COMPUTER ENGINEERING & I.T.

M.Tech.(COMPUTER-COMPUTER ENGINEERING)

Effective from A. Y. 2011-12

3INDEX

List of Abbreviations

Sr. No.	Abbreviation	Stands for:
1	DEC	Departmental Elective Course
2	PCC	Program Core Course
3	LC	Laboratory Course
4	HSSC	Humanities and Social Science Course
5	MLC	Mandatory Learning Course
6	LLC	Liberal Learning Course
7	OEC	Open Elective Course
8	SEC	Science Elective Course
9	PSEC	Program Specific Elective Courses

M. Tech., RULES AND REGULATIONS
(Effective from 2011-12)

COLLEGE OF ENGINEERING, PUNE
Wellesley Road, Shivajinagar, Pune 411005

1. Rules

1.1 The Senate and BOG, College of Engineering, Pune, recommends University of Pune to award the degree of Master of Technology (M. Tech) in Engineering to those who have successfully completed the stipulated Postgraduate Masters Program.

1.2 The Postgraduate Masters Program with the governing Rules and Regulations are formulated & approved by the Senate and BOG of the institute. The Senate can modify or change the course structure, the governing rules and regulations from time to time and shall recommend them to BOG for its approval. These rules and regulations will be applicable to any candidate seeking admission for M. Tech/P.G. programme in the institute.

1.3 A candidate becomes eligible for the recommendation to the Pune University for the award of the M. Tech. degree after fulfilling all the academic requirements prescribed by the Senate of the Institute.

1.4 Director, COEP and Chairman Senate would appoint a Professor from the Institute to work as a Chairman of the PG admission committee on his/behalf. Chairman, PG Admissions would be responsible for the entire admission process including scrutiny of applications and conduct of entrance test, interviews of the candidates etc. He/she would be assisted by the respective departmental heads and departmental admission committee appointed by the Director.

2. CATEGORIES OF M. TECH. STUDENTS

The Institute admits M. Tech students under the following categories:

I) REGULAR (FULL-TIME)

These are students who work **full time** for their M. Tech. degree and receive assistantship from the Institute or any other recognized funding agency.

II) SPONSORED (FULL-TIME) STUDENTS

A candidate in the category is sponsored by a recognized R&D organization, national institute, governmental organization or industry for doing M.Tech in the Institute **on a full time basis**. He/she should have at least two years of working experience in the respective field. He/She will not receive any financial support from the Institute. Sponsorship letter (Form I) should be attached with the application. During the course of programme if a regular student secures a job and wishes to join the same, then he/she will be treated as a sponsored candidate and he/she will have to get the sponsorship letter from him employer. He/she would be charged institutional fees as for sponsored candidates.

III) PROJECT STAFF

This category refers to candidates who are working on sponsored projects in the Institute and admitted to the M. Tech. program. The duration of the project at the time of admission should be at least 2 years. This category of students may be registered on a full-time or a part-time basis.

IV) INSTITUTE FACULTY

This category refers to the candidates who are the staff of College of Engineering , Pune, who can attend classes at the Institute while employed. These candidates should be able to attend regular classes as per the schedule of the Institute. The applicant must be a regular employee of the institute with at least two years of experience with the institute at the time of admission and be engaged in professional work in the discipline in which admission is sought. No financial assistance will be provided by the Institute to such students. A No Objection Certificate from the Head of the Department must be enclosed at the time of applying. This candidate would pay regular fees of the institute under full/part time student category and no concession in institute fees can be allowed.

V) FOREIGN STUDENTS

This category refers to all the Foreign Nationals, who are eligible for Admission to the M.Tech program and who have a certification from the Pune University Foreign Students Cell about their admissions to M.Tech. These students will submit a certificate from the Pune University certifying their Equivalence of Courses at undergraduate levels. These students will have to appear for the institute entrance examination and also a English language test, conducted by the institute. If these students fail in the English language test their applications will be rejected even though they pass in the institute admission test. No financial assistance of any sort will be available for these students. Before admission, these students will have to get a clearance about their background check by the Department of Home, Government of India. A candidate in this category will be admitted **on a full time basis** subject to compliance of various norms laid down by the competent authority from time to time.

3. MINIMUM QUALIFICATIONS

Students for admission to the M. Tech. Program in Engineering Departments must satisfy one of the following criteria:

(i) Bachelor's degree in Engineering/Technology or equivalent in an appropriate area, with a minimum of First Class/60% marks or CGPA of 6.5 on a scale of 10 or equivalent (CGPA of 6.00 or equivalent in case of SC / ST).

(ii) Valid GATE score for Regular (full-time) students.

Departments may specify additional requirements over and above these minimum requirements. All the Non-GATE candidates will have to undergo an entrance test conducted by department in which he/she is applying. Passing in this test will be mandatory for admission.

For the Foreign Students the criteria as in para 2(V) above will be applicable. For these students Institute Admission Test as well as English Test will be mandatory.

4. ADMISSION PROCEDURE

4.1 Admission to the M. Tech. Program of the Institute will normally be in the months of June/July every year. For admission an advertisement will be issued in the month of April/May in National level English news paper, State level Marathi News papers as well as on the Institute website.

4.2 Admission to all the category of students is granted on the basis of GATE scores and / or an interview / admission test held usually during the month of June or July every year. It will be mandatory for every candidate to appear for the Entrance Test and Interview. No absentia of any sort would be allowed.

4.3 The applicants who have completed or are likely to complete all the examinations including the thesis oral examination, viva etc. of the qualifying degree by the date of admission to the program may be considered for admission; however, if admitted, they must produce the evidence of their having passed the qualifying degree examination with the specified minimum marks/CPI (as specified in clause 3) within 8 weeks of the beginning of the semester, failing which their admission is liable to be cancelled. In case of any dispute or discrepancy decision of the Director COEP and Ex-officio Chairman of the Senate will be final and shall be binding on the candidate.

4.4 Candidates seeking admission for the M.Tech course other than the area in which candidate has completed his/her bachelor's degree will be eligible to apply provided they have a valid GATE score in the area in which they wish to pursue their M.Tech. These candidate will not be eligible for the scholarships from the external funding agencies. These students will have to under go Institute Entrance Test/Interview conducted by the concerned department.

5. FINANCIAL SUPPORT

Students admitted to the M. Tech. Programs will be considered for assistantships, fellowships etc. subject to the following norms:

5.1 A student must have a valid GATE score at the time of admission.

5.2 Students receiving assistantship from the Institute or from any other funding agencies will be required to perform academic duties assigned to them by the departments as per rules in force from time to time.

5.3 The continuation of the assistantship/fellowship will be subject to satisfactory performance of the duties assigned by the department and satisfactory progress in the postgraduate program. Financial assistance of the candidates failing to secure minimum grades in the semester examination would be stopped without any prior notice.

5.4 Financial assistance will normally be for a maximum period of two years. In no case, it will be extended beyond 2 years.

5.5 No financial assistance from the Institute will be available to foreign students. Project staff will get funding from project as per rules but will not get any additional assistance from the Institute.

5.6 Only those students who are currently registered in the postgraduate program shall be entitled to scholarships. The students on leave longer than that specified under the leave rules, and those who are not registered are not entitled to scholarship.

6. LEAVE RULES

6.1 An M Tech student is eligible for maximum 30 days of leave in a calendar year.

6.1.1 The leave of 30 days includes medical and all other leaves, in an academic year. If any Saturday, Sunday or Holiday falls during the leave, they will be counted towards the leave except for such holidays prefixed or suffixed with the leave. **The accumulated leave can be availed during vacation only.**

6.1.2 Out of the 30 days of leave per annum, an M. Tech. Student will be permitted to avail maximum 15 days of leave on completion of each semester. However, any leave not availed at the end of any semester can be carried over to the next semester and the cumulative can be availed together, subject to a maximum of 30 days at a time.

6.1.3 During the semester period, (i.e. July – November and January – May), a student will be allowed only a maximum of 5 days of leave .
6.2 Absence without obtaining prior sanction of leave will be considered as an act of indiscipline and shall entail reduction of scholarship on a prorata basis, besides any other action that may be decided by the Institute.
6.3 Any absence over and above the prescribed limit of admissible leave shall entail deduction from the scholarship, besides other actions as may be decided by the Institute.
6.4 If a student remains absent or discontinues from the course for a period of more than 3 months his/her admission to the course will be automatically cancelled.
6.5 If a student is unable to complete his/her M.Tech within a period of two years, he/she must apply for permission for the extension of time by six months immediately after completion of two years, with recommendations of the concerned guide and head of the department to Dean Academics. Dean academics will seek the approval of the Director COEP and the Chairman, Senate for granting such extensions on case to case basis. Maximum two extensions of six months duration would be permissible for M.Tech student from any category of students as stipulated in Section(2) above. This extension period will not exceed the total period of three years from the date of admission of the candidate in the institute. Candidate will have to pay institute fees prevailing during this extension period.
6.6 If a student fails to complete his/her M.Tech within a period of four years from the date of admission for the course he/she will automatically cease to be a student of the institute and his/her admission would be automatically cancelled.

7. REGULATIONS

7.1 Rules and regulations

All the rules and regulations pertaining to academics, academic calendar, semesters, discipline etc. will be same as that of B.Tech. regulations.

7.2 Admission

Candidates whose selection is approved by the Chairman, Senate will be admitted to the M. Tech. program of the Institute after payment of the prescribed fees prevailing at the time of admission. BOG reserves the right to modify the Institute fees time to time.

