SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

UNIVERSITY OF DELHI

NETAJI SUBHAS INSTITUTE OF TECHNOLOGY

CHOICE BASED CREDIT SYSTEM

SCHEME OF COURSES FOR M.TECH. (INFORMATION SYSTEMS) FULL-TIME AND PART TIME

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

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PREAMBLE

I. INTRODUCTION

Higher education is very important for the growth and development of any country. It is a living organ and requires continuous changes to ensure the quality of education. National Knowledge Commission and University Grants Commission have recommended many academic reforms to address the challenges of today's networked globalized world. People are coming together with the help of new technologies which is resulting towards new aspirations, expectations, collaborations and associations. The concept of "work in isolation" may not be relevant and significant anymore. The UGC guidelines on adoption of Choice Based Credit System may be an important step to revamp the processes, systems and methodologies of Higher Educational Institutions (HEIs). The teacher centric mode be changed to learner centric mode. Classroom teaching and learning be made effective; relevant and interesting. Concepts and theories be explained with examples, experimentation and related applications.

A culture of discussions, arguments, interpretations, counter-interpretations, re-interpretations, opposing interpretations must be established. Research should not only be confined to redefinition, extension and incremental change. Innovation & creativity should become an epicentre for all research initiatives. The most important capital is the human capital and thus the ultimate objective is to develop good human beings with utmost integrity & professionalism for this new world.

The Choice Based Credit System supports the grading system which is considered to be better than conventional marks system. It is followed in many reputed institutions in India and abroad. The uniform grading system facilitates student mobility across the institutions within and across the countries and also enable potential employers to assess the performance of the students. The Choice Based Credit System makes the curriculum interdisciplinary and bridge the gap between professional and liberal education.

II. CHOICE BASED CREDIT SYSTEM

The Indian Higher Education Institutions have been moving from the conventional annual system to semester system. Currently many of the institutions have already introduced the choice based credit system. The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice

based credit system provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning. It is desirable that the HEIs move to CBCS and implement the grading system.

A. Types of Courses

Courses are the subjects that comprise the M.Tech. programme.

1. A course may be designed to comprise lectures, tutorials, laboratory work, field work, outreach activities, project work, vocational training, viva voce, seminars, term papers, assignments, presentations, self-study etc. or a combination of some of these components.

2. The learning objectives and learning outcomes of each course will be defined before the start of a semester.

3. Courses are of two kinds: Core and Elective.

   i. **Core Course (CC)**: This is a course which is to be compulsorily studied by a student as a core requirement to complete the requirement of B.E. Computer Engineering.

   ii. **Elective Course**: An elective course is a course which can be chosen from a pool of subjects. It is intended to support the discipline of study by providing an expanded scope, enabling exposure to another discipline/domain and nurturing a student's proficiency/skill. An elective may be of following types:

      a) **Discipline Centric Elective (ED)**: It is an elective course that adds proficiency to the students in the discipline.

      b) **Open Elective (EO):** It is an elective course taken from other engineering disciplines that broadens the perspective of an Engineering student.

4. Each course contributes certain credits to the programme. A course can be offered either as a full course (4 credits) or as a half course (2 credits). A full course is conducted with 3 hours of lectures and either 1 hour of tutorial or 2 hours of practical work per week. A half course is conducted with 2 hours of lectures.

5. A student of Postgraduate programme has to accumulate about 40% credits from the Core Courses and the remaining credits from the Elective Courses to become eligible for the award of degree/ diploma/ certificate programmes.

6. A course (full/half) may also be designed without lectures or tutorials. However, such courses may comprise Field work, Outreach activities, Project work, Vocational Training, Seminars, Self-study etc. or a combination of some of these.

7. A Project work/Dissertation is considered as a special course involving application of the knowledge gained during the course of study in exploring, analyzing and solving complex problems in real life applications. A candidate completes such a course on his own with an advisory support by a teacher/faculty member.

B. Examination and Assessment

The following system will be implemented in awarding grades and CGPA under the CBCS system.

1. **Letter Grades and Grade Points:** A 10-point grading system shall be used with the letter grades as given in Table 1 below:

Table1:Grades and Grade Points

Letter Grade	Grade point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (absent)	0

2. **Mapping of marks and grades:** In consonance with the absolute grading system, the marks obtained by a student will be converted to grades. The following mapping is given in Table 2, shall be used for awarding grades under the absolute grading system:

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3. **Fail grade:** A student obtaining Grade F shall be considered failed and will be required to reappear in the examination. If the student does not want to reappear in an elective subject (that is ED or EO *but not CC courses*) then he/she can re-register afresh for a new elective subject.
4. **Non-credit course:** For non-credit courses, 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.
5. **Fairness in Assessment:** The CBCS promotes continuous evaluation system where end semester examinations weightage should not be more than 60%. The Departments should design their own methods for continuous evaluation. They have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi & teaching, learning methods. In this regard, checks and balances will be implemented to fair and effective assessment and examination process.
6. **Computation of SGPA and CGPA:** The following procedure be used to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

   i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, that is:

$$SGPA(S_i) = \frac{\sum C_j \times G_j}{\sum C_j}$$

   Where S_i is the i^{th} semester C_j is the number of credits of the j^{th} course of the semester and G_j is the grade point scored by the student in the j^{th} course.

   ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student overall the semesters of a programme, that is:

$$CGPA = \frac{\sum C_i \times SGPA(S_i)}{\sum C_i}$$

   Where S_i is the SGPA of the i_{th} semester and C_i is the total number of credits in that semester.

   iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

iv. CGPA shall be converted into percentage of marks, if required, by multiplying CGPA with 10.

III. PROGRAMME STRUCTURE

1. The M.Tech. Information Systems programme consists of 4 semesters, normally completed in 2 years for Full-Time and 6 semesters, normally completed in 3 years for Part-Time. The total span period cannot exceed 4 years for Full-Time and 5 years for Part-Time.

2. The courses offered in each semester are given in the **Semester-wise Course Allocation.**

3. The discipline centric subjects under CC and ED categories are listed for each discipline separately.

4. A course may have prerequisite course(s) that are given in the **Semester-wise Course Allocation**. A student can opt for an elective only if he/she has fulfilled its pre-requisite(s).

5. A student has to register for all electives before the start of a semester.

IV. COURSE CODIFICATION

The codes for various Postgraduate Programme are as follows:

i. Department of Electronics and Communication Engineering:
   1. Signal Processing-SP
   2. Embedded System and VLSI-ES

ii. Department of Computer Engineering:
   1. Information System-IS

iii. Department of Instrumentation and Control Engineering:
   1. Process Control-PC
   2. Industrial Electronics-IE
   3. Mechatronics-MT

iv. Department of Biotechnology: BT
   1. Biochemical Engineering -BCE
   2. Bioinformatics-BICS

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v. Manufacturing processes and Automation Engineering: MPAE

1. CAD CAM-CDCM
2. Manufacturing process and Automation Engineering-MPA
3. Production Engineering-PE
4. Engineering Management-EM
5. Nanotechnology-NT

The codes for Departmental core subjects and Domain-specific Electives are specific to each Discipline. The first two characters are derived from Departmental codes listed above.

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Table 2: Semester wise Course Codes

a) Semester- I

ISC01	CC
ISC02	CC
ISD-***	Elective
ISD-***	Elective
ISD-***	Elective
EO-***	Open Elective

b) Semester - II

ISC03	CC
ISC04	CC
ISD-***	Elective
ISD-***	Elective
ISD-***	Elective
EO-***	Open Elective

c) Semester - III

ISD-***	Elective
ISD-***	Elective
ISD-***	Elective
ISC05	Seminar
ISC06	Major Project

d) Semester - IV

ISC07	Dissertation

******* Code as specified in the Table 3 and Table 4 of discipline centric electives.

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V. EVALUATION SCHEME

The courses are evaluated on the basis of continuous assessments, mid-semester exams and end-semester exams. The weightage of each of these modes of evaluation for the different types of courses are as follows.

Type of Course	**Continuous Assessment (CA)** **Theory**	**Mid-Semester Exam (MS)** **Theory**	**End-Semester Exam (ES)** **Theory**	**Continuous Assessment (CA)** **Lab**	**End-Semester Exam (ES)** **Lab**
CC/ED/EO Theory with Tutorial	25	25	50	Nil	Nil
CC/ED/EO Theory with Practical	15	15	40	15	15
Major Project and Dissertation	Nil	Nil	Nil	40	60

VI. DECLARATION OF RESULTS

The M.Tech. (ES) programme consists of 82 credits. CGPA will be calculated on the basis of the best 78 credits earned by the student.

VII. EVALUATION AND REVIEW COMMITTEE

The Committee of Courses and Studies in each department shall appoint one or more Evaluation-cum-Review Committees (ERC), each committee dealing with one course or a group of courses. This ERC consists of all faculty members who are likely to teach such courses in the group. Normally Head of the department shall be ERC Chairman. The ERC has the following functions:

(i) To recommend appointment of paper setters/examiners of various examinations at the start of each semester.

(ii) To prepare quizzes, assignments, test papers etc. for Continuous Assessment (CA), Mid-Semester examination (MS) and End Semester (ES) examination and to evaluate them. Normally, each concerned faculty member, who is also a member of ERC, will do this job for his/her class. However, in exceptional circumstances any part of the work may be entrusted to some other member of the ERC.

(iii) To consider the individual representation of students about evaluation and take remedial action if needed. After scrutinizing, ERC may alter the grades awarded upward/downward. The decision of the ERC shall be final.

(iv) To moderate assignments, quizzes etc. for courses given by each of the concerned faculty members for his/her class with a view to maintain uniformity of standards.

(v) To review and moderate the MS and ES results of each course with a view to maintain uniformity of standards.

(vi) To lay guidelines for teaching a course.

VIII. ATTENDANCE, PROMOTION AND DETENTION RULES

1. A student should normally attend all the classes. However, a student will be allowed to appear in the examination if he/ she has put in a minimum of 75% attendance separately in each course for which he / she has registered. A relaxation up to a maximum of 25% may be given on the production of satisfactory evidence that (a) the student was busy in authorized activities, (b) the student was ill.

2. A student should submit the evidence to the fact 1(a) and / or 1(b) above within seven working days of resuming the studies. Certificates submitted later will not be considered.

3. No relaxation in attendance beyond 25% is permitted in any case.

4. A student may re-register for a course if he/ she want to avoid a decrement in the grades.

5. There shall be no supplementary examinations. A student who has failed in a course will have to re-register for the course in a subsequent year.

6. If the student does not want to reappear in an elective course (that is, ED, EO, but not CC courses) then he/she can re-register afresh for a new elective course.

IX. DECLARATION OF RESULTS

1. The MTech (IS) program consists of 82 credits. A student will be awarded the degree if he/she has earned all 82 credits.
2. CGPA will be calculated on the basis of the best 78 credits earned by the student.

3. The candidate seeking re-evaluation of a course shall apply for the same on a prescribed proforma along with the evaluation fee prescribed by the university from time to time only for the End Semester Examination within seven days from the date of declaration of result.
4. The Institution/University may cancel the registration of all the courses in a given semester if
   i. The student has not cleared the dues to the institution/hostel.
   ii. A punishment is awarded leading to cancellation of the student's registration.

X. CURRICULUM MODIFICATION

The curriculum will be updated regularly within a period of 5 to 10 years since last revision, to keep pace with the advancements in the field of Information Systems.

XI. CENTRAL ADVISORY COMMITTEE

There shall be a Central Advisory Committee consisting of the following:

a) Dean, Faculty of Technology, Chairman

b) Dean PGS

c) Head of Institution

d) Heads of Departments running M. Tech. Course

XII. PROGRAM EDUCATIONAL OBJECTIVE

1. Program graduates will have successful careers in research and development, academia, industry and entrepreneurship.

2. Program graduates will engage in research and developmental activities to generate creative outputs and add to the body of knowledge in information systems.

3. Program graduates will hold strong professional ethics with good team skills and communication abilities.

4. Program graduates will engage in lifelong learning to acquire new knowledge in an evolving technological landscape.

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PROGRAM OUTCOMES

1. An ability to apply knowledge of computing and mathematics appropriate to the discipline.

2. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.

3. An ability to design, implement and evaluate a computer-based system, process, component, or program to meet desired needs.

