SCHEME OF COURSES – M.TECH. (SIGNAL PROCESSING)

UNIVERSITY OF DELHI

NETAJI SUBHAS INSTITUTE OF TECHNOLOGY

Choice Based Credit system

Scheme of Courses

for

Master of Technology

in

Signal Processing

Electronics and Communication Engineering

SCHEME OF COURSES – M.TECH. (SIGNAL PROCESSING)

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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. Class room 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 epicenter 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, 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 M. Tech. Signal Processing.

   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 is offered as a full course (4 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.

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 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.

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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 l etter 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. **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, EO but not CC courses) then he/she can re-register afresh for a new elective subject.
3. **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. However, a student must get satisfactory to get the degree.
4. **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, the checks and balances be implemented which

enable departments would effectively and fairly carry out the process of assessment and examination.

5. **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 and the grade points scored in all the courses of a semester, to the sum of the number of credits of all the courses taken by a student, that is:

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

where S_i is the i^{th} Semester C_j is the number of credits of the j^{th} course 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 taken by a student over all the semesters of a programme, i.e.

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

where $SPGA(S_i)$ 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. Signal Processing 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.**

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3. The discipline centric subjects under course courses (CC) and Discipline-centric elective (ED) categories are listed for each discipline separately.

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

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-ECSP
   2. Embedded System and VLSI-ECES

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

iii. Department of Instrumentation and Control Engineering:
   1. Process Control-ICPC
   2. Industrial Electronics-ICIE
   3. Mechatronics-ICMT

iv. Department of Biotechnology:
   1. Biochemical Engineering - BTBC
   2. Bioinformatics- BTBF

v. Manufacturing processes and Automation Engineering:
   1. CAD CAM- MACD
   2. Manufacturing process and Automation Engineering.- MAMP
   3. Production Engineering- MAPE
   4. Engineering Management- MAEM
   5. Nanotechnology- MANT

The first two letters of the code represent the department, and the remaining two letters represent the course. The codes for Departmental core subjects and Domain-specific Electives are specific to each Discipline.

For Ist semester, the codes are:

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SPC01	CC
SPC02	CC
SPD**	Elective
SPD**	Elective
SPD**	Elective
EO***	Open Elective

For II[nd] semester, the codes are:

SPC03	CC
SPC04	CC
SPD**	Elective
SPD**	Elective
SPD**	Elective
EO***	Open Elective

For III[rd] semester, the codes are:

SPC05	Seminar
SPC06	Major Project
SPD**	Elective
SPD**	Elective
SPD**	Elective

For IV[th] semester, the codes are:

SPC07	Dissertation

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/ without 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

1. The M.Tech (SP) programme 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.

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. 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 Biochemical Engineering.

X. 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 Courses

XI. PROGRAM EDUCATIONAL OBJECTIVE:

The major objectives of the M. Tech programme in Signal Processing are to equip the students with adequate knowledge and skills in Signal Processing to prepare them for the following career options:

1. Provide graduates with a strong foundation in Signal Processing fundamentals to enable them to devise and deliver efficient solutions to challenging problems in Electronics, Communications and allied disciplines.

2. Practice the ethics of their profession consistent with a sense of social responsibility and develop their engineering design, problem –solving skills and aptitude for innovations and research as they work individually and in multi disciplinary teams.

3. Be receptive to new technologies and attain professional competence through lifelong learning such as doctoral degree, professional registration, publications and other professional activities.

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XII. PROGRAM OUTCOMES

1. Capability of applying knowledge of Signal Processing to solve Communication Engineering problems.
2. Ability to create suitable models of complex systems and analyze them.
3. Capability to design/conduct experiments and draw inference and conclusions there from.
4. Ability to provide/devise solutions for engineering problems related to the needs of the Industries and Society.
5. Ability to apply knowledge of Signal Processing to develop useful products/prototypes/hardware/software.
6. Capability to understand professional and ethical responsibilities.
7. Capability to communicate effectively, orally as well as in writing.
8. Ability to work independently as well as part of teams.

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SEMESTER-WISE COURSE ALLOCATION (Full-Time)

M.TECH. SIGNAL PROCESSING (Full Time) SEMESTER I

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPC01	CC	Linear Algebra for Signal Processing	3	0	2	4	15	15	40	15	15	100
SPC02	CC	Digital Signal Processing	3	0	2	4	15	15	40	15	15	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
EO***	EO	Open Elective #	3	1	0	4	25	25	50	-	-	100
		Total	-	-	-	24						
			$									

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 2-3. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

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M.TECH. SIGNAL PROCESSING (Full Time) SEMESTER II

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPC03	CC	Advanced Digital Signal Processing	3	0	2	4	15	15	40	15	15	100
SPC04	CC	Adaptive Signal Processing	3	0	2	4	15	15	40	15	15	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
EO***	EO	Open Elective #	3	1	0	4	25	25	50	-	-	100
		Total	-	-	-	24						
			$									

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 2-3. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

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M.TECH. SIGNAL PROCESSING (Full Time) SEMESTER III

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPC05	CC	Seminar	-	-	-	2	100	-	-	-	-	100
SPC06	CC	Major Project	-	-	-	6	-	-	-	40	60	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
		Total	-	-	-	20						
			$									

The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in Table 2-3. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. SIGNAL PROCESSING (Full Time) SEMESTER IV

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPC07	CC	Dissertation	-	-	-	14	-	-	-	40	60	100
		Total	-	-	-	14						

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SEMESTER-WISE COURSE ALLOCATION (Part-Time)

M.TECH. SIGNAL PROCESSING (Part Time) SEMESTER I

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPC01	CC	Linear Algebra for Signal Processing	3	0	2	4	15	15	40	15	15	100
SPC02	CC	Digital Signal Processing	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective #	3	1	0	4	25	25	50	-	-	100
		Total	9	1	4	12						

M.TECH. SIGNAL PROCESSING (Part Time) SEMESTER II

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPC03	CC	Advanced Digital Signal Processing	3	0	2	4	15	15	40	15	15	100
SPC04	CC	Adaptive Signal Processing	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective #	3	1	0	4	25	25	50	-	-	100
		Total	9	1	4	12						

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M.TECH. SIGNAL PROCESSING (Part Time) SEMESTER III

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	-	-	-	12						
			$									

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 2-3. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. SIGNAL PROCESSING (Part Time) SEMESTER IV

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	-	-	-	12						
			$									

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 2-3. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

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M.TECH. SIGNAL PROCESSING (Part Time) SEMESTER V

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPC06	CC	Major Project	-	-	-	6	-	-	-	40	60	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	-	-	-	14						
			$									

The LTP allocation, Evaluation scheme and pre- requisites for Electives are given in Table 2-3. The course code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon the elective(s) chosen by the student.

M.TECH. SIGNAL PROCESSING (Part Time) SEMESTER VI

CODE	Type	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	CA	ES	
SPC05	CC	Seminar	-	-	-	2	-	-	-	-	-	100
SPC07	CC	Dissertation	-	-	-	14	-	-	-	40	60	100
SPD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	-	-	-	20						
			$									

$ The actual weekly load will depend upon the elective(s) chosen by the student.

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Table 2: LIST OF DISCIPLINE CENTRIC ELECTIVES

CODE	COUSRE OF STUDY	PREREQUISITE	L	T	P	C
SPD01	Probability Theory and Stochastic Process	___	3	1/0	0/2	4
SPD02	Digital Communication	___	3	1/0	0/2	4
SPD03	Analog IC for Signal Processing	___	3	1/0	0/2	4
SPD04	Digital System Design	___	3	1/0	0/2	4
SPD05	Theory of Error Control Coding	___	3	1/0	0/2	4
SPD06	Optical Signal Processing	___	3	1/0	0/2	4
SPD07	BIMOS Analog Integrated Circuits	___	3	1/0	0/2	4
SPD08	RF and Microwave Signal Processing	___	3	1/0	0/2	4
SPD09	Detection and Estimation Theory	SPC01	3	1/0	0/2	4
SPD10	Speech Processing	SPC02	3	1/0	0/2	4
SPD11	Digital Image Processing	SPC02	3	1/0	0/2	4
SPD12	Array Signal Processing	SPC01	3	1/0	0/2	4
SPD13	Multirate and Wavelets	SPC02	3	1/0	0/2	4
SPD14	DSP Algorithm and Architecture	SPC02	3	1/0	0/2	4
SPD15	Wireless Communication	SPD02	3	1/0	0/2	4
SPD16	Current Mode Techniques for Signal Processing	___	3	1/0	0/2	4

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SPD17	Optimization Techniques	___	3	1/0	0/2	4
SPD18	Selected Topics in Signal Processing	___	3	1/0	0/2	4
SPD19	Signal Processing Techniques for Wireless Communication	SPC03, SPD15	3	1/0	0/2	4
SPD20	Radar and Sonar Signal Processing	SPC03	3	1/0	0/2	4
SPD21	Signal Compression Techniques	SPC03, SPD13	3	1/0	0/2	4
SPD22	Network Security and Cryptography	___	3	1/0	0/2	4
SPD23	VLSI Signal Processing	SPC02, SPC03	3	1/0	0/2	4
SPD24	Pattern Recognition	SPC01	3	1/0	0/2	4
SPD25	Digital Video Processing	SPD11	3	1/0	0/2	4

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Table 3: LIST OF OPEN ELECTIVES

LTP Allocation			Evaluation Scheme				
			Theory			Practical	
L	T	P	CA	MS	ES	CA	MS
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	Sociology		None				
EO009	Entrepreneurship		None				
EO010	Social work		None				
EO011	IP and Patenting		None				
EO012	Supply Chain Management-Planning and logistics		None				
EO013	Organization Development		None				
EO014	Industrial Organisation and Managerial Economics		None				
EO015	Global Strategy and Technology		None				
EO016	Engineering System Analysis and Design		None				
EO017	Biology for Engineers		None				
EO018	Energy, Environment and Society		None				
EO019	Public Policy and Governance		None				

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SYLLABUS OF CORE COURSES

Course Code	Course Name	Course Structure	Pre-Requisite
SPC01	Linear Algebra for Signal Processing	L-T-P 3-0-2	___

COURSE OUTCOME (CO):

CO-1: A comprehensive understanding of the formulation of problems in abstract algebra framework.
CO-2: A comprehensive understanding of the concept of orthogonality, bases and unitary transforms.
CO-3: A comprehensive understanding of linear transformations.
CO-4: Understand the role of matrices in linear transformation representations.

