KALASALINGAM
ACADEMY OF RESEARCH AND EDUCATION
(DEEMED TO BE UNIVERSITY)
Under sec. 3 of UGC Act 1956.
Anand Nagar, Krishnankoil - 626126. Srivilliputtur (Via), Virudhunagar (Dt), Tamil Nadu | info@kalasalingam.ac.in | www.kalasalingam.ac.in
SCHOOL OF ELECTRONICS AND ELECTRICAL TECHNOLOGY
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BACHELOR OF TECHNOLOGY
ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM AND SYLLABUS


KALASALINGAM
ACADEMY OF RESEARCH AND EDUCATION
அறிவு
அற்றம் காக்கும்
கருவி

UNIVERSITY VISION

To be a University of Excellence of International Repute in Education and Research

UNIVERSITY MISSION

- To provide a scholarly teaching-learning ambience which results in creating graduates equipped with skills and acumen to solve real-life problems.
- To promote research and create knowledge for human welfare, rural and societal development.
- To nurture entrepreneurial ambition, industrial and societal connect by creating an environment through which innovators and leaders emerge.

DEPARTMENT VISION

To strive towards excellence in Electronics and Communication Engineering through teaching, experiential learning, quality research and scholarship, while adhering to ethical and societal requirements

DEPARTMENT MISSION

- To help students achieve their goals by recognizing, identifying, and fostering their unique strengths through quality education and cutting-edge research training.
- To imbibe ability in the students to solve real life problems as per need of the society through nurturing their skills, creative thinking, and research acumen.
- To create an elite workforce, without compromise in the ethics and societal values.

B.TECH. E.C.E. PROGRAMME EDUCATIONAL OBJECTIVES

Within a few years of obtaining an undergraduate degree in Electronics and Communication Engineering, the students will:

PEO1: Technical Proficiency:

Succeed as creative, productive, and valued engineers in their career by applying the technical knowledge and skills gained.

PEO2: Professional Growth:

Continue to develop professionally through life-long learning, higher education, and research expertise to meet the expectations of their organisation and the society.

PEO3: Management Skills:

Exhibit the management qualities in a responsive, ethical, and innovative manner.

ABET STUDENT OUTCOMES

Graduates of the undergraduate electrical and computer engineering programs will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal context.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyse, and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

B.TECH. E.C.E. PROGRAMME SPECIFIC OUTCOMES

At the end of the programme, the students will be able to:

PSO1: Apply the basic sciences and engineering knowledge in the design and development of complex systems in the areas related to electronics and communication engineering

PSO2: Use the cutting-edge hardware and software tools with the obtained technical and managerial skills to design software and systems for applications including signal processing, communication engineering, computer networks, VLSI design, and embedded systems

PSO3: Possess the attitude of continuous learning for producing effective solutions for the applications, directly and indirectly, related to Electronics and Communication engineering

B.TECH. E.C.E. PROGRAMME OUTCOMES (AS PER NBA)

At the end of the programme, the students will be able to:

Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.

Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.
Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
Life-long learning: Recognise the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

B.TECH. ELECTRONICS AND COMMUNICATION ENGINEERING CURRICULUM

Curriculum Structure:

Sl.	Category	Credits	
I.	**Basic Science and Mathematics**		**31**
	Compulsory Courses	**25**	
	Open Elective (Basic Science and Mathematics)	**6**	
II.	Humanities and Social Science	**3**	**12**
	Soft Skills	**3**	
	Humanities Elective	**6**	
III.	Basic Engineering		**24**
IV.	**Programme Core**		**61**
	Core Courses	**48**	
	Community Service Project	**3**	
	Project Work	**10**	
V.	**Elective Courses (Engineering)**		**30**
	Professional Elective	**18**	
	Open Elective (Engineering)	**12**	
VI.	Internship / Industry Training		**2**
VII.	Mandatory Courses		**--**
		Total Credits	**160**

I. Basic Sciences and Mathematics

S.	Course Code	Course Name	Type	L	T	P	Credits
1.	PHY18R171	Introduction to Electromagnetic Theory	IC	3	1	2	5
2.	CHY18R171	Chemistry	IC	4	0	2	5
3.	BIT18R101	Biology for Engineers	T	3	0	0	3
4.	MAT18R101	Calculus and Linear Algebra	T	3	0	2	4
5.	MAT18R102	Multiple Integration, Ordinary Differential Equations and Complex Variable	T	3	0	2	4
6.	MAT18R204	Partial Differential Equations and Trans-forms	T	3	0	2	4

S.	Course Code	Course Name	Type	L	T	P	Credits
7.	OEEXXX	Open Elective (Basic Sciences and Mathematics) – I	T	3	0	0	3
8.	OEEXXX	Open Elective (Basic Sciences and Mathematics) – II	T	3	0	0	3
						Total	**31**

II. Humanities and Social Sciences

S.	Course Code	Course Name	Type	L	T	P	Credits
1.	HSS18R151	English for Technical Communication	TP	2	0	2	3
2.	HSS18R101	Soft Skills – I	T	1	0	0	1
3.	HSS18R102	Soft Skills – II	T	1	0	0	1
4.	HSS18R201	Soft Skills – III	T	1	0	0	1
5.	HSS18R0XX	Humanities Elective – I	T	3	0	0	3
6.	HSS18R0XX	Humanities Elective – II	T	3	0	0	3
						Total	**12**

III. Basic Engineering

S.	Course Code	Course Name	Type	L	T	P	Credits
1.	EEE18R172	Basic Electrical Engineering	IC	3	1	2	5
2.	MEC18R151	Engineering Graphics and Design	TP	2	0	2	3
3.	MEC18R211	Engineering Mechanics	T	3	1	0	4
4.	MEC18R152	Engineering Practice	TP	2	0	2	3
5.	ECE18R172	Digital Circuits and Systems Design	IC	3	1	2	5
6.	ECE18R171	Electronic Devices	IC	3	0	2	4
						Total	**24**

IV. Program Core

A. Core Courses

Sl.	Course Code	Course Name	Type	Pre-requisite	Co-requisite	L	T	P	C
1.	ECE18R201	Network Theory	T			3	1	0	4
2.	ECE18R202	Signals and Systems	T			3	1	0	4
3.	ECE18R203	Analog Integrated Circuits	T	ECE18R271		3	0	0	3
4.	ECE18R271	Electronic Circuits	IC	--		3	0	2	4
5.	ECE18R316	Probability Theory and Stochastic Processes	T			3	1	0	4
6.	ECE18R273	Digital Signal Processing	IC	ECE18R202		3	0	2	4

Sl.	Course Code	Course Name	Type	Pre-requisite	Co-requisite	L	T	P	C
7.	ECE18R274	Electromagnetic Waves and Transmission Lines	IC	--		3	0	2	4
8.	ECE18R275	Analog and Digital Communication	IC	--		3	0	2	4
9.	ECE18R281	Analog Integrated Circuits Laboratory	L		ECE18R203	0	0	2	1
10.	ECE18R301	Control Systems	T	ECE18R202		3	1	0	4
11.	ECE18R371	Microprocessors and Microcontrollers	IC	--		3	0	2	4
12.	ECE18R372	Antennas and Propagation	IC	ECE18R274		3	0	2	4
13.	ECE18R373	Computer Communication and Networks	IC	--		3	0	2	4
Total:									**48**

B. Community Service Project

S.	Course Code	Course Name	Credits
1.	ECE18R399	Community Service Project	**3**

C. Project Work

S.	Course Code	Course Name	Credits
1.	ECE18R498 / ECE18R499	Project Work	**10**

V. Electives

A. Professional Electives

S.	Course Code	Course Name	Type	Pre-requisite/ Co-requisite	L	T	P	C
Stream: ELECTRONIC PRODUCT DESIGN AND PROGRAMMING								
1.	ECE18R236	Linux and Shell Programming	IC	--	3	0	2	4
2.	ECE18R237	C Essentials	IC	--	3	0	2	4
3.	ECE18R238	Linux and Regular Expressions	IC	--	3	0	2	4
4.	ECE18R250	PCB Design	TP	--	3	0	1	3.5
5.	ECE18R251	Data Structures	IC	--	3	0	2	4
6.	ECE18R252	Object-Oriented Programming with C++	TP	--	3	0	1	3.5
7.	ECE18R253	Numerical Analysis using MATLAB	TP	--	3	0	1	3.5
8.	ECE18R254	Electronic Sensors and Measurements with LABVIEW	TP	EEE18R172	3	0	1	3.5
9.	ECE18R312	Computer Architecture	T	--	3	1	0	4
10.	ECE18R313	Scientific Computing	T	--	3	1	0	4

S.	Course Code	Course Name	Type	Pre-requisite/ Co-requisite	L	T	P	C
11.	ECE18R350	Python Programming for Electronics Engineers	IC	--	3	0	2	4
12.	ECE18R402	Reliability Engineering	T	--	3	1	0	4
Stream: VLSI DESIGN								
1.	ECE18R239	RTL Design using Verilog HDL	IC	--	3	0	2	4
2.	ECE18R255	Electronic Material Physics	TP	--	3	0	1	3.5
3.	ECE18R256	FPGA Based System Design	TP	--	3	0	1	3.5
4.	ECE18R314	CMOS Analog IC Design	T	ECE18R203	3	1	0	4
5.	ECE18R315	Microelectronics Physics	T	ECE18R255	3	1	0	4
6.	ECE18R351	Process and Device Simulation by TCAD	TP	--	3	0	1	3.5
7.	ECE18R352	CMOS Design	TP	ECE18R271	3	0	1	3.5
8.	ECE18R353	MEMS Technology and Modelling	TP	ECE18R254	3	0	1	3.5
9.	ECE18R354	Digital Logic and State Machine Design	TP	--	3	0	1	3.5
10.	ECE18R370	Python Programming for Design and Verification Engineers	IC	--	3	0	2	4
11.	ECE18R376	ASIC Design Flow	IC	ECE18R172	3	0	2	4
12.	ECE18R377	System Verilog for RTL Verification	IC	ECE18R239	2	0	2	3
13.	ECE18R380	Static Timing Analysis	IC	ECE18R376	2	0	2	3
14.	ECE18R404	Mixed Signal Design	T	ECE18R314	3	1	0	4
15.	ECE18R405	Nano Electronics	T	ECE18R315	3	0	0	3
16.	ECE18R406	IC Layout Design	T	ECE18R352	3	1	0	4
17.	ECE18R450	Systematic Digital Design	TP	ECE18R354	3	0	1	3.5
18.	ECE18R470	Universal Verification Methodology	IC	ECE18R377	2	0	2	3
19.	ECE18R473	Physical Design and Verification	IC	ECE18R376	2	0	2	3
Stream: SIGNAL PROCESSING								
1.	ECE18R257	Digital Signal Processing with FPGA	TP	--	3	0	1	3.5
2.	ECE18R258	Digital Signal Processing and Filter Design	TP	ECE18R202	3	0	1	3.5
3.	ECE18R355	Digital Signal Processing Architecture	TP	--	3	0	1	3.5
4.	ECE18R356	Speech and Audio Signal Processing	TP	ECE18R273	3	0	1	3.5
5.	ECE18R357	Digital Image Processing	TP	ECE18R273	3	0	1	3.5
6.	ECE18R358	Digital Video Processing	TP	ECE18R273	3	0	1	3.5

S.	Course Code	Course Name	Type	Pre-requisite/ Co-requisite	L	T	P	C
7.	ECE18R359	Computer Vision	TP	ECE18R273	3	0	1	3.5
8.	ECE18R375	Statistical Inference and Machine Learning	IC	--	3	0	2	4
9.	ECE18R379	Deep Learning Implementations in TensorFlow and Keras	IC	ECE18R375	2	0	2	3
10.	ECE18R407	Adaptive Signal Processing	T	ECE18R273	3	1	0	4
11.	ECE18R452	Digital Signal Processing System Design	TP	ECE18R355	3	0	1	3.5
12.	ECE18R472	Applied Data Modelling and Deep Learning for Engineers	IC	ECE18R376	2	0	2	3
Stream: COMMUNICATION ENGINEERING AND NETWORKING								
1.	ECE18R259	Information Theory and Coding Principles	TP	--	3	0	1	3.5
2.	ECE18R320	RFID and Applications	T	--	3	1	0	4
3.	ECE18R322	Data Compression	T	ECE18R259	3	1	0	4
4.	ECE18R361	Fibre Optic Communication	TP	ECE18R275	3	0	1	3.5
5.	ECE18R362	Mobile Communication	TP	ECE18R275	3	0	1	3.5
6.	ECE18R363	Microwave Theory and Techniques	TP	ECE18R274	3	0	1	3.5
7.	ECE18R364	Wireless Network Technologies	TP	ECE18R373	3	0	1	3.5
8.	ECE18R410	Error Correcting Codes	T	ECE18R259	3	1	0	4
9.	ECE18R411	High Speed Electronics	T	ECE18R363	3	1	0	4
10.	ECE18R413	Next Generation Mobile Communication	T	ECE18R362	3	0	0	3
11.	ECE18R454	Cryptography and Network Security	IC	--	3	0	2	4
12.	ECE18R455	Wireless Ad-Hoc and Sensor Networks	TP	ECE18R373	3	0	1	3.5
Stream: EMBEDDED SYSTEM DESIGN								
1.	ECE18R260	Internet of Things	TP	--	3	0	1	3.5
2.	ECE18R365	AVR Microcontroller Programming	TP	ECE18R371	3	0	1	3.5
3.	ECE18R366	Embedded ARM Development using BeagleBone	TP	ECE18R371	3	0	1	3.5
4.	ECE18R367	Embedded C	TP	--	3	0	1	3.5
5.	ECE18R374	Embedded Systems for IoT	IC	--	3	0	2	4
6.	ECE18R378	System Design and Applications for IoT	IC	ECE18R374	2	0	2	3
7.	ECE18R414	Flexible Electronics	T	--	3	1	0	4
8.	ECE18R456	Embedded Systems Design and Programming	TP	ECE18R367	3	0	1	3.5

S.	Course Code	Course Name	Type	Pre-requisite/ Co-requisite	L	T	P	C
9.	ECE18R471	IoT Protocols and their Applications	IC	--	2	0	2	3

B. Professional (Special) Electives (Honours Electives)

S.	Course Code	Course Name	Type	Pre-requisite/ Co-requisite	L	T	P	C
Stream: ELECTRONIC PRODUCT DESIGN AND PROGRAMMING								
1.	ECE18R310	Display Systems	T	--	3	0	0	3
2.	ECE18R311	Electronics Product Design for Manufacturing	T	--	3	0	0	3
3.	ECE18R401	Electronic Packaging	T	--	3	0	0	3
4.	ECE18R403	Green Electronics Manufacturing	T	--	3	0	0	3
5.	ECE18R323	Electronics and Computing in Textile Industries	T	--	3	1	0	4
Stream: EMBEDDED SYSTEM DESIGN								
6.	ECE18R415	Smart Textile Technologies	T	--	3	1	0	4
7.	ECE18R416	IoT for Smart Agriculture	T	-	3	1	0	4
Stream: SIGNAL PROCESSING								
8.	ECE18R317	Bio-Medical Electronics	T	--	3	0	0	3
9.	ECE18R318	Wavelets	T	ECE18R273	3	1	0	4
10.	ECE18R408	Virtual Reality	T	--	3	1	0	4
11.	ECE18R409	Augmented Reality	T	--	3	1	0	4
Stream: COMMUNICATION ENGINEERING AND NETWORKING								
12.	ECE18R319	RADAR and Navigational Aids	T	ECE18R274	3	1	0	4
13.	ECE18R321	Satellite Communication	T	ECE18R275	3	1	0	4

C. Humanities Electives

S.	Course Code	Course Name	Type	L	T	P	Credits
1.	HSS18R001	Management Concepts and Techniques	T	3	0	0	3
2.	HSS18R002	Marketing Management	T	3	0	0	3
3.	HSS18R003	Organisational Psychology	T	3	0	0	3
4.	HSS18R004	Project Management	T	3	0	0	3
5.	HSS18R005	Stress Management and Coping Strategies	T	3	0	0	3
6.	HSS18R006	Economics for Engineers	T	3	0	0	3
7.	HSS18R007	Human Resource Management and Labour Law	T	3	0	0	3
8.	HSS18R008	Entrepreneurship Development	T	3	0	0	3
9.	HSS18R009	Cost Analysis and Control	T	3	0	0	3
10.	HSS18R010	Product Design and Development	T	3	0	0	3

S.	Course Code	Course Name	Type	L	T	P	Credits
11.	HSS18R011	Business Process Reengineering	T	3	0	0	3
12.	HSS18R012	Political Economy	T	3	0	0	3
13.	HSS18R013	Professional Ethics	T	3	0	0	3
14.	HSS18R014	Operations Research	T	3	0	0	3
15.	HSS18R015	Total Quality Management	T	3	0	0	3
16.	HSS18R016	Advanced Soft Skills	T	3	0	0	3

VI. Industrial Training / Internship

S.	Course Code	Course Name	Credits
1.	ECE18R397	Industry Training / Internship	**2**

VII. Mandatory Courses

S.	Course Code	Course Name	Credits
1.	MAN18R001	Environmental Sciences	-
2.	MAN18R002	Indian Constitution	-
3.	MAN18R003	Essence of Indian Traditional Knowledge	-

I BASIC SCIENCES AND MATHEMATICS

MAT18R101 CALCULUS AND LINEAR ALGEBRA

MAT18R101 Calculus and Linear Algebra	L	T	P	C
	3	0	2	4
Pre-requisite: Basic Mathematics Knowledge at School Level	**Course Category:** Basic Science and Mathematics **Course Type:** Theory			

Course Objective(s):

To enable the students to acquire knowledge and skills in basic components of calculus, to handle the situations involving multivariable calculus, and to diagonalize a symmetric matrix using eigenvalues and eigenvectors.

Course Outcome(s):

Upon successful completion of this course, students will be able to

CO1: Know the fundamental theorems such as Rolle's theorem, Mean value theorem, Taylor's theorem, and its applications.

CO2: Understand the basic concepts of limit, continuity, derivative, partial derivative and total derivative and its applications.

CO3: Solve the real-world problems using differentiation and integration.

CO4: Understand the concepts of sequence, convergent of sequences, series, and testing of convergent of series using different methods.

CO5: Find the solution of simultaneous linear equations using matrices and to find the eigen values and eigen vectors of a matrix, Cayley-Hamilton theorem, and orthogonal transformations.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H												H		
CO3	H												H		
CO4	H												H		
CO5	H												H		

Course Topics:

Unit 1: Calculus:

Rolle's Theorem- Mean value theorems - Taylor's and Maclaurin theorems with remainders -indeterminate forms and L'Hospital's rule - Maxima and minima.

Unit 2: Multivariable Calculus (Differentiation):

Limit, continuity, and partial derivatives - directional derivatives - total derivative - Maxima, minima, and saddle points - Method of Lagrange multipliers.

Unit 3: Calculus (Applications):

Curvature (Cartesian coordinates) - Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Unit 4: Sequences and series:

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions.

Unit 5: Matrices:

System of linear equations; Symmetric, skew-symmetric, and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Cayley-Hamilton Theorem - Diagonalization of matrices - Orthogonal transformation- Reduction of Quadratic form to Canonical form.

TEXTBOOKS:

1. Grewal, B.S., Grewal, J. S., "Higher Engineering Mathematics", Khanna Publishers India, 43rd Edition, 2017, ISBN: 978-81-933284-9-1

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 10th Edition (International Student Version), 2001, ISBN: 9788126554232
2. Bandaru Venkata Ramana, "Engineering Mathematics", McGraw Hill India, 1st Edition 2006, ISBN: 9780070634190

MAT18R102 MULTIPLE INTEGRATION, ORDINARY DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLE

MAT18R102 Multiple Integration, Ordinary Differential Equations and Complex Variable	L	T	P	C
	3	0	2	4
Pre-requisite: Basic Mathematics Knowledge at School Level	**Course Category:** Basic Science and Mathematics **Course Type:** Theory			

Course Objective:

To enable the students to understand the concepts of multiple integrations, their applications, and to handle analytic functions on complex plane and perform complex integration.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: understand the concepts of double and triple integral and its applications.
CO2: know about the applications of double and triple integral in vector calculus.
CO3: know the methods of solving differential equations of first and second orders.
CO4: understand the concepts of analytic functions, conformal mappings, and bilinear transformations.
CO5: understand the concepts of singularity, residues, and evaluation of certain improper integrals.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H												H		
CO3	H												H		
CO4	H												H		
CO5	H												H		

Course Topics:

Unit 1: Multivariable Calculus (Integration):

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to polar), Applications: areas and volume; Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds;

Unit 2: Integral theorems:

Gradient, curl, and divergence. Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Unit 3: Ordinary differential equations:

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equations.

Unit 4: Complex Variable – Differentiation:

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Unit 5: Complex Variable – Integration:

Contour integrals, Cauchy Integral formula (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of

definite integral involving sine and cosine, Evaluation of certain improper integrals (Integration around small semicircles and rectangular contours).