4. An ability to function effectively on teams to accomplish a common goal.

5. An understanding of professional, ethical, legal, security, and social issues and responsibilities.

6. An ability to communicate effectively with a range of audiences.

7. An ability to analyze local and global impact of computing on individuals, organizations and society.

8. Recognition of the need for, and an ability to engage in, continuing professional development.

9. An ability to use current techniques, skills, and tools necessary for computing practices.

10. Provide students with the understanding of processes that support the delivery and management of information systems within a specific application environment.

11. An ability to effectively create and update Project Management Plan deliverables.

12. An understanding of the principles of information security and how to employ them in a manner to effectively secure the information and supporting infrastructure in an organization.

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

SCHEME SEMESTER-WISE COURSE ALLOCATION – FULL TIME

M.TECH. INFORMATION SYSTEMS (Full Time) SEMESTER I

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISC01	CC	Behaviour Oriented Conceptual Modeling	3	0	2	4	15	15	40	15	15	100
ISC02	CC	Distributed Computing	3	0	2	4	15	15	40	15	15	100
ISD**	ED	Elective #	3	0	2	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
EO***	EO	Open Elective	3	1	0	4	-	-	-	-	-	100
		TOTAL	18	3	6	24						
			$									

#: The LTP allocation, evaluation scheme and pre-requisites for electives are given in Table 3-4. The course code will depend upon student's choice of electives.

$: The actual weekly load will depend upon the electives chosen by the student.

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M.TECH. INFORMATION SYSTEMS (Full Time) SEMESTER II

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISC03	CC	Software Testing	3	0	2	4	15	15	40	15	15	100
ISC04	CC	Advances in Computer Architecture	3	0	2	4	15	15	40	15	15	100
ISD**	ED	Elective #	3	0	2	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
EO**	EO	Open Elective	3	1	0	4	-	-	-	-	-	100
		TOTAL	18	3	6	24						
			$									

#: The LTP allocation, evaluation scheme and pre-requisites for electives are given in table 3-4. The course code will depend upon student's choice of electives.

$: The actual weekly load will depend upon the electives chosen by the student.

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M.TECH. INFORMATION SYSTEMS (Full Time) SEMESTER III

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISD**	ED	Elective #	3	0	2	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	50	-	50	-	-	100
ISC05	CC	Seminar	0	0	4	2	100	-	-	-	-	100
ISC06	CC	Major Project	0	0	-	6	-	-	-	40	60	100
		TOTAL	6	1	-	20						
			$									

#: The LTP allocation, evaluation scheme and pre-requisites for electives are given in table 3-4. The course code will depend upon student's choice of electives.

$: The actual weekly load will depend upon the electives chosen by the student.

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M.TECH. INFORMATION SYSTEMS (Full Time) SEMESTER IV

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISC07	CC	Dissertation	0	0	-	14	-	-	-	40	60	100
		TOTAL	0	0	-	14						

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

SCHEME SEMESTER-WISE COURSE ALLOCATION-PART TIME

M.TECH. INFORMATION SYSTEMS (Part Time) SEMESTER I

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISC01	CC	Behaviour Oriented Conceptual Modeling	3	0	2	4	15	15	40	15	15	100
ISC02	CC	Distributed Computation	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective	3	1	0	4	-	-	-	-	-	100
		TOTAL	9	1	4	12						
			$									
$: The actual weekly load will depend upon the electives chosen by the student.												

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M.TECH. INFORMATION SYSTEMS (Part Time) SEMESTER II

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISC03	CC	Software Testing	3	0	2	4	15	15	40	15	15	100
ISC04	CC	Advances in Computer Architecture	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective	3	1	0	4	-	-	-	-	-	100
		TOTAL	9	1	4	12						
			$									

$: The actual weekly load will depend upon the electives chosen by the student.

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M.TECH. INFORMATION SYSTEMS (Part Time) SEMESTER III

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISD**	ED	Elective #	3	0	2	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
		TOTAL	9	2	2	12						
			$									

#: The LTP allocation, evaluation scheme and pre-requisites for electives are given in table 3-4. The course code will depend upon student's choice of electives.

$: The actual weekly load will depend upon the electives chosen by the student.

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M.TECH. INFORMATION SYSTEMS (Part Time) SEMESTER IV

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISD**	ED	Elective #	3	0	2	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
		TOTAL	9	2	2	12						
			$									

#: The LTP allocation, evaluation scheme and pre-requisites for electives are given in table 3-4. The course code will depend upon student's choice of electives.

$: The actual weekly load will depend upon the electives chosen by the student.

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M.TECH. INFORMATION SYSTEMS (Part Time) SEMESTER V

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISD**	ED	Elective #	3	0	2	4	-	-	-	-	-	100
ISD**	ED	Elective #	3	1	0	4	-	-	-	-	-	100
ISC06	CC	Major Project	0	0	-	6				40	60	100
		TOTAL	6	1	-	16						
			$									

#: The LTP allocation, evaluation scheme and pre-requisites for electives are given in table 3-4. The course code will depend upon student's choice of electives.

$: The actual weekly load will depend upon the electives chosen by the student.

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M.TECH. INFORMATION SYSTEMS (Part Time) SEMESTER VI

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
ISD**	ED	Self-Learning Course#	3	1	0	4	50	-	50	-	-	100
ISC05	CC	Seminar	0	0	4	2	100	-	-	-	-	100
ISC07	CC	Dissertation	0	0	-	14	-	-	-	40	60	100
		TOTAL	0	0	-	18						
			$									

#: The LTP allocation, evaluation scheme and pre-requisites for electives are given in table 3-4. The course code will depend upon student's choice of electives.

$: The actual weekly load will depend upon the electives chosen by the student.

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TABLE 3: LIST OF DISCIPLINE CENTRIC ELECTIVES

(A)WITH PRACTICALS					
CODE	**COUSRE OF STUDY**	**L**	**T**	**P**	**C**
ISD**		3	0	2	4
ISD01	Machine Learning	3	0	2	4
ISD02	Computer Vision	3	0	2	4
ISD03	Semantic Web	3	0	2	4
ISD04	Digital Watermarking and Steganography	3	0	2	4
ISD05	Soft Computing	3	0	2	4
ISD06	Advances in Software Engineering	3	0	2	4
ISD07	Digital Image Processing	3	0	2	4
ISD08	Advances in Mobile Computing	3	0	2	4
ISD09	Information Security	3	0	2	4
(B) WITHTUTORIALS					
CODE	**COUSRE OF STUDY**	**L**	**T**	**P**	**C**
ISD10	Software Quality	3	1	0	4
ISD11	Service Oriented Architecture	3	1	0	4
ISD12	Information Theory and Coding	3	1	0	4
ISD13	Digital Forensic	3	1	0	4

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ISD14	IT Law and Ethics	3	1	0	4
ISD15	Design and Architectural Patterns	3	1	0	4
ISD16	Emerging Trends in Computational Intelligence	3	1	0	4
ISD17	Emerging Trends in Information Systems	3	1	0	4
ISD18	Embedded Systems	3	1	0	4
ISD19	Information Storage and Retrieval	3	1	0	4
ISD20	Advances in Databases	3	1	0	4
ISD21	Internet of Things	3	1	0	4
ISD22	Requirement Engineering	3	1	0	4
ISD23	Real-time Systems	3	1	0	4
ISD24	Human Computer Interface	3	1	0	4
ISD25	Rule Based Computing	3	1	0	4
ISD26	Cloud Computing	3	1	0	4
ISD27	Big Data and Analytics	3	1	0	4
ISD28	Advances in Compiler Technology	3	1	0	4

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TABLE 4: LIST OF OPEN ELECTIVES EO***

LTP Allocation			Evaluation Scheme				
L	T	P	CA	MS	ES	Int	Ext
3	1	0	25	25	50	-	-

Code	Name of Elective	Pre-Requisites
EO001	Technical Communication	None
EO002	Disaster Management	None
EO003	Basics of Finance Management	None
EO004	Basics of Human Resources Management	None
EO005	Project Management	None
EO006	Basics of Corporate Law	None
EO007	Biological computing	None
EO008	Basic of Social Science	None
EO009	Entrepreneurship	None
EO010	Social Work	None
EO011	Intellectual Property and Patenting	None
EO012	Supply Chain Management, Planning and Logistics	None
EO013	Organization Development	None
EO014	Industrial Organization and Managerial Economics	None
EO015	Global Strategy and Technology	None
EO016	Engineering System Analysis andDesign	None
EO017	Biology for Engineers	None
EO018	Energy, Environment and Society	None
EO019	Public Policy and Governance	None

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Course Contents of Core Courses

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISC01	**Behavior Oriented Conceptual Modeling**	**3L-0T-2P**	**None**

COURSE OUTCOMES

1. To acquire knowledge of Object-oriented Analysis using UML
2. To acquire Knowledge of Rational Unified Process
3. To acquire Knowledge of Meta-modeling
4. To be able to think analytically and analyze a problem using the techniques learned

COURSE CONTENT

Introduction to Conceptual modeling, Structured Vs Object Oriented Modeling.
Review of Structured analysis and Design Techniques.
Detailed study of Unified Modelling Language with applications, object Constraint Language, Estimation using Use Case Points, Object Oriented Metrics, Configuration Management
Introduction to Rational Unified process
Introduction to meta-modelling; meta-data and meta-activity models

Guidelines for practical/project work:

Students will implement assignments based upon the concepts covered in the lectures.

SUGGESTED READINGS

1. Object Oriented Modeling and Design with UML by Michael R Blaha and James R Rumbaugh, Pearson
2. UML distilled Third Edition by Martin Fowler, Pearson
3. The Unified Software Development Process by Jacob so, Booch and Rumbaugh,Pearson Education

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Course No.	Title of the Course	Course Structure	Pre-Requisite
ISC02	Distributed Computing	3L-0T-2P	None

COURSE OUTCOMES

1. Understand the concepts of distributed computing systems along with design and implementation issues.
2. Acquire skills to analyze design and implement distributed algorithms.

COURSE CONTENT

Distributed computing systems: Introduction, DCS design goals: Transparencies, Fundamental issues.
Distributed coordination: Temporal ordering of events, Lamport's logical clocks, Vector clocks; Ordering of messages, Physical clocks, Global state detection.
Process synchronization: Distributed mutual exclusion algorithms, Performance matrix, Inter-process communication.
Deadlocks, load scheduling and balancing techniques: Deadlock in distributed systems, Round robin load balancing, client side load balancing, server side load balancing, applications (such as routers).
Distributed system models: System Architectures & Client-Server Models.
Distributed algorithms and programming systems: Search Engines, Page ranking, leader election, Hashing, Caching, Remote Procedure Call.
Discussion on distributed computing platforms such as CORBA/ DCOM/ Java RMI/ Hadoop Map-Reduce.
Workflow Systems: Grid Computing, Cloud Computing, Virtualization, IaaS Clouds, Filesystems, Networked Filesystems, Parallel Filesystems.
Distributed filesystems: Data-Intensive Computing, Distributed Hash Tables, Consistency Models, Fault Tolerance, Many-core Computing.

Guidelines for practical/project work:
Programming using RPC mechanisms using Java RMI/CORBA/DCOM, Map Reduce Programming with Hadoop / Spark Programming with message passing for implementing distributed algorithms.Project work to build a cluster.

SUGGESTED READINGS

1. Distributed Systems Concepts and Design, G. Coulouris, J. Dollimore,Addison Wesley.
2. Distributed and Cloud Computing, 1st Edition, From Parallel Processing to the Internet of Things, Hwang & Dongarra & Fox.

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3. Advanced Operating Systems, M. Singhal, N.G. Shivarathri, McGraw Hill.
4. Distributed Operating Systems and Algorithms, Randy Chow, T. Johnson, Addison Wesley.
5. Distributed Operating Systems, A.S. Tanenbaum, Prentice Hall.
6. Principles of Distributed Database Systems, M. Tamer Ozsu, PatrickValduriez, Prentice Hall International.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISC03	**Software Testing**	**3L-0T-2P**	**None**

COURSE OUTCOMES

1. Learn the various concepts and methods that can be used to test software before it is delivered to the end user.
2. Learn about various challenges and difficulties faced during the process of software testing and approach for tackling them.