COURSE CONTENT:

Vector Spaces: Complex numbers, Definition of Vector Spaces, Properties of Vector Spaces, Subspaces, Sums and Direct Sums, Span and Linear Independence, Bases, Dimension. Inner Product Spaces:- Inner Products, Norms, Orthogonal Bases, Orthogonal Projections and Minimization Problem, Linear Functionals. Some Important bases: Standard Ordered Bases, DFT Bases, DCT Bases. Operators on Inner Product Spaces:-Operators and Square Matrices,Self Adjoint and Normal Operators, Spectral Theorem, Polar and Singular Value Decompositions. Some Important Classes of Linear Systems: Shift Invariant Systems and Topelitz Matrices, Hermitian Matrices, Projections and idempotent matrices. Rotations and unitary matrices. Matrix Methods and Transforms: Eigen values, Eigen vectors, Generalized Eigen vectors, Diagonalizability, orthogonal diagonalization, Symmetric, Hermitian and Unitary matrices. Linear Maps: Definitions and Examples, Null Spaces and Ranges, matrix of a Linear Map, Invertibilty: Invariant Subspaces, Polynomials Applied to Operators, Upper Triangular Matrices, Diagonal Matrices, Invariant Subspaces on Real Vector Space. Transformations : Linear Transformations, four fundamental subspaces of linear transformation, inverse transformation, Matrix representation of linear transformation, square matrices,unitary matrices, Inverse of a square matrix, system of linear equations, existence and uniqueness of solutions, least square solution, pseudo inverse,Fourier basis, DFT as a linear transformation, Translation invariant linear transformation, wavelet basis, wavelet transforms.

SUGGESTED READINGS:

1. Todd K. Moon and Wynn C. Stirling, “Mathematical Methods and Algorithms for Signal Processing,” Prentice Hall
2. Peter D. Lax, “Linear Algebra,” Wiley Students Edition.
3. Michael W. Frazier, “An Introduction to Wavelets Through Linear Algebra,” Springer.
4. Gilbert Strang, “Linear Algebra and Its Applications,” Thomson Learning.
5. Hoffman Kenneth and Kunze Ray, “Linear Algebra,” Prentice Hall of India.

Course Code	Course Name	Course Structure	Pre-Requisite
SPC02	Digital Signal Processing	L-T-P 3-0-2	____

COURSE OUTCOME (CO):

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CO-1: A comprehensive understanding of the Discrete Fourier Transform (DFT), its properties, and applications of DFT in spectrum estimation of a discrete-time signal.
CO-2: A comprehensive understanding of the problems related to computational complexity of the DFT and use of Fast Fourier Transform (FFT) to compute DFT with reduced computations.
CO-3: Study and analysis of different realizations/structures of digital systems.
CO-4: A comprehensive understanding of the significance of poles and zeros in designing of digital filters.
CO-5: A comprehensive understanding of analysis and design of linear-phase FIR digital filters, FIR digital differentiators, Hilbert transformers and their applications.
CO-6: A comprehensive understanding of analysis and design of IIR digital filters and their applications.
CO-7: A comprehensive understanding of the concept of finite word length effects in signal processing systems, e.g., DFT computation, FIR and IIR system structures, zero-input limit cycle

COURSE CONTENT:
Review of DTFT and z-transform, Discrete Fourier transform and FFT algorithms. High speed convolution and its application to digital filtering, Realization of digital Filters, Symmetric and anti-symmetric FIR filters and their Frequency response, Design of Linear-phase FIR filters using Windows and Frequency sampling method, IIR filter design by Impulse Invariance and bilinear transformation method. Frequency transformations in the digital domain, Analysis of finite word length effects.

SUGGESTED READINGS:

1. S.K. Mitra, "Digital Signal Processing, A Computer Based approach," Tata Mc GrawHill.
2. John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms and Applications," Pearson.
3. Tarun Kumar Rawat, "Digital Signal Processing," Oxford University Press.

Course Code	Course Name	Course Structure	Pre-Requisite
SPC03	Advanced Digital Signal Processing	L-T-P 3-0-2	_____

COURSE OUTCOME (CO):
CO-1: A comprehensive understanding of MMSE & orthogonality principle and derivation of the Wiener filter for signals with known second order statistics.
CO-2: A comprehensive understanding of formulation of the Wiener filter as a constrained optimization problem.
CO-3: A comprehensive study and analysis of Lattice structures of FIR (AZ), and IIR (AP and PZ Lattice-Ladder) systems and their advantages.
CO-4: A comprehensive understanding of spectrum estimation methods

COURSE CONTENT:
Signal Modeling, All pole (AR), all zero (MA), pole zero models (ARMA), Generation of random processes and whitening, prony's method, pade approximation, shanks method, spectral factorization, Optimum linear filters, Lattice structures, Forward and backward linear prediction, The Levinson-Durbin algorithm, Power Spectrum Estimation: Nonparametric methods, Parametric methods, Eigenanalysis algorithms for spectrum estimation: PHD, Eigen-decomposition, MUSIC, ESPRIT algorithms.

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SUGGESTED READINGS:

1. S.K. Mitra, "Digital Signal Processing, A Computer Based approach," Tata Mc-Graw Hill.
2. P.P. Vaidyanathan, "Multirate Systems & Filter Banks," Prentice Hall, Englewood cliffs, NJ.
3. Tarun Kumar Rawat, "Digital Signal Processing," Oxford University Press.

Course Code	Course Name	Course Structure	Pre-Requisite
SPC04	Adaptive Signal Processing	L-T-P 3-0-2	_____

COURSE OUTCOME (CO):

CO-1: A basic understanding of the random signal theory, adaptive signal processing systems and their applications to a variety of practical problems such as interference and echo cancellation, system identification and channel equalization etc.

CO-2: A comprehensive understanding of MMSE & orthogonality principle, derivation of the Wiener filter for signals with known second order statistics and formulation of the Wiener filter as a constrained optimization problem.

CO-3: A comprehensive study and analysis of Lattice structures of FIR (AZ), and IIR (AP and PZ Lattice-Ladder) systems, their advantages.

CO-4: Study the Levinson-Durbin algorithm for the solution of Wiener-Hopf equations.

CO-5: A comprehensive understanding of derivation and application of the Steepest Descent and Newton's algorithm for iteratively estimating the Wiener filter weights.

CO-6: A comprehensive understanding of derivation and application of the LMS algorithm for iteratively estimating the Wiener filter weights.

CO-7: A comprehensive understanding of derivation and application of the RLS algorithm for iteratively estimating the Wiener filter weights.

COURSE CONTENT:

Basic concepts of Adaptive Filtering. Mathematical preliminaries, Review of Random signal theory, correlation matrix and some linear algebra, KL expansion, Mean-square error criterion, Wiener filters, principle of orthogonality, Gradient Search Algorithm (Newton), steepest descent algorithms, The LMS algorithm; convergence, misadjustment, Normalized LMS algorithm, Frequency domain LMS algorithm, Weighted Least squares algorithm, Recursive Least squares algorithm Properties, Kalman Filtering, Fundamentals of array signal processing.

SUGGESTED READINGS:

1. Tamal Bose, "Digital Signal and Image Processing," Wiley.
2. B. Widrow and S. D. Stearns, "Adaptive Signal Processing, " Pearson Education.
3. B. Farhang-Boroujeny, "Adaptive Filters Theory and Applications," John Wiley and Sons.
4. Tarun Kumar Rawat, "Digital Signal Processing," Oxford University Press.

