – Project financing in India

Chandra Prasanna, Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill (4th Edition).

MBA844 Six Sigma (3-0-0) 3

History of six sigma , why six sigma , six sigma and applications in different industries and functions roles and infrastructures , the non-delegable , role of executives , lean and six sigma , work out and six sigma , organization culture and six sigma , the customer connection, process improvement – DMAIC , design for six sigma , process management , managing with dashboards , preparing for six sigma , launching six sigma , cross cultural aspects of deploying six sigma, stabilizing , extending and integrating six sigma, measuring the effectiveness of six sigma, deployment , change management , and communication , black belt selection and development, project selection, project review , replicating results and managing knowledge . Measuring and auditing results, developing change leadership capacity

Rath and Strong, Six Sigma A Leadership Handbook, AON Management Consultant

MBA845 Materials Management (3-0-0)3

Introduction to materials management-role of materials management in business - purchasing & quality sources of supply. International buying - importance - global sourcing - global trading - green purchasing - supply chain management (SCM) - exim policy - exchange rate management - forward contracts . contracts & pricing practices - negotiation - purchase timing - make or buy - capital equipment purchase - sourcing of projects. Strategic material planning - materials budgeting - inventory management - approach to system design. Stores and transportation. stores management - insurance - sales tax - transportation - marine insurance. Policies - standards and practices - procedures.

Gopalakrishnan P. & Sundaresan M., Materials Management: An Integrated approach, Tata-McGraw Hill, New Delhi,1996.

MBA851 Customer Relationship Management (3-0-0) 3

Marketing: Evolution and New Paradigms - CRM – Definition and The Basic Concepts. CRM and Services Marketing - Tools For CRM. Key Account Management - CRM and Knowledge Management – Life Time Value of the Customer. Data Mining and Data Warehousing - Real-World Applications. Strategies for Profitable Dialog with Customers- Sales Force Automation- Marketing Automation- Call Centers- BPO And KPO. CRM Implementation and Effectiveness – Banking- Health Care- Insurance- Travel Industries.

Stanley A. Brown , Customer Relationship Management, Wiley,1st Edition,2000.
Paul Greenberg – CRM at the speed of light – Tata Mcgraw Hill, 3rd Edition, 2004.
Jagdish N. Sheth and others, Customer Relationship Management-A strategic Perspective, Macmillan Publishers India, 1st Edition, 2005.
William G. Zikmund and McLeod, Raymond Jr,Customer Relationship Management, Wiley, 2003.

MBA852 System Thinking and Strategic Modeling (3-0-0) 3

Introduction to system thinking-system philosophy- system theory- system methodology, holistic, operational and design thinking – business architecture- system practice, membership, learning and business systems - analytic approach to system thinking-business process- decision system- introduction to strategic modeling and system feedback thinking- modeling dynamic systems-managing business growth- public sector application of strategic modeling- model validity, mental model and learning.

Jamshid Gharajedhagi, System Thinking, Morgan Kaufhann, 2011
John Morecroft, Strategic Modeling and Business Dynamics, John Wiley and Sons, 2007

MBA853 Enterprise Resource Computing (3-0-0) 3

Overview of enterprise wide software solution – evolution, concept, difference between ERP and traditional information system, overview of the ERP package – ERP market – players and characteristics. technical architecture of ERP systems – distributed computing – client server systems – concept of business objects – distributed object – computing architecture – support for data mining and warehousing. Functional architecture – salient features functional modules of ERP – marketing, finance, human resources, production and operations – comparisons of ERP packages. Implementing ERP systems – business process re engineering using ERP- business process modeling – framework for ERP implementation – extending the scope of ERP through supply chain management and CRM.

Garg V K & Venkitaraman N K, Enterprise Resource Planning: Concepts and erpPractice, Prentice Hall of India, New Delhi, 1998.
Alexis Leon, Enterprise Resource Planning.
Sadagopan, Enterprise Resource Planning.

MBA854 Product Pricing (3-0-0) 3

Key Principles: Overview of Break Even Analysis- Contribution- Discounting- Price-Contribution- Volume Relationship. Demand and Supply- Elasticity - Perfect and Imperfect Competition - Commoditization. Pricing Points - Odd and Even Endings - Sticker Shock and Other Horrors. Understanding Value: Defining Value- The Value Triad and Value Triangle- Differentiation and Value. Pricing Strategies: Cost Based Pricing- Competition Based Pricing- Market Based Pricing- Overview of Value Based Pricing- Price Building. Assessing Pricing Choices: Impact of Pricing Policy on Business Strategy- Impact of Pricing on Profitability.

Michael V. Marn, Eric V. Roegner and Craig C. Zawada, The Price Advantage, Wiley, 2004.
Baker Ronald J., Pricing on Purpose: Creating and Capturing Value, Wiley, 2006.

MBA8G1 Business Process Design and Reengineering (3-0-0)3

Introduction to BPR - re-engineering and its relationship with functional areas of business, history of re-engineering, deterministic machines, complex dynamic system, interacting feedback loops and social constructs perspectives of BPR. - managing process flows business process and flows – through put rate, work-in-process, cycle time, little's law - cycle time and capacity analysis – cycle time reduction, theory of constraints. - implementation process - redesign of business processes – systematic or clean sheet, main and supporting processes, key enablers of BPR, technology for BPR, critical success factors, cross functional teams, tools and techniques of BPR, virtual ingredient – 'black hole', using process simulation to minimize the risk – business process map and simulation model, parameter analysis, simulation and key performance indicators. - ERP and BPR, ERP in modeling business processes, workflow management systems in BPR, steps of BPR, five-stage model of as-is/to-be analysis, process centric organizations, business process maturity model, business process performance measurement.

Laguna, Business Process Modeling, Simulation and Design, 2005, Pearson.
Chan Meng Khoong, Re-engineering in action, 1st Edition, 2009, Cambridge.
Charles Poirier, Business Process Management Applied, 2005, Cengage.
Varun Grover, M. Lynne Markus, Business Process Transformation, 2010, PHI.
Daniel Minoli, Business Process Re-engineering, 2010, Routledge

MBA8G2 Contemporary Issues in Management (3-0-0) 3

Understanding emerging environment - emergence of vertical environment, understanding hyper-turbulence, networks and business eco-systems, role of information technology , understanding networked, knowledge-based economy - organisations as networks, self-organizing systems, organisational designs for change and innovation – team working, high performance work systems, managing empowerment and accountability, roles and systems in flat, networked organisations, developing competencies for new organizational forms - changing models of people technology and ethical behavior, business success through social responsibilities, cost effective business models – changing business cycles – emerging trends - triple bottom-line concept, ethical leadership , empowerment, teamwork & communication, lean business, customer driven marketing, sustainable competitive advantages , balanced scorecards .

Claude George Jr, The History of Management Thought, Prentice Hall.
Subhash Sharma, Management in New Age: Western Windows Eastern Doors, New Age International Publishers, New Delhi.
Siddharth Shastri (ed.), Indian Management for Nation Building, WISDOM, Banasthali Vidyapith, Banasthali.

MBA8G3 Economic Environment & Policy (3-0-0) 3

Economic and non-economic environment. Interaction between economic and non-economic environment. Analysis of contemporary macro-economic and micro-economic problems and issues, related governmental policies and their impact on the business firm including unemployment, inflation, fiscal and monetary policy. Government regulation of business. Business concentration and anti-trust policy; income distribution and international economic relations.

Welch, Patrick J. and Welch, Gerry F., Economics: Theory and Practice, John Wiley & Sons, 2000.
Mankiw N. Gregory, Macroeconomics, Worth Publishers, 2008.
Bimal Jalan, India's Economic Policy, Viking, 1996.

MBA8G4 International Business Management (3-0-0) 3

Introduction. Globalization of world economy, world trade & foreign investment trends. Technological changes. Types of international business. The cultural dimensions of international business. The global trade and investment environment. Trading practices. World financial environment. Tariff and non-tariff barriers. WTO and regional blocks. Global financial environment. Determinants of exchange rates. International banks. Non-banking financial institutions. Global competitiveness: export and import

financing. Licensing and joint ventures. Research and development in global market. Globalization with social responsibility. World economic growth and environment. Negotiations in international business and multilateral settlements.

Hill Charles W. L., International Business: Competing in the Global Marketplace, 5/E, McGraw Hill/Irwin, 2005.
Hill Charles W. L., Global Business Today,4/E, McGraw Hill/Irwin, 2006.
Bhalla V. K. and Shivaramu S., International Business: Environment and Management, Anmol, 2003.

MBA8G5 Enterprise Risk Management (ERM) (3-0-0) 3

Introduction – benefits of risk management , environment of business, know business, establishment checks and balances, set limits and boundaries ,concepts : risk concepts, risk process, risk awareness, risk measurement, risk control, enterprise risk management frame work, enterprise risk management : benefits of enterprise risk management, chief risk officer, components of ERM. Corporate governance, line management, portfolio management, risk transfer, risk analysis, data and technology, stake holder management , risk management application : credit risk management , market risk management , operations risk management ,business applications , financial institutions , energy firms, non financial corporation's look up to future : predictions

James Lam, Enterprise risk management (ERM): from incentives to control, Publisher : Wiley finance

MBA8G6 Entrepreneurship Lab (3-0-0) 3

Nature and importance of entrepreneurship, entrepreneurial decision making process, role of entrepreneurship in economic development , National knowledge commission report, entrepreneurship- characteristics, motivation, role models and support systems, entrepreneurial entry into international business, MSME's in India , intrepreneurship, entrepreneurial process - identifying and evaluating opportunities, developing business plan, assessment of resources, project appraisal and feasibility plan , creating and starting venture- legal requirements, marketing strategies, financial plans and human resources management, managing growth, concept of family business, conceptual models of family business, challenges facing entrepreneurs -individuals ,family ,groups, society , provisions for nursing sick units.

Robert D. Hisrich and Michael P. Peters, Entrepreneurship, Mc Graw – Hill, 2006
Donald Roratko & Richard Hodgetts , Entrepreneurship – A contemporary approach , PHI, 2007
David holt , New venture Creation - , Prentice hall India, 5TH ED, 2008

MBA8G7 E-Business (3-0-0)3

Introduction to e-commerce – business models in e-commerce – environment – economic and social impact of e-business. Structure and organization of e-business – internet architecture – web technology – structure, sub systems, communications. Salient features of web programming – multimedia production, file conversions – principles of animation – concepts of java, applets and CGI scripts. Building interactivity – component technologies and writing interfaces. Servers, server sw, security aspects of server, tools for preparing web pages. Internet marketing – advertising – attracting traffic to the site – CRM – mobile commerce – cyber laws. marketing an e-business, search engines and directories, consumer communication, news groups & forums, exchanging links, web rings, e-business back end systems, business record maintenance, back up procedures and disaster recovery plans - e-business security/payment services - knowledge management - ERP, e-business backbone - e-business strategy into action, challenges, and e-transition

Andrew S. Tanenbaum, Distributed Operating Systems, Prentice Hall of India.
Bharat Bhasker, Electronic Commerce -Framework, technologies and Applications - TMH Publications
Napier, Judd, Rivers, Creating a winning E-Business, Wagner-Course Technology- Thomson Learning, 2001

MBA8G8 Management Control System (3-0-0) 3

Introduction to MCS - purpose- types- approaches to MCS- cybernetic and contingency approach- business strategy and management control system- hierarchy of control process- industrial dynamics and management control- design of MCS- steps- factors influencing design of MCS- it and design of MCS- key success variables as control indicators- environment and MCS- goals strategy and organization for adaptive control- divisional autonomy and responsibilities- management control tools and - processes – strategic planning and programming process- budgeting and budgetary control- standard costing system and variance analysis for control- transfer pricing- reward system- management control of operations- strategic cost management- auditing as a tool- MCS in organizations-MCS in non-profit organizations- current issues in MCS- corporate governance and management control.

Subhash Chandra Das- Management Control System- Prentice-Hall India- 2011
Kenneth Merchant and Wim Van Der Stede - Pearson Publication- 2011

MBA8G9 Merger and Acquisitions (3-0-0)3

Mergers, Acquisitions, Amalgamations – Strategic Perspective, SWOT Analysis, BCG Matrix, Porter's Five Forces Model – Corporate Restructuring, Methods – Valuation Approaches, Methods Of Financing Mergers, Accounting For Amalgamation, Methods Of Payment, Share Repurchase And Exchanges – Takeovers, Types, Defenses – Legal And Regulatory Framework, Company's Act, Income Tax Act, SEBI Guidelines, Provisions Of Competition Act – International Mergers And Acquisitions.

Weston, F., Chung, K.S., Hoag, S.E. Mergers, Restructuring and Corporate Control, Pearson Education.

Vadapalli., R.,Mergers acquisitions and Business valuation, Excel books, 1/e 2007
Damodaran,A., Corporate Finance-Theory And Practice, John Wiley & Sons

MBA8G10 Services Management **(3-0-0) 3**

Introduction to service operations - nature of services, strategy and positioning - designing service operations - technology and its impact on services - design and development of services and service delivery systems - work measurement, locating facilities, designing their layout - managing service operations - capacity planning and waiting line management (queuing) - managing capacity and demand - improving service processes – use of tools for process improvement - project presentations

James A. Fitzsimmons, Mona J.Fitzsimmon , Service Management , Tata McGraw Hill

MBA8G11 Supply Chain Management **(3-0-0) 3**

Supply chain – objectives – importance – decision phases – process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – factors influencing distribution – distribution networks in practice – network design in the supply chain –supplier scoring and assessment– procurement process-sourcing planning and analysis– CRM – internal supply chain management – supplier relationship management – Bullwhip effect – obstacle to coordination – building partnerships and trust – collaborative planning, forecasting and replenishment - logistics interfaces with other areas – approaches to analyzing logistics systems. – channels of distribution, cases in supply chain management.

Sunil Chopra and Peter Meindl, Supply Chain Management: Strategy, Planning and Operation, Pearson/PHI, 3rd Edition 2007.
Donald J. Bowersox, D J Closs, M B Coluper, Supply Chain Logistics Management, TMH, Second Edition, 2008.
Wisner, K Leong and Keah – C Tan- Principles of Supply Chain Management: A Balanced Approach, Thomson Press, 2005.

MBA8G12 Econometrics Theory and Applications **(3-0-0) 3**

Econometrics as a tool for Economic and Managerial Analysis – Modeling, Data and Methodology

The Classical Multiple Linear Regression Model –Least Squares Regression, Goodness of Fit and Analysis of Variance, Hypothesis Testing, Multicollinearity, Heteroscadasticity and Autocorrelation

Qualitative Response Regression Models – Logit, Probit and Tobit Models

Panel Data Regression Models –Estimation of Fixed and Random Effects Models

Endogeneity and Instrumental Variable (IV) Model

Gujarati, Damodar N. (2003). Basic Econometrics. Fourth Edition, McGraw – Hill Higher Education
Wooldridge, J. (2002). Econometric Analysis of Cross section and Panel data, MIT Press
Wooldridge, J. (2013). Introductory Econometrics: A Modern Approach. 5th Edition. South-Western Cengage Learning.

HU 800 Research Methodology **(1 -1- 0) 2**

Nature of science,Human Inquiry and Science , Learning and creativity , Innovation and creativity , Nature of Research, Research Ideas and problems , Critically Reviewing the Literature and Literature Map, Identifying research gaps , Framing research questions, Research objectives, Ethics in Research , Research approaches, process, strategies, Research Design: Conceptualization, Operationalization and Measurement, Sampling: Probability and Non - Probability, Using Primary and Secondary Data, Quantitative and Qualitative data , Data collection , Exploring and Examining, Analysis and interpretation ; Communicating research findings: Written , oral , visual ; Referencing .

William M.K. Trochim, Research Methods, Biztantra publications, 2nd Edition.
John W. Creswell, Research Design, Qualitative, Quantitative and Mixed Approaches, 2nd Edition, Sage Publication, 2003.
Earl Babbie, The Basic of Social Research, Wadsworth- Thomson Learning, 2nd Edition, 2002.
E. M. Phillips And D. S. Pugh, How To Get A PhD -A Handbook for PhD Students and their supervisors, Viva Books, 2006
Antony Wilson, Jane Gregory, Steve Miller, Shirley Earl, Handbook of Science Communication, Overseas Press India Pvt ltd, 2005
Donald R. Cooper, Pamela S. Schindler, Business Research Methods, TMH, New Delhi, 2006.
Juri Neimark, Mathematical Models in Natural Sciences and Engineering, Springer, 2003.
Rutherford Aris, Mathematical Modeling Techniques, Dover Publications, New York, 1994.
J N Kapur, Mathematical Modeling New Age Publishers, New Delhi, 1988.
T. Roscoe, Writing Reviews for Systems Conferences, http://people.inf.ethz.ch/troscoe/pubs/review- writing.pdf.
H. Schulzrinne, Writing Technical Articles, http://www.cs.columbia.edu/ hgs/etc/writing-style.html.
G.M. Whitesides, Writing a Paper, http://www.che.iitm.ac.in/misc/dd/writepaper.pdf.

HU 801 Comparative Literature (3-1-0) 4

Definition and Scope of Comparative Literature, Development of the Discipline, Methodology; History and Literary History, Elements of Literary History, Problems of Periodisation; Theory of Genres: Oral, Written, Ancient, Medieval and Modern; Comparative Indian Literature: Traditions, Movements, Themes and Genres; Literary Theory: Sanskrit, Tamil/Kannada Poetics, Western Literary Theories; Cross-Cultural Literary Relations: Influence, Analogy and Reception; Translation Studies: History of Translation - Indian and Non-Indian Theories of Translation, Linguistic and Cultural Problems of Translation; Literature and Other Arts; Literature and Cultural Studies

Sisir Kumar Das and Amiya Dev. Comparative Literature: Theory and Practice, Allied Publishers, 1989
Sheldon Pollock. Literary Cultures in History: Reconstructions from South Asia, University of California Press, 2003
Aijaz Ahmad. In Theory: Classes, Nations, Literatures. OUP, 1992.
Krishna, Daya, India's Intellectual Traditions: Attempts at Conceptual Reconstructions. ICPR & Motilal Banarsidass, 1987.
Tejaswini Niranjana, P. Sudhir and V. Dhareshwar, Interrogating Modernity: Culture and Colonialism in India Seagull, 1993.
M. Rader, (ed.) A Modern Book of Esthetics, Harcourt, 1979 Alan
Singer, et al. (eds.) Literary Aesthetics. Blackwell, 1999
V.S. Seturaman, (ed.) Indian Aesthetics: an introduction. Macmillan, 1992.
Byran S. Turner, (ed) Theories of Modernity and Post-modernity. Sage, 1990. Patricia
Waugh (ed) Postmodernism: A Reader. Edward Arnold, 1992.
Peter V. Zima, The Philosophy of Modern Literary Theory. The Athlone Press, 1999

HU 802 Research Methoddology in Literature (3-1-0)4

Types of Literary Research: Theoretical Research, Textual Research, Historical Research, Interpretative Research, Interdisciplinary Research. Methods of Literary Research: Presentation, References, Footnotes, Indexing, Bibliography.

R. Altick, The Art of Literary Research, Norton & Co., N.Y.
C. Saunders, An Introduction to Research in English Literary History, Macmillan, N.Y.
G. Watson, (Ed.), The Concise Cambridge Bibliography of English Literature, CUP, Cambridge
F.W. Bateson, The Scholar-Critic: An Introduction to Literary Research, Routledge and Kegan Paul, London
J. Anderson, B.H. Durston, and M. Poole, Thesis and Assignment Writing, Wiley Eastern Limited, New Delhi J.
Gibaldi, MLA Handbook for Writers of Research Papers, MLA, N.Y.
E. Burns & T. Burns (Eds.), Sociology of Literature and Drama, Penguin, Harmondsworth R.
Schechner, Essays on Performance Theory: 1970-1976. Drama Book Specialists, N.Y.

HU 803 Literary Theory (3-1-0)4

The nature of literary evaluation and critical discussion. The place of universal criteria in literary criticism. Is iterary experience autonomous? The relation between literary value and (a) social reality: the problem of Commitment, Black literature, Dalit literature, etc., (b) psychological reality, the problem of the unconscious (Freudian and Jungian).The theory of the forms/genres of literature. Structuralism and stylistics.

R. Wellek, and A. Warren, Theory of Literature, Penguin, Harmondsworth
W. Wimsatt and C. Brooks, Literary Criticism: A Short History, OUP & IBH, New Delhi
T. Engleton, Literary Theory: An Introduction, Oxford, Blackwell K. Elam,
Semiotics of Theatre & Drama, Methuen, N.Y.
T.S. Eliot, The Use of Poetry and the Use of Criticism, Faber, London
D. Lodge, (Ed.), Twentieth-Century Literary Criticism, Longman, London
D. Lodge (ed.), Modern Criticism & Theory. Longman, London
I.A. Richards, Principles of Literary Criticism, Routledge & Kegan Paul, London
M. Rader, (Ed.), A Modern Book of Aesthetics, Fourth Edition, Holt, Reinhart & Winston, New York
D. Craig, (Ed.), Marxists on Literature, An Anthology, Penguin, Harmondsworth N. Frye,
Anatomy of Criticism, Princeton University Press, N.Y.

COURSE CONTENTS - 900 Level Courses

DEPARTMENT OF APPLIED MECHANICS & HYDRAULICS

AM901 Fuzzy Logic, ANN & GA **3**

Fuzzy logic - Classical sets and fuzzy sets. Fuzzy set operations. Fuzzy relations. Extension principle. Membership functions. Lambda-cuts for fuzzy sets and relations. Defuzzification methods. Fuzzy rule-based systems. Fuzzy nonlinear simulation. Fuzzy regression. Artificial Neural Networks (ANN) - McCulloch-Pitts model of a neuron. Learning rules. Activation functions. Single layer perceptron networks. Multilayer feedforward networks. Back propagation algorithm. Hopfield networks. Genetic Algorithms (GA), fitness function. Genetic Algorithm operators - reproduction, crossover, mutation. Schemata and schema theorem. Application of GA to optimization problems.

Ross T.J., Fuzzy logic with Engineering Applications, McGraw Hill.
Haykin S., Neural Networks - A comprehensive foundation, Prentice Hall.
Goldberg D., Genetic Algorithms, Addison-Wesley.

AM902 Wetland & Management **3**

Introduction, Scope, Importance, Wetland Classification system, Wetland Indicators for Identification and Delineation, Wetlands Processes (Functions) and Values, Types of wetlands and their roles in the watershed. Human Impacts: wetland loss and Degradation, Major Causes, The Main Activities that cause wetland impairment, Wetland Protection and Successful Mitigation - Issues, Measures of Success, Common Mitigation-pitfalls, Wetland Management- Natural wetland protection, The Challenge of Protection, Management Issues Buffers and Other Protective Measures for Wetlands Natural wetlands and Riparian areas as Buffers, Wetland restoration and creation, Constructed wetlands, Comparison of created and natural wetlands.

Environmental Laboratory. Crops of Engineers Wetlands Delineation Manual, U.S. Army Engr. Waterways Expt Station, Vicksburg, MS,.1987, (Rev. Version 1997)
Lawrence R. Liebesman, The Water Supplier's Guide to Wetlands Regulation and Management, American Water Works Association, Denver CO 80235, USA, 1995

AM 903 Groundwater Systems Analysis **3**

Digital simulation models for groundwater development, application of finite difference and finite element methods for solving problems in groundwater development and management; Analog methods: direct electric analog, viscous flow analog and other analogs; Optimization methods, models for conjunctive development of surface and groundwater; Special problems in ground-water development and management; Artificial recharge, ground subsidence, salt water intrusion and others.

Rushton, K.R. Groundwater hydrology: Conceptual and computational models. Wiley, 2003.
Anderson, M.P. and W.W. Woessner, Applied groundwater modeling, Academic Press, 2002.

AM904 Finite Element Application to Flow Problems **3**

Introduction to partial differential equations, numerical methods, initial and boundary value problems, weighted residual techniques. Galerkin finite element method, element families, formulation of element equations, global matrix, higher order elements, solution techniques application of Galerkin. FEM to various surface and subsurface flow problems.

Huyakern P.S. and Pinder G. F, Computational Methods in sub-surface flow, Academic Press, 1983
J.Donea, Finite Element methods for flow problems, Applied Publishers, 2003

AM905 Computational Methods in Subsurface Flow **3**

Partial differential equations in subsurface flow, initial and boundary value problems, solution methodology. Finite difference method -various schemes and their solution, simulation of single phase subsurface fluid flow. Finite element method - Galerkin method, element families, solution of steady and transient groundwater flow problems. Boundary element method - Basic concepts, application to one and two dimensional sub-surface flow problems. Method of characteristics and its applications, Analytical elements, infinite elements and applications.

Huyakern P.S. and Pinder G. F, Computational methods in sub-surface flow, Academic Press, 1983
Bear J. and Verruijit A., Modelling groundwater flow and pollution, 1988

AM906 Inverse Modelling in Regional Ground Water System **3**

Introduction to regional Ground Water system, Introduction to inverse modelling, Sensitivity analysis, parameter identifiability, parameterization, parameter structure, parameter uniqueness and stability. Uncertainty analysis using covariance matrix, some case studies.

Taha, Operation Research
Katanth, Ground Water Engineering

AM907 Innovative Type Breakwaters **3**

Different types of breakwaters, function, location, design wave, advantage and disadvantage, rubble mound breakwaters : design factors, hydraulics of cover layer, stability of breakwaters and factors effecting them, artificial armour units, construction method. Berm breakwaters: stability and reshaping of berm breakwaters, factors influencing them, material specification, construction method, Tandem breakwaters: design factors, stability coefficient and factors effecting them, performance of other type of breakwaters: reef breakwaters submerged breakwaters, pile breakwaters, floating breakwaters, design factors, modelling technique: rubble mound and other types of breakwaters.

US Army Corps of Engineers - Shore Protection Manual Per
Brunn - Port Engineering Vol. 1.
Herbich J.B. - Hand Book of Coastal and Ocean Engineering Vol. 1

AM908 Advanced GIS **3**

Statistical analysis, measurement, proximity analysis (buffering), overlay analysis, classification, network analysis, multicriteria analysis, site suitability analysis, nearest neighbor analysis, Theissen polygons, Surface mapping, interpolation (including TIN), digital elevation model (DEM), terrain classification -slope aspect, angle of incidence etc.

Atikson P and Tate N.J., Modelling scale in Geographical Information Science, John Wiley & Sons, Chichester.
Shekhar S. and Chawla S., Spatial Databases, A Tour, Prentice Hall, Englewood Cliffs.

AM909 Digital Image Processing **3**

Image enhancement, contrast enhancement, spatial filtering, Image transformation, spectral rationing, principal component analysis, analysis of hyper spectral data, image classification, supervised classification, unsupervised classification, fuzzy classification, post classification analysis, neural networks, context analysis, accuracy assessment

Lillesans, Thomas M. and Ralph W.Kiefer, Remote Sensing and Image Interpretation, John Wiley, 1994.
Campell, James B., Introduction to Remote Sensing, 2nd Edition, The Guilford Press NewYork 1995.
Richards, Introduction to Digital Image Processing

AM910 Soil Physics **4**

General physical characteristics of soils, soil texture, structure, particle size distribution, classification of soils, soil water content, soil water potential, flow of water in unsaturated soils and saturated soils, solute transport. Water and energy balance in the field, soil hydraulic properties, spatial variability.

Daniel Hillel, Fundamentals of Soil Physics, Academic Press.
Maidment, Handbook of Hydrology, McGrawHill.