COURSE CONTENT

Introduction to Software Testing: Definition, Goals, Test metrics, Effective Software Testing versus Exhaustive Software Testing.
Software Testing Terminology: Role of testing in SDLC, Discussion of testing terminology such as error, bug and failure, test case and Test plan, V-Testing Life Cycle Model.
Software Verification: Verification and validation Activities, Role of verification and Validation in Testing Strategy. Verification methods: Inspections, Walkthroughs and reviews, SRS document verification, SDD document verification.
Overview of Test Generation Strategies: Types of Testing-White box and Black Box testing, Test case generation from source code, test generation from requirements, Test generation from finite state models, test generation from combinatorial designs.
Static White Box Testing Techniques: Inspections, structured walkthroughs and Technical reviews.
Structural/Dynamic White Box Testing Techniques: Logic Coverage Criteria, Basis Path Testing, Loop testing, Data Flow Testing, slice based testing, Mutation Testing.
Dynamic Black Box Testing Techniques: Boundary Value Analysis(BVA), Equivalence Class Testing, State-Table Based Testing, decision Table Based Testing, Cause-Effect Graphing Based Testing.
Essentials of Graph Theory: What is graph, matrix representation of graph, paths and independent paths, generation of a graph from a program, identification of independent paths selection.

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Test Selection and Test minimization and Prioritization of Test Cases for Regression Testing: What is Regression testing, Regression test case selection, reducing the number of test cases, Risk analysis, code coverage prioritization.

Introduction to Object Oriented Testing: Path testing, state based testing class testing**,**
Testing Tools: Static Testing Tools, Dynamic testing Tools

Outline of practical work for Software Testing:

1. Create a test plan document for any application
2. Study of any Testing Tool (Win Runner), any Test Management Tool (QA Complete)
3. Automate the Test cases using Test Automation tool (using QA Complete)
4. Learn how to raise and report Bugs using Bug tracking tool (Bugzilla, Jira using QA Complete)
5. Study of any open source testing tool.

SUGGESTED READINGS

1. Yogesh Singh, “Software Testing”, Cambridge University Press.
2. Aditya P. Mathur, “Foundations of Software Testing, Fundamental Algorithms and Techniques”, Pearson Education.
3. Naresh Chauhan, “Software Testing Principles and Practices”, Oxford University Press.
4. Ramesh Desikan,” Software Testing Principles and Practices”,Pearson Education.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISC04	**Advances in Computer Architecture**	**3L-0T-2P**	**None**

COURSE OUTCOMES

1. To gain an appreciation of the wide variety of hardware architectures and platforms for building computer and information systems and their applications.
2. To continue to keep abreast of the latest developments in the domain of computer system architectures.

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COURSE CONTENT

Overview of languages for systems design: hardware definition languages (VHDL/Verilog/System-C, hardware verification languages (Open-VERA/Sugar), Languages for parallel reactive systems (Esterelle), System specification languages (Z/LOTOS)

Hardware software systems: Hardware software co-design flow: co-specification/ co-synthesis/ co-design/ co-verification, different computing and communication platforms for implementation of hardware-software systems, techniques and tools for co-design steps, distributed embedded systems

Emerging VLSI architectures: ReconfigurableFPGA architectures, dynamic FPGA architectures, SOC architectures, approaches and CAD tools for VLSI processes such partitioning/ placement/ routing/ testing, applications.

SUGGESTED READINGS

1. Web resources for various languages.
2. Staunstrup Jørgen, Wolf Wayne,"Hardware Software Co-design: Principles and Practices", Springer.
3. Processor Design,System-On-Chip Computing for ASICs and FPGAs, Nurmi, Jari

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Course Contents of Discipline Centric Electives

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD01	Machine Learning	3L-0T-2P	Computer Programming

COURSE OUTCOMES

1. To develop an understanding of the fundamentals of machine learning and statistical pattern recognition.
2. To gain an insight into the various components of machine learning such as supervised learning, unsupervised learning, learning theory, reinforcement learning and adaptive control.
3. To acquire skills that can be applied to various components of machine learning to applications like robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing.

COURSE CONTENT

Introduction: Definition of learning systems. Goals and applications of machine learning.

Inductive Classification: The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts.

Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity.Occam's razor.Overfitting, noisy data, and pruning.

Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting, and DECORATE. Active learning with ensembles.

Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing.

Computational Learning Theory: Models of learnability: learning in the limit; probably approximately correct (PAC) learning. Sample complexity: quantifying the number of examples needed to PAC learn. Computational complexity of training. Sample complexity for finite hypothesis spaces. PAC results for learning conjunctions, kDNF, and kCNF. Sample complexity for infinite hypothesis spaces, Vapnik-

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Chervonenkis dimension.
Rule Learning: Propositional and First-Order, Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Horn-clause induction (Inductive Logic Programming) and Foil.Learning recursive rules.Inverse resolution, Golem, and Progol.
Artificial Neural Networks: Neurons and biological motivation. Linear threshold units.Perceptrons: representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.
Support Vector Machines: Maximum margin linear separators. Quadractic programming solution to finding maximum margin separators.Kernels for learning non-linear functions.
Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm.Parameter smoothing.Generative vs. discriminative training.Logisitic regression.Bayes nets and Markov nets for representing dependencies.

Guidelines for project based work: Semester long projects, presentations, research work, term papers based on the above topics.

SUGGESTED READINGS

1. Richard Duda, Peter Hart and David Stork, Pattern Classification, 2nd ed. John Wiley & Sons, 2001.
2. Tom Mitchell, Machine Learning. McGraw-Hill, 1997.
3. Richard Sutton and Andrew Barto, Reinforcement Learning: An introduction. MIT Press, 1998
4. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning. Springer, 2009

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD02	**Computer Vision**	**3L-0T-2P**	**Computer Programming, Computer Graphics**

COURSE OUTCOMES

1. To develop an understanding of the fundamentals of image formation, camera imaging geometry, feature detection and matching, multiview geometry including

stereo, motion estimation and tracking, and classification.
2. To gain an insight into the image formation and analysis, as well as the ability to extract information much above the pixel level.
3. To acquire skills that can be appliedwhile operating on images in a context-aware manner or where images from multiple scenarios need to be combined or organized in an appropriate way.

COURSE CONTENT

Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Depth estimation and Multi-camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection

Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Shape from X: Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Miscellaneous: Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing; Modern trends - super-resolution; GPU, Augmented Reality; cognitive models, fusion and SR&CS.

Guidelines for project based work: Semester long projects, presentations, research work, term papers based on the above topics.

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SUGGESTED READINGS

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
4. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD03	**Semantic Web**	**3L-0T-2P**	**Computer Programming, Computer Networks**

COURSE OUTCOMES

1. Identify the component technologies of the Semantic Web and understand the concept of Linked Web.
2. Illustrate the design principles of the Ontology and Semantic for developing technologies
3. Understand certain limitations of the Semantic Web technologies, and be aware of the kinds of services it can and cannot deliver.

COURSE CONTENT

Overview and Introduction: Knowledge Representation, Ontologies and Description Logic, Semantic Web in Depth: RDF and RDF Schema, Semantic Web in Depth: OWL. **Writing OWL ontologies:** Protégé, Semantic Web Methodologies and Design Patterns, Semantic Web in Depth: SPARQL, Semantic Web in Depth: Rules. **Publishing on the Semantic Web:** Linked Data, Semantic Web Vocabularies and Applications, Semantic Web vs Web2.0, Trust and Community. **Applications**: Information Integration, Ontology Alignment, Scalable Reasoning and Knowledge Acquisition.

SUGGESTED READINGS

1. A Semantic Web Primer, third edition, MIT Press, 2012, Grigoris Antoniou, Paul Groth, Frank van Harmelen and Rinke Hoekstra

2. Allemang, D., & Hendler, J. (2011). Semantic Web for the working Ontologist.2nd Edition, Morgan & Kaufmann Publisher. [ISBN:978-0-12-385965-5]
3. Heath, T., & Bizer, C. (2011). Linked Data: Evolving the Web into a Global Data Space.Morgan & Claypool Publisher.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD04	**Digital Watermarking and Steganography**	**3L-0T-2P**	**Computer Programming**

COURSE OUTCOMES

1. Acquire the knowledge of emerging digital watermarking and steganography techniques and their potential impact on society.
2. Understand the significance of digital watermarking in different applications.
3. Analyze the various issues related to security of user data.

COURSE CONTENT

Digital Watermarking: Introduction to Watermarking techniques. A Survey of Current Watermarking Techniques, Watermark detection and analysis, Application of cryptography in digital watermarking.
Classification of watermarking techniques: Robust and Fragile Watermarking. Techniques for protection of multimedia data and databases, Security Analysis of watermarking techniques.
Applications of digital watermarking: Copyright protection, Intellectual property issues, Digital Signatures, Authentication.
Steganography: History of Steganography, Principles of Steganography, Steganography in computer file systems, Steganalysis techniques, Application of cryptography in steganography, Steganography algorithms, Various applications of steganography.
Emerging trends: Advance steganography or watermarking techniques, Forensic watermarking and steganography.

SUGGESTED READINGS

1. Katzenbeisser and Petitcolas, “Information Hiding: Techniques for steganography and digital watermarking”, Artech House.
2. Johnson, Duric, and Jajodia, “Information Hiding – Steganography and Watermarking – Attacks and Countermeasures”, Kluwer Academics publishers.

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3. Cox, Miller, and Bloom, "Digital Watermarking", Academic Press.
4. Jeng-Shyang Pan, Hsiang-Cheh Huang, Lakhmi C. Jain, "Information Hiding and Applications", Springer.
5. Michael Konrad Arnold, Martin Schmucker, Stephen D. Wolthusen, "Techniques and applications of Digital watermarking and content protection", Artech House.
6. Research papers on Digital watermarking and steganography of refereed journals.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD05	**Soft Computing**	**3L-0T-2P**	**Computer Programming, Algorithms**

COURSE OUTCOMES

1. An understanding of the complexity of current information systems with their inherent uncertainty and imprecision.
2. Ability to use methodologies that can exploit the tolerance for imprecision to develop robust and cheap solutions for intelligent systems.
3. Skills to apply various components of soft computing such as fuzzy logic, evolutionary computing, probabilistic computing etc. and their combination to implement the solutions.

COURSE CONTENT

Foundations of soft computing: Computational issues in intelligent information systems, Fuzzy set theory and Rough Set theory
Neural networks: learning process, single layer perceptrons, back propagation algorithm, support vector machines
Evolutionary Algorithms: Overview and theory of genetic algorithms, genetic operations, selection methods, tackling multi-objective functions, extensions
Swarm optimization: Techniques based on nature-driven optimization such as ant colony, bird flocking, fish schooling, bat algorithm, cuckoo search etc.
Future trends: Cooperative agents, adaptive systems applications, emerging methodologies

SUGGESTED READINGS

1. N.K. Sinha and M.M. Gupta, Soft computing and Intelligent systems, Elsevier
2. Eva Volna, Introduction to soft computing. Free e-book.
3. Andrea G. B. Tettamanzi, Marco Tomassini, Soft Computing: Integrating

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Evolutionary, Neural, and Fuzzy Systems, 2001			
Course No.	**Title of the Course**	**Course Structure**	**Pre-Requisite**
ISD06	**Advances in software Engineering**	**3L-0T-2P**	**Software Engineering**

COURSE OUTCOMES

1. To gain an understanding of emerging concepts, tools and techniques in the field of software engineering.
2. To continue to learn and adopt new developments in software engineering and software practices.

COURSE CONTENT

The course will cover the latest topics and techniques in the area of Software Engineering.

SUGGESTED READINGS

As suggested by the Instructor.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD07	**Digital Image Processing**	**3L-0T-2P**	**Computer Programming,Algorithms**

COURSE OUTCOMES

1. To be able to use the algorithms and approaches of digital image processing for developing image based applications.
2. To apply programming skills and tool usage efficiently in developing programs and applications.
3. To conduct research in the area of digital image processing.

COURSE CONTENT

The origins of Digital Image Processing. Examples of Fields that Use Digital Image Processing, Fundamentals Steps in Image Processing, Elements of Digital Image Processing Systems, Image Sampling and Quantization, Some basic relationships like Neighbors, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations.

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Image Enhancement in the Spatial Domain. Some basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Combining Spatial Enhancement Methods.
Image Enhancement in the Frequency Domain. Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering.
Image Restoration. A model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations.
Image Compression. Coding, Interpixel and Psychovisual Redundancy, Image Compression models, Elements of Information Theory, Error free comparison, Lossy compression, Image compression standards.
Image Segmentation. Detection of Discontinuities, Edge linking and boundary detection, Thresholding, Region Oriented Segmentation, Motion based segmentation.
Representation and Description. Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Introduction to Morphology, Some basic Morphological Algorithms.
Object Recognition. Patterns and Pattern Classes, Decision-Theoretic Methods, Structural Methods.