TEXTBOOKS:

1. Grewal, B.S., Grewal, J. S., "Higher Engineering Mathematics", Khanna Publishers India, 43rd Edition, 2017, ISBN: 978-81-933284-9-1

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2. Bandaru Venkata Ramana, "Engineering Mathematics", McGraw Hill India, 1st Edition 2006, ISBN: 9780070634190

MAT18R204 PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS

MAT18R204 Partial Differential Equations and Transforms	L	T	P	C
	3	0	2	4
Pre-requisite: Basic Mathematics Knowledge at School Level	**Course Category:** Basic Science and Mathematics **Course Type:** Theory			

Course Objective:

To enable the students to solve the partial differential equations, to understand discrete and continuous transformations, and to solve differential equations and difference equations using transform techniques.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: know the method of solving first and second order partial differential equations.
CO2: classify the second order partial differential equations and to know about solving of initial and boundary value problems.
CO3: understand the concept of Laplace transform and its application in solving ordinary differential equations and partial differential equations.
CO4: know about Z transform and its application in solving difference equations.
CO5: know about Fourier transforms and its properties.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H												H		
CO3	H												H		
CO4	H												H		
CO5	H												H		

Course Topics:

Unit 1: Partial Differential Equations

First order partial differential equations, solutions of first order linear and non-linear PDEs. Solution to homogenous and non-homogenous linear partial differential equations second and higher order by complimentary function and particular-integral method.

Unit 2: Applications of Partial Differential Equations

Flows, vibrations and diffusions, second-order linear equations and their classification, Initial and boundary conditions, solution of the wave equation and diffusion equation by the method of separation of variables, The Laplacian in plane, cylindrical and spherical polar coordinates and solutions.

Unit 3: Laplace Transform

Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method.

Unit 4: Z Transform

Z-transform - Elementary properties - Inverse Z - transform - Convolution theorem –Formation of difference equations - Solution of difference equations using Z - transform.

Unit 5: Fourier Transform

Fourier series – Half range sine and cosine series - Fourier integral theorem (without proof) - Fourier transform pair - Sine and Cosine transforms – Properties - Transforms of simple functions – Convolution theorem - Parseval's Identity.

TEXTBOOKS:

1. Grewal, B.S., Grewal, J. S., "Higher Engineering Mathematics", Khanna Publishers India, 43rd Edition, 2017, ISBN: 978-81-933284-9-1

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 10th Edition (International Student Version), 2001, ISBN: 9788126554232
2. Bandaru Venkata Ramana, "Engineering Mathematics", McGraw Hill India, 1st Edition 2006, ISBN: 9780070634190

PHY18R171 INTRODUCTION TO ELECTROMAGNETIC THEORY

PHY18R171 Introduction to Electromagnetic Theory	L	T	P	C
	3	1	2	5
Pre-requisite: Basic Physics Knowledge at School Level	**Course Category:** Basic Science and Mathematics **Course Type:** Integrated Course			

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Describe the properties of static charges.
CO2: Understand the basic concepts of magnetic field effects.
CO3: Understand the fundamentals of magnetic properties of materials.
CO4: Explore the basic idea about electromagnetic induction.
CO5: Apply the knowledge on electromagnetism in solving real world problems.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H												H		
CO3	H												H		
CO4	H												H		
CO5	H												H	M	L

Course Topics:

Unit 1: Electrostatics

The Electric Field- Continuous Charge Distributions-Divergence and Curl of electrostatic field: Field lines, Flux and Gauss's law, Divergence of E-Application of Gauss's law-The Curl of E-Electric Potential: Poisson's equation and Laplace equation, The potentials of a Localized Charge Distribution, Boundary Conditions-Work and Energy in electrostatics: Energy of a point charge distribution and energy of continuous charge distribution. Electric field and potential due to electric dipole

Unit 2: Magnetostatics

The Lorentz Force Law-Biot-Savart's Law- Applications of Biot-Savart's Law- Magnetic field due to current in a straight conductor-Magnetic field due to a circular current loop- Divergence and curl of static magnetic field - Ampere's Circuital law- Integral and differential form of Ampere's law- Applications of Ampere's law: Magnetic field due to solenoid and Magnetic field due to Toroid-Magnetic vector potential

Unit 3: Magnetic and Dielectric Materials

Properties of magnetic materials, Diamagnetism, Paramagnetism and Ferromagnetism- Ferromagnetic Domains-Hysteresis curve- Comparison of Dia, Para, and Ferro magnetism.

Dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarization – internal field – Claussius Mosotti equation – dielectric breakdown mechanisms.

Unit 4: Faraday's law, Displacement current and Maxwell's equations

Faraday's laws of electromagnetic induction-Lenz's law-Inductance- Electromotive force- motional EMF - Self-inductance of single coil-Mutual inductance of two coils-Energy stored in magnetic field - displacement current - physical interpretation - Maxwell's equation in free space, Maxwell's equation in linear isotropic media.

Unit 5: Electromagnetic waves

Poynting Theorem - Waves in one Dimension (Sinusoidal wave), Polarization-Electromagnetic waves in vacuum- Monochromatic plane waves-Energy and momentum in electromagnetic waves-Electromagnetic waves in matter. Application of electromagnetic waves: Reflection and Refraction at Dielectric interface (Normal Incidence only).

List of Experiments

1. To compare capacitances using De'Sauty's bridge.
2. To determine the self-inductance of the coil using Anderson's bridge
3. To determine the specific resistance of the material of two given wires using a meter bridge
4. To determine the internal resistance of a primary cell using a potentiometer
5. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
6. To study the series LCR circuit and determine its (a) Resonant Frequency, (b)Quality Factor
7. To study the parallel LCR circuit and determine its (a) Anti-resonant frequency and(b) Quality factor Q
8. To determine the Low Resistance by Carey Foster's Bridge
9. Determination of Thermo emf- direct method – BG
10. To determine the volume magnetic susceptibility of Manganese sulphate solution at different concentrations.
11. Determination of dielectric constant of liquids.
12. To determine the mutual inductance of the coil using Anderson's bridge.

TEXTBOOK(S):

1. David. J. Griffiths, "Introduction to Electrodynamics", Pearson India, 2015(4th Edition), ISBN: 9789332550445.
2. Sathya Prakash, "Electricity and Magnetism", Pragati Prakashan India, 2016(31st Edition), ISBN: 978-93-86104-26-7.
3. Halliday, Resnick, and Jearl Walker, "Fundamentals of Physics: Electricity and Magnetism", Wiley India, 2011(9th Edition), ISBN: 9788126532254.

REFERENCE BOOKS:

1. Shobhit Mahajan and S Rai Choudhary, "Electricity, Magnetism and Electromagnetic Theory", McGraw Hill India, 2012(1st Edition), ISBN: 9781259004599.
2. Edward M. Purcell, "Electricity and Magnetism (In SI Units)", McGraw Hill India, 2011(2nd Edition), ISBN: 9780070702141.
3. Indu Prakash, Ram Krishna and A.K. Jha, "A TEXTBOOK of Practical Physics (Engineering Students)", Kitab Mahal India, 2011, ISBN: 81-225-0416-7.
4. R. Murugeshan, "Electricity and Magnetism", S, Chand Publishing India, 2017(10th Edition), ISBN: 9789352534319

CHY18R171 CHEMISTRY

CHY18R171 Chemistry	L	T	P	C
	3	1	2	5
Pre-requisite: Basic Chemistry Knowledge at School Level	**Course Category:** Basic Science and Mathematics **Course Type:** Integrated Course			

Course Objective(s):

Introducing the fundamental concepts and applications of Chemistry to the engineering students to understand, analyse and apply the same to complex technical issues

Course Outcome(s):

Upon successful completion of this course, students will be able to

CO1: Demonstrate some knowledge on the significance and role of water quality parameters in the domestic and engineering applications and analysing the same through modern methods

CO2: Explain the principles of thermodynamics for solving engineering problems

CO3: Explain the basic concepts of electrochemistry, batteries, corrosion and to apply the same for the betterment of society

CO4: Explain about synthesis, characteristics and applications of technologically important polymers, composites, and nanomaterials

CO5: Explain the underlying principles, instrumentation, and applications of analytical techniques

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H												H		
CO3	H												H		
CO4	H												H		
CO5	H												H		

Course Topics:

Unit 1: Atomic and Molecular Structure

Schrodinger wave equation: Derivation of time independent Schrodinger wave equation, Representation of Schrodinger wave equation in polar coordinates - Radial distribution function graphs of s, p, d, and f orbitals. Molecular Orbital Theory: MOT concept, MO diagrams of homo-nuclear diatomic molecules (hydrogen, nitrogen, and oxygen) and hetero-nuclear diatomic molecules (carbon monoxide and nitric oxide). Crystal field theory: CFT concept, weak and strong ligands, energy level diagrams of transition metal ions (Fe^{2+}& Fe^{3+}) in octahedral and tetrahedral complexes and their magnetic properties. Intermolecular forces - Ionic, dipolar and van der Waals interactions.

Unit 2: Periodic Properties

Effective nuclear charge - Factors affecting effective nuclear charge: Penetration or shielding of orbitals - Variation of s, p, d and f orbital energies of atoms in the periodic table - Aufbau principle (Building-up principle)**:** Application of Aufbau principle in writing electronic configuration, Deviation from Aufbau principle - Periodicity of properties in a periodic table - Periodic properties: Atomic and ionic sizes, ionization energies, electron affinity and electronegativity - Variation of periodic properties in the periodic table - Hard soft acids and bases: Concept and examples.

Unit 3: Free Energy and Chemical Equilibria

Thermodynamic functions: Definition and mathematical expression for Work, Energy, Enthalpy, Entropy and Free energy - Nernst equation: Derivation, apply Nernst equation to determine of solubility product, pH (glass electrode). Potentiometric titrations: Acid-Base, Redox and precipitation reaction - Water analysis: Hardness by EDTA method and chloride ion by Argentomentric method - Corrosion: Definition, types (dry & wet) and mechanism. and control of Dry and Wet corrosion.

Unit 4: Organic Reactions

Nucleophilic substitution reactions: Definition, types, and examples of nucleophile, Compare nucleophilicity and basicity of a nuceophile - Types of nucleophilic substitution (case RX and ArX): Mechanism of S_N1, S_N2, S_Ni and Benzyne. Electrophilic substitution reactions: Definition, types, and examples of electrophile - Electrophilic substitution reactions of hydrocarbons: Halogenation, sulphonation, nitration. Friedel crafts alkylation and acylation reaction. Nucleophilic addition reactions (case aldehydes and ketones): Polarity of C=O bond. General mechanism of nucleophilic addition reactions on aldehydes and ketones: HCN, HOH, ROH and $NaHSO_3$ addition. Electrophilic addition reactions (case alkenes): General mechanism of electrophilic addition reactions on alkene - Addition of HBr [Markownikoff & Anti-Markownikoff (peroxide effect)] - Addition of alkene (polymerization of ethylene). Elimination reactions: Types of elimination reactions (case alkyl halides): Dehydrohalogenation of alkyl

halides - E_1 and E_2 mechanism - Dehydration of alcohols to alkene and ethers. Greener synthesis of drug molecules (Aspirin and Ibuprofen)

Unit 5: Stereochemistry and Spectroscopic Techniques

Stereochemistry - Definition with examples: Geometrical isomers (alkene) and stereoisomers, symmetry, chirality, enantiomers, diastereomers, meso and racemic mixture. Representation of 3D structures: Wedge formula, Fischer projections, Newmann and Sawhorse formula (up to 2 carbons) - Conformational analysis: Ethane, butane and cyclohexane - Configurational analysis: Rules of RS nomenclature and application of RS nomenclature to molecules containing one chiral centre. Electronic spectroscopy: Principle, instrumentation, selection rules and medicinal application of fluorescence spectroscopy. Nuclear magnetic resonance spectroscopy (^{1}H-NMR): Principle, instrumentation, chemical shift, coupling constant and application (structural identification of the compound C_3H_6O from ^{1}H-NMR data). X-ray diffraction: Principle, instrumentation, and applications X-ray diffraction.

List of Experiments (Any 10):

1. Determination of Viscosity by Ostwald Viscometer.
2. Determination of surface tension by stalagmometer.
3. Adsorption of acetic acid by charcoal.
4. Determination of chloride content of water.
5. Estimation of hardness of water by EDTA method.
6. Determination of the rate constant of a reaction
7. Thin layer chromatography.
8. Determination of the partition coefficient of a substance between two immiscible liquids
9. Determination of Saponification /acid value of oil.
10. Preparation of Aspirin
11. Potentiometric titration of strong acid vs strong base.
12. Potentiometric titration of weak acid vs strong base.
13. Determination of cell constant and conductance of solutions.

TEXTBOOKS

1. Ernest L. Eliel, Samuel H. Wilen, Lewis N. Mander, “Stereochemistry of Organic Compounds”, Wiley India, 2017, ISBN: 9788126515707.
2. Bruce M. Mahan and Rollie J. Meyers, “University Chemistry”, Pearson India, 2017(11th Edition), ISBN: 9788131729571

REFERENCE BOOKS

1. Colin Banwell and Elaine McCash, “Fundamentals of Molecular Spectroscopy”, McGraw Hill India, 2016(4th Edition), ISBN: 9789352601738.
2. Peter Atkins, Julio de Paula, “Atkins’ Physical Chemistry”, Oxford University Press India, 2014(10th Edition), ISBN: 9780198728726
3. R.D. Madan and Satya Prakash, “Modern Inorganic Chemistry”, S. Chand Publishing India, 2009(4th Edition), ISBN: 9788121900744.
4. Paula Yurkanis Bruice, “Organic Chemistry”, Pearson India, 2014(7th Edition), ISBN: 9789332519046.
5. B. R. Puri, L. R. Sharma, M. S. Pathania, “Principles of Physical Chemistry”, Vishal Publishing Co., 2017 (47th Edition), ISBN: 978-9382956013.
6. Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, “Spectrometric Identification of Organic Compounds”, Wiley India, 2010(8th Edition), ISBN: 9788126556595.
7. Mark Weller, Fraser Armstrong, Jonathan Rourke, and Tina Overton, “Inorganic Chemistry”, Oxford University Press India, 2015(6th Edition), ISBN: 9780198757177.
8. I. L. Finar, “Organic Chemistry Volume I”, Pearson India, 2014(6th Edition), ISBN: 9788177585421.

BIT18R101 BIOLOGY FOR ENGINEERS

BIT18R101 Biology for Engineers	L	T	P	C
	3	0	0	3
Pre-requisite: Basic Science Knowledge at School Level	**Course Category:** Basic Science and Mathematics **Course Type:** Theory Course			

Course outcomes

CO1: Describe the fundamentals of cell structure and cell cycle
CO2: Understand the classification and functions of biomolecules
CO3: Elaborate the basic cellular mechanisms such as replication, transcription, and translation
CO4: Describe the underlying concepts of infection and immunity.
CO5: Explain various applications of biology

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H												H		
CO3	H												H		
CO4	H												H		
CO5	H												H		

Course Topics:

Unit 1: INTRODUCTION

Fundamental difference between science and engineering- comparison between eye and camera, Bird flying and aircraft; major discoveries in biology; Classification based on: Cellularity- Unicellular and Multicellular; Ultra structure - prokaryotes and eukaryotes; three major kingdoms of life; Cell structure, intracellular organelles and their functions, comparison of plant and animal cells- Overview of Cell cycle and cell division

Unit 2: BIOMOLECULES

Chemistry of biomolecules: Carbohydrates, Lipids, Proteins; classification of amino acids; classification of proteins based on structure and functions; Nucleic acids -types, structure and function of DNA and RNA

Unit 3: GENES TO PROTEINS

Gene, Genome and chromosome; Central dogma of molecular biology; Classical experiments of DNA: Griffith and, Avery, McCarty and MacLeod, Meselson and Stahl - DNA replication, Transcription and Translation

Unit 4: MICROBIOLOGY

Microscopy; Microbes as infectious agents - malaria, tuberculosis, typhoid, polio, dengue, AIDS; cultivation of bacteria. Immunity - innate and acquired immunity - organs and cells of the immune system - classification of antibodies - types of T cells - transplantation, autoimmunity overview

Unit 5: APPLICATIONS OF BIOLOGY

Healthcare-antibiotics, vaccines, monoclonal antibodies, insulin, and interferons; Beneficial bacteria - probiotic bacteria, nitrogen fixing bacteria, fermentation and fermented foods and products Environmental - waste water treatment, bioremediation; Biomaterials and biopolymers for medical and environmental applications; Biosensors.

TEXTBOOKS:

1. De Robertis, E.D.P. and Jr. De Robertis, E.M.F., “Cell and Molecular Biology (South Asian Edition)”, Lippincott Williams and Wilins (Wolters Kluwer Health) India, 2010 (2008), ISBN: 9788184734508.
2. Judith G. Voet., “Biochemistry”, Wiley India, 2010(4th Edition), ISBN: 9781118139936

REFERENCES:

1. Michael J. Pelczar (Jr.), E.C.S. Chan, Noel R. Krieg, Diane D. Edwards, Merna F. Pelczar, “Microbiology: An Application Based Approach”, McGraw Hill India, 2010(7th Edition), ISBN: 978-0-07-015-147-5

II HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT COURSES

HSS18R101 SOFT SKILLS - I

HSS18R101 Soft Skills - I	L	T	P	C
	1	0	0	1
Course Category: Humanities and Social Sciences	**Course Type:** Theory			

Course Outcomes:

- Learners would have developed the skills of reading and comprehension by mastering the basic linguistic skills
- Learners would have acquired an understanding of the methods of reading and interpretation

Course Outcomes Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							H	M	H	H				H	L
CO2							H	M	H	H				H	L

Course Topics:

S.	Course	Module Name	Topics	# hours
1	Remedial English	Foundation	Parts of Speech	2
2			Articles	
3		Delightful Descriptions	Nouns	
4			Adjectives	
5		Double Actions	Verbs	2
6			Adverbs	
7		Meaningful Links	Prepositions	
8			Conjunctions	
9		Yesterday Today Tomorrow	Past Tense	2
10			Present Tense	
11			Future Tense	
12			Special Cases	
13		Matching Blocks	Subject Verb agreement	2
14		Questions and Expressions	Modals	
15			Question Tags	
16	Business English	Professional Communication	Concise Cogent Communication	2
17			Active Listening	2
18			Interact Interpret Respond	2
19		Expositions and discussions	JAM and Extempore-JAM and Extempore- BIKER B {Extempore}- Six Thinking Hats- JAM	2

S.	Course	Module Name	Topics	# hours
20	Verbal	Grammar and Vocabulary	Finding Errors Phrase substitution	2
21			Vocabulary	2
22			Idioms and Phrases; Collocations	2
23		Blanks and Jumbles	Fill in the blanks Sentence Completion	2
24			Para jumbles/Jumbled Sentences	2
25		Reading Comprehension	Cloze Passage; Theme Detection	2
26			Reading Comprehension	2

HSS18R102 SOFT SKILLS - II

HSS18R102 Soft Skills - II	L	T	P	C
	1	0	0	1
Course Category: Humanities and Social Sciences	**Course Type:** Theory			

Course Outcomes:

- Will be able to critically evaluate various real-life situations by resorting to Analysis
- of key issues and factors.
- Will be able to read between the lines and understand various language structures
- Will be able to demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions.