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SYLLABUS OF DISCIPLINE CENTRIC ELECTIVE COURSES

Course Code	Course Name	Course Structure	Pre-Requisite
SPD01	Probability Theory and Stochastic Process	L - T - P 3 - 1/0 - 0/2	____
COURSE OUTCOME (CO): CO-1: Fundamental knowledge of the basic probability concepts CO-2: A comprehensive understanding of standard distributions which can describe real life phenomena. CO-3: Acquire skills in handling situations involving several random variable and functions of random variables CO-4: Understand and characterization of random process and their response to LTI systems.			
COURSE CONTENT: Introduction to Signal: Continuous time, discrete time, deterministic, random signals,Random variables: Introduction, discrete and continuous random variable , cumulative distribution function (c.d.f.) , probability density function (p.d.f.), characteristic function (c.f.), functions of one random variable , functions of two random variable, moments, Distributions: Bernaulli, Binomial, Poisson, Geometric, Gamma, Gaussian, Rician, Rayleigh, chi-square, exponential, Nakagami-m, Weibull, log-normal. Multivariate Gaussian random variables, Complex Gaussian distribution. Introduction to random processes, specification of random processes, nth order joint PDFs, independent increments, stationary increments, Markov property, Markov process and martingales, Gaussian process, Poisson process and Brownian motion, Mean and correlation of random processes, stationary, wide sense stationary, ergodic processes, Mean-square continuity, mean-square derivatives. Random processes as inputs to linear time invariant systems: power spectral density, Gaussian processes as inputs to LTI systems, white Gaussian noise.			
SUGGESTED READINGS: 1. H. Stark and J. W. Woods, "Probability and Random Processes with Applications to Signal Processing," Prentice Hall. 2. A. Papoulis and S. U. Pillai, "Probability, Random Variables and Stochastic Processes," McGraw-Hill.			

Course Code	Course Name	Course Structure	Pre-Requisite
SPD02	Digital Communication	L - T - P 3 - 1/0 - 0/2	_____
COURSE OUTCOME (CO): CO1: Studied the different digital modulation techniques and are able to evaluate the error performance of digital communication system in the presence of noise. CO2: Gained the fundamental knowledge about Information theoretical concepts of digital			

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communications and can utilize these concepts for designing of various source coding algorithms. CO3: Understand, analyze, and design fundamental digital communication systems.
COURSE CONTENT: Characterization of communication signals and systems: Representation of bandpass signals and systems, signal space representation, representation of digitally modulated signals, spectral characteristics, Optimum receivers for the AWGN channel: Optimum receiver for signals corrupted by AWGN, performance of optimum receiver for memoryless modulation, Limits of Communication: Introduction to information, Entropy, Capacity of discrete and continuous time channels, Wireless Communication: Wireless Channel Models, path loss and shadowing models, statistical fading models, Narrow band and wideband fading models, review of performance of digital modulation schemes over wireless channels
SUGGESTED READINGS: 1. J G proakis , "Digital communication," McGraw-Hill Education. 2. Simon Haykin, "Digital Communication," Wiley.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD03	Analog IC for Signal Processing	L - T - P 3 - 1/0 - 0/2	____
COURSE OUTCOME (CO): CO-1 To understand the devices available for Bi-CMOS ICs and their modelling CO-2 To understand the basic building blocks their characteristics and their limitations CO-3 To understand the basic pitfalls of Bi-CMOS circuits CO-4 To appreciate the prevalent practices related to Bi-CMOS analog IC design			
COURSE CONTENT: Introduction to MOSFET device structure and operation, MOS as amplifier, Biasing in MOS amplifier circuits, small signal equivalent circuit model, Single stage MOS amplifiers, characterizing amplifiers, MOS internal capacitance and high frequency model, frequency response. IC biasing-current sources, current mirrors and current-steering circuits, cascode and wilson current mirror, Common Source, common gate and common drain IC amplifiers, low frequency and high frequency response, noise performance, Multiple-Transistor IC amplifiers, Cascode configuration, folded cascode and self cascode structure, Voltage follower, flipped voltage follower. MOS differential pair, small signal operation, differential gain ,common mode gain, common mode rejection ration, non ideal characteristics, active loaded differential amplifier, Frequency response, Noise Spectrum, sources, types, Thermal and Flicker noise, representation in circuits, Noise bandwidth, Noise figure. CMOS analog integrated circuits, Op-amp design, practical opamp characteristics and model, DC offset and DC bias currents, Gain, bandwidth and slew rate, Noise, Input stage, output stage, CMOS and BiCMOS OTA, folded cascode CMOS OTA, Operational Current amplifier design, BiMOS and BiFET configurations, Current trends in Analog IC Design.			
SUGGESTED READINGS: 1. Gregorian and Temes, "Analog integrated circuits for signal processing," Jonh wiley Publication. 2. Kenneth R. Laker and Willy M.C. Sansen, "Design of Analog Integrated Circuits and systems,"			

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McGraw-Hill.
3. Philip E. Allen & Douglas R. Holberg, "CMOS Analog Circuit Design," Oxford University Press.
4. Behzad Razavi , "Design of Analog CMOS Integrated Circuit," Tata McGraw Hill.
5. Gray R.Paul, Hurst J. Paul, Lewis H. Stephen and Meyer G. Robert, "Analysis and Design of Analog Integrated Circuits", John Wiley and Sons.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD04	Digital System Design	L - T - P 3 - 1/0 - 0/2	____

COURSE OUTCOME (CO):

CO-1: Foster ability to identify and code the module using different modeling styles.

CO-2: Foster ability to write test benches in VHDL.

CO-3: Acquired knowledge about FSM and how to code a FSM.

CO-4: Ability to develop synthesizable code in VHDL.

COURSE CONTENT:

Digital hardware elements and their description in a hardware description language; system structuring methodology; hardware, software and firmware consideration in designing control units for arithmetic and logic processors; I/O processors with different methods of data handling: stored program control, electronic switching; process interface design such as numerical control, data acquisition systems, programmed logic arrays and designing with PLAs; microprocessor-based system design; technology considerations in system design. Introduction to place & route process, Introduction to ROM, PLA, PAL, Architecture of CPLD (Xilinx / Altera).

SUGGESTED READINGS:

1. Charles H. Roth, "Fundamentals of Logic Design," Cengage Learning.
2. Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, "Digital Systems Testing and Testable Design ," John Wiley & Sons Inc.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD05	Theory of Error Control Coding	L - T - P 3 - 1/0 - 0/2	____

COURSE OUTCOME (CO):

CO-1: explain the requirement of source coding, channel coding etc.

CO-2: understand the structure of various error correcting codes.

CO-3: compare different codes like block codes, cyclic codes, and convolution codes.

CO-4: discuss the trellis codes and their importance in communication theory.

COURSE CONTENT:

Finite Field Arithmetic: Introduction, Groups, Rings, Fields, Arithmetic of Galois Field Integer Ring, Polynomial Rings, Polynomials and Euclidean algorithm, primitive elements, Construction and basic properties of Finite Fields, Measure of information; Source coding; Communication channel models; Channel Capacity and coding; Block codes; Cyclic codes; BCH codes; Reed Solomon codes; Convolutional

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codes; Trellis coded modulation; Introduction to cryptography.
SUGGESTED READINGS: 1. Lin, S. and Costello Jr., D.J., "Error Control Coding," Pearson Prentice-Hall. 2. Blahut, R.E., "Algebraic Codes for Data Transmission," Cambridge University Press. 3. McEliece, R., "Theory of Information and Coding," Cambridge University Press. 4. Huffman, W.C. and Pless, V., "Fundamentals of Error Correcting Codes," Cambridge University Press.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD06	Optical Signal Processing	L - T - P 3 - 1/0 - 0/2	_____
COURSE OUTCOME (CO): CO1: Acquired the knowledge about OSP systems CO2: Understood the various optical modulation and demodulation techniques CO3: Study various optical filters CO4: Gain the fundamental knowledge about heterodyne systems and spectrum analyzer			
COURSE CONTENT: Need for OSP, fundamentals of OSP, The Fresnel Transform, Convolution and impulse response, Transform of a slit, Fourier Transforms in Optics, Transforms of aperture functions, Inverse Fourier Transform. Resolution criteria. A Basic Optical System, Imaging and Fourier Transform conditions. Cascaded systems, scale of Fourier Transform Condition. Maximum information capacity and optimum packing density.Chirp _ Z transform and system Coherence. Spectrum Analysis, Spatial light Modulators, special detector arrays. Performance parameters for spectrum analyzers. Relationship between SNR and Dynamic range. The 2 D spectrum Analyzer. Spatial Filtering, Linear Space Invariant systems, Parseval's theorem, Correlation, Input/Output Spectral Densities, Matched filtering, Inverse Filtering. Spatial Filters. Interferometers. Spatial filtering systems. Spatial Modulators . Applications of Optical Spatial Filtering, Effects of small displacements. Heterodyne systems. Temporal and spatial interference. Optimum photo detector size, Optical radio. Direct detection and Hetero dyne detection. Heterodyne spectrum Analysis. Spatial and temporal Frequencies. The CW signal and a short pulse. Photo detector geometry and bandwidth. Power spectrum analyzer using a CCD array.			
SUGGESTED READINGS: 1. Anthony VanderLugt, "Optical Signal Processing," John Wiley & Sons. 2. D. Casasent, "Optical data processing-Applications" Springer-Verlag, Berlin. 3. P.M. Dufffieux, "The Fourier Transform and its applications to Optics," John Wiley & Sons.			