7.3 Academic requirements

7.3.1 Semester load and course units

A semester load would be as per the Syllabus structure in force and as recommended/modified by the Senate from time to time. The minimum credit requirements for the successful completion of M.Tech. would be as specified in the syllabus structure prevailing at the time of admission for the course. The current minimum credits for the completion of M. Tech is 80 credits as specified in the syllabus structure. Any changes subsequently made by the Senate in the minimum credit requirements or syllabus structure will be applicable to only the new/fresh students and not applicable to the old candidates.

7.3.2 The residence requirements for students registered in M Tech. is four semesters. They will be required to complete a minimum credits of load as specified in the course structure in force. Every M Tech student must complete prescribed courses as specified in the syllabi structure. SGPA and CGPA will be calculated on the basis of all the courses taken by the student. No regular student/sponsored student/Research Staff/Institute Faculty/ Foreign student registered for the M Tech program shall continue in the program for more than 3 years after the first registration. The course and research requirements in individual

departments/program may be over and above the minimum stated here. The departments/program shall obtain prior approval of the Senate of such requirements and will also inform the students in their postgraduate program at the time of their admission.

7.3.3 Grades and points

(a) The performance of the students in their course work will be evaluated in terms of letter grades: AA, AB, BB, BC, CC, CD, DD & F. These grades are equivalent to the following points/ratings on a 10 point scale representing the quality of performance.
AA = 10, AB = 9, BB = 8, BC = 7, CC = 6, CD = 5, DD = 4, FF = 0.
(b) If a student has done a part of the course work, but has for a genuine reason not been able to do the remaining part, the instructor may send the grade 'I' (incomplete). In this case the student must contact the Instructor soon after the examination and if the Instructor is convinced that the reasons for missing a part of the course/examinations are genuine he may let the student make up for the portion missed. The 'I' Grade can be converted into a regular grade by the Instructor within two weeks of the last date of the End Semester Examination. Otherwise, this will automatically be converted into 'F' Grade.

7.3.4. Academic performance requirements

(a) The SGPA (Semester Grade Point Average) or CGPA (Cumulative Grade Point Average) of a student in any particular semester is calculated as follows:
(i) The points equivalent to the grade awarded in each course for which the student has registered is multiplied by its unit rating.
(ii) These products are added and sum is divided by the total number of units. The ratio is the SGPA or CGPA depending on whether the number of units refer to those in that particular semester or to those in the total period of student's postgraduate program.
(b) **The minimum CGPA requirement for continuing in the M. Tech. program is 5.0**. However, M Tech student securing a CGPA between 4.5 and 5.0 may be allowed to continue in the following semester on the recommendation of the DPPC (Departmental Postgraduate Program Committee) and with approval of the Senate.
Students who secure a CGPA below 5.0 in two consecutive semesters will not be allowed to continue in the postgraduate program. Students must obtain a minimum CGPA of 5.0 in order to graduate. In the first semester in which the student registers the minimum CGPA (SGPA) requirement can be relaxed to 4.5.

7.3.5 Thesis/Project

(a) Project duration shall be one year or two semesters. Thesis supervisor(s) for a student will be appointed from amongst the faculty members of the College of Engineering, Pune. Departments will evolve modalities for appointing of supervisors keeping in view the students' aspirations and faculty interest. The DPPC will co-ordinate this activity and will formally communicate the appointment of thesis supervisor(s) of a student to the COE. No change/addition of Supervisor(s) is allowed after the thesis has been submitted to the academic section. In case there has been a change/addition in the Supervisor(s) the thesis

will be submitted not earlier than three months from the date of communication of such change/addition to the academic section.

No student once registered for thesis/project units will be allowed to continue the program without a Thesis Supervisor having been appointed by the DPPC. No student will have more than two supervisors. No change in thesis supervisor(s) will be allowed without the consent of the Chairman, DPPC. In exceptional cases, with prior approval of the Chairman, Senate on the recommendation of the DPPC and COE a student may be allowed to have a co-supervisor from outside the institute.

(b) Project evaluation:

Project evaluation shall be done in two phases in both the semesters. First phase of evaluation shall be in the middle of the semester and second phase of the examination shall be after the end-semester theory examination of the semester.

There will be separate grades awarded for the project course in two semesters. The credits in the first semester shall be relatively less and evaluation shall be based on the literature survey, problem definition, problem formulation, fabrication or software development and preliminary results.

A brief report is required to be submitted at the end of semester. The evaluation and grading will depend on the candidate's performance in the two phases of evaluation in the semester.

The second semester of the project shall carry relatively more weightage and the evaluation shall involve external examiners. The details are provided in the following sub-section.

(c) Thesis/Project Oral Examination Committee :

The thesis/project will be examined by an oral examination committee consisting of the supervisor(s) or in his/her absence the program co-ordinator with prior consent of the supervisor and at least two but not more than four other faculty members of the institute proposed by the thesis supervisor(s)/program co-ordinator in consultation with Head of the Department, recommended by the convener, DPPC and approved by the Dean Academics and COE. The thesis supervisor/program co-ordinator will act as the convener of the committee and one of the members of the committee will be an External Examiner as a part of the panel of examiners.

(d) The Convenor, DPPC will submit to the academic section for approval of the Chairman, DPPC the names of the thesis/project examiners on the prescribed form, at least two weeks before the submission of the thesis. Unbound typed copies of thesis/project one for each examiner prepared according to the prescribed format available in the academic section will be submitted at least one week before the probable date of the oral examination. The oral examination will be held within two months from the date of submission of the thesis/project. If however the student does not make available for the examination, his/her program will be deemed to have been terminated. Request for revival of the program by such a student should be addressed to the Chairman, Senate.

The Department will record the date of submission of the thesis/project and arrange to send the thesis to the examiners. The supervisor/program co-ordinator will inform the examiners of the date of the oral examination and send a copy to the academic section. The

thesis/project will be evaluated and the Oral Examination conducted by the Committee on the scheduled date. The report will be communicated by the Convener, DPPC to the academic section for record and necessary action.
The grade to be awarded to a student shall be evolved by the committee by consensus. The report of the oral examination committee including the grade shall be submitted to the Convenor, DPPC by the committee.

(e) Acceptance/Rejection of the Thesis/Project

A thesis/project will be considered to have been accepted if all members of the committee recommend its acceptance. Otherwise thesis/project will be considered to have been rejected. If a thesis/project is rejected along with a recommendation by the Committee for resubmission after incorporating and modification/correction suggested by the Committee, oral examination for the re-submitted thesis/project will be conducted by the same Committee unless otherwise approved by the Chairman Senate. If the resubmitted thesis/project is rejected, the matter will be reported to the Senate for appropriate action. Acceptance of thesis/project will be reported by the COE to the Senate for approval.

7.3.6. Provision for the Change of Guide

Project Guide may submit his request for change of guide to the HoD of the concerned department stating the reasons for the change request. HOD of the concerned department will forward the Application with his/her recommendations and name of the new proposed guide to the Dean Academics for the permission. Dean Academics in consultation with the Director, COEP and Chairman of the Senate may approve such applications.

Procedure for submission of M. Tech. Project Thesis and Oral Examination

1. The supervisor(s) shall be satisfied that the work has been completed. The supervisor(s) shall forward a list of examiners (comprising of at least two but not more than four faculty members from the department, in addition to the supervisor(s) and one member from outside the department or an external expert) through the Departmental PG Coordinator, to HOD.
2. The HOD will then forward the list of examiners to the Dean of Academics for the approval at least 15 days before submission of the thesis.
3. Following the approval, unbound copies of the thesis (one each for every examiner) shall be submitted to the Department (PG Coordinator) at least one week before probable date of the examination.
4. The PG Coordinator, will fix the date of oral examination, make an announcement (through notices and e-mail) and forward unbound copies of thesis to the examiners. The date of oral examination shall be communicated to the COE.
5. The oral examination of a M. Tech. Project shall be held as per announced schedule and it shall be an open one.
6. The Supervisor / PG Coordinator (if Supervisor is not available at the time of oral examination) shall be the convener of the oral examination committee. The committee shall evaluate the project of the candidate on the basis of presentation of the report, originality of the contents therein, demonstration of equipment model/ hardware/ software developed, the

oral presentation and oral examination. In case the committee recommends a major revision and recommends a re-examination of the project, Grade "I" shall be awarded and the student shall be required to continue the project and resubmit the thesis within a period of two months. In case the committee rejects the thesis, Grade "F" shall be awarded and the student shall be required to re-register for the project in the next semester.

7. On successful completion of Oral Examination, each student shall submit bound copies of the thesis making corrections, if any, suggested by the examiners (one each to the supervisor(s), Academic Section and the department). The academic section will forward the copy of the thesis/report to the Central library after verification.

8. The candidate should also submit a soft copy of the thesis in pdf format to the PG Coordinator who shall compile all the M. Tech project reports of the academic year of the department on a CD and same shall be placed in the dept library and institute website server.

FORM-I

Format of Certificate by the Employer/Management for Sponsored Candidates

This is to certify that ,

Shri./Smt._____

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is working in this Institute as _____ since _____and he/she is permitted to study for **M.Tech program** at College of Engineering, Pune. If he/she is admitted to the said program, he/she will be permitted to attend the College as a full time student during the working hours of the College till completion of his/her program. We understand that he/she will fulfill institute norms for the attendance.

This is further to certify that he/she has been appointed on regular basis and his/her appointment is not temporary.

FORM II – APPLICATION FOR THE EXTENSION OF TIME

Reference No.
Date:
To
The Dean Academics,
College of Engineering , Pune

Sub : Grant of six months extension in order to complete M. Tech. Program

Dear Sir,

I of Mr./ Ms .....who is M.Tech student in ……..Department and pursuing my M. Tech in ……..specialization. I have joined the M.Tech. course in the academic year …… . I am unable to complete my M.Tech. in the prescribed period of two years. I am aware that maximum duration of my M.Tech. course is four years and my admission for the M.Tech will get cancelled after a period of four years from the date of admission and no extension of time is permissible after three years.