AM911 Advanced RS & GIS Applications in Coastal Engineering **3**

Fundamentals of RS & GIS, Data products and data formats, fundamentals of visual and digital image processing, ground truth and accuracy estimation, Overview of instruments image processing and GIS software.

Case Studies : Shoreline change detection, Coastal land use / land cover, suspended sediment concentration, marine ecology, coastal cadastral mapping, Bathymetry, marine resources monitoring and management, ICZMP, Harbour area information system (HIS), CZIS, Coastal wetland monitoring and management, Disaster warning system, Coastal vulnerability analysis, Ocean parameter estimation wing, Satellite data.

Thomas N Lillesand and R W Kiefer - Remote Sensing and Image interpretation.
Cracknen A.P. - Remote Sensing in Meteorology, Oceanography and Hydrology.
Sabins F.L. - Remote Sensing Principles and Interpretation. Jenson - Digital Image Processing.

AM912 Watershed Management **3**

Principles of watershed management: Basic concepts, surface water, groundwater, water availability, conjunctive use, Watershed management in arid, semi-arid and per-humid regions. Watershed management through wells, water supply, case studies. Long term and short strategic planning for conservation of water, recycle and reuse. Watershed management - community participation, private sector participation. Sustainable watershed management, water harvesting. Application of GIS and remote sensing in watershed management.

Murthy, J.V.S., Watershed management, New Age International, New Delhi, 2nd edition, 1998.
Singh, V.R., Watershed planning and management,Yash Publishing House, Bikaner,1996.
Murthy, J.V.S., Watershed management in India. Wiley Eastern, New Delhi,1994.
ASCE, Watershed management. ASCE, New York.
Allam, G.I.Y., Decision support system for integrated watershed management. Colorado State Univ., USA, 2003.

AM 913 Physical and Stochastic Hydrology **3**

Review of physical hydrological principles, collection and interpretation of hydrological data, characteristics of hydrologic phenomena, random phenomena and their distributions. Combinational analysis, geometric probability, Markov chains, expectation and variance of random variables, concepts of risks and uncertainty in hydrology, sampling theory, testing of hypothesis, correlation and regression, multivariable analysis, auto-correlation and cross correlation, hydrologic series, intermittent hydrologic process.

Mays L.W., Water Resources Handbook. McGraw Hill, First edition,1996.
Maidment, D., Handbook of Hydrology, McGraw Hill, First edition,1993.
Yevjevich, V., Probability and statistics in hydrology. Water Resources Pub., Fort Collins, Colorado.,1996.
Yevjevich, V., Stochastic process in hydrology. Water Resources Pub., Fort Collins, Colorado,2001.

DEPARTMENT OF CIVIL ENGINEERING

CV900 Soil Chemistry **4**

Introduction, Soil formation, Soil structure, Clay mineralogy, Chemical composition of soils, Soil-lime reactions, Flyash reactions, Soil-cement reactions, Reactions of various other chemicals with soil, Soil grouting, Colloid chemistry, Change in soil properties due to chemical reactions, Impact of environment on soil properties.

Engineering Principles of Ground Modifications, McGraw-Hill.
Renben H. Carol, Chemical Grouting and Soil Stabilization, M. Drekker Publishers, NY.

CV901 Advanced Soil Reinforcing Techniques **4**

Historical background, Reinforced soil structures and RCC, Vidalean concept of reinforced earth, Triaxial studies on reinforced soil, Enhanced confining pressure concept and apparent anisotropic cohesion concept, Reinforcing man made slopes, and natural slopes, Reinforcement in body embankment stability of reinforced steep soil slopes, reinforced walls, type of reinforcements, properties of backfill soils, Soil-reinforcement interaction studies, pullout tests and direct shear tests, Reinforcement beneath foundations and embankments, Geosynthetics properties, tests and applications in civil engineering. Recent advances in Soil Reinforcing Techniques.

CJFP Jones, Earth Reinforcement and Soil Structures, Butterworths, London.
R. M. Koerner, Designing with Geosynthetics, Prentice-Hall.

CV902 Vibration of Plates **4**

Strain energy of vibrating systems, free and forced vibration, continuum and discrete systems, differential equations of lateral motions, flexural vibration of plates, Hamilton's principle, Energy methods for determining natural frequencies, eigenvalue and eigenvector, solution methods.

AW Leissa, Vibration of Plates, NASA SP-160.

CV903 Hydrogeology **4**

Hydrologicalcycle, Aquifers, classification and characteristics, Groundwater distribution, occurence, movements, Groundwater exploration, Geological, hydrological, geophysical and remote sensing methods, Groundwater budgeting, Groundwater recharge, Rainwater harvesting, Quality of groundwater, Groundwater management, Case histories of typical groundwater studies.

David Keith Todd, Ground Water Hydrology, John Wiley and Sons.
Karanth K. R., Groundwater assessment, development, management, Tata McGraw-Hill.

CV904 Advanced Environmental Geotechnology **4**

Perspective of environmental geotechnology, Soil, environment, water interaction, mass transport, Energy gradient and conductivity, Sources of water contamination, Under ground, groundwater flow conditions, Contaminate migration, Disposal and containment of solid, water remediation. Recent advances in Environmental Geotechnology.

Donald P. Coduto, Geotechnical Engineering, Principles and Practices, Prentice-Hall.
Daniel, D. E. Geotechnical Practice for Waste Disposal, Chapman and Hall, London.
Reddi L. N., and Inyang. H. F. Geoenvironmental Engineering- Principles and Applications, Marcel Dekker, Inc.

CV905 Special Concretes **4**

High performance concrete, definition, materials used, mix design methods, properties of fresh and hardened states, Recent advances in mix design procedure, Lightweight aggregate concrete, definition materials used, mix proportioning and properties, Self compacting concrete, definition, mix proportioning, testing at fresh state, No fines concrete, definition, mix design and properties.

PC Aitcin, High Performance Concrete, E&FN SPON, London.
AM Neville, Properties of Concrete, Longman Scientific and Technical Publishers.

CV906 Mechanics of Composite Laminates **4**

Types and classification, Lamina stress strain relationship, Classification of laminates, Failure theories, Classical lamination theory, Stress strain variation in a laminate, Stress analysis, Intra and interlaminar stresses in laminates, First and higher order deformation theories, Bending, vibration and buckling analyses using the above theories, Equilibrium equations using PMPE, Boundary conditions, Solution methods.

RM Jones, Mechanics of Composite Materials, McGraw-Hill.
JR Vinson and RL Seierakowski, The Behaviour of Structures Composed of Composite Materials, Martinus Nijhoff Publishers.

CV907 Basic Operation Research & Shape Optimisation **4**

Structures, Hall marks of good structures, Stability Strength, Safety, Serviceability, Durability and economy, Need and scope for Optimization. Optimization basics, Classical methods, Numerical techniques, Objective function, Constraints, Problem formulation and solution. Structural Configuration, Inherent relationships between load and shape - topology. Minimum weight, minimum cost, Maximum strength to weight ratio, Multi-objective techniques of topology

SS Rao, Optimization, Wiley Eastern
Gallagher, Optimum Structural Design, Wiley, New York.

CV908 Structural Systems for Tall Buildings **4**

Configuration, Structural Concepts, Building frames, Hard and soft connections, Lateral loads, Stability, lateral load resisting systems, Shear walls, Shear cores, Tube-in-tube concept, Soft tube structures, Core-frame interaction, Outriggers. Transmission line towers, Chimneys, Cooling towers, analysis and design, detailing.

Taranath, Analysis and Design of Tall Buildings, McGraw Hill, New York
Pinfold, RC Chimneys and Towers, Viewpoint Publ., London

CV909 Innovative Applications of Shells in Foundations **4**

Foundations, Criteria for design, General and local shear failures, Settlements, Bearing Capacity and Allowable Pressures, Conventional Foundation Types. Shells and folded plates as foundations, Shell geometry, Classifications, Stability of shells and plates as footings, Strategic considerations for selection of type. Analysis, design and detailing of singly and doubly curved shell foundations, Applications of V and trough folded plates in footings and retaining structures.

G. S. Ramaswamy, Design and Construction of shell roofs, CBS Publishers.
N. P. Kurian, Design of Foundation Systems: Principles and Practices, Wesley Publishing Co.

CV910 Numerical Analysis **4**

Solution of algebraic transcendental and polynomial equations. Newton-Raphson method, Muller method, Graeffe's and Bairstow's methods. Lagrange's, Hermite and Cubic Spline interpolation, Numerical differentiation and integration, Numerical solution to ordinary and partial differential equations, Finite element method, formulations using Galerkin and Ritz method. Gaussian integration, Frontal solution technique.

MK. Jain, SRK. Iyengar and RK Jain, Numerical Methods for Scientific and Engineering Computations, Wiley Eastern.
AR. Mitchell and R. Wait, Finite Element Method in Partial Differential Equations, John Wiley and Sons.

CV911 Advanced Geotechnical Instrumentation **4**

Requirements of a good instrumentation; Theory, Design, Methods of analysis of data; laboratory and field instrumentation; Planning an instrumentation program; transducers, hydrometers, strain measuring devices, load cells, LVDTs, pH meter etc, measuring rock and rock mass properties; settlement gauges, inclinometers, earth pressure cells, piezometers, instruments used in geophysical exploration methods, ground probing radar and instruments used in field tests such as SPT, SCPT, DCPT etc., nuclear moisture meter/densitometer, frequency analyzer, role of electronics in instrumentation; calibration, maintenance and installation of instruments, uncertainty analysis. Recent advances in Geotechnical Instrumentation.

Hanna, T.H., Field Instrumentation in Geotechnical Engineering, Trans-Tech Publications.
Bowles, J.E., Engineering Properties of Soils and their Measurements, McGraw-Hill.

CV912 Earthquake Resistant Design of Structures **4**

Introduction to earthquake resistant design, seismicity and earthquake ground motions, dynamic characteristics of structures, dynamic response of structures, initial design considerations, calculation of earthquake induced forces, IS1893, purpose of seismic strengthening, common deficiencies, seismic vulnerability assessment, procedures for repair, restoration and retrofitting of RC and masonry structures, examples seismic retrofitting.

Williams A, Seismic Design of Buildings & Bridges, Engineering Press, 1998
Dowrick, Earthquake Resistant Design
IS codes IS1893, IS 4326, IS13935, IS13920

CV913 Design of Structures with Seismic Isolation **3**

Principles of base isolation, general considerations, basic elements of seismic isolation systems, energy dissipation, force deflection characteristics, seismic-isolation design principles, feasibility of seismic isolation, design methods, design examples

CV914 Performance Based Seismic Engineering **3**

Seismic performance, damage control, life safety, collapse prevention, immediate occupancy, performance based design, seismic demand and capacity, ADRS spectrum, target displacement, performance objectives, push-over analysis, capacity spectrum, static analysis, nonlinear analysis

CV915 Geotechnical Earthquake Engineering **4**

Introduction, seismology and earthquakes, strong ground motion, seismic hazard analysis, seismic wave propagation, dynamic soil properties, ground response analysis, local site effects and design ground motions, liquefaction, seismic slope stability, seismic design of retaining walls, soil improvement against seismic hazards

Cramer S L, Geotechnical Earthquake Engineering, Pearson Education 2003.
Day, Geotechnical Earthquake Engineering Handbook.

CV916 Seismic Design of RC & Steel Structures **3**

Concrete structures: Design for inertial effects, estimates of demand and capacity, ductility in earthquake resistant design, behaviour of concrete members under earthquake-type loading, codal provisions, nonlinear response, design examples.

Steel Structures: Introduction, codal provisions, design of moment resisting frames, design of concentrically braced frames, hysteretic energy dissipation capacity, design of eccentrically braced frames, design examples.

Williams A, Seismic Design of Buildings & Bridges, Engineering Press, 1998
Dowrick, Earthquake Resistant Design
IS codes IS1893, IS 4326, IS13935, IS13920

CV917 Design of Structures Against Blast Loading **3**

Introduction, partial safety factors in blast design, basic guidelines for enhancing building resilience, blast loading, structural response to blast loading, design of various structural elements for blast loading

Mays G C & Smith P D, Blast Effects on Buildings, Thomas Telford 1995.

CV918 Advanced Offshore & Coastal Structural Engineering **3**

Introduction, deep water offshore structures, TLPs and compliant structures, dynamic analysis of offshore structures, breakwaters, jetties and other coastal structures, design parameters, codal provisions

CV919 Structural Safety and Reliabiliy **3**

Reliability theory, Structural reliability - levels 1, 2, & 3. FOSM and AFOSM methods of structural assessment, Interpretation of safety, determination of partial safety factors, reliability-based design examples.

Ranganathan, Reliability analysis & design of structures.

CV920 FEM Applications in Structural Engineering **4**

Types of elements-Discretization of structures-Interpolation functions-Generalised and natural coordinates-Formulation using variational method-Numerical integration-Timoshenko beam element-Plate bending elements-C^o and C^1 continuity elements-Mindlin element-Shell elements-Formulation and program development for plate and shell elements-Techniques for material and geometric non-linear problems.

Krishnamoorthy C.S, Finite Analysis : Theory and Programming, Tata McGraw-Hill.
Zienkiewicz O.C and R.L. Taylor, The Finite Element Method (vol. 1 and vol. 2), McGraw-Hill

CV921 Theory & Analysis Plates **4**

Thin and thick plates-Deflection of laterally loaded plates-Navier and Levy's method-Energy and finite difference methods-Plate subjected to in-plane and lateral loads-Circular plate with symmetrical loading-stiffened plates-Introduction to vibration and buckling of plates-Analytical and finite element methods to solve stress, vibration and buckling problems of plates.

Timoshenko S. P. and S.W. Kriegar, Theory of Plates and Shells, McGraw-Hill
Chandrashekara K., Theory of Plates, University Press, Hyderabad.

CV922 Smart Materials & Structures **4**

Smart materials and their properties-Piezoelectric, magneto structures-Shape memory materials-Electro rhieological fluids-Optical fibres-Actuation-Sensing and control augmentation-Distributed and discrete sensing and actuation-Methods of analyses-Finite elements-Applications-Vibration suppression-Shape control-Sizing-Damage detection.

Gandhi M.V.and Thomson, B.S. Smart Materials and Structures, Champan & Hall.

Meirovitch L., Dynamics and Control of Structures, John Wiley.

CV923 Geoenvironment **4**

Understanding the earth, atmosphere and processes governing environmental conditions. Study and Significance of natural resources; mineral, rock, water and Soil resources.
Natural hazards- Volcanic eruption, earthquakes, landslides, Land subsidence, floods.
Soil erosion - Soil profile, causes and effects of soil erosion, sitting of estuaries and reservoirs, Soil conservation coastal hazards - coastal processes, coastal protection Pollution - Definition, various contaminants, point and non-point sources. Surface water pollution, ground water pollution, ground water quality, health hazards associated with pollution, case histories Environmental impact of mining and quarrying Land use planning.
Jain, Environmental impact analysis.

CV924 Dynamic Soil-Structure Interaction **4**

Equation of motion in the time domain, correspondence principle, discrete Fourier transform, formulations in total displacements for flexible base and rigid base, Kinematic and inertial interactions, spatial variation of seismic loads, fundamentals of wave propagation, one dimensional wave equation, free field response of site, Direct analysis of total structure soil system, Substructure analysis.
John. P. Wolf, Dynamic soil structure interaction, Prentice Hall.

CV925 RS and GIS Applications in Engineering Geology **4**

Introduction to remote sensing, spectral signatures, False color concepts etc., Orbits, Flatforms, Sensors and Scanners. Indian satellite family. Launch vehicles, data products. Interpretation analysis techniques. Multispectral, multitemporal, multisensor and multistage concepts. Photo interpretation techniques for aerial photo's and satellite imageries. Interpretation elements.
Advanced GIS concepts, overlay analysis, network analysis, multicriterion analysis, site suitability analysis, nearest neighbourhood analysis, thesian polygons, surface mapping, interpolations (including tins), Digital Elevation models(DEM), terrain classification- slope, aspect and angle of incidence etc., applications of RS and GIS in Engineering Geology.
Thomas N Lillesand and R. W. Keifer - Remote sensing and image interpretation.
Atkinson P and Tata N. J.-Modeling scale in Geographic Information Science, John Wiley and sons, Chichesler.

CV926 Ground Water Exploration and Development **4**

Ground Water Exploration: Introduction, Regional Groundwater exploration, Hydrogeological exploration, Pumping tests, Remote Sensing applications, Geophysical exploration - Electrical Resistivity method, Self Potential method, Induced polarization method, Magnetic method, Seismic methods, Well logging methods. Groundwater exploration in different terrains - hard rock terrains, sedimentary rocks and coastal tracts. Groundwater Development: Groundwater developments in India, Well design, construction and maintenance-types of wells, methods of construction, tube well, drilling techniques, dug wells, well failures, hydro fracturing, rain water harvesting, Recharge estimates, Conjunctive use, Ground water quality.
Karanth, K. R., Groundwater Assessment, Development, Management, Tata McGraw-Hill Todd, David Keith., Ground water Hydrology, John Wiley and Sons.

CV927 Advances in Hot Mix Asphalt Technology **4**

Rheological Properties of asphalt binders: age hardening, temperature susceptibility, shear susceptibility, stiffness, and consistency. Pavement performance. Characterization of asphalt mixtures: criteria for asphalt mixture tests, physical properties, and mechanical and performance tests. Concepts of Superpave. Field compaction of ashalt mixture and mixture segregation. Special Mixtures, recycling, and additives.
NAPA Education Foundation, Hot Mix Asphalt Materials, Mixture Design and Construction, Maryland, USA.
The Asphalt Institute, Performance Graded Asphalt Binder Specification and Testing, SP1, Lexington, KY, 1995.
The Asphalt Institute, Superpave Level 1 Mix Design, SP2, Lexington, KY, 1995.

DEPARTMENT OF MINING ENGINEERING

MN901 Applied Rock Mechanics **4**

Rock mechanics applications in mining and civil constructions, Design and stability analysis of underground openings. Caverns for underground storage, Rock mechanics for improved mining methods in coal and non-coal mines. Design of pillars, Rock support and reinforcement -rock support inter action analysis. Evaluation and testing of rock support systems. Selection of supports and roof capability.

Obert L. and Duvell W. I., Rock Mechanics and design of structures in rock. Jaeger and Cook, Fundamentals of rock mechanics. Bray and Brown, Rock Mechanics. Peng, Coal Mine Ground Control.

MN902 Rock Mechanics & Ground Control **4**

Introduction to Rock Mechanics. Analysis of stress and strain. representation of stress- strain, Engineering properties of Rocks. Determination of various rock indices, Determination of physical and mechanical properties of Rocks. Elastic Constants, Engineering classification of rock mass. Instrumentation used for determination of in - situ stresses and laboratory investigations, Design of underground openings. Design of pillars in underground coal mines, Rock reinforcement / Ground improvement techniques in rock masses, Subsidence: Prediction and measurement of subsidence. Subsidence damage and control.

Obert L. and Duvell W. I., Rock Mechanics and design of structures in rock. Jaeger and Cook, Fundamentals of rock mechanics. Bray and Brown, Rock Mechanics.

MN903 Geomechanics **4**

Geological structures in rockmass, Objective and methods of rockmass characterisation. Methods of determination of strength and deformability of rock and rockmass, Failure criteria for rock and rockmass, Influence of anisotropy and discontinuity on rock behaviour, Pre-mining state of stress: sources, methods of determination and presentation, Propagation of elastic waves in rock medium and dynamic behaviour of rocks, Stress distributions around single and multiple openings in rocks: methods of estimation; factors influencing stress concentration; zone of influence of an excavation; effect of planes of weaknesses and shape of excavation; delineation of zone of failure. Introduction of mechanics of rock cutting, drilling and blasting.

Obert L. and Duvell W. I., Rock Mechanics and design of structures in rock. Jaeger and Cook, Fundamentals of Rock Mechanics. Bray and Brown, Rock Mechanics.

MN904 Drilling Engineering **4**

Classification of rock drilling. Applicability and limitations, Factors influencing drilling. Drillability of rocks, Construction, operation and limitations of various drills, Drill bits. Coring and core barrels. Alignment and deviation in drilling. Fishing tools. Directional drilling, Surveying and logging of drill holes, Drilling practices. Drilling patterns for drivages.

Chugh. C.P., Diamond drilling. Pfleider, Surface mining.
Tabia, Oil well drilling engineering.

MN905 Rock Fragmentation Engineering **4**

Developments in explosives and accessories. Substitutes for explosives, Mechanisms of rock fragmentation due to blasting. Factors controlling fragmentation. Fragmentation prediction models. Fragmentation Assessment methods, Blast design. Choice of explosives, Theory of shaped charges. Recent advances in blasting techniques, Special techniques of blasting. Environmental effects and their control. Economic evaluation of blasting operations.

Mishra G.B. , Opencast mining
Gregory, Explosives for North American Engineers
Sastry V.R., Advances in drilling and blasting

MN906 Rock Slope Engineering **4**

Role of slope stability in economics, design and operation of surface mines, waste dumps and embankments, Factors affecting slope stability, Geological data collection and graphical presentation, Mechanics of slope failure, Factor of safety of slopes, Slope stability analysis-techniques, Monitoring of slope deformations, field instrumentation, stabilistaion of slopes.

Hoek, E. and Bray, J.W., Rock slope engineering

Brawner , Stability in surface mining Giani,
Rock slope stability analysis

MN907 Physical & Numerical Modelling **4**

Concept, methodology and principles of physical modeling. Dimensional analysis. Different materials used for physical modeling. Modeling as a technique for rock load determination and analysis. Physical modeling of rock mass. Elastic linear, elasto-plastic and time dependent rheological models, Various numerical techniques of mine simulation, FEM, FDM and BEM, Application in strata mechanics.

Kidybinski A & Kwasniewski M. (Eds); Modelling of mine structures, A.A. Balkema, Rotterdam. 1988.
Kidybinski A. & Dubinski J. (Eds); Strata control in mines, A.A. Balkema, Rotterdam. 1990.

MN908 Tunneling Technology **4**

Design principles of underground openings, Rock conditions and initial state of stresses. Computer aided tunnel design, Tunnel driving techniques for hard and soft rocks. Blasting in tunnels, Tunnel supports, Remote control and automation of supports, Shield tunneling system with road headers, Support assessment, Tunneling in soft strata. Tunnel lining, Tunnel stability analysis, Monitoring. Back analysis, Case histories.

Obert L. and Duvell W. I., Rock Mechanics and design of structures in rock
Vutukuri V.S. and Lama R.D., Physico - mechanical properties of rocks
SME-AIME. Rapid excavation tunneling conference proceedings (1975-1998).

MN909 Design of Mine Supports **4**

Insitu and induced stresses: Methods for determination insitu stresses and instrumentation:. Analysis of induced stresses, Rockmass classification systems, Design of support systems for bord and pillar method and longwall method of working, Rock reinforcement.

Biron C. and Arioglu, E., Design of supports in mines.
Kaiser P.K., Rock support in mining and underground construction
Chugh Y.P., Ground control in Room & Pillar mining

MN910 Planning of Underground Coal Mines **4**

Status of Underground Coal Mining in India, Stages of planning of underground coal mines: Feasibility and Detail Project Report, Bord and pillar mining systems. Design of Blasting gallary layout method, Design of Longwall Mining. Design considerations for exploitation of thick seams, Exploitation of contiguous seams and seams liable to bumps; hydraulic mining and underground gassification of coal.

Singh R.D., Principles and practices of modern coal mining, New Age Int.(P) Ltd Publishers.
Singh T.N., Underground mining of coal Oxford and PBA Publishing Co. Pvt. Ltd. Peng, S.S.
Longwall mining.

MN911 Planning of Underground Metal Mines **4**

General engineering design; design methods in mining, Classification of exploitation methods; choice of mining systems, Design of stoping layouts, Mining in rockburst prone areas, Novel and innovative mining methods, Mine closure, sealing and abandonment.

Hartman H.L., Introductory Mining Engineering, John Wiley and Sons, Toronto, 1987.
Hustrulid W.A., (Editor) SME Handbook on Metalliferous Mining, USA, 1984.
Agoshkov M., et. Al., Mining of Ores and Non-Metallic Minerals, Mir Publishers, Moscow, 1983.

MN912 Planning of Surface Mines **4**

Mine planning & its components; planning phases & planning costs; economic concepts, Steps in mine planning; reserve estimation; determination of mine size, Geometrical considerations; mine layouts; pit slope geometry; stripping ratios, Choice of mining system; determination of ultimate pit, Production planning & calendar plans for mining programme, Selection of equipment system, Design of high wall slopes and waste dumps, Design of haul roads.

Hartman H.L., Introductory Mining Engineering, John Wiley and Sons, Toronto, 1987.
Hustrulid W.A., (Editor) Openpit planning and design. Misra
G.B., Surface mining.

MN913 Underground Excavation Equipment **4**

Various types of drilling equipment, Shaft drills and mucking system; shaft boring machines, loading and transportation techniques, Maintenance of excavation equipment, automation in excavation equipment.

C.P. Chug , Drilling technology hand book

Statham, Coal mining practice
Stack, Mining & Tunneling machinery

MN914 Surface Excavation Technology & Equipment **4**

Classification of surface excavating equipment systems vis-à-vis unit operations. Equipment selection criteria. Continuous and conventional systems.

Misra G.B., Surface mining
Pfleider, Surface mining
Das S.K, Surface mining technology

MN915 Environmental Impact Assessment & Management in Mines **4**

Nature and Causes of environmental problems due to mining. Monitoring and control. Acid mine drainage and its control, Pollution due to noise and vibrations: Causes, monitoring and control techniques, Environmental Impact Assessment. Impact Assessment methods and preparation of EMP for mineral industries. Ranking of Impacts, Environmental Management plan. Environmental audits. Changes of Social Environment due to mining, Socio-economic factors. Legislation and Pollution Control Acts.

B.B. Dhar (Editor) Environmental management of mining operations.
Chad-wicketal, Environmental impacts of coal mining and utilization, Pergamon Press.
Proceedings of training programme on mining project plan, IBM, Bangalore, July 29-30, 1987.

MN916 Planning of Underground Ventilation Systems **4**

Introduction to fluid mechanics: Fluid pressure, fluid in motion, Fundamentals of steady flow thermodynamics: Thermodynamic diagrams, Subsurface ventilation engineering, Incompressible flow relationships, Ventilation surveys, Ventilation network analysis, Simulation studies for heat flow in underground mines.

Vutukuri V.S. and Lama, R.D., Environmental engineering in mines
McPherson, M.J., Subsurface Ventilation and Environmental Engineering

MN917 Risk & Safety Management in Mines **4**

Accidents at work, accident prevention. Safety concepts management and direction of safety. Statutory provisions for safety in mining operations, Conceptional health problems in rock excavation; prevention and suppression of dust, Risk analysis, safety management, Hazard identification methodologies, risk assessment methods, Mine Safety, Safety audits and control, Accident investigation; reporting, analysis

Singh, C.P., Occupational safety and health in industries and mines Rakesh
& Prasad , Legislation in Indian mines a critical appraisal
Singh, V.N., Industrial and mine management

MN918 Research Methodology **4**

Defining research problem and formulation of hypothesis, Experimental designs, Methods and techniques of data collection, Processing and analysis of data, Testing of hypothesis, Analysis of variance and covariance. Principles of multi-variable analysis, Interpretation and report writing.

Kothari C.R., Research Methodology : Methods and Techniques. Wiley Eastern Ltd., New Delhi 1995.
Jobson. J.D., Apllied Multivariate Data Analysis, Vol I: Regression and Experimental Design. Springer Verlag 1991.
Joseph F. Hair, J.R. , Rolph E. Anderson et al., Multivariable Data Analysis, IV Ed, Prentice Hall 1995.