Course Outcomes Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							H	M	H	H				H	L
CO2							H	M	H	H				H	L
CO3							H	M	H	H				H	L

Course Topics:

S.	Course	Module	Description of learning Imparted	# of hours
1	Aptitude Training	Quantitative	Number Theory- Real numbers, Divisibility, HCF and LCM, Remainder theorem, last digit, factorials, recurring decimals	2
2		Quantitative	Percentages, Profit & Loss, Discount	2
3		Quantitative	Ratio, Proportion, Allegation, Mixture, Partnership	2
4		Quantitative	Time, Speed, Distance, Trains, Boats, and streams	2
5		Quantitative	Age Problem, Word Problem, Averages	2
6		Quantitative	Time & Work, pipes, and cisterns	2
7		Quantitative	Mensuration 2D, Mensuration 3D, Interest calculations	2
8		Quantitative	Algebra, Clocks & Calendar	2
9		Quantitative	Probability, Permutation & Combination	2
10		Reasoning	Blood relations, Figure series	2
11		Reasoning	Series completion, cubes	2
12		Reasoning	Coding decoding, Alphabet test	2
13		Reasoning	Puzzles, Analogies	2
14		Reasoning	Syllogisms, Directions	2

HSS18R201 SOFT SKILLS - III

HSS18R201 Soft Skills - III	L	T	P	C
	1	0	0	1
Course Category: Humanities and Social Sciences	**Course Type:** Theory			

Course Outcomes:

- Learners would have developed the skills of reading and comprehension by mastering the basic linguistic skills
- Learners would have acquired an understanding of the methods of reading and interpretation

Course Outcomes Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							H	M	H	H				H	L
CO2							H	M	H	H				H	L

Course Topics:

Sl no:	Course	Module	Topics Covered	No: of hrs
1	Business English	Presentations	Structure	2
2			Develop and Edit	2
3			Refine and Deliver	2
4		Writing skills	Essay Writing	2
5		Expositions and Discussions	Organize Content; Emphasize Key Points	2
6			Differing Opinions; Logical Conclusions	2
7	Interview preparation and Orientation	Research and Prepare	Pre Interview Preparation	2
8			Resume Preparation	2
9		Facing Interviews	Resume Based questions; Competency Based questions	2
10			Mock Interviews	2
11		Group discussions	Group discussions	2
12			Mock GD	2
13		Corporate Rehersal	Personal Accountability; Managing self	2
14			Business Ettiquette	2
15			Team Dynamics	2

HSS18R151 ENGLISH FOR TECHNICAL COMMUNICATION

HSS18R151 English for Technical Communication	L	T	P	C
	2	0	2	3
Pre-requisite: Basic English Knowledge at School Level	**Course Category:** Humanities and Social Sciences **Course Type:** Theory with Practical			

Course Objective(s):

To help the learner develop listening skills by providing them with inspiring material
To help the learner acquire the ability to speak comfortably in real-life situations
To inculcate in students a taste for English so that they take to reading novels, dailies, and motivational books and dailies
To help learners passionately improve their vocabulary
To enable students to write all kinds of letters, job applications, and reports
To help learners sit for the BEC Examinations

Course Outcome(s):

After completing this course, the student will be able to:
CO1: Speak good English covering their day to day activities
CO2: Analyse the importance of Listening to communicate well
CO3: Make Situational Dialogues on emerging multiple situations
CO4: Read aloud Newspapers and other Texts
CO5: Compose effective error free composition

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M												H	M
CO2			M											H	L
CO3				L										H	M
CO4	M													H	H

CO5											M			H	H

Course Topics:

1 **UNIT I – VOCABULARY BUILDING**
1.1 The concept of word formation
1.2 Root words from foreign languages and their use in English
1.3 Prefixes and suffixes; word derivatives using them
1.4 Synonyms, Antonyms, and standard Abbreviations
2 **UNIT II – BASIC WRITING SKILLS**
2.1 Sentence structures
2.2 Use of phrases and clauses in sentences
2.3 Creating Coherence
2.4 Techniques for Writing Precisely
3 **UNIT III – IDENTIFYING COMMON ERRORS IN WRITING**
3.1 Tenses
3.2 Subject – verb agreement
3.3 Noun –Pronoun Agreement
3.4 Verbs – Transitive, Intransitive
3.5 Misplaced Modifiers
3.6 Articles
3.7 Prepositions
3.8 Redundancies and Clichés
3.9 Direct, Indirect speech
3.10 Infinitives, Gerunds
3.11 Comparison of adjectives
4 **UNIT IV NATURE AND STYLE OF SENSIBLE WRITING**
4.1 Describing
4.2 Defining
4.3 Classifying
4.4 Providing examples or evidence
4.5 Writing introduction or conclusion
5 **UNIT V WRITING PRACTICES**
5.1 Comprehension
5.2 Precis writing
5.3 Essay writing
5.4 Letter writing
5.5 Instructions
5.6 Paragraph development
6 **UNIT VI – ORAL COMMUNICATION**
6.1 Listening comprehension
6.2 Pronunciation, intonation, stress, and rhythm
6.3 Common everyday situations: Conversations and dialogues
6.4 Interviews
6.5 Formal presentations

HSS18R001 MANAGEMENT CONCEPTS AND TECHNIQUES

HSS18R001 Management Concepts and Techniques	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To introduce students about the definition of management, its characteristics, evolution, and importance as well as the functions performed by managers-planning, Organising, directing, and controlling **to** achieve the Organisational goals.

To illustrate students about the applications of management functions in various enterprises in the field of marketing, finance, personnel, production, etc

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the historical backdrop and fundamentals of Management thoughts vital for understanding the conceptual framework of Management as a discipline

CO2: Apply about the various concepts of planning, decision making and controlling to help solving managerial problems

CO3: Explain concepts of Ethics, Delegation, Coordination and Teamwork

CO4: Develops an understanding about the management concepts and styles in Global context

CO5: Develops an understanding about emerging concepts in management thought and philosophy

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							L				M			H	
CO2		M				H	H	H		M				H	L
CO3								H		L	H			H	
CO4						M		L	L	L		H		H	
CO5											H			H	

Course Topics:

Unit 1: Development of Management Thoughts

Scientific Management Movement - Administrative Movement - Human Relations Movement -Decision Movement - Behavioural Science Movement - Systems Movement - Contingency Movement.

Unit 2: Essentials of Planning

Planning Objectives – Goals - Programmed Decisions and Unprogrammed Decisions; Decision – Making - Creativity in Decision - Making, Forecasting and Strategy to Formulation

Unit 3: Effective Organising

Span of Control – Departmentation - Authority; Responsibility - Bureaucracy and Adhocracy; Group Dynamics

Unit 4: Staffing and Directing

Staffing: Manpower Planning – Recruitment Sources – Selection Procedure – Training Methods – Performance Evaluation Methods – Executive Development Programs - Directing: Communication Process and Barriers – Motivation Techniques – Financial and Non – Financial Motivation- Leadership Qualities and Styles

Unit 5: Controlling and Recent Concepts

Controlling: Meaning and Process - Requisites of Effective Control - Control Techniques. Emerging Issues in Management: Japanese and American Management – Management by Objectives – Knowledge Management – Technology Management – Business Process Outsourcing- Social Responsibility and Business Ethics

TEXTBOOK(s):

1. Harold (Late) Koontz and Heinz Weihrich, “Essentials of Management: An International, Innovation and Leadership Perspective”, McGraw Hill India, 2015(10th Edition), ISBN: 9789339222864
2. Stephen P. Robbins, Mary A. Coulter, “Management”, Pearson U.S. (International Edition), 2015(13th Edition), ISBN: 9780133910292

Reference(s):

1. C. B. Gupta, “Management: Theory and Practice”, Sultan Chand and Sons India, 2017(19th Edition), ISBN: 9789351610939
2. L. M. Prasad, “Principles and Practices of Management”, Sultan Chand and Sons India, 2015(9th Edition), ISBN: 9789351610502
3. K. Aswathappa, “Essentials of Business Environment: Text Cases and Exercises”, Himalaya Publishing House India, 2016(13th Edition), ISBN: 9789352021819
4. P C Tripathi and P N Reddy, “Principles of Management”, McGraw Hill India, 2012(5th Edition), ISBN: 9780071333337

HSS18R002 MARKETING MANAGEMENT

HSS18R002 Marketing Management	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To develop students understanding the gap between how Organisations match the requirements of consumers in competitive environments, and develop strategies to create the competitive edge

To familiarize students with analysis, planning, implementation, and control, as well as the marketing mix, exportation, and the social aspects of marketing

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Develop understanding of marketing concepts, philosophies, and historical background

CO2: Develop understanding of marketing operations and complexities for students to apply in practical business situations

CO3: Explain concepts related to Segmentation, Targeting and Positioning, product attributes, and pricing strategies prevalent in domestic and international scenario

CO4: Demonstrate the knowledge of various tools and techniques of promoting the products in ethical manner

CO5: Explain emerging concepts of marketing in the emerging global markets

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						H	H		L	M	M	L		H	L
CO2						H			M	H				H	L
CO3						L	H	H	L	H	M	L		H	
CO4						H	H		L	M	M	L		H	
CO5						H				H				H	L

Course Topics:

Unit 1: Marketing

Meaning - concept - functions - marketing Planning and implementation marketing Programmes - Marketing environment – Market Segmentation and consumer behaviour – Influencing factors, Decision process –Marketing mix – Marketing department

Unit 2: Product

Meaning - Product planning - policies - positioning - New product development Product life cycle – BCG Matrix - branding. Packing, labelling

Unit 3: Pricing

Pricing objectives – Setting and modifying the price – Different pricing method Product line pricing and new product pricing

Unit 4: Distribution

Nature of Marketing channels - Types of Channel flows – Channel functions - Channel co-operation, conflict, and competition - Direct Marketing Telemarketing, Internet shopping

Unit 5: Promotion

Promotion Mix - Advertisement - Message - copy writing – Advertisement - budgeting - Measuring advertisement effectiveness - Media strategy - sales promotion - Personal selling steps, publicity, and direct marketing

TEXTBOOK(s):

1. Philip. T. Khotler, Kevin Lane Keller, “Marketing Management”, Pearson, India, 2016(15th Edition), ISBN: 9789332557185
2. V S Ramaswamy and S Namakumari, “Marketing Management: Global Perspective, Indian Context”, McGraw Hill India, 2013(5th Edition), ISBN: 9781259026416

Reference(s):

1. Rajan Saxena, "Marketing Management", McGraw Hill India, 2015(15th Edition), ISBN: 9789339223304
2. K. S. Chandrasekar, "Marketing Management: Text and Cases", McGraw Hill India, 2010(1st Edition), ISBN: 9780071067737
3. Tapan K. Panda, "Marketing Management: Text and Cases (Indian Context)", Excel Books, 2006(2nd Edition), ISBN: 9788174465480

HSS18R003 ORGANISATIONAL PSYCHOLOGY

HSS18R003 Organisational Psychology	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To clarify the principles and basic concepts of Organisational psychology based on efficiency and quality of employee life. It also aims at enhancing the quality of life of employees.

To make students to understand Organisation's aspects in terms of psychological assessment, personnel decisions in line with training and development, Organisational change, and Organisational health in specific the intrinsic problems

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the knowledge on basic concepts of industrial and organisational psychology
CO2: Illustrate different ways of achieving organisational effectiveness through individual behaviour
CO3: Examine the concepts relating to individual behaviour to achieve group target and achieve leadership position in organisation
CO4: Develop an understanding of the organisational changes and means to evaluate based on nature of organisations
CO5: Analyse the implications of changes aligning the interest of individual, group and organisation

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						M		H		H		M		H	L
CO2						L	H		M		L			H	L
CO3						M		L						H	
CO4						M		H		M				H	
CO5						L	H		H		L	M		H	L

Course Topics:

Unit 1: Focus and Purpose

Organisational Behaviour - Need and importance, nature and scope, framework

Unit 2: Individual Behaviour

Personality – types – factors influencing personality – theories – learning – types of learners – learning theories – Organisational Behaviour modification. Attitudes – characteristics –components – formation – measurement. Perceptions – importance – factors influencing perception – interpersonal perception

Unit 3: Group Behaviour

Pricing objectives – Setting and modifying the price – Different pricing method Product line pricing and new product pricing

Unit 4: Leadership

Leadership styles – theories – Qualities - leaders Vs managers – sources of power – power centres – power and Organisational Politics- Motivation

Unit 5: Organisational Development

Organisational development - Importance, characteristics, objectives, stability Vs change, proactive vs reaction change, the change process, resistance to change, managing change, team building - Organisational effectiveness, perspective, effectiveness Vs efficiency, approaches, the time dimension, achieving Organisational effectiveness

TEXTBOOK(s):

1. Stephen P. Robbins and Timothy A. Judge, "Organisational Behaviour", Pearson India, 2017(17th Edition), ISBN: 9789332542228
2. Fred Luthans, "Organisational Behaviour: An Evidence-Based Approach", McGraw Hill India, 2013(12th Edition), ISBN: 9781259097430

Reference(s):

1. Aswathappa, "Organisational Behaviour", Himalaya Publishing House India, 2016(12th Edition), ISBN: 9789352020652
2. P. Subba Rao, "Management and Organisational Behaviour: (Text and Cases)", Himalaya Publishing House India, 2017(2nd Edition), ISBN: 9789350249512
3. Laurie J. Mullins and Gill Christy, "Organisational Behaviour", Pearson India, 2016(10th Edition), ISBN: 9789332571204
4. L. M. Prasad, "Organisational Behaviour", Sultan Chand and Sons India, 2014(5th Edition), ISBN: 9788180548413

HSS18R004 PROJECT MANAGEMENT

HSS18R004 Project Management	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To describe concepts relating to project management and enable students to evolve project objectives appropriately with relevance to business proposals

To make students to understand about evaluation of project by testing the technical feasibility, financial viability, market acceptability and social desirability of projects

To give an account on risk and profitability analysis that facilitates the making of the effective project proposal and guides learners in project planning, implementation and control and emancipates the scope of project management in undertaking foreign collaboration projects

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Familiarizes the concept of project and steps in project management
CO2: Explain the basics stages involved in preparing business proposals
CO3: Evaluate the technical feasibility, financial viability, market acceptability and social desirability of projects
CO4: Analyse the Risk and profitability of the project proposals
CO5: Empathize oneself as a project manager and as part of project teams and enable effective decision making

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							M				H			H	L
CO2						L		H	H	L		H		H	L
CO3											M			H	
CO4						M		L				M		H	
CO5										M	H	L		H	L

Course Topics:

Unit 1: Introduction to Project Management

Projects - Project ideas and preliminary screening. Developments - Project planning to Project completion - Pre-investment phase, Investment phase, operational phase - Governmental Regulatory framework. Capital Budgeting

Unit 2: Stages of Project Management

Opportunity studies - prefeasibility studies, functional studies or support studies, feasibility study expansion projects, data for feasibility study. Market and Technical Appraisal: Market

and Demand analysis, Market Survey, Demand forecasting. Technical analysis- Materials and inputs, Choice of Technology, Product mix, Plant location, capacity, Machinery, and equipment

Unit 3: Appraisal Process

Concepts. Time value of money - Present and future value. Appraisal criteria - Urgency, Payback period, Rate of return, Debt service coverage ratio, Net present value, Benefit cost ratio, Internal rate of return, Annual capital charge, Investment appraisal in practice

Unit 4: Risk and Profitability Analysis

Risk analysis- Measures of risk, Sensitivity analysis, and Decision tree analysis. Means of financing, Term Loans, Financial Institutions. Cost of capital. Profitability - Cost of Production, Break-even analysis. Assessing the tax burden and financial projections

Unit 5: Project Planning, Implementation and Control

Forms of Project Organisation, Project Planning, Implementation, and Control - Network construction, CPM, PERT, Development of Project schedule, Crashing of Project Network. Introduction to Foreign collaboration projects - Governmental policy framework, Need for foreign technology, Royalty payments, Foreign investments, and procedural aspects

TEXTBOOK(s):

1. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", McGraw Hill India, 2014(8th Edition), ISBN: 9789332902572
2. M. R. Gopalan, Mantel, Meredith, Shafer, and Sutton, "Project Management: Core Textbook", Wiley India, 2014(2nd Edition), ISBN: 9788126550807

Reference(s):

1. Harold Kerzner, "Project Management: Best Practices (Achieving Global Excellence), Wiley India, 2015(3rd Edition), ISBN: 9788126555154
2. Sidney M. Levy, "Project Management in Construction", McGraw Hill International U.S., 2011(6th Edition), ISBN: 9780071753104
3. Gary R. Heerkens, "Project Management – Briefcase Books", McGraw Hill India, 2013(2nd Edition), ISBN: 9780071818483
4. John M. Nicholas and Herman Steyn, "Project Management for Engineering, Business and Technology", Routledge (Taylor and Francis) India, 2017(5th Edition), ISBN: 9781138049529

HSS18R005 STRESS MANAGEMENT AND COPING STRATEGIES

HSS18R005 Stress Management and Coping Strategies	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To make students to approach stress and its effect in the right manner and to develop the skills required to understand and to overcome the same

To make them to be aware of the intricacies of stress and overcoming it through appropriate approaches

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the responsibility of tackling stress

CO2: Identify and modify the approaches of stress accordingly while dealing with team in workplace.

CO3: Analyse to tackle stress appropriately without ignoring who are prone to face high- pressure working conditions

CO4: Implement a stress -free work environment.

CO5: Demonstrate an enriches in their way of behaviour and personality and ensure professional working condition and balanced quality of life.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1								M		M				H	M

CO2						H			M					H	M
CO3							L	H		L				H	M
CO4								H		H		H		M	H
CO5						L		M	L	L	L	H		M	H

Course Topics:

Unit 1: Understanding Stress

Meaning - Symptoms: Biological and Behavioural - Work Related Stress - Individual Stress – Reducing Stress – Burnout

Unit 2: Common Stress Factors Time

Common Sources of Stress Biological, Personality and Environmental – Time Management – Techniques – Importance of planning the day – Time management schedule – Developing concentration – Organising the Work Area - Prioritizing – Beginning at the start – Techniques for conquering procrastination – Sensible delegation – Taking the right breaks – Learning to say 'No'

Unit 3: Crisis Management

Implications – People issues – Structure issues, environmental issues, psychological fall outs – Learning to keep calm – Preventing interruptions – Controlling crisis – Importance of good communication – Taking advantage of crisis – Pushing new ideas – Empowerment

Unit 4: Workplace Humour

Developing a sense of Humour – Learning to laugh, role of group cohesion and team spirit, using humour at work, reducing conflicts with humour. Coping Styles Defensive Behaviours and Problem-Solving

Unit 5: Self Development

Improving Personality – Leading with Integrity, enhancing creativity – Effective Decision Making – Sensible Communication – The Listening Game – Managing Self - Meditation for Peace – Yoga for Life

TEXTBOOK(s):

1. Daniel Girdano, George S. Everly Jr. and Dorothy E. Dusek, "Controlling Stress and Tension", Pearson International U.S., 2013(9th Edition), ISBN: 9780321842800(U.S.)
2. Jerrold S. Greenberg, "Comprehensive Stress Management", McGraw Hill International U.S., 2016(14th Edition), ISBN: 9780078028663(U.S.)

Reference(s):

1. P. K. Dutta, "Stress Management", Himalaya Publishing House India, 2016(1st Edition, Reprint) – ISBN: 9788184886078
2. Wolfgang Linden, "Stress Management: From Basic Science to Better Practice", Sage Publications U.S., 2005(1st Edition), ISBN: 9780761929468
1. Brian Luke Seaward, "Essentials of managing Stress", Jones and Bartlett Learning U.S., 2017(4th Edition), ISBN: 9781284101508

HSS18R006 ECONOMICS FOR ENGINEERS

HSS18R006 Economics for Engineers	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To introduce students to a broad range of economic concepts, theories, and analytical techniques by considering both microeconomics and macroeconomics

To analyse demand and market structure at the firm level by understanding government policies and market failures in various levels using case studies

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Identify and learn economic concepts into market economies.

CO2: Explain the pricing methods, interpret the market factors to determine the price for products or services and to making decisions based on demand factors.

CO3: Describe the major characteristics of different market structures and the implications for the behaviour of the firm.
CO4: Measure living standards, inflation, and unemployment for use as economic indicators.
CO5: Demonstrate an understanding of the role of international trade and analyse the determinants of the relative strengths of monetary policy for sustainable growth of our nation and International Trade.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						H		M		M		M		H	L
CO2							L	M			H	M		M	
CO3						H			M			L		M	L
CO4							L	M			L	M		M	M
CO5						L		M		M		M		M	M

Course Topics:

Unit 1: Definition and Scope of Economics
Meaning - Symptoms: Biological and Behavioural - Work Related Stress - Individual Stress – Reducing Stress Definitions by A. Smith, A. Marshal and L. Robbins, P. Samuels on and their critical examination - Nature and scope of Economics - Micro-economics in relation to other branches of Economics
Unit 2: Pricing and Law of Demand
Demand, Factors influencing demand, Elasticity of demand - price, income and cross, concepts and measurement - Break Even Analysis – Law of Demand - Price, income, and substitution effects - Giffen goods- Pricing Methods.
Unit 3: Market Structure
Definition of market. Concepts of product and factor markets. Different types of market: perfect competition, monopoly, imperfect competition, monopolistic, competition and oligopoly. Demand and Supply schedules. Price determination under perfect competition in long and short run. Price determination under monopoly. Discriminating monopoly
Unit 4: Macro Economics
Meaning, Macro-economic Policy and Its Objectives and Instruments - National Income and Social Accounting - Concepts, components, and measurement - Basic circular flow of income model, Unemployment, trade cycle, Inflation - causes, types, effects, and control
Unit 5: Commercial and Central Banks
Credit creation, monetary policy, and tools - Balance of payments - Items in the balance of payments account, equilibrium in the balance of payments

TEXTBOOK(s):

1. Suraj B. Gupta, “Monetary Economics: Institutions (Theory and Practice)”, S. Chand Publishing India, 2010(1st Edition Reprint), ISBN: 9788121904346
2. Gaurav Datt and Ashwani Mahajan, “Datt and Sundharam’s Indian Economy (Ruddar Datt and K.P.M Sundharam)”, S. Chand Publishing India, 2016(72nd Edition), ISBN: 9789352531295

Reference(s):

1. D. N. Dewedi, “Managerial Economics”, S. Chand Publishing (Vikas Publishing Imprint) India, 2015(8th Edition), ISBN: 9789325986688
2. D N Dwivedi, “Macroeconomics: Theory and Policy”, McGraw Hill India, 2015(4th Edition), ISBN: 9789339221843
3. G.S.N. Gupta, “Macroeconomics: Theory and Applications”, McGraw Hill India, 2014(4th Edition), ISBN: 9789339214364
4. Andreu Mas-Colell, Michael D. Whinston and Jerry R. Green, “Microeconomic Theory”, Oxford University Press India, 2012(1st Edition), ISBN: 9780198089537

HSS18R007 HUMAN RESOURCE MANAGEMENT AND LABOUR LAW

HSS18R007 Human Resource Management and Labour Law	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To explore key issues related to the management, performance, and development of human resources in the workplace

To emphasis on making decisions and developing plans that will enable managers to make the best possible use of their human resources

To gain knowledge about manpower planning, analysis and evaluation, recruitment and selection, wages and salaries, training and management development, performance appraisal, and industrial relations

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the basic knowledge on developing the employment relations and knowledge to resolve the issues.