Course Code	Course Name	Course Structure	Pre-Requisite
SPD07	BiMOS Analog Integrated Circuits	L - T - P 3 - 1/0 - 0/2	_____
COURSE OUTCOME (CO):			

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CO-1 To understand the devices available for Bi-CMOS ICs and their modelling CO-2 To understand the basic building blocks their characteristics and their limitations CO-3 To understand the basic pitfalls of Bi-CMOS circuits CO-4 To appreciate the prevalent practices related to Bi-CMOS analog IC design
COURSE CONTENT: Silicon Conductivity, pn Junctions, Diode Current, Bipolar Transistors, MOS Transistors, DMOS Transistors, Zener Diodes, EpiFets, Bipolar Transistors, MOS Transistors, Small Signal Models for Hand Calculations, Current Mirrors in Bipolar Technology, Current Mirrors in MOS Technology, Simple Voltage References, VBE Multiplier, Zener Voltage Reference Temperature Characteristics of I_C and V_{BE}, Bandgap Voltage Reference, The Common-Emitter Amplifier, The Common-Base Amplifier, Common-Collector Amplifiers, Two-Transistor Amplifiers, CC-CE and CC-CC Amplifiers, The Darlington Configuration, The CE-CB Amplifiers or Cascode, Emitter-Coupled Pairs; The MOS Case: The Common-Source Amplifier, The CMOS Inverter, The Common-Source Amplifier with Source Degeneration, The MOS Cascode Amplifier, The Common Drain (Source Follower) Amplifier, Source-Couple Pairs, Comparator with V_{BE}-Dependent Hysteresis, The Bandgap Reference Comparator, A Programmable Current Reference, A Triangle-Wave Oscillator, A Four-Bit Current Summing DAC, The MOS Case, The Emitter Follower: A Class A Output Stage, The Common-Emitter Configuration as a Class A Output Stage, The Class B (Push-Pull) Output, The Class AB, Output Stage, CMOS Output Stages, Overcurrent Protection, IR Drops, Lateral pnp, npn Transistors, Comparators, Latch-up, Floating Tubs, Parasitic MOS Transistors, Matching, Electrostatic Discharge Protection (ESD), ESD Protection Circuit Analysis
SUGGESTED READINGS: 1. James C Daly and Denis P. Galipeau, “Analog BiCMOS Design: Practices and Pitfalls” CRC Press.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD08	RF and Microwave Signal Processing	L - T - P 3 - 1/0 - 0/2	_____
COURSE OUTCOME (CO): CO1: Understand RF and Microwave circuits and devices. CO2: Understand microwave circuit analysis techniques. CO3: Understand S-parameters and network characterization techniques. CO4: Apply the ZY Smith chart to design microwave matching networks. CO5: Apply stability circles, stability criteria to solve stable and potentially unstable networks. CO6: Design microwave amplifiers. CO7: Design microwave oscillators. CO8: Design microwave mixers.			
COURSE CONTENT: RF and Microwave circuit elements, Microwave circuit analysis techniques, Circuit representation of two-port networks, Review of high speed RF devices, RF transistor amplifier design and matching, microwave oscillator circuits, microwave passive components, microwave semiconductor devices, coupler, mixer circuits.			

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SUGGESTED READINGS:

1. Bahl and P. Bhartia, “Microwave Solid State circuit Design," Wiley.
2. K. Chang, “Microwave Solid-State Circuits and Applications,” John Wiley & Sons.
3. S. Y. Liao, “Microwave Circuit Analysis and Amplifier Design,” Prentice Hall.
4. D. M. Pozar, “Microwave Engineering,” Wiley & Sons.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD09	Detection and Estimation Theory	L - T - P 3 - 1/0 - 0/2	SPC01

COURSE OUTCOME (CO):

CO-1: A comprehensive understanding of how to cast a generic detection problem into a hypothesis testing framework and to find the optimal test for the given optimization criterion.
CO-2: A comprehensive understanding of statistical decision theory used for signal detection and estimation (Classical and Bayesian Estimation Approaches).
CO-3: A comprehensive understanding of finding optimal estimators for various signal parameters, derive their properties and assess their performance.
CO-4: A comprehensive understanding of the detection of deterministic and random signals using statistical models.
CO-5: Comprehend the elements and structure of nonparametric detection.
CO-6: Examine the performance of signal parameters using optimal estimators.
CO-7: Analyze signal estimation in discrete-time domain using filters.

COURSE CONTENT:

Detection theory: hypothesis testing, Bayes, minimax, and Neyman-Pearson criteria, signaling in additive Gaussian noise, receiver operating characteristic. M-ary hypothesis testing, MAP and ML decision rules. Estimation of random parameters, MMS and MAP estimates. Estimation of nonrandom parameters, Cramer-Rao inequality, consistent estimate. Bounds on estimation errors, composite hypotheses. Elements of sequential and non-parametric detection. Wiener-Hopf and Kalman filtering.

SUGGESTED READINGS:

1. H. L. Van Trees, “Detection, Estimation and Modulation Theory: Part I,” John Wiley.
2. H. V. Poor, “An Introduction to Signal Detection and Estimation,” Springer.
3. James L. Melsa, David L. Cohn, “Decision and Estimation Theory,” McGraw Hill.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD10	Speech Processing	L - T - P 3 - 1/0 - 0/2	SPC02

COURSE OUTCOME (CO):

CO1: Understand basic characteristics of speech signal in relation to production and hearing of speech by humans.
CO2: Understand how the articulation mode of different classes of speech sounds determines their acoustic characteristics.

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CO3: Understand basic algorithms of speech analysis common to many applications in Time and frequency domain.
CO4: Solve given problems regarding parameter estimation in source-filter production models and regarding speech analysis and synthesis using these models,
CO5: Design a simple system for speech enhancement, end point detection, pitch period detection and its implementation into applications such as speech and speaker recognition, speech compression, speech enhancement etc.
CO6: Perform Matlab-based project(s) requiring some independent reading, programming, simulations, and technical writing.

COURSE CONTENT:
The speech signal, classification, process of speech production, acoustic phonetics, articulatory phonetics, Pitch, formants, various applications. Digital Model of Speech Signal: The process of Speech production, Sound propagation, tonal/ non-tonal components, global threshold (MPEG- I), Uniform lossless tube model, digital model. Time dependent processing of Speech, Short time average energy, short time average magnitude, short time average zero crossing rate, speech Vs silence discrimination, pitch period estimation, short time auto correlation function.
Short time Fourier analysis: Fourier transform interpretation, Linear filtering Interpretation, filter bank summation method, overlap addition method, Homomorphic speech processing. Digital representation of Speech: Sampling, A law, mu law, scalar quantization, vector quantization, mp3 compression.
Coding theory (strategies and standards) : Introduction, algorithm objectives and requirements, coding strategies, waveform coding, voice coders, hybrid coders, CELP. Insight to Speech recognition: Basic building blocks, Hidden markov models

SUGGESTED READINGS:

1. Rabiner and Schaffer, “Digital processing of Speech Signals,” Pearson.
2. Douglas O’ Shaugnessy, “Speech Communication, Human and Machine” Wiley.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD11	Digital Image Processing	L - T - P 3 - 1/0 - 0/2	SPC02

COURSE OUTCOME (CO):
CO-1: A comprehensive understanding of how images are formed, sampled, quantized and represented digitally, and how image are processed by discrete, linear, time-invariant systems.
CO-2: A comprehensive understanding of spatial filtering techniques, including linear and nonlinear methods.
CO-3: A comprehensive understanding of image enhancement algorithms such as histogram modification, contrast manipulation, and edge detection.
CO-4: A comprehensive understanding of the mathematical principles of image restoration. segmentation, feature detection and contour finding algorithms.
CO-5: A comprehensive understanding of the mathematical principles of image segmentation, feature detection and contour finding algorithms.
CO-6: A comprehensive understanding of Image transforms and compression schemes.

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CO-7: Demonstrated programming skills in digital image processing related problems.
COURSE CONTENT: Introduction to 2-D Signals and Systems. Image Digitization. Image Transforms. Image Data Compression: Transform Domain Coding, Predictive Coding, JPEG. Image Enhancement, Image Restoration: Inverse Filtering, Algebraic Approach to Restoration, Wiener (LMS) approach, Constrained Least Squares Restoration. Image Segmentation and Representation: Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Oriented Segmentation, Descriptors.
SUGGESTED READINGS: 1. R. C. Gonzales and R. E. Woods, "Digital Image Processing," Prentice-Hall. 2. A.K. Jain, "Fundamentals of Digital Image Processing," Prentice-Hall. 3. Tamal Bose, "Digital Signal and Image Processing," Wiley.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD12	Array Signal Processing	L - T - P 3 - 1/0 - 0/2	SPC01
COURSE OUTCOME (CO): CO-1: Understand the principles of Array Signal Processing CO-2: Understand the basics of Beam Forming. CO-3: A comprehensive understanding of linear arrays. CO-4: A comprehensive understanding of subspace methods.			
COURSE CONTENT: Signals in space and time, spatial frequency, Direction vs. frequency, Array Signal Model, Wave fields, Far field and Near field signals, Spatial sampling, Nyquist criterion, Sensor arrays, Uniform linear arrays, planar and random arrays, Array transfer (steering) vector, Array steering vector for ULA. Broadband arrays, Aliasing in spatial frequency domain, Spatial Frequency Transform, Spatial spectrum, Spatial Domain Filtering, Beam Forming, Spatially white signal, Non parametric methods - Beam forming and Capon methods, Resolution of Beam forming method, Subspace methods - MUSIC, Minimum Norm and ESPRIT techniques, Spatial Smoothing			
SUGGESTED READINGS: 1. D. E. Dugeon and D. H. Johnson, "Array Signal Processing: Concepts and Techniques," Prentice Hall. 2. P. Stoica and R. L. Moses, "Spectral Analysis of Signals," Prentice Hall. 3. D. G. Manolakis, V. K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing," McGraw-Hill.			