I may be permitted Six months extension for completing M. Tech. Program at your Institute as a full -time student.

Date: Signature of the Student

Recommendation of the Project Guide

FORM III – Undertaking By the Full Time M.Tech (Non-Sponsored Student)

Reference No.
Date:
To
The Dean Academics,
College of Engineering , Pune

Sub : Undertaking by the M.Tech Students who is a Non-Sponsored Full Time Student

Dear Sir,

I of Mr./ Ms ..... is M.Tech student in .....Department and pursuing my M. Tech in .....specialization. I have joined the M.Tech course in the academic year ..... .

I here by solemnly affirm that I am not in any sort of full time/Part Time or Visiting employment of any sort in any organization while joining my M.Tech as fulltime student. I do here by undertake that I will not engage myself in any sort of employment either fulltime/part time or visiting during my studentship as fulltime M.Tech student of College of Engineering, Pune, unless otherwise I am offered such privilege by COEP under a sponsored project.

I do understand that if I am found to indulge in such employment any time during my tenure as a Full Time M.Tech student of College of Engineering, Pune , my admission to M.Tech course will be immediately cancelled by the institute in addition to financial penalty and other disciplinary action initiated by Dean Academics, on behalf of the institute.

Date: Signature of the Student

Recommendation of the HOD

M Tech (Computer Engineering)
Specialization: Computer Engineering

Structure

Semester I

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	OEC-I IS - 501	Software System Engineering	3	0	0	3
2.	Core-I CT - 501	Advanced Computer Architecture	3	0	0	3
3.	Core-II CT - 503	Advanced Computer Networks	3	0	0	3
4.	Core-III CT - 505	Topics in Databases	3	0	0	3
5.	DE-I CT - 513 CT-515	A. Distributed Operating Systems B. Program Verification	3	0	0	3
6.	DE-II CT-519 CT-521 CT-523	A. Advanced Compiler Construction B. Machine Learning C. Graphics and Visualization	3	0	0	3
7.	PGL CT-511	PG laboratory I /Mini Project	0	0	3	2
		Total	**18**	**0**	**3**	**20**

Semester II

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	OEC-II IS-502-2	Financial Computing	3	0	0	3
2.	DE-III CT-506 CT-522 CT-516	A. Data Mining and Warehousing B. Advanced topic in Graph Theory C. Linux Kernel Programming	3	0	0	3
3.	Core –IV CT-502	Advanced Algorithms	3	0	0	3
4.	Core – V CT-504	Security in Computing	3	0	0	3
5.	DE-IV CT-518 CT-520	A. Embedded System B. Bio Informatics	3	0	0	3
6.	MLC ML-504	Intellectual Property Rights	1	0	0	1
7.	PGL CT-512	PG Laboratory- II/ Mini Project	0	0	3	2
8.	PGL CT-514	PG Laboratory- III/ Mini Project	0	0	3	2
		Total	**16**	**0**	**6**	**20**

Semester-III

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	MLC ML-601	Constitution of India	2	0	0	2
2.	MLC ML-603	Environmental Studies	2	0	0	2
3.	PS-I CT-601	Project Work-I	0	0	0	15
4.	LLC ML-601	Liberal Learning Elective	0	0	0	1
		Total	**4**	**0**	**0**	**20**

Semester-IV

Sr. No.	Course Code	Course Name				Credits
			L	T	P	
1.	PS-II CT-602	Project Work-II	0	0	0	20
		Total	**0**	**0**	**0**	**20**

Semester I

OEC I (IS-501) - Software System Engineering

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:
After learning this course students will be able to

a. Understand Full life cycle Software Engineering Activities
b. Apply the understanding and create a software applications and systems
c. Analyze requirements in various areas like custom built applications/systems and products in areas like finance, retail, health, manufacturing and socially relevant areas like energy, education and water management.
d. Evaluate different tools, process that can be used for software engineering processes.
e. Evaluate quality of various software systems / applications / products.
f. Understand how to maintain applications and systems and apply that understanding in real life situations.
g. Understand how to test applications and systems and apply that understanding in real life situations.

Introduction **(6 Hrs)**
Performance Trends of Software Development Activities, Types of Software Systems - Real Time Systems, Systems Integration, Products, Application. Types of Projects – Development, Maintenance, Reengineering, Reverse Engineering.

Estimation and Benchmarking **(6 Hrs)**
Estimation Methods – COCOMO, CoSysMo, Use Case Points, Cosmic Function Points. Benchmarking.

Current Paradigms **(6 Hrs)**
Model Driven Development, Agile Methodology, SQC.

Software Engineering Process **(6Hrs)**
CMMi, Use of Statistical Quality Control.

Testing **(6Hrs)**
Testing Types – load stress, performance, usability, Automation of Testing.

Current Topics **(6Hrs)**
Current Topics from IEEE Software and Computer Magazine and Transactions on Software Engineering.

References:

1. Thomas M. Pigoski, Practical Software Maintenance: Best Practices for Managing Your Software Investment, Wiley, 1996.
2. April Alain and Abran Alain, Software Maintenance Management. Evaluation and Continuous Improvement, Wiley-IEEE Computer Society Press, 2008
3. Gopalaswamy Ramesh, Ramesh Bhattiprolu, Software Maintenance: Effective Practices for Geographically Distributed Environments, Tata Mc Graw-Hill, 2006
4. Capers Jones, Estimating Software Costs, Mc Graw-Hill, 2nd Edition, 2007.
5. Capers Jones, Software Assessments, Benchmarks and Best Practices, Addison-Wesley Professional, 2000.

6. Barry Boehm, Chris Abts, A. Winsor Brown, Software Cost Estimation with COCOMO II, Prentice-Hall, 2000.
7. Mary Beth Chrissis, Michael D. Konrad and Sandra Shrum, CMMI for Development: Guidelines for Process Integration and Product Improvement, Addison-Wesley Professional, 3rd Edition, 2011
8. Eileen C. Forrester; Brandon L. Buteau and Sandy Shrum, CMMi for Services: Guidelines for Superior Service, Addison-Wesley Professional, 2nd Edition, 2009.

Core I (CT-501) - Advanced Computer Architecture

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:
After learning this course students will be able to

a. Distinguish PVP, SMP, MPP, DSM & Cluster of Workstations (COW) & their Hardware / Software Architectures.
b. Explain Advanced Microprocessor Techniques including EPIC and Multi core Technologies through the study of State-of-the–Art Processor Families.
c. Explain System Area Networks including InfiniBand, 10 Gigabit Ethernet, Memory Channel Interconnect & SCI & with Storage Networks like DAS, NAS & SAN.
d. Discuss HPCC Software Stack & Parallel Programming Models like PVM & MPI.
e. Give examples of architectures of IBM SP System, Digital Tru-Cluster, C-DAC's latest PARAM System PARAM Yuva.

System Architecture: (8 Hrs)
History /Evolution, Definition: Hardware /Software Architecture Flynn's Classification: SISD, SIMD, MISD, MIMD, Physical Models: PVP, MPP, SMP, Cluster of Workstations (COW). Memory Architectures: Shared, Distributed & Hybrid, UMA, NUMA, CC-NUMA, Performance Metrics & Benchmarks, Architectural Trends based on TOP500 List of Supercomputers.

Advanced Microprocessor Techniques: (8 Hrs)
CISC, RISC, EPIC, Superscalar, Superpipelined, ILP, TLP. Power Wall, Moore's Law redefined, Multicore Technologies Intel's TickTalk Model. Study of State-of-the –Art Processors: Intel//AMD x86 Series, Intel //IBM Itanium// POWER series, Introduction to Graphics Processing Units (GPU: NVIDIA)

System Interconnects: (4 Hrs)
SAN: System Area Networks, Storage Area Networks including InfiniBand, GigaBit Ethernet. Scalable Coherent Interface (SCI) Standard.

Storage: (4 Hrs)
Internal/ External, Disk Storage, Areal Density, Seek Time, Disk Power, Advanced RAID Levels, SATA vs SAS Disks, Network Attached Storage (NAS) and Direct Attached Storage, I/O Performance Benchmarks.

Software Architecture: **(8 Hrs)**
Parallel Programming Models: Message Passing, Data Parallel, MPI /PVM Typical HPCC Software Stack including Cluster Monitoring Tools e.g. GANGLIA CUDA Programming Environment.
Case Studies: **(8 Hrs)**
A typical Petaflop System based on Hybrid CPU/GPU Architectures, IBM SP System, C-DAC's latest PARAM System.

References:

1. John L. Hennesy and David Patterson, Computer Architecture : A Quantitative Approach, 4th Edition**,** 2007
2. Kai Hwang and Zhiwei Xu, Scalable Parallel Computers, McGraw- Hill, 1998.
3. Data Manuals of respective Processors available at Website.