CO2: Design an appropriate and suitable role of HR specialist for implementing Human Resource Management policies.

CO3: Manage the manpower to motivate and attract them to retain in the Organisation.

CO4: Develop the skills necessary to hold responsibility of employer and legal system to manage the employment relations

CO5: Explain the applicability of business law on various functional domains this in turn enhancing a strong human relation

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						H	L		L	L	L			L	L
CO2							L	M	H	H	L			M	L
CO3							H					M		M	L
CO4						L			M	L	M			M	L
CO5									H	M		L			M

Course Topics:

Unit 1: Fundamentals of Human Resource Management

Human Resource Development Systems-HR environment in India-Functions and Operations of a Personnel Office - Emerging HR Trends - HR information system

Unit 2: Human Resource Manager Functions

Job analysis and job design - HR planning – Recruitment - selection and induction- Staff Training and Development-Career planning and Development- Job Evaluation-Performance Appraisal and Potential Evaluation-Wage determination; salary structure-Wage policies and Regulations-Employee benefits and services.

Unit 3: Motivating Human Resources

Team and Teamwork - Collective Bargaining Employee Morale – Participative Management – Quality Circle – Empowerment –counselling and mentoring

Unit 4: Maintenance of Workers

Compensation Management- Reward system – Labour relations –Employee Welfare, Safety and Health – Employee benefits and services – Promotion, Transfers, and separation – Ethical issues in HR Management and International Human Resource Management - Legal Aspect of Labour

Unit 5: Business Law

Factories Act, 1948 - Industrial Dispute Act, 1947 – Industrial employment – Standing Orders Act, 1946 – Trade Union Act, 1926 - Workmen Compensation Act, 1923, Employees State Insurance Act, 1948, Employees Provident Fund and Miscellaneous Provision Act, 1952, Payment of Gratuity Act, 1972. Payment of Wages Act 1936, Minimum wages Act, 1948– Payment of Bonus Act, 1965.Tamil Nadu Shops and Establishments Act.

TEXTBOOK(s):

1. David A. Decenzo, Stephen P. Robbins, Susan L. Verhulst, "Human Resource Management", Wiley India, 2013(11th Edition), ISBN: 9788126553785
2. Prasad L. M, "Human Resource Management", Sultan Chand and Sons India, 2014(3rd Edition Reprint), ISBN: 9788180547690

Reference(s):

1. Biswajeet Pattanayak, "Human Resource Management", PHI Learning India, 2014(4th Edition Revised), ISBN: 9788120349629
2. C. B. Gupta, "Human Resource Management: Text and Cases", Sultan Chand and Sons India, 2014(18th Edition Revised), ISBN: 9789351610977
3. V. S. P. Rao, "Human Resource Management", Excel Books India, 2010(3rd Edition), ISBN: 9788174468956
4. Frank B. Cross and Roger LeRoy Miller, "The Legal Environment of Business: Text and Cases", Cengage Learning, U.S./India, 2017(10th Edition), ISBN: 9781305967304(U.S.)

HSS18R008 ENTREPRENEURSHIP DEVELOPMENT

HSS18R008 Entrepreneurship Development	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To focus on the entrepreneurial process and the different kinds of entrepreneurial outcomes by making students to understand about opportunity identification through analysis of industry niches, skills needed to turn an opportunity into reality, business plans, launch decisions, and obtaining risk capital

To deal with the problems and challenges facing the management of businesses in raising funds, marketing products and services, improving effectiveness and flexibility, and achieving growth

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the knowledge on the concept of entrepreneurship and which in turn leads to think creatively for new business opportunities to sustain individual as well as social goals

CO2: Develop entrepreneurial spirit and provides a framework of successful business world with relation to agencies to promote employment opportunities

CO3: Develop an understanding of a successful business models and explains operational implementations for investment details and improve the focus on women entrepreneurship

CO4: Develops the knowledge on the role of government in promoting the entrepreneurship among the individuals and Organisations as a whole

CO5: Explain emerging concepts of marketing in the emerging global markets and provide more insights into project management and venture promotion

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						H		H		H		H		H	M
CO2						M	L	H		L	M	L		H	M
CO3						L	L	M	H	L		H		H	M
CO4						M		M			M	H		H	M
CO5										L				M	

Course Topics:

Unit 1: Basics

Concepts of entrepreneur, entrepreneurship, and entrepreneur - Characteristics and competencies of a successful entrepreneur - General functions of an entrepreneur - Type of entrepreneurs - Role of entrepreneur in economic development - Distinction between an entrepreneur and a manager - Entrepreneur and Intrapreneur

Unit 2: Growth of Entrepreneurship

Emergence of entrepreneurship - Economic and non-economic factors for stimulating entrepreneurship development - Obstacles to entrepreneurship development in India - Growth of entrepreneurship in India.

Unit 3: Women and Entrepreneurship

Concept of women entrepreneurship - Reasons for growth of woman entrepreneurship - Problems faced by them and remedial measures

Unit 4: Role of the Government in Entrepreneurship Development

Concept and meaning of entrepreneurship development - Need for entrepreneurship development programmes (EDPs) - Objectives of EDPs - Organisations for EDPs in India; NIESBUD, SISI – their roles and activities.

Unit 5: Venture Promotion and Project Formulation

Concept of projects classification of projects and project report - Project identification and selection - Constraints in project identification - Techniques of Project Identification, Significance – contents - formulation of project report - Need for Project Formulation - Elements of project Formulation

TEXTBOOK(s):

1. Dr Michael H Morris, Donald F Kuratko and Jeffrey G Covin, "Corporate Entrepreneurship and Innovation", South Wester (Cengage Learning) U.S./India, 2010(3rd Edition), ISBN: 9780538478922
2. Jerry Katz and Richard P. Green, "Entrepreneurial Small Business", McGraw Hill U.S./International, 2017(5th Edition), ISBN: 9781259573798(U.S.)

Reference(s):

1. Khanka S.S., "Entrepreneurial Development", S. Chand Publishing India, 2007(1st Edition Reprint), ISBN: 9788121918015
2. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", McGraw Hill India, 2014(8th Edition), ISBN: 9789332902572
3. Robert D Hisrich, Michael P Peters, Mathew Manimala and Dean A. Shepherd, "Entrepreneurship", McGraw Hill India, 2014(9th Edition), ISBN: 9789339205386

HSS18R009 COST ANALYSIS AND CONTROL

HSS18R009 Cost Analysis and Control	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To exhibit the concepts on costing by describing its elements, types, and cost sheet preparation.

To encompasses the analytical framework that can be applied in cost analysis like Marginal costing, CVP analysis, break even analysis, etc enabling the students to make decisions on cost parameters.

To enable students to apply techniques like standard costing, activity-based costing, etc to manage and control cost effectively

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basics of costing and preparation of cost sheet.

CO2: Analyse the cost by applying tools like marginal costing, CVP analysis and other applications.

CO3: Evolve budgets for controlling cost in manufacturing or production centres.

CO4: Define cost standards and critically examine the application of standard costing in a production centre.

CO5: Explain the application of various strategic cost alternatives including activity-based costing.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						M		H			L	H		M	
CO2							M		H			L		H	L
CO3						L				H		M		M	L

CO4						M		H			L	H		H	L
CO5							M		H			L		H	

Course Topics:

Unit 1: Basics of Costing
Costing, Elements of costing, Types of cost, Preparation of cost sheet
Unit 2: Cost Analysis
Marginal costing, Cost - volume – Profit analysis, Break-Even- Analysis, Break –Even - Chart, Applications.
Unit 3: Control Techniques
Budgeting and Budgetary control, Types of Budgets, Preparation of purchase Budget, Flexible budgets, Cash Budget, Sales Budget, Materials Budget, Master Budget, zero based Budgeting
Unit 4: Standard Costing
Types of Standards, Setting up of standards, Advantages and Criticism of Standard Costing –Control through variances.
Unit 5: Activity Based Costing
Transfer Pricing, Target costing, Lifestyle Costing, Activity Based Costing (only theory)

TEXTBOOK(s):

1. K. Saxena and C.D. Vashist, "Advanced Cost Accounting and Cost Systems: (For CA final examination)", Sultan Chand and Sons India, 2001(4th Edition), ISBN: 8170148731
2. Simmi Agarwal, S.P. Jain and K.L Narang, "Advanced Cost Accounting (Cost Management)", Kalyani Publishers, 2013(13th Edition), ISBN: 9789327230260

Reference(s):

1. Edward J. Blocher, David E. Stout, Paul E. Juras and Gary Cokins, "Cost Management: A Strategic Emphasis", McGraw Hill International U.S., 2016(7th Edition), ISBN: 9780077733773(U.S.) / 9781259253096 (U.S.)
2. Don R. Hansen and Maryanne M. Mowen, "Cornerstones of Cost Management", Cengage Learning U.S., 2016(4th Edition), ISBN: 9781305970663(U.S.)
3. Roger Hussey (Author), Audra Ong (Author), and Kenneth A. Merchant (Editor), "Strategic Cost Analysis", Business Expert Press, 2012(1st Edition), ISBN: 9781606492390

HSS18R010 PRODUCT DESIGN AND DEVELOPMENT

HSS18R010 Product Design and Development	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):
To understand the principles and basic concepts of product design and development
To study about product's mechanical architecture, selection of materials and production processes and engineering the various components necessary to make the product work
To make students to identify market opportunity, creation of product to appeal to the identified market, and finally, testing, modifying, and optimizing the product until it is ready for production
Course Outcome(s):
After completing this course, the student will be able to:
CO1: Explain basic concepts related to design and development of new product
CO2: Demonstrate the understanding of the structured approach towards incorporating quality, safety, and reliability into design.
CO3: Analyse the concepts relating to simulating product performance and manufacturing processes.
CO4: Discover the technologies related to computer aided group technology
CO5: Correlate implications of changes related to Economic analysis.

Mapping of Course Outcome(s):

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1						H	M	L	M		M	L		H	

CO2						H	H		H	M		M		M	L
CO3						H	M					H		H	
CO4							M					M		M	L
CO5							M	H		L		M		M	L

Course Topics:

Unit 1: New Product Idea

Definition – Design by Evolution and by Innovation - factors to be considered for product design – Production-Consumption cycle – The morphology of design – Primary design Phases and flowcharting. Role of Allowance, Process Capability, and Tolerance in Detailed Design and Assembly Product strategies, Market research – identifying customer needs – Analysis of product – locating ideas for new products, Selecting the right product, creative thinking, curiosity, imagination and brain storming - product specification

Unit 2: New Product Design

Task - Structured approaches – clarification – search – external and internal – systematic exploration – conception, selection - methodology benefits. The value of appearance - principles and laws of appearance – incorporating quality, safety, and reliability into design. Man-machine considerations – Designing for ease of maintenance.

Unit 3: Role of Technology in Designing

Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing process – Needs for industrial design-impact – Industrial design process – Technology driven products - user driven products – assessing the quality of the product

Unit 4: Methods and Principles of Designing

Methodologies and tools - Design axioms - Design for assembly and evaluation - Minimum part assessment - Taguchi Method - Robustness assessment - Manufacturing process rules - Designer's tool kit - Computer aided group process rules - Designer's tool kit - Computer aided group technology - Failure Mode Effective Analysis – Design for minimum number of parts – Development of modular design – Minimising part variations – Design of parts to be multifunctional, multi-use, ease of fabrication – Pooka Yoka principles.

Unit 5: Feasibility Analysis

Estimation of manufacturing cost – cost procedures – Value Engineering - reducing the component cost and assembly cost – minimizing the system complexity – Basics and Principals of prototyping – Economic Analysis: Break even analysis. Classes of exclusive rights – Patents – Combination versus aggregation – Novelty and Utility – Design patents – Paten disclosure – Patent application steps - Patent Office prosecution - Sales of patent rights - Trademarks – copy rights.

TEXTBOOK(s):

1. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw Hill India, 2016(5th Edition), ISBN: 9789352601851
2. A.K. Chitale and R. C. Gupta, "Product Design and Manufacturing", PHI Learning, India, 2013(6th Edition), ISBN: 9788120348738

Reference(s):

1. Richard Crowson (Editor), "Product Design and Factory Development", CRC (Taylor & Francis), U.K./India, 2005(2nd Edition), ISBN: 9780849355196
2. Thomke, Stefan H., and Ashok Nimgade, "IDEO Product Development", Harvard Business School Case 600-143 - 2000. (Revised April 2007)
3. George Dieter and Linda C. Schmidt, "Engineering Design", McGraw Hill India, 2013(4th Edition), ISBN: 9781259064852
4. Kevin Otto, Kristin Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Pearson India, 2009(1st Edition Reprint), ISBN: 9788177588217

HSS18R011 BUSINESS PROCESS REENGINEERING

HSS18R011 Business Process Reengineering	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To clarify the principles and basic concepts of Business Process Engineering by focusing on both quantitative and qualitative analytical skills and models' essential to operations process design, management, and improvement in both service and manufacturing oriented companies

To prepare the students to play a significant role in the management of a world class company which serves satisfied customers through empowered employees, leading to increased revenues and decreased costs

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basic concepts related to Business Process Reengineering.

CO2: Demonstrate an understanding of the methodologies and tools used for Business Process Reengineering.

CO3: Analyse the concepts relating to benefit/cost analysis and its impact on the business organisations.

CO4: Assess the need of business re-engineering and the factors contributing to its success.

CO5: Identify the best practices used in Business Process Reengineering with illustrations from corporate world.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						H	M		L	M	L	M		M	
CO2						L		L	M	M	H	H		H	L
CO3							H	L	L	L				H	L
CO4						H	L			M				H	L
CO5						H	M	L	M	M	M	L		H	M

Course Topics:

Unit 1: Basic Concepts

Introduction to BPR Definition; the paradigm shifts in production; the positioning concept; the re-engineering visions; the benefits of business re-engineering

Unit 2: Methodologies for BPR

Methodologies and Tools for BPR, Process management; dynamic business re-engineering change framework; steps to reengineer the process.

Unit 3: Modelling the Business

Methodologies and Tools for BPR, Process management; dynamic business re-engineering change framework; steps to reengineer the process

Unit 4: Change Management

Change Management, Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business re-engineering.

Unit 5: Best Practices in BPR

Best Practices in BPR, Case studies: Bell Atlantic, Nissan, Chrysler, Xerox, and Hewlett Packard etc.

TEXTBOOK(s):

1. Ali K. Kamrani, Maryam Azimi, Abdulrahman M. Al-Ahmari (Editors), "Methods in Product Design: New Strategies in Reengineering", CRC Press (Taylor & Francis) U.K./India, 2013(1st Edition), ISBN: 9781439808320
2. Bassam Hussein, "PRISM-Process Reengineering Integrated Spiral Model: An Evolutionary Approach to Dynamic Process Reengineering - VDM Verlag Dr. Müller", OmniScriptum Publishing Group, (MoreBooks! Online Publishers), Germany, 2008(1st Edition), ISBN: 9783639087901

Reference(s):

1. Paul Harmon (Author), Business Process Trends (Author), Foreword by Tom Davenport, "Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals", Morgan Kaufmann / Elsevier / The OMG Press U.S./India, 2007(2nd Edition), ISBN: 9780123741523
2. Ravi Anupindi, Sunil Chopra, Sudhakar D. Deshmukh, Jan A. Van Mieghem, Eitan Zemel, "Managing Business Process Flows: Principles of Operations, Pearson India, 2013(3rd Edition), ISBN: 9789332518346

HSS18R012 POLITICAL ECONOMY

HSS18R012 Political Economy	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

This course introduces the political economy of India. It examines the interplay of politics and economics. Some of the key themes to be explored are globalization, economic reform, poverty, redistribution, federalism, political protest, public goods delivery, gender, and ethnic politics. Although this class focuses specifically on India, the themes discussed in this course mostly are functions of institutions, rights, party systems and challenges

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the key concepts of political economy analyse the significant developments in the political ideologies.

CO2: Describe the salient features of the constitution of India and its functions and interpret, integrate, and critically analyse the fundamental rights duties and responsibilities.

CO3: Explain the political party system, their evolution and role in the economy

CO4: Demonstrate an understanding of the various ideological of Indian political thoughts

CO5: Explain undergoing major economic and social transformation in India

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						H	H		L	M	M	L		H	
CO2						H				H				M	L
CO3						L	H	H	L	H	M	L		H	L
CO4						H	H		L	M	M	L		H	L
CO5						H				H				M	

Course Topics:

Unit 1: Basics of Political Economy

Political Economy as a Method, perspectives, Politics as Reproduction of Social Relations, State and Social Opportunity, Politics of Rent Seeking -Evolution of State in India: Historical Roots of planning, Redistribution

Unit 2: Indian Constitution

The Pre-amble- Fundamental rights and duties, Directive Principles- Offices of the President, Prime Minister, Cabinet Government, Chief Election Commissioner, and Governor – Parliamentary system and Procedures - The Judiciary system.

Unit 3: Party System

National and regional political parties, ideological and social bases of parties; patterns of coalition politics; Pressure groups, trends in electoral behaviour; changing socio- economic profile of Legislators.

Unit 4: Indian Political Thought

Political Ideologies: Liberalism, Socialism, Marxism, Fascism, Gandhism and Feminism - Dharamshastra, Arthashastra and Buddhist traditions; Sir Syed Ahmed Khan, Sri Aurobindo, M.K. Gandhi, B.R. Ambedkar, M.N. Roy.

Unit 5: Challenges to Indian Democracy

Uneven Development of Regions in India – Communalism – Regionalism – Violence – Corruption – environmental degradation- illiteracy –population

TEXTBOOK(s):

1. Charles Sackrey, Geoffrey Schneider, and Janet Knoedler, "Introduction to Political Economy", Dollars and Sense U.S., 2016(8th Edition), ISBN: 9781939402264

Reference(s):

1. Barry R. Weingast and Donald Wittman (Editors), "The Oxford Handbook of Political Economy: Oxford Handbooks", Oxford University Press U.S., 2008, ISBN: 9780199548477
2. Sanjay Ruparelia, Sanjay Reddy, John Harriss, and Stuart Corbridge (Editors), "Understanding India's New Political Economy: A Great Transformation", Routledge (Taylor & Francis) U.K./U.S., 2011, ISBN: 9780415598118
3. M. Laxmikanth, "Indian Polity", McGraw Hill India, 2016(5th Edition), ISBN: 9789352603633
4. Niraja Gopal Jayal and Pratap Bhanu Mehra (Editors), "The Oxford Companion to Politics in India: Student Edition", Oxford University Press India, 2011, ISBN: 9780198075929

HSS18R013 PROFESSIONAL ETHICS

HSS18R013 Professional Ethics	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To understand the ethical problems and principles through theory, historical case studies and research and presentation

To allow students to explore the relationship between ethics and engineering and apply classical moral theory and decision making to engineering issues encountered in academic and professional careers

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Identify the multiple ethical interests at stake in a real-world situation or practice

CO2: Assess their own ethical values and the social context of problems

CO3: Develop critical thinking skills and professional judgement and understand practical difficulties of bringing about change

CO4: Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work

CO5: Manage differing opinions on complex ethical scenarios

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						L		H	M	M		L		M	L
CO2									H	M	M	L		H	L
CO3						M		L		L				M	L
CO4							H			M				M	L
CO5								M		M				M	M

Course Topics:

Unit 1: Engineering Ethics

Functions of Being a Manager – Stockholder and stakeholder management – Ethical treatment of employees - ethical treatment of customers- supply chain management and other issues

Unit 2: Engineering as Social Experimentation

Senses of Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional ideals and virtues – Theories about right action – Self-interest – Customs and religion – Use of Ethical Theories.

Unit 3: Engineer Responsibility for Safety

Corporate social responsibility - Collegiality and loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Discrimination.

Unit 4: Responsibility and Rights

Moral imagination, stake holder theory and systems thinking - One approach to management decision – making Leadership.

Unit 5: Global Issues

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample code of conduct

TEXTBOOK(s):

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill India, 2014(4th Edition – Indian Edition), ISBN: 9789339204457
2. Charles D Fledderman, "Engineering Ethics", Pearson International U.S., 2011(4th Edition), ISBN: 9780132145213

Reference(s):

1. R. S. Naagarazan, "A Textbook on Professional Ethics and Human Values", New Age International, India, 2016(2nd Edition), ISBN: 9788122439724
2. Gail Baura, "Engineering Ethics: An Industrial Perspective", Academic Press / Elsevier U.S., 2006(1st Edition), ISBN: 9780120885312
3. Jr. Charles E. Harris, Michael S. Pritchard, Michael J. Rabins, "Engineering Ethics: Concepts and Cases", Cengage, India, 2012(4th Edition), ISBN: 9788131517291
4. Govindarajan, M., Natarajan, S., Senthilkumar, V. S., "Engineering Ethics (Includes Human Values)", PHI Learning, India, 2013(1st Edition), ISBN: 978-81-203-2578-4
5. Dr. V. Jeyakumar, "Professional Ethics in Engineering", Lakshmi Publication, Chennai - 2014

HSS18R014 OPERATIONS RESEARCH

HSS18R014 Operations Research	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To provide students with ability to understand and analyse managerial problems in industry so that they can use resources like capitals, materials, staffing, and machines more effectively

To provide the knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry

To enhance the skills in the use of operations research approaches and computer tools in solving real problems in industry

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Identify and develop operational research models from the verbal description of the real System.