Course Code	Course Name	Course Structure	Pre-Requisite
SPD13	Multirate and Wavelets	L - T - P 3 - 1/0 - 0/2	SPC02
COURSE OUTCOME (CO):			

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CO1: A comprehensive understanding of Multirate Signal Processing.
CO-2: A comprehensive understanding of analysis and design of linear-phase FIR digital filters used in decimation & interpolation, and their computationally efficient implementation techniques.
CO-3: A comprehensive understanding of the Difference between Fourier and wavelet transform.
CO-4: Understanding of multiresolution analysis for different types of signals.
CO-5: A comprehensive understanding of data compression using wavelet transforms.
CO-6: Implement and apply wavelet transform for various applications.

COURSE CONTENT:
Basic Multirate operations, Interpolator, Decimator, Fractional sampling rate convertor, Multi-stage designs, Identities, Computationally efficient realizations of Interpolator and Decimator, Nyquist Filters, Half band filters, Introduction, M-channel Filter banks, QMF banks, Perfect reconstruction systems, Alias free filter banks, Paraunitary perfect reconstruction Filter banks, Linear phase perfect reconstruction QMF banks, STFT, Wavelet Transform, Discrete Wavelet Transform, Multiresolution analysis, Discrete-time orthonormal wavelets and their Relationship to Filter Banks, Digital filtering interpretation, examples of orthogonal basic generating wavelets, Data Compression: transform coding, DTWT for image compression, audio compression, and video coding using multiresolution techniques.

SUGGESTED READINGS:

1. P. P. Vaidyanathan, “Multirate Systems and Filter Banks,” Prentice Hall.
2. S. K. Mitra, “Digital Signal Processing: A Computer Based Approach,” McGraw-Hill.
3. S. Mallat, “A Wavelet Tour of Signal Processing,” Academic Press.
4. G. Strang and T. Q. Nguyen, “Wavelets and Filter Banks,” Wellesley-Cambridge Press.
5. B. W. Suter, “Multirate and Wavelet Signal Processing,” Academic Press.
6. C. S. Burrus, R. A. Gopinath, “Introduction to Wavelets and Wavelets Transforms, “ Prentice Hall.
7. R. M. Rao and A. S. Bopardikar, “Wavelet Transforms: Introduction to Theory and Applications,” Addison-Wesley.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD14	DSP Algorithm and Architecture	L - T - P 3 - 1/0 - 0/2	SPC02

COURSE OUTCOME (CO):
CO-1: A comprehensive understanding of Basic Architectural features of DSPs.
CO-2: A comprehensive understanding of DSPs Computational Building Blocks.
CO-3: A comprehensive understanding of the issues involved in implementing DSP algorithms on processors.
CO-4: A comprehensive understanding of CORDIC Algorithm.
CO-5: A comprehensive understanding of the implementation of common DSP tasks on processors.

COURSE CONTENT:
Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP

systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter, Architectures for Programmable DSP Devices: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation, Programmability and Program Execution, Speed Issues, Features for External interfacing. Instruction Level Parallelism (ILP): Concepts, Dynamic Scheduling - Reducing Data hazards. Computer arithmetic- Signed Digit Numbers(SD) - Multiplier Adder Graph –Logarithmic and Residue Number System (LNS, RNS) - Index Multiplier – Pipelined Adders - Modulo Adders - Distributed Arithmetic(DA) - CORDIC Algorithm. Interfacing Memory and I/O Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA). Current trends: Current trend in Digital Signal Processor or DSP Controller- Architecture and their applications.

SUGGESTED READINGS:

1. B. Venkataramani and M. Bhaskar, “Digital Signal Processors, Architecture, Programming and Applications,” Tatac McGraw Hill.
2. Jonatham Stein , “Digital Signal Processing,” John Wiley.
3. Uwe Mayer-BAeses , “Digital Signal Processing with FPGAs,” Springer.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD15	Wireless Communication	L - T - P 3 - 1/0 - 0/2	SPD02

COURSE OUTCOME (CO):

CO1: gain the fundamental knowledge about the propagation of light beam in atmosphere

CO2: discuss the various channel issues like atmospheric turbulence, absorption losses and scattering.

CO3: analyze the performance of simple optical wireless communication systems.

CO4: understand about the modulators and demodulators of optical signals.

COURSE CONTENT:

Introduction: Propagation of light in unguided media - laser beam characteristics -atmospheric effects on optical signals - coding for atmospheric optical propagation.

Light Sources: Modulators - photo detectors and receivers - optical amplification – optical signal to noise ratio - acquisition, pointing and tracking - adaptive and active optics – laser safety.

Performance analysis of various optical wireless systems, MIMO optical wireless communications, Cooperative FSO systems, Hybrid FSO and RF - FSO point to multipoint – FSO point to mobile.

FSO inherent security features; FSO Specific Applications: FSO networks for highway assisted communications - mesh FSO in disaster areas - visual light communication.

SUGGESTED READINGS:

1. Stamatios V. Kartalopoulos, “Free Space Optical Networks for Ultra-Broad Band Services”, IEEE Press, 2011.
2. Arun K. Majumdar and Jennifer C. Ricklin, “Free-Space Laser Communications: Principles and

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Advances", Springer.
3. Olivier Bouchet, Herve Sizun, Christian Boisrobert and Frederique De Fornel, "Free-Space Optics: Propagation and Communication," John Wiley and Sons.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD16	Current Mode Techniques for Signal Processing	L - T - P 3 - 1/0 - 0/2	_____

COURSE OUTCOME (CO):
CO1: Gain the fundamental knowledge of translinear circuits
CO2: Study and design of current mode amplifiers, followers, conveyors etc.
CO3: To gain knowledge about current mode converters.
CO4: Study current mode circuits for neural systems and analog interface circuits for VLSI

COURSE CONTENT:

Current mode circuits from a translinear viewpoint, various translinear circuits-squaring, rms to DC conversion, square-rooting, geometric mean vector magnitude, multiplier/divider cells and trigonometric function generators, current-mode analog amplifiers, current followers, current conveyers, current feedback amplifiers and current mode op-amp architectures, High frequency CMOS transconductors Ga analog IC design, basic building blocks, current mode A/D, D/A converters, application of current feedback to voltage amplifiers, Current mode circuits for neural systems, current mode analog interface circuits for VLSI.

SUGGESTED READINGS:

1. Chris Toumazou, F. J. Lidgey, David Haigh, "Analogue IC Design: The Current-mode Approach By Integrated Circuits for Analog Signal Processing," IET.
2. Fei Yuan , "CMOS Current-Mode Circuits for Data Communications," Springer Science & Business Media.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD17	Optimization Techniques	L - T - P 3 - 1/0 - 0/2	_____

COURSE OUTCOME (CO):
CO-1: A comprehensive understanding of basic theoretical principles in optimization.
CO-2: Understanding of formulation of optimization models.
CO-3: Understanding of optimization methods.
CO-4: Understanding of methods of sensitivity analysis and post processing of results.
CO-5: Understanding of applications to a wide range of engineering problems.

COURSE CONTENT:

Mathematical Background: Sequences and Subsequences- Mapping and functions-Continuous functions-Infimum and Supremum of functions- Minima and maxima of functions- Differentiable functions. Vectors and vector spaces- Matrices- Linear transformation- Quadratic forms- Definite quadratic forms-

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Gradient and Hessian- Linear equations- Solution of a set of linear equations-Basic solution and degeneracy. Convex sets and Convex cones- Introduction and preliminary definition- Convex sets and properties -Differentiable convex functions- Generalization of convex functions
Linear Programming: Introduction -Optimization model, formulation and applications- Classical optimization techniques: Single and multi variable problems-Types of constraints. Linear optimization algorithms: The simplex method -Basic solution and extreme point -Degeneracy-The primal simplex method -Dual linear programs - Primal, dual, and duality theory - The dual simplex method -The primal-dual algorithm-Duality applications. Post optimization problems: Sensitivity analysis and parametric programming

Nonlinear Programming: Minimization and maximization of convex functions- Local & Global optimum-Convergence-Speed of convergence. Unconstrained optimization: One dimensional minimization - Elimination methods: Fibonacci & Golden section search - Gradient methods - Steepest descent method. Constrained optimization: Constrained optimization with equality and inequality constraints. Kelley's convex cutting plane algorithm - Gradient projection method - Penalty Function methods.

Constrained optimization: Lagrangian method - Sufficiency conditions - Kuhn-Tucker optimality conditions- Rate of convergence - Engineering applications Quadratic programming problems-Convex programming problems.