Core II (CT-503) - Advanced Computer Networks

Teaching Scheme **Examination Scheme**
Lectures : 3 hrs/week T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:
After learning this course students will be able to

a. Explain issues in the design of network processors and design network systems
b. Explaining advanced knowledge of networking and wireless networking in particular finding different solutions for communications at each network layer.
c. Explain simulations of wired and wireless networking
d. Develop solutions by applying knowledge of mathematics, probability, and statistics to model and analyse some network design problems
e. Explain Storage and Networking technologies

Network System: **(6 hrs)**
Introduction: Review of Protocols and Packet Format, Network Systems and the Internet, Network Systems Engineering, Packet Processing, Network Speed, Hardware, Software and Hybrids. Network Interface Card functionality, Onboard Address Recognition, Packet Buffering, Promiscuous mode. Review of Protocols and Packet Formats
Network Processors: **(6 hrs)**
Complexity of Network Processor Design, Network Processor Architectures, Issues in Scaling a Network Processor, Examples of Commercial Network Processors
SNMP and Network Management **(6 hrs)**
Basic Foundations: Standards, Models, and Language,SNMPv1 Network Management: Organization and Information Models, SNMPv2, SNMPv3, RMON**,** Network Management Tools, Systems, and Engineering, Network Management Applications
Design and Validation of Computer Protocols **(4 hrs)**
Protocol Structure, Protocol Design, Protocol Synthesis, Protocol Validation, Design Tools-Protocol Simulator, Protocol Validator
High Speed Networks and Wireless Networks **(8 hrs)**
High Speed Networks, Performance Modeling and Estimation, Internet Routing, Quality of Service in IP Networks, MAC Protocols for Ad Hoc Wireless Networks, Routing Protocols for Ad Hoc Wireless Networks, Multicast routing in Ad Hoc Wireless Networks, Transport Layer and Security Protocols for Ad Hoc Wireless Networks, Quality of Service in Ad Hoc Wireless Networks.

Storage and Networking **(4 hrs)**

Storage and Networking Concepts, Fiber Channel Internals, Fiber Channel SAN Topologies, Fiber Channel Products, IP SAN Technology, IP SAN Products, Management of SANs, SAN Issues

References:

1. Douglas Comer, Network Systems Design using Network Processor, Pearson Education, 2004.
2. Mani Subramanian, Timothy A. Gonsalves,N. Usha Rani; Network Management: Principles and Practice; Pearson Education India, 2010
3. Holzmann, Gerard J., Design and Validation of Computer Protocols, Prentice Hall, 1990.
4. William Stallings, High-Speed Networks and Internets, Pearson Education, 2nd Edition, 2002.
5. C. Siva Ram Murthy, B.S. Manoj, Ad Hoc Wireless Networks: Architectures and Protocols, Prentice Hall, 2004
6. Muthukumaran B, Introduction to High Performance Networks, Tata Mc Graw Hill, 2008
7. Tom Clark, Designing Storage Area Networks, A Practical Reference for Implementing Fibre Channel and IP SANs, Addison-Wesley Professional, 2nd Edition, 2003 .

Core III (CT-505) - Topics in Databases

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks ,End-Sem Exam-60

Course Outcomes:

After learning this course students will be able to

a. Understand foundation of the RDBMS theory
b. Understand internal functioning of RDBMS
c. Understand advanced topics of RDBMS
d. Analyze and understand the latest trends of RDBMS.

Transaction Processing **(10 hrs)**

Serial and Serializable Schedules, Conflict-Serializability, Enforcing Serializability by Locks (Two-Phase Locking), Locking Systems With Several Lock Mode, Concurrency Control by Timestamps, Serializability and Recoverability, The Dirty-Data Problem, Cascading Rollback, Recoverable Schedules, Managing Rollbacks Using Locking, Logical Logging, Recovery From Logical Logs, ARIES (Algorithm for Recovery and Isolation Exploiting Semantics), which supports partial rollbacks of transactions, fine granularity (e. g., record) locking and recovery using write-ahead logging (WAL).

Query Processing **(10 hrs)**

Architecture of Query Execution Engines, Disk Access, Aggregation and Duplicate Removal, Sorting and Hashing, Binary Matching Operations (Join Algorithms), Execution of complex query plans, Mechanism for parallel query execution, Non standard query processing algorithms: Nested Relations; Temporal and Scientific Database Management; Object Oriented DBMS, Additional Techniques for performance improvement: Precomputation and Derived data; Data Compression; Surrogate Processing; Bit vector filtering; Specialized Hardware, Query Evaluation Techniques for Large Databases

Query Optimization **(10 hrs)**

Basic Optimization Strategies, Algebraic Manipulation, Optimizations of Selections in System R

Case Studies: **(10 hrs)**

Hadoop Distributed File System: Study of Hadoop Distributed File System. HadoopP is a distributed file system that provides high-throughput access to application data; HIVE - Data warehousing application built on top of Hadoop; MapReduce - It is a patented software framework introduced by Google in 2004 to support distributed computing on large data sets on clusters of computers; Dynamo – It is a highly available, proprietary key-value structured storage system or a distributed data store; Eventual Consistency Model for Distributed Systems

References:

1. J. D. Ullman, Principles of Database Systems, Galgotia Publication, 2nd Edition, 1999
2. C. Mohan, ARIES: A Transaction Recovery Method Supporting Fine-Granularity Locking and Partial Rollbacks Using Write-Ahead Logging, ACM Transactions on Database Systems, Vol. 17, No. 1, March, 1992, pp. 94–162.
3. P. Selinger, M. Astrahan, D. Chamberlin, Raymond Lorie and T. Price. Access Path Selection in a Relational Database Management System, Proceedings of ACM SIGMOD, pp 23-34, 1979
4. http://hadoop.apache.org
5. Jeffrey Dean and Sanjay Ghemawat, MapReduce: Simplified Data Processing on Large Clusters, Communications of the ACM, vol. 51, no. 1, pp. 107-113, 2008
6. Fay Chang, Jeffrey Dean, Sanjay Ghemawat, Wilson C. Hsieh, Deborah A. Wallach, Mike Burrows, Tushar Chandra, Andrew Fikes, and Robert E. Gruber, Bigtable: A Distributed Storage System for Structured Data , Proceedings of Operating Systems Design and Implementation , pp. 205-218, 2006.
7. W. Vogels. Eventually Consistent. ACM Queue, vol. 6, no. 6, December 2008
8. Goetz Graefe, Query Evaluation Techniques for Large Databases, ACM Computing Surveys, Vol. 25, No. 2, June 1993
9. R. Elmasri, and S. Navathe, Fundamentals of Database Systems, Benjamin Cummings, Pearson, 6th Edition, 2010
10. Korth , Silberschatz and Sudarshan, Database System Concepts, Tata McGraw Hill, 6th Edition, 2011.

DE I (CT-513) - A. Distributed Operating Systems

Teaching Scheme	**Examination Scheme**
Lectures : 3 hrs/week	T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:

After learning this course students will be able to

a. Explain Characteristics and challenges of distributed systems.
b. Distinguish the design issues in distributed operating systems
c. Discuss RPC mechanisms, Distributed Shared Memory for inter process communication
d. Summarize the Synchronization issues in Resource and Process management, Process Migration, Distributed File System etc
e. Deconstruct the key components in distributed systems

Fundamentals and Message Passing (10 Hrs)

Fundamentals: Characteristics and challenges of distributed systems. Design issues in distributed operating systems; Architectural models, DCE. Message passing: Desirable features of good message passing systems, Issues in IPC by message passing; Synchronization, Buffering, Multi-datagram Messages, Encoding and decoding of message data, process Addressing, Failure Handling, Group Communication

Remote procedure Call (7 Hrs)

RPC Model, Transparency of RPC, Implementing RPC mechanisms, RPC messages, Server management, parameter-passing semantics, call semantics Communication protocols for RPC, Client-Server Binding, RPC in Heterogeneous Environment

Distributed Shared Memory & Synchronization (7 Hrs)

General Architecture of DSM Systems, Design and Implementation issues in DSM, Consistency Models, Implementing Sequential Consistency Model, Page based distributed shared memory, shared – variable distributed shared memory, object-based distributed shared memory. Replacement Strategy, Thrashing, Heterogeneous DSM, Advantages of DSM, Synchronization : Clock Synchronization, Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms

Resource and Process management (6 Hrs)

Desirable features of good global scheduling algorithms, Task Assignment Approach, Load-Balancing Approach, Load-Sharing Approach, Process management: Process Migration, Threads

Distributed File System and Naming (6 Hrs)

File-Accessing Models, File-Sharing Semantics, File-caching Schemes, File Replication, Fault Tolerance, Atomic Transactions, Design Principles, Naming: Fundamental Terminologies and Concepts, System-Oriented names, Object-Locating Mechanisms, Human-Oriented names, Name cache, Naming and Security.

Security (6 Hrs)

Potential Attacks to Computer Systems, Cryptography, Authentication, Access Control, Digital Signatures.

References:

1. Sinha P. K., Distributed Operating Systems Concepts and Design, PHI, 1997
2. Tanenbaum A. S., Distributed Operating Systems, Pearson Education India, 1995

DE I (CT-515) - B. Program Verification

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks
End-Sem Exam-60

Course Outcomes:

After learning this course students will be able to

a. Understand the importance and economics of verification and validation.
b. Design the properties of verification.
c. Correlate the various types of systems and properties: transformational, real time and reactive nature of environment.
d. Describe at a high level view of propositions as facts, logic, Kripke structures, temporal logic and expression of properties.
e. Analyze the mapping verification problems to binary decision diagrams, liveness, fairness and algorithms over binary decision diagrams.
f. Address state explosion problems by application of verification techniques.
g. Apply learned techniques on the recent issues of verification, state of the art software tools for model checking suitable for industry.
h. Understand recent issues in verification, state of the art software tools for model checking suitable for industry.

(4 Hrs)

Review of software engineering methods and challenges. The role of verification and validation. The economics of verification and validation**.**

(6 Hrs)

Introduction and logistics. Brief overview of reactive and transformative systems, and the need for specialized specification formalisms. A simple imperative programming language for describing transformative systems that operate on integers. Notion of a state. A simple assertion language for specifying properties of states. Semantics of assertions.