CO2: Build and solve Transportation Models and Assignment Models

CO3: Use mathematical software to solve the proposed models.

CO4: Develop a report that describes the model and the solving technique, analyse the results, and propose recommendations in language understandable to the decision-making processes in Management Engineering.

CO5: Design new simple models, like CPM, MSPT to improve decision –making and develop critical thinking and objective analysis of decision problems

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						H	M		H			H		M	L

CO2						L		L		H		L		M	L
CO3					M	M				H		L		M	L
CO4						H	M		H	H		M		H	M
CO5						H	M		H			H		M	L

Course Topics:

Unit 1: Linear Programming Basics

Introduction to applications of operations research in functional areas of management - Linear Programming - formulation, solution by graphical and simplex methods (Primal - Penalty, Two Phase), Special cases - Dual simplex method

Unit 2: Transportation Models and Assignment Models

Transportation Models (Minimising and Maximising Cases) – Balanced and unbalanced cases – Initial Basic feasible solution by N-W Corner Rule, least cost and Vogel's approximation methods - Check for optimality - Solution by MODI / Stepping Stone method - Cases of degeneracy - Transhipment Models - Assignment Models (Minimising and Maximising Cases) – Balanced and Unbalanced Cases - Solution by Hungarian and Branch and Bound Algorithms - Travelling Salesman problem - Crew Assignment Models.

Unit 3: Integer Linear Programming and Game Theory

Solution to pure and mixed integer programming problem by Branch and Bound and cutting plane algorithms - Game Theory - Two Person Zero sum games - Saddle point, Dominance Rule, graphical and LP solutions.

Unit 4: Replacement Models and Decision Theory

Replacement Models-Individuals Replacement Models (With and without time value of money) – Group Replacement Models - Decision making under risk – Decision trees – Decision making under uncertainty.

Unit 5: Project Management Method and Simulation

PERT / CPM – Drawing the network, computation of processing time, floats, and critical path. Resource levelling techniques - Application of simulation techniques for decision making

TEXTBOOK(s):

1. Kalavathy S, "Operations Research", Vikas Publishing House India, 2012(4th Edition), ISBN: 9789325963474
2. Paneerselvam R., "Operations Research", PHI Learning India, 2009(2nd Edition), ISBN: 9788120329287
3. P. C. Tulsian and Vishal Pandey, "Quantitative Techniques: Theory and Problems", Pearson India, 2002(1st Edition), ISBN: 9788131701867

Reference(s):

1. D.S. Hira and Prem Kumar Gupta, "Problems in Operations Research: Principles and Solutions", S. Chand Publishing India, 2015(4th Edition Revised), ISBN: 9788121909686
2. R. C. Mishra and Ankit Sandilya, "Principles of Operations Research", New Age International India, 2011(1st Edition), ISBN: 9788122430196
3. P. K. Gupta and Man Mohan, "Problems in Operations Research: Quantitative Approaches in Decision-Making", Sultan Chand and Sons India, 14th Edition (2014), ISBN: 9789351610076

HSS18R015 TOTAL QUALITY MANAGEMENT

HSS18R015 Total Quality Management	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

To provide students with the knowledge to understand the philosophy and core values of Total Quality Management (TQM)

To determine the voice of the customer and the impact of quality on economic performance and long-term business success of an Organisation; apply and evaluate best practices for the attainment of total quality

To make students to critically appraise management techniques, choose appropriate statistical techniques for improving processes and write reports to management describing processes and recommending ways to improve them

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the role and nature of quality in evolving international economic conditions
CO2: Apply the Principles of Quality Management for real time problems
CO3: Analyse the quality encounter process, including supporting facilities and customer requirements/characteristics
CO4: Classify quality measurement methods and continuous improvement process
CO5: Frame Management strategy methods, including identification, development, implementation, and feedback processes

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	L					H				L	L		L	M	
CO2	M						L			L		M	L	M	L
CO3						M	M	L	L	L	L			M	L
CO4	H	L							H	L	M	H	L	M	L
CO5							M	L	L	L	L	L		M	L

Course Topics:

Unit 1: Introduction to Quality Management

Definitions – TOM framework, benefits, awareness, and obstacles - Quality – vision, mission, and policy statements - Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality

Unit 2: Principles and Philosophies of Quality Management

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi, Shingeo and Walter Shewhart - Concepts of Quality circle, Japanese 5S principles and 8D methodology.

Unit 3: Statistical Process Control and Process Capability

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed - Process capability – meaning, significance and measurement – Six sigma concepts of process capability - Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve - Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.

Unit 4: Tools and Techniques for Quality Management

Quality functions development (QFD) – Benefits, Voice of customer, information Organisation, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process, and documentation.

Unit 5: Taguchi Techniques

Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio - Seven old (statistical) tools - Seven new management tools - Bench marking and POKA YOKE

TEXTBOOK(s):

1. Poornima M. Charantimath, “Total quality management”, Pearson India, 2017(3rd Edition), ISBN: 9789332579392
2. Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield, Mary Besterfield-Sacre, Hermant Urdhwareshe, Rashmi Urdhwareshe, “Total Quality Management”, Pearson India, 2015(4th Edition), ISBN: 9789332534452

Reference(s):

1. Shridhara Bhat K, “Total Quality Management: Text and Cases”, Himalaya Publishing House India, 2016(2nd Edition), ISBN: 9789352622399

2. Jams R. Evans and James W. Dean Jr., "Total Quality: Management, Organisation and strategy", Cengage Learning U.K., 2002(3rd Edition Revised) – ISBN: 9780324178715
3. Vincent K. Omachonu, Joel E. Ross, "Principles of Total Quality", CRC Press, India, 2004(3rd Edition), ISBN: 9781574443264
4. S. Rajaram, M. Sivakumar, "Total Quality Management", Wiley (Biztantra - Dreamtech Press) India, 2008(1st Edition), ISBN: 9788177226232

HSS18R016 ADVANCED SOFT SKILLS

HSS18R016 Advanced Soft Skills	L	T	P	C
	3	0	0	3
Course Category: Humanities Elective	**Course Type:** Theory			

Course Objective(s):

This course provides the students with the knowledge in problem solving skills in addition with the logical thinking and reasoning. This would enhance the effective communication and it also enhance the verbal ability and data interpretation techniques which is very much needed to survive and enter the industries.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basic concepts in effective communication with the enhanced knowledge in vocabulary
CO2: Identify and solve the problems related to the quantitative ability.
CO3: Apply the basic problems involved in the non-verbal reasoning
CO4: Illustrate the basic knowledge in verbal questions with proper comprehensive studies
CO5: Identify the problems related to data interpretation

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1										M		M		H	L
CO2						M						M		M	
CO3						M						M		M	L
CO4										M		M		M	M
CO5						L						M		M	M

Course Topics:

Unit 1: Effective Communication

Comprehending Ability, Business Vocabulary, Speed Reading, Non-Verbal Communication, Cross Cultural Communication, Meeting Management, Technology trend awareness

Unit 2: Quantitative Ability

Time and Work, Time-Speed-Distance, Permutation and Combination Probability, Geometry and Mensuration, Number Properties, Ratio and Proportion, Mixtures and Allegation, Percentages, Profit-Loss-Discount, Averages, Progression, Higher Mathematics

Unit 3: Logical Ability

Non-Verbal Reasoning, Deductive & Inductive Reasoning, Binary Logic, Number Series, Clocks, Calendars

Unit 4: Verbal Ability

Reading Comprehension, Parajumbles, Critical Reasoning, Subject-Verb Agreement, Synonyms and Antonyms, Grammar Reading Comprehension and Logic Miscellaneous Verbal questions

Unit 5: Data Interpretation

Line Charts, Bar Charts, Pie Charts, Venn diagrams, Caselets, Data tables

TEXTBOOK(s):

1. R.S. Agarwal, "Quantitative Aptitude", Edition: 3, S Chand Publishing, 2017.
2. R. V. Praveen, "Quantitative Aptitude and Reasoning", Edition: 2, PHI Learning Private Limited, 2013.

Reference(s):

1. Dinesh Khattar, "Quantitative Aptitude for Competitive Examination", Edition: 1, Pearson Education, 2008.
2. Sarvesh K Kumar, "Quantum CAT", Edition: 1, Arihant Publication, 2016.
3. R. S. Agarwal, "A modern Approach to Verbal and Non-verbal reasoning", Edition: 3, S. Chand Publication, 2018.

MAN18R001 ENVIRONMENTAL SCIENCE

MAN18R001 ENVIRONMENTAL SCIENCE	L	T	P	C
	3	0	0	-
Course Category: Mandatory Course				

Course Objective(s):

Imparting knowledge on principles of environmental science and engineering.
Understanding the concepts of ecosystem, biodiversity, and impact of environmental pollution.
Awareness on value education, population, and social issues.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Create the awareness on natural resources by having an understanding environmental problem
CO2: Realise the benefits of ecology and biodiversity
CO3: Describe and analyse different levels of pollution and its management techniques
CO4: Recognise the importance of global warming and cooling of earth's atmosphere
CO5: Categorise and understand about the relation between human population and environment

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1										M		M		H	L
CO2						M						M		M	
CO3						M						M		M	L
CO4										M		M		M	M
CO5						L						M		M	M

Course Topics:

Unit 1: Natural Resources

Definition, scope, and importance of Environmental Studies - Need for public awareness. Renewable and Non-renewable Resources: Forest resources: Use and over-exploitation, deforestation, case studies. Water resources: Use and over-utilization of surface and ground water. Water borne diseases & water induced diseases - Fluoride problem in drinking water. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Energy resources: Growing energy needs, renewable (Solar, hydroelectric, wind and biomass) and non-renewable energy sources (Nuclear energy) - use of hydrogen as an alternate energy source. Case studies. Role of an individual in conservation of natural resources.

Unit 2: Ecosystems and Biodiversity

Ecosystems:

Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers, and decomposers. Energy flow in the ecosystem. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure, and function of the following ecosystem: - Forest ecosystem, Grassland ecosystem, Desert ecosystem. Aquatic ecosystems (ponds, lakes, rivers)

Biodiversity and its conservation:

Introduction – Definition: genetic, species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. India as a mega-diversity nation. Hotspots of biodiversity. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity

Unit 3: Environmental Pollution

Definition, causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, and Noise pollution.

Solid waste Management: Causes, effects, and control measures of urban and industrial wastes.
E – Waste Management and Biomedical Waste Management – Sources, Characteristics and Disposal methods.
Role of an individual in prevention of pollution. Pollution case studies.

Unit 4: Social Issues and the Environment

Disaster management: floods, earthquake, cyclone, and landslides.
Water conservation: rainwater harvesting and watershed management
Resettlement and rehabilitation of people; its problems and concerns. Case-studies
Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, and holocaust. Case Studies
Environment Protection Acts: Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act

Unit 5: Human Population and the Environment

Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.
Field work: (A report to be submitted by the student after visiting at least one of the following spots in his/her own interest)

Visit to a local area to document environmental assets: Forest/grassland/hill/mountain.
Visit to a local polluted site-Urban/Rural/Industrial/Agricultural areas.
Study of common plants, insects, birds in the locality.
Study of simple ecosystems-pond, river, hill slopes, etc.

TEXTBOOK(s):

1. E.R. Nagarajan and A. Murugan, Environmental Science, 1st Edition, Wiley Publishers, New Delhi, 2017

Reference(s):

1. Erach Bharucha, Textbook of Environmental Studies, 2nd Edition, University Press, 2013
2. M. P. Poonia and S.C. Sharma, Environmental Studies, 1st Edition, Khanna Publishing House, 2017.
3. R. Rajagopalan, Environmental Studies: From Crisis to Cure, 3rd Edition, Oxford University Press, 2015.
4. A. K. De, Environmental Chemistry, Wiley Eastern Ltd., New Delhi, 1990.
5. G. Tyler Miller Jr., Environmental Science: Working with the Earth, 11th Edition, Thomson South-Western, 2006.

MAN18R002 INDIAN CONSTITUTION

MAN18R002 Indian Constitution	L	T	P	C
	3	0	0	-
Course Category: Mandatory Course				

Course Objective(s):

The Students will be able to:
1. Learn about the basis of Indian constitution and its preamble
2. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
3. To understand on the central and federal system of Indian government
4. To learn about the welfare bodies and right protective mechanisms

Course Outcome(s):

After completing this course, the student will be able to:
CO1: Describe about the basis of Indian constitution and its preamble
CO2: Develop the knowledge on the premises informing the twin themes of liberty and freedom from a civil rights perspective
CO3: Describe the central and federal system of Indian government
CO4: Recognise the importance of welfare bodies and right protective mechanisms

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Topics:

Unit 1:

Meaning of the term Constitution; History of Making of the Indian Constitution; Drafting Committee, (Composition and Working); Philosophy of the Indian Constitution: Preamble, The Salient Features of Indian Constitution

Unit 2:

Fundamental Rights; Fundamental Duties; The Directive Principles of State Policy; Rights Protective Mechanisms in India; Right to Education Act 2009; Right to Information 2005

Unit 3:

Union Government; Union Legislature (Parliament); Lok Sabha and Rajya Sabha (with Powers and Functions); Union Executive; President of India (with Powers and Functions) ; Prime Minister of India (with Powers and Functions); Union Judiciary (Supreme Court) ; Jurisdiction of the Supreme Court.

Unit 4:

State Government; State Legislature (Legislative Assembly / Vidhan Sabha, Legislative Council / Vidhan Parishad); Powers and Functions of the State Legislature ; State Executive; Governor of the State (with Powers and Functions); The Chief Minister of the State (with Powers and Functions); State Judiciary (High Courts)

Unit 5:

72nd and 73rd Amendment of the Indian Constitution; Panchayati Raj and Municipality systems in Tamil Nadu state. Election Commission: Powers, Role, and function of Election commission in India

TEXTBOOK(s):

The Constitution of India, 1950 (Bare Act), Government Publication.

Reference(s):

1. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
2. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
3. Laxmikanth. (2013) Indian Polity. McGraw Hill Education India
4. Subhash Kashyap (2011) Indian Administration. National Book New Delhi
5. D.D. Basu (2015) Introduction to the Constitution of India, Lexis Nexis
6. Avasti and Avasti (2017) Indian Administration. Lakshmi Narain Agarwal India

MAN18R003 ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

MAN18R003 Essence of Indian Traditional Knowledge	L	T	P	C
	3	0	0	-
Course Category: Mandatory Course				

Course Objective(s):

The course aims at imparting basic principles of thought process, reasoning, and inferencing. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature. Holistic lifestyle of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific worldview and basic principles of Yoga and holistic health care system

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Connect and explain basics of Indian traditional knowledge with modern scientific perspective

CO2: Explain our ancient values-Specialities of Products, relevant of preserve the things and ideas

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							H		L	L		M		M	M
CO2							H		L	L		M		M	M

Course Topics:

Module 1:

Agriculture and Protection Techniques Society formation: Basic need Identification; Needs and Resident thoughts- Farm making; Agricultural techniques - Tools Invention - Hunting society to develop the constructive Society

Module 2:

Medicines and Herbal Usages

Sushruta and Charaka and Sages of south India Bohar - Herbal treatments - Diseases and surgery methods of Healers. Yoga and Pranayama practices. Herbal Usages and medicine making methods

Module 3:

Scientific Values

Wheel. Fire Inventions, Transports, and communications Boat building - Business diversity Economic Importance

Module 4:

Languages, Language Family, Society bonding practices and thoughts-Veda Purana values, Literatures, Education systems, cultures

Module 5:

Temples Temple types, Sculpture specialities, Temples Individualities Festivals and hopes

Module 6:

Arts

Variety of Instruments Flute, Miruthangam – Dances Bharatanatyam, kathak stories and dramas, Identifications, and techniques

Module 7:

Geographical Indications Intellectual Properties and Patent rights and know about UNESCO

TEXTBOOK(s):

1. Basanta Kumar Mohanta, Vipin Kumar Singh, Traditional Knowledge System and Technology in India (English, Hardcover) Edition: 2012
2. Bakthavachala Barathi, Panpaatu Maanudaviyal, Meyappan Pathippagam, Edition: 2009.

III BASIC ENGINEERING

MEC18R151 ENGINEERING GRAPHICS AND DESIGN

MEC18R151 Engineering Graphics and Design	L	T	P	C
	3	0	2	3
Pre-requisite: Basic graphical drawing skill at school level	**Course Category:** Basic Engineering **Course Type**: Theory with Practical			

Course Objective(s):

This course aims to introduce the concept of graphic communication, develop the drawing skills for communicating concepts, ideas and designs of engineering products, demonstrate skills in interpreting, and producing engineering drawings accurately and to give exposure to national standards relating to engineering drawing

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Create the projection of points in all quadrants and straight lines
CO2: Construct the projections of planes and solid objects with refer to reference planes
CO3: Illustrate the true shape of truncated solids in both the manual and computerized manner
CO4: Develop surfaces of truncated solids in both the manual and computerized man
CO5: Apply orthographic and isometric projections in both the manual and computerized man

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M	M		L								H	L	
CO3	H	M	M		L								H	L	
CO4	H	M	M		L								H	M	
CO5	H	M	M		L								H	L	

Course Topics:

Unit 1: Projection of Points and Straight Lines

Importance of graphics – use of drafting instruments – BIS conventions and specifications – size, layout and folding of drawing sheets – lettering dimensioning and scales - Projection of points, located in all quadrants - projection of straight lines located in the first quadrant, determination of true lengths and true inclinations

Unit 2: Projection of Planes and Solids

Projection of polygonal surface and circular lamina located in first quadrant inclined to one or both reference planes-Projection of solids like prisms, pyramids, cylinder, and cone when the axis is inclined to one reference plane by change of position method

Unit 3: Section of Solids

Section of simple solids like prisms, pyramids, cylinder, and cone in vertical position by cutting planes inclined to any one of the reference planes, obtaining true shape of section

Unit 4: Development of Surfaces

Development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders, and cones

Unit 5: Orthographic and Isometric Projection

Orthographic principles – missing view - free hand sketching in first angle projection from pictorial views. Principles of isometric projection – isometric view and projections of simple solids, truncated prisms, pyramids, cylinders, and cones. Introduction to CAD software – menus and tools – drafting platform demonstration

Practical Modules

1. Construction of conic sections using CAD software
2. Construction of simple planes using exclusive commands like extend, trim etc.,
3. Construction of 3D model – solids and sectional views
4. Generating 2D orthographic blueprints from 3D part models
5. Vectorization of simple building plan and elevation

TEXTBOOKS:

1. Basant Aggarwal and C. Aggarwal, "Engineering Drawing", McGraw Hill India, 2013.
2. N. S. Parthasarathy, Vela Murali, "Engineering Drawing", Oxford University Press India, 2015.
3. K. Venugopal, "Engineering Drawing + AutoCAD", New Age International India, 2011 (5th Edition).

REFERENCES:

1. Shah, M.B., and Rana, B.C., "Engineering Drawing", Pearson India, 2009
2. Natarajan, K.V., "A TEXTBOOK of Engineering Graphics", Dhanalakshmi Publishers India, 2012 (21st Edition).
3. Paul Richard, Jim Fitzgerald., "Introduction to AutoCAD 2017: A Modern Perspective", Pearson India, 2016.
4. Bhatt, N.D., "Engineering Drawing", Charotar publishing House India, 2014 (53rd Edition).
5. Luzadder and Duff, "Fundamentals of Engineering Drawing", PHI India, 2009.
6. Venugopal K., "Engineering Graphics", New Age International India, 2009.

MEC18R211 ENGINEERING MECHANICS

MEC18R211 ENGINEERING MECHANICS	L	T	P	C
	3	1	0	4
Pre-requisite: Basic Physics at School Level	**Course Category:** Basic Engineering **Course Type:** Theory			

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the vectoral and scalar representation of forces and moments of particles and rigid bodies both in two dimensions and in three dimensions.

CO2: Apply the knowledge of trusses in frames, beams, and machine components.

CO3: Contrast the effect of friction on equilibrium.

CO4: Illustrate the importance of properties of surfaces and solids.

CO5: Demonstrate the dynamic equilibrium equation.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M	M										H	L	
CO3	H	M											H	L	
CO4	H	M											H	L	
CO5	H	M	M										H	L	

Course Topics:

Unit 1: Statics of Particles and Rigid bodies

Six Fundamental principles and concepts - vector algebra - Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D - System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant - Equations of Equilibrium of Coplanar Systems and Spatial Systems.

Rigid Body equilibrium in 2-D & 3-D - Moment of Forces and its Application - Couples and Resultant of Force System - Equilibrium of System of Forces, Free body diagrams - Equations of Equilibrium of Coplanar Systems and Spatial Systems.