SUGGESTED READINGS

1. Jayaraman, Digital image processing, Tata Mcgraw Hill, 2011
2. R.C. Gonzalez and R.E. Woods, Digital Image Processoing (3rd Edition)

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD08	Advances in Mobile Computing	3L-0T-2P	Computer Networking

COURSE OUTCOMES

1. Understand the characteristics and limitations of mobile hardware devices including their user-interface modalities.
2. Interface a mobile computing system to hardware and networks.
3. Program applications on a mobile computing system and interact with servers and database systems.

4. Develop an awareness of professional and ethical issues, in particular those relating to security and privacy of user data and user behavior.

COURSE CONTENT

Introduction: Overview of Wireless Telephony, Wireless and Mobile Computing Architecture – Limitations of wireless and mobile communication – Wireless Telecommunication Networks: Digital cellular Systems, TDMA - CDMA – Wireless Networking Techniques –Mobility Bandwidth Tradeoffs – Portable Information Appliances.

Wireless LAN Overview: MAC issues, IEEE 802.11, Blue Tooth, Wireless multiple access protocols, TCP over wireless, Wireless applications, data broadcasting, WAP: Architecture, protocol stack, application environment, applications.

Mobile Networking: Virtual IP Protocols - Loose Source Routing Protocols - Mobile IP – CDPD – GPRS – UMTS - Security and Authentication – Quality of Service – Mobile Access to the World Wide Web.

Database Issues : Hoarding techniques, caching invalidation mechanisms, client server computing with adaptation, power-aware and context-aware computing, transactional models, query processing, recovery, and quality of service issues.

Data Dissemination: Communications asymmetry, classification of new data delivery mechanisms, push-based mechanisms, pull-based mechanisms, hybrid mechanisms, selective tuning (indexing) techniques.

Mobile Agents computing, security and fault tolerance, transaction processing in mobile computing environment.

Mobile Ad hoc Networks (MANETs): Overview, Properties of a MANET, spectrum of MANET applications, routing and various routing algorithms, security in MANETs. Recent Advances in Mobile Computing.

Outline of practical work:

1. Study of GSM architecture and signaling techniques.
2. Study of Cellular system and related concepts.
3. Study of GPRS service
4. Study of WAP architecture
5. Study of Bluetooth architecture.
6. Study of IEEE 802.11 network topology.
7. Study of Distributed mobile computing.

SUGGESTED READINGS

1. Mobile Communication 2nd edition by Jochen Schiller, Pearson education

2. Mobile Computing by Asoke Talukder, Roopa Yavagal (Tata McGraw Hill)

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD09	**Information Security**	**3L-0T-2P**	**Computer Programming,Algorithms**

COURSE OUTCOMES

1. Understand the principles, techniques and tools used for designing secure information systems.
2. Design, implement and maintain secure computer networks.
3. Safely recover an information system or network from a security attack.

COURSE CONTENT

Computer Security Concepts: Threats, Attacks, and Assets, Security Functional Requirements, Fundamental Security Design Principles, Information Security: Confidentiality, Integrity, Availability, Identification and Authentication, Authorization and Access control, Accountability and Auditing.

Cryptography for Data Security: Basic Concepts and Historical Overview, Mathematical Foundations of Cryptography, Symmetric Encryption Techniques, Asymmetric Key Encryption Techniques, Public Key Infrastructure (PKI), Authentication, Message Digest & Digital Signature, Kerberos Key Exchange, Encryption standards and case studies.

Types of Attacks: Malicious programs (e.g., viruses, worms, Trojan horses), Buffer overflow attack, Hacking methods and software tools, Denial-of-service attacks and distributed denial-of-service attacks, IP Spoofing, Routing Protocol attacks, “Spam” Email, DNS and the DNS Cache Poisoning Attack, Windows and Unix Vulnerabilities, Dictionary Attacks and Rainbow-Table Attacks on Password Protected Systems, Security Issues in Structured Peer-to-Peer Networks, Web Security: PHP Exploits, Cross-Site Scripting and Other Browser-Side Exploits, Bots and Botnets.

Internet Security: SSL / TLS, Secure Shell, Secure HTTP, Secure FTP, Secure E-Mail (PGP), IPsec: AH, ESP, IKE; DNS Security, Multicast Security, VPN, Secure Internet Routing (BGP, OSPF), Software tools for Internet security.

Protection of Networks from Attacks: Firewalls: Packet Filtering, Proxy-Server; Port and Vulnerability Scanning, Packet Sniffing, Intrusion Detection, and Penetration Testing and tools, Honeypot, Anti-virus software, Access control, Trusted OS design, Auditing and Monitoring.

Wireless / Mobile Network Security: Security Vulnerabilities of Mobile Devices,

Wireless network attacks and defenses, Secure ad-hoc network routing.
Database and Cloud Security: The Need for Database Security, SQL Injection Attacks, Database Access Control, Inference, Database Encryption, Cloud Computing: Cloud Security Risks and Countermeasures, Data Protection in the Cloud, Cloud Security as a Service, Study of recent advances in network security domain.

Guidelines for Practical Work:
1. Students will develop programs in C/C++/Java/Python to implement the algorithms covered in the course.
2. Assignments will be given to study the modern day tools being used to detect vulnerabilities of systems and ensure their security.

SUGGESTED READINGS
1. William Stallings ,"Cryptography and Network Security: Principles and Practice", 6th Edition, Prentice Hall.
2. Behrouz A. Forouzan,"Cryptography & Network Security", 2nd Edition, McGraw Hill.
3. Michael E. Whitman, Herbert J. Mattord, "Principles of Information Security" 5th Edition, Cengage Learning.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD10	Software Quality	3L-1T-0P	Software Engineering

COURSE OUTCOMES
1. Understand the quantitative aspect of quality.
2. Get acquainted with prevalent quality tools and techniques for measuring quality in traditional manufacturing set up.
3. Get to know how to apply these tools and techniques in the software scenario.
4. Understand the role and relevance of the various quality management tools in the different stages of Software Development life cycle

COURSE CONTENT
Introduction to Quality: The Quality Tradition, Origins of Quality Movement, Deming and Crosby's view of quality, Different Views of Quality: Transcendental, User, Manufacturing, Product, Value based, Total Quality Movement (TQM), Application of TQM to Software Engineering, Why does software fail?

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Software quality: Definition, How is software quality different? Static quality attributes, Dynamic quality attributes, Software Quality Models, McCalls, Boehms, ISO9126, GQM, Gilb's template, Quality Management, Quality assurance Standards, ISO standards, CMM, CMMI, 3 Sigma, 6 Sigma Statistical Information Systems (SIS), Seven tools of quality control: Pareto Charts, Graphs, Check sheets, histograms, Scatter Plots, Cause and Effect Diagrams,

Business Process Redesign (BPR): Benefits of BPR in software development, TQM and BPR poised opposite to each other, Quality Function Deployment (QFD), Application of Seven Management and Planning tools for Software Requirements Capturing: Affinity diagrams, Interrelationship diagraphs, Hierarchy diagrams, Matrix diagram, Matrix data analysis, process decision program chart, arrow Diagram/Precedence Diagram

Computer Aided quality engineering (CAQE) and tools for quality management

Software Metrics: Definition, Types of Software Metrics:Organisation, Project, Process, Product, Product Complexity metrics, Halsteads Software Science Metrics, OO Metrics: Chidamber and Kemrer OO metrics suite

SUGGESTED READINGS

1. Akao, Y. (1988), Quality function deployment: Integrating Customer requirementsinto Product design, Productivity press
2. Crosby, P., Quality is free
3. Fenton N., Software Metrics:ARigorous Approach, Wiley

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD11	**Service Oriented Architecture**	**3L-1T-0P**	**Computer Networks**

COURSE OUTCOMES

1. An understanding of the basic principles of service orientation and service oriented
2. analysis techniques
3. An insight in the technology underlying the service design and learn advanced concepts such as service composition, orchestration and Choreography
4. Skills to apply various components of service oriented architecture such as SOAP,
5. Entity-centric business service design, Application service design etc. and theircombination to implement the solutions.

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COURSE CONTENT

Introduction: Roots of SOA, Characteristics of SOA, Comparing SOA to client-server and distributed internet architectures, Anatomy of SOA, How components in an SOA interrelate, Principles of service orientation

Web Services: Service descriptions, Messaging with SOAP, Message exchange Patterns, Coordination, Atomic Transactions, Business activities, Orchestration, Choreography, Service layer abstraction, Application Service Layer, Business Service Layer, Orchestration Service Layer

Service Oriented Analysis: Business-centric SOA, Deriving business services, service modeling, Service Oriented Design, WSDL basics, SOAP basics, SOA composition guidelines, Entity-centric business service design, Application service design, Task-centric business service design

SOA Platform Basics: SOA support in J2EE, Java API for XML-based web services (JAX-WS), Java architecture for XML binding (JAXB), Java API for XML Registries (JAXR) , Java API for XML based RIS (JAX-RIS)

WS-BPEL basics: WS-Coordination overview, WS-Choreography, WS-Policy, WS-Security

SUGGESTED READINGS

1. Thomas Erl, "Service-Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005.
2. Papazoglou Mike, Web Services & SOA: Principles and Technology , Pearson – Prentice Hall, January 2012
3. Bell, Michael, Service-Oriented Modeling (SOA): Service Analysis, Design, and Architecture, Wiley, 2008.
4. Erl, Thomas , SOA Design Patterns, Prentice Hall.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD12	Information Theory and Coding	3L-1T-0P	None

COURSE OUTCOMES

1. To learn the mathematics and logic underlying the principles of information theory and coding
2. To learn and implement the algorithms for different kinds of error control codes and their applications

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

COURSE CONTENT

Introduction: Uncertainty and Information, Shannon Entropy, Joint and conditional Entropies, Mutual Information, Uniquely decipherable and Instantaneous codes, Noiseless coding problem. Source coding Theorem, Block coding, construction of Optimal codes, Huffman's & Shannon – Fano methods.

Discrete memoryless channel: channel capacity, BSC and other channels, Information measure for continuous ensembles capacity of AWGN channel.

Error control coding: The channel coding Theorem, Application to BSC, Source Coding with fidelity criteria

Types of codes: error and error control strategies, Linear block codes, syndrome and error detection, Minimum distance, Error detecting and correcting capabilities of a block code, Syndrome decoding, Hamming codes, Cyclic codes, Generator and parity – check matrices, encoding, syndrome computation and error detection and decoding. BCH codes, decoding, of the BCH codes, Introduction to RS codes, Convolution codes, Maximum likelihood decoding The Viterbi algorithm. Introduction to Turbo codes. Current trends and future directions

Seminar and talks

SUGGESTED READINGS

1. Information Theory, R Ash, Dover Science Publications.
2. Element of Information Theory, Cover and Thomas, John Wiley & Sons.
3. Error Control coding: Fundamental & Application by Shulin& Daniel J. Costello Jr, Prentice Hall Inc
4. Communication Systems, Simon Haykin, Wiley Student Edition

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD13	Digital Forensic	3L-1T-0P	Computer Networks

COURSE OUTCOMES

1. Conduct digital investigations that conform to accepted professional and ethical standards of conduct, including impartiality and the protection of personal privacy and are based on the standard investigative process: identification, preservation, examination, analysis and reporting.
2. Identify and document potential security breaches of computer data that suggest violations of legal, ethical, moral, policy and/or social standards.

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

3. Apply a solid foundational grounding in computer networks, operating systems, file systems, hardware and mobile devices to digital investigations and to the protection of computer network resources from unauthorized activity.
4. Work collaboratively with clients, management and/or law enforcement to advance digital investigations or protect the security of digital resources.

COURSE CONTENT

Introduction: History, Types of investigations, The Forensic Process, Traditional Digital Forensic Process, Concepts of Computer Security, Security Incidents and Response, Real life examples of Computer Crime, Digital Forensics rules, Procedures, and Challenging aspects

Legal Issues: Stages of Investigative Process, Applying Forensic Science procedures to digital resources

File Systems, File Structures, Boot Processes and Systems logs of various popular operating systems (Windows, Linux, Macintosh), State-of-the art Computer Forensics Tools, Role of Image Files and Multimedia Files in digital forensics,

Network Forensics: Digital Evidence on Physical, Data-Link Layers, Network and Transport Layers, Internet Application Services; Live Acquisitions, Investigating Intrusions, Cell Phone and mobile device forensics, Virtual Machine and Cloud Forensics

Digital Evidence in the Courtroom: Admissibility, Authenticity and Reliability,Evidence classification, Evidence presentation: Report Writing for High Tech Investigations, Forensics tools to generate reports, Expert Testimony in High Tech Investigations, Ethics for the Investigator and Expert Witness

Anti-forensics: Counter measures to impair forensics analysis

Current development in the field and research Challenges

Students will be allotted a study project that will require them to explore the new dimensions in this area and present their work at the end of course.