(7 Hrs)

Abstract configuration transition graphs as Kripke structures, notion of an infinite path in a Kripke structure, notion of atomic propositions as facts of interest. Introduction to temporal logic operators. Discussion on state formulae and path formulae. Model Checking, Characteristics of Model Checking. Transition Systems, Parallelism and Communication, The State-Space Explosion Problem, Deadlock, Linear-Time Behavior, Safety Properties and Invariants, Liveness Properties, Fairness. Binary Decision Diagrams (BDDs), Algorithms over BDDs..

(6 Hrs)

Computation Tree Logic, Expressiveness of CTL vs. LTL, CTLModel Checking, Fairness in CTL, Counterexamples and Witnesses, Symbolic CTLModel Checking, CTL.. Bisimulation. Timed Automata, Timed Computation Tree Logic, Markov Chains, Probabilistic Computation Tree Logic.

(5 Hrs)

Deterministic Programs: while Programs, Recursive Programs, Recursive Programs with Parameters, Object-Oriented Programs.
Parallel Programs: Disjoint Parallel Programs, Parallel Programs with Shared Variables, Parallel Programs with Synchronization.

(6 Hrs)

Recent issues in verification and state of the art software tools for model checking and theorem proving.

References:

1. Zohar Manna and Amir Pnueli, Temporal Verification of Reactive Systems – Safety", Springer, 1995.
2. Krzysztof R. Apt, Frank S. de Boer, Ernst-Rudiger Olderog, Verification of Sequential and Concurrent Programs, Springer, 1991.
3. Clarke, Grumberg and Peled, Model Checking, The MIT Press, 1999.
4. Christel Baier, Joost-Pieter Katoen, Principles of Model Checking, MIT Press, 2008.
5. Paul Boca , Jonathan P. Bowen, Jawed I. Siddiqi, Formal Methods: State of the Art and New Directions, Springer, 2009

DE II (CT-519) - A. Advanced Compiler Construction

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks,End-Sem Exam-60

Course Outcomes:
After learning this subject, students will be able to understand the design of Compiler and also will be able to design a prototype for the toy compiler

Introduction **(6 Hrs)**
Review of Compiler Structure, Advanced Issues in Elementary Topics, Importance of Code Optimization, Structure of Optimizing Compilers, Placement of Optimizations in Aggressive Optimizing Compilers

Context –Sensitive Analysis & Intermediate Representation **(6 Hrs)**
Introduction to type systems, The Attribute –grammar framework, Adhoc Syntax directed translation, Harder problems in type inference and changing associativity, Issues in designing an intermediate languages, Graphical & Linear IR, Static-single Assignment form, Mapping values to names & symbol tables.

Code Optimization **(8 Hrs)**
Introduction, Redundant expressions, Scope of optimization, Value numbering over regions larger than basic blocks, Global redundancy elimination, Cloning to increase context, Inline substitution, Introduction to control flow analysis, Approaches to control flow analysis, Interval analysis and control trees, Structural analysis, Reaching definitions.

Data Flow Analysis & Scalar Optimization **(10 Hrs)**
Basic concepts : Lattices, flow functions and fixed points, Iterative data flow analysis, Lattice of flow functions, Control –tree based data flow analysis, Structural analysis and interval analysis, Static Single Assignment (SSA) form, Dealing with arrays, structures and pointers, Advanced topics: Structures data-flow algorithms and reducibility, Inter procedural analysis (Control flow, data flow, constant propagation, alias), Inter procedural register allocation, Aggregation of global references, Introduction to scalar optimization, Machine –independent and dependent transformations, Example optimizations (eliminating useless and unreachable code, code motion, specialization, enabling other transformation, redundancy elimination)., Advanced topics (Combining optimizations, strength reduction).

Instruction Selection & Scheduling **(8 Hrs)**
Introduction, Instruction selection and code generation via Sethi Ullman, Aho Johnson algorithm, Instruction selection via tree-pattern matching, Instruction selection via peephole optimization, Learning peephole patterns, Generating instruction sequences,

Introduction to instruction scheduling, The instruction scheduling problem, List scheduling, Regional scheduling.

Register Allocation **(6 Hrs)**

Introduction, Issues in register allocation, Local register allocation and assignment, Moving beyond single block, Global register allocation and assignment, Variations on Graph Coloring Allocation, Harder problems in register allocation, CASE Study of GCC compiler.

References:

1. Keith D. Cooper and Linda Torczon, Engineering a Compiler, Elsevier-Morgan Kaufmann Publishers, 2004.
2. Steven S. Muchnick, Advanced Compiler Design Implementation, Elsevier-Morgan Kaufmann Publishers, 2003.
3. Andrew Appel, Modern Compiler Implementation in C: Basic Techniques, Cambridge University Press, 1997.
4. Y.N. Srikant, Priti Shankar, The Compiler Design Handbook: Optimizations and Machine Code Generation, CRC Press, 2nd Edition, 2002.
5. Uday Khedker, Amitabha Sanyal, Bageshri Karkare , Data Flow Analysis: Theory and Practice, CRC Press, 2009
6. David R. Hanson , Christopher W. Fraser, A Retargetable C Compiler: Design and Implementation, Addison-Wesley, 1995
7. Morgan, Robert, Building an Optimizing Compiler, Digital Press Newton, 1998.

DE II (CT-521)- B. Machine Learning

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 mark, End-Sem Exam-60

Course Outcomes:

After learning this course students will be able to

a. Study of probabilistic analysis, parametric and non-parametric algorithms
b. Estimation of Maximum Likelihood, losses and risks
c. Understand Supervised, unsupervised and semi supervised machine learning algorithm
d. Apply categories of these algorithms such as Neural Network, Genetic Analysis etc for real life problem solving.

(6 hrs)

Introduction to Machine Learning : Examples of ML Application, Design, Perspective and Issues in ML, Supervised, Unsupervised, and Semi-supervised Learning, Concept Learning, Version Space and Candidate-Elimination Algorithm, Inductive Bias

(6 hrs)

Bayesian Decision Theory: Bayes Theorem, Classification, Losses and Risks, Discriminant Functions, Utility Theory, Value of Information, Bayesian Belief Network, Influence Diagram, Association Rule, **Parametric Methods:** Maximum Likelihood Estimation, Bias and Variance, Bayes Estimator, Parametric Classification, Regression, Tuning Model Complexity, Model Selection Procedure.

(6 hrs)

Decision Tree: Decision Tree Representation, Decision Tree Algorithm, Hypothesis Space Search, Issues in Decision Tree Learning, Pruning, Rule extraction from Tree, Learning rules from Data, **Multivariate Methods**: Data, Parameter Estimation,

Multivariate Classification, Multivariate Regression, Dimensionality Reduction: Subset Selection, PCA, Factor Analysis, Multidimensional Scaling, LDA.

(6 hrs)

Clustering : Mixture Densities, K-means Clustering, Expectation –Maximization Algorithm, Mixture of Latent Variable Models, Hierarchical Clustering, **Non-parametric Methods**: Nonparametric Density Estimation, Nonparametric Classification, Nonparametric Regression

(6 hrs)

Artificial Neural Networks: ANN Representation, Perception, Training Perception, MLP with BP, Radial Basis Function Network, GNN, SOM, Error Estimation, Training Procedures, Recurrent Network, **Support Vector Machine:** Application of SVM, Kernel Methods and Evolution of SVM, Vapnik-Chervonenkis dimension, probably approximately correct learning, Noise, Linear and Nonlinear SVM and Kernel Trick, SMO

(6 hrs)

Genetic Algorithm: Genetic Programming, Hidden Markov Models, Discrete Markov Processes, **Reinforcement Learning:** Q Learning, Nondeterministic Rewards and Actions, Model based learning, Temporal Difference Learning, **Analytical Learning**.

References:

1. Tom Mitchell, Machine Learning, McGraw-Hill, 1997
2. Ethem Alpaydin, Introduction to Machine Learning, PHI, 2005
3. K.P. Soman, R. Longonathan and V. Vijay, Machine Learning with SVM and Other Kernel Methods, PHI-2009
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer 2006
5. R.O. Duda, P.E. Hart, D.G. Stork. Pattern Classification, John Wiley and Sons, Second edition 2000

DE II (CT-523) - C. Graphics and Visualization

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks End-Sem Exam-60

Course Outcomes:

After learning this course students will be able to

a. explain fundamental concepts within computer graphics such as geometrical transformations, illumination models, removal of hidden surfaces and rendering
b. Enhance their perspective of modern computer system with modeling, analysis and interpretation of 2D and 3D visual information.
c. Understand, appreciate and follow the development and advancement of computer graphics technologies

(8 Hrs)

Rasterization, 2D, 3D transformations, Viewing and projection, Clipping

Modeling **(8 Hrs)**

Polygonal mesh modeling, Shading, Subdivision surfaces, Parametric curves and surfaces, Fractals

Rendering **(6 Hrs)**

Lighting and shading, Hidden surface removal, Anti-aliasing, Transparency and fog, Ray tracing, Image based rendering, Radiosity

Texture Mapping **(5 Hrs)**

Texture mapping: Projective Textures, Environment Mapping, Image Warping and Dewarping, 3D Textures, Procedural Texture Generation

Animation and Simulation **(6 Hrs)**

Key frame based animation, Motion capture, Particle Animation Morphing, Simulating Accelerations, Motion Specifications

Introduction to Visualization **(6 Hrs)**

Visualization techniques and methodologies, Volume visualization, Flow visualization, Information visualization, Multivariate visualization

References:

1. Peter Shirley, et al. Fundamentals of Computer Graphics, A K Peters, 2nd Edition, 2005.
2. Alan Watt, 3D Computer Graphics, Addison-Wesley, 3rd Edition, 1999.
3. Steve Cunningham, Computer Graphics: Programming, Problem Solving, and Visual Communication , California State University Stanislaus Turlock, CA, 2003
4. David S. Ebert, Musgrave, Peachey, Perlin Worley, Texturing & Modeling, Morgan Kaufmann Publishers, 3rd Edition, 2003.
5. Philip Schneider, David Eberly, Geometric Tools for Computer Graphics, Morgan Kaufmann Publishers, 2003.
6. Richard S. Gallagher, Solomon, Computer Visualization: Graphics Techniques for Engineering and Scientific Analysis, CRC, 1994.
7. Alan Watt , M. Watt, Advanced Animation and Rendering Techniques, ACM Press, 1992

PGL (CT-511) - PG laboratory I / Mini Project

Teaching Scheme	Examination Scheme
Practical: 3 hrs/week	Term Work - 50 Marks

It should consist of various Practical / Simulation assignments related to all core subjects and electives.