MN919 Optimization of Mining Operations **4**

Mathematical programming problem. Mathematical Models, Methods for special linear programs, Lagrange's method; sensitivity analysis, Non-Linear programming methods, Geometric programming; Goal Programming; stochastic linear programming, Dynamic programming; Game Theory.

Kalyanmoy Deb, Optimization for Engineering design: Algorithons and Examples, Prentice Hall of India, 2000.
Kambo N.S. Mathematical Programming Techniques, Affliated East-West Press 1991.
Mital K.V. and Mohan C. , Optimization Methods in operations research and systems analysis, New Age Intl. Publi. 1996.

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

CS901 Wireless Networks & Systems 4

Introduction to network resilience problems & solutions, Wireless beyond 3G, Performance modeling of (Wireless)networks & Formal Methods, Network design algorithms and Network design using Network Processors, Wireless Ad-hoc Networks, Security Issues in control, Management, routing and other areas of networks, Distributed control in(Wireless) network and Middleware, Distributed Mobile Computing, Embedded Systems in Mobile/ Wireless/Network Systems – Hardware & Software Design/ Development issues, Standardization in Wireless / Mobile Network Systems.

Theodore. S Rappaport, Wireless Communications – Principles & Practices, Pearson Education, 2nd Edition, 2002.
Boucher. N, Cellular Radio Handbook, Quantum Publishing, 1991.
Feng & Leonidas, Wireless Sensor Networks, Elsevier India, 2005.

CS902 Network Management 4

Network management Overview, Network Management, SNMP and Network Management, TMN, Network Management Applications, Management of Heterogeneous Network with Intelligent Agents, Network Security Management, Internet Management(IEEE Communication May, Oct /03), QoS in IP Network, Basic Methods & Theory for Survivable Network Design & Operation, Network Planning, Network Management Standards.

Subramanian M., Network Management: Principles and Practice, Addson – Wesly, 2000
James F. Kurose and Keith W. Rose, Computer Networking, Pearson Education, LPE, 2003
Burke J., Network Management Concepts and Practice, A Hands- On Approach, Pearson Education
John Strassner, Policy based Network Management, Elsevier India, 2004.

CS903 Evolutionary Computing 4

Introduction to Evolutionary Computation, Search Operators, Selection Schemes, Search Operators and Representations, Evolutionary Combinatorial Optimisation, Co-evolution, Niching and Speciation, Constraint Handling, Genetic Programming, Multi objective Evolutionary Optimisation, Learning Classifier Systems, Theoretical Analysis of Evolutionary Algorithms.

Baeck T., D. B. Fogel, and Z. Michalewicz (eds.), Handbook on Evolutionary Computation, IOP Press.
Z Michalewicz, Genetic Algorithms + Data Structures = Evolution Programs (3rd edition) Springer-Verlag,1996.
Goldberg D E, Genetic Algorithms in Search, Optimisation & Machine Learning, Addison-Wesley, 1989.

CS904 Software & It Systems – Architecture, Measurement And Testing 4

Architecture, Measurement, Testing, Tools.

Len Bass, Software Architecture in practice, Paul elements & Rick Addison – Wesley
Edward Kit, Software Testing in the Real world, Pearson Education
Craig R. D. &. Jaskiel S. P, Systematic Software Testing, Artech House, Bosten.

CS905 Bioinformatics 4

Introduction to Bioinformatics, Biological Databanks, Sequence Analysis, Structure Prediction, Protein Folding, Proteomics, Emerging Areas in Bioinformatics.

Krane D.E. & Raymer M.L, Fundamental Concepts of Bioinformatics, Pearson, 2003
Attwood & Parrysmith: Introduction to Bioinformatics, Pearson Ed, 2003
Zoe.L & Terenee. C, Bioinformatics, Elseiver, 2004.

CS906 VlSI Systems-Design & Testing: Perspectives From Computer Engineering 4

State machine model design of VLSI system, Computational aspects of VLSI and algorithm, Genetic algorithms for VLSI Design partitioning cell routing.

S. Sjoholm & L. Lindth, VHDL for Designers, Prentice Hall.
J. D. Ullman, Computational aspects of VLSI, Computer Science Press
Genetic Algorithm for VLSI Design, Layout & Test Automation, Pinaki Mazumder, Elizabeth M. Rudrick PH PTR

CS907 Protocol Engineering 4

Protocol Design & Implementation, Protocol Verification and Validation, Protocol Testing, Formal Methods (FDTs)

Web sites, IEEE, ISO and ITU-T sites.

P. Venkatram & S. S., Manavi, Communication Protocol Engineering, PHI, 2004.

CS908 Software Reliability & Fault Tolerance 4

Introduction to fault tolerant computing, Software Safety, Software Fault Injection and fault analysis.

Les Hatton, Software Faults & Failures, Addison Wesley, 2000.

Neil Storey, Safety critical computer systems, Addison Wesley, 1996.

CS909 Simulation & Modeling 4

System models, System Simulation, Exponential growth models, exponential decay models, Discrete system simulation, Web based simulation and Distributed Simulation.

Geoffrey Gordon, System simulation, Prentice Hall, 1987

Maryanski. F., Digital Computer Simulation, CBS Distributors.

Banks and Carson, Discrete Event System simulation. Prentice Hall 2004.

Bernard, Herbert & Tag, Theory of modeling and simulation, 2/e, Elsevier India, 2004.

CS910 Web Engineering 4

Requirements specification and analysis, Web-based systems development methodologies and techniques, Migration of legacy systems to Web environments ,Web-based real-time applications development, Testing, verification and validation ,Quality assessment, control and assurance, Configuration and project management, "Web metrics" – generating metrics for estimation of development efforts, Performance specification and evaluation ,Update and maintenance, Development models, teams, staffing, Integration with legacy systems, Human and cultural aspects, User-centric development, user modeling and user involvement and feedback, End-user application development.

Journal of Web Engineering, Rinton Press & IEEE and ACM publications on these areas.

Cato & John, User centered Web design, Pearson Education, 2001.

Zimmermann Olaj, Tomlinson Mark R, Peuser, Stefan, Perspectives on Web Services, Allied Publishers, 2004.

CS911 Advanced Parallel Computation 4

Survey of leading high-end computing systems and their programming environments. Advanced models of parallel computation. Mapping of parallel algorithms to architectures. Performance programming and tools for performance optimization on parallel systems. Execution environments and system software for large-scale parallel computing. Multiprocessor Programming**,** Case studies of parallel applications, Expression of parallelism: CUDA, SSE and OpenMP.

Ananth Grama, George Karypis, Vipin Kumar, and Anshul Gupta, Introduction to Parallel Computing, Addison-Wesley, 2003.

Michael J. Quinn: Parallel Programming in C with MPI and OpenMP, McGraw Hill Higher Education, 2004.

Ian Foster, Designing and Building Parallel Programs.

CS912 Advanced Optimizing Compilers 4

Introduction and Motivation, Effectiveness of parallelizing compilers, Basic Transformations, Program Analysis, Advanced Loop Optimizations, Program Analysis, Performance of Compiler Techniques, optimizations for Accelerators, Class Presentations.

Michale Wolfe, High Performance Compilers for Parallel Computing, Addison-Wesley

Utpal Banerjee, Ken Kennedy and John R. Allen, Optimizing Compilers for Modern Architectures: A Dependence based Approach, Morgan Kaufmann Publishers.

Cooper and Torczon, Engineering a Compiler, Morgan Kaufmann, 2004

CS913 Intelligent Information Retrieval 4

Overview of IR Systems, Historical Perspectives, Basic Evaluation, Document Representation: Statistical Characteristics of Text, Basic Query Processing, Data Structure and File Organization for IR, Automatic Indexing and Indexing Models, Retrieval Models: Similarity Measures and Ranking, Boolean Matching, Vector Space Models, Probabilistic Models, Search and Filtering Techniques: Relevance Feedback, User Profiles, Collaborative Filtering, Document and Term Clustering, Document Categorization, IR Systems and the WWW, Heterogeneous Information Sources, Intelligent Web Agents, Web Mining and Its Applications.

D. Grossman and O. Frieder. Information Retrieval: Algorithms and Heuristics, Kluwer Academic Press, Richard K. Belew, Finding Out About: A Cognitive Perspective on Search Engine Technology and the WWW, Cambridge University Press, 2001.

C. J. van Rijsbergen , Information Retrieval(online book).

CS914 Autonomic Computing 4

Key concepts and techniques underlying the design and engineering of autonomic computing and networking (AC) systems, characteristics of AC, foundational AC principles based on control theory, artificial intelligence and systems concepts. Architectures and technologies for AC, Machine learning in AC systems, Agent-based systems, Algorithms and optimization methods for AC, Autonomic networking and communications , Advanced topics, Case studies and technologies used to implement AC systems.

Joseph L. Hellerstein, Yixin Diao, Sujay Parekh, Feedback Control of Computing Systems, John Wiley & Sons, Inc, 2004

CS915 Network Algorithms 4

Algorithms for data aggregation in networks and distributed systems, algorithms for distributed search, algorithms for distributed configuration management, and algorithms for distributed trust and reputation schemes, overlay networks.

Ravindra K. Ahuja, Thomas L. Magnanti, James B. Orlin. Network flows. Theory, Algorithms, and Applications. Prentice-Haal, Englewood Cliffs, New Jersey, 1993

Alexander Schrijver, Combinatorial Optimization. Polyhedra and Efficiency. Springer-Verlag, 2003.

Christos H. Papadimitriou, Kenneth Steiglitz , Combinatorial optimization : Algorithms and complexity .

CS916 Network-on-Chips 4

Network-on-Chip specifications. Traffic patterns. Butterfly Networks, Torus, Mesh vs. Torus. Express cubes. Non-Blocking Networks - Non-blocking vs. Non-interfering, Crossbars, Clos, Benes, Sorting networks. Concentrators and distributors. Slicing multistage networks. Routing Taxonomy, Deterministic routing. Oblivious routing. Randomized routing, Adaptive routing. Flow control - Resources and allocation units, bufferless flow control. Buffered flow control Packet-buffer flow control, Flit-buffer flow control, buffer management and backpressure, flit -reservation flow control. Router architecture, router datapath. Arbitration. Network interfaces. Error control Buses. Performance analysis. Simulation of interconnection networks. Case studies and current NoC proposals.

William Dally and Brian Towles, Principles and Practices of Interconnection Networks. Morgan Kaufmann, 2004.

Recent publications from NOCS, ISCA, MICRO and other leading conferences.

Li-Shiuan Peh and Natalie Enright Erger. On Chip Networks. Synthesis Lectures on Computer Architecture. Morgan and Claypool Publishers.

Christopher J. Nitta, Matthew K. Farrens , Venkatesh Akella . On-Chip Photonic Interconnects: A Computer Architect's Perspective. Synthesis Lectures on Computer Architecture. Morgan and Claypool Publishers.

CS917 Architecture Simulation 4

Performance evaluation. Performance Metrics, Workloads. System throughput. Average performance: Harmonic vs. arithmetic average, Geometric average. Workload Design. Analytical Performance Modeling. Mechanistic modeling. Hybrid mechanistic-empirical modeling. Simulation Fundamentals. Functional simulation, Operating system effects, Full-system simulation, Trace-driven simulation, Execution-driven simulation. Modular simulation infrastructure. Sampled Simulation: Statistical sampling, Targeted Sampling. Initializing architecture state, Initializing microarchitecture state. Sampled multiprocessor and multi-threaded processor simulation, Statistical Simulation. Parallel Simulation and Hardware Acceleration: Parallel sampled simulation, Parallel simulation, FPGA-accelerated simulation.

Lieven Eeckhout. Computer Architecture Performance Evaluation Methods. Synthesis Lectures on Computer Architecture. Morgan and Claypool Publishers. 2010.

Recent publications from NOCS, ISCA, MICRO and other leading conferences.

CS918 Power Efficient Computer Architecture 4

Power problem. CMOS Power Consumption: Dynamic Power, Leakage, Other Forms of CMOS Power Dissipation. Modeling, Simulation, and Measurement: Dynamic-power Models, Leakage Models, Thermal models, Power Simulation. Dynamic Voltage and Frequency Scaling: System-Level DVFS, Program-Level DVFS, Offline and online. Compiler Analysis, Program-Level DVFS for Multiple-Clock Domains, Hardware-Level DVFS. Optimizing Capacitance and Switching Activity to Reduce Dynamic Power, Idle-Capacity Switching Activity: Instruction Queue, Caches. Parallel Switching-Activity in Set-Associative Caches. Cacheable Switching Activity, Value-dependent Switching Activity: Bus encodings, Dynamic Work Steering. Managing Static (Leakage) Power: Subthreshold Leakage, Gate Leakage, Architectural Techniques Using the Stacking Effect. Architectural Techniques Using the Drowsy Effect, Architectural Techniques Based on VT.

Stefanos Kaxiras and Margaret Martonosi. Computer Architecture Techniques For Power-Efficiency. Synthesis Lectures on Computer Architecture. Morgan and Claypool Publishers. 2008.
Recent publications from ISCA, MICRO, HPCA, ASPLOS, and other leading conferences.

CS919 Large Scale Data Analysis 4

Big Data Analysis Systems and Frameworks: Map-Reduce, Mahout, Spark , Big data Storage and Processing: Parallel DB, Data Store, Big Data Analysis Models and Algorithms : Structured Data Mining, Text Analysis, Graph mining, Image Retrieval, Dimensionality Reduction, New Research Trends, and Applications: Crowd-sourcing, Human intelligence, Probabilistic Databases, Knowledge Bases, Data Visualization.

Mining of Massive Datasets by Anand Rajaraman and Jeff Ullman.
Software for Data Analysis: Programming with R (Statistics and Computing) by John M. Chambers (Springer). Data Analysis Using Regression and Multilevel/Hierarchical Models, 1st Edition by Andrew Gelman, Jennifer Hill.
Categorical Data Analysis by Alan Agresti, Wiley publications

CS921 Design of Secure Protocols 4

One-Way Functions, Pseudorandom Generators, Hash functions, Block ciphers, Stream Ciphers, Access Control Methods, Message Authentication and Digital Signatures, Vulnerabilities and Security Challenges of Wireless networks, Trust Assumptions, Adversary models and Protocols, Attacks against naming and addressing in the Internet, Security protocols for address resolution and address auto configuration, Security for global IP mobility, IP Security (IP Sec) protocol, Key Establishment and Revocation Protocols in Sensor Networks, Secure Neighbor Discovery, Secure routing protocols in multi-hop wireless networks, Provable Security for Ad-hoc Network routing protocols, Privacy preserving routing in Ad-hoc Networks, Location privacy in vehicular Ad-hoc networks, Secure protocols for behavior enforcement Game theoretic model of packet forwarding.

L. Buttyan, J. P. Hubaux, "Security and Cooperation in Wireless Networks", Cambridge University Press, 2008.
O. Goldrich, "Foundation of Cryptography-Vol. 1 and Vol. 2", Cambridge University Press, 2001.
James Kempf, "Wireless Internet Security: Architecture and Protocols", Cambridge University Press, 2008

CS922 Elliptic Curve Cryptosystems 4

Introduction: Wierstrauss Equation, The Group Law, Projective Space and the Point at Infinity, Proof of Associativity, Equations for Elliptic Curves, Coordinate Systems, The j-invariant, Endomorphisms, Singular Curves, Elliptic Curves mod n. Tortion Points: The Tate-Lichtenbaum Pairing Elliptic Curve over Finite Fields- Zeta Functions: A Family of Curves, Schoof's Algorithm, Super singular Curves. Discrete Logarithm Problem: Elliptic Curve Cryptography: Introduction, The Basic Setup, Diffie-Hellman Key Exchange, Massey-Omura Encryption, El-Gamal Public Key Encryption. Primality and Factorization of Integers: Primality, Complexity of factoring, RSA. Elliptic Curve OVER Q. The Torsion Subgroup. The Lutz-Nagell Theorem, Descent and the Weak Mordell-Weil, Theorem Heights, the Height Pairing, Fermat's Infinite Descent, 2-Selmer Groups; Shafarevich-Tate Groups, A Nontrivial Shafarevich-Tate Group, Galois Cohomology, Mordel-Weil Theorem. Elliptic Curve OVER C: The Torsion Subgroup: Doud's Method, Division Polynomials. Complex Multiplication: Elliptic Curves over C, Elliptic Curves over Finite Fields, Integrality of invariants, Kronecker's Jugendtraum. Isogeny: The Complex Theory, The Algebraic Theory, Velu's Formulas, Point Counting, Complements.

L.C. Washington, Ellipptic curves: Number Theory and Cryptography.
H. Cohen and G.Frey, Handbook of Elliptic curve and Hyperelliptic Curve Cryptography, CRC Press, 2006. Darrel Hankerson, Alfred Menezes, Scott Vanstone, Guide to Elliptic Curve Cryptography Springer 2004.

CS923 Algorithmic Game Theory 4

Non-cooperative Game Theory: Games in Normal Form - Preferences and utility, examples of normal-form, Analyzing games: Pareto optimality, Nash equilibrium, Maxmin and minmax strategies, dominated strategies, Rationalizability, Correlated equilibrium Computing Solution Concepts of Normal-Form Games: Computing Nash equilibria of two player, zero-sum games, Computing Nash equilibria of two-player, general-sum games, Complexity of computing Nash equilibrium, Lemke–Howson algorithm, Searching the space of supports, Computing Nash equilibria of n-player, general-sum games, Computing maxmin and minmax strategies for two-player, general-sum games, Computing correlated equilibria Games with the Extensive Form.

Repeated games: Finitely repeated games, Infinitely repeated games, automata, Stochastic games Bayesian games: Transferable Utility, Analyzing Coalitional Games, The Shapley Value, The Core Mechanism Design: strategic voting,

unrestricted preferences, Implementation, quasilinear setting, Efficient mechanisms, Computational applications of mechanism design, Task scheduling, Bandwidth allocation in computer networks Auctions: Single-good auctions, Canonical auction families, Bayesian mechanisms, Multiunit auctions, Combinatorial auctions

Noam Nisan, Tim Roughgarden, Eva Tardos, Vijay V. Vazirani, Algorithmic Game Theory, Cambridge University Press, 2007.

Ronald Cohn Jesse Russell, Algorithmic Game Theory, VSD Publishers, 2012.

CS924 Formal Methods in Computing 4

Introduction to Formal Methods, Propositional and Predicate logic, Equality and Definite Description, Sets and Definitions Relations and Functions, Sequences and Free Types, Schema and Schema Operators, Promotion and Preconditions Examples; Cyber-physical Systems and Mathematical Models of Systems: Introduction to Cyber-Physical Systems, Synchronous Models: Dataflow languages, Safety and Liveness Specifications: ω-automata and temporal logics, Asynchronous Models: Communicating machines and synchronization, Continuous Dynamical Systems Timed and Hybrid Systems, Techniques for reasoning about dynamical systems; Verification Techniques: Model Checking, Deductive Verification: Lyapunov and Barrier Certificates

Alur, Rajeev. Principles of Cyber-Physical Systems. MIT Press, 2015.

Tabuada, Paulo. Verification and control of hybrid systems: a symbolic approach. Springer Science & Business Media, 2009.

Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, ISBN 978-1-312-42740-2, 2015.

Lee, Edward A., and Sanjit A. Seshia. "An introductory textbook on cyber-physical systems." Proceedings of the 2010 Workshop on Embedded Systems Education. ACM, 2010.

CS925 Green and Sustainable ICT 4

Green ICT and environmental sustainability: Basic Green ICT concepts, importance of Green ICT, impact of ICT components on environmental sustainability, aims of Green ICT, Green ICT standards and initiatives; Greening by ICT: Planning and executing a Green ICT policy, adopting Green ICT strategies - web conferencing, telecommuting, going paperless, etc.; Greening of ICT: green devices, green cloud computing, green data centres, green storage, green networking, green algorithms, green software; Measurement and management: metrics, measuring the resource utilization, energy consumption, GHG emission, carbon footprint of ICT components, automated power management, tools and techniques; Research challenges: recent trends in Green ICT research, explored and unexplored topics, open research challenges.

San Murugesan, & G. R. Gangadharan (Eds.). (2012). Harnessing Green IT: Principles and Practices. A John Wiley & Sons, Ltd., Publication.

Ishfaq Ahmad & Sanjay Ranka (Eds.). (2012). Handbook of Energy-Aware and Green Computing - Two Volume Set (1st ed.). Chapman &Hall/CRC.

Mohammad S. Obaidat, Alagan. Anpalagan & Isaac Woungang (Eds.). (2013). Handbook of Green Information and Communication Systems. (1st ed.). Academic Press.

Coral Calero Munoz, & Mario Piattini (Eds.). (2015). Green in Software Engineering. (1st ed.). Springer International Publishing.

CS926 Research Practicum 2

This course is specifically designed for research students and is a practice oriented course. A student is expected to learn different tools that will be used in his/her areas of area of research. The tools that are used can be of any type as long as they are relevant to the current context in which the research work is planned to be carried out. The number of tools and assisting technologies is not limited by any numbers but the researcher's are expected to choose most appropriate set of tools or tool that is latest and which perfectly fits into the working research area.

Whiteman, Wayne E., William J. Wepfer, and Jeffrey A. Donnell. "Study of a Teaching Practicum in an engineering Ph. D. Curriculum." American Society for Engineering Education, 2011.

EC900 Selected Topics in Advanced VLSI Design **(4-0-0) 4**

Topics from state-of-the-art design methodologies. Architecture, circuit and layout level issues, Timing and Design closure. Deep sub-micron circuit design-logic and layout issues.

Neil Weste and David Harris, "CMOS VLSI Design: A circuits and Systems perspective", 3rd Ed., Addison Wesley, 2004
RF microelectronics, Behzad Razavi, Prentice Hall, 1998.
William J. Dally, John W. Poulton, "Digital Systems Engineering, "Cambridge University Press 1999
Yaun Taur and Tak H.Ning, "Fundamentals of modern VLSI devices", Cambridge University Press 1999
Recent publications from IEEE, IEICE and ACM Journals

EC901 Modeling and Design of High-Speed VLSI Interconnects **(4-0-0) 4**

Course Description: Detailed study of various problems in modeling and design of high-speed VLSI interconnect at both IC and packaging levels, including device and interconnect modeling, interconnect topology optimization for delay minimization, wire sizing and device sizing for both delay and performance optimization, and clock network design for high performance systems. Noise issues and reliability

William J. Dally, John W. Poulton, "Digital Systems Engineering, "Cambridge University Press 1999
Howard Johnson, Martin Graham, "High-Speed Digital Design" A handbook of black magic, "Prentice Hall 1993.
Recent publications from IEEE, IEICE and ACM Journals

EC902 Integrated Circuits for Communications **(4-0-0) 4**

Course Description: Analysis and design of electronic circuits for communication systems, with an emphasis on integrated circuits for wireless communication systems. Analysis of distortion in amplifiers with application to radio receiver design. Power amplifier design with application to wireless radio transmitters. Class A, Class B, and Class C power amplifiers. Radio-frequency mixers, oscillators, phase-locked loops, modulators, and demodulators. System integration in single chip/multichip module, system partitioning, high throughput and low latency design requirement for real-time communication, critical path analysis for high speed VLSI design, design of analog front ends, impedance matching with bonding pads, Si-Ge devices for RF circuits, interface for optical fibres.

The design of CMOS radio-frequency integrated circuits, Thomas H.Lee. Cambridge University Press, 1998. RF microelectronics, Behzaad Razavi, Prentice Hall, 1998.
Analysis and Design of Integrated Circuits, Paul R Gray, Paul J Hurst, Stephen H. Lewis, Robert G Meyer, Wiley, 2001.
Recent publications from IEEE, IEICE and ACM Journals

EC903 RF and High-Speed Integrated Circuits **(4-0-0) 4**

Course Description: Design of RF and high-speed electronic circuits with special attentions to integrated circuits at both transistor and system levels. Topics include basic RF design concepts, wireless/wireline transceivers, active/passive devices, the physics of noise, amplifiers, low noise amplifiers, mixers, oscillators and phase noise, phase locked loops, frequency synthesizers, clock and data recoveries, and power amplifiers

Thomas H Lee, The Design of CMOS RF IC, Cambridge University Press, 1998. Razav, RF microelectronics, Prentice Hall, 1998.
Hagen, RF Electronics: Circuits and Applications, Cambridge University Press, 1996.
Gray, Hurst, Lewis, and Meyer, Analysis and Design of Integrated Circuits, Wiley and Sons, 2001. Van Der Ziel, Noise in Solid-Stage Devices and Circuits, John Wiley and Sons, 1986.
Ott, Noise Reduction Techniques in Electronic Systems, John Wiley and Sons, 1988.
Recent publications from IEEE, IEICE and ACM Journals

EC904 Advanced Topics in Digital Communications **(4-0-0) 4**

Fading channels, Characterization of Mobile Radio propagation, Signal-time spreading, channel variance, mitigating the degradation effects of fading, fundamentals of statistical detection theory, Baye's theorem, Decision theory, Neyman-Pearson theorem, Multiple hypothesis testing, minimum Baye's risk detection for binary and multiple hypothesis, Orthogonal Frequency Division multiplexing (OFDM), OFDM transmission techniques, synchronization, modulation, demodulation, amplitude limitation of OFDM signals, Space-Time Wireless communications,

Introduction, Space-Time propagation, Space-Time channel and signal models, spatial diversity, Space-Time OFDM.
J G Proakis, Digital Communications, 4th edition.
H L Van Trees, Detection, Estimation and Modulation Theory, Part I.
T S Rappaport, Wireless Communications " Principles and Practice, 2nd Edition.

EC905 Advanced RF Techniques (4-0-0) 4

Planar Transmission Lines-Stripline, microstrip line, suspended stripline and coplanar line; Parallel coupled lines in stripline and microstrip - Analysis, design and characteristics. Microwave Network Analysis - Microwave network representation, Impedance and admittance matrices, Scattering and ABCD parameters, Typical two-port, three port, four port networks. Impedance Matching Techniques - Smith chart, Matching networks using lumped elements, Single and double-stub matching, Quarter wave transformer. Basic Passive Components -Lumped elements in MIC, Discontinuities and resonators in microstrip, Balun, Analysis and design of stripline/microstrip components- Directional couplers, Power divider, Hybrid ring. Basics of MIC, MMIC and MEMS technologies - Substrates used. Fabrication process, and Design techniques. Transistor Amplifiers - Types of amplifiers. S-parameter characterization of transistors; FETs- Equivalent circuit models. Single stage amplifier design- unilateral and bilateral case, Amplifier stability, Constant gain and noise circles, DC bias circuits for amplifiers. Detectors and Mixers - Point contact and Schottky barrier diodes-Characteristics and equivalent circuit, Theory of microwave detection, Detector circuit design. Types of mixers. Mixer theory and characteristics. SSB versus DSB mixers. Single-ended mixer and single-balanced mixer-Design and realization in microstrip. Double balanced and image rejection mixers. Oscillators-Oscillator versus amplifier design, Oscillation conditions. Gunn diode- Modes of operation, Equivalent circuit. Design of Gunn diode oscillator in microstip. FET oscillators. Frequency tuning techniques.

EC906 Selected topics in Signal Processing (4-0-0) 4

Statistical Signal Processing - Autocorrelation and power spectrum, Filtering, Linear estimation, Spectrum estimation, Adaptive filters. Multirate Systems – Multirate operations, Filter banks, PR systems, Tree structured and cosine modulated filter banks. Wavelet analysis – Localization and uncertainty, Orthogonal wavelets, biorthogonal wavelets, Block transforms, frames, approximation and denoising in frames. Sparse signal processing – Sparsity and redundant dictionaries, Matching pursuits.