SUGGESTED READINGS

1. Bill Nelson, Christopher Steuart, Amelia Phillips , "Guide to Computer Forensics and Investigations", 2015, 5th Edition, Cengage
2. John Sammons, "The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics", 1st Edition, Syngress Media
3. Eoghan Casey, "Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet", 3rd Edition, Academic Press Inc

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD14	IT Law and Ethics	3L-1T-0P	None

COURSE OUTCOMES

1. An understanding of the law that governs the development and dissemination of software.
2. An understanding of the law that governs the dissemination of digitized information.
3. An understanding of ethics related to the IT profession.

COURSE CONTENT

Introduction: Definition, Applicability, Nature of Intellectual Property: Patents, Trademarks and copyright, Process of Patenting and Development: technological research, Innovation, Patenting, development, International Cooperation on Intellectual Properly, Procedure for grants of patents.

Scope of Patent Rights: Government rules for licensing and transfer of technology within country, government rules for licensing and transfer of technology from other country, Patent information and documentation.Legal framework infringement actions and remedies.

Administration of Patent System: New Development in IPR, IPR of Biological systems, Computer software, Machinery etc.Case studies.

Protection of databases: Laws under Sui generis, EC Directive 96/9/EC, Technological Protection measures, Digital Rights Management, watermarking and certification.

Overview of Indian IT laws

Current trends and future directions

SUGGESTED READINGS

1. Introduction to intellectual property: Theory and Practice, World Intellectual Property Organization.
2. Intellectual Property Rights: Innovation, Governance and the Institutional Environment, Birgitte Andersen, Edward Elgar Publishing Limited.
3. Innovation, Intellectual Property, and Economic Growth,CristineGreenhalgh, Mark Rogers.
4. The global challenge of intellectual property rights,Robert C. Bird, SubhashChander Jain.
5. Digital Media and Intellectual Property, Nicola Lucchi.

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Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD15	**Design and Architectural Patterns**	**3L-1T-0P**	**Software Engineering**

COURSE OUTCOMES

1. To appreciate the benefits of design and architectural patterns in object oriented software development.
2. To learn the use of various design patterns and architectural patterns.

COURSE CONTENT

Introduction: Patterns andMotivation for using patterns

Design patterns: Façade, adaptor, strategy, bridge, decorator, publisher-subscriber, factory method, factory, template, singleton, object pool and their implementation in Object Oriented languages such as C#/Java.

Architectural patterns: Architectural patterns used in various applications such as interactive applications (Model View Controller MVC and Presentation-Abstraction-Control PAC) ,distributed architectures (Broker, pipes and filters), Adaptable systems (Reflection), Communication (Proxy) and other architectural patterns.

Guidelines for project work: Project/ seminars/ talks/ presentations/ research work/ term papers based on the above topics.

SUGGESTED READINGS

1. Pattern oriented software architecture, Frank Buschmann *et al,* Wiley India.
2. Design Patterns: Elements of Reusable Object-Oriented, Software by ErichGamma, RichardHelm, RalphJohnson,and JohnVlissides (the Gan gOfFour).
3. Software architectural patterns, OReilley media.
4. Architectural Patterns – the Open Book, http://pubs.opengroup.org/architecture/togaf8-doc/arch/chap28.html.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD16	**Emerging Trends in Computational Intelligence**	**3L-1T-0P**	**Algorithms**

COURSE OUTCOMES

1. To learn the new developments in the ever-evolving field of

computationalintelligence and utilize them for developing practical applications.
COURSE CONTENT The course will cover the latest topics and techniques in the area of Computational Intelligence.
SUGGESTED READINGS As suggested by the Instructor.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD17	**Emerging Trends in Information Systems**	**3L-1T-0P**	**None**
COURSE OUTCOMES 1. To gain knowledge of the various trends and developments in the ever-evolving area of Information Systems and apply them in developing new applications.			
COURSE CONTENT The course will cover the latest concepts, topics and techniques in the emerging areas of Information systems.			
SUGGESTED READINGS As suggested by the Instructor.			

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD18	**Embedded Systems**	**3L-1T-0P**	**Computer Architecture, Microprocessors**
COURSE OUTCOMES 1. To understand the design methodologies, platforms and design issues of embedded systems. 2. To equip oneself with software skills needed to model and implement embedded systems. 3. To develop full hardware software embedded applications governed by an operating			

system using micro-controllers or other platforms.

COURSE CONTENT

Embedded Systems & HW-SW Co-Design: Introduction to embedded systems: Evolution, Issues and Challenges, Co-design Flow methodologies, Design exploration, Co-specification, Co-verification, Validation and testing, Co-simulation, Physical design.

Embedded System Architectures:(i) Microcontroller Architecture based on 8051/AVR/ARM with interfacing of Memory and Peripheral Devices, Interrupts Processing, Interfacing with sensors and actuators. (ii) Alternative architectures: Programmable Logic Devices (PLD), Application Specific Integrated Circuits (ASIC), Application Specific Instruction Processors (ASIP), Field Programmable Gate Arrays (FPGA), Reconfigurable devices, Systems On Chip (SOC),VLIW architectures

Embedded System Software: Modeling UML and RT-UML, Software Development: Flow, Environments and Tools;RTOS Fundamentals

Embedded System Design Issues: Performance Analysis and Optimization: Speed, Power and Area Optimization; System Reliability, Safety and Security.

Guidelines for Assignments:

Programmingon Microcontroller kits
Interfacing input output devices with micro-controller kits
Developing micro-controller based systemsandwriting control programs
FPGA based hardware software systems: programming, simulation and emulation.

SUGGESTED READINGS

1. Marilyn Wolf, Computers as Component: Principles of Embedded ComputingSystem Design, 3rd Edition, Elsevier, 2011.
2. Frank Vahid, Tony Givargis, Embedded System Design: A Unified Hardware/ Software Introduction, 3rdEdition, Wiley, 2006.
3. K. Shibu, Introduction to Embedded Systems, Tata McGraw Hill, 2009.
4. Raj Kamal, Embedded Systems: Architecture, Programming and Design, 2ndEdition, Tata McGraw Hill, 2008.
5.Hardware software codesign of embedded systems: The polis approach, F.Balarin et al, Springer.
6. Hardware software codesign, G.D. Michelli, M. Sami, Kluer academic publishers.

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD19	**Information Storage and Retrieval**	**3L-1T-0P**	**Database Management Systems**

COURSE OUTCOMES

1. To gain an understanding of how information systems deal with large-scale collections of data as objects to be stored, searched over, selected, and transformed for use.

COURSE CONTENT

We examine both the background theory and practical application of information retrieval, database design and management, data extraction, transformation and loading for data warehouses, and operational applications. We will determine traditional methods of information retrieval and database management as well as new approaches that use massively parallel computation (MapReduce/Hadoop). Through readings, discussion, and hands-on experimentation, students will be prepared to discuss, plan, and implement storage, search and retrieval systems for large-scale structured and unstructured information systems using a variety of software tools. They will also be able to evaluate large-scale information storage and retrieval systems in terms of both efficiency and effectiveness in providing timely, accurate, access to needed and reliable information.

SUGGESTED READING

1. Robert R Korfhage, Information Storage and Retrieval,Wiley.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD20	**Advances in Databases**	**3L-1T-0P**	**Database Management Systems**

COURSE OUTCOMES

1. To get acquainted with new models and optimization techniques in digital databases.
2. To conduct research in the domain of databases and acquire the habit of keeping abreast with latest developments.

COURSE CONTENT

Database system architecture, query processing and optimization, transaction

processing concepts, concurrency control techniques, database recovery techniques, database security and authorization, enhanced data models for advanced applications,
Object relational databases, Object oriented databases, Non-SQL databases, Temporal databases, Deductive databases, database technology for decision support systems, Distributed and Web databases, data mining techniques
Advanced database concepts, emerging technologies and applications.

SUGGESTED READINGS

1. Nabil R. Adam, Bharat K. Bhargava, Advanced database systems, Lecture Notes in Computer Science.
2. Object Oriented databases clearly explained, jan L. Harrington, Morgan Kaufmann, 2000.
3. Carlo Zanialo, Advanced database systems, Morgan Kauffmann, 1997.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD21	Internet of Things	3L-1T-0P	Computer Networking

COURSE OUTCOMES

1. To design full connected-product experiences by integrating Internet services and physical objects.
2. To analyze, design and develop prototypes of Internet-connected products using appropriate tools.
3 To identify, classify and describe different kinds of Internet-connected product concepts.
4. To analyze the challenges and applying adequate patterns for user-interaction with connected-objects.

COURSE CONTENT

Introduction to the internet of things. Origins. Early concepts and products. Examples of current products and value propositions. Architectures and Design patterns. Analysis of a full connected-object experience. State of the Art, challenges and future directions.
Design principles for connected devices: Calm and ambient technology, privacy, loosely connected devices, graceful degradation.
Prototyping: Cost and ease of prototyping, changing embedded platform by moving

into the cloud, open source, closed source and mixed source
Prototyping devices: sensors, actuator, platforms for IoT design: micro-controllers, systems on a chip, Arduino, Raspberry-pi, Electric Imp
Integrating internet services.XML and JSON. HTTP APIs for accessing popular Internet services (Facebook, Twitter, and others). Practical activities.
User experience and interaction design. The three levels of user engagement: aesthetics, functional and emotional. Good examples of user interaction design. Designing your own user experience. Practical activities.
Project development and competition. Development of a project including: value proposition, physical connected object prototyping, programming the behavior, accessing Internet services and designing the user experience. Project competition.

SUGGESTED READINGS

1. Smart Things: Ubiquitous Computing User Experience Design. Mike Kuniavsky. Morgan Kaufmann Publishers. 2010.
2. Designing the Internet of Things,
3. Adrian McEwen, Hakim Cassivalli, Wiley.
4. Getting Started with Arduino (Make: Projects). Massimo Banzi. O'Reilly Media. 2008.
5. Emotional Design: Why We Love (or Hate) Everyday Things. Donald A. Norman. Basic Books, 2004.
6. Physical Computing: Sensing and Controlling the Physical World with Computers. Tom Igoe, Dan O'Sullivan. Premier Press. 2004.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD22	**Requirement Engineering**	**3L-1T-0P**	**Software Engineering**

COURSE OUTCOMES

1. To model the real life problem with the help of requirements engineering techniques.
2. To learn about representation of requirements through various requirements engineering techniques.

COURSE CONTENT

Introduction: What is requirement, Requirements management, Requirements and software life cycle.Processes in Requirements Engineering: Framework for describing

requirements engineering process.Conceptual foundation of elicitation, **System Analysis techniques used for elicitation**. Requirements specification, **Requirements validation.**Modeling Principles and Techniques for Requirements **Engineering:** Requirements specification from the enterprise view.Representation of with functional and non-functional view of the requirements.
Tools: Concept –Method –Tool view of Requirements Engineering, Role of CASE in Requirements Engineering.
Current topics may be included.

Guidelines for Practical Work:
A real life case study/ problem should be selected and all the requirements engineering techniques should be applied and a formal requirements document should be prepared.

SUGGESTED READINGS

1. System Requirements Engineering, P. Loucopoulos and V. Karakostas, McGraw-Hill
2. Software Requirements, K.Weigers, Microsoft Press.
3. Requirements engineering a good practice Guide, Ian Sommerville and P Sawyer,Wiley India.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD23	Real-time Systems	3L-1T-0P	Operating Systems

COURSE OUTCOMES

1. Understand the real-time system requirements and design analysis.
2. Understand the architectures, operating systems and performance issues of real-time systems.
3. Design a real-time multi-tasking system or an embedded system controller.

COURSE CONTENT

Introduction: Real-time systems models and classification, real-time task characterization, performance measures and estimation techniques.
Real-time process management: Task Scheduling for uniprocessor systems- Rate monotonic, EDF, handling priorities with critical sections and interrupts, reward based scheduling for accuracy-driven tasks
Advanced task scheduling: Scheduling for multiprocessor systems, adaptive scheduling techniques, fault tolerant scheduling

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Programming environment: RTOS, Programming languages, tools and techniques.
Real-time system design: Design techniques for reliability, fault tolerance and other application-specific quality considerations.
Real-time communication: Communication media, network topologies, protocols.
Recent developments: Trends in real-time systems design and development.