1. Advanced Software Engineering.
2. Distributed Operating Systems.
3. Program Verification.
4. Advanced Compiler Construction.
5. Machine Learning.
6. Graphics and Visualization.

Semester II

OEC II (IS-502-2) - Financial Computing

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:
After learning this course students will be able to

a. Explain fundamentals of finance vertical
b. Develop and Utilize computer science / software concepts to solve real life problems

Basics of Finance **(4 Hrs)**
What is Finance?, Money, Currency and Inflation, Financial Institutions – Banks, Financial Markets, Random Variables and Expected Values , Rates of Returns and Interest Rates

Derivatives **(8 Hrs)**
Pricing Futures, Properties of Stock Option, Random Walk Models, Binomial Trees. The Black Scholes Model, Exotic Options

Time Series Analysis **(10 Hrs)**
Financial Time Series Data, Linear Time Series Analysis, Garch Models, Regression Analysis

Stochastic models of financial markets **(10 Hrs)**
Forward and futures contracts, European options and equivalent martingale measure Hedging strategies and management of risk, Term structure models and interest rate derivatives, Optimal stopping and American options

Trading Strategies **(8Hrs)**
The Capital Assets Pricing Mode, Order Execution and Leverage, Introduction to Online Algorithms, Competitive analysis for finance, Money management and the Kelly criteria Technical analysis

References:

1. John C. Hull and S. Basu, Options, Futures and Other Derivatives, Pearson, 7th Edition, 2009
2. Prof. Steven Skiena, Course Material at Stony Brook University, Link: http://www.cs.sunysb.edu/~skiena/691/
3. Free E-book on A first Course in Finance, Link: www.freeinfosociety.com/pdfs/misc/introtofinance.pdf

DE III (CT-506) - A. Data Mining and Warehousing

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks,End-Sem Exam-60

Course Outcomes:
With this subject, students could use the concepts to apply data mining algorithms to find the solution for real life problems

Introduction to Data Mining **(4 Hrs)**
Data Flood, Data Mining and Knowledge Discovery, Data Mining Tasks Data Preparation for Knowledge Discovery, Data understanding, Data cleaning, Data transformation, False "predictors" , Feature reduction, Randomization.

Knowledge Representation **(6 Hrs)**
Decision tables, Decision trees, Decision rules, Rules involving relations, Instance-based representation ,Classification -Statistical Based Algorithms, Decision Trees Based Algorithms, Neural Networks Based Algorithms, Rules, Regression, Instance-based (Nearest neighbor), Case study

Clustering **(6 Hrs)**
Introduction, Clustering Methods, Ways of scaling clustering algorithms, Case study

Associations, Transactions, Frequent itemsets, Association rules, Applications **(6 Hrs)**

Data warehousing, OLAP and Data mining, web warehousing, Schema integration and data cleaning, Deduplication, Data marts: Multidimensional databases (OLAP) Advanced topics: ETL, Integrating OLAP and mining, Online aggregation, Recap, future and visions. **(6 Hrs)**

Advanced Topics: Mining Multimedia Databases, Text Mining, Web Mining, Spatial Mining, Temporal Mining Applications and Trends in Data Mining Data Mining Applications, Additional Themes on Data Mining, Social impacts of Data Mining, Trends in Data Mining **(8 Hrs)**

References:

1. Jiawei Han, Micheline Kamber. Data Mining: Concepts and Techniques. Morgan-Kaufmann, 2000.
2. Heikki Mannila, Padhraic Smyth, David Hand. Principles of Data Mining, MIT Press, 2001.
3. Margaret H. Dunham. Data Mining: Introductory and Advanced Topics, Pearson Education, 2003
4. Soumen Chakrabarti. Mining the Web- Discovering Knowledge from Hypertext Data, Morgan-Kaufmann, 2003
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Education, 2006
6. Ian H. Witten & Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, Morgan-Kaufmann, 2000.
7. T Hastie, R Tibshirani, J H Friedman,The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer Verlag, 2

DE III (CT-522) - B. Advanced Topics in Graph Theory

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:
Students should be able to :

a. Explaining topics such as matching, graph colouring, Ramsey theory etc
b. Discuss algorithmic aspect of graph theory and utilize it to solve graph related problems of various domains using computers
c. Design solutions using graph theory for other domain problems
d. Summarize issues related to handling large databases
e. Explain the need of efficient algorithms in case of very large graphs
f. Give examples of active research areas in computer science (theory)

Trees **(6 Hrs)**
Basic Properties, Spanning Trees and Enumeration, Enumeration of Trees, Spanning Trees in Graphs, Decomposition and Graceful Labeling, Optimization and Trees, Minimum Spanning Tree.

Matching and Factors **(6 Hrs)**
Matchings in Bipartite Graphs, Hall's Matching Condition, Min-Max Theorems, Independent Sets, Tutte's 1-Factor Theorem, Maximum Bipartite Matching , Weighted Bipartite Matching, Stable Matching, Faster Bipartite Matching

Connectivity and Paths **(6 Hrs)**
Cuts and Connectivity, Flows in Directed Graphs, Connectivity and Menger's Theorem, Edge-Connectivity, Blocks,K-connected Graphs and k-edge-connected Graphs, 2-connected Graphs, Applications of Menger's Theorem

Graph Coloring **(8 Hrs)**
Vertex Colorings and Upper Bounds: Definitions , Upper bounds, Brooke's Theorem, Structure of k-chromatic Graphs, Graphs with Large Chromatic Number, Critical Graphs, Counting Proper Colorings, Chordal Graphs, A Hint of Perfect Graphs, Line Graphs and Edge Colorings, Characterization of Line Graphs.

Ramsey Theory **(4 Hrs)**
The Fundamental Ramsey Theorems, Canonical Ramsey Theorems, Ramsey Theory for Graphs

Random Graph **(4 Hrs)**
Existence and Expectation, Properties of Almost All Graphs, Threshold Functions, Evolution and Properties of Random Graphs, Connectivity, Cliques and Colorings

Extremal Problems **(6 Hrs)**
Paths and Cycles, Complete Subgraphs, Hamilton Paths and Cycles, Szemeredi's Regularity Lemma and its simple applications, Encodings of Graphs, Branchings and Gossip, List Colorings and Choosability, Circumference

References:

1. Douglas B. West, Introduction to Graph Theory, Prentice-Hall, 3rd Edition, 2008
2. Béla Bollobás, Modern Graph Theory, Springer, 1998.

DE III (CT-516) - C. Linux Kernel Programming

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:

Students should be able to :

a. Write kernel testing scripts
b. Write modules for the Linux kernel, including device drivers
c. Handle synchronization issues in writing kernel code, taking care of race conditions and deadlocks
d. Read and understand parts of the kernel code related to file systems, page fault handling

Introduction **(5 Hrs)**

Basic operating system concepts review; an overview of the Unix filesystem; an overvie w of Unix kernels; Linux kernel source code – organization; building the kernel; gdb and debugging techniques; code browsing tools; review of Intel Pentium architecture; module programming – writing and inserting a module in kernel

Virtual File System and Device drivers **(7 Hrs)**

System calls; virtual file system; registering, mounting; file system debugger; ext2 and e xt3 file systems; disk cache, swapping; device drivers: character, block and other devices; character and block device operations

Processes **(7 Hrs)**

Overview of the boot process; grub the boot loader; preliminary setup, overview of kern el startp and initialization; swapper, init and initial processes; process switching; scheduling policy; the scheduling algorithm; data structures used by the scheduler; functions used by the scheduler; unqueue balancing in multiprocessor systems; lightweight processes and threads

Kernel Synchronization **(7 Hrs)**

How the kernel services requests; synchronization primitives; spinlocks; semaphores;mutexes; reader/writer locks; read-copy-update mechanism; synchronizing accesses to kernel datastructures;examples of race condition prevention; locking and int erprocess communication

Memory Management **(7 Hrs)**

Segmentation and paging in hardware and in the kernel; page cache and buffer cache; Page frame management;
memory area management; slab allocator; noncontiguous memory area managemn;cac hing (kmalloc) and process address space (vmalloc); swapping

Exceptions and Interrupts **(5 Hrs)**

The role of interrupt signals; interrupts and exceptions; nested execution of exception an d interrupt handlers, initializing the interrupt descriptor table,exception handling; interrupt handling,softirqs and tasklets; work queues; returning from interrupts and excep tions

References:

1. Daniel P. Bovetand Marco Cesati,Understanding the Linux Kernel,O'Reilly Media, 3rd Edition, 2005
2. Wolfgang Mauerer, Professional Linux Kernel Architecture, Wiley Publishing, 2008.
3. Jonathan Corbet, Alessandro Rubiniand Greg Kroah-Hartman.,Linux device driver s", O'Reilly Media, 3rd Edition, 2005
4. Siever, Stephen Figgins, Robert Love, Arnol-Robbins, Linux in a Nutshell, O'Reilly Media, 6th Edition, 2009

Core IV (CT-502) - Advanced Algorithms

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks End-Sem Exam-60

Course Outcomes:

Students should be able to :

a. Explain advanced algorithm design techniques such as randomized algorithms, approximation algorithms
b. Discuss different areas such as network flows, number theory and utilize concepts therein to develop algorithms in various domains
c. Design programs using advanced algorithms
d. Critique performance and efficiency related issues to all the life cycle activities
e. Discuss active areas of research

(6 Hrs)

Probabilistic Analysis and Randomized Algorithms: The Hiring Problem, Indicator Random Variables, Randomized Algorithms**.**Network Flow and Matching: Flows and Cuts, maximum Flow, Maximum Bipartite Matching, Minimum-Cost Flow, Efficiency Analysis

(6 Hrs)

Text Processing: String and pattern matching algorithms, tries, text compression, text similarity testing, performance analysis.