Sophocles J. Orfanidis, Optimum Signal Processing An Introduction, McGraw-Hill, 2007.
P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education India, 2006.
Stephane Mallat, A Wavelet Tour of Signal Processing - The Sparse Way, AP, 2009.
Jelena K., Vivek K Goyal, and Martin Vetterli, Fourier and Wavelet Signal Processing, EPFL Press, 2013.

EC 907 Multi-dimensional Signal Processing (4-0-0) 4

Speech Fundamentals, Perception and Production, Analysis, Lossless and Perceptually lossless compression, Recognition, Speaker recognition and identification, Image Fundamentals, Transforms, Segmentation, Restoration, Enhancement, Compression standards, Medical Imaging Video analysis, MPEG standard of coding, Segmentation and tracking. Biometrics.

Anil K .Jain, Fundamentals of Digital Image Processing, PHI, 2010
R.C.Gonzalez and R.E.Woods, Digital Image Processing, Pearson, 2008
Douglas O'Shaughnessy, Speech Communication, Human and Machine, IEEE Press, 1999
L.R. Rabiner and R.W. Schafer, Digital Processing of speech signals, Prentice Hall, 2013
Fundamentals of Medical Imaging , Paul Suetens, Cambridge Press, 2009

EC908 Selected Topics in Computer Communication Networks (4-0-0) 4

Introduction to network resilience problems & solutions, Wireless beyond 3G, Performance modeling of (Wireless) networks & Formal Methods, Network design algorithms and Network design using Network Processors, Wireless Ad-hoc Networks, Security Issues in control, Management, routing and other areas of networks, Distributed control in Wireless network and Middleware, Distributed Mobile Computing, Embedded Systems in Mobile/ Wireless/ Network Systems – Hardware & Software Design/ Development issues, Standardization in Wireless / Mobile Network Systems. Wireless Sensor Networks & Protocol, Queuing Theory in Networking, Network Management

Feng & Leonidas, Wireless Sensor Networks, Elsevier India, 2005
Kumar D. Manjunath and J. Kuri Communication Networking, An analytical approach, Elsevier, 2004
Subramanian M., Network Management: Principles and Practice, Addson – Wesley, 2000

Burke J., Network Management Concepts and Practice, A Hands- On Approach, Pearson Education, 2000.

EC909 Selected Topics in Radar Signal Processing (4-0-0) 4

Elements of a Radar, statistical models of radar cross section (RCS), probability density functions (PDFs) for RCS, RCS Correlation, Swerling models, range and Doppler ambiguities, Radar waveforms, Matched filter for continuous waveforms, Matched filtering for moving targets, ambiguity functions of single pulse and pulse burst of waveforms, The Linear FM (LFM) Waveform, Vector matched filter, Tracking principles, Detection principles, Space time adaptive processing (STAP).

Mark A Richards, Fundamentals of Radar Signal Processing, Tata McGraw Hill, 2005
Nadav Levanon, Radar Signals, Wiley-IEEE Press, 2004
M.I Skolnik (ed), Radar Hand Book, McGraw Hill Publication, 1990

EC910 Selected topics in Analog and Mixed Signal Integrated Circuits (4-0-0) 4

Trade-offs in mixed signal design, Data converters and Switched Capacitor circuits, Calibration and Digital error correction.

R. Jakob Beker, CMOS: Mixed Signal Circuit Design, 2nd Ed., Wiley-IEEE, 2009
Behzad Razavi, Principles of Data Conversion System Design, Chand & Company Ltd (IEEE Press), 2000.
Gabriele Manganaro, Advanced Data Converters, Cambridge Univ. Press, 2012
Mingliang (Michael) Liu, Demystifying Switched capacitor Circuits, Elsevier, 2006
Analog Devices Inc. (edited by Walt Kester), The Data Conversion Handbook, Newnes, 2005

EC911 Mathematical Methods for Signal Processing and Communication Engg (4-0-0) 4

Selected Topics in Vector spaces: Vectors, Vector norms, vector algebra, subspaces, basis vectors, Gramm-Schmidt orthonormalization. Matrices, matrix rank, matrix norms, determinant, inverse, condition number. Hermitian and symmetric matrices, positive definite matrices unitary matrices, projection matrices and other special matrices. LDU decomposition, QR decomposition, Eigenvalue decomposition, singular value decomposition. Solving linear system of equations using matrices. Least-Squares approach, total least squares approach. Numerical issues. Perturbation theory of matrices. Differentiation of scalar functions of vectors and matrices. Matrix functions of scalar variables, Kronecker product of matrices.

Analysis: Review of real and complex number systems, topology of metric spaces. Continuity and differentiability. Construction of the Lebesgue measure, measurable functions, limit theorems. Lebesgue integration. Different notions of convergence and convergence theorems. Product measures and Fubini's theorem. Signed measure and the Radon-Nikodym theorem, change of variables.

Optimization Techniques: Need for unconstrained methods in solving constrained problems. Necessary conditions of unconstrained optimization, structure of methods, quadratic models. Methods of line search, Armijo-Goldstein and Wolfe conditions for partial line search. Global convergence theorem, steepest descent method. Linear and Quadratic Programming. Duality in optimization.

Stochastic Models: Review of Random variables, Stochastic processes, Markov chains, stationary distribution of Markov chains, Poisson and birth and death processes.

Todd K Moon, Striling, "Mathematical Methods and Algorithms for Signal Processing, Prentice Hall, 2000.
Stephen Boyd, Lieven Vandenberghe, Convex Optimization, Cambridge University Press
Ross S.M, Introduction to Probability Models, Academic Press and Hardcourt Asia, 2000.
Rudin, W., Principles of Mathematical Analysis, McGraw-Hill, 1986.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

EE900 Selected Topics in Power Electronics **4**

Multilevel inverters, Topologies, High-power applications of multilevel inverters, Active filters, FACTS Controllers, High-voltage power supplies, Topologies and design, Current topics in Power Electronics.

EE901 Selected Topics in Electric Drives **4**

Switched reluctance motors, Permanent magnet synchronous machines, applications, Special drives for electric vehicles, topics of current interest.

EE902 Selected Topics in Power System Protection **4**

Topics of current interest in power system protection.

EE903 Selected Topics in Power System Dynamics and Stability **4**

Topics of current interest in power system control, stability, dynamics, Applications of FACTS controllers, Voltage-Stability analysis, Interrelation between voltage and angle -stability.

EE904 Current Topics in Electric Machines **4**

Design of special machines, disc motors, switched reluctance motors, high-power stepper motors.

EE905 Finite-Element Methods and Applications **4**

Field analysis of electric machines, Finite-element methods and their applications to the analysis of electric machines and related topics of interest.

EE906 Real-Time Operating Systems **4**

Basic Real-time concepts, The Software life cycle, Real-time specifications and design techniques, Operating system concepts, Introduction to RTOS, Tasks, Semaphores, Message queues, Exceptions and interrupts, Timer and timer services, I/O subsystem, Memory management, modularization, Synchronization and communication, Common design problems.

P. A. Laplante, Real-Time Systems Design and Analysis: Engineer's Handbook, 2nd Edition, IEEE Press.
Qing Li, Caroline Yao, Real-Time Concepts for Embedded Systems, CMP Books.

EE907 Selected Topics in Power System Communications **4**

Remote metering of electrical energy, Fundamentals of computer-networking protocols, DLMS/COSEM specification of electricity meters, Study of Device Language Messaging Specification (DLMS), Companion Specification for Energy Metering (COSEM) Standards, IEC 62056-21, 42, 46, 47, 53, 61, 62 : 2002, IEC 61334-6:2002, xDLMS - Extended Device Language Messaging Specification.

Centre for Software Engineering and Training, Tutorial on International Electricity Metering Protocol, CPRI, Bangalore.
IEEE/IEE Papers on Electricity metering.
http://www.dims.com

EE908 Design of Intelligent Electronic Devices **4**

Role of Intelligent Electronic Devices (IED), Architecture of IEDs, Design methodology, Communication protocols for IEDs, Case studies of IED application, Recent developments in instrumentation for power station and control applications, Digital simulation of IEDs for specific power apparatus monitoring and control.

J. NorthCotem, G. David Hart, R. Wilson, Control and Automation of Electric Power Distribution Systems, CRC Press.
C. Rehtanz, Autonomous Systems and Intelligent Agents in Power System Control and Operation, Kluwer, 2003.

EE909 Overvoltages in Power Systems **4**

Transient phenomena on transmission lines, Method of computation, Use of PSPICE, Lightning discharges, Origin and characteristics of lightning and switching overvoltages, behaviour of apparatus and line insulation under overvoltages, VFTO in GIS, Protection of apparatus against overvoltages, Surge arresters and insulation coordination.

A. Greenwood, Electrical Transients in Power Systems, Wiley Interscience.

EPRI, Transmission Line Reference Book: 345 kV and Above, EPRI, 1984.

EE910 Computational Methods in Electromagnetics **4**

Laplace's and Poisson's equations in insulation design, Transient fields due to finite conductivity, Method of images, Images in two-layer soil, Numerical methods, Finite differences, Finite-element and charge simulation methods.

J. A. Stratton, Electromagnetic Theory, McGraw-Hill.
P. P. Silvester, R. L. Ferrari, Finite Elements for Electrical Engineers, Cambridge University Press, 1996.
Andrew F. Peterson, Scott L. Ray, Raj Mitra, Computational Methods for Electromagnetics.

EE911 Dynamic Security Analysis of Power Systems **4**

Security Analysis: Static and dynamic security analysis, Transient stability analysis: Time domain and energy function based analysis, Trajectory sensitivity analysis.

K.R. Padiyar, Power Systems Stability and Control, Interline, 1996.

EE912 Selected topics in Power System Deregulation **4**

Horizontal and vertical structures, Deregulated market, ATC calculations.

EE913 System Analysis with FACTS devices **4**

Modeling of FACTS devices, Load flow, Transient stability, Small-signal stability, Voltage-stability and SSR analysis with FACTS devices**.**

EE914 Embedded Generation **4**

Concept of embedded generation, Optimum placement, Stability and control studies.

EE915 Advanced Energy Auditing **4**

Introduction to energy auditing, Analysis of domestic electrical systems in urban/rural areas., Micro and macro perspectives of rational use of energy, Energy utilization and requirements, Methodology and case study of generating station/distribution systems.

J. H. Shirley, W. James, J. H. Brown, Investment Grade Energy Audit.
R. W. Donald, Energy Efficiency Manual, Energy Institute Press.

EE916 Direct Energy Conversion **4**

Energy conversion and thermodynamic principles, Electrochemical effects and fuel cells, thermoelectric systems, MHD generation.

S. L. Soo, Direct Energy Conversion.
S .W. Angrist, Direct Energy Conversion.

EE917 Electric Vehicles **4**

EV working systems, poer sources for EV systems, Types of drive systems used for EVs, Embedded systems for EV drive/controllers.

EE918 Selected Topics in Alternative Energy Sources **4**

Photovoltaic systems, Grid-connected PV Systems, Power generating systems with wind energy, Micro and pico hydro power generating systems, Hybrid power generating systems.

EE919 Selected Topics in Condition Monitoring Techniques for Electrical Equipments **4**

Introduction to diagnostic techniques. Insulation resistance, Polarization index, Recovery voltage measurement, Sweep frequency response analysis, Capacitance and dissipation factor, Dielectric spectroscopy, Partial discharge measurements (Electrical and acoustic), Thermal imaging, Surge measurements and issues related to their measurement, diagnostics.

Baldev, R., Jayakumar, T. and Thavsimuyhu, 2008. Practical non-destructive testing. Narosa Pub. House.
IEEE Standard 43.
IEEE Standard, 2004. C-62-2
IEEE Standard, 2000. C-57-127.

EE920 **SELECTED TOPICS IN CONTROL SYSTEMS** **4**

Review of classical control theory, state-variable methods, optimal control, robust control, introduction to non-linear control.

K. Ogata, Modern Control Engineering, Prentice Hall International, NJ.2004

Gopal, Madan. *Control systems: principles and design*. Tata McGraw-Hill Education, 2002.

Gopal, Madan. *Modern control system theory*. New Age International, 1993.

M. Athans and P. L. Falb, *Optimal Control: An Introduction to the Theory and Its Applications*, Dover Books on Engineering, 2006.

D. S. Naidu, *Optimal Control Systems*, CRC Press, 2002.

Gu, Da-Wei, Petko Petkov, and Mihail M. Konstantinov. *Robust control design with MATLAB*. Springer Science & Business Media, 2005.

DEPARTMENT OF INFORMATION TECHNOLOGY

IT900 Advanced Database Management Systems 4

Basic concepts and terminology, software architecture for data sharing, federated database management system, designing distributed databases, distributed transactions, client server architecture, multimedia databases, object oriented DBMS, query Processing & optimization.

Tamer Ozsu, Patrick Valduring: Principles of Distributed Database systems, PHI Ceri
S, Pelagatti S: Distributed Databases: Principles and Systems, McGraw Hill.
Thomas Connolly & Carolyn Begg, Database systems: A Practical Approach to Design, Implementation and Management, 3/e, Pearson Education, 2003. (Chapters 19 & 20)
Patrick O'Weil & Elizebeth O'Weil, Database Principles, Programming & Performance, Harcourt India Pvt. Ltd., 2/e, 2002(Chapters 8, 9 & 10)

IT901 Distributed Computing Systems 4

Introduction Computer Networks and Multi-processor systems, Evolution of modern operating systems, Design Goals, transparencies and fundamental issues in Distributed systems, Temporal ordering of events, Global state detection, Physical clocks, Mutual Exclusion Algorithms, Interprocess Communication, Deadlocks in distributed systems, Load balancing techniques, Distributed databases

Shivarathi & Shingal, Advanced Operating Systems
Randy Chow, Distributed Operating Systems and Algorithms
George Couloris et al, Distributed Systems - concepts and design, Pearson Education, 2002
A.S. Tanenbaum and M.V. Steen, Distributed Systems - Principles and Paradigms, Pearson Education 2003.
Wolfgang Emmerich, Engineering Distributed Objects, Wiley, 2000.
Gerald Tel, Introduction to Distributed Algorithms, 2/e, Cambridge, 2004.

IT902 Advanced Software Engineering 4

Managing software projects : Project management concepts, Project metrics, Project planning, Project scheduling and tracking; Quality, Configuration management, Technical metrics and formal methods; Object oriented software engineering; Reuse, Reengineering, Client/Server software engineering, CASE.

Roger S Pressman, Software Engineering - A Practitioner's Approach, McGraw-Hill
Ian Sommerville, Software Engineering, Addison Wesley.
Joel Henry, Software Project Management, Pearson Education, 2003.
Kenneth R. Bainey, Integrated IT Project Management: A Model-Centric Approach, Allied Publishers, 2004.
Mario E. Moreira, Software Configuration Management Hand Book, Allied Publishers, 2004.
Len Bass, Paul Clements, and Rick Kazman, Software Architecture in Practice, Addison-Wesley, 1998.
William J. Brown, Raphael C. Malveau, Hays W. "Skip" McCormick III and Thomas J.Mowbray Wiley. AntiPatterns: Refactoring Software, Architectures, and Projects in Crisis, 1998.

IT903 Design & Analysis of Algorithms 4

Fundamentals of Algorithmic Problem Solving, Fundamental data Structures, Fundamentals of the Analysis of Algorithm Efficiency, Brute Force, Divide-and-Conquer, Decrease and Conquer, Transform and Conquer, Space and Time Tradeoffs, Dynamic Programming, Greedy Technique, Limitations of Algorithm Power. Coping with the Limitations of Algorithm Power.

Anany Levitin, Introduction to The Design And Analysis Of Algorithms, Pearson Education, 2003.
T.H. Cormen, C.E. Leiserson, R.L. Rivest, Introduction to Algorithms, McGraw Hill, 1994. Dan
Gusfield, Algorithms on Strings, trees and Sequences, Cambridge, 2005.
Sara Baase, Computer Algorithms: Introduction to Design and Analysis, Addison Wesley, 1998.
Michael T Goodrich & Roberto Tamassia, Algorithm Design: Foundations, Analysis & Internet Examples, John Wiley, 2002.

IT904 Advanced Operating Systems 4

An overview of operating system functions, Distributed operating systems, Protection and security, Multiprocessor operating systems, Database operating systems, Concurrency control, Object oriented operating systems and its characteristics, Case studies of OS such as UNIX OS, Netware OS, Windows etc,

Mukesh Singhal Niranjan, Shivorothri G: Advanced concepts in Operating Systems
Andrew S Tenanbaum: Distributed Operating systems
Doreen L Galli, Distributed Operating System- Concepts and Practice, Prentice-Hall, 2000. A.
Silberschatz, Applied Operating System Concepts, Wiley, 2000.
Lubemir F. Bic & Alan C. Shaw, Operating Systems Principles, Pearson Education, 2003.

IT905 Data Warehousing & Data Mining 4

Data Warehousing, Data Mining, Association Rules, Classification, Clustering, Decision Trees, Other Techniques for Data Mining, Web Mining, Searching Techniques

Jiawei Han, Micheline Kamber: Data Mining: Concepts and Techniques, Harcourt India Pvt. 2001. Arun Poojary K., Data Mining Concepts, Hyderabad Press, 2001.
George M. Marakas, Modern Data Warehousing, Mining & Visualization, Pearson Education, 2003.
Margaret H. Dunham, Datamining: Introductory & Advanced Concepts, Pearson Education, 2003.

IT 906 Genetic Algorithms 4

Population based search techniques, Introduction to Genetic algorithms, Mathematical foundations, Computer implementation of genetic algorithms, Advanced operators and techniques in genetic algorithm search, Industrial application of genetic algorithms.

David Goldberg, Genetic Algorithms in Search, Optimization and Machine learning, Addison Wesley International
Charles L Karr and L Michael Freeman, Industrial Applications of Genetic Algorithms, CRC Press

IT 907 Advanced Compilers 4

Review of Compiler structure, overview of advanced architectures, compiler challenges, Data Flow and Control Flow Analyses, Dependences and Transformations, Loop Transformations and its applications, Scheduling concepts: instruction/vector unit, register allocation, compiling for HPF, a few recent advances.

Steven Muchnik, "Advanced Compiler Design Implementation" Elsevier Publications, 2003
Randy Allen and Ken Kennedy, "Optimizing for Compilers for Modern Architectures", Elsevier Press, 2002

IT 909 Intelligent Information Systems 4

Emerging Technologies and applications with latest knowledge applied to customized logic systems, agent based approaches to modeling, and human-based models, multi-mobile agent systems, the product development process, fuzzy logic systems, neural networks, and ambient intelligent environment such as development of information and communication technologies for spatial audio and video information, multimedia data hiding and watermarking algorithms for real world audio and video applications.

Xuan F. Zha, "Artificial Intelligence and Integrated Intelligent Information Systems: Emerging Technologies and Applications",
IGI Global, 2006
Jialie Shen, "Intelligent Music Information Systems: Tools and Methodologies", Idea Group Reference Publishers, 2007
Pan, J.-S; Huang, H.-C; Jain, L.C.; Fang, W.-C; "Intelligent Multimedia Data Hiding", Springer, 2007

IT 910 Adaptive Blind Signal & Image Processing 4

Introduction to Blind Signal and Image Processing: Principal Component analysis (PCA), Blind Source Separation (BSS) and Independent Component Analysis (ICA), BSS of Instantaneous and Convolutive Mixtures, Sequential Blind Signal Extraction, Robust BSS/ICA with noisy data; Learning Algorithms for Estimation of Sources; Applications: Audio, Speech, Image and Biomedical Signal Processing.

A.*Cichocki and S. Amari, "Adaptive Blind Signal and Image Processing: Learning Algorithms & Applications", John Wiley, 2002*
Hyvarinen, J. Karhunen, and E. Oja, "Independent Component Analysis", John Wiley, 2001
C S. Roberts and R. Everson, "Independent Components Analysis: Principles and Practice", Cambridge University Press, 2001
A. S. Bregman, "Auditory Scene Analysis", MIT Press, 2nd Edition, 1999
Handbook on Speech Processing and Speech Communication, Springer, 2007

IT 911 Perceptual Audio & Speech Processing 4

Audio Coding and Human Auditory Perception; Speech Analysis - Short Time Discrete Fourier Transforms, Gamma-tone Filter banks, Sub-band coding and Wavelet Transforms, Audio Processing, Standards for audio compression in multimedia applications - MPEG.

Ben G. and Nelson M., "Speech and Audio Signal Processing: Processing and Perception of Speech & Music", Wiley, 1999
K. Rao et al,, "Introduction to Multimedia Communications: Applications, Middleware, Networking", Wiley 2006
Douglas O'Shaugnessy, "Speech Communication - Human and Machine", IEEE Press, 2000
L R Rabiner, "Digital Processing of Speech Signals", Pearson, 1978 Zi Nian
Li, "Fundamentals of Multimedia", Pearson Education, 2003

IT 912 Perceptual Image & Video Processing 4

Picture Coding and Human Visual Perception; Perceptual Video Quality Metrics, Perceptual Coding and Processing of

Digital Pictures; Image Transforms - DCT, Hadamard, Haar, KL and Wavelet; Standards for Image Compression - JPEG; Standards for Video Compression - MPEG, H.264.

H. R. Wu and K. R. Rao, "Digital Video Image Quality and Perceptual Coding", CRC Press, 2005
R. C. Gonzalez and R E Woods, "Digital Image Processing", Pearson Education, 2002
W Pratt, "Digital Image Processing", Wiley, 2001
Al Bovik, "Handbook of Image and Video", Academic Press, 2000
Keith Jack, "Video Demystified", LLH, 2001

IT913 MODERN CRYPTOGRAPHY 4

Classical Encryption Techniques and their Cryptanalysis : Symmetric cipher models Symmetric-Key Encryption Schemes: Data Encryption Standard and Advanced Encryption Standards, RC4, Attacks on DES, AES. Number Theory: Prime numbers and factoring, modular arithmetic, computations in finite fields, Discrete logarithms. Public-Key (Asymmetric) Cryptography. Hash Functions: Design of Collision-Resistant Hash Functions, Popular Uses of Collision-Resistant Hash Functions, Random Oracle Model. Hash algorithms: MD5, SHA-256. Message Authentication: Message Authentication Codes Definitions, Constructions of Secure Message Authenticate Codes, Practical Constructions of Message Authentication Codes. Digital Signatures and Applications:.

William Stallings, Cryptography & Network Security, Pearson Education Asia. 2006
Schiner Bruce, Applied Cryptology, John Wiley & Sons, 2001.
Wade Trappe & Lawrence C Washington, Introduction to Cryptography with Coding Theory, Pearson Education, 2006.
Kahate A, Cryptography & Network Security, Tata Mc Graw Hill, 2004.
Charlie Kaufman, Radia Perlman and Mike Speciner, Network Security: Private Communication in a Public World, Prentice Hall of India Private Limited.
Behrouz A. Forouzan, Cryptography and Network Security, Mc Graw Hill.
Jonathan Katz and Lindell, Introduction to Modern Cryptography: Principles and Protocols, Chapman and Hall/CRC.
Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, CRC Press.
A. Menezes, P. Van Oorschot and S. Vanstone, Handbook of Applied Cryptography, CRC Press, 1996.

IT914 COMPUTER NETWORK SECURITY 4

Security at the Application Layer: Email architecture, PGP (Pretty Good Privacy), S/MIME. Security at the Transport Layer (SSL and TLS): SSL architecture, Four protocols, SSL message formats, Transport Layer Security, Secure Electronic Transaction. Security at the Network Layer (IPSec) : Two modes, Two Security protocols, Security Association, Security Policy, Internet Key Exchange, ISAKMP. Intruder: Intruder, Intrusion Detection, Password Management. Malicious Software : Viruses and Related Threats, Virus Countermeasures, Distributed Denail of Service Attack. Firewall : Firewall Design Principles, Trusted systems, Common Criteria for Information Technology Security Evaluation. Authentication : Kerberos V4 and V5, X.509 Authentication Service, Public Key Infrastructure. Physical Layer Security:Shannon's perfect secrecy, Secure Communication over Noisy Channel, Channel Coding for Secrecy, Secret Key Agreement from noisy observation, Active attacks, Physical Layer Security and Classical Cryptography.

William Stallings, Cryptography and Network Security, Third Edition.
William Stallings, Network Security Essentials, Third Edition.
Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill.
Jie Wang, Computer Network Security Theory and Practice, Springer Berlin Heidelberg New York.
William Stallings, Cryptography and Network security Principles and Practice , Fifth Edition.
Kwok T. Fung, Network Security Technologies, Second Edition, Auerbach Publications, A CRC Press Company.
Joseph Migga Kizza, A guide to Computer Network Security, Springer Publications.

IT915 DIGITAL FORENSIC 4

Introduction to legal issues, context, and digital forensics; Stages of Forensic: acquisition or imaging of exhibits, analysis and reporting standards. Computer forensics. Network forensics: monitoring and analysis of Computer Networks, Social Network analysis for Online Forensics. Database forensics: forensic study of databases and their metadata. Investigative use of database contents, log files and in-RAM data in order to build a time-line or recover relevant information. Mobile device forensics: recovery of digital evidence or data from a mobile device. Media Analysis: disk structure, file systems (NTFS, EXT 2/3, HFS), and physical layer issues; Tools for digital forensics. Analysis Techniques: keyword searches, timelines, hidden data; Application Analysis; Network Analysis; Analysis of

Cell phones, PDAs, etc.; Binary Code Analysis; Evidence: collection, preservation, testimony.

Kanellis, Panagiotis, Digital Crime and Forensic Science in Cyberspace, IGI Publishing.
Jones, Andrew, Building a Digital Forensic Laboratory. Butterworth-Heinemann, 2008.
Marshell, Angus M., Digital Forensics: Digital Evidence in Criminal Investigation, Wiley-Blackwell, 2008.
Philip Craiger, Sujeet Shenoi, Advances in Digital Forensics, Springer, 2007.
Paul Crowley Dave Kleiman, CD and DVD Forensics, Syngress Publishing Inc, 2007.
Chris Prosise, Kevin Mandia, Incident Response & Computer Forensics, McGraw-Hill, 2nd Edition, 2003.

IT916 SPECIAL TOPICS IN COMPUTER NETWORKS 4

Voice Packetization: Quality of Service, Distributed Network Architecture. Packet Transport Technologies: Voice over the Internet Protocol, Voice over ATM, Voice Over Frame Relay, Comparison among other technologies. Broadband Access and Evaluation Networks: Voice over cable, Voice over DSL. Fast access technologies. (For example, ADSL, Cable Modem, etc.) IPv6: Why IPv6, basic protocol, extensions and options, support for QoS, security, etc., neighbour discovery, auto-configuration, routing. Changes to other protocols. Application Programming Interface for IPv6. Mobility in networks. Mobile IP. IP Multicasting. Multicast routing protocols, address assignments, session discovery, etc. TCP extensions for high-speed networks, transaction-oriented applications. Other new options in TCP.

David J. Wright, Voice over Packet Network, Wiley Publisher.
W. R. Stevens, TCP/IP Illustrated, Volume 1: The Protocols, Addison Wesley, 1994.
G. R. Wright, TCP/IP Illustrated, Volume 2: The Implementation, Addison Wesley, 1995.
W. R. Stevens, TCP/IP Illustrated, Volume 3: TCP for Transactions, HTTP, NNTP, and the Unix Domain Protocols, Addison Wesley, 1996.
R. Handel, M. N. Huber, and S. Schroeder, ATM Networks: Concepts, Protocols, Applications, Addison Wesley, 1998.
C. E. Perkins, B. Woolf, and S. R. Alpert. Mobile IP: Design Principles and Practices, Addison Wesley, 1997.