SUGGESTED READINGS

1. Phillip A. Laplante, "Real-time systems design and analysis, Wiley India.
2. Jane, W.S. Liu, "Real-time Systems"

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD24	**Human Computer Interface**	**3L-1T-0P**	**Computer Architecture**

COURSE OUTCOMES

1. To be able to understand the importance of designing interactive products that are usable.
2. To be able to communicate effectively about requirements, design, and evaluation activities relating to interactive products.
3. Evaluate an interactive product using suitable techniques.

COURSE CONTENT

Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design.
The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.
Design process – Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions.
Screen Designing : Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.

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Windows – New and Navigation schemes selection of window, selection of devices based and screen based controls.
Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.
Software tools – Specification methods, interface – Building Tools.
Interaction Devices – Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers.

Guidelines for project based work: Semester long projects/presentations/ research work/ term papers based on the above topics.

SUGGESTED READINGS

1. Galitz, W. O. 2007. The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques. 3rd Edition, Wiley.
2. Dix, A. Finlay, J., Abowd, G. and Beale, R. 2004. Human-Computer Interaction, 3rd Edition, Prentice Hall.
3. Preece, J., Sharp, H. and Rogers, Y. 2015. Interaction Design: Beyond Human-Computer Interaction, 4th Edition, Wiley.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD25	**Rule Based Computing**	**3L-1T-0P**	**Algorithms**

COURSE OUTCOMES

1. Understand the basic knowledge representation, problem solving, and learning methods.
2. Develop intelligent systems by assembling solutions to concrete computational problems.
3. Understand the role of knowledge representation, problem solving, and rule based learning in intelligent-system engineering.

COURSE CONTENT

Overview: Rule based Reasoning**,** Production systems, Rule-based Systems, Review of propositional and first order logic, Skolemisation, unification and its algorithms, Goals and sub-goals, forward and backward chaining.
Intelligent Agents: Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents, How the components of agent programs work.

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Solving Problems: Solving problems by Searching, Problem-Solving Agents, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies. Adversarial Search and Constraint Satisfaction Problems, Study of minimax algorithm
Building a knowledge base: Logical agents and Classical Planning, Study and comparison of knowledge representation structures, Knowledge Representation and Inference, Natural Language
Quantifying Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Bayes' Rule and Its Use, Representing Knowledge in an Uncertain Domain, Other Approaches to Uncertain Reasoning, Rule-based methods for uncertain reasoning, Representing vagueness: Fuzzy sets and fuzzy logic, Study of fuzzy logic and Decision trees, Implementation aspects of Decision trees
Learning from Examples: Forms of Learning, Supervised Learning, Learning Decision Trees, The decision tree representation, Expressiveness of decision trees, Inducing decision trees from examples

Guidelines for project work: Project/ Seminars/ Talks/presentations/ research work/ term papers based on the above topics.

SUGGESTED READINGS

1. Russell, Stuart J., and Peter Norvig. *Artificial intelligence: a modern approach*. 2nd edition. Upper Saddle River, NJ: Prentice Hall, 2003. ISBN: 0137903952.
2. Artificial intelligence, Patrick Henry Winston:, 1992, Addition Wesley 3rd Ed.,
3. Artificial Intelligence, Elain Rich and Kevin Knight, 1991, TMH.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD26	**Cloud Computing**	**3L-1T-0P**	**Computer Networking**

COURSE OUTCOMES

1. Understand the concept of cloud computing, its quality issues, services, applications, benefits and limitations.
2. Understand the underlying technologies that drive a cloud computing environment.
3. To keep abreast of the trends in cloud technology and available cloud environments such as GoogleApps, Microsoft Azure and Amazon Web Services.

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COURSE CONTENT

Introduction: Concept of a cloud, Purpose, characteristics, challenges and developments in cloud computing, Virtualization, On-demand Cloud Computing, Current cloud Technologies and Environments, Benefits and limitations.
Virtualization: Characteristics of virtualization, Types of virtualization, Hypervisors and some case studies.
Cloud architectures: Software as a Service, Platform as a Service, Infrastructure as a Service, Storage as a Service, Applications as a Service, other services
Types of cloud architectures: Public, Private, Hybrid, Design issues with cloud: scalability, fault tolerance, security, trust, privacy.
Data in the cloud: GFS,HDFS, Big Tables.
Concurrent computing: Thread programming, MPI programming, Parallel Computing with Map Reduce and extensions.
Case studies and emerging trends: Related toissues in migration to cloud, Cloud computing economics etc.

SUGGESTED READINGS

1. K. Chandrasekaran, Essentials of Cloud Computing.
2. T. Velte, A. Velte and R. Estenpeter, Cloud Computing – A practical approach.
3. U.S.Pandey, KavitaChoudhary, Cloud Computing, S. Chand.
4. R. Buyya, C. Vecchiola, S.T. Selvi, Mastering Cloud Computing.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD27	**Big Data and Analytics**	**3L-1T-0P**	**Computer Networking, Database Management Systems**

COURSE OUTCOMES

1. Gain a conceptual understanding of big data analytics concepts, algorithms, data management tools and statistical analysis.
2. Acquire tools to manage various aspects of big data such as Hadoop, HDFS, Map-Reduce based HBase, Cassandra, Pig, Hive etc.
3. Build applications based on big data.

COURSE CONTENT

Introduction to Big Data: Databases and their evolution,convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and

marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.

NoSql Data Management: Introduction to NoSQL, Types of NoSQL, aggregate data models, aggregates, key-value, document data models, relationships, graph databases, schema less databases, materialized views. Overview of MongoDB. MapReduce, partitioning and combining, composing map-reduce calculations, MapReduce examples such as matrix multiplication.

Hadoop: Introduction to Hadoop, Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, Hadoop distributed file system (HDFS), HDFS concepts, data flow, Hadoop I/O, data integrity, compression, serialization, Avro file-based data structures**,** Map Reduce workflows, unit tests with MRUnit, test data and local tests – anatomy of Map Reduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats.

Hadoop Related Tools: Hbase,data model and implementations, Hbaseclients, Hbase examples – praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration. Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation – HiveQL queries, Overview of spark.

Data Analysis: Overview of R programming language, Regression Modeling, Multivariate Analysis, Bayesian Modeling, Inference and Bayesian Networks, Support Vector and Kernel Methods, Analysis of Time Series, Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks, Learning And Generalization, Competitive Learning, Principal Component Analysis and Neural Networks, Fuzzy Logic: Extracting Fuzzy Models from Data, Fuzzy Decision Trees, Stochastic Search Methods.

Guidelines for practical work: Exercises on Hadoop, MapReduce, HDFS, MongoDB, R.

SUGGESTED READINGS

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. Big-Data Black Book, DT Editorial Services, Wiley India.
3. Massive Online Open Courses (MOOCS): Big Data University, Udacity and

Coursera.
4. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
5. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
6. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
7. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
8. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011. 8. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010. 9. Alan Gates, "Programming Pig", O'Reilley, 2011.

Course No.	Title of the Course	Course Structure	Pre-Requisite
ISD28	**Advances in Compiler Technology**	**3L-1T-0P**	**Compilers**

COURSE OUTCOMES

1. To gain an insight of the wide range of advanced compilation techniques available, with emphasis on parallelism.
2. To gain a detailed knowledge of different types of code optimization techniques.
3. To acquire skills necessary to design a nontrivial programming language and implement a production quality compiler for the same.

COURSE CONTENT

Advanced runtime management techniques: dynamic memory allocation, garbage collection.
Code optimization techniques: dataflow analysis, loop optimization, region-based analysis, interprocedural analysis, peephole optimization.
Instruction-level parallelism: basic-block scheduling, global code scheduling, software pipelining.
Optimizing for parallelism and locality: affine indexes, data dependence analysis, synchronization issues, locality optimizations.
Compilation techniques for generating energy-conserving code: techniques for embedded systems and high-performance computers.

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

SUGGESTED READINGS

1. Aho, A. V., Lam, M. S., Sethi, R. and Ullman J. D. 2006. Compilers – Principles, Techniques and Tools (2nd ed.), Pearson.
2. Chattopadhyay, S. 2005. Compiler Design, PHI.
3. Appel, A. W. 2004.Modern Compiler Implementation in C, Cambridge University Press.

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

Course Contents of Open Electives

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO001	**Technical Communication**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. The course will improve writing and documentation skills of students with emphasis on the importance of effective communication with focus on choice of words, formation of proper sentence structures and writing styles.
2. This will enhance the student's capability to prepare technical documents and correspondence.
3. The course will equip the student with good communications skills for placements, preparing SOPs and CVs.
4. The course will sensitize the students towards research ethics, copyright and plagiarism.

COURSE CONTENT

Communication: Definition,Meaning, Importance &Process of Communication, objectives, types, C's of communication, Barriers to communication, Human &Non - human communication, distinctive features of human languages

Business Correspondence-definition, meaning and importance of business communication, business letters- purchase, enquiry, quotation, order, follow-up, acceptance-refusal

Paragraph Writing: Kinds, coherence & cohesion

Thesis Writing: Selection of topic and its development

Report Writing: Writing reports, Manuals,

Official Communication: Notices, Memos, Agendas, Minutes
Interviews, Speeches, Presentations,

Research: Ethics, methodologies, copyright, plagiarism

SUGGESTED READINGS

1. Advanced English Grammar: Martin Hewing
2. Technical Communication: Meenakshi Raman &Sangeeta Sharma

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Course No.	Title of the Course	Course Structure	Pre-Requisite
EO002	Disaster Management	3L-1T-0P	None

COURSE OUTCOMES

1. Demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

COURSE CONTENT

Introduction: Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Disaster Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

Disaster Preparedness and Management: Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

Risk Assessment: Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

SUGGESTED READINGS

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

1. R. Nishith, Singh AK, Disaster Management in India: Perspectives, issues and strategies New Royal book Company, Lucknow, 2012.
2. Sahni, Pardeep Et.Al. (Eds.), Disaster Mitigation Experiences And Reflections. Prentice Hall Of India, New Delhi, 2002.
3. Goel S. L., Disaster Administration and Management, Text And Case Studies Deep & Deep Publication Pvt. Ltd., New Delhi, 2007

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO003	**Basics of Financial Management**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Understanding of theoretical framework for considering corporate finance problems and issues and to apply these concepts in practice.
2. Learn the art of organizing the financial transactions effectively and with integrity.
3. To have the ability and confidence to tackle common financial problems in practice.

COURSE CONTENT

Introduction: Nature, scope and objectives of financial management, Time value of money, Risk and return (including Capital Asset Pricing Model).

Long term investment decisions: The Capital Budgeting Process, Cash Flow Estimation, Payback Period Method, Accounting Rate of Return, Net Present Value (NPV), Net Terminal Value, Internal Rate of Return (IRR), Profitability Index.

Financing Decisions: Sources of long-term financing, Estimation of components of cost of capital, Methods for calculating Cost of Equity, Cost of Retained Earnings, Cost of Debt and Cost of Preference Capital, Weighted Average Cost of Capital (WACC). Capital Structure- Theories of Capital Structure (Net Income, Net Operating Income, MM Hypothesis, Traditional Approach). Operating and Financial leverage. Determinants of capital structure

Dividend Decisions: Theories for Relevance and irrelevance of dividend decision for corporate valuation-Walter's Model, Gordon's Model, MM Approach, Cash and stock dividends. Dividend policies in practice.

Working Capital Decisions: Concepts of Working Capital, Operating & Cash Cycles, sources of short term finance, working capital estimation, cash management, receivables management, inventory management.

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

SUGGESTED READINGS

1. Khan, M.Y. and P.K. Jain, Financial Management: Text and Problems, Tata McGraw Hill.
2. Srivastava, Rajiv, and Anil Mishra, Financial Management, Oxford University Press
3. Chandra, P. Financial Management-Theory and Practice, Tata McGraw Hill.
4. Horne, Van; James C., Wachowicz John, Fundamentals of Financial Management, Pearson Education.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO004	**Basics of Human Resource Management**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. To have an understanding of Human Resource Management (HRM) functions within organizations
2. To design and implement effective HRM policies and practices.

COURSE CONTENT

Introduction: Evolution and growth of human resource management (with special reference to scientific management and Human relations approaches).Role of HR in strategic management.Nature.objectives, scope, and functions of HR management.

Challenges of HR:the changing profile of the workforce - knowledge workers, employment opportunities in BPOs, IT and service industries, Flexi options, Workforce diversitycauses, paradox, resolution of diversity by management.