Unit 2: Analysis of Trusses

Basic Structural Analysis- Equilibrium in three dimensions - Method of Sections- Method of Joints- How to determine if a member is in tension or compression- Simple Trusses- Zero force members- Beams & types of beams- Frames & Machines.

Unit 3: Friction

Types of friction, limiting friction, Laws of Friction, Static and Dynamic Friction - Motion of Bodies, simple contact friction, sliding block, wedge friction, screw jack & differential screw jack, rolling resistance.

Unit 4: Properties of Surfaces and Solids

Centroid of simple figures from first principle, centroid of composite sections - Centre of Gravity and its implications - Area moment of inertia - Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections (T section and I section) - Mass moment inertia of circular plate, Cylinder, Cone, Sphere- Principal moment of inertia.

Unit 5: Dynamics

Review of particle dynamics - Displacements, velocity and acceleration, their relationship - Equations of motions - Rectilinear motion- Plane curvilinear motion - Newton's 2nd law- Impulse, momentum, impact - D' Alembert's principle and its applications in plane motion and connected bodies - Work energy principle and its application in plane motion of connected bodies - Virtual Work and Energy Method - Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies.

TEXTBOOK(S):

1. Beer, F.P., and Johnson, E.R., "Vector Mechanics for Engineers – Statics and Dynamics", McGraw Hill India, Tenth Edition in SI units

REFERENCES:

1. Merriam, J.L., "Engineering Mechanics, Volume I – Statics, and Volume – II, Dynamics", Wiley India, Seventh Edition.
2. Irving, H., Shames, "Engineering Mechanics, Statics and Dynamics", PHI India, Fourth Edition

MEC18R152 ENGINEERING PRACTICE

MEC18R152 Engineering Practice	L	T	P	C
	3	0	2	3
Pre-requisite: A pass in HSC	**Course Category:** Basic Engineering **Course Type:** Theory with Practical			

Course Outcomes:

Upon completion of this course, will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Laboratory Outcomes:

Upon completion of this laboratory course, students will be able to fabricate components with their own hands. They will get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes and able to produce small devices of their interest.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	L	L										H	L	
CO3	H	M											H	L	
CO4	H	M											H	L	

Course Topics:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing **(1 lecture)**
3. Fitting operations & power tools **(1 lecture)**
4. Carpentry **(1 lecture)**
5. Plastic moulding, glass cutting **(1 lecture)**
6. Metal casting **(1 lecture)**
7. Welding (arc welding & gas welding), brazing **(1 lecture)**

(ii) Workshop Practice:

1. Machine shop (10 hours)
2. Fitting shop (8 hours)
3. Carpentry (6 hours)
4. Welding shop (8 hours (Arc welding 4 hrs. + gas welding 4 hrs.)
5. Casting (8 hours)

6. Smithy (6 hours)
7. Plastic moulding and Glass Cutting (6 hours)

Examinations could involve the fabrication of simple components, utilising techniques covered above.

TEXTBOOK(S):

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I and Vol. II, Media Promoters and Publishers India, 2008/2010
2. Kalpakjian S. and Steven S. Schmid, "Manufacturing Engineering and Technology", Pearson India, 2002 (4th Edition).
3. Gowri P. Hariharan and A. Suresh Babu, "Manufacturing Technology – I" Pearson India, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", PHI India, 1998 (4th Edition).
5. Rao P.N., "Manufacturing Technology Vol. I and Vol. II", McGraw Hill India, 2017.

EEE18R172 BASIC ELECTRICAL ENGINEERING

EEE18R172 Basic Electrical Engineering	L	T	P	C
	3	1	2	5
Pre-requisite: Basic Physics at School Level	**Course Category:** Basic Engineering **Course Type:** Integrated Course			

Course Objective(s):

To focus the fundamental ideas of the Electrical Engineering by providing wide exposure to the basic concepts of Electrical Engineering such as DC Circuits, AC Circuits, electrical machines, measuring instruments and electrical installations etc.

Course Outcomes

At the end of the course, the students will be able to"

CO1: To Apply basic laws of electricity in DC Circuits
CO2: To Apply basic laws of electricity in AC Circuits
CO3: To study the working principles of dc Machines and Transformers.
CO4: To study and working principle of AC Machines
CO5: To study the basic components of Low Voltage Electrical Installations

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M	L										H	L	
CO3	H	M											H		
CO4	H	M											H		
CO5	H	M					L					L	H		

Course Topics:

UNIT 1: DC CIRCUITS

Electrical circuit elements (R, L and C), voltage and current sources, Series and Parallel circuits. Kirchhoff current and voltage laws, analysis of simple dc circuits-Mesh and Nodal methods. Superposition, Thevenin and Norton Theorems. Time-domain analysis of I order RL and RC circuits.

UNIT 2: AC CIRCUITS

Representation of sinusoidal waveforms, RMS and Average values - form and peak factors, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

UNIT 3: DC MACHINES AND TRANSFORMERS

Construction and working principle of DC Generator and DC Motor and its emf equations- related problems. Transformer – construction, working and types- ideal and practical transformer, equivalent circuit, losses in transformers, regulation, and efficiency.

UNIT 4: AC MACHINES

Constructional details - Principle of operation - Torque-slip characteristics - Starting torque - Relation between torque and slip - Losses and efficiency. Types of single-phase induction motor- construction and working of alternators

UNIT 5: ELECTRICAL INSTALLATIONS

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery Backup.

LIST OF EXPERIMENTS

1. Verification of Kirchhoff's Laws.
2. Verification of AC voltage measurements
3. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C Circuits.
4. Demonstration of DC Motor
5. Demonstration of Transformer
6. Load test on three-phase transformer
7. Open circuit and short circuit tests on single phase transformer
8. Torque Speed Characteristic of separately excited dc motor.
9. Demonstration of Induction Motor
10. Load test on three-phase squirrel cage induction motor.
11. Study basic electrical installation components for LT switchgear

TEXTBOOK(S):

1. V.K. Mehta, "Principles of Electrical Engineering and Electronics", S. Chand & Company Ltd, 2012
2. Kothari D P and Nagrath I J, "Basic Electrical Engineering", McGraw Hill, 2009.
3. Mithal G K, Electronic Devices & Circuits, Khanna Publications, 1997

REFERENCES:

1. T. Thyagarajan, "Fundamentals of Electrical and Electronics Engineering", SciTech Publications India, 2015 (3rd Edition).
2. Muraleedharan K.A, Muthususbramanian R and Salivahanan S, "Basic Electrical, Electronics and Computer Engineering", McGraw Hill India, 2006.

ECE18R171 ELECTRONIC DEVICES

ECE18R171 Electronic Devices	L	T	P	C
	3	0	2	4
Pre-requisite: Basic Physics at School Level	**Course Category:** Basic Engineering **Course Type:** Integrated Course			

Course Objective(s):

To acquaint the students with the construction, theory, and operation of the basic electronic devices such as PN junction diode, Transistors and Opto-electronic devices

Course Outcome(s):

After completing this course, the student will be able to:

After completing this course, the student will be able to:

CO1: Explain the underlying concepts of Semiconductor Physics
CO2: Explain the working of PN Junction diodes and its industrial applications
CO3: Explain the working of MOS and Nanometre devices and its use in IC design
CO4: Explain the working of BJTs and special devices and its use in IC design
CO5: Explain the fabrication step used to fabricate an IC
CO6: Operate electronic equipment and hardware/software tools to analyse the characteristics of electronic devices with an understanding of limitations and impact on environment
CO7: Communicate the technical information related to device analysis by means of reports

Mapping of Course Outcome(s):

CO	PO	PSO

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H	M										H		
CO2	H	H	L	L									H	M	
CO3	H		H	L									H	M	
CO4		H											M		
CO5	H												H		
CO6				M	H	H	H		M			M		H	H

Course Topics:

Unit 1: Semiconductor Physics

Atomic structure -Review of quantum mechanics - Photoelectric effect, Energy band diagrams - Charge carriers - Intrinsic semiconductor -Extrinsic semiconductor - Carrier concentration -Drift and diffusion Hall effect- Einstein's Relation Carrier generation and recombination

Unit 2: P-N Junction

Basic PN junction, equilibrium -Forward and reverse bias junction - VI Characteristics - Junction breakdown - Junction Capacitance - Diodes: Clipper and Clamper circuits - Analysis of diode circuits - Spice modelling of diode - Small signal model - Application example - Metal-Semiconductor junction - Zener Diode

Unit 3: BJT and Special Devices

BJT: Working and I-V characteristics - BJT Configuration types - BJT: Switch, Amplifier (CE) - Non-ideal effects - Equivalent circuits - Eber's-moll - Hybrid-PI model - switching characteristics - Frequency limitations - Application - Spice model and spice code - UJT , LED Photo diode , Solar cells

Unit 4: MOSFET and Nano-Electronic Devices

Introduction to Transistors and types of transistor - MOS general structure and types of MOS - NMOS working: Vgs / Vds - VI Characteristics - MOS Capacitor - C-V characteristics – PMOS: Working , VI characteristics - Non Ideal effects - MOS Selection , MOS failures - Application example - Small Signal Model - MOSFET as switch / Pass transistor - Transmission gate - Implementing logic using pass transistors - Introduction to CMOS - CMOS general structure - Basic digital gates in CMOS- NMOS current derivation - Equating strengths of PMOS and nMOS- Unskewed inverter - Skewed inverters -Concept of drive strength - Design INVX1 , X2 - Design NAND X1 , NOR X1 (Compare area) - MOS Switching characteristics - CMOS five regions of operation-Spice Models -Writing spice code - FinFET and Introduction to quantum devices

Unit 5: Device Technology

IC definition and classification - IC Design flow - Layout, DRC rules - Bulk crystal growth - Doping techniques - Epitaxial growth – Photolithography - Double patterning – Etching -Monolithic device fabrication - Bonding and packaging – Photolithography – Etching – Monolithic device elements fabrication – bonding and packaging

Laboratory Experiments:

1. Study of electronic instruments and components
2. Study of Function generator, CRO and their applications
3. Study of Breadboard and building circuits with NI ELVIS Kit
4. Study of Simulation Software –NI Multisim.
5. Measuring real world data from NI Elvis Kit in NI Multisim
6. Diode Characteristics
7. Clipper and clamper circuits
8. Enhancement mode MOSFET Characteristics
9. Pass transistor logic and transmission gates
10. CMOS inverter characteristics
11. Performance analysis of inverter
12. Bipolar Junction Transistor Characteristics
13. Common Emitter amplifier

TEXTBOOK(s):

Theory:

1. Ben G. Streetman, Sanjay Banerjee, "Solid State Electronic Devices", Pearson India, 2016(7th Edition), ISBN: 9789332555082
2. D. K. Bhattacharya, Rajnish Sharma, "Solid State Electronic Devices", Oxford University Press India, 2018(2nd Edition Reprint), ISBN: 9780198084570

Laboratory:

1. David Báez-López, Félix E. Guerrero-Castro, "Circuit Analysis with Multisim", Morgan and Claypool India, 2011, ISBN: 978160845756

Reference(s):

1. Donald A Neamen and Dhrubes Biswas, "Semiconductor Physics and Devices", McGraw Hill India, 2012(4th Edition), ISBN: 9780071070102
2. Simon. M. Sze, Kwok K. Ng, "Physics of Semiconductor Devices", Wiley India, 2008(3rd Edition), ISBN: 9788126517022
3. Sima Dimitrijev, "Principles of Semiconductor Devices", Oxford University Press India, 2013(2nd Edition), ISBN: 9780198097365
4. S. Poornachandra, B. Sasikala, "Electronics Laboratory Primer", S. Chand and Company India, 2014, ISBN:81-219-2459-6
5. K A Navas, "Electronics Lab Manual – Volume I", PHI India, 2015(5th Edition), ISBN: 9788120351424
6. Yannis Tsividis, Colin McAndrew, "Operation and Modelling of: The MOS Transistor", Oxford University Press India - 2013(3rd Edition), ISBN: 9780198097372
7. http://www.textbooksonline.tn.nic.in/Books/12/Std12-Phy-EM-1.pdf
8. http://www.textbooksonline.tn.nic.in/Books/12/Std12-Phy-EM-2.pdf
9. Bart Van Zeghbroeck, "Principles of Semiconductor Devices", E-Book - https://ecee.colorado.edu/~bart/book/book/contents.htm
10. NPTEL, "Basic Electronics and Lab", http://nptel.ac.in/courses/122106025/
11. NPTEL, "Semiconductor Devices", http://nptel.ac.in/courses/117102061/
12. NPTEL, "Solid State Devices", http://nptel.ac.in/courses/117106091/

ECE18R172 DIGITAL CIRCUITS AND SYSTEMS DESIGN

ECE18R172 Digital Circuits and Systems Design	L	T	P	C
	3	1	2	5
Pre-requisite: Basic Physics at School Level	**Course Category:** Basic Engineering **Course Type:** Integrated Course			

Course Objective(s):

To introduce the theoretical and aspects of digital electronics, which is the backbone for the basics of the hardware aspect of computers and other modern electronic gadgets

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basic concepts like Number systems, codes in Digital design
CO2: Utilise Boolean algebra and its tools in digital design
CO3: With an understanding of characteristics of Logic gates and combinational circuits, apply them in circuit design as part of their experimentation works
CO4: With an understanding of characteristics of sequential circuit elements, apply them in state machines and digital design as part of their experimentation
CO5: Operate electronic test equipment and hardware/software tools to create, evaluate and troubleshoot digital circuits by applying the knowledge on them with an understanding of their limitations and impact on society, environment
CO6: Work and communicate as part of a team and as individual effectively in designing digital circuits following the safety procedures and ethics

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H	M	M										H		
CO3	H	M	M		H							H	H	M	L
CO4	H	M	M		H							H	H	M	L
CO6	H	M	M	M	M	L	L							H	
CO7								H	H	H	L	L		M	M

Course Topics:

Unit 1: Boolean Algebra

Boolean expression - Logic gates NOT, AND, OR, XOR, XNOR, NAND, NOR-Laws of Boolean algebra and its applications - Simplification of Boolean expression using Boolean laws

Maxterms and minterms of Boolean expression, Product of Sum, Sum of Products - K-map importance, 3 variable K-map - conversion of POS to SOP and SOP to POS

Unit 2: Combinational Logic I

Half adder and full adder circuit, Half Subtractor and full subtractor circuit -Design of 4 bit Ripple Adder, Implementation of Carry lookahead adder - Design of 4 bit Parallel Subtractor, Design of 4 bit parallel adder and Subtractor - 2:1 multiplexer circuit,4:1 and 8:1 multiplexer circuit and its application - Implementing 8:1 mux using 2:1 mux and 4:1 mux using 2:1 mux - Designing all basic gates using mux - Demultiplexer implementation and introduction to encoders, 4:2 Encoder and 8:3 encoder circuits - Implementation of Priority encoders and its application

Unit 3: Combinational Logic II

Design and implementation of a 2:4 decoder, Application of decoder - Shannon's theorem -- Implementation of a given function using 2:1 Mux , 4:1 Mux and 8:1 Mux - Binary to Gray code converter and Gray to binary code converter - Implementation of Comparator circuit --- 1-bit and 2-bits comparator circuit -Timing diagram of combinational circuits without propagation delay - Timing diagram of combinational circuits with propagation delay - Glitches and Hazards in combinational circuits - LUT's in FPGA -Design of ALU

Unit 4: Sequential Logic I

Combinational and sequential circuit difference, Edge triggering and Level triggering - SR latch implementation with NOR gate and SR latch implementation with NAND gate -Implementation of JK and T flip flops - Working of D latch and D flip flop --- timing diagram and truth table - Realisation of JK flop from D flop, Realisation of T flop from SR flop - Realisation of D flop from SR flop, Realisation of D flop from JK flop - Characteristic Equations and Excitation table for D,T flop, SR,JK flop -Metastability Issues

Unit 5: Sequential Logic II

Introduction to counters, 4-bit asynchronous down counters using JK flop – 3-bit asynchronous ripple counters, drawbacks of asynchronous counters – 4-bit synchronous up/down counters using JK flop – 4-bit synchronous up/down counters using T flop - Design of a Synchronous Mod-7 Counter JK flip-Flop - Introduction to FSM, types of FSM - Sequence detector using Moore state machine - Sequence detector using Mealy state machine - Introduction to FIFO and depth calculation of FIFO

Laboratory Experiments:

Hardware using NI Elvis Kit / Equivalent

1. Implementation of all basic gates using 2:1 Mux
2. Shannon's theorem verification -- implementation a given Boolean function using 4:1 Mux
3. Implement NOT, AND, OR, EXOR, EXNOR gates using ABbar logic
4. Design and implement 4:2 Priority encoder for the given functional specifications
5. Design and optimize an ALU for the given functional specification and verify the functionality
5. English statement to Boolean function conversion and digital circuit implementation
6. Design a 2-bit Magnitude Comparator and check the functionality
7. Design of half subtractor using multiplexer
8. Design a sequence generator and verify
9. Design an electronic voting machine

TEXTBOOK(s):

1. A. Ananda Kumar, "Fundamentals of Digital Circuits", PHI India, 2016 (4th Edition), ISBN: 9788120352681
2. G. K. Karate, "Digital Electronics", Oxford University Press, India, 2017 (1st Edition), ISBN: 9780198061830

Reference(s):

1. John F. Wakerly, "Digital Design: Principles and Practice", Pearson India, 2008(4th Edition), ISBN: 9788131713662
2. Noel M. Morris, "Digital Electronic Circuits and Systems", MacMillan Education India, 2012(1974 Edition Reprint), ISBN: 978-0-333-14862-4/ 978-1-349-01895-6 (eBook), DOI 10.1007/978-1-349-01895-6
3. R. Ananda Natarajan, "Digital Design", PHI India, 2015, ISBN: 9788120349773
4. NPTEL, "Digital Circuits and Systems", http://nptel.ac.in/courses/117106086/
5 NPTEL, "Digital System Design", http://nptel.ac.in/courses/117105080/

IV PROGRAMME CORE

CORE COURSES

ECE18R201 NETWORK THEORY

ECE18R201 Network Theory	L	T	P	C
	3	1	0	4
Pre-requisite: Basic Physics at School Level	**Course Category:** Programme Core **Course Type:** Theory			

Course Objective(s):

To make the students capable of analysing any given electrical network.

Course Outcome(s):

At the end of the courses, the students will be able to:

CO1: Analyse basic electrical circuits with nodal and mesh analysis
CO2: Apply electrical network theorems
CO3: Apply transform techniques for stead-state and transient analyses
CO4: Determine the network functions for the given network
CO5: Apply the frequency domain techniques to analyse and design networks like resonant circuits, filters

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H		
CO2	H	M	L										H	L	
CO3	H	H	L				M					M	H	M	M
CO4	H	H	L				M					M	H	M	M
CO5	H	H	M				M					M		M	M

Course Topics:

Unit 1: Node and Mesh Analysis

Node and Mesh Analysis – matrix approach of network containing voltage and current sources and reactance – source transformation and duality.

Unit 2: Network Theorems

Network theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tellegen's theorem as applied to D.C. and A.C. circuits. Wye-Delta transformation

Unit 3: Steady state and Transient Analysis

Analysis of RC, RL, and RLC networks with and without initial conditions with and without Laplace transforms

Unit 4: Network Functions

Driving points and transfer functions poles and zeros of immittance function – their properties

Unit 5: Frequency Domain Application

Two port network and interconnections – parameters
Behaviours of series and parallel resonant circuits
Introduction to band pass, low pass, high pass, and band reject filters **(Qualitative Treatment)**

TEXTBOOK(s):

1. William H. Hayt, Jack Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis", McGraw Hill India, 2013(8th Edition – Indian Edition), ISBN: 9781259098635
2. M.S. Sukhija and T.N. Nagsarkar, "Circuits and Networks: Analysis, Design and Synthesis", Oxford University Press India, 2016, ISBN: 9780199460922

Reference(s):

1. William H. Hayt, "Problems and Solutions in Engineering Circuit Analysis", McGraw Hill India, 2012 (1st Edition – SIE), ISBN: 9780071333030

2. Sudhakar A., S. P. Shyammohan, "Circuits and Networks: Analysis and Synthesis", McGraw Hill India, 2015(5th Edition), ISBN: 9789339219604
3. M Nahvi, Joseph Edminister and K Uma Rao, "Electric Circuits (Schaum's Outline Series)", McGraw Hill India, 2010(5th Edition), ISBN: 9780070151437
4. David Báez-López, Félix E. Guerrero-Castro, "Circuit Analysis with Multisim", Morgan and Clay-pool India, 2011, ISBN: 9781608457564
5. K. Mahadeven, C. Chitra, "Electrical Circuit Analysis", PHI India, 2015, ISBN: 9788120350472
6. NPTEL, "Basic Electrical Circuits", http://nptel.ac.in/courses/117106108/
7. NPTEL, "Circuit Theory", http://nptel.ac.in/courses/108102042/
8. NPTEL, "Networks, Signals and Systems", http://nptel.ac.in/courses/108105065/
9. MIT OCW, "Circuits and Electronics", https://ocw.mit.edu/courses/electrical-engineering-and-com-puter-science/6-002-circuits-and-electronics-spring-2007/

ECE18R202 SIGNALS AND SYSTEMS

ECE18R202 Signals and Systems	L	T	P	C
	3	1	0	4
Pre-requisite: Basic Mathematics at HSC Level	**Course Category:** Programme Core **Course Type:** Theory			

Course Objective(s):

The aim of the course is for understanding signals and systems in terms of both the time and frequency domains which is needed for communication engineering and signal processing.