SUGGESTED READINGS:

1. David G Luenberger, “Linear and Non Linear Programming,” Addison- Wesley.
2. S.S.Rao, “Engineering Optimization; Theory and Practice,” New Age International Publishers.
3. Fletcher R., “Practical methods of optimization,” John Wiley.
4. Saul I Gass, “Linear programming,” McGraw-Hill.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD18	Selected Topics in Signal Processing	L - T - P 3 - 1/0 - 0/2	____
COURSE OUTCOME (CO):			
COURSE CONTENT: Select topics in signal processing; details will be decided by the instructor.			
SUGGESTED READINGS:			

Course Code	Course Name	Course Structure	Pre-Requisite
SPD19	Signal Processing Techniques for Wireless Communication	L - T - P 3 - 1/0 - 0/2	SPC03, SPD15
COURSE OUTCOME (CO):			

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CO1: To gain an understanding of the principles behind the design of wireless communication systems and technologies.
CO2: Knowledge about the effect of fading and Different fading models.
CO3: Study different diversity techniques and signal processing associated with them

COURSE CONTENT:

Overview of current wireless systems and standards

Wireless channel models- statistical fading models, multiple input and multiple output (MIMO) channels.

Diversity in wireless communications - Non-coherent and coherent reception realization of diversity: time diversity; frequency diversity: DSSS and OFDM; receiver diversity: SC, EGC and MRC; transmit diversity: space-time codes.

Information theory for wireless communications- Capacity of fading channels: ergodic capacity and outage capacity; high versus low SNR regime; waterfilling algorithm; capacity of MIMO channels

Multiuser wireless communications: multiple access: FDMA, TDMA, CDMA and SDMA schemes; interference management: power control; multiuser diversity, multiuser MIMO systems.

SUGGESTED READINGS:

1. A. J. Goldsmith, “Wireless Communications,” Cambridge University Press.
2. D. Tse and P. Viswanath, “Fundamentals of Wireless Communications,” Cambridge University Press.
3. A. Molisch, “Wireless Communications,” John Wiley & Sons.
4. S. Haykin and M. Moher, “Modern Wireless Communications,” Pearson Education.
5. T. S. Rappaport, “Wireless Communications,” Prentice Hall.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD20	Radar and Sonar Signal Processing	L - T - P 3 - 1/0 - 0/2	SPC03

COURSE OUTCOME (CO):
CO1: get familiar with fundamentals of radar systems, Propagation of EM waves in space and time, Doppler shift, Range equation, system structure. Sampling complex bandpass signals, Sampling rates in range, angle, Doppler, space, Digital I/Q.
CO2: understand the concept of Signal Models, Radar cross section of targets and clutter, multipath statistical signal models, Swerling models, advanced statistical signal models for clutter, convolutional models in range and angle, frequency domain models.
CO3: understand the ambiguity function, Basic waveforms, Coded waveforms, Optimum waveforms for time delay, velocity, acceleration measurements, Measurement accuracy, Cramer-Rao bounds

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CO4: know the theory of Matched filter, MTI, DFT/pulse Doppler approx to matched filter for known target velocity, Improvement factor, DPCA for airborne MTI
CO5: understand the concept of Optimal Detection, Neyman-Pearson detection and the likelihood ratio, threshold detection, targets in Gaussian noise, coherent and noncoherent integration; binary integration, Optimal detectors for non-Gaussian interference, CFAR
CO6: get acquainted with Synthetic Aperture Radar, the SAR principle from aperture, system issues, range migration, processor structure, SAR modes, Doppler beam sharpening, Inverse SAR.
CO7: Perform practicals based on radar processing and understand the use in practical applications.
CO8: Perform project works based on theoretical concepts using various simulation software and do hardware implementation.

COURSE CONTENT:
Fundamentals of radar systems, Propagating EM waves in space and time, Doppler shift, Range equation, system structure. Sampling complex bandpass signals, Sampling rates in range, angle, Doppler, space, I/Q imbalance and correction techniques, Digital I/Q, Signal Models, Radar cross section of targets and clutter, multipath statistical signal models, Swerling models, advanced (compound) statistical signal models for clutter, convolutional models in range and angle, frequency domain models. Basic waveforms: simple pulse, LFM, coherent pulse train, Coded waveforms: frequency, phase (biphase, Costas), MCW, step-freq, Optimum waveforms for time delay, velocity, acceleration measurements, Measurement accuracy, Cramer-Rao bounds, Doppler processing, Matched filter, MTI as approximation to matched filter for unknown target velocity, DFT/pulse Doppler approx to matched filter for known target velocity, Improvement factor, DPCA for airborne MTI, Neyman-Pearson detection and the likelihood ratio, threshold detection, targets in Gaussian noise, coherent and noncoherent integration; binary integration, Optimal detectors for non-Gaussian interference, CFAR, Synthetic Aperture Radar, The SAR principle from aperture, Doppler, chirp viewpoints, SAR overview: system issues, range migration, processor structure, SAR modes: strip map, spotlight, Doppler beam sharpening, Inverse SAR, Spotlight SAR and polar format data collection, Polar format processing, Range migration and chirp scaling algorithms for spotlight SAR , Autofocus: correlation, phase gradient algorithms, Interferometric 3D SAR

SUGGESTED READINGS:
1. I. Haykin, Simon S, “Rader Adaptive signal processing”, John Wiley & Sons.
2. Mark A Richards, “Fundamentals of Radar signal processing”, McGraw Hill.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD21	Signal Compression Techniques	L - T - P 3 - 1/0 - 0/2	SPC03, SPD13

COURSE OUTCOME (CO):
CO1: Students should achieve broad knowledge of compression techniques as well as the mathematical foundations of data compression
CO2: Factual knowledge about existing compression standards or commonly-used compression utilities
CO3: Understanding of the ubiquity and importance of compression technologies in today’s environment

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CO4: Students will be able to compare the efficiency of various compression techniques in terms of speed and compression ratio.
COURSE CONTENT: Review of Information Theory: The discrete memoryless information source - Kraft inequality; optimal codes Source coding theorem. Compression Techniques - Lossless and Lossy Compression - Mathematical Preliminaries for Lossless Compression -Huffman Coding - Optimality of Huffman codes - Extended Huffman Coding - Adaptive Huffman Coding - Arithmetic Coding - Adaptive Arithmetic coding, Run Length Coding, Rate distortion theory: Rate distortion function R(D),Properties of R(D); Calculation of R(D) for the binary source and the Gaussian source, Rate distortion theorem, Converse of the Rate distortion theorem, Quantization - Uniform & Non-uniform - optimal and adaptive quantization, vector quantization and structures for VQ, Optimality conditions for VQ, Predictive Coding - Differential Encoding Schemes, Mathematical Preliminaries for Transforms, Karhunen Loeve Transform, Discrete Cosine and Sine Transforms, Discrete Walsh Hadamard Transform, Lapped transforms - Transform coding - Subband coding - Wavelet Based Compression - Analysis/Synthesis Schemes. Speech Compression Standards: PCM-G.711, ADPCM G.726, SBC G.722, LD-CELP G.728, CS-ACELP G.729, G.723.1, GSM HR VSELP, LPC10, CELP, G721. Audio Compression standards: MPEG, Philips PASC, Sony ATRAC, Dolby AC-3, Image Compression standards: GIF, JPEG & JPEG derived industry standards, SPIHT, EZW, JPEG 2000. Video Compression Standards: MPEG, H.261, H.263 & H264.
SUGGESTED READINGS: 1. Khalid Sayood, “Introduction to Data Compression,” Morgan Kaufmann Publishers. 2. David Salomon, “Data Compression: The Complete Reference,” Springer Publications. 3. Toby Berger, “Rate Distortion Theory: A Mathematical Basis for Data Compression,” Prentice Hall. 4. K.R.Rao, P.C.Yip, “The Transform and Data Compression Handbook,” CRC Press.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD22	Network Security and Cryptography	L - T - P 3 - 1/0 - 0/2	_____
COURSE OUTCOME (CO): CO1: understand the principles of Cryptography and Network Security algorithms, public key cryptography. CO2: Possess necessary background for OSI Security Architecture, Security mechanism and Security services, Steganography, Cipher Design Principles and Modes of Operation, Confusion and Diffusion. CO3: Understand the basic theory of Encryption techniques. CO4: understand authentication functions and protocols, Message Authentication Codes, Hash Functions MD5 message Digest algorithm, Secure Hash Algorithm, HMAC Digital Signatures, and Digital Signature Standard. CO5: possess necessary background of authentication Services, Electronic Mail Security, IP Security,			