HRD: Human resource management as a profession.Concepts of line-staff in the structure of human resource department and the role of human resource manager.

Manpower planning: Objectives, Elements, Advantages, Process. Job design - simplification, rotation, enlargement, enrichment and approaches, Job analysis.Job evaluation.

Recruitment:factors affecting, sources, policy, evaluation, Selectionprocedure, tests, interviews, Placement and Induction.

SUGGESTED READINGS

1. Aswathappa K., Human Resource and Personnel Management, Tata McGraw-Hill, New Delhi, 2002.
2. Chhabra T.N., Human Resource Management, DhanpatRai and Co. Delhi, 2002.

3. Saiyadain S. Mirza, Human Resource Management, Tata Mc-GrawHill, India, 2003.
4. Chadha, N.K., Human Resource Management-issues, case studies, experiential exercises, Sri SaiPrintographers, New Delhi.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO005	**Project Management**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Gain knowledge of the fundamentals of project management
2. Able to plan a manageable project schedule and execute.

COURSE CONTENT

Introduction: Objectives of Project Planning, monitoring and control of investment projects. Relevance of social cost benefit analysis, identification of investment opportunities. Pre-feasibility studies.

Project Preparation: Technical feasibility, estimation of costs, demand analysis and commercial viability, risk analysis, collaboration arrangements; financial planning; Estimation of fund requirements, sources of funds.Loan syndication for the projects.Tax considerations in project preparation and the legal aspects.

Project appraisal: Business criterion of growth, liquidity and profitability, social cost benefit analysis in public and private sectors, investment criterion and choice of techniques. Estimation of shadow prices and social discount rate.

Project Review/Control: Evaluation of project, PERT/CPM. Resource handling/leveling, Cost and Time Management issues in Project planning and management, success criteria and success factors, risk management.

SUGGESTED READINGS

1. Ravi Ravindran: Operations Research and Management Science Handbook, CRC Press, 2008.
2. Harold Kerzner: Applied Project Management: Best Practices on Implementation, John Wiley & Sons, Inc., 2000.
3. Goodpasture, J. C.: Quantitative Methods in Project Management, J Ross Publishing, Boca Raton, Florida, USA, 2003.
4. Meredith, J. R. and Mantel Jr., S. J.: Project Management: A Managerial Approach, John Wiley, New York. 2004.
5. Clifford Gray, Project Management, Richard D. Irwin, 2005.

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO006	Basics of Corporate Law	3L-1T-0P	None

COURSE OUTCOMES

1. Gain in-depth knowledge of the Corporate laws and process related to integrate these aspects of management studies in decision making within an organization
2. Analyze and interpret management information and make decisions based on the information available
3. Understand and apply the theoretical aspects of accounting methods used for collecting, recording and reporting financial information
4. Explain and appraise the taxation laws which govern corporations and individuals.

COURSE CONTENT

Introduction: Administration of Company Law, characteristics of a company; common seal; lifting of corporate veil; types of companies including private and public company, government company, foreign company, one-person company, small company, associate company, dormant company, producer company; association not for profit; illegal association; formation of company, promoters and their legal position, pre incorporation contract and provisional contracts; on-line registration of a company.

Documents: Memorandum of association and its alteration, articles of association and its alteration, doctrine of constructive notice and indoor management, prospectus, shelf prospectus and red herring prospectus, misstatement in a prospectus; GDR; book building; issue, allotment and forfeiture of shares, calls on shares; public offer and private placement; issue of sweat capital; employee stock options; issue of bonus shares; transmission of shares, buyback and provisions regarding buyback; share certificate; D-Mat system; membership of a company.

Management and Meetings: Classification of directors, additional, alternate and adhoc director; women directors, independent director, small shareholders' director; director identity number (DIN); appointment, who can appoint a director, disqualifications, removal of directors; legal position, powers and duties; key managerial personnel, managing director, manager; meetings of shareholders and board; types of meeting, convening and conduct of meetings, requisites of a valid meeting; postal ballot, meeting through video conferencing, e-voting; committees of board of directors – audit committee, nomination and remuneration committee, stakeholders relationship committee, corporate social responsibility committee; prohibition of insider trading.

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

SUGGESTED READINGS

1. Hicks, Andrew & Goo S.H., Cases and Material on Company Law, Oxford University Press
2. Gowar, LCB, Principles of Modern Company Law, Stevens & Sons, London.
3. Majumdar, A.K., and G.K. Kapoor, Company Law and Practice, Taxmann, New Delhi
4. Hanningan, Brenda, Company Law, Oxford University Press, U.K.
5. Sharma, J.P., An Easy Approach to Corporate Laws, Ane Books Pvt. Ltd., New Delhi
6. Ramaiya, A Guide to Companies Act, LexisNexis Buttersworthwadhwa.
7. Kannal, S., & V.S. Sowrirajan, Company Law Procedure, Taxman's Allied Services (P) Ltd., New Delhi.
8. Meredith, J. R. and Mantel Jr., S. J.: Project Management: A Managerial Approach, John Wiley, New York. 2004.
9. Clifford Gray, Project Management, Richard D. Irwin, 2005.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO007	**BIOLOGICAL COMPUTING**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Understand computing in context of biological systems
2. Understand computing languages needed to solve biological problems
3. Acquire computational skills for analysis of biological processes through grid computing
4. Gain knowledge of different biological databases and their usage
5. Gain innovative insight into DNA computing

COURSE CONTENT

Introduction: Orientation, Introduction to Bioinformatics, UNIX,Python, R language
DNA Analysis, RNA Analysis, Protein Analysis, DNA computing
Grid computing, Biogrid, Biological databases, Internet Resources
Multiple Sequence Alignment and Phylogeny
Introduction to Genomics

SUGGESTED READINGS

SCHEME OF COURSES – M.TECH. (INFORMATION SYSTEMS)

1. Computations in cells & tissues, 1st Edition by H. Bolouri, R. Paton; Published by Springer
2. Haubold, Bernhard, Wiehe, Thomas, Introduction to Computational Biology: An Evolutionary Approach, Springer

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO008	**Basic of Social Science**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Have an understanding of howSociologyis concerned with society and the relationships among individuals within a society.

COURSE CONTENT

Introduction: The Development of Sociology in the 19th Century
Sociology as Science: Science, scientific method and critique, Major theoretical strands of research methodology, Positivism and its critique, Fact value and objectivity, Non- positivist methodologies.
Religion and Society: Sociological theories of religion, Types of religious practices: animism, monism, pluralism, sects, cults, Religion in modern society: religion and science, secularization, religious revivalism, fundamentalism.
Politics and Society: Sociological theories of power, Power elite, bureaucracy, pressure groups, and political parties, Nation, state, citizenship, democracy, civil society, ideology, Protest, agitation, social movements, collective action, revolution.
Sociological Thinkers: Karl Marx- Historical materialism, mode of production, alienation, class struggle, Emile Durkheim- Division of labour, social fact, suicide, religion and society, Max Weber- Social action, ideal types, authority, bureaucracy, protestant ethic and the spirit of capitalism, Talcolt Parsons- Social system, pattern variables, Robert K. Merton- Latent and manifest functions, conformity and deviance, reference groups, Mead - Self and identity.

SUGGESTED READINGS

1. Beteille, Andre, 2002, Sociology: Essays in Approach and Method, Oxford University Press
2. Giddens, Anthony, 2010, Sociology, Polity Press
3. Weber, M. 1949. The Methodology of the Social Sciences. New York: Free Press.
4. Durkheim, E. 1982. The Rules of Sociological Method. London: Macmillan

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Course No.	Title of the Course	Course Structure	Pre-Requisite
EO009	**ENTREPRENEURSHIP**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Develop entrepreneurial skills by giving an overview of who the entrepreneurs are and what competences are needed to become an entrepreneur.

COURSE CONTENT

Introduction: Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.

Creating Entrepreneurial Venture: Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Challenges in managing innovation; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership- components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection- Patents Trademarks and Copyrights – importance for startups, Legal Acts Governing Business in India.

Functional plans: Marketing plan– for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, pro forma cash budget, funds Flow and Cash flow statements; Pro forma balance sheet; Break Even Analysis; Ratio Analysis.

Entrepreneurial Finance: Debt or equity financing, Sources of Finance- Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India.

Enterprise Management: Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers & acquisitions.

SUGGESTED READINGS

1. Kumar, Arya, Entrepreneurship: Creating and Leading an Entrepreneurial Organization, Pearson, India.

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2. Hishrich., Peters, Entrepreneurship: Starting, Developing and Managing a New Enterprise, Irwin
3. Taneja, Entrepreneurship, Galgotia Publishers.
4. Barringer, Brace R., and R. Duane Ireland, Entrepreneurship, Pearson Prentice Hall, New Jersy (USA)
5. Hisrich, Robert D., Michael Peters and Dean Shephered, Entrepreneurship, Tata McGraw Hill, New Delhi
6. Lall, Madhurima, and ShikhaSahai, Entrepreneurship, Excel Books, New Delhi
7. Charantimath, Poornima, Entrepreneurship Development and Small Business Enterprises, Pearson Education, New Delhi

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO010	**Social Work**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Learn about various methods of social work, community organization, social welfare administration, Problems pertaining to Marriage, Family and caste etc.

COURSE CONTENT

Social Work: Philosophy and Methods. Social work: Meaning, Objectives, Scope, Assumptions & Values; History of Social work in U.K. U.S.A.and India, philosophy of Social Work. Democratic (Equality, Justice Liberty & Fraternity) and Humanitarian (Human Rights) Matrix.Social works as a profession.

Methods of Social Work: Meaning, Scope Principles, Processes (Psychosocial study, Assessments, treatment-goal formulation and techniques), Evaluation, Follow-up and Rehabilitation. Social Groups work: Meaning,Objective, Principles, Skills, Processes (Study, Diagnosis, treatment and evaluation), Programme, Planningand Development, Role of Social group worker, Leadership Development.

Community organization: Meaning, Objective, Principles, Approaches, Roles of Community Organization Worker.

Social Welfare Administration: Meaning Scope, Auspices-Private and Public, Principles, Basic Administrative Processes and Practice decision making communication, planning, organization, budgeting and financial control, reporting. Social work Research: Meaning objectives, types, scope, scientific method, Selection and formulation of the problem Research Design Sampling, Sources and Methods of Data Collection, Processing of Data, analyzing and interpretation, Report writing. Social Action: Meaning,Scope, approaches (Sarvodays, Antyodaya etc.) and Strategies.

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Work in India Problem pertaining to Marriage, Family and caste: Dowry- child Marriage, Divorce, Families with working couples, Disorganised Families, Families with Emigrant Heads of the Households, Gender Inequality, Authoritarian Family structure, Major Changes in Caste systems and problem of casteism. Problems Pertaining of Weaker Sections. Problems of Children, Women Aged. Handicapped and Backward Classes (SCs, STs, and other Backward Classes).
Problems of Deviance: Truancy Vagrancy and Juvenile Delinquency, Crime, White Collar Crime, Organized Crime,Collective Violence, Terrorism, Prostitution and Sex Related Crimes. Social Vices: Alcohilism, Drug Addiction, Beggary, Corruption and communalism.
Problems of Social Structure: Poverty, Unemployment, Bonded Labour, Child Labour.
Fields of Social work India: Child Development, Development of Youth, Women's Empowerment, Welfare of aged, Welfare of Physically. Mentally and Social Handicapped, Welfare of backward Classes (Scs, STs and Other Backward Classes) Rural Development Urban Community Development, Medical and Psychiatric Social work, Industrial Social work, Social Security Offender Reforms.

SUGGESTED READINGS

1. Rajni Bedi, Social Work: An Introductory Text Book
2. Sanjay Bhattacharya, Social Work: An Integrated Approach
3. Nitesh Dhawan, Social work perspective Philosophy and Methods
4. P. R. Gautam, Social Work: Methods Practices and Perspectives

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO011	**Intellectual Property and Patenting**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Gain in-depth knowledge of the laws and process related to Trademarks, Copyrights and other forms of IPs with focus on Patents, the Indian and International Patent filing procedure, drafting patent application and conducting prior art searches.