(6 Hrs)

Number Theory Algorithms: Elementary Number Theory algorithms like Euclid's GCD algorithm, modular arithmetic algorithms, primality testing, polynomials and FFT, representation of polynomials, DFT, FFT algorithm, Multiplying Big Integers.

(6 Hrs)

Parallel Algorithms: Model for parallel computation, basic techniques, parallel evaluation of expressions, parallel sorting networks, parallel sorting

(6 Hrs)

Computational Geometry Algorithms: Range trees, Priority Search trees, Quadtrees and k-D trees, Plan Sweep Technique, Convex Hulls

(6 Hrs)

NP-Completeness and Approximation Algorithms: Polynomial time, Polynomial time verification, NP-completeness and reducibility, profs, NP-completeness examples, Vertex Cover problem, Travelling Salesman Problem, Set Covering Problem

References:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms, MIT Press, 3rd Edition, 2009.
2. Michael T. Goodrich and Roberto Tamassia, Algorithm Design Foundations, Analysis, and Internet Examples, John Wiley & Sons, Inc., 2nd Edition, 2009.
3. Gilles Brassard and Paul Bratley, Fundamentals of Algorithmics, Prentice Hall, 1996.
4. Parag Himanshu Dave, Himanshu Bhalchandra Dave, Design and Analysis of Algorithms, Pearson Education, 2008.

Core V (CT-504) - Security in Computing

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:

After learning this course students will be able to

a. Demonstrate the overarching importance of security in networked computing in subsequent courses
b. Determine appropriate mechanisms such as encrypt, decrypt and transmit messages using cryptographic techniques for protecting networked systems.
c. Explain the functioning of security services in computing environments
d. Describe at a high level the vulnerabilities and threats in the Internet and networked computing systems.
e. Describe basic system security mechanisms, such as those used in operating systems, file systems and computer networks
f. Understand legal and privacy issues to designing secure software systems
g. Understand basic issues, concepts, principles, and mechanisms in network security

Introduction **(6 Hrs)**

Introduction to Computer Security, Basic concepts: threats, vulnerabilities, controls; risk; confidentiality, integrity, availability; security policies, security mechanisms; assurance; prevention, detection, deterrence, Basic cryptography: Basic cryptographic terms, Historical background, Symmetric crypto primitives, Modes of operation, Cryptographic hash functions Asymmetric crypto primitives

Program security **(6 Hrs)**

Flaws: Malicious code: viruses, Trojan horses, worms, Program flaws: buffer overflows, time-of-check to time-of-use flaws, incomplete mediation, Defenses: Software development controls, Testing techniques

Operating System Security **(6 Hrs)**

Memory, time, file, object protection requirements and techniques, Protection in contemporary, operating systems, Identification and authentication, Identification goals: Authentication, requirements, Human authentication, Machine authentication, Trusted Operating Systems: Assurance and trust, Design principles, Evaluation criteria, Evaluation process

Database Management System Security **(6 Hrs)**

Database integrity and reliability, Database secrecy, Inference control, Multi-level databases, Data Mining: Privacy and Sensitivity, Data Correctness and integrity, Availability of Data, Privacy issues:

Network Security **(6 Hrs)**

Network threats: eavesdropping, spoofing, modification, denial of service attacks, Introduction to network security techniques: firewalls, virtual private networks, Intrusion Detection, E-mail Security

Security Management and Privacy in Computing **(6 Hrs)**

Security Planning, Risk Analysis, Organizational Security Policies, Physical Security, Privacy issues:

References:

1. C. Pfleeger and S. Pfleeger, Security in Computing, Prentice Hall,4th Edition, 2007.
2. William Stallings, Cryptography and Network Security, Prentice Hall, 4th Edition, 2006
3. Behrouz A Forouzan, Cryptography & Network Security, McGraw-Hill, 2008
4. Atul Kahate, Cryptography and Network Security, Tata McGraw-Hill, 2nd Edition, 2008.
5. Eric Maiwald, Fundamentals of Network Security, McGraw-Hill, 2004.
6. Jay Ramachandran, Designing Security Architecture Solutions, Wiley Computer Publishing, 2002.
7. Bruce Schneier, Applied Cryptography, John Wiley & Sons Inc, 2001.
8. Charlie Kaufman, Radia Perlman and Mike Speciner, Network Security Private Communication in a public world, Prentice Hall of India Private Ltd., New Delhi
9. William Stallings, Network Security Essentials Applications and Standards, Pearson Education, New Delhi.

DE IV (CT-518) - A. Embedded System

Teaching Scheme	Examination Scheme
Lectures : 3 hrs/week	T1, T2 – 20 marks,End-Sem Exam-60

Course Outcomes:

After learning this course students will be able to

a. Explain Characteristics & Salient Features of Embedded Systems
b. Analyze Architecture & Recent Trends of Embedded Systems
c. Discuss PIC and ARM families
d. Understand general process of embedded system development and implement them.
e. Explain communication interface for wired and wireless protocols
f. Discuss hardware and software design methodologies for embedded systems

Overview of Embedded Systems **(4 Hrs)**

Introduction, Definition, Characteristics & Salient Features, Classification, Application Areas, Overview of Embedded System Architecture & Recent Trends

Hardware Architecture **(8 Hrs)**

Embedded Hardware based on Microprocessors, Microcontrollers & DSPs. Study of PIC Microcontrollers: PIC16C6X/7X Family & Applications. Study of ARM Family : ARM 7,9,10 &11: Overview & Architecture Comparison, Detailed Study of ARM7-TDMI including Core Architecture, ARM/Thumb State, On Chip Debug & Development Support, AMBA Bus, Applications.

Communication Interface **(6 Hrs)**

Serial, Parallel, Wired Wireless Protocols Wired : CAN ,I2C,USB, FireWire Wireless : Blue Tooth , IrDA, IEEE802.11

Software Architecture **(6 Hrs)**

Concepts: Embedded OS, Real-Time Operating Systems (RTOS), Detailed Study of RT Linux ,Hand Held OS, Windows CE. & Development Tools

Embedded Systems for Automotive Sector **(6 Hrs)**

Electronic Control Units (ECU) for Engine Management, Antilock Braking System (ABS), Crusie Control, Design Challenges, Legislative Emission Norm, Interface Standards, Developmental Tools Navigation Systems : Global Positioning System (GPS):Detailed Study & Applications

(4 Hrs)

Smart Cards: Classifications, Interfacing, Standards & Applications

RFID Systems: Technology, RFID Tag ,RFID Reader, Applications

Case Studies **(6 Hrs)**

Embedded System for Mobile Applications, DSP Based Embedded System, Networked Embedded System & Digital Camera

References:

1. K.V.K. Prasad, Embedded / Real Time Systems: Concepts, Design and Programming Black Book, Dreamtech Press, 2005.
2. Vahid F. and Givargies T., Embedded Systems Design, John Wiley X. Sons, 2002
3. John B Peatman, Design with PIC Microcontrollers, Pearson Education, 1998
4. Liu, Real-Time Systems, Pearson Education, 2000.
5. Technical Manuals of ARM Processor Family available at ARM Website on Net

DE IV (CT-520) - B. Bio Informatics

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1, T2 – 20 marks, End-Sem Exam-60

Course Outcomes:

After learning this course students will be able to

a. Explain the basics of biology required to work in the field of bioinformatics
b. Judge real life problems which could be solved only with the help of computers
c. Discuss active areas of research in the field

(6 Hrs)

Introduction, chronological history of Bioinformatics, evolution of Bioinformatics, Objectives of Bioinformatics, Importance of bioinformatics, Bioinformatics in business, future scope of Bioinformatics.

(6 Hrs)

Bioinformatician and bioinformaticist, role, need and importance of Biology, Computer Science, mathematics and information technology in bioinformatics, biological classification and nomenclature, life in space and time.

(6 Hrs)

Introduction, information networks, protein and genome information resources, DNA sequence analysis, pairwise alignment techniques, multiple alignment techniques, secondary databases, analysis packages.

(6 Hrs)

The dawn of sequencing, the biological sequence or structure deficit, human genome project and its status, homology and analogy, web browsers.

(6 Hrs)

Molecular biology networks, National centre for biotechnological information, specialized genomic resources. Building a sequence search protocol, practical approach for structural and functional interpretation.

(6 Hrs)

Introduction to analysis package, commercial databases, softwares and comprehensive packages, internet packages specializing in DNA and protein analysis.