IT917 VEHICULAR ADHOC NETWORKS 4

Introduction to Vehicular Networks. Vehicular Network Applications and Services. Medium Access Control Protocols for Vehicular Networks. Heterogeneous Wireless Communications for Vehicular Networks. Routing in Vehicular Networks. Routing in Vehicular Networks: A User's Perspective. Data Dissemination in Vehicular Networks .

Hassnaa Moustafa, Yan Zhang (Ed), Vehicular Networks Techniques, Standards, and Applications, CRC Press.
Hannes Hartenstein, VANET: Vehicular Applications and Inter-Networking Technologies, A John Wiley and Sons, Ltd., Publication.
Radu Popescu-Zeletin, Ilja Radusch, Mihai Adrian Rigani, Vehicular-2-X Communication, Springer publisher.

IT918 SPECIAL TOPICS IN WIRELESS SENSOR NETWORKS 4

Motivation for a Network of Wireless Sensor Nodes. Sensor Network Architecture and Sensor Devices, Physical Layer in Sensor Networks, MAC Layer in Sensor Networks, Higher Layer Issues in Sensor Networks, Time Synchronization in Wireless Sensor Networks. Software Issues in Wireless Sensor Networks. Sensor Networks' Integration. Mobility Aspects in WSN. Medical Applications of Wireless Sensor Networks. Vehicular Sensor Networks: General Aspects and Implementation Issues

Waltenegus Dargie, Fundamentals of Wireless Sensor Networks Theory and practice, John Wiley =.
Application and Multidisciplinary Aspects of Wireless Sensor Networks Concepts, Integration, and Case Studies, Springer Publisher.
Kaveh Pahlavan and Prashant Krishnamurthy, Networking Fundamentals Wide, Local and Personal Area Communications, John Wiley.

IT919 PERFORMANCE ANALYSIS OF LOCAL AREA NETWORKS AND WIDE AREA NETWORKS 4

Transmission systems **:** Introduction, Subscriber Loop Design, Unigauge Design for Telephone Customer Loop Plants Signal Multiplexing, Digital Transmission Systems, Optical Fiber Transmission Systems. Switching systems**:** Centralized Switching, Switching Techniques, Congestion in Space-Division Switching Networks, AND Time-Division Switching Networks, Nonblocking Networks. Modeling of traffic flows, service times and single-server queues: Distribution for Number of Arrivals in a Fixed Time Interval, The Interarrival Time Distribution, The Service Time Distribution, The Residual Service Time Distribution, The Birth and Death Process, Erlang Loss System and Erlang Delay System. Engset loss and delay systems. Local area networks. Polling networks. Token ring networks. Random access networks

Wah Chun Chan, Kluwer, Performance Analysis of Telecommunications and Local Area Networks, Academic Publishers.

IT920 MODELLING AND ANALYSIS OF NETWORKS PROTOCOLS 4

Introduction and Overview. Introduction to Queuing Theory. Layered Architectures in Data Networks. Data Link Layer: Examples and Performance Analysis. Network Layer: Flow Control and Congestion Control. Network Layer: Routing Function Transport Layer. Polling and Random Access in Data Networks. Local Area Networks. Introduction to Circuits Switching. Call Processing in Digital Circuit-switching Systems. The Evolution toward Integrated Networks

Mischa Schwartz, Telecommunication Networks: Protocols, Modeling and Analysis, Addison-Wesley

IT921 PACKET FORWARDING TECHNOLOGIES 4

Basic Functionalities of Routers, Evolution of Router Architecture, Key Components of a Router, Network Processor, IP-Address Lookup and Routing Table, Construction of Optimal Routing Tables, Matching Techniques, Difficulty of the Longest-Prefix Matching Problem, , Multibit Tries. Pipelined Multibit Tries. Efficient Data Structures for Bursty Access Patterns. Caching Technologies: Suez Lookup Algorithm, Host Address Range Cache, Prefix Caching Schemes, Multi-Zone Caches, Hashing Schemes: Binary Search on Hash Tables, Parallel Hashing in Prefix Length, Multiple Hashing Schemes, Using Bloom Filter. TCAM-Based Routing-Table Partitioning, Technologies Forwarding Engine

Weidong Wu, Packet Forwarding Technologies , Auerbach Publications Taylor & Francis Group.

IT922 COMPUTER NETWORK SYSTEMS DESIGN 4

Traditional Protocol Processing Systems, Conventional Computer Hardware Architecture, Basic Packet Processing: Algorithms And Data Structures, Packet Processing Functions, Protocol Software On A Conventional Processor, Hardware Architectures For Protocol Processing, Classification And Forwarding, Switching Fabrics, Network Processor Technology The Complexity Of Network Processor Design, Network Processor Architectures, Issues In Scaling A Network Processor, Examples Of Commercial Network Processors, Design Tradeoffs And Consequences ability, Overview Of The Intel Network Processor, Embedded RISC Processor (XScale Core), Packet Processor Hardware (Microengines).

Version Douglas E. Comer. Network Systems Design Using Network Processors (Intel2XXX).

IT923 Topics in Affective Computing 4

Introduction to affective computing; Emotion research from **Cyber Psychology & Behaviour**: concepts related to 'affective computing' (e.g., emotion, mood, personality, attitude) in ways that facilitate their use in computing; Computational models of human emotion processes (e.g., decision-making models that account for the influence of emotion; predictive models of user emotional state); Studies on cross-cultural, group and cross-language differences in emotional expression; **Behavior Generation & User Interaction:** Computational models of visual, acoustic and textual emotional expression for synthetic and robotic agents; Models of verbal and nonverbal expression of various forms of affect that facilitate machine implementation; Methods to adapt interaction with technology to the affective state of users; Computational methods for influencing the emotional state of people; New methods for defining and evaluating the usability of affective systems and the role of affect in usability; Methods of emotional profiling and adaptation in mid- to long-term interaction; Application of affective computing including education, health care, entertainment, customer service, design, vehicle operation, social agents/robotics, affective ambient intelligence, customer experience measurement, multimedia retrieval, surveillance systems, biometrics, music retrieval and generation; **Sensing & Analysis:** Algorithms and features for the recognition of affective state from face and body gestures; Analysis of text and spoken language for emotion recognition; Analysis of prosody and voice quality of affective speech; Recognition of auditory and visual affect bursts; Recognition of affective state from central (e.g. fMRI, EEG) and peripheral (e.g. GSR) physiological measures; Methods for multi-modal recognition of affective state; Recognition of group emotion.

Picard, R. (2000), "Affective Computing", Cambridge, MA: MIT Press.

Fellous, J-M, and Arbib, M. (2005), "Who Needs Emotions? The Brain Meets the Robot", Oxford University Press.

Minsky, M. (2007*), "The Emotion Machine: Commonsense Thinking, Artificial Intelligence & Future of Human Mind", NY, NY:* Simon & Schuster.

Lewis, M., Haviland-Jones, J.M., Feldman Barrett, L. (2010), "*Handbook of Emotions"*, Third Edition. NY, NY: The Guilford Press.

Journal Articles from IEEE Transactions on Affective Computing [2010 to Till Date].

IT924 Topics in Big Data Analytics 4

Introduction to Big Data Analytics, Big Data Analytics Platforms, Big Data Storage and Processing, Big Data Analytics Algorithms, Linked Big Data Analysis - Graph Computing and Network Science, Big Data Visualization, Big Data Mobile Applications, Large Scale Machine Learning, Big Data Analytics on Specific Processors, Hardware and Cluster Platforms for Big Data Analytics.

Michael Minelli, Michele Chambers, *Ambiga Dhiraj* [2013], "*Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley CIO.*

David Loshin [2013], "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann.

Mike Barlow [2012], " Real-Time Big Data Analytics: Emerging Architecture", [Kindle Ed.], O'Reilly Media.

IT925 Topics in Bio-Inspired Computing 4

Life: Life and Information, Logical Mechanisms of Life; Computation: Universal Computation and Computability, Simulations and Realizations; Limitations of Life: Computational Beauty of Nature, Bio-inspired computing, Natural computing, Biology through the lens of computer science; Complex Systems and Artificial Life: Complex Networks, Self-Organization and Emergent Complex Behavior, Cellular Automata, Boolean Networks, Development and Morphogenesis, Open-ended evolution; Evolutionary Algorithms: Evolution and Adaptation, Genetic Algorithms, Genetic Programming, Differential Evolution; Collective Behavior and Swarm Intelligence: Social Insects, Stigmergy and Swarm Intelligence, Competition and Cooperation, Communication and Multi-Agent simulation, Meta-Heuristics: Ant Colony Optimization, Artificial Bee Colony algorithm, Bat-Termite Algorithm Particle Swarm Optimization, Cat Swarm Optimization, Glowworm swarm optimization, Grey-Wolf Optimization, Wolf-pack Optimization, Multi-Swarm Optimization; Immuno-Computing: Artificial immune systems, Distributed Design for Computational Intelligence, Engineering Application.

Nunes de Castro, Leandro [2006], "Fundamentals of Natural Computing: Basic Concepts, Algorithms and Applications", Chapman & Hall.

Floreano, D. and C. Mattiussi [2008], "Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies", MIT Press.

Nunes de Castro, Leandro and Fernando J. Von Zuben [2005], "Recent Developments in Biologically Inspired Computing", MIT Press.

Forbes, N. [2004], "Imitation of Life: How Biology is Inspiring Computing", MIT Press.

Flake, G. W. [1998], "The Computational Beauty of Nature: Computer Explorations of Fractals, Complex Systems and Adaptation", MIT Press.

IT926 Topics in Cloud Computing 4

Overview of Cloud Computing: Cloud Computing Characteristics (elasticity, multi-tenant, on-demand, ubiquitous access, usage metering, self-service, SLA-monitoring, etc.), Cloud Computing and SOA, Enterprise Cloud drivers and adoption trends, Typical Cloud Enterprise workloads, Cloud service models & types (public, private, hybrid, and community clouds), Cloud deployment models (IaaS, PaaS, SaaS, BPaaS), Cloud ROI models, Cloud reference architectures, Cloud standards (OSDIAPIs, etc.), Technology providers vs. Cloud providers vs. Cloud vendors, Planning Cloud transformations (suitability assessment, future state definition, financial assessment and platform selection, roadmap definition); Infrastructure as a Service (IaaS): Virtualization-VMware/Xen/KVM virtualization, adaptive virtualization, Cloud Computing & on-demand resource provisioning, Infrastructure services (storage, compute, services management, cloud brokers, etc.), IaaS vendor solutions: Amazon EC2, HP, Microsoft, Savvis, Terremark, Right Scale, Rackspace cloud, IBM, Oracle, Verizon; Platform as a Service (PaaS): Cloud platform services (monitoring/management, application servers, messaging, data management, development and testing, integration, business intelligence, etc.), PaaS vendor solutions: EMC, Google App Engine, HP, IBM, Microsoft Azure, Rackspace, Savvis, Verizon, force.com, VMware vFabric, OpenStack, Eucalyptus, Storage-as-a-Service platforms (Google Storage, ObjectStore S3, Amazon Dynamo, etc.); Software as a Service (SaaS): Cloud application development lifecycle; SaaS platform services (application development, application migration, SaaS implementation, business intelligence - Cloud-based/big data/real time analytics); Quality of Service (QoS) Aware Load Balancing in Large Scale Heterogeneous Cloud Environment and other Recent Trends in Cloud Computing.

Kai Hwang, Jack Dongarra, Geoffrey C. Fox [2011], " Distributed and Cloud Computing: From Parallel Processing to Internet of Things", Morgan Kauffmann.

Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi [2013], "Mastering Cloud Computing", Tata McGraw-Hill.

Toby Velte, Anthony Velte, Robert C. Elsenpeter [2010], " Cloud Computing: Practical Approach", *McGraw-Hill.*

Journal Articles from IEEE Transactions on Cloud Computing [2013 to Till Date].

IT927 Topics in Green Computing 4

Introduction to Green Cloud Computing, Migrating into Cloud, Green IT: An Overview, Green Devices and Hardware, Green Software; Green Data Centers: Data Centers and Associated Energy Challenges, Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, IT Infrastructure Management, Green Data Centre Metrics, Data Centre Management Strategies, Green Data Storage: Introduction, Storage Media Power Characteristics, Energy Management for Hard Disks, System-Level Energy Management; Green Networks and Communications: Introduction, Objectives of Green Network Protocols, Green Network Protocols and Standards, Sustainable Information Systems and Green Metrics; Green Cloud Computing and Environmental Sustainability: Energy Usage Model, Features of Clouds Enabling Green Computing, Towards Energy Efficiency of Cloud Computing, Green Cloud Architecture; Energy Adaptive Computing for Ecosystem: Implementing the Data Center Energy Productivity Metric in a High-Performance Computing Data Center, Sustainable Dynamic Application Hosting Across Geographically Distributed Data Centers, Energy Efficient task scheduling and Resources allocation at Data Center using Bio inspired Techniques, Energy Efficient Virtual Machine Provisioning and Migration w.r.t S.L.A agreements; Cloud Computing Tools : Simulators such as CloudSim, iCanCloud, Open Stack, Green Cloud, Open Nebula, Aneka; Recent Trends in Green Computing and IT.

"The Green Computing Book: Tackling Energy Efficiency at Large Scale", Edited by Wu-chun Feng, Chapman & Hall/CRC Computational Science, CRC Press, June 2014.

"Design Technologies for Green and Sustainable Computing Systems", Edited by Partha Pratim Pande, Amlan Ganguly, Krishnendu Chakrabarty, Springer, 2013.

"Harnessing Green IT: Principles and Practices", Edited by San Murugesan, G.R. Gangadharan, Wiley, 2012.

"Cloud Computing: Principles and Paradigms", Edited by Rajkumar Buyya, Jams Broberg, Andrzej Goscinski, Wiley, February 2011.

IT928 Topics in Internet of Things 4

IoT definitions: overview, applications, potential & challenges, and architecture; IoT examples: Case studies, e.g. sensor body-area-network and control of a smart home; Internet of Things: layers, protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia; Mobile Networking: roaming and handoffs, mobile IP, and ad hoc and infrastructure less networks; Real-time networking: soft and real time, quality of service/information, resource reservation and scheduling, and performance measurements; IoT Security; IoT Ethics/Privacy; IoT in Energy/Environment; IoT in Infrastructure: Smart Homes/Cities; IoT in Healthcare.

Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-On Approach", Published by VPT, 1st Ed., Aug. 2014.

Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", John Wiley & Sons, 2014.

Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press (Taylor & Francis), 2013.

Articles from IEEE Internet of Things Journal [2014 to Till Date].

Articles from IEEE Transactions on Emerging Topics in Computing [2013 to Till date].

IT929 Topics in Social Media Analysis 4

Introduction and Phenomenology of Social Media: Social Information Processing in Social News Aggregation, Influence and correlation in social networks; Social Network Analysis: Networks, Crowds, and Markets: Reasoning about a Highly Connected World, Four Degrees of Separation; Topic Analysis: Probabilistic topic models, Matrix Factorization Techniques For Recommender Systems; Sentiment Analysis and Opinion Mining; Influence and Centrality in Social Networks; Wikipedia Knowledge Extraction; Search Query Logs; Social Ties and Information Diffusion; Social Ties and Link Prediction; Social Spam & Malicious Behavior; Geospatial Social Data Mining; Privacy in a Networked World; Health and Social Media; Politics and Social Media; Predicting Future with Social Media; Emotional Contagion, Friendship Paradox and Detection of Contagions; Crowd Sourcing; Modelling individuals and collective behaviour; Social Multimedia Analysis: Photos, Videos.

Stanley Wasserman, Katherine Faus, "Social Network Analysis: Methods & Applications", Cambridge University Press, 1994.

David Easley and Jon Kleinberg, "Networks, Crowds and Markets", Cambridge University Press, 2010

Christina Prell, "Social Network Analysis: History, Theory and Methodology", SAGE Publications, 2011.

John Scott, "Social Network Analysis", SAGE Publications, 3rd Edition, 2013.

Journal Articles from IEEE Transactions on Computational Social Systems, Elsevier Journal of Social Networks and Springer International Journal of Social Network Analysis and Mining.

IT930 NATURAL LANGUAGE PROCESSING AND APPLICATIONS 4

Introduction to NLP, History and Applications; Language Modelling: Grammar based Language Models, Statistical Language Models; Mathematical Foundations of NLP and Information Theory; Word Level Analysis and Collocation, n-grams; Syntactic Analysis: CFGs, Parsing, Treebanks, Semantics: Representing Meaning, Lexical Similarity, Lexemes, WordNets; Semantic Analysis: Word Sense Disambiguation; Sentiment Analysis and opinion mining, Generating and developing sentiment lexicons, learning lexicons, machine learning based techniques, case studies, Text Mining and Document Categorization Techniques; Machine Translation, NL Applications.

Christopher D. Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing" MIT Press, 1999
Daniel Jurafsky and James H. Martin. "Speech and Language Processing: An Introduction to Natural Language Processing", Prentice Hall 2000.
Tanveer Siddiqui and U.S Tiwary, "Natural Language Processing and Information Retrieval", Oxford Press, 2008
James Allen, "Natural Language Understanding". Benjamin/Cummings, 2ed, 1995
Steven Bird. "Natural Language Processing with Python". O'Reilly, 2009

IT931 DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING 4

Introduction to NLP and Deep Learning, Language Modeling, History and Applications, Basic Text Processing, Simple Word Vector representations: word2vec, GloVe, Advanced word vector representations: language models, softmax, single layer networks, Neural Networks and back-propagation -- for named entity recognition; Gradient checks, overfitting, regularization, activation functions; Recurrent neural networks -- for language modeling and other tasks; GRUs and LSTMs, Recursive neural networks -- for parsing and other applications; Convolutional neural networks -- for sentence classification; Reinforcement Learning and applications, The future of Deep Learning for NLP: Dynamic Memory Networks.

Li Deng and Dong Yu, "Deep Learning Methods and Applications", Microsoft Research, Foundations and Trends Book, 2014
Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach" 1st Edition, 2016
Christopher D. Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing" MIT Press, 1999
Collobert, Ronan, et al. "Natural language processing (almost) from scratch." Journal of Machine Learning Research 12.Aug (2011): 2493-2537.

IT932 INTELLIGENT INFORMATION RETRIEVAL 4

Introduction, Basics Concepts, IR System Architecture; IR Models and Operations - Preprocessing, Bag of Words, Indexing, Boolean, Term Weighting, Vector-Space Retrieval, Probabilistic Models, Best Match Models, Latent Semantic Indexing, ; Experimental Evaluation of IR Systems; Document Representations; Query Operations and Languages; Relevance feedback and query expansion; Web Search and Link Analysis: Algorithms and evaluation; Structured Information Retrieval, Multimedia Information Retrieval; Recommender Systems; Information Extraction and Integration; Selected research papers on upcoming trends and open problems.

C. D. Manning, P. Raghavan and H. Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008.
Baeza-Yates & Ribeiro-Neto, Modern Information Retrieval, Pearson Education, 2010
Information Retrieval: Algorithms and Heuristics, by D. Grossman and O. Frieder, 2004
Information Retrieval: Implementing and Evaluating Search Engines, by S. Büttcher, C. Clarke, and G. Cormack., 2010
Korfhage Robert R, Information Storage and Retrieval, John Wiley & Sons, Inc, 1997.

DEPARTMENT OF CHEMICAL ENGINEERING

CH901 Membrane Separation Processes 4

Introduction, Classification of Membrane Processes, Membrane Materials and their Selection, Membrane modules. Transport in Membranes. Non-porous membranes. Flow patterns in membrane modules. Concentration Polarisation. Modelling and Design considerations of various membrane processes - Reverse Osmosis, Dialysis, Electrodialysis, Ultra filtration, Pervaporation, Gas permeation Membranes. Membrane Applications in Waste Water Treatment.

Seader J.D., Emest J. Henley, Separation Process Principles, John Wiley & Sons, 1998,
Judd S., B. Jafferman, Membranes for Industrial Waste Water Recovery and Re-use, Elsiever Publications, 2003.

CH902 Industrial Effluent Treatment 4

Introduction - Waste water sources and characteristics. Classification, Application and Selection of treatment methods - Principles and design. Chemical preparation, chlorination processes, activated sludge process, aerated lagoons, trickling filters, sludge digestion facilities, waste water reclamation and reuse. Treatment of effluents in specific industries.

Metcalf and Eddy, Waste water Engineering - Treatment, Disposal and Re-use, Tata-McGraw-Hill, 1991.
Mahajan S.P, Pollution Control in Process Industries, Tata-McGraw-Hill, 1985.
Arundel J, Sewage and Industrial Effluent Treatment, Blackwell Sewer Ltd., 1995.

CH903 Instrumental Techniques for Effluent Analysis 4

Fundamentals. Spectro Analytical Methods. Chromatographic Methods. Electro and Radio Analytical Methods. Thermal Analysis.

Willard H., Merritt, L. Dean D.A. and Settle F.A., Instrumental Methods of Analysis, CSS Publisher, 1986.
Ewing C.W., Instrumental Methods of Chemical Analyser, 5th Edition, McGraw Hill 1995.

CH904 Computational Methods for Process Simulations 4

Introduction to Computational Methods. Modelling and Simulation of chemical Engineering systems. MATLAB - Simulation exercises using MATLAB.

Ramirez W.F., Computational Methods in Process Simulation, Butterworth, 1989.
Franks R.E, Modelling and Simulation in Chemical Engineering, John Wiley, 1972.
Rudra Pratap, MATLAB - A Quick Introduction for Scientists and Engineers, Oxford University Press, 2002.

CH905 Fundamentals of Biochemical Engineering 4

Microbiology. Environmental and Industrial microbiology, ecology, microbiology of soil and air. Laboratory techniques in microbial operation. Control of Microorganisms by physical and chemical methods Biochemistry/Chemistry of life Microbial metabolism, biosynthesis, molecular genetics and control systems Mechanism and kinetics of enzyme catalysed reactions. Mixed microbial populations in applications.

Bailey J.E. and Ollis D.F., Biochemical Engineering Fundamentals, McGraw Hill, 1977.
Aiba S., Biochemical Engineering, Academic Press, 1965.
N.J.Pelczar Jr. Microbiology, McGraw Hill, 1988.

CH906 Design & Analysis of Bioreactors 4

Transport Phenomena in bioprocess systems. Design of bioreactors. Sterilization reactors, Immobilized biocatalysts, Multi-phase bioreactors, Design and operation of typical fermentation process. Operating considerations for bioreactors. Selection, scale up, operation, Instrumentation and control of bioreactors. Product recovery operations.

B.Atkinson, Biochemical Reactors, Pion Ltd. 1974.
Michael L. Shules, Fikret Kargi, Bioprocess Engineering - Basic Concepts, Prentice Hall, 1992. Baily J.E and D.F.Ollis, Biochemical Engineering Fundamentals, McGraw-Hill, 1977.

CH907 Modeling & Simulation of Environmental Bioprocesses 4

Modeling Principles. Formulation of Dynamic balance equations. Chemical and Biological reaction systems. Modes of reactor operation. Modeling of bioreactor systems. Mass transfer theory. Optimization, parameter estimation and sensitivity analysis. Description, modeling and simulation of waste water treatment processes. Primary treatment processes. Secondary treatment processes.

Snape J.B, Dunn I.J, Ingham J., Prenosil J.E., Dynamics of Environmental Bioprocesses, V& H Publishers, 1995
Jasun K. Ghosh, Process Computations in Biotechnology, McGraw Hill 1994.

CH908 Applied Mathematics for Chemical Engineering 4

Introduction to computational methods - Matrix algebra by computers, elementary matrix operations, solutions of simultaneous linear equation, eigen values and eigen vector problems, matrix representation of extremum problems. Finite difference method. Solution of ordinary differential equations, partial differential equation.

Hanna O.T. and Sandall O.C., Computational Methods in Chemical Engineering, Prentice Hall, 1995

Brebba C. A., and Ferranta A. J., Computational Methods for Solution of Engineering Problems, Pented Press, 1978.

CH909 Genetic Engineering 4

Isolation of genes using probes, Modifying the genes using DNA modifying enzymes, Cloning and expression vectors, Plasmid, Lambda, Cosmid, BACs, YACs, MACs, Construction and screening of genomic and cDNA library. Chromosome walking. Techniques of transformation / Introduction of DNA into animal cells and plant cells. DNA sequencing by Maxim and Gilbert method, Sanger method, automatic sequencing. Gene analysis techniques: Nucleic acid hybridization, Southern and Northern Blotting. Polymerase chain reaction - Types, application, RAPD, AFLP, Microsatellite, EST, SNP. DNA chip technology : microarrays, types, technique and applications. Applications of genetic engineering in Agriculture, Industry, Pharmaceuticals and therapeutics.

Principle of gene manipulation, R. N. Old and S.B. Primrose, 1994, Blackwell scientific Publication

Molecular Biology of the gene. J.D. Watson, W.H. Hopkins, J.W. Roberts, J.A.Steitz and A.M. Weiners, The Benjamin Cummings Publication Company, Inc. California

Genes, B. Lewin, Oxford University Press, New York.

Gene cloning. T.A.Brown, Chapman and Hall 1998 From

Genes to Clones. Winnacker EL. VCH, 2003

CH910 Molecular Biology 4

Central Dogma of molecular biology; DNA helix topology and types of DNA. Genetic code, Wobble hypothesis. Concept of prokaryotic gene structure and eukaryotic gene structure, C-value paradox, gene families and multigene concepts. DNA replication: In prokaryotes and Eukaryotes, Role of regulatory proteins and enzymes in replication. Transcription: Mechanism in prokaryotes, .Eukaryotic transcription, RNA polymerase, transcription factors, initiation, elongation and termination. Post transcriptional modification- capping, polyadenylation, splicing. Translation: Amino acid activation, amino acylation of tRNA, Prokaryotic and eukaryotic translation mechanism of initiation, elongation, termination and inhibitors of translation, post translational modifications. Regulation of gene expression in prokaryotes: control elements, negative and positive regulation with operon concept of *lac* and *trp*. Regulation of gene expression in Eukaryotes: cis control elements, promoters, enhancers, Trans acting factors, Activators, hormonal regulation of gene expression, post transcriptional control.

Molecular biology of cell, Alberts, B, D. Bray, J.Lewis, M. Raff, K.Roberts and J.D.Watson. Garland Publising company inc. New York.

Molecular Cell Biology, Lodish H., D. Baltimore, A.Berk, S.L.Zipurksy, P.Matsudaira and J.Darnell, 1995, Scientific American books, Inc,.NewYork.

Cell and Molecular Biology, G.Karp. John Wiley and Sons Inc.

Molecular Biology. D.Freifelder. Narosa Publishing House.2000

CH911 Fluid - Particle Systems 4

Hydrodynamics of fluidized beds; bubbles in dense beds; flow patterns in fluidized beds; entertainment and elutriation in fluidized beds; spouted beds - hydrodynamics; applications.

D. Kunii and O. Levenspiel, Fluidization Engineering, John Wiley & Sons, 1969. J. F.

Davidxon and D-Harrison, Fluidization, Academic Press, 1971.

CH912 Adsorption & Catalysis 4

Equilibria, Kinetics, measurement techniques multicomponent, Adsorption equilibria. Porous media, bulk separation, purification purposes, characterization of catalysts, experimental methods in catalysis.

Mantell C. L., Adsorption, McGraw Hill, New York, 1951.

Adsorption Analysis - Equilibria and kinetics, D.O.D.D., ICP, London, 1998

Chakrabarty, D. K., Adsorption and catalysis by solids, Wiley, New Delhi, 1990.