Course Outcome(s):

At the end of the courses, the students will be able to:

CO1: Analyse different types of signals to formulate, and solve complex engineering problems by applying principles of mathematics
CO2: Represent continuous and discrete systems in time and frequency domain using different trans-forms
CO3: Apply engineering design to investigate whether the system is stable
CO4: Analyse and interpret data to reconstruct a signal in real time applications

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		L	H										M	H	
CO2	H	M	L										H	L	
CO3	H	L	H										H	M	
CO4	L	L	H										H	H	L

Course Topics:

Unit 1: Signals and Systems

Signal: Analogue/Discrete/Digital signals, Representation way, amplitude, period, frequency, phase – Classification of signals: Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals, periodic and aperiodic signals, even and odd signals – Transformation of independent variables: Time shift, Time reversal, Time scaling – Delta/Step functions (Sequences), and their usage –System properties: linearity and non-linearity, linearity: additivity and homogeneity, shift-invariance, causality, stability, realisability, memory/memoryless.

Unit 2: LSI Systems

Linear shift-invariant (LSI) systems – impulse response and step response – convolution – input output behaviour with aperiodic convergent inputs. Characterisation of causality and stability of linear shift-invariant systems – Periodic and semi-periodic inputs to an LSI system.

Unit 3: Fourier Transform

The notion of a frequency response and its relation to the impulse response – the Fourier transform, FFT – The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT) – Properties of DFT – Parseval's theorem – The idea of signal space and orthogonal bases – System representation through differential equations and difference equations

Unit 4: Laplace Transform and z-Transform

The Laplace Transform – notion of eigen functions of LSI systems – a basis of eigen functions – region of convergence – poles and zeros of system – Laplace domain analysis – solution to differential equations and system behaviour – The z-Transform for discrete time signals and systems- eigen functions – region of convergence – z-domain analysis.

Unit 5: State-space Analysis and Sampling

State-space analysis and multi-input, multi-output representation – The state-transition matrix and its role – The Sampling Theorem and its implications – Spectra of sampled signals. Reconstruction: ideal interpolator – zero-order hold, first-order hold – Aliasing and its effects – Relation between continuous and discrete time systems.

TEXTBOOK(s):

1. Bhagwandas Pannalal Lathi, Roger A. Green, "Principles of Linear Systems and Signals", Oxford University Press U.S., 2017(3rd Edition – International Edition), ISBN: 9780190200176
2. Alan V. Oppenheim, Alan S. Willsky, "Signals and Systems", Pearson India, 2015(2nd International Edition), ISBN: 9789332550230

Reference(s):

1. Rodger E. Ziemer, William H. Tranter, D. Ronal Fannin, "Signals and Systems: Continuous and Discrete", Pearson India, 2015(4th Edition), ISBN: 9789332542044
2. M.J. Roberts, "Signals and Systems: Analysis Using Transform Methods and MATLAB", McGraw Hill India, 2018(3rd Edition), ISBN: 9780078028120
3. Simon Haykin, Barry Van Veen, "Signals and Systems", Wiley India, 2008(2nd Edition), ISBN: 9788126512652
4. D. Sundararajan, "A Practical Approach to Signals and Systems", Wiley India, 2008, ISBN: 9780470823538
5. V. Krishnaveni, A. Rajeswari, "Signals and Systems", Wiley India, 2012, ISBN: 9788126522897
6. A. Anand Kumar, "Signals and Systems", PHI India, 2013(3rd Edition), ISBN: 978-81-203-4840-0
7. NPTEL, "Circuit Theory", http://nptel.ac.in/courses/108102042/
8. NPTEL, "Networks, Signals and Systems", http://nptel.ac.in/courses/108105065/
9. NPTEL, "Digital Signal Processing", http://nptel.ac.in/courses/117104070/

ECE18R203 ANALOG INTEGRATED CIRCUITS

ECE18R203 Analog Integrated Circuits	L	T	P	C
	3	0	0	3
Pre-requisite: ECE18R271 Electronic Circuits / equivalent	**Course Category:** Programme Core **Course Type:** Theory			

Course Objective(s):

To make students known about blocks, characteristics of operational amplifier; To design analog integrated circuits using Op-amp in linear and nonlinear domain.

Course Outcome(s):

At the end of the courses, the students will be able to:

CO1: Explain analog sub-circuits and various differential amplifiers of an Op-Amp and hence infer the DC and AC characteristics of operational amplifiers
CO2: Design the op-amp circuits for linear and non-linear applications
CO3: Design op-amp based data converters and switched capacitor circuits
CO4: Design timer and wave form generator circuits for the required applications using linear ICs

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H											H		
CO2	H	H					L					L	H	H	
CO3	H						L					L	H	H	
CO4	H	H	M	L			L					L	H		L

Course Topics:

Unit 1 Operational Amplifier

Ideal Op-Amp – AC, DC Characteristics – Internal Circuit -Differential amplifier: Basic structure and principle of operation – Calculation of Differential gain, Common mode gain, CMRR - Design of Differential Amplifier –Circuits for Improving CMRR: Constant current source, Wilson current source and Widlar current source – Various configurations of Op-Amp.

Unit 2 OP-Amp Applications

OP-AMP applications: review of inverting and non-inverting amplifiers, integrator, and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines

Unit 3 Data Converters and Switched Capacitor Circuits

Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string types
Analog to-digital converters (ADC): Single slope, dual slope, successive approximation, flash types.
Switched capacitor circuits: Basic concept – practical configurations – application in amplifier, integrator, ADC

Unit 4 Waveform Generators

Op-amp: Multi-vibrator – LC Oscillators – RC Oscillators – Sawtooth wave generator.

Unit 5: Timers and Voltage Regulator ICs

555 Timer and its application as Multivibrators
PLLs: Basic principle – PLL IC – Applications
VCO: Principle – VCO IC – Applications
Voltage Regulator IC (723)

TEXTBOOK(s):

1. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits (ISV)”, Wiley India, 2010(5th Edition), ISBN: 9788126521487
2. D. Roy Choudhury, Shail B. Jain, “Linear Integrated Circuits”, New Age, 4th Edition, 2012

Reference(s):

1. Bruce Carter Ron Mancini, “Op Amps for Everyone”, Elsevier / Newnes U.S./India, 2017(5th Edition), ISBN: 9780128116487
2. Ramakant Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson India, 2010(4th Edition), ISBN: 9789332549913
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill India, 2002, ISBN: 9780070529038
4. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, McGraw Hill India, 2016(4th Edition), ISBN: 9789352601943
5. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, “Microelectronic Circuits: Theory and Applications”, Oxford University Press India, 2015(7th Edition), ISBN: 9780199476299
6. Texas Instruments (Ron Mancini – Editor in Chief), Op amps for everyone, e-book (http://www.ti.com/lit/an/slod006b/slod006b.pdf)
7. NPTEL, “Analog Circuits”, http://nptel.ac.in/courses/117107094/
8. NPTEL, “Analog ICs”, http://nptel.ac.in/courses/108106068
9. NPTEL, “Circuits for Analog System Design”, http://nptel.ac.in/courses/117108038/
10. Paul Horowitz, Winfield Hill, “The Art of Electronics”, Cambridge University Press / Amazon US/India, 2015(3rd Edition), ISBN: 9780521809269

ECE18R271 ELECTRONIC CIRCUITS

ECE18R271 Electronic Circuits	L	T	P	C
	3	0	2	4
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Programme Core **Course Type:** Integrated Course			

Course Objective(s):

To gain knowledge about the small signal models of transistor; To acquire an in-depth knowledge of low frequency and high frequency analysis of BJT and FET amplifiers; To design feedback amplifiers, power amplifiers, tuned amplifiers and oscillators.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the features of various amplifier models and various biasing configurations of transistors
CO2: Analyse the low frequency response of the designed transistor amplifier circuit
CO3: Analyse the high frequency response of the designed transistor amplifier circuit
CO4: Design transistor-based feedback circuits as per the requirements
CO5: Design high power amplifiers and tuned amplifiers as per the requirements
CO6: Work as a team or individual efficiently to operate electronic test equipment and hardware/software tools for the creation, evaluation and troubleshooting of transistor-based circuits by applying the knowledge on them with an understanding of their limitations and impact on society, environment
CO7: Communicate the technical information related to designed electronic circuits by means of oral and written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H	M										H		
CO2	H	L											H	M	
CO3	H	H	M				M						H	M	
CO4	H	H						L					H	M	
CO5	H	H		M								L	H	M	
CO6				M	H	H	M		H			M		H	
CO7								M	H	H				M	M

Course Topics:

Unit 1: Amplifier Models

Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier - Biasing schemes for BJT and FET amplifiers – bias stability – various configurations (such as CE/CS, CB/CG, CC/CD) and their features

Unit 2: Low Frequency Analysis

Small signal analysis – low frequency transistor models – estimation of parameters like voltage gain, input resistance, output resistance – design procedure for specifications – low frequency analysis of multistage amplifiers

Unit 3: High Frequency Analysis, Large Signal Amplifiers

High frequency transistor models – frequency response of single stage amplifiers and multistage amplifiers – Cascode amplifier

Difference between voltage and power amplifiers - Class A, Class B, Class AB, Class C and Class D amplifiers, their power efficiency and linearity issues

Unit 4: Feedback Amplifiers and Oscillators using BJT

Feedback topologies: Voltage series, current series, voltage shunt, current shunt – effect of feedback on gain, bandwidth. – calculation with practical circuits – concept of stability, gain margin and phase

margin – Negative Feedback Characteristics – Positive feedback – Oscillators: Barkhausen criterion – RC oscillators (Phase shift, Wien bridge) – LC oscillators (Hartley, Colpitts, Clapp) – Non-sinusoidal oscillators – Multivibrators – Schmitt trigger

Unit 5: Tuned Amplifiers using BJT Diode Circuits, Power Supplies

Tuned Amplifiers: Single, Double and Stagger Tuned Amplifiers

Simple diode circuits: rectification, clipping and clamping, Zener diode as voltage regulator

Power supplies: ripple removal and regulation. Voltage regulator ICs (78xx, 79xx) – Linear mode power supply and SMPS – Thermal management, Heat sinks and types

A. Laboratory Experiments (NI Multisim with ELVIS Kit preferred):

1. Familiarisation with the laboratory equipment and basic components
2. Biasing Circuit and Bias Stability **(Hardware Only)**
3. Characteristics and h-parameter calculation for BJT CE configuration **(Both Hardware and Simulation)**
4. Single Stage BJT Amplifier Frequency Response **(Both Hardware and Simulation)**
5. Darlington Pair Study **(Hardware Only)**
6. Two-stage CE amplifier, CE-CB Cascode Amplifier **(Simulation Only)**
7. Oscillators: RC Oscillator [Phase Shift or Wien Bridge], LC Oscillator [Hartley or Colpitts or Clapp] **(Simulation Only)**
8. Diode Applications: Full Wave Rectifier with and without filter **(Hardware Only)**.
9. Study of heat-sink and Eagle PCB software

B. Design Experiments (Mini Project Only based on any one of the following topics):

1. BJT Darlington Pair application
2. Multistage BJT Amplifier application
3. BJT Multivibrator application
4. IC 78xx/79xx and Zener as regulator application
5. BJT Tuned Amplifier application
6. BJT Crystal Oscillator application
7. BJT Window Comparator application
8. BJT Power amplifier application
9. Thermal management and Heat sink design

TEXTBOOK(s):

Theory:

1. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, “Microelectronic Circuits: Theory and Applications”, Oxford University Press India, 2015(7th Edition), ISBN: 97801994762993

Laboratory:

1. K A Navas, “Electronics Lab Manual – Volume I”, PHI India, 2015(5th Edition), ISBN: 9788120351424

Reference(s):

1. Paul Horowitz, Winfield Hill, “The Art of Electronics”, Cambridge University Press / Amazon, US/India, 2015(3rd Edition), ISBN: 9780521809269
2. Jacob Millman, Christos C. Halkias and Satyabrata Jit, “Millman’s Electronic Devices and Circuits”, McGraw Hill India, 2015(4th Edition), ISBN: 9789339219543
3. Robert L. Boylestad, “Electronic Devices and Circuit Theory”, Pearson India, 2015(11th Edition), ISBN: 9789332542600
4. Donald A Neamen and Dhrubes Biswas, “Electronic Circuits: Analysis and Design (SIE)”, McGraw Hill India, 2006(3rd Edition), ISBN: 9780071070102
5. David A. Bell, “Electronic Devices and Circuits”, Oxford University Press India, 2008(5th Edition), ISBN: 9780195693409
6. David Báez-López, Félix E. Guerrero-Castro, “Circuit Analysis with Multisim”, Morgan and Claypool India, 2011, ISBN: 978160845756

7. Maheshwari L.K., Anand M.S., "Laboratory Experiments and PSPICE Simulations in Analog Electronics", PHI India, 2006, ISBN: 9788120329270
8. NPTEL, "Basic Electronics", http://nptel.ac.in/courses/117103063/
9. NPTEL, "Analog Electronic Circuits", http://nptel.ac.in/courses/108102095/
10. NPTEL, "Analog Circuits", http://nptel.ac.in/courses/117101106/

ECE18R273 DIGITAL SIGNAL PROCESSING

ECE18R273 Digital Signal Processing	L	T	P	C
	3	0	2	4
Pre-requisite: ECE18R202 Signals and Systems / equivalent	**Course Category:** Programme Core **Course Type:** Integrated Course			

Course Objective(s):

Make Students: Familiar with Linear and Circular Convolution on signals; Familiar with FIR and IIR filters; Understand Finite word length effect; Understand the concepts of Multirate signal processing in real time applications

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Represent signals mathematically in continuous and discrete time and frequency domain
CO2: Get the response of an LSI system to different signals
CO3: Design the digital filters for various applications meeting the requirements
CO4: Analyse Finite word length effect on DSP systems
CO5: Design as well as conduct experiments, analyse and interpret the results to provide valid conclusions for signal processing systems with help of appropriate tools and software understanding their limitations and impact on society
CO6: Work effectively in as team and individual in doing digital signal processing experiments following the safety procedures and ethics
CO7: Document effectively the digital signal processing experiments carried in the laboratory

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H		
CO2	M	H											L	H	
CO3		M	H		L								H		
CO4	M	H											H		
CO5		M	H	H	H							L		H	H
CO6				L		H		H	H		L	H		H	H
CO7								L	L	H				M	M

Course Topics:

Unit 1 Discrete Time Signals

Classification of analogue/discrete-time/digital signals – Discrete time signals: Sequences – representation of signals on orthogonal basis – Sampling and reconstruction of signals: representation of discrete-time signals (periodic/aperiodic), quantization in amplitude: representation of digital signals, quantization error, reconstruction by ideal LPF (sinc function)

Unit 2 Discrete systems

Discrete systems attributes – Z-Transform – Analysis of LSI systems, frequency Analysis – Inverse Systems – Discrete Fourier Transform (DFT) – Fast Fourier Transform Algorithms and applications – Implementation of Discrete Time Systems

Unit 3 FIR Filters

Concept of FIR/IIR – Designing the FIR – LPF Design of FIR Digital filters: Window method (Rectangular, Hamming, Hanning and Blackman window), Park-McClellan's method, Frequency sampling method.

Unit 4 IIR Filters

Frequency pre-warping: Converting Digital normalized frequency into Analogue normalized frequency – Design of IIR Digital Filters: Butterworth, Chebyshev, and Elliptic Approximations; Lowpass, Band pass, Band stop and High pass filters.

Unit 5 Number Representation

Number representations – fixed point and floating-point numbers - Quantization of fixed- and floating-point numbers, coefficient of quantization - over flow error – truncation error – co–efficient of quantization error - limit cycle oscillation – signal scaling-Decimation by a factor D - Interpolation by a factor I - applications of multirate signal processing

Laboratory Experiments:

A. Simulation Experiments (Any 9 experiments)

1. Familiarisation of Software
2. Realization of correlation of two discrete signals
3. Linear and Circular Convolutions
4. Noise cancellation of signal
5. Long sequence convolution (overlap add and save method)
6. Design and implementation of FIR filter
7. Design and implementation of IIR filter
8. Calculation of FFT of a Signal
9. Truncation in signed magnitude representation
10. Limit cycle Oscillation
11. Decimation
12. Interpolation

TEXTBOOK(s):

Theory:

1. Tarun Kumar Rawat, “Digital Signal Processing”, Oxford University Press India, 2014, ISBN: 9780198081937
2. Alan V. Oppenheim and Ronald W. Schafer, “Digital Signal Processing”, Pearson India, 2015, ISBN: 9789332550339

Laboratory:

1. K.A. Navas, R. Jayadevan, “Lab Primer Through MATLAB: Digital Signal Processing, Digital Image Processing, Digital Signal Processor and Digital Communication”, PHI India, 2014, ISBN: 9788120349322

Reference(s):

1. Sanjit K Mitra, “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill India, 2013(4th Edition), ISBN: 9781259098581
2. Lawrence R. Rabiner and Bernard Gold, “Theory and Applications of Digital Signal Processing”, Pearson India, 2016, ISBN: 9789332560123
3. John G. Proakis and Dimitris G Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson India, 2007(4th Edition), ISBN: 9788131710005
4. Udayashankara V., “Modern Digital Signal Processing: Includes Signals and Systems Matlab Programs, DSP Architecture with Assembly, and C Programs”, PHI India, 2013(3rd Edition), ISBN: 9788120351677
5. Alan V. Oppenheim and Ronald W. Schafer, “Discrete-time Signal Processing”, Pearson India, 2014(3rd Edition), ISBN: 9789332535039
6. K.A. Navas, “Electronics Lab Manual Volume 2”, Rajath Publishers India, 2009
7. NPTEL, “Digital Signal Processing”, http://nptel.ac.in/courses/117102060/
8. NPTEL, “Digital Signal Processing”, http://nptel.ac.in/courses/108105055/
9. NPTEL, “Digital Signal Processing”, http://nptel.ac.in/courses/117104070/

ECE18R274 ELECTROMAGNETIC WAVES AND TRANSMISSION LINES

ECE18R274 Electromagnetic Waves and Transmission Lines	L	T	P	C
	3	0	2	4
Pre-requisite: Introduction to Electromagnetic Theory / equivalent	**Course Category:** Programme Core **Course Type:** Integrated Course			

Course Objective(s):

Make the students to familiarise with: Characteristics and wave propagation on high frequency lines, impedance transformation, Wave propagation in waveguides and Radiation principles with radiating elements

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Analyse characteristics and wave propagation on high frequency transmission lines
CO2: Carryout impedance transformation on transmission lines
CO3: Explain the Basic laws of Electromagnetics and Maxwell Equations
CO4: Characterise uniform plane wave
CO5: Calculate reflection and transmission of waves at media interface
CO6: Analyse wave propagation on metallic waveguides in modal form
CO7: Explain the principle of radiation and radiation characteristics of an antenna

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H	L	H	H	H	H	L	H	H	H	H	H		
CO2	M	H		H	H	M	H		H	H	M	H		H	
CO3	M	H											H		
CO4		H	L	M	H		H	L	M	H		H		H	
CO5	L	H	L	M	H	L	H	L	M	H	L	H		H	
CO6	L	H	L	L	H	L	H	L	L	H	L	H	H		
CO7	H					H					H		H		

Course Topics:

Unit 1 Transmission Lines

Transmission Lines- Equations of Voltage and Current on TX line – Propagation constant and characteristic impedance, and reflection coefficient and VSWR – Impedance Transformation on Loss-less and Low loss Transmission line – Power transfer on TX line – Smith Chart, Admittance Smith Chart – Applications of transmission lines: Impedance Matching, use transmission line sections as circuit elements.

Unit 2 Maxwell's Equations

Maxwell's Equations- Basics of Vectors, Vector calculus – Basic laws of Electromagnetics – Maxwell's Equations – Boundary conditions at Media Interface.

Unit 3 Uniform Plane Wave and Plane waves at a Media interface

Uniform Plane Wave: Uniform plane wave – Propagation of wave – Wave polarization – Poincare's Sphere – Wave propagation in conducting medium, phase and group velocity – Power flow and Poynting vector – Surface current and power loss in a conductor

Plane Waves at a Media Interface- Plane wave in arbitrary direction – Reflection and refraction at dielectric interface – Total internal reflection, wave polarization at media interface – Reflection from a conducting boundary.