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Web Security. CO6: Understand the basic theories behind Intrusion detection, password management, Viruses and related Threats, Virus Counter measures, Firewall Design Principles. CO7: Realize cryptography and network security techniques and implement the design using some simulation techniques.
COURSE CONTENT: Introduction to security attacks, services and mechanism, Classical encryption techniques substitution ciphers and transposition ciphers, cryptanalysis, steganography, Stream and block ciphers, Data encryption standard(DES), Introduction to group, field, finite field of the form GF(p), Advanced Encryption Standard (AES) encryption and decryption Fermat's and Euler's theorem, Primality testing, Chinese Remainder theorem, Discrete Logarithmic Problem, Principals of public key crypto systems, RSA algorithm, security of RSA, Message Authentication Codes,Digital Signatures: Digital Signatures, Elgamal Digital Signature Techniques, Digital signature standards (DSS), Key Management and distribution: Symmetric key distribution, Diffie-Hellman Key Exchange, Public key distribution, X.509 Certificates, Public key Infrastructure. Authentication Applications: Kerberos, IP Security,System Security
SUGGESTED READINGS: 1. William Stallings, "Cryptography and Network Security – Principles and Practices," Pearson Education. 2. Behrouz A. Foruzan, "Cryptography and Network Security," Tata McGraw-Hill. 3. Bruce Schneier, "Applied Cryptography," John Wiley &.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD23	VLSI Signal Processing	L - T - P 3 - 1/0 - 0/2	SPC02, SPC03
COURSE OUTCOME (CO): CO-1: Understanding of VLSI design methodology for signal processing systems. CO-2: A comprehensive understanding of VLSI algorithms and architectures for DSP. CO-3: A comprehensive understanding of VLSI algorithm transforms including retiming, folding/unfolding, algebraic transforms. CO-4: A comprehensive understanding of pipelining and parallel processing of FIR and IIR digital filters. CO-5: A comprehensive understanding of systolic architectures for DSP.			
COURSE CONTENT: Introduction to DSP Systems: Introduction; representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph. Iteration Bound: Data flow graph representations, loop bound and iteration bound, longest path matrix algorithm, iteration bound of Multirate data flow graphs. Pipelining and Parallel Processing: Pipelining and parallel processing of FIR digital filters, pipeline interleaving in digital filters: signal and multichannel interleaving. Retiming, Unfolding and Folding: retiming techniques; algorithm for unfolding, Folding transformation, systolic architecture design, systolic array design methodogy. Fast Convolution, Filters and Transforms: Cook-toom algorithm, modified cook-toom algorithm, Winogard algorithm, iterated convolution Algorithm strength reduction in filters and transforms.			

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SUGGESTED READINGS:
1. K. Parhi, "VLSI Digital Signal Processing Systems," John Wiley & Sons.
2. U. Meyer-Baese, "Digital Signal Processing with Field Programmable Gate Arrays," Springer-Verlag.
3. Kung S. Y, H. J. While House, T. Kailath , "VLSI and Modern Signal Processing," Prentice Hall.
4. Medisetti V. K. , "VLSI Digital Signal Processing," IEEE Press (NY), USA.

Course Code	Course Name	Course Structure	Pre-Requisite
SPD24	Pattern Recognition	L - T - P 3 - 1/0 - 0/2	SPC01

COURSE OUTCOME (CO):
CO-1: A comprehensive understanding of designing systems and algorithms for pattern recognition (signal classification), with focus on sequences of patterns that are analyzed using, e.g., hidden Markov models (HMM).
CO-2: A comprehensive understanding to analyze classification problems probabilistically and estimate classifier performance.
CO-3: Understand and analyze methods for automatic training of classification systems.
CO-4: Apply Maximum-likelihood parameter estimation in relatively complex probabilistic models, such as mixture density models and hidden Markov models.
CO-5: Understand the principles of Bayesian parameter estimation and apply them in relatively simple probabilistic models.
CO-6: A comprehensive understanding of how to apply supervised learning methods (model-based maximum likelihood, k-nearest neighbors) to the classifier design.

COURSE CONTENT:
Basics of pattern recognition, Design principles of pattern recognition system, Learning and adaptation, Pattern recognition approaches, Mathematical foundations: Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi squared test. Statistical Patten Recognition: Bayesian Decision Theory, Classifiers, Normal density and discriminant function. Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods - Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM), Gaussian mixture models. Nonparametric Techniques: Density Estimation, Parzen Windows, K-Nearest Neighbor Estimation, Nearest Neighbor Rule, Fuzzy classification.Unsupervised Learning & Clustering: Criterion functions for clustering, Clustering Techniques.

SUGGESTED READINGS:
1. C.M. Bishop, "Pattern Recognition and Machine Learning," Springer.
2. Richard Duda, Peter Hart, and David Stork, "Pattern Classification" John Wiley and Sons.

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Course Code	Course Name	Course Structure	Pre-Requisite
SPD25	Digital Video Processing	L - T - P 3 - 1/0 - 0/2	SPD11
COURSE OUTCOME (CO): CO-1: A comprehensive understanding of basics of digital video processing. CO-2: A comprehensive understanding of motion estimation methods. CO-3: Understanding of depth perception and stereo imaging principle. CO-4: A comprehensive understanding of video coding and its international standards. CO-5: A comprehensive understanding of video compression techniques.			
COURSE CONTENT: Introduction to video processing, Principles of colour video processing, Video display, Composite versus component video, Progressive and interlaced scan, Sampling of video signals, Two-Dimensional Motion Estimation: Optical flow based methods, Block-based methods, Pel-recursive methods, Bayesian methods based on Gibbs Random Fields, Categorization of video coding schemes, Information Theory for source coding, Binary encoding, Scalar quantization, Vector quantization, Wave form based coding, Block-based transform coding, Predictive coding, Content dependent video coding, Scalable video coding, Stereo and multi view sequence processing, Depth perception, Stereo imaging principle, Disparity estimation, Intermediate view synthesis, Stereo sequence coding, Video compression: Interframe compression methods (3-d waveform and motion-compensated waveform coding), Video compression standards (H.261, MPEG-1, MPEG-2).			
SUGGESTED READINGS: 1. John W. Woods, “Multidimensional Signal, Image, and Video Processing and Coding,” Academic Press. 2. M. Tekalp, “Digital Video Processing,” Prentice Hall. 3. Alan C. Bovik, “The Essential Guide to Video Processing,” Elsevier Science.			

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SYLLABUS OF OPEN ELECTIVE COURSES

Course Code	Course Name	Course Structure	Pre-Requisite
EO001	Technical Communication	L-T-P 3-1-0	____
COURSE OUTCOME (CO): CO-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. CO-2: This will enhance the students capability to prepare technical documents and correspondence. CO-3: The course will equip the student with good communications skills for placements, preparing SOPs and CVs. CO-4: The course will sensitize the students towards research ethics, copyright and plagiarism.			
COURSE CONTENT: Definition of communication, 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, followup, acceptance-refusal Emphasis on (i) paragraph writing, its kinds, coherence & cohesion (ii)writing a paragraph/thesis: selection of topic and its development (iii) writing reports, manuals, notices, memos, agendas, minutes (iv)Interviews, speeches, presentations, Research ethics, methodologies, copyright, plagiarism			
SUGGESTED READINGS: 1. Martin Hewing , "Advanced English Grammar: A Self Study Reference And Practice Book For Advanced South Asian Students," Cambridge University Press. 2. Meenakshi Raman & Sangeeta Sharma , "Technical Communication," Oxford University Press.			

Course Code	Course Name	Course Structure	Pre-Requisite
EO002	Disaster Management	L-T-P 3-1-0	____
COURSE OUTCOME (CO): CO-1: Demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response. CO-2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. CO-3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. CO-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.			

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COURSE CONTENT:

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.

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

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.

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.

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:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, Issues and Strategies, " New Royal book Company.

2. Sahni, Pardeep Et.Al., "Disaster Mitigation Experiences And Reflections," Prentice-Hall.

Course Code	Course Name	Course Structure	Pre-Requisite
EO003	Basics of Financial Management	L-T-P 3-1-0	____

COURSE OUTCOME (CO):

The course's objective is to provide a theoretical framework for considering corporate finance problems and issues and to apply these concepts in practice. In this course, you will enhance your knowledge and understanding of financial management. You will learn how managers should organize their financial transactions effectively and with integrity and how to give everybody the ability and confidence to tackle common financial problems in practice. It will also provide adequate preparation for future finance classes.

COURSE CONTENT:

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

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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.

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, UK.
3. Chandra P., "Financial Management-Theory and Practice," Tata McGraw Hill.
4. Horne, Van; James C., John Wachowicz, "Fundamentals of Financial Management," Pearson Education.

Course Code	Course Name	Course Structure	Pre-Requisite
EO004	Basics of Human Resource Management	L-T-P 3-1-0	____

COURSE OUTCOME (CO): This course is designed to provide students with an understanding of human resource management (HRM) functions within organizations, including an appreciation of the roles of both HRM specialists and line managers in designing and implementing effective HRM policies and practices.

COURSE CONTENT:

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 diversity (causes, 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). Selection (procedure, tests, interviews). Placement and Induction.

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SUGGESTED READINGS: 1. Aswathappa K., "Human Resource and Personnel Management," Tata McGraw-Hill. 2. Saiyadain S. Mirza, "Human Resource Management," Tata Mc-GrawHill.

Course Code	Course Name	Course Structure	Pre-Requisite
EO005	Project Management	L-T-P 3-1-0	____
COURSE OUTCOME (CO): In this comprehensive course, student will learn the fundamentals of project management: how to initiate, plan, and execute a project that meets objectives and satisfies stakeholders. This course provides a step-by-step guide to planning and executing a project and to develop a manageable project schedule.			
COURSE CONTENT: 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. 2. Harold Kerzner, "Applied Project Management: Best Practices on Implementation," John Wiley & Sons. 3. Goodpasture, J. C., "Quantitative Methods in Project Management, " J Ross Publishing. 4. Meredith, J. R. and Mantel Jr., S. J., "Project Management: A Managerial Approach," John Wiley.			

Course Code	Course Name	Course Structure	Pre-Requisite
EO006	Basics of Corporate Law	L-T-P 3-1-0	____
COURSE OUTCOME (CO): The objective of this Course is to provide in-depth knowledge of the Corporate laws and process related to integrate these aspects of management studies in decision making within an organization; analyze			

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and interpret management information; make decisions based on the information available; communicate information effectively; understand and apply the theoretical aspects of accounting methods used for collecting, recording and reporting financial information; explain and appraise the taxation laws which govern corporations and individuals.
COURSE CONTENT: 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. 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. 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.
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. Hanningan Brenda, "Company Law," Oxford University Press.