DEPARTMENT OF MECHANICAL ENGINEERING

ME900 Satellite Thermal Control 3

Introduction: Satellite Temperature and Thermal Energy Management. Relation Between Heating and Temperature: Method of Control. Thermal Interface Requirements. Heat Transfer: Conduction, Convection, Radiation. Radiation in Thermal Control, Heating Fluxes, Orbit Environment Heating Fluxes, Satellite Thermal Analysis, Thermal Energy Equation, Thermal Model, Approximate Analytical Solution, Thermal Control Hardware, Heat Pipes, Thermal Verification Tests

Robert D. Karam, Satellite Thermal Control for System Engineers.

ME901 Estimation of Thermodynamic & Thermo physical Properties of Working Fluids 3

Development of thermodynamic and thermophysical properties of various working fluids used in power plants, refrigeration plants(pure and mixtures)

ME902 Computer Simulation of IC Engines 3

Introduction S.I. Engines and C.I. engines, reactive processes, adiabatic flame temperature, isentropic changes of state, simulation: with air as working medium, with adiabatic combustion, with progressive combustion, with gas exchange processes.

V. Ganesan, computer simulation of S.I. Engines processes, Universities press V. Ganesan, computer simulation of C.I. Engines processes, Universities press Ramos J.I, internal combustion engine modelling, Hemisphere publishing Corp.

ME903 Tribology in Machine Design 3

Introduction to Tribology, Basic Principles of Tribology, Elements of Contact Mechanics, Friction, Lubrication and Wear in Kinematics pairs, Sliding element and Rolling contact Bearings, Lubrication and efficiency of Involute Gears.

T.A. Stolarshi, Tribology in Machine Design, Industrial Press Inc. 1990.
Arnell R.D., Davies P.B., Halling J., Whomes T.L., Tribology, Principles and Design Applications, Springer Verlag.
Karl-Heinz Zum Gahr, Microstructure and Wear of Materials, Elsevier, 1987.

ME904 Failure of Materials in Mechanical Design 3

Modes of Mechanical Failures, High cycle & low cycle fatigue, Use of statistics in fatigue analysis and testing. Concepts of cumulative damage, Life Prediction and Fracture Control, Tribological Failures - Frelting, Frelting Fatigue and Frelting Wear, Buckling and Instability, creep, stress rupture, corrosion.

J.A. Collins, Failure of Materials in Mechanical Design - Analysis, Prediction, Prevention, John Wiley, 1981.

ME905 Materials in Tribological Applications 3

Tribological properties of solid materials, metals, bearing, alloys, solid lubricants, polymers and composites, ceramics and cermets, super alloys. Materials for Nuclear Reactors. Friction Materials for Clutches and Brakes. Surface treatments to reduce wear.

William A. Glaeser, Materials for Tribology, Elsevier, 1992.

ME906 Selected topics in Advanced welding processes 3

Metallurgy of welding- Analysis of HAZ- optimization of process parameters in welding process- Modeling of metal flow and Heat transfer in welding process- Recent developments in the metal joining process.

Saddat Ali Rivzi, Advanced Welding Technology, S. K. Kataria & Sons, 2010,
Joseph William Giachino, William R. Weeks, George Stewart Johnson ,Welding technology 2nd edition, American Technical Society, 2007
Little Mn ,Welding & Welding Technology, Tata McGraw-Hill Education, 2001
Radhakrishnan, Welding Technology And Design, 2nd edition, New Age International, 2005,
A. L. Phillips, Welding Handbook: Fundamentals of welding, American Welding Society, 2009
Boniface E. Ross , Welding Engineering, McGraw-Hill Interamericana, 2007

ME907 Selected topics in Advanced Metal Casting Process 3

Analysis of fluid flow and heat transfer in solidification process.- Science of solidification phenomena- Microstructure modeling - Simulation studies in metal casting- Modern trends in metal casting.

Roy A. Lindberg, Process and materials of manufacturing , Allyn and Bacon publication, 4th edition, 1990.

Richard W. Heine, Carl R. Loper, Philip C. Rosenthal , Principles of Metal Castings , Tata McGraw-Hill Education, 2nd edition, 2001.
P.N. Rao, Manufacturing Technology, Tata McGraw-Hill Education, 3rd edition, 2009

ME908 Selected topics in Composite materials **3**

Analysis of PMC, CMC and MMC - Recent advances in processing of composite materials- Natural composites- Nano-composites- Modeling and analysis of composite structures for engineering applications- FEM of composite structure.

Mein Schwartz , Composite Materials Handbook - Mc Graw Hill, 2nd edition , 1992
Autar K Kaw Mechanics of Composite Materials - CRC Press New York. – 2nd edition, 1997.
Rober M. Joness , Mechanics of Composite Materials - Taylor & Francis Group, 2nd edition, 1999.
M. W. Hyer, Scott R. White, Stress Analysis of Fiber Reinforced Composite Materials , Destech Publications, Inc, 2009.
Krishan K , Chawla , Composite Material Science and Engineering , Springer, 2nd edition - 1999.
P.C. Mallik , Fiber Reinforced Composites , Marcel Decker- 2nd edition, 1993.

ME909 Advanced Theory of Vibrations **(3-0-0)3**

Review of free and forced vibrations, vibration, isolation, transmissibility, multi d-o-f systems, experimental methods in vibration analysis, vibration of continuous systems: transverse, flexural, torsional vibration of beams, Timoshenko beam, Hamilton principle, vibration of plates; collocation method, Myklested -Prohl method, transient vibrations, nonlinear vibrations and random vibrations.

SS Rao, Mechanical vibrations, Pearson Education Inc., New Delhi. 2004
CW De Silva, Vibration: Fundamentals and practice, CRC Press, New York , 1999
WT Thomson , Theory of Vibration with Applications, CBS Publishers & Distributors, New Delhi, 1998
Allan G Piersol and Thomas L Paez, Harris' Shok and Vibration Handbook, McGraw Hill, 2010
CF Beards, Structural Vibration: Analysis and Damping , John Wiley & Sons Inc, NewYork, 1996

DEPARTMENT OF METALLURGICAL & MATERIALS ENGINEERING

MT900 Metallurgical Process Design 3

Design and its significance. Modern trends, fluid flow and heat transfer principles applicable to design. Furnaces, classifications, Glinkove theory. Burners. Principles of chimney design. Fuel economy. Design features of electric arc furnaces, induction furnaces, reheating furnaces and soaking pits. Refractories for furnaces.

A. Glinkove, A Ggeneral Theory of Furnaces, Mir Publishers Moscow, 1980

G. E. Dieter, Engineering Design, 2nd Edition, McGraw Hill, 1990

MT901 Mass Transfer and Chemical Kinetics 3

Review of various rate theories, Gibbs and Langmiuir isotherms, diffusion in solids, liquids and gases. Mass Transfer: interfacial phenomenon-significance, interfacial turbulence, electrocapillary effects, enhanced vaporization electro-chemical theory of smelting and refining. Process analysis, impinging jets and submerged jets. Continuous flow systems. Analysis of single particle reactions - correlation with packed beds and fluidised beds.

N. J. Thumelis, Transport and Chemical Rate Phenomena, Gordon Breach, New York, 1995

MT902 Thermodynamics of Solids 3

First law of thermodynamics, second law of thermodynamics, some relations between thermodynamics quantities, thermodynamics of phase transformation and chemical reactions. Partial molar and excess quantities. Thermodynamic properties of alloy system - equilibrium between phases of variable composition. Free energy of binary system. Thermodynamics of surfaces and interfaces. Classification of defects in the crystal, defects in the metals, defects in elemental semiconductors, defects in nearly stoichiometric compound, defects in non - stoichiometric compound.

R. A. Swalin, Thermodynamics of solids, John Wiley, 1962

MT903 Solidification of Metals 3

Heat flow in solidification, plane front solidification of single phase alloy, cellular solidification, plane front solidification of polyfront alloy, solidification of castings and ingots, solidification of polyphase alloy. Fluid flow, thermodynamics of solidification, nucleation and interface kinetics growth. Processing and properties: homogenization, mechanical properties of equiaxed cast structure, properties of columnar structure, aligned composites, effect of working.

M.C. Flemings, Solidification Processing, McGraw Hill, 1974

W. Kurz, D. J. Fischer, Fundamentals of Solidification, Trans Tech, 1984.

MT904 Materials Science & Engineering 3

Introduction, atomic structure and bonding, crystal structure and crystal geometry, solidification, crystal imperfections and diffusion in solids, electrical properties of materials, mechanical properties of metals, polymeric materials, phase diagrams, engineering alloys, ceramic materials, silicate structure, processing of ceramics, electrical, mechanical, thermal properties of ceramics. Magnetic materials, corrosion, composite materials, optical properties, superconducting materials.

E. Reed Hill, Introduction to Physical Metallurgy, Van Nostrand, East west Press, New Delhi, 1973.

MT905 Plastic Deformation 3

Interatomic forces, metallic crystals and their elastic properties, elementary theory of structural imperfections in crystals, plastic deformation of single crystals, plastic deformation of polycrystals. Deformation textures, characteristics and driving forces of softening process in deformed crystals. Fracture, resistance of metal to plastic deformation, ductility and deformability of metals and alloys, thermo-mechanical treatment, superplasticity and its applications.

G. E. Dieter, Mechanical Metallurgy, McGraw Hill, 1988.

MT906 Structure & Properties of Alloys 3

Structure of pure metal, properties of pure metal, solidification solid solution, working and annealing, two phase alloy, Aluminum alloys and age hardening, magnesium and berylium, theory of heat treatment of steels, steels for structural applications, carbon and alloy tool steels, stainless steels, cast iron, reactive and refractory metals for high temperature applications, failure of materials, non-destructive testing.

MT907 Heat Transfer 3

Modes of heat transfer, one dimensional, steady state conduction, transient conduction, external flow (convection), internal flow (convection), free (natural, buoyant) convection, boiling and condensation, radiation, radiation exchange between surfaces.

J. P. Holman, Heat Transfer, 9th Edition, McGraw Hill, 2002.

MT908 Corrosion Engineering 3

Definition of corrosion, corrosion damage, standard expressions for corrosion rate, classification of corrosion, electrochemical aspects, electrochemical reactions, Pourbaix diagrams, mixed potential theory, polarization, Evan's diagrams, passivity, effects of environment - oxygen and oxidizers, temperature, corrosive concentration, cathode/anode area ratio, galvanic coupling using mixed potential theory. Forms of corrosion - uniform, galvanic, crevice, intergranular, pitting, selective leaching, erosion, stress corrosion, corrosion fatigue, fretting. Corrosion rate measurements - Tafel and linear polarization, AC impedance, small - amplitude cyclic voltammetry. Corrosion testing. Interpretation of results, Corrosion protection: materials selection, alternative environment, design, cathodic and anodic protection, coatings, High - temperature corrosion: mechanisms and kinetics, high - temperature materials.

Mars G. Fontana, Corrosion, McGraw - Hill Book Company 1986.

David Talbot and James Talbot, Corrosion Science and Technology, CRC Press, NewYork, 1998 Denny A. Jones, Principles and Prevention of Corrosion, Maxwell Macmillan 1992 Metals Handbook, Vol.13, Corrosion, ASM Metals Book, Ohio,1987.

MT909 Surface Engineering 3

Surface Cleaning: Classification and Selection of Cleaning Processes Finishing Methods: Classification and Selection of Finishing Processes; Topography of Surfaces; Microstructural Analysis of Finished Surfaces Plating and Electroplating: Electrodeposition Processes: Copper Plating; Nickel Plating; Zinc Plating; Zinc Alloy Plating; Selective (Brush) Plating; Electroforming. Nonelectrolytic Deposition Processes: Eletroless Nickel Plating; Electroless Alloy Deposition Dip, Barrier and Chemical Conversion Coatings: Batch Hot Dip Galvanized Coatings; Phosphate Coatings; Chromate Conversion Coatings; Rust Preventive Compounds; Painting; Ceramic Coatings and Linings; Anodizing. Vacuum and Controlled - Atmosphere Coating and Surface Modification Processes: Thermal Spray Coatings; Chemical Vapor Deposition of Nonsemiconductor Materials; Chemical Vapor Deposition of Semiconductor Materials; Plasma - Enhanced Chemical Vapor Deposition; Growth and Growth - related Properties of Films Formed by Physical Vapor Deposition; Vacuum Deposition, Reactive Evaporation, and Gas Evaporation; Sputter Deposition; Ion Plating; Ion-Beam-Assisted Deposition; Arc Deposition; Ion Implantation; Diffusion Coatings; Pulsed - Laser Deposition. Testing and Characterization of Coatings and Thin Films: Film Thickness Measurements Using Optical Techniques; Corrosion Testing; Evaluation of Mechanical Properties of Thin Films.

P. K. Dutta & I. S. Gray, Surface Engineering, Vol. I - III, Royal Society of Chemistry, 1993.

ASM Hand Book, Vol.5, ASM International, Metals Park, Ohio, 1999.

Kenneth G. Budinsk, Surface Engineering for wear resistance, Prentice Hall, NJ 1988.

MT910 Instrumental Methods of Analysis 3

Spectroanalytical Methods: Introduction and fundamentals, Beer-Lambert's law, Selection rules; Fundamental principles, instrumentation and applications of IT spectroscopy, UV-visible spectroscopy, Raman spectroscopy, Atomic absorption spectroscopy; Thermal Analysis: Fundamental principles, instrumentation and application of Thermogravimetry, Differential thermal analysis, Differential scanning calorimetry, Dynamic mechanical thermal analysis, Hyphenated techniques; Surface characterization by spectroscopy, Fundamental principles, instrumentation and applications of X-ray photoelectron spectroscopy, TOF-SIMS; Surface analysis by microscopy, Fundamental principles, instrumentation and application of Scanning probe microscopy, Scanning tunneling microscopy, sample preparation techniques for electron microscopy.

J. W. Robinson, E. M. S. Frame and G. M. Frame II, Undergraduate Instrumental Analysis, 6th Ed., Marcel Dekker, 2005.

D. A. Skoog, F. J. Holler and T. A. Nieman, Principles of Instrumental Analysis, 4th Ed., Harcourt, 2001.

C. R. Brundle, C. A. Evants, Jr., and S. Wilson, Encyclopaedia of Materials Charaterization, Butterworth-Heinemann, 1992

J. D. Menczel, R. B. Prime, Thermal Analysis of Polymers, Wiley, 2009.

http://www.cem.msu.edu/~reusch/VirtualText/Spectrphy/spectro.htm#intro

DEPARTMENT OF CHEMISTRY

CY900 Polymer Chemistry 4

Introduction. Classification. Elastomers, Fibres and Plastics. Copolymers. Types of polymerization, mechanisms and kinetics. Metathesis. Group-Transfer polymerization. Solution Properties, Thermodynamics, and Molecular-weight determination. Thermal properties and Degradation, Stability, & environmental issues. Polymer recycling. Biodegradation. Polymer additives, blends, interpenetrating networks & composites. Applications for polymers in separations, biotechnology, and electronics - Membrane separations, Biomedical applications. Applications in electronics. Photonic polymers.

Joel R. Fried, Polymer Science and Technology, Prentice Hall 1999.
Fred W. Billmeyer, Jr, Text Book of Polymer Science, Wiley-Interscience 1985.

CY901 Advanced Organic Chemistry 4

Stereochemistry: Asymmetric carbon atoms. Configuration. Racemic modification. Properties. Resolution. Conformations. O R D. and Circular Dichroism. Named Organic reactions, Rearrangements and Reagents. Photochemistry: Photochemical reactions. Woodward-Hoffmann rules. Proteins and Enzymes. Structure. Vitamins and Nucleic acids. Biosynthesis of pyrimidines, purines and proteins, Haemoglobin.

Ernest L. Eliel, Stereochemistry of carbon compounds, Tata McGraw-Hill, 1976. I. L.
Finar,Organic Chemistry, Vol. 1 and 2, ELBS and Longman, 1975.

CY902 Spectroscopy of Organic Compounds 4

UV-Visible Spectroscopy: Principle, Instrumentation, and its applications in structural elucidation of organic compounds. Quantitative analysis. IR-Spectroscopy and Raman spectroscopy: Theory and FT Raman Spectrometer. Applications. NMR Spectroscopy: Quantum description of NMR. NMR spectrometer. Sample handling. Applications to structure determination. Carbon-13 NMR. Nuclear Overhauser enchancement. Applications of NMR to P-31 and F-19 nuclei, 2-D NMR. Mass spectrometry: Principle. Double focusing spectrometer. Identification of organic compounds. Structural information and fragmentation patterns. Rearrangements. GCMS and its applications.

J. R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall, 1974.
D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, Harcourt Asia PTE Ltd., V Ed., 1992.

CY903 Chromatography 4

Classification and Principles of Chromatography: Theory and general description of various types and applications. Gas Chromatography: Instrumentation and applications. Gas-solid chromatography. Liquid Chromatography: Types-Liquid-solid. Liquid-liquid. Instrumentation. HPLC: Instrumentation, Components, and applications. Partition chromatography, Ion chromatography and Gel Permeation chromatography: Theoretical plate theory and applications. Ion Chromatography: Ion-exchange resins, ion selectivity, Applications, Gel permeation chromatography: Theory & applications in polymer analysis. Paper chromatography, Thin layer chromatography. Adsorption chromatography: Solvents, development of chromatogram.

Lloyd R Snyder, Principles of Adsorption Chromatography, Marcel Dekker Inc, 1968. R.
Stock and C. Rice, Chromatographic Methods, II Ed, Chapman and Hall, 1967.

CY904 Advanced Physical Chemistry 4

Quantum Mechanics: Schrodinger wave equation: Solutions for simple systems. Particle in a 3-d.box. Radial probability distribution. Wave mechanical treatment of probability distribution. Chemical Kinetics and Catalysis: Kinetics and mechanism of complex reactions, Molecular reaction dynamics. Acid-base and Enzyme catalysis. Quantitative correlations of reaction rates and equilibria. The Hannut and Taft equations. Ionic equilibria and Electrolytic Conductance: The theory of electrolytic conductance. Debye- Huckel limiting equations. Instrumental Methods of Electrochemistry: Polarization. Overvoltage. Electroanalysis and coulometry-principles & applications. Voltametry and Polarography: Principles. Kinetics of electrochemical reactions.

Samuel Glestone, An introduction to Electrochemistry, East-West edition, New Delhi.
Paul Delahay, New Instrumental methods is electrochemistry, Interscience .

CY905 Advanced Inorganic Chemistry 4

Acids and Bases: Acid-base concepts. Strengths. Solvents: Theory and factors affecting solubility. Energy change. Born equation. Coordination Chemistry-I: Valence Bond Theory for Complexes, Inner and outer orbital complexes.

Magnetic properties, Crystal Field Theory. Molecular Orbital Theory- for sigma bonding complexes and pi-bonding complexes. Coordination Chemistry II: Spectral properties. Magnetic permeability and susceptibility. Factors affecting stability, Kinetics and mechanism of reactions of complexes. Organometallic Chemistry: Metal carbonyls, Nitrosyls, Metallocenes, Dinitrogen compounds.

J.E. Huhuy, E.A. Keiter, R.L. Keiter, Inorganic Chemistry: Principle of Reactivity and Structure, Addison Wesley Pub.1993.
H.J. Emeleces and A.G. Sharpe, Modern Aspects of Inorganic Chemistry, Universal Book Stall, New Delhi, 1989.

CY906 Environmental Chemistry 4

Concept and scope of Environmental Chemistry. The hydrological, oxygen, nitrogen, phosphate and sulphur cycle. Atmosphere: Composition, structure and evolution. Chemical and photochemical reactions. Water resources, Physical Chemistry of sea and fresh water. Composition of Lithosphere, water, air, organic and inorganic components in soil. Air pollutants: CO, NO_X , Hydrocarbons, Photochemical smog, SO_2, acid rain, particulates, radioactivity. Tropospheric chemistry. Water pollution. Water quality parameters, sampling, preservation, monitoring techniques and methodology. Chemical toxicology: Toxic chemicals and their impact on the environment.

A.K.De, Environmental Chemistry, New Age Intl.(Pvt) Ltd.,1998. Peter
O'neil, Environmental Chemistry, Chapman and Hall, 1985.

CY907 Electroanalytical & Thermal Methods 4

Conductometry: Conductivity. Measurement. Conductometric titrations - principle of different types. High frequency titrations. Potentiometry: Theory. Various types of Potentiometric titrations. Voltammetry: Polarography. Principle and applications. Sinusoidal a.c. polarography. Stripping voltammetry. Amperometric titrations. Biamperometric titrations. Chronopotentiometry. Electrogravimetry. Coulometry. Thermogravimetry. Theory and Instrumentation. Differential thermal analysis. Instrument, applications. DSC. Instrument and applications. Thermometric titrations.

G.H.Jeffery & others, Vogels Textbook of quantitative Chemical analysis, V Ed. Longman.
Willard, Merritt, Dean and Settle, Instrumental methods of analysis, VI Ed., CBS Publishers and Distributors, Delhi, 1986.

CY908 Advanced Membrane Technology (4-0-0) 4

Introduction, Importance of membranes in water management, Types of membranes; Micro filtration, Ultra filtration, Nano filtration, Reverse osmosis membranes. Advantages of NF membranes over RO membranes, common materials used for preparation of membranes, requirements of good membranes, various applications of synthetic membranes, different types of membrane preparation Nafion membranes, polysulphone based membranes, cellulose acetate membranes. Membranes for fuel cell applications. Support for membranes. Characterization of membranes by SEM, performances studies of different membranes.

Naylor T Dev, Polymer membranes Elsevier science, Vol8, No5, 1996.
Schafer A, Anthony Fane T David Waite, Nanofiltration: Principles & applications. ElsevierSscience, 2002.
Rijin C.J.M Van, Nano and micro engineered membrane technology. Elsevier Science 2004.

CY 909 Advanced Electrochemical Methods of Analysis (4-0-0) 4

Introduction, principles of potentiometry and polarogrpahy, cyclic volametry, stripping voltametry, Concept of parallel plate capacitors and its applications, super capacitors, Energy storage devises, Semiconductor electrodes, Potentyiodynamic and galvanodynamic polarization method for corrosion study, AC impedance spectroscopy and its advantages over DC method, Interpretation of Nyquist and Bode's plot, p-n type capacitors, Mott-Schottky plot. Capacitance vs. E plot. Electrochemical Noise study and its applications. Scanning electrochemical microscope (SECM): Instrumentation and its applications. Inhibitors, Frumkin and Langmuir adsorption. Electrochemical methods in development and characterization of nano materials.

Banerjee S N, An Introduction to Corrosion and Corrosion Inhibition, Oxonian Press Ltd., New Delhi, 2000.
Fontana M G and Greene N D , Corrosion Engineering McGraw Hill New York, 3nd Edn., 2004. Roos Macdonald J, Impedance Spectroscopy, John Wiley and sons, new York. 1987.
Stephen Bialkowski, Photothermal Spectroscopy Methods for Chemical Analysis, Wiley- Interscience, 1996.
Robert Cottis and Stephen Turgoose, Electrochemical impedance and noise, NACE International, 1999.

CY 910 Specialty Polymers (4-0-0) 4

Conjugated or conducting polymers (CPs), types of conjugated polymers: polyacetylene, PPP, PPV, polythiophenes, polypyrroles, polyfluorenes and their synthetic methods, determination of molecular weights (number average and weight average) of polymers: gel permeation chromatography-theory, conductivity in CPs:doping dopants and doping level, mechanism of conductivity in CPs, charge carriers in conjugated polymers: polarons, bipolarons, solitons. Optcal properties of conjugated polymers: energy levels in CPs, HOMO-LUMO, fluorescence emission in CPs.

Electroluminescence (EL), electroluminescence efficiency, factors affecting EL efficiency. Applications of conjugated polymers: polymer light-emitting diodes (PLEDs), electrochemical cells, sensors, FETs, photovoltaic cells etc. Conjugated polymers for photonic applications: Nonlinear optical properties of conjugated polymers, Liquid crystal polymers, Polymers for TFT applications.

T.A. Skotheim, R.N. Elsenbaumer, J.R. Reynolds Handbook of conducting polymers, 2 Ed., Marcel Dekker Inc. New York, 1998.
P.N. Prasad, D.J. Williams, Intrduction to Nonlinear Optical Effects in Molecules and Polymers, John Wiley, New York, 1990.
R.L. Sutherland, Handbook of Nonlinear Optics, Series of Optical Engineering, Marcel Dekker Inc. New York, 1996.

CY911 Supramolecular Chemistry (4-0-0) 4

Introduction to Supramolecular Chemistry: Inspiration, History and definitions. Molecular Forces. Molecular Structure: Shape and Size, van der Waals radii, bond lengths and bond angles, conformation. Common Motifs in Supramolecular Chemistry. Overview of Experimental Techniques in Supramolecular Chemistry. Host / Guest Chemistry: Cation binding, Anion binding, Neutral molecule binding. Crystal engineering: Introduction & Tectons - synthons, Special role of hydrogen bonding, Cambridge Structural data bases, Polymorphism, Co-crystals, Hydrogen bond synthons common & exotic, Halogen bonding. Supramolecular polymers, gels and fibres.

Steed J. W., and Atwood J. L., Supramolecular Chemistry, Wiley & Sons: Chichester, 2000, 2 Edn., 2009.
Katsuhigo Ariga & Toyoki Kunitake, Supramolecular chemistry- fundamentals & applications, Springer publications, 2007. Jonathan W. Steed, David R. Turner, Karl Wallace, Core Concepts in Supramolecular Chemistry and Nanochemistry, *,2007.*
Lehn J. M., Supramolecular Chemistry: Concepts and Perspectives, Weinheim: VCH 1995.
Paul D. Beer, Philip A. Gale and David K. Smith, Supramolecular Chemistry, Oxford university press, 2005.

DEPARTMENT OF MATHEMATICAL & COMPUTATIONAL SCIENCES

MA900 Advanced Graph Theory 3

Trees, Eulerian Graphs and Digraphs, Matchings, Connectivity, Coloring, Perfect graphs, Domination

Douglas West B., Introduction to Graph Theory, Prentice Hall of India, 2001.
Harary F., New Directions in the Theory of graphs, Academic Press, New York.

MA901 Advanced Mathematical Methods 3

Ordinary Differential Equations, Local Analysis, Difference equations, Perturbation Method, Global Analysis

Earl A Coddington, An Introduction to Ordinary Differential Equations, PHI.
Carl Bender M.Steven Orszag A. Advanced Mathematical Methods for Scientists & Engineers, McGraw Hill

MA902 Computational Fluid Dynamics 3

Basic concepts and equations of fluid dynamics, non-dimensional forms, boundary layer equation, grid generation, grid refinement, adaptive grids, finite difference methods, explicit and implicit methods, fundamentals of fluid flow modeling, upwind scheme.

Yuan S.W., Fluid Mechanics, PHI
Patankar S.V., Numerical Heat Transfer, McGraw Hill
White F.M., Viscous Fluid Flow, McGraw Hill

MA903 Life Testing & Reliability Estimation 3

Exponential failure models, Gamma and Weibull distributions, Normal and related distribution, Mixtures and Compound distributions

Sinha S. K. Kale B.K. Life Testing and Reliability Estimation, Wiley Eastern Ltd.
Lewis E.E, Introduction to Reliability Engineering, John Wiley & Sons Inc.

MA904 Linear Algebra & Matrix Theory 3

Matrices and linear Equations, Types of Matrices, Vector Spaces and linear transformations, Inner Products, Orthonormal basis, Gram-Schmidt Orthogonalization Process, Vector Norms, Matrix Norms, Eigen values and Eigen Vectors, Triangular, Jordon and Rational Canonical forms and applications, Perturbation theory.