Unit 4 Waveguides, Cavity Resonator

Wave propagation in parallel plane waveguide – Analysis of waveguide general approach – Rectangular waveguide – Modal propagation in rectangular waveguide – Surface currents on the waveguide walls – Field visualization – Attenuation in waveguide. Cavity resonator

Unit 5 Radiation and EM Wave Applications

Radiation: Solution for potential function – Radiation from the Hertz dipole – Power radiated by hertz dipole – Radiation Parameters of antenna, receiving antenna, Monopole and Dipole antenna.
Applications of EM Waves: Fibre Optic Communications, RADAR, Remote Sensing and EMC

A Laboratory Experiments:
(CST Studio / equivalent preferred)

1. Study of field patterns of various modes inside a waveguide / cavity
2. Observe the transient phenomenon of terminated coaxial transmission lines to study their time domain behaviour
3. Study the behaviour of terminated coaxial transmission lines in frequency domain
4. Study of microstrip transmission line
5. Radiation pattern of monopole / dipole
6. Smith chart and its application for the unknown impedance measurement
7. Study the behaviour of impedance matching for passive networks using Smith chart
8. Find the change in characteristics impedance and reflection coefficients of the transmission line by changing the dielectric properties of materials embedded between two conductors
9. Open-Ended Experiment (To be given by faculty to a batch of 3/4 students)

TEXTBOOK(s):

Theory:

1. R K Shevgaonkar, "Electromagnetic Waves", McGraw Hill India, 2006(1st Edition), ISBN: 9780070591165
2. Edward C. Jordan, Keith G. Balmain, "Electromagnetic Waves and Radiating Systems", Pearson India, 2015(2nd Edition), ISBN: 9789332551770

Laboratory:

1. CST Studio Manual https://www.cst.com

Reference(s):

1. G.S.N. Rao, "Electromagnetic Field Theory and Transmission Lines", Pearson India, 2005(1st Edition), ISBN: 9788131701713
2. David K. Cheng, "Field and Wave Electromagnetics", Pearson India, 2015(2nd Edition), ISBN: 9789332535022
3. Matthew N.O. Sadiku and S.V. Kulkarni, "Principles of Electromagnetics", Oxford University Press India, 2015(6th Edition), ISBN: 9780199461851
4. CST Microwave Studio Manual, https://perso.telecom-paristech.fr/begaud/intra/MWS_Tutorials.pdf
5. Dikshitulu K. Kalluri, "Electromagnetic Waves, Materials, and Computation with MATLAB®", CRC Press (Taylor and Francis Group), 2012, ISBN: 9781439838679 / 9781439896273(e-book)
6. Daniel G. Swanson, Wolfgang J. R. Hoefer, "Microwave Circuit Modeling Using Electromagnetic Field Simulation", Artech House, 2003
7. NPTEL, "Electromagnetic Fields", http://nptel.ac.in/courses/108106073/41
8. NPTEL, "Transmission Lines and EM Waves", http://nptel.ac.in/downloads/117101057/
9. NPTEL, "Transmission Lines and EM Waves", http://nptel.ac.in/courses/117101056/

ECE18R275 ANALOG AND DIGITAL COMMUNICATION

ECE18R275 Analog and Digital Communication	L	T	P	C
	3	0	2	4
Pre-requisite: Signals and Systems / equivalent	**Course Category:** Programme Core **Course Type:** Theory			

Course Objective(s):
To understand the key modules of communication systems

Course Outcome(s):
At the end of the courses, the students will be able to:

CO1: Use the knowledge of basic electronic communication process for solution of engineering problems

CO2: Compare various analog and digital modulation/demodulation techniques and select the necessary technique for an application

CO3: Analyse the noise impact and error controlling techniques in both analog and digital communication

CO4: Evaluate the complete or part of a communication system in a laboratory by designing its intermediary functional units using proper modulation techniques by applying the theoretical knowledge gained on them with an understanding of their limitations and impact on society

CO5: Work as part of a team and as individual effectively in measuring and interpreting the parameters of a communication system using proper tools, software and equipment following the safety procedures and ethics

CO6: Communicate the technical information related to communication engineering principles and systems by means of oral and written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2		H												H	
CO3		H	M										H	L	
CO4			M	H	H	M	M					H		H	
CO5					L			H	H		L			H	L
CO6								M		H				M	M

Course Topics:

Unit 1 Analog Modulation

Review of signals and systems – Frequency domain representation of signals – Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM, and PM signals – Spectral characteristics of angle modulated signals.

Unit 2 Noise and Filtering in Analog Modulation

Review of probability and random process – Gaussian and white noise characteristics – Noise in amplitude modulation systems – Noise in Frequency modulation systems. Pre-emphasis and Deemphasis – Threshold effect in angle modulation.

Unit 3 Pulse Modulation

Pulse modulation – Sampling process. Pulse Amplitude and Pulse code modulation (PCM) – Differential pulse code modulation – Delta modulation – Noise considerations in PCM – Time Division multiplexing, Frequency Division Multiplexing – Coded Division Multiplexing – Application: Digital Multiplexers for telephony

Unit 4 Digital Modulation

Elements of Detection Theory – Optimum detection of signals in noise – Coherent communication with waveforms – Probability of Error evaluations – Inter symbol Interference and Nyquist criterion

Pass band Digital Modulation schemes: Phase Shift Keying – Frequency Shift Keying – Quadrature Amplitude Modulation – Continuous Phase Modulation and Minimum Shift Keying.

Unit 5 Digital Modulation Trade-offs

Optimum demodulation of digital signals over band-limited channels - Maximum likelihood sequence detection (Viterbi receiver) – Equalisation Techniques – Synchronization and Carrier Recovery for Digital modulation.

Laboratory Experiments:

A. Hardware Experiments

1. Familiarisation of components and software; Study of spectrum measurement using Spectrum Analyser and Software
2. FM Transmitter and Receiver (Using PLL IC CD4066 or 565 or equivalent)
3. PAM (Using CD4016 or equivalent)
4. FSK Modulation and Demodulation (Using CD74HC4046A PLL IC)

5. Study of ZigBee / Wi-Fi / Bluetooth / GSM Trainer Kit (Any 1 Kit)

B. Software Simulation Experiments (Any 4 Experiments)
(Matlab with Simulink or NI LabVIEW or equivalent)

1. Simulation of AM using M-file and Library functions
2. Simulation of DSBSC and SSB
3. Simulation of FM
4. Simulation of Phase Modulation and Demodulation using communication toolbox
5. Simulation of ASK, BFSK, M-ARY FSK
6. Simulation of BPSK, QPSK, MSK
7. Simulation of PAM, PWM, PPM
8. BER Analysis of PSK
9. Simulation of Line coding, adaptive equalisation

C. Design Experiment

Model a communication system (Generate sine signal, apply any one modulation studied at transmitter, add AWGN of channel, demodulate the received signal, calculate SNR)

TEXTBOOK(s):

Laboratory:

1. B. Preetham Kumar, "Communication Systems Laboratory", CRC Press India, 2015, ISBN: 9781482245448

Theory:

1. B.P. Lathi, Zhi Ding and Hari Mohan Gupta, "Modern Digital and Analog Communication", Oxford University Press India, 2017(4th Edition), ISBN: 9780199476282

Reference(s):

1. K. C. Raveendranathan, "Communication Systems Modelling and Simulation: using MATLAB and Simulink", Universities Press India, 2011
2. Simon Haykin, "Communication Systems", Wiley India, 2009(5th Edition -International Student Version), ISBN: 9788126521517
3. John G. Proakis, Masoud Salehi – Communication Systems Engineering", Pearson India, 2016(2nd Edition), ISBN: 9789332555136
4. NPTEL, "Communication Engineering", http://nptel.ac.in/courses/117102059/
5. NPTEL, "Digital Communication", http://nptel.ac.in/courses/117101051/
6. NPTEL, "Modern Digital Communication Techniques", http://nptel.ac.in/courses/117105144/
7. NPTEL, "Digital Communication", http://nptel.ac.in/courses/108102096/
8. NPTEL, "Principles of Communication – Part I", http://nptel.ac.in/courses/108104091/
9. NPTEL, "Principles of Communication – Part II", http://nptel.ac.in/courses/108104098/

ECE18R281 ANALOG INTEGRATED CIRCUITS LABORATORY

ECE18R281 Analog Integrated Circuits Laboratory	L	T	P	C
	0	0	2	1
Co-requisite: ECE18R203 Analog Integrated Circuits / equivalent	**Course Category:** Programme Core **Course Type:** Laboratory Course			

Course Objective(s):

To design circuits using Op-amp in linear and nonlinear domain.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Operate electronic test equipment and hardware/software tools to create, evaluate and trouble-shoot analog IC based circuits by applying the knowledge on them with an understanding of their limitations and impact on society, environment

CO2: Work as part of a team and as individual effectively in designing simple circuits following the safety procedures and ethics

CO3: Communicate the technical information related to designed electronic circuits by means of oral and written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			H	H	H	L	L				L	L		H	M
CO2								H	H		L			M	H
CO3								M	H	H				M	M

Course Topics:

A. Laboratory Experiments:

Hardware Experiments (TI Analog System Lab Kit Preferred)

1. Familiarisation of components, equipment, and tools
2. Study the negative feedback amplifier characteristics by design of instrumentation amplifier
3. Study of Integrator and Differentiator Characteristics
4. Design of a high-Q Band pass self-tuned filter
5. A/D and D/A converters using Op-Amp
6. Design and testing of Tuned Amplifier using Op-Amp

Simulation Experiments (TI Tina Preferred)

7. Familiarisation of Software
8. Analysis of differential amplifier with passive and active loads, CMRR
9. Design of current mirror
10. Design of OP-Amp applications: Comparator, Wave generators, Data converter: Counting ADC

Both Hardware and Software

11. Study the regenerative feedback characteristics by multivibrator using 555-Timer
12. Working of PLL/VCO

B. Mini-Project

TEXTBOOK(s):

1. Bruce Carter Ron Mancini, “Op Amps for Everyone”, Elsevier / Newnes U.S./India, 2017(5th Edition), ISBN: 9780128116487
2. TI Analog System Lab Kit Manual, https://download.mikroe.com/documents/specials/educational/aslk-pro/aslk-pro-manual-v103.pdf

Reference(s):

1. K.A. Navas, “Electronics Lab Manual Volume 2”, Rajath Publishers India, 2009
2. S. Poornachandra, B. Sasikala, “Electronics Laboratory Primer”, S. Chand and Company India, 2014, ISBN:81-219-2459-6

ECE18R301 CONTROL SYSTEMS

ECE18R301 Control Systems	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R202 Signals and Systems / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To introduce the elements of control system and their modelling using various techniques and methods for analysing the time response, the frequency response, and the stability of systems

Course Outcome(s):

At the end of the courses, the students will be able to:

CO1: Develop mathematical models of control systems

CO2: Simplify a control system using block diagram and signal flow graph techniques

CO3: Analyse the transient and steady state performances of control systems
CO4: Investigate the stability of a system using time domain and frequency domain techniques
CO5: Design different compensators and controllers in time/frequency domain as per the requirements
CO6: Solve liner, non-liner, and optimal control problems

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L				L	L						H		
CO2	H	H	M		L	L	L	L					M	H	
CO3		H											H	L	
CO4		H			L	L	L	L	L				H	L	
CO5		M	H										H	M	
CO6		M	H										H		

Course Topics:

Unit 1 System Representation

Introduction to control problem- Industrial Control examples – Transfer function – System with dead-time – System response – Control hardware and their models: potentiometers, synchro, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems – Block diagram and signal flow graph analysis

Unit 2 Feedback and Stability

Feedback control systems- Stability – steady-state accuracy – transient accuracy – disturbance rejection, insensitivity, and robustness – proportional – integral and derivative systems – Feedforward and multi-loop control configurations – stability concept – relative stability – Routh stability criterion

Unit 3 Time Response and Frequency Response

Time response of second-order systems – steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.

Frequency-response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion – Performance specifications in frequency-domain – Frequency domain methods of design – Compensation and their realization in time and frequency domain. Lead and Lag compensation – Op-amp based and digital implementation of compensators – Tuning of process controllers – State variable formulation and solution.

Unit 4 State Variable Analysis

State variable Analysis- Concepts of state – state variable, state model – state models for linear continuous time functions – diagonalisation of transfer function – solution of state equations – concept of controllability and observability.

Unit 5 Optimal control and Non-linear control

Optimal Control problem – Regulator problem – Output regulator and Tracking Problem
Nonlinear system – Basic concept and analysis.

TEXTBOOK(s):

1. I.J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International India, 2017(6th Edition), ISBN: 9789386070111
2. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill India, 2012(4th Edition), ISBN: 9780071333269

Reference(s):

1. Katsuhiko Ogata, “Modern Control Engineering”, Pearson India, 2015(5th Edition), ISBN: 9789332550162
2. Farid Golnaraghi, Benjamin C. Kuo, Kunche Sridhar, “Kuo and Golnaraghi: Automatic Control Systems”, Wiley India, 2012, ISBN: 9788126534401
3. Farid Golnaraghi, Benjamin C. Kuo, “Automatic Control Systems”, McGraw Hill India /Wiley India, 2018(10th Edition) / 2014(9th Edition), ISBN: 9789387572973 / 9788126552337
4. Subathra, S. Sesadhri, “Control Systems”, Vijay Nicole India, 2012 (3rd Edition), ISBN: 9788182091948

ECE18R316 PROBABILITY THEORY AND STOCHASTIC PROCESSES

ECE18R316 Probability Theory and Stochastic Processes	L	T	P	C
	3	1	0	4
Pre-requisite: Basic Mathematics at School Level	**Course Category:** Programme Core **Course Type:** Theory			

Course Objective(s):

This course provides a foundation in the theory and applications of probability and stochastic processes and an understanding of the mathematical techniques relating to random processes in the areas of signal processing, detection, estimation, and communication.

Course Outcome(s):

At the end of the courses, the students will be able to:
CO1: Explain the representation of random signals
CO2: Investigate characteristics of random processes
CO3: Make use of theorems related to random signals
CO4: Explain the propagation of random signals in LTI systems

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H		
CO2	H	L											H		
CO3	H		L										H		
CO4	H	L	L									L	H		

Course Topics:

Unit 1: Probability Theory
Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.
Unit 2: Distribution and Density Functions
Discrete random variables: probability mass function – probability distribution function – example random variables and distributions.
Continuous random variables: probability density function – probability distribution function – example distributions.
Unit 3: Operations on Random Variables
Joint distributions – functions of one and two random variables – moments of random variables; Conditional distribution – densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds.
Unit 4: Random Sequences and Convergence
Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution, and mean square); Limit theorems; Strong and weak laws of large numbers – central limit theorem.
Unit 5: Random Process and Power Spectral Density
Random process. Stationary processes. Mean and covariance functions. Ergodicity. Transmission of random process through LTI. Power spectral density.

TEXTBOOK(s):

1. Scott Miller Scott Miller Donald Childers - Probability and Random Processes: With Applications to Signal Processing and Communications – Academic Press U.S./ Elsevier, India, 2012(2nd Edition), ISBN: 9780123869184
2. Henry Stark, John W. Woods – Probability and Random Processes with Applications to Signal Processing", Pearson India, 2012 (3rd Edition Reprint), ISBN: 8177583565

Reference(s):

1. Charles Therrien, Murali Tummala, "Probability and Random Processes for Electrical and Computer Engineers", CRC Press U.S. / Taylor and Francis India, 2012(2nd Edition), ISBN: 9781138569539
2. Athanasios Papoulis and S Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", McGraw Hill India, 2012(4th Edition Reprint), ISBN: 9780070486584
3. John A. Gubner, "Probability and Random Processes for Electrical and Computer Engineers", Cambridge University Press U.K. / India, 2012(1st Edition Reprint), ISBN: 9780521864701

ECE18R371 MICROPROCESSORS AND MICROCONTROLLERS

ECE18R371 Microprocessors and Microcontrollers	L	T	P	C
	3	0	2	4
Pre-requisite Digital Circuits and Systems Design / equivalent	**Course Category:** Programme Core **Course Type:** Integrated Course			

Course Objective(s):

To gain knowledge about architecture and programming concepts of ARM processor, 8086 Microprocessor

Course Outcome(s):

At the end of the courses, the students will be able to:

CO1: Describe about the architecture of Intel 8086 based processors
CO2: Describe about RISC processors and the design of RISC processor like ARM based system design
CO3: Interface the processor and peripherals like, I/O, A/D, D/A in the design of microprocessor/microcontroller-based systems
CO4: Write assembly language programs by applying the knowledge on instruction set of 8086 - microprocessor
CO5: Work effectively in developing microprocessor / microcontroller-based systems following the safety procedures and ethics
CO6: Communicate efficiently the technical information related to designed microprocessor / microcontroller system

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H		M	H	H									H	L
CO2	H		M	H	H									H	L
CO3	H		M	H	H									H	L
CO4	H													H	L
CO5		L	M	H	H			H	H		L	L		H	H
CO6								L	L	H				M	M

Course Topics:

Unit 1 Microprocessors (8086)

Microcomputer systems and their building blocks – memory interfacing – concepts of interrupts and Direct Memory Access – instruction sets of microprocessors (with examples of 8086) – timing diagrams - programming.

Advanced Microprocessors: Concepts of virtual memory, Cache memory – Pentium IV microarchitecture and Intel Core / Core 2 microarchitectures.

Unit 2 Microprocessor (8086) Interfacing

Interfacing with peripherals - timer, serial I/O, parallel I/O, A/D and D/A converters – Arithmetic Coprocessors – System level interfacing design.

Unit 3 RISC Processors (ARM)

Microprocessor vs. Microcontroller – Microcontroller types

RISC Architecture: History – Hybrid architecture – Basic features, Design issues of RISC processors – Performance issues in pipelined systems
ARM Family of processors – Cortex A, R, M processors a comparison
ARM Cortex M3 Basics: Functional Blocks of ARM CORTEX-M3, Registers, Special Registers, Operation Mode, Memory Protection Units, Buses and Memory Systems, Exceptions, and Interrupts

Unit 4 RISC Instructions

ARM Cortex-M3 Assembly Language: Syntax, Addressing Modes and Operands, Instruction List, Instruction Descriptions, Memory Access Instructions, Logical Operations, Shift Operations, Arithmetic Operations, Stacks, Functions and Control flow, Saturating instructions, Bitfield instructions, Miscellaneous instructions, Assembler Directives, Thumb Instruction Set

Unit 5 RISC Programming

Cortex–M3 Programming: Using C, Using Assembly

A. Laboratory Experiments:

Microprocessor: Using MASM/TASM, Programmer's Work Bench, Code Viewer/ DOS Debugger Software or any equivalent ASM software (Any 4)

1. Segmentation and Addressing modes
2. Using subroutines-stack
3. Block Move
4. Terminate and Stay Resident (TSR)
5. Identification and displaying the activated key using DOS and BIOS function calls.
6. Detecting mouse movement

RISC processor: Using ARM Trainer Kit (Any 5)

1. LED and Switch Interface
2. Relay and Stepper Motor Interface
3. 4x4 Matrix Keypad Interface
4. Time delay program using built in Timer / Counter feature
5. Displaying a message in a 2-line x 16 Characters LCD display
6. I^2C Interface – 7-Segment display

TEXTBOOK(s):

Theory:

1. Krishna Kant, "Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096", PHI India, 2014(2nd Edition), ISBN: 9788120348530
2. Douglas V. Hall and S S S P Rao, "Microprocessors Interfacing", McGraw Hill India, 2012(3rd Edition), ISBN: 9781259006159

Laboratory:

1. Lyla B Das, "The x86 Microprocessors: 8086 to Pentium, Multicores, Atom and the 8051 Microcontroller: Architecture, Programming, and Interfacing", Pearson India, 2014(2nd Edition), ISBN: 9789332536821

Reference(s):

1. Joseph You, "The Definitive Guide to the ARM Cortex-M3",", Newnes /Science Direct / Elsevier, 2010(2nd Edition), ISBN: 9781856179638 (https://doi.org/10.1016/C2009-0-61538-5)
2. Jonathan W Valvano, "Embedded Systems: Introduction to Arm® Cortex (TM)-M3 Microcontrollers: Volume 1", 2014(5th Edition), E-book – http://s1.nonlinear.ir/epublish/book/Embedded_Systems_Introduction_to_Arm_CortexTM_Microcontrollers_1477508996.pdf
3. Joseph You, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Newnes /Science Direct / Elsevier, 2013(3rd Edition), Paperback ISBN: 9780124080829, eBook ISBN: 9780124079182 (https://doi.org/10.1016/C2012-0-01372-5)
4. Trevor Martin, "The Designer's Guide to the Cortex-M Processor Family: A Tutorial Approach", Science Direct / Elsevier, 2013 (1st Edition), eBook ISBN: 9780080982991, Paperback ISBN: 9780080982960

5. K M Bhurchandi and A. K. Ray, "Advanced Microprocessor and Peripherals", McGraw Hill India, 2012(3rd Edition), ISBN: 9781259006135
6. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson India, 2012(2nd Edition), ISBN: 9788131759905
7. N. Senthil Kumar, M Saravanan and S Jeevananthan, "Microprocessors and Microcontrollers", Oxford University Press India, 2016(2nd Edition), ISBN: 9780199466597
8. Steve Furber, "ARM System-On-Chip Architecture", Pearson India, 2000 (2nd Edition), ISBN: 9789332555570
9. NPTEL, "Microcontrollers and Microprocessors", http://nptel.ac.in/courses/106108100/
10. NPTEL, "Microcontrollers and Applications", http://nptel.ac.in/courses/117104072/

ECE18R372 ANTENNAS AND PROPAGATION

ECE18R372 Antennas and Propagation	