Course Code	Course Name	Course Structure	Pre-Requisite
EO007	Biological Computing	L-T-P 3-1-0	____
COURSE OUTCOME (CO): CO-1. To understand computing in context of biological systems CO-2. To understand computing languages needed to solve biological problems CO-3. To acquire computational skills for analysis of biological processes through grid computing CO-4. To gain knowledge of different biological databases and their usage CO-5. To gain innovative insight into DNA computing			
COURSE CONTENT: Introduction, Orientation and UNIX, Python: Introduction to Variables and Control flow, Python II -			

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Parsing In and Output, Python III - Scripting and Functions, Python IV- Number Crunching and Plotting, Grid computing, Biogrid, R basics and Visualization, Unix for fast text processing, SQL Database Biological databases, R for speed, R for fun, Local BLAST, Unit Testing and Code Correctness DNA computing,
SUGGESTED READINGS: 1. H. Bolouri, R. Paton, "Computations in cells & tissues," Springer. 2. Haubold Bernhard and Wiehe Thomas, "Introduction to Computational Biology: An Evolutionary Approach," Springer.

Course Code	Course Name	Course Structure	Pre-Requisite
EO008	Sociology	L-T-P 3-1-0	____
COURSE OUTCOME (CO): Sociology is a major category of academic disciplines, concerned with society and the relationships among individuals within a society. It in turn has many branches, each of which is considered a "social science".			
COURSE CONTENT: The Development of Sociology in the 19th Century Science, scientific method and critique. Major theoretical strands of research methodology. Positivism and its critique. Fact value and objectivity. Non- positivist methodologies. Sociological theories of religion. Types of religious practices: animism, monism, pluralism, sects, cults. Religion in modern society: religion and science, secularization, religious revivalism, fundamentalism. 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. Kar l 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, "Sociology: Essays in Approach and Method," Oxford University Press. 2. Giddens Anthony" Sociology," Polity Press, Chap 17. 3. Weber M. , "The Methodology of the Social Sciences," New York: Free Press.			

Course Code	Course Name	Course Structure	Pre-Requisite
EO009	Entrepreneurship	L-T-P 3-1-0	____
COURSE OUTCOME (CO):			

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This Course Aims at Instituting Entrepreneurial skills in the students by giving an overview of who the entrepreneurs are and what competences are needed to become an entrepreneur.
COURSE CONTENT: 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. 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. 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. 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. 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. 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.

Course Code	Course Name	Course Structure	Pre-Requisite
EO010	Social Work	L-T-P 3-1-0	____
COURSE OUTCOME (CO): In this course students will learn about various methods of social work, about community organization, social welfare administration, Problems pertaining to Marriage, Family and caste.			
COURSE CONTENT: 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 &			

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Fraternity) and Humanitarian (Human Rights) Matrix. Social works as a profession. 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, Planning and Development, Role of Social group worker, Leadership Development. Meaning, Objective, Principles, Approaches, Roles of Community Organization Worker.
Meaning Scope, Auspices-Private and Public, Principles, Basic Administrative Processes and Practice decision making communication, planning. organisation, budgeting and finacial 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, analysing and interpretation, Report writing. Social Action: Meaning, Scope, approaches (Sarvodays, Antyodaya etc.) and Strategies. 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 Colla 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 Soclal 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," Regal Publications.
2. Sanjay Bhattacharya , "Social Work: An Integrated Approach," Deep and Deep.

Course Code	Course Name	Course Structure	Pre-Requisite
EO011	Intellectual property and Patenting	L-T-P 3-1-0	____

COURSE OUTCOME (CO):

The objective of this Course is to provide 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. Students will be exposed to the technical, management and legal aspects of IP and Patents.

COURSE CONTENT:

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
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
New and useful: (A) The legal requirement of novelty (B) First to invent vs. first inventor to file, The legal requirement of non-obviousness.
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., "Create or Perish: The Case for Inventions and Patents," Acropolis.

Course Code	Course Name	Course Structure	Pre-Requisite
EO012	Supply Chain Management and Logistics	L-T-P 3-1-0	____

COURSE OUTCOME (CO):
Supply chain management consists of all parties (including manufacturer, marketer, suppliers, transporters, warehouses, retailers and even customers) directly or indirectly involved in fulfillment of a customer. The main objective is to acquaint the students with the concepts and tools of supply chain management and logistics as relevant for a business firm.

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

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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. Jhonand Langley,Brian J Gibs, "Logistics approach to Supply Chain Management," Cengage Learning.

Course Code	Course Name	Course Structure	Pre-Requisite
EO013	Organization Development	L-T-P 3-1-0	____
COURSE OUTCOME (CO): Organisation Development is a growing field of Human Resource Management. It has its foundations in a number of behavioural and social sciences .			
COURSE CONTENT: Organizational Systems and Human Behavior - Developing a basic knowledge of how organizations and groups function as systems; introducing and discussing various theoretical approaches and issues. 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. 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. Intervention and Change in Organizations Consolidating and further developing consulting skills and strategies Action Research Project - Carrying out a change activity in an organization, while also researching the effects and for the process. This provides participants with an opportunity to consolidate and de, menstruate skills and knowledge gained in other units of the course			
SUGGESTED READINGS: 1. Mee-Yan, Cheung-Judge, "Organization Development: A Practitioner's Guide for OD and HR," Koran Page.			

Course Code	Course Name	Course Structure	Pre-Requisite
EO014	ndustrial organisation and managerial economics	L-T-P 3-1-0	____
COURSE OUTCOME (CO): This course helps students in understanding the basics of management and Industrial organisation.			
COURSE CONTENT: Principles of management, General idea, various functions, scope of engineering. Organisation structure, Types, merits and demerits. Plant location and layout, Factors effecting location, types of layout. Production planning and control, Sequence of planning and control of production. Scheduling, routing,			

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dispatching. Methods Study, Methods analysis, time study methods of rating. General idea of personnel management, Industrial psychology, job evaluation and monitoring. Business decision making and forward planning. Demand and demand for casting 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," Palgrave Macmillan U.K.

Course Code	Course Name	Course Structure	Pre-Requisite
EO015	Global Strategies and Technology	L-T-P 3-1-0	____
COURSE OUTCOME (CO): This subject focuses on the specifics of strategy and organization of the multinational company, and provides a 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. Mike W. Peng , "Global Strategy," South Western College Pub. 2. Pankaj Ghemawat, "Redefining Global Strategy," Harward Business Review Press.			

Course Code	Course Name	Course Structure	Pre-Requisite
EO016	Engineering System Analysis and Design	L-T-P 3-1-0	____
COURSE OUTCOME (CO): 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: 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 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,			

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Maintenance

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

User Interfaces – Relational Analysis – Database design – program design– structure chart – HIPO – SSADM – Alternate Life cycles – Prototypes.

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. Harysz kiewycz, "Introduction to Systems Analysis and Design," Prentice Hall of India.
2. James A Senn, "Analysis and Design of Information Systems," McGraw Hill.

Course Code	Course Name	Course Structure	Pre-Requisite
EO017	Biology for Engineers	L-T-P 3-1-0	____

COURSE OUTCOME (CO):

CO-1. General understanding of organization in biological systems

CO-2. Conceptual knowledge of functioning in biological systems

CO-3. Clarity about relevance of Biology to engineering graduates

CO-4. Understanding human body or any other suitable organism as a study-model for engineering students.

CO-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. T. Johnson , "Biology for Engineers," CRC Press.
2. Michael Small , "Dynamics of Biological System," CRC Press.
3. Johnny T. Ottesen, MS Olufsen, JK Larsen , "Applied Mathematical Models and Human Physiology," Society for Industrial and Applied Mathematics.

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Course Code	Course Name	Course Structure	Pre-Requisite
EO018	Energy Environment and Society	L-T-P 3-1-0	____
COURSE OUTCOME (CO): CO-1: To be able to assess the energy resources available worldwide CO-2: To understand the negative impact of conventional energy resource utilization on ecosystem CO-3: To learn about various types of pollutions and their control strategies CO-4: To understand renewable energy resources and their socio-economic impact			
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). 2. G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable Energy Sources," Narosa Publishing House. 3. Mital K. M, "Biogas Systems: Principles and Applications," New Age International Publishers.			

Course Code	Course Name	Course Structure	Pre-Requisite
EO019	Public Policy and Governance	L-T-P 3-1-0	____
COURSE OUTCOME (CO): Students will be introduced to Public Policy and Administrative governance. They will also learn about Administrative Governance.			
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			

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SUGGESTED READINGS:

1. Beryl Radin, "Beyond Machiavelli: Policy Analysis Reaches Midlife," Georgetown University Press.
2. Frank R. Baumgartner, Jeffrey M. Berry, Marie Hojnacki, and David C. Kimball, "Lobbying and Policy Change: Who Wins, Who Loses, and Why. Chicago," University of Chicago Press.
3. Timothy Conlan, Paul Posner, and David Beam, "Pathways of Power: The dynamics of National Policymaking," Georgetown University Press.