David Lewis W., Matrix Theory, Allied Publications Ltd
Gilbert Strang, Linear Algebra and Its Applications III Edition, Thomson Learning (Int.Student Edition)

MA905 Number Theory 3

Divisibility and Congruences, Some functions of Number Theory, Some Diophantine Equations, Primes and Multiplicative Number Theory, Algebraic Numbers.

Niven I, Zuckermann H, Montgomery H.L: An Introduction to the Theory of Numbers, Vth Edition, John Wiley, 2000.
HardyG.H., Wright E.L: Introduction to the Theory of Numbers, Vth Edition, Oxford University Press, 1980.
Introduction to Number Theory and Cryptography, II Edition, Springer- Verlag, 1994.

MA906 Numerical Methods 3

Finite difference discretization, consistency and stability, explicit and implicit methods, finite difference applications in heat transfer, finite volume method, application of FVM in diffusion and convection problems, finite volume methods for unsteady problems, Finite Element Method: Weighted Residual and Variational formulations, applications of FEM to 1D and 2D problems in fluid flow and heat transfer.

Smith G.D., Numerical Solution of Partial Differential Equations, Clarendan Press
Jain M.K., Numerical Solution of Differential Equations, Wiley Eastern
Patanker S.V., Numerical Heat Transfer and Fluid Flow, McGraw Hill

MA907 Numerical Solution of Differential Equations 3

Elements of Ordinary Differential IVP Approximation, Single Step Methods, Systems of differential Equations, Higher order differential equations, Multistep methods, Implicit methods, General linear multistep methods, Difference methods for boundary value problems in ordinary differential equations, Difference methods for Parabolic Partial Differential Equations, Hyperbolic Partial Differential Equations, Elliptic Partial Difference Equations.

Jain M.K,. Numerical Solution of Differential Equations, Wiley Easter, 1984,

MA908 Operations Research 3

Linear Programming, Network Analysis, Queuing Theory

Hamdy Taha A, Operations Research, Vth Edition Prentice Hall of India
Hiller, Liberman, Introduction to Operations Research, Prentice Hall of India

MA909 Stochastic Processes, Queueing Theory & Reliability 3

Preliminaries of Probability, random variables, probability distributions, Stochastic processes Queueing Models, Reliability Theory

Medhi J., Stochastic Processes, New Age International Publishers
Lewis E.E., Introduction to Reliability Engineering, John Wiley & Sons Inc.

MA910 Data Structures & Network Algorithms 3

Trees and Graphs, Disjoint sets and compressed Trees, Heaps, Search Trees, Self-Adjusting Binary trees, Linking and cutting Trees, Minimum spanning trees, shortest path trees, flows, cuts, minimum cost flows, bipartite matching, network flows. Algorithms for Non-Bipartite Matching.

Robert E. Tarjan, Data Structures and Network Algorithms, SIAM, CMBS-44.
Todd Kind, Dynamic Data Structures, Academic Press.

MA911 Network Flow Optimization 3

Networks, Paths and cuts, flows and capacities, Analysis of flows, Matching Theory and assignment problems, potentials and spans, networks with linear costs, optimal flows and potentials algorithms for convex costs, Linear systems of variables.

Ford and Fulkerson, Flows in Networks, Princeton Univ. Press
R. T. Rockafellar, Network Flows and Monotropic Optimization, Wiley Interscience.

MA912 Monotropic Optimization 3

Optimization and equilibrium, examples of Monotropic programming, duality and existence of solutions, boundedness property, decomposition, applications to network flow optimization, Basic Descent algorithms, Fortified and Discretised Descent, Simplex methods, Generalised out-of-kilter algorithm, Parametric monotropic programming.

R. T. Rockafellar, Network Flows and Monotropic Optimization, Wiley Interscience.
Eugene L. Lawler, Combinatorial Optimization- Networks and Matroids, Hort-Rinehart-winston.

MA913 Combinatorics 3

Study of known configurations; Investigation of unknown configurations; Counting of configurations; Enumeration of configurations; optimization of configurations.

C. Berge, Principles of Combinatorics, Academic Press
H. Rosen, Handbook of Discrete Mathematics

MA914 Combinatorial Problems 3

Basic enumeration; the sieve; permutations; Labelled and Unlabelled Trees; spanning Trees; 1-factors; the Ising problem; restricted permutations; Parity and Duality; connectivity Factors of graphs; Independent sets of Points; chromatic number; external problems for graphs; spectra of graphs; Automorphisms of graphs; Hypergraphs; Ramsey theory; the Reconstruction Problem.

Laszlo Lovasz, Combinatorial Problems and Exercises.
North Holland, Combinatorial optimization, An Algorithmic approach

MA915 Combinatorial Optimization 3

Polynomial Boundedness; network optimization problems; Greedy algorithms; Matroid theory ; Matroid Intersections; Matroid Partitions; Primal weighted Intersection algorithm; Duality Theory; Matroid polyhedra ; Primal-Dual weighted Intersection Algorithm; Matroid Parity; Generalizations.

Eugene L. Lawler, Combinatorial Optimization- Networks and Matroids
Holt-Rinehart-winston, Combinatorial Optimization, An Algorithmic Approach

MA916 Convex Analysis 3

Definitions, Algebra of convex sets, Topological properties, Duality Correspondences, representation and inequalities, differential theory, constrained extremum Problems, Saddle Functions and Minimax Theory, Convex Algebra.

R. T. Rockafellar, Convex Analysis, Princeton Univ. Press
John M. Danskin, The theory of Max-Min, Springer Verlag
V. F. Dem'yanov and V.N. Malozemov, Introduction to Minimax, Keter Publishing House.

MA917 Conjugate Duality & Optimization 3

Convexity and Duality, Examples of convex optimization Problems, conjugate convex Functions in paired spaces, Dual Problems and lagrangians Examples of Duality schemes, continuity and derivatives of convex functions, solutions to optimization Problems, computation of conjugates and subgradients, Integral Functionals, Applications.

R.T.Rockafellar, Conjugate Duality and optimization, SIAM, CBMS16.
Olivi. M. Mangasarian, Non-linear Programming, McGraw Hill.

MA918 Nonlinear Programming 3

Linear Inequalities and Theorems of the Alternative; Convex sets; Convex and concave Functions; Saddle Point Optimality criteria of Nonlinear Programming without Differentiability; Differential convex and concave Functions; optimality criteria in nonlinear Programming with differentiability; Duality in nonlinear Programming; generalizations of convex functions; Quasi - convex, strictly quasi - convex; Pseudoconvex; Optimality and Duality for generalized convex and concave Functions; Optimality and Duality in the presence of nonlinear equality constraints.

Olvi M. Mangasarian, Non-linear Programming, McGraw Hill.
R.T. Rockafellar, Convex Analysis, Princeton Univ. Press

MA919 Selected Topics in Computational Systems Science & Engineering 3

MA920 Non-smooth Analysis 3

Generalised Gradients; Generalized Jacobians; Differential Inclusions; Calculus of Variations; Finite Lagrangians; the Maximum Principle in Optimal Control; Implicit Functions; Directional Contractions and Fixed Points. Hamiltonian Trajectories and Boundary Value Problems.

Frank. H. Clarke, Optimization and Nonsmooth Analysis, John Wiley & Sons R. T.
Rockafellar, The Theory of Subgradients, Heldermann Verlag.

MA921 The Theory of Subgradients 3

Non-differentiable Functions; Tangent Cones; Normal vectors; subderivatives; subgradients; lipschitzian cases; subgradients as limits; Stationary Points; Sub differential Calculus; Duality and Marginal Functions; Monotonicity of subgradient Multifunctions.

R. T. Rockafellar, The Theory of Subgradients, Heldermann Verlag
Frank H. Clarke, Optimization and Non-smooth Analysis, John Wiley & Sons.

MA922 The Theory of Max-Min or Minimax 3

Best approximation by algebraic polynomials-discrete as well as continuous cases; The discrete minimax problem unconstrained as well as constrained cases; the generalized Problem of Nonlinear Programming. The continuous minimax problem; special cases.

V.F. Demyanov and V. N. Malozemov, Introduction to Minimax, Keter Publishing House.
John M. Danskin, The Theory of Max-Min Springer-Verlag.

MA923 Non-Differentiable Optimization 3

Aggregate subgradient Methods for unconstrained convex minimization; Methods with subgradient locality Measures for Minimizing non-convex functions; methods with subgradient deletion rules for unconstrained non-convex minimization; Feasible point methods for convex constrained minimization problems; Methods of feasible directions for non-convex constrained problems; Bundle Methods; Numerical examples; subgradient methods with space dilation; computational algorithms.

N. Z. Shor, Minimization Methods for non-differentiable Functions
Krzysztof C. Kiwiel, Methods of Descent for Non-differentiable Optimization, Springer Verlag.

MA924 Advanced Database Management Systems 3

Basic concepts and terminology, software architecture for data sharing, federated database management system, designing distributed databases, distributed transactions, client server architecture, multimedia databases, object oriented DBMS

Tamer Ozsu, Patrick Valduring: Principles of Distributed Database systems, PHI
Ceri S, Pelagatti S: Distributed Databases: Principles and Systems, McGraw Hill, New York

MA925 Advanced Operating Systems 3

An overview of operating system functions, Distributed operating systems, Protection and security, Multiprocessor operating systems, Database operating systems, Concurrency control, Object oriented operating systems and its

characteristics, Case studies of OS such as UNIX OS, Netware OS, Windows etc,
Mukesh Singhal Niranjan, Shivorothri G: Advanced concepts in Operating Systems
Andrew S Tenanbaum: Distributed Operating systems

MA926 Analysis & Design of Algorithms 3

Fundamentals of Algorithmic Problem Solving, Fundamental data Structures, Fundamentals of the Analysis of Algorithm Efficiency, Brute Force, Divide-and-Conquer, Decrease and Conquer, Transform and Conquer, Space and Time Tradeoffs, Dynamic Programming, Greedy Technique, Limitations of Algorithm Power , Coping with the Limitations of Algorithm Power.
Anany Levitin, Introduction To The Design And Analysis Of Algorithms, Pearson Education, 2003

MA927 Data Warehousing & Data Mining 3

Data Warehousing, Data Mining, Association Rules, Classification, Clustering, Decision Trees, Other Techniques for Data Mining, Web Mining, Searching Techniques.
Jiawei Han, Micheline Kamber: Data Mining: Concepts and Techniques, Harcourt India Pvt., 2001. Arun
Poojary K., Data Mining Concepts, Hyderabad Press, 2001.

MA928 Distributed Systems 3

Evolution of modern operating systems, Design Goals, transparencies and fundamental issues in Distributed systems, Temporal ordering of events, Global state detection, Physical clocks, Mutual Exclusion Algorithms, Interprocess Communication, Deadlocks in distributed systems, Load balancing techniques, Distributed databases
Shivarathi & Shingal, Advanced Operating Systems.
Randy Chow, Distributed Operating Systems and Algorithms.

MA929 Number Theory and Cryptography 3

Elementary Number Theory Congruences, applications to Factoring. Finite fields, Quadratic residues and reciprocity. Simple cryptosystems, public key cryptography, RSA, Discrete logs. Primality and Factoring, the rho method, Fermat factorization, continued fraction and Quadratic Sieve methods.
N.Kobltiz., A Course in Number Theory and Cryptography, Springer, 1994.

MA930 Elliptic Curves and Cryptography 3

Introduction to Elliptic curves, Discriminant and j-invariant, curves over K, char (K) $\neq$ 2, 3 and char (K) = 2, Group structure, Divisor Theory, Elliptic curves over Z_n, Isomorphism classes of Elliptic curves over Finite Fields, The Discrete Logarithm problem, Pohlig - Hellman Method, Index Calculus Method, Singular Elliptic curves. The Elliptic curve Logarithm problem, The Weil pairing, Reduction to Logarithms in a Finite Field, Supersingular curves, Cryptographic Implications.

Implementation of Elliptic curve Cryptosystems, Counting points on Elliptic curves over F_{2m}.
A Menezes: Elliptic Curve Public Key Cryptosystems, Kluwer Academic, Dordsecht. 1993.
A Menezes, S. Vanstone & P. Van Oorschot: Handbook of Applied Cryptography, CRC, Boca Raton, 1996.

MA931 Finite Fields and Applications 3

Lattices, Applications of Lattices, Finite Fields and Polynomials, Coding Theory, Cryptology, Applications of Groups, Fast Fourier Transforms, Grobner bases for Algebraic and Differential Equations.
Rudolf Lidl & Gunter Pitz: Applied Abstract Algebra, Springer, 1998.

MA932 Algebraic Number Theory 3

Algebraic Numbers and Number fields, Discriminants, Norms and Traces, Algebraic Integers and Integral Bases, Factorization and Divisibility, Applications of Unique Factorization, Quadratic Fields, Units in Number Rings, Geometry of Numbers, Dirichlet's unit Theorem, The Number Field Sieve, Ideal Classes, the Class group, Class Numbers of Quadratic Fields, Cyclotomic fields and Kummer's Theorem, Cryptography in Quadratic Fields, Ideal decomposition and Reciprocity Laws.
R. A. Mollin: Algebraic Number Theory, CRC, Boca Raton, 1999.
J. Esmonde, M.Ram Murthy: Problems in Algebraic Number Theory, Springer, 1999.

MA933 Computational Number Theory 3

Fundamentals, Euclidean Algorithm, Modular Arithmetic, Fast Powers, Congruences - Linear and Quadratic

congruences, Chinese Remainder Theorem, Euler's Phi-function, Primitive Roots for Primes, Universal Exponent, The Form of Carmichael Numbers, Prime testing and certification, Strong Liars are scarce, Coding secrets and Factoring Algorithms, Pepin's Test, Quadratic Reciprocity, Continued Fractions, Prime testing with Lucas Sequences, Gaussian integers and primes.

D. Bressoud, S. Wagon: A Course in Computational number Theory, Springer, 2000.

MA934 Analytic Number Theory 3

Arithmetical Functions and Dirichlet Multiplication, Mobius Functions, Euler totient function, Mangoldt function, Liouville's function, Averages of Arithmetical functions, some Elementary Theorems on the Distribution of Prime Numbers, Congruences, Finite Abelian Groups and Their Characters, Dirichlet's Theorem on Primes in Arithmetic Progressions, Periodic Arithmetical functions and Gauss Sums, Quadratic Residues and the Quadratic Reciprocity Law, Primitive Roots, Dirichlet Series and Euler Products. The functions $\zeta(s)$ and $L(s, \chi)$, Analytic Proof of the Prime Number Theorem.

Tom M.Apostol: Introduction to Analytic Number Theory, Springer, 1989. M.
Ram Murthy: Problems in Analytic Number Theory Springer, 2001.

MA935 Algebra 3

Groups - Permutation groups, Sylow theorems solvable groups, Direct products of groups and finite abelian groups. Rings: - Ideals, Euclidean and Principal ideal rings, Unique factorization domains and Polynomial rings. Fields: - Extension fields, Prime fields, Algebraic and Transcendental extensions. Roots of polynomials, splitting fields, finite fields, Separable and inseparable extensions Galois Theory, solvability of polynomials by radicals and Abel's theorem.

I.N. Herstein, Topics in Algebra, Wiley casten Ltd.
J.B.Fraleigh; A first course in Abstract algebra, Narera publishers
N.S. Gopalakrishnan, University, Algebra, vikas publishing House Pvt. Ltd.,

MA936 Fixed Point Theory & Its Applications 3

Banach's contraction principle on complete metric spaces, its variants and applications. Fixed point theorem for non-expansive and set valued maps. Brouwer's and schauder's theorems and its applications. Fixed point theorems on topological spaces and partially ordered spaces and partially ordered spaces.

Mohamed A. Khamsi and William A. Krik, An Introduction to Metric spaces and fixed point theory, Wiley - Inter-science, New York.
Eberhard Zeidler, Nonlinear Functional Analysis and its Applications, Part I: Fixed Point Theorems Springer - Verlag, Heidelberg.
Smart, D., Fixed Point Theorems, London (1973)

MA937 Measure Theory & Integrations 3

Lebesgue measure on R^n: Introduction, outer measure, measurable sets, Lebesgue measure, regularity properties, a nonmeasurable set, measurable functions, Egoroff's theorem, Lusin's theorem. Lebesgue integration: Simple functions. Lebesgue integral of a bounded function over a set of finite measure, bounded convergence theorem, integral of nonnegative functions Fatou's Lemma, monotone convergence theorem, the general Lebesgue integral, Lebesgue convergence theorem, change of variable formula. Differentiation and integration: Functions of bounded variations, differentiation of an integral, absolutely continuity. L^p - Spaces : The Minkowski's inequality and Holder's inequality, convergence and completeness approximation in Lp, denseness results in L^p , bounded linear functionals on Lp spaces. Fourier series: Definition of Fourier series, formulation of convergence problems, L^2 theory of Fourier series , convergence of Fourier series.

H.L. Royden, Real Analysis, Macmillan, New York
G. de Barra, Measure theory and integration, New Age, New Delhi

MA938 Topology 3

Topological spaces, bases, continuous functions, subspaces, quotient spaces, nets and filters, compactness, connectedness, separation properties, Tychonoff Theorem, compactification, Urysohn Lemma and Tietze Extension Theorem, function spaces.

J. Munkres, Topology, Prentice - Hall, New Delhi
J. Dugundji, Topology, Practice Hall, New Delhi.

MA939 Functional Analysis 3

Topological Vector spaces: Linear mappings, boundedness and continuity, Baire category, the Banach - Steinhaus theorem, the open mapping theorem, the closed graph theorem, bilinear mappings. Geometry of Hilbert spaces: Inner product spaces, the Riesz representation theorem, the adjoint of a linear and bounded operator, the existence of orthonormal bases, the dimension of Hilbert spaces. Banach Algebras: Banach algebras, the space of multiplicative linear functions, invertible elements, the Gelfand transform, basic properties of spectra, the Gelfand-Mazur theorem, the Gelfand theorem for commutative Banach algebras, the spectral radius formula, the Stone- Weierstrass theorem. C* - Algebras: The multiplier algebra, the unitization of a C* - algebras, *- homomorphisms, Gelfand's structure theorem for commutative C* - algebras, functional calculus with normal operators, the spectral mapping theorem.

W. Rudin, Functional Analysis, Second Edition, Tata McGraw- Hill, New Delhi

R.G. Douglas, Banach Algebras Techniques in Operator Theory, Second Edition, Springer- Verlag, New York

G.J. Murphy, C - Algebras and Operator Theory, Academic Press, San Diego*

MA940 Operator Theory 3

Operator on normed linear spaces: Normed linear spaces, characterization of Banach spaces, schauder basis and reparability, Riesz lemma, projection theorem, bounded operators, Riesz representation theorem, convergence of sequence of operators, closed operators. Compact Operators: Some characterizations, space of compact operators, the dual space of compact operators and trace class. Operators on Hilbert theory: Adjoint of an operator, self-adjoint, normal and unitary operator, numerical range and numerical radius, Hilbert-Schmidt operators. Spectral results: Eigenspectrum and approximate eigenspectrum, spectral radius, spectral mapping theorem, integration of operator-valued functions, spectral projections, Riesz- Schauder theory, spectral results for Hilbert Space operators, spectral theorems for bounded normal operators, compact normal operators.

R.G. Douglas, Banach Algebra Techniques in Operator Theory, Second Edition, Springer - Verlag, New York.

John B. Conway, A Course in Operator Theory, Springer, New York. M. Thamban Nair, Functional Analysis, Prentice - Hall, India.

MA941: Selected Topics in Speech Coding 4

Basic Principles; Objectives; Speech Coder Attributes; A Universal Speech Coder; Coding with Autoregressive Models; Distortion Measures; Coding Architecture; Robust Encoding; Packet Loss Concealment in Speech Transmission over Packet Networks; Low Bit Rate Speech Coding; Parametric Modeling of Speech Signals; Flexible Parametric Models; Efficient Quantization of Model Parameters; Low Bit Rate Speech Coding Standards; Analysis-by-Synthesis Speech Coding; Multipulse Linear Predictive Coding (MPLPC); Regular Pulse Excitation with Long Range Prediction(RPE-LTP); Code Excited Linear Prediction (CELP) Coder; Vector Sum Excited Linear Prediction (VSELP); Low Delay CELP; Pitch Synchronous Innovation CELP (PSI-CELP); Algebraic CELP (ACELP); Conjugate Structure CELP (CS-CELP) and CS-ACELP; Relaxed CELP (RCELP); Generalized Analysis by Synthesis; ex-CELP; iLBC; TSNFC; Embedded CELP; Perceptual Audio Coding of Speech Signals for Real Time Speech Communication; Recent Trends and Future Scope.

N. S. Jayant, Peter Noll; "Digital Coding of Wave Forms: Principles and Applications to Speech and Video"; Prentice Hall.

Wai C. Chu; "Speech Coding Algorithms: Foundations and Evolution of Standardized Coders"; Wiley.

Eleanor Selfridge-Field; "Beyond MIDI: The Handbook of Musical Codes"; MIT Press.

Selected Research Publications from International Refereed Jounals.

MA942: Selected Topics in Speech Processing 4 credits

Signal Processing for Speech; Wiener and Adaptive Filters; Signal Models; Adaptive Algorithms; MIMO Wiener Filter; Forward and Backward Linear Prediction; Levision Durbin Algorithm; Lattice Predictor; Spectral Representation; Multi-channel Linear Prediction; Kalman Filter; Estimation of Parametric Stochastic Process from Noisy Observations; Homomorphic Systems and Cepstrum Analysis of Speech; z-transform Analysis; Discrete Time Model; The Cepstrum of Speech; Relation of LPC; Application to Pitch Detection; Applications to Analysis / Synthesis Coding; Pitch and Voicing Determination of Speech and Extensions to Music Signals; Time Variant Quasi Periodic Acoustic Signals; Formant Estimation and Tracking; Vocal Tract Resonances; Acoustics of Vocal Tract; Formant Estimation; Short Term Fourier Transform (STFT); Sinusoidal Models; Speech Modification; Adaptive Blind Multi-channel Identification; Identifiability Principle; Constrained Time Domain Multi Channel LMS and Newton Algorithms; Unconstrained Multi Channel LMS Algorithm with Optimal Step Size Control; Frequency Domain Blind

Multi Channel Identification Algorithms; Adaptive Multichannel Exponentiated Gradient Algorithm; Recent Trends and Future Scope.

Jacob Benesty, M. Mohan Sondhi, Yiteng Huang; "Springer Handbook of Speech Processing".
Lawrence R. Rabiner, Donald Schafer; "Theory and Applications of Digital Speech Processing"; Prentice Hall.
Li Deng, Douglas O'Shaughnessy; "Speech Processing: A Dynamic and Optimization Approach"; CRC Press.
John R. Deller Jr., John H. L. Hanson, John G. Proakis; "Discrete Time Processing of Speech Signals"; Wiley.
Selected Research Publications from International Refereed Jounals.

MA943: Selected Topics in Speech Synthesis **4 credits**

Text-to-Speech Synthesis; Concatenative Synthesis; Speech Signal Transformation; Rule Based Speech Synthesis; Rule Based Parametric Synthesis; Corpus Based Speech Synthesis; Concatenative Synthesis with fixed Inventory; Unit Selection Based Synthesis; Statistical Parametric Synthesis; Linguistic Processing for Speech Synthesis; Architectures for Multi-lingual Llinguistic Processing; Prosodic Processing; Voice Transformation; Source Filter Theory and Harmonic Models; Quality Issues in Voice Transformations; Expressive / Affective Speech Synthesis; Characteristics of Affective Speech; Communicative Functionality of Speech; Synthesis of Affective Speech; Modeling Human Speech; Recent Trends and Future Scope.

Jacob Benesty, M. Mohan Sondhi, Yiteng Huang; "Springer Handbook of Speech Processing".
Paul Taylor; "Text-to-Speech Synthesis"; CUP.
Selected Research Publications from International Refereed Jounals.

MA944: Selected Topics in Speech Recognition **4 credits**

Approaches to Speech Recognition; Pattern Recognition Approach; Statistical Modelling Approach; HMM Based Speech Recognition; Normalization; Adaptation; Multipass Recognition Architectures; Speech Recognition Algorithms Based on Weighted Finite State Transducers; Machine Learning Framework; Rational Kernel Methods; Multidomain Conversational Listening and Recognition Experiments; Natural Language Understanding; Transcription and Distillation of Spontaneous Speech; Environmental Robustness; Noise Robust Speech Recognition; Model Retraining and Adaptation; Feature Transformation and Normalization; Structured Model Adaptation; Structured Feature Enhancement; Unifying Model and Feature Techniques; Network Based and Device Based Speech Applications; Recent Trends and Future Scope.

Jacob Benesty, M. Mohan Sondhi, Yiteng Huang; "Springer Handbook of Speech Processing".
Frederick Jelinek; "Statistical Methods for Speech Recognition"; MIT Press.
Selected Research Publications from International Refereed Jounals.

MA945: Selected Topics in Speaker Recognition **4 credits**

Measuring Speaker Features; Constructing Speaker Models; Adaptation; Automatic Speaker Recognition; Text Dependent Speaker Recognition; Text Dependent Challenges; Text Independent Speaker Recognition; Likelyhood Ratio Detector; Features; Classifiers; Performance Assessment; Recent Trends and Future Scope.

Jacob Benesty, M. Mohan Sondhi, Yiteng Huang; "Springer Handbook of Speech Processing".
Chin-Hui Lee, Frank K. Soong, Kuldip K. Paliwal; "Automatic Speech and Speaker Recognition"; Springer.
Selected Research Publications from International Refereed Jounals.

MA946: Selected Topics in Spoken Language Recognition **4 credits**

Language Modelling; Spoken Language Characterization; Spoken Language Verification; Discriminative Classifier Design; Spoken Language Characterization; Human Language Identification; Automatic Language Recognition through Spectral and Token Based Approaches; System Fusion; Performance Assessment; Vector Based Spoken Language Classification; Vector Space Characterization; Unit Selection and Modelling; Front End - Voice Tokenization; Back End – Vector Based Classifier Design; Language Classification Experiments; Recent Trends and Future Scope.

Jacob Benesty, M. Mohan Sondhi, Yiteng Huang; "Springer Handbook of Speech Processing".

Mark Johnson, Sanjeev P. Khudanpur, Mari Ostendorf; Roni Rosenfeld; "Mathematical Foundations of Speech and Language Processing"; Springer.

Selected Research Publications from International Refereed Jounals.

MA947 Topics in Functional Equations 3

Introduction to functional equations.Cauchy's equations and applications.Functional equations on several variables including d'Alembert's equation, Jensen's equation. Selected topics on iterative functional equation.

J. Aczel, Lectures on functional equations and their applications, Academic Press, New York, 1966.

M. Kuczma, B. Choczewski, R. Ger, Iterative Functional Equations, Cambridge University Press, Cambridge, 1990.

MA948: Mathematical methods for image processing (4-0-0) 4

Mathematical preliminaries: space of functions of bounded variation; deterministic image models; elements of differential geometry. Image restoration: Energy based methods; regularization of the problem; Euler equations; numerical approximation, PDE based models; smoothing and enhancing methods, Segmentation problem: energy minimization approaches and contour based approaches, Image inpainting: variational and curvature based models, Scopes for future research.

T.F. Chan, J.H. Shen, "Image processing and analysis", SIAM,First edition, 2005.

R.C. Gonzalez, R.E. Woods, "Digital image processing using MATLAB", Prentice Hall, Second edition, 2003.

Henri Maitre, "Image Processing",Wiley, first edition, 2008.

Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing" , Addison-Wesley, 2nd edition, 2002.

Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1992.

G. Aubert and P. Kornprobst, " Mathematical problems in image processing", Springer, Second edition, 2006.

Recent journal papers published in the relevant areas.

MA949: Topics in Computer vision and applications (4-0-0)4

A review of Linear algebra, Singular Value Decomposition, Principal component analysis, Linear Discriminant analysis, Independent component analysis and applications, Kalman filter, Multi resolution representation: Active contours, Texture, colour and motion descriptors, shape representation, Pattern analysis, recognition and classification, Vision as an inverse problem, Applications: Face recognition, detection and interpretation, Scopes for future research.

S. Gong, Dynamic Vision: From Images to Face Recognition, Imperial College Press, 2001.

A. Hyvärinen, J. Karhunen, E. Oja Independent Component Analysis, John Wiley & Sons, 2001.

Shapiro, L., Stockman, G., "Computer Vision", Prentice Hall, 2001.

S. Umbaugh, Computer Vision and Image Processing: A Practical Approach Using CVIP tools, Prentice Hall, 1999.

MA950 Topics in Differential Equations (4-0-0)4

Nonlinear first-order PDE: Complete Integrals, Envelopes, Characteristics, Boundary Conditions and local solution, Conservation laws, Shocks, entropy condition, Lax-Oleinik formula, Weak solution, Uniqueness, Riemann's problem, Long time behaviour, Hamilton- Jacobi equations, Calculus of variations , Legendre transform, Hopf-Lax formula.

Sobolev Spaces: Holder Spaces, Sobolev spaces, Weak derivatives, Elementary properties, Approximations by smooth functions, Extensions, Traces, Sobolov inequalities, Gagliardo-Nirenberg-Sobolev inequality, Morrey's inequality and Compactness.

L.C. Evans, Partial Differential Equations, AMS Publishers, 2009.

I. P. Stavroulakis and S. A. Tersian, Partial Differential Equations, World Scientific Publishers, 2004.

MA951 Theory of Partial Differential Equations (4-0-0)4

Linear PDE: Transport Equation, Laplace's Equation, Mean-value formulas, Green's function, Energy methods, Heat equation, Fundamental solutions, Properties of solutions, Wave equation, Solutions by spherical means, Nonhomogeneous problem.

Distributions: Test functions, Operations with Distributions, Support of Distributions, Convolution of Distributions, Fundamental solutions, Fourier Transform, Schwartz space, Fourier Inversion Formula, Tempered Distributions.

I. P. Stavroulakis and S. A. Tersian, Partial Differential Equations, World Scientific Publishers, 2004.

L. C. Evans, Partial Differential Equations, AMS Publishers, 2009.

S. Kesavan, Topics in Functional Analysis and Applications, New Age International Publishers, 2008.

DEPARTMENT OF PHYSICS

PH900 Advanced Solid State Physics 4

Crystal Structure, Symmetry operations; Symmetry elements, Point groups, and space group. Lattice Vibration and Phonons; optical properties in the infrared phonons; inelastic scattering Thermal Properties of Solid-Various theories of lattice specific heat; Free Electron Theory of Solid Heat capacity of the electron gas; spin paramagnetism of free electron; Band Theory of Solid-Nearly free electron model; origin of energy gap; Bloch theorem; Kronig and - Penney model; concepts of hole; effective mass of electron in crystals; tight band electron approximation; application to a simple cubic lattice; Brillouin zone; density of state; overlapping energy levels. Semiconductors, Superconductivity, theoretical and experimental aspects.

Asheroft and Mermin, Solid State Physics.
C. Kittel, Introduction to Solid State Physics.

PH901 Advanced Crystallography 4

Symmetry of crystals, crystal projection, reciprocal lattice, diffraction of x-rays, Factors affecting intensity of diffraction beams, experimental techniques of structure analysis.

L.V. Azaroff, Elements of x-ray crystallography, McGraw Hill

PH902 Materials Preparation Techniques 4

Crystal growth equilibrium, growth methods - solid-solid, liquid-solid and vapour-solid transformation, Growth from aqueous solutions, hydrothermal, high temperature solution and zone melting techniques.

R.A. Laudise, Growth of single crystals.

PH903 High & Ultra High Vacuum Technology 4

Production and measurement of vacuum, behaviour of gases at low pressure, vacuum materials, vacuum assembly techniques, design of vacuum systems and ultra high vacuum systems.

L.I. Maissel & R. Glang, Hand book of thin film technology, McGraw Hill.
G.W. Green, Design & construction of small vacuum system, Chapman & Hall.

PH904 Crystal Growth & Characterization 4

Basic concepts, Nucleation phenomena, Mechanisms of Crystal Growth, Dislocations, Crystal dissolution, Materials preparation and phase diagrams. Experimental methods of crystal growth, Growth from liquid-solid equilibria, Growth from vapor-solid equilibria. Mono-component and multi-component techniques. Thin film growth methods including LPE, MOCVD, MBE, PLD, etc. Crystal characterization.

Ivan V. Markov, Crystal Growth for Beginners, Fundamentals of Nucleation, Crystal Growth & Epitaxy, World Scientific, Singapore, 1996.
R. A. Laudise, Growth of Single Crystals, Prentice-Hall, 1970

PH905 Properties of Materials 4

Structure of metals - elements and simple alloys. Semiconductors - properties and structure - junctions, metal-metal, metal-semiconductor and p-n junctions. Properties of insulators - electrical, optical and magnetic.

LV Azaroff, Introduction to solids, Tata McGraw Hill, New Delhi.

PH906 Electronic Thin Film Science 4

Thin film deposition and Layered structures, Surface energies, diffusion in solids, stress in thin films, Surface Kinetic Processes, Homoepitaxy: Si and GaAs, Heteroepitaxy and Superlattices, Electrical and Optical Properties of heterostructures, Quantum wells, Barriers, Schottky barriers and Interface Potentials, Interdiffusion, Thin film reactions, Morphological changes in thin films.

King-Ning Tu, James W. Mayer and Leonard C. Feldmann, Electronic Thin Film Science for Electrical Engineers and Materials Scientists , Macmillan Pub. Co, New York, 1987
O. S. Heavens, Thin Film Physics, Methuen & Co. Ltd, London, 1970

PH907 Experimental Techniques for Characterisation of Materials 4

Metallographic Techniques - Optical Microscopy, Image Analysis. Diffraction Method - Characterisation of X-ray diffraction. Crystallographic Texture Measurement and Analysis, X-ray diffraction residual stress techniques, Neutron Diffraction. Resonance Methods - Electron Spin Resonance, Ferromagnetic Resonance, Nuclear Magnetic Resonance, Mossbauer Spectroscopy.

Electron Optical Methods - Analytical Transmission Electron Microscopy, Scanning Electron Microscopy, Scanning Tunneling Electron Microscopy (STEM), Electron Probe X-ray Micro-analysis. Classical, Electrochemical and Radiochemical Analysis- Classical Wet Analytical Chemistry, Volummetry, Electrogravimetry, Electrometric Titration, Radio Analysis.

Spectroscopy and Other Methods-Atomic Absorption Spectrometry, X-ray Spectrometry, Infrared Spectrometry, Raman Spectroscopy, Augar Electron Spectroscopy, Field Ion Microscopy, Atom Probe Micro-analysis, Electric, Dielectric and Magnetic Properties characterisation.

Edington J.W., Practical Electron Microscopy, Vol-01.
B.D. Cullity, Elements of X-ray diffraction.

PH908 Thin Film Technology & Devices 4

Methods of preparation, theories of growth, measurement of film thickness, properties - mechanical, electrical, structural characterization, Pattern generation, thin film devices.

L.I. Maissel & R. Glang, Hand book of thin film technology, McGraw Hill.
K L Chopra, Thin film phenomena, McGraw Hill.

PH909 Modern Optics 4

Propagation of light; Ray optics. Plane harmonic waves. Polarization, Fresnel's Equations. Coherence and Interference-Multiple beam Interference. Diffraction. Optics of solids. Thermal radiation and light quanta, optical spectra-Amplification of Light and lasers. Fibre Optics- Modes in step-index fibers and their Intensity patterns, LP modes, Dispersion and mode cut-off.

Grant R. Fowles, Introduction to Modern Optics , (2nd Ed.), Dover Pub. 1989.
Eugene Hecht, Optics (4th Ed.) Pearson Ed. Indian Ed. 2002

PH910 Laser Physics 4

The Einstein coefficients, Optical amplification and population inversion; Line shape functions:

Laser Rate Equations: Theshold condition for laser oscillation, Optimum output coupling; Q-switching and mode locking in lasers, Single longitudinal and single transverse mode oscillation; Laser systems: Ruby, Nd:YAG, Nd:

Glass lasers; Tunable lasers: Ti-Sapphire laser; Semiconductor lasers: quantum well lasers,

Thyagarajan K and Chatak A.K., Lasers, Theory and Applications, Plenum Press New York.
Koichi Shimoda, Introduction to Laser Physics, Spriger - Verlag, 1984.

PH911 Numerical Methods & Programming 4

Interpolation - Neuton's Langrange's Aitken - Neville's, Hermite's, spline techniques. Incurse interpolation-solution of transcendental and polynomial equations - Neuton - Rapson method-Iterative methods-Successive bisection. Numerical differentiation and integration methods- Simpsons's rule- Gaussion quadrature formula-Monte-Carlo method.

Linear systems and Matrices-Cramer's rule-Jacobi method-Eigen value problems. Solution of differential equations-Euler, Picard, Runge-Kutta methods. Polynomial and trigonometric approximations.

H.M. Antia , Numerical Methods for Scientists and Engineers, Tata McGraw Hill.
Yohn H. Mathews, Numerical Methods for Methetics, Science and Engineering, Prentice Hall.

PH912 Advanced Magnetic Resonance 4

Resonance theory, relaxation times. Nuclear Magnetic Resonance (NMR): Bloch equations,

Wide-line and high resolution NMR. Electron Spin Resonance (ESR): Zeeman interaction (g- tensor), Nuclear hyperfine interaction, Nuclear quadrupole interaction, Application to transition metal ions and free radicals. Principles of Nuclear Quadruplole Resonance (NQR): Zeeman effect, Phase transition. Double resonance: Electron Nuclear Double Resonance (ENDOR), Electron Electron Double Resonance (ELDOR), Nuclear Magnetic Double Resonance (NMDR), Optical Detection of Magnetic Resonance (ODMR). Zero Field Nuclear Magnetic Resonance, Ferromagnetic Resonance, Spin Wave Resonance. Practical aspects of resonance spectrometers: NMR, ESR and ENDR. Pulsed spectrometers: Measurement of relaxation times.

A. Carrinton and A.D. McLechlan, Introduction to Magnetic Resonance and Application to Chemistry and Chemical Physics. Chapman & Hall, 1979.
.E. Wertzd and J.R.Bolton, Electron Spin Resonance, Chapman and Hall, 1972.

PH913 Semiconductor Materials & Devices 4

Review of atomic structure and statistical mechanics : Schrodinger wave equation- Particle in a periodic potential well.

Crystalline and amorphous; inorganic and organic; elemental and compound semiconductors. Band models. Impurities and Defects. Bulk and thin film preparation methods. Equilibrium and non-equilibrium characteristics. Carrier transport phenomena. Optical and dielectric properties. Oxidation methods, Diffusion, Ion implantation, Metallization and Etching processes. The PN Junction Diode: Basic device technology; Heterojunction. Bipolar transistor, Microwave and power transistor and related devices. Metal-semiconductor contacts. JFET, MESFET, MOSFETs : Device structures and characteristics. Transferred-electron devices - Gunn effect. Principles of Photonic devices - LEDs, Diode, LASERs, Photodiodes. APDs and Solar Cells.

M. S. Thyagi, Semiconductor Materials and Devices, John Wiley & Sons, 1991
S Mahajan and K S Sree Harsha, Principles of Growth and Processing of Semiconductors, McGraw-Hill, 1998.

PH914 Applied Quantum Mechanics 4

Schrodinger wave equation and applications: free electrons in 3-dimensions, harmonic oscillator, Hamilton's equations, Hydrogen atom, Many electron atoms, Molecules, Crystals, Bonds in solids. Transitions, Tunneling, Statistical Physics, Bosons and Fermions, Electrons and Phonons, Electron Dynamics, Lattice vibrations, Operators, Quantum Optics: Coherent states, Many body effects, Magnetism.

Walter A. Harrison, Applied Quantum Mechanics, World Scientific, 2000
Ajoy Ghatak and S Lokanathan, Quantum Mechanics, Theory and Applications (fourth edition), Macmillan, 1975

PH915 Electronic Materials & Devices 4

The Crystalline nature of materials, bonding, Space lattices and X-ray diffraction. Wave mechanics of electrons, quantum wells and tunneling, particle in a box, Periodic Potentials, Electrical transport, Quantum statistics, Semiconductor Devices, PN Junction, BJT, MOSFET. Dielectric effects - Piezoelectric, Pyroelectric and Ferroelectric materials. Optoelectronic devices : Photodiodes and Lasers. Magnetic materials: dia, para, ferro and ferrimagnetism. Superconductivity. London's equations and BCS Theory.

David K Ferry and J.P. Bird, Electronic Materials and Devices, Academic Press, 2001
Rolf E Hummel , Electronic Properties of Materials, Narosa Pub. House, 1994.

SCHOOL OF MANAGEMENT

HU900 Quantitative Methods for Managerial Decisions 4

Basic concepts of probability, probability distributions, decision trees and different decision criterion. Linear Programming: Sensitivity analysis. Transportation problem. Integer programming, goal programming and dynamic programming. Introduction to Queueing theory, Simulation and Game theory. Nonlinear programming.

H.M. Wagner, Principle of Operations Research, Prentice Hall.
F.S. Hiller and G.J. Liebermann, Introduction to Operations Research, Holden Day, 1967. H.A.
Taha, Operations Research, 2nd edition, Macmillian, 1982.

HU901 Marketing Research 4

Introduction to Market/ Marketing Research, Research Components, Identification of Research Variables, Qualitative, Quantitative Research; Issues in Market Research, Research Problem definition, Research Methodology, Research Design, Data collection approaches, Sampling, Measurement and scaling, Data Processing, Hypothesis Testing, Statistical analysis of data; Analysis of Variance, Application of Computers in Market Research, Software Packages, Market Research Report Writing, Case studies, Mini Project.

G.A. Churchill, Marketing Research, Chicago Drydin Press, 1983.
P.E. Green and D.S. Tull, Research for Marketing Decision, PHI, 1982.
D.J. Luck, R.S. Rubin: Marketing Research (Seventh Edition), Prentice Hall, 1987.

HU902 Marketing Management 4

Marketing concept. Marketing management process. Marketing environment. Organizational market and buyer behaviour. Marketing Information System and research. Market segmentation, targeting and positioning. Planning marketing tactics. Product, price distribution and promotion decisions, E-Commerce, Ethnic Marketing, E-Marketing, Issues related to IPR, Case studies.

P. Kotler : Marketing Management, Prentice, Hall of India, 1984.
D.J. Dalrymple and L.J. Parsons, Marketing Management, John Wiley, 1982. R.W.
Haas: Industrial Marketing Management, Petrocelli / Charter, 1974.

HU903 Managerial Accounting 4

An overview of the accounting process, Nature and scope of corporate accounting, Elements of cost; Classification and distribution of overheads, Cost accounting flows, Financial accounting concepts, Impact of exchange rates, Balance sheet preparation, Financial statement analysis, Cost and management decisions: Product costing. Break-even analysis and cost profit relationships. Capital and cash budgeting for return on capital, periodic and continuous budgeting, budgetary control. Reporting systems for control: Scope for computerization.

R.N. Anthony, Management Accounting Principles, Irwing-Taraporewala.
Taylor & Shearing, Financial and Cost Accounting for Management, ELBS.
Horngren, Accounting for Management Control, Prentice Hall.

HU904 Management of Human Resources in Organizations 4

An introduction of the personal and interpersonal dynamics of the organization - Managing high performance: A challenge - Work motivation: Theoretical and behavioural framework. Improving work motivation in organizations. Human Resources Development (HRD): Behaviour scientist's view. Human capacity: Organizational change and development. T group and sensitivity training, management by objectives (MBO), transactional analysis (TA), quality circles (QC), performance appraisal (PA), AND training programmes. Managing human resources and organizational development: The present status.

C.R. Anderson, Management : Skills, Functions, and Organizational Performance, Wm. C. Brown, 1984.
W.L. French, C.H. Bell, and R.A. Zawacki, Organizational development: Theory, Practice and Research, Irwin, 1989.
P. Hersey and K.H. Blanchard, Management of Organizational Behaviour: Utilizing Human Resources. Prentice Hall, 1988.

HU905 Organizational Behaviour & Implications for Management 4

An Introduction of Organizational Behaviour, Historical development and basic concepts, Understanding a social system, Mainsprings of motivation, Human needs and motivating employees. Interpreting motivational models of Maslow, Herzberg, Vroom, and McClelland. Job satisfaction and work performance. Appraising and rewarding performance. Leadership and organizational development. Supervision and participation. Interpersonal and communication problems within the organizations. Organizational Development Techniques: Their applications in Indian Organizations. Japanese Management: Basic philosophy and features. Comparative analysis of American and

Japanese management. Organizational behaviour in perspective.

Davis, K. Human behaviour at work:Organizational behaviour. NY: The Groller Business Library, 1987.
Luthans, F. Organizational behaviour. NY: McGraw, 1995.
Hersey, P. & Blanchard, K.H. Management of organizational behaviour: Utilising human resources. Prentice- Hall, 1988.

HU906 Research Methodology - Methods & Techniques 4

Research Methodology: An introduction. Defining the Research Problem. Research Design. Sampling Design. Measurement and Scaling Techniques. Methods of Data Collection. Processing and Analysis of Data. Sampling Fundamentals. Testing of Hypotheses - I (Parametric or Standard tests of Hypotheses). CHI- Square Test. Analysis of Variance and Covariance. Testing of Hypotheses- II (Non-parametric or Distribution-Free Tests). Multivariate Analysis Techniques. Interpretation and Report Writing. The Computer: Its Role in Research.

Kothari C.R. - Research Methodology- Methods and Techniques, Wiley Eastern, 1990.

HU907 Management Information System 4

Various issues revolving around the strategic role of managing information - Purposes of various hardware components comprising the computer system - Internet, Intranet and Extranet - Strategic role of major business applications software - Current operating systems and network support utilities commonly found in a variety of IS environments - Methodologies used to redesign the information infrastructure of the organizational enterprise - Managing systems security and implementing systems wide information controls - Factors to consider when managing international information systems.

Kenneth C. Laudon and Jane Price Laudon, Management Information Systems, Prentice Hall
O'Brien, Irwin, Management Information Systems: Managing Information Technology in the E-Business Enterprise, 2002.

HU908 Strategic Management 4

Introduction to Business Strategy; Industry and Firm Analysis - Industry, Organization, Stakeholders, Market Environment Analysis; Formulation of Business Policy and Strategy; Evaluation and Choice of Business Policy; Strategy Alternatives and Selection; Competitive Dynamics - Game Theory; Corporate and Global Strategy; Strategy Implementation. Case Analysis -The cases are about real world business situations, which provide an opportunity to apply the concepts, discussed in class as well as further develop ability to think about business strategy.

Hitt, Michael A., R. Duane Ireland, and Robert E. Hoskisson, Strategic Management: Competitiveness and Globalization, Cincinnati, Ohio, South- Western College Publishing, 2002.
George A. Steiner, John R. Miner and Edmund R. Gray Management Policy and Strategy, Maxwell MacMillan Intl. 1989.

HU 909 Mathematical Economics 4

The nature of mathematical economics - Mathematical vs. non-mathematical economics - mathematical economics vs. econometrics.Elementary mathematics: Revision concepts- Matrix algebra - functions, differentiation and integration, maximisation and minimisation, set theory. Marginal analysis, Equilibrium analysis: Static, dynamic and comparative static analysis. Optimisation and linear programming. Input-output analysis - Static and dynamic versions. Game theory. Micro, macro applications of the models.

Allen, R. G. D., Mathematical Analysis for Economists, ELBS, London, 1973.
Chiang, A. C., Fundamental Methods of Mathematical Economics, Mcgraw-Hill, New York, 1967.
Mckenna, C. J. and Rees, R., Economics: A Mathematical Introduction, OUP, London, 1992.
Basu, A. K., Ghosh, J. K., Sen, P.K. and Sinha, B.K., Perspectives in Statistical Sciences, OUP, New Delhi, 2001.

HU 910 Research Methods in Economics 4

The Methodological Foundations of Economic Analysis - Historicism, Positivism, Abstraction and Generalisation in Economic Science. The purpose of and approach to Research. Formulation of Research problem and Research Design. Meaning of Hypothesis and Testing of hypotheses. Methodology of model building. Types of Economic models - Methods of data collection. Surveys and Sampling techniques. Structure of Dissertation.

C.T. Kurien, (Ed.), A Guide to Research in Economics, Sangam Publishers, Madras, 1973.
C.R. Kothari, Research Methodology: Methods and Techniques, Wiley Eastern, New Delhi, 1985.
M. Blaug, The Methodology of Economics, Cambridge University Press, Cambridge, 1980.

HU 911 Financial Institutions and Markets 4

Financial System - Type of Financial Institutions - Commercial and Co-operative Banks - Non-Banking Financial Institutions - Equity Market - Debt Market - Government Securities Market - Major Financial Services - Foreign Exchange Market - Interest Rates in Financial Markets.

Bhole, L. M., Financial Institutions and Markets [New Delhi: Tata McGraw Hill], Third Edition, 1999.
Edminister, R. O. Financial Institutions and Markets, and Management [New York: Tata McGraw Hill], 1986.
Johnson, H. J. Financial Institutions and Markets [New York: McGraw Hill], 1993.

HU 912 Technology, Industry and Trade **4**

Technology, Industry, Trade and Cycles: Technological and Non-technological theories linking industrialization with trade. The Process of Technological Innovation: Patterns and influence. Evaluating Policies for Technological Innovation and Elements of Technology Policy. The Technological Structure and Performance of Developing Country Exports. Skills and Competitiveness in developing countries. Multinational Corporations, Technology Development and Export Competitiveness. Global Business Environment, Technology and Trade. Globalisation and Technology Intermediation. Trade Prospects with Reindustrialization and Technology Policy.

Dunning, John H., The Globalisation of Business [London: Routledge], 1993.
Lall, Sanjaya. Competitiveness, Technology and Skills [Cheltenham: Edward Elgar], 2001.
Nayyar, Deepak (Ed.). Trade and Industrialization [New Delhi: Oxford University Press], 1999.
Siddharthan, N. S. and Y.S. Rajan. Global Business, Technology and Knowledge Sharing: Lessons for Developing Country Enterprises [New Delhi: Macmillan], 2002.
Srinivasan, T. N., Developing Countries and the Multilateral Trading System: From the GATT to the Uruguay Round and the Future [New Delhi: Oxford University Press], 2000.

HU 913 Economic Environment & policy **4**

Economic and Non-Economic Environment, Interaction between Economic and Non-Economic Environment. Analysis of contemporary Macro - Economic and Micro - Economic Problems and Issues, Related Governmental Policies and Their Impact on the Business Firm. Including Unemployment, Inflation, Fiscal and Monetary Policy, Government Regulation of Business, Business Concentration and Anti - Trust Policy; Income Distribution and International Economic Relations.

Dunning, John H., The Globalisation of Business [London: Routledge], 1993.
Welch, Patrick J. and Welch, Gerry F., Economics: Theory and Practice, John Wiley & Sons, 2004, (7th Edition)

HU 918: Aesthetics and Criticism **4**

The nature of Aesthetics: Aesthetics as "metacriticism"; the relationship between art-criticism and aesthetic theorizing; the relationship between creative practices and aesthetics. Some major theories of art: Western- (a) Formalism-Structuralism; (b) Post-structuralism; (c) Art and the human mind: Psychoanalysis; (d) Art and human society and culture: Marxism, Cultural Studies; (e) Feminism; (f) Post-modernism and Post-colonialism; Some major theories of art: Indian- (a) the Dhvani theory; (b) the Rasa theory

Ahmad, Aijaz. In Theory: Classes, Nations, Literatures. Delhi: OUP, 1992.
Krishna, Daya India's Intellectual Traditions:Attempts at Conceptual Reconstructions. Delhi: ICPR & Motilal Banarsidass, 1987.
Niranjana, T., P. Sudhir and V. Dhareshwa, Interrogating Modernity: Culture and Colonialism in India Calcutta: Seagull, 1993.
Rader, M. (ed.) A Modern Book of Esthetics, Harcourt, 1979. Singer, Alan et al (eds.) Literary Aesthetics. Blackwell, 1999.
Seturaman, V. S. (ed.) Indian Aesthetics: an introduction. Madras: Macmillan, 1992.
Turner, Byran S. (ed) Theories of Modernity and Post-modernity. London: Sage, 1990.
Waugh, Patricia (ed) Postmodernism: A Reader. London: Edward Arnold, 1992.
Zima, Peter V. The Philosophy of Modern Literary Theory. London: The Athlone Press, 1999.

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NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

STUDENT DECLARATION ON THE *NITK HONOUR CODE*

I do hereby undertake that as a student at NITK-Surathkal, I shall be bound by the NITK Academic Regulations & Curriculum, and all the applicable Rules governing the academic programmes; and also specifically that :

(1) I will not give or receive aid in examinations; that I will not give or receive un-permitted aid in class work, in preparation of reports, or in any other work that is to be used by the instructor as the basis of evaluation/grading; and

(2) I will do my share and take an active part in seeing to it that others as well as myself uphold the spirit and letter of the *NITK Honour Code*.

I realize that some examples of misconduct which are regarded as being in violation of the *Honour Code* include (but is not limited to) what is listed here below:

- Copying in examination, from another's paper or from any other source;
- Allowing another to copy from one's own examination paper;
- Un-permitted collaboration in any form whatsoever;
- Plagiarism of any form or extent;
- Revising and resubmitting a marked quiz or examination paper for re-grading without the instructor's knowledge and consent;
- Giving or receiving un-permitted aid on take-home examinations, etc.;
- Representing as one's own work the work of another, including information available on the Internet, etc.;
- Giving or receiving aid on an academic assignment under circumstances in which a reasonable person should have known that such aid was not permitted;
- Committing a cyber offence, such as, breaking passwords and accounts, sharing passwords, electronic copying, planting viruses, etc.;
- Engaging in any act of indiscipline whatsoever, directly or indirectly, whether in the Institute premises or in the Hostels/Campus/etc, or even outside the Institute, that would reflect or project an undesirable image on the Institute;

I understand and accept that any act of mine that can be considered to be a violation of the NITK *Honour Code* will invite disciplinary action as decided by the Institute Authorities.

Student's Full Signature : _____

FULL NAME IN BLOCK LETTERS : _____

_____

Semester Fee Payment Receipt Number & Date : _____

Student Register Number :

Admission Number (if assigned)						Roll Number (if assigned)						

Date : _____

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to be duly filled-in by the student, and *signed in presence of the Faculty-Advisor or the HOD.*

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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- Representing as one's own work the work of another, including information available on the Internet, etc.;
- Giving or receiving aid on an academic assignment under circumstances in which a reasonable person should have known that such aid was not permitted;
- Committing a cyber offence, such as, breaking passwords and accounts, sharing passwords, electronic copying, planting viruses, etc.;
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Admission Number (if assigned)						Roll Number (if assigned)						

Date : _____

- copy to be retained by the student, as a *Reference* -