COURSE CONTENT

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Introduction: Historical and philosophical background of patents and other intellectual property, Patent System: the Constitution, Congress, Patent Office (PTO), and courts; Analyzing and understanding judicial opinions

Comparative overview of patents, copyrights, trade secrets, and trademarks: Legal fundamentals of patent protection for useful inventions**,** Design and plant patents, Legal fundamentals of copyright protection, Similarity and access, Expression vs. ideas and information, merger, Fair use of copyrighted works (e.g., for classroom use), Contributory copyright infringement, Critical differences between patent and copyright protection, Copyright infringement distinguished from plagiarism, Legal fundamentals of trade-secret protection, Legal fundamentals of trademark protection

Requirements and limitations of patentability: New and useful: (A) The legal requirement of novelty (B) First to invent vs. first inventor to file, The legal requirement of non-obviousness.

The process of applying for a patent ("patent prosecution"): Anatomy of a patent application, Adequate disclosure, The art of drafting patent claims, Patent searching: (A) Purposes and techniques, Actions for patent infringement, Interpretation of claims, Doctrine of equivalents, Product testing as a possibly infringing use, Doctrine of exhaustion

SUGGESTED READINGS

1. Rines, Robert H. 1964. Create or Perish: The Case for Inventions and Patents, Acropolis.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO012	**Supply Chain Management and Logistics**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Have acquaintance with the concepts and tools of supply chain management and logistics as relevant for a business firm.

COURSE CONTENT

Introduction: Concept of supply chain management (SCM) and trade logistics; Scope of logistics; Logistic activities – an Overview; Contribution of logistics at macro and micro levels; SCM and trade logistics; Business view of SCM; Concept, span and process of integrated SCM; Demand management – methods of forecasting; Supply

chain metrics (KPIs), performance measurement and continuous improvement; Product development Process and SCM; Strategic role of purchasing in the supply chain and total customer satisfaction; Types of purchases; Purchasing cycle.

Managing Relationship: Role of Relationship marketing in SCM; Managing relationships with suppliers and customers; Captive buyers and suppliers; Strategic partnerships; Supplier-retailer collaboration and alliances.

Focus Areas of Logistics and Supply Chain management: Transportation- Importance of effective transportation system; Service choices and their characteristics; inter-modal services; Transport cost characteristics and rate fixation; In-company management vs. out-sourcing; World sea borne trade; International shipping- characteristics and structure; Liner and tramp operations; Liner freighting; Chartering-Types, principles and practices; Development in sea transportation- Unitization, containerisation, inter and multimodal transport; CFC and ICD. Air transport: Set up for air transport and freight rates; Carriage of Goods by sea -Role and types of cargo intermediaries. Warehousing and inventory management: Reasons for warehousing; Warehousing evaluation and requirements; Warehousing location strategies; Inventory management principles and approaches; Inventory categories - EOQ, LT, ICC

IT Enabling Logistics and Supply Chain: Technology in logistics – EDI, bar Coding, RFID etc., data warehousing, electronic payment transfers; Business management systems; TRADITIONAL ERP, SPECIAL ERP, MR, DRP, PDM, EIP, CPFR, WMS, TMS; Re-engineering the supply chain- Future directions.

Trends and Challenges in logistics and supply chain management: Third party logistic outsourcing –challenges and future directions.

SUGGESTED READINGS

1. Christopher, M., Logistics and Supply Chain Management, Prentice Hall.
2. Handfield and Nicholas, Jr., Introduction to Supply Chain Management, Prentice Hall.
3. Jhon J Coyle, C. JhonandLangley,Brian J Gibs, Logistics approach to Supply Chain Management, Cengage Learning.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO013	**ORGANIZATION DEVELOPMENT**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. Gain understanding how Organisation Development is a growing field of Human

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Resource Management with foundations in a number of behavioural and social sciences.

COURSE CONTENT

1. Organizational Systems and Human Behaviour - Developing a basic knowledge of how organizations and groups function as systems; introducing and discussing various theoretical approaches and issues.

2. Interpersonal and Consulting Skills - Increasing effectiveness as a change agent by providing a variety of opportunities in order to increase self-awareness, practice alternative ways of approaching personal and interpersonal problem-solving and develop basic consulting and interviewing skills.

3. Introduction to Organization Development - Introducing some basic theories, models and methods in the field of organization development, especially those relating to the role of consultant and strategies for change.

4. Intervention and Change in Organizations - Consolidating and further developing consulting skills and strategies

5. Action Research Project - Carrying out a change activity in an organization, while also researching the effects of the process. This provides participants with an opportunity to consolidate and demonstrate skills and knowledge gained in other units of the course

SUGGESTED READINGS

As suggested by the course instructor.

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO014	**INDUSTRIAL ORGANISATION AND MANAGERIAL ECONOMICS**	**3L-1T-0P**	**None**

COURSE OUTCOMES

Students will gain an understanding of the basics of management and Industrial organisation.

COURSE CONTENT

Unit I: Principles of management, General idea, various functions, scope of engineering. Organisation structure, Types, merits and demerits.

Unit II: Plant location and layout, Factors effecting location, types of layout. Production planning and control, Sequence of planning and control of production. Scheduling , routing, despatching., Methods Study, Methods analysis, time study

methods of rating.
Unit III: General idea of personnel management, Industrial psychology, job evaluation and monitoring. Business decision making and forward planning. Demand and demand forcasting of production analysis- prices and pricing decision-profit and capital, management. Analysis of inter-industry relation, macro-economics and business.

SUGGESTED READINGS
1. Koutsoyiannis A : Modern Microeconomics, ELBS.
2. Managerial Economics for Engineering :Prof. D.N. Kakkar
3. Managerial Economics : D.N. Dwivedi
4. Managerial Economics :Maheshwari.
5. Indian economy: Ruddardutt and K.P.M. Sundharam

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO015	GLOBAL STRATEGIES AND TECHNOLOGY	3L-1T-0P	None

COURSE OUTCOMES
1.Understand the specifics of strategy and organization of the multinational company.
2.Learn the framework for formulating successful and adaptive strategies in an increasingly complex world economy.

COURSE CONTENT
Globalization of industries, the continuing role of country factors in competition, organization of multinational enterprises, and building global networks, Analysis of competitive situations from the general management point of view, including fit between key environmental forces and the firm's resources, and changes in these over time. Formulating and implementing strategy based on that analysis. Developing and leveraging a firm's core competencies to gain long-term sustainable advantage.

SUGGESTED READINGS
1. Global strategy by Mike W. Peng
2.Redefining Global Strategy by pankajghemawat
3.Fundamentals of Global Strategy by Cornelis A. de Kluwer

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Course No.	Title of the Course	Course Structure	Pre-Requisite
EO016	**ENGINEERING SYSTEM ANALYSIS AND DESIGN**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. The students will learn about system definitions and role of system analyst. They will learn about system modeling and design. They will be exposed to System Implementation and Maintenance issues.

COURSE CONTENT

Unit 1. System definition and concepts: Characteristics and types of system, Manual and automated systems
Real-life Business sub-systems: Production, Marketing, Personal, Material, finance
Systems models types of models: Systems environment and boundaries, Real-time and distributed systems, Basic principles of successful systems
Unit 2. Systems analyst: Role and need of systems analyst, Qualifications and responsibilities, Systems Analyst, agent of change.
Various phases of systems development life cycle: Analysis, Design, Development, Implementation, Maintenance
Unit 3. Systems Design and modeling:Process modeling, Logical and physical design, Design representation, Systems flowcharts and structured charts, Data flow diagrams, Common diagramming conventions and guidelines using DFD and ERD diagrams.
Data Modeling and systems analysis, designing the internals: Program and Process design, Designing Distributed Systems
Unit 4. User Interfaces – Relational Analysis – Database design – program design– structure chart – HIPO – SSADM – Alternate Life cycles – Prototypes.
Unit 5. System Implementation and Maintenance:Planning considerations, Conversion methods, producers and controls, System acceptance Criteria, System evaluation and performance, Testing and validation, Systems qualify Control and assurance, Maintenance activities and issues.

SUGGESTED READINGS

1. Haryszkiewycz, "Introduction to Systems Analysis and Design", II Ed. PHI 1995.
2. James A Senn : Analysis and Design of Information Systems, McGraw Hill 1989.

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Course No.	Title of the Course	Course Structure	Pre-Requisite
EO017	**BIOLOGY FOR ENGINEERS**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. General understanding of organization in biological systems
2. Conceptual knowledge of functioning in biological systems
3. Clarity about relevance of Biology to engineering graduates
4. Understanding human body or any other suitable organism as a study-model for engineering students.
5. Understanding electrical, chemical and magnetic forces, and communication networks in biosystem.

COURSE CONTENT

The Biological system – An Introduction; Biomolecules &self assemblies; Molecular recognition; Bioenergetics; Communication network in biosystem; Mechanics in biology; Storage, preservation and propagation of biological information; Biomaterials in engineering applications; Organisms as factories for biomaterials; Engineering organisms for novel applications

SUGGESTED READINGS

1. Biology for Engineers By: T. Johnson, CRC Press, 2010 Edition
2. Dynamics of Biological system By: Michael Small, CRC Press, 2011 Edition
3. Applied Mathematical Models and Human Physiology By: Johnny T. Ottesen, MS Olufsen,
5. JK Larsen, Published by Society for Industrial and Applied Mathematics,
4. Advanced Biology By Michael Roberts, Michael Jonathan Reiss, Grace Monger
5. Ecology: A Textbook By: Hermann Remmer
6. Basic Biotechnology By: Colin Ratledge, Bjorn Kristiansen (Ed.)

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO018	**ENERGY, ENVIRONMENT AND SOCIETY**	**3L-1T-0P**	**None**

COURSE OUTCOMES

1. To be able to assess the energy resources available worldwide
2. To understand the negative impact of conventional energy resource utilization on ecosystem

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3. To learn about various types of pollutions and their control strategies 4. To understand renewable energy resources and their socio-economic impac
COURSE CONTENT Introduction to Environment, Energy and its impact on society Universe, Environment and Ecosystem: Origin of earth, atmosphere, Origin of Life, Ecosystem, Biotic and abiotic components, Ecological pyramids, Food chain, Food web, Habitat and Niche, Major ecosystems, Atmosphere, Biodiversity Pollution: Air Pollution, Water Pollution, Soil Pollution, Noise Pollution Energy: Different sources of Energy, Renewable sources of energy, Non renewable energy, Bioenergy, Bioethanol and Biodiesel Biofertilizers, Biopesticides and Biopolymers Environmental Ethics and Morals
SUGGESTED READINGS 1. Kishore V V N, Editor, Renewable Energy Engineering and Technology, Principles and Practice, The Energy and Resources Institute (TERI), 2009 2. Fundamentals of Renewable Energy Sources, G. N. Tiwari and M. K. Ghosal, Narosa Publishing House, N.D, 2007 3. Mital K. M, "Biogas Systems: Principles and Applications", New Age International publishers (P) Ltd., 1996. 4. Nijaguna, B.T., Biogas Technology, New Age International publishers (P) Ltd., 2002. 5. D. Yogi Goswami, Frank Kreith, Jan. F .Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003 6. Rezaiyan. J and N. P. Cheremisinoff, Gasification Technologies, A Primer for Engineers and Scientists, Taylor and Francis, 2005

Course No.	Title of the Course	Course Structure	Pre-Requisite
EO019	**Public Policy And Governance**	**3L-1T-0P**	**None**
COURSE OUTCOMES 1. Students will be introduced to Public Policy and Administrative governance. They will also learn about Administrative Governance.			

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COURSE CONTENT

Introduction to Public Policy and Administrative Governance: Introduction to public policy, econometrics for policy research, policy analysis, economics for public decision making.

Public Bureaucracy in Theory and Practice: Benefit cost analysis, public budgeting, revenue and expenditures, managing and leading public service organisations.

Administrative Governance: The Challenge of Policy Implementation, public and non-profit programme evaluation.

Non-state Actors in Policy-making and Administrative Governance: governance in twenty-first century, Social Diversity and the Question of "Difference" in Policy-making and administrative Governance.

SUGGESTED READINGS

1. John Shields and B. Mitchell Evans. Shrinkingthe State: Globalization and Public administration "Reform." Halifax: Fernwood, 1998.
2. Beryl Radin (2013), Beyond Machiavelli: Policy Analysis Reaches Midlife, 2nd edition. Washington, DC: Georgetown University Press.
3. Frank R. Baumgartner, Jeffrey M. Berry, Marie Hojnacki, and David C. Kimball (2009), Lobbying and Policy Change: Who Wins, Who Loses, and Why. Chicago, IL: University of Chicago Press.
4. Timothy Conlan, Paul Posner, and David Beam (2015), Pathways of Power: The dynamics of National Policymaking. Washington, DC: Georgetown University press.