References:

1. T.K. Attwood and Parry Smith, Introduction to Bioinformatics, Benjamin-Cummings Publishing Company, 2001.
2. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, 3rd Edition, 2008
3. Krane and Raymer, Fundamental Concepts in Bioinformatics, Benjamin-Cummings, 2002.

MLC (ML-504) - Intellectual Property Rights

Teaching Scheme
Lectures : 1 hr/week

Examination Scheme
T1, T2 20 marks each, End-Sem Exam 60

Course Outcomes:
After learning this course students will be able to

a. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
b. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
c. Understand how IP is an important element of the institutional fabric of an efficiently organized society.
d. Understand that Intellectual property is about preserving the differences between competitors.
e. Understand that Intellectual property right (IPR) is an attempt to safeguard the rights of original contributor of ideas, concept, and creativity of individuals.
f. Understand that how at present, IPR are regarded as a source of national wealth and mark of an economic leadership in the context of global market scenario.
g. understand the national IP system.
h. Got familiarized with the origins and the development of the international framework of IP
i. Created internal vigilance and enlightenment among students to generate new ideas.
j. makes students understand that things are dynamic and more complex than they appear which reinforces the motivation of the students to learn
k. Students find answers to many of the whys and why not's.
l. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.
m. As such the importance to emphasis the need of awareness and knowledge about IPR in engineering students, who are tomorrow's technocrats and creator of new technology

(2 Hrs)

Introduction: Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

(2 Hrs)

International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

(3 Hrs)

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

(3 Hrs)

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

(3 Hrs)

Registered and unregistered trademarks, design, concept, idea patenting.

Reference:

- Industrial Design by Mayall, Mc Graw Hill
- Resisting Intellectual Property by Halbert,Taylor & Francis Ltd,2007
- Product Design by Niebel, Mc Graw Hill
- Introduction to Design by Asimov, Prentice Hall
- Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley
- Intellectual Property Rights Under WTO by T. Ramappa, S. Chand.

PGL (CT-512) - PG laboratory II / Mini Project

Teaching Scheme
Practical: 3 hrs/week

Examination Scheme
Term Work - 50 Marks

It should consist of various Practical / Simulation assignments related to all core subjects and electives.

1. Financial Computing.
2. Data Mining and Warehousing.
3. Advanced topic in Graph Theory.
4. Linux Kernel Programming.
5. Embedded System.
6. Bio Informatics.

PGL (CT-514) - PG laboratory III / Mini Project

Teaching Scheme
Practical: 3 hrs/week

Examination Scheme
Term Work - 50 Marks

It should consist of various Practical / Simulation assignments related to all core subjects and electives.

1. Advanced Algorithms.
2. Security in Computing.

Semester III

MLC (ML-601)– Constitution of India

Teaching Scheme	Examination Scheme
Lectures : 1 hr/week	T1, T2 20 marks each, End-Sem Exam 60

Course Outcomes:

After learning this course students will be able to

n. Understand how India has come up with a Constitution which is the combination of the positive aspects of other Constitutions.
o. Understand the interpretation of the Preamble.
p. Understand the basics of governance of our nation.
q. Understand the different aspects covered under the different important Articles.
r. Understand the basic law and its interpretation. Understand the important amendments which took place and their effects.
s. Understand our Union and State Executive better.
t. Understand the basic that along with enjoying the rights one needs to fulfill one's duties.
u. Gain confidence on our Constitution by knowing it better

(2 Hrs)

Preamble to the constitution of India. Fundamental rights under Part – III, details of Exercise of rights, Limitations & Important cases.

(2 Hrs)

Relevance of Directive principles of State Policy under Part – IV, Fundamental duties & their significance.

(3 Hrs)

Union Executive – President, Prime Minister, Parliament & the Supreme Court of India.

(2 Hrs)

State executive – Governors, Chief Minister, State Legislator and High Courts

(2 Hrs)

Constitutional Provisions for Scheduled Castes & Tribes, Women & Children & Backward classes. Emergency Provisions.

(2 Hrs)

Electoral process, Amendment procedure, 42nd, 44th, 74th, 76th, 86th and 91st Constitutional amendments.

References:

- Introduction to the Constitution of India by Durga Das Basu (Students Edn.) Prentice – Hall EEE, 19th/20th Edn., 2001.
- Engineering Ethics by Charles E.Haries, Michael. S.Pritchard and Michael J.Robins Thompson Asia, 2003-08-05.
- An Introduction to Constitution of India by M.V.Pylee, Vikas Publishing, 2002.

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MLC (ML-603)– Environmental Studies

Teaching Scheme	Examination Scheme
Lectures : 2 hr/week	T1, T2 20 marks each, End-Sem Exam 60

Course Outcomes:

After learning this course students will be able to

a. Importance of environment, its purpose, design and perspectives.

b. Environmental issues related to the exploration of natural resources and development of the mankind.

c. Role of professional in protecting the environment from degradation.

d. The solutions for environmental problems created by local, national and global developmental activities.

(4 Hrs)

Multidisciplinary nature of environmental studies: Definition, scope and importance, need for public awareness.

(6 Hrs)

Natural Resources :

Renewable and non-renewable resources: Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

(4 Hrs)

Biodiversity and its conservation: Introduction – Definition : genetic, species and ecosystem diversity, Biogeographically classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values,

(6 Hrs)

Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management.

(6 Hrs)

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns.

References:

- Environmental studies from crisis to cue R Rajgopalan , III edn. OUP ISBN no.0-19-537393-X
- Environmental Science, S C Santra**,** New Cental Book Agency PVT LTD London ISBN no. 81-7381-404-X
- Environmental Chemistry by De A.K., Wiley Eastern Ltd.

- The Biodiversity of India by Bharucha Erach, Mapin Publishing Pvt. Ltd., Ahmedabad –380 013, India, Email:mapin@icenet.net
- Handbook of Environmental Laws by Trivedi R.K.,Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media

PS I (CT-601) - Project Stage - I

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The dissertation should have the following:

i. Relevance to social needs of society
ii. Relevance to value addition to existing facilities in the institute
iii. Relevance to industry need
iv. Problems of national importance
v. Research and development in various domain

The student should complete the following:

i. Literature survey
ii. Problem Definition
iii. Motivation for study and Objectives
iv. Preliminary design / feasibility / modular approaches
v. Implementation and Verification
vi. Report and presentation

Semester IV

PS II (CT-602) - Project Stage - II

1. The dissertation stage II is based on a report prepared by the students on dissertation allotted
2. to them.
3. It may be based on:
4. i. Entirely on study and analysis of typical Instrumentation and Control system, Process
5. Instrumentation / devices / instruments / related topic
6. ii. Experimental verification / Proof of concept
7. iii. Design, fabrication, testing, and calibration of an instrumentation system
8. iv. The viva-voce examination will be based on the above report and work.

Annexure I

Sample list of Professional Science/Elective courses offered by various departments

Branch Name	Subject Name
Civil Engineering (Construction and Management)	Environmental Impact Assessment
Civil Engineering (Environmental and Water)	Numerical Method
Civil Engineering (Geotechnical Engineering)	Advanced Mathematical Methods
Civil Engineering	Introduction to Coastal Engineering
Civil Engineering	Fortran Programming for Engineering Application
Civil Engineering	Housing and Social aspects of planning
Computer/ Information Technology	Financial Computing
Electrical Engineering (Control System)	Matrix and linear Algebra
Electrical Engineering (Power System)	Wind and Solar Energy
Electrical Engineering (Power System)	Engineering Optimization
Electrical Engineering (Power System)	Linear Systems Theory and Design
Electrical Engineering	Industrial Motion Control
Electronics and Telecommunications (Signal Processing)	Mobile Communication
Electronics and Telecommunications	Applied Statistical Physics
Electronics and Telecommunications(VLSI and Embedded)	Image processing and analysis
Electronics and Telecommunications	Artificial Intelligence
Mechanical Engineering	Finite Element and Boundary Element Methods
Mechanical Engineering	Energy Conservation and Management
Mechanical Engineering	Operation Research
Mechanical Engineering	Introduction to Nuclear Energy
Metallurgical Engineering (Physical/Process)	Electronics and Magnetic Materials
Metallurgical Engineering (Physical/Process)	Thermomechanical Processing of Metals
Metallurgical Engineering	Nanotechnology
Town and Country Planning	Quantitative Techniques
Production Engineering (Manufacturing Engineering and Automation)	Microcontroller and Applications
Production Engineering (Manufacturing Engineering and Automation)	Reliability Engineering
Production	Robot Dynamics and Analysis
Production	Commercial Law
Project Management	Project Planning and Control
Applied Physics	Laser Technology
Mathematics	Complex Analysis
Mathematics	Advanced Mathematical Methods (for all except Mech. and Instru.)
Mathematics	Advanced Mathematics
Mathematics	Engineering Mathematics for Problem Solving
Mathematics	Linear Algebra

Annexure-II:

Sample list of Liberal Learning courses offered at Institute level

Course Outcome:
Student will be able to choose and enhance practical learning and application in the subject of his/her choice.

One credit course spread over the semester to enhance practical learning and application

1. **Agriculture (**Landscaping, Farming, etc.**)**
2. **Business (**Management, Entrepreneurship, etc.**)**
3. **Defense (**Study about functioning of Armed Forces**)**
4. **Education (**Education system, Policies, Importance, etc.**)**
5. **Fine Arts (**Painting, Sculpting, Sketching, etc.**)**
6. **Linguistics**
7. **Medicine and Health (**Diseases, Remedies, Nutrition, Dietetics, etc.**)**
8. **Performing Arts (**Music, Dance, Instruments, Drama, etc.**)**
9. **Philosophy**
10. **Social Sciences (**History, Political Sc., Archeology, Geography, Civics, Economics, etc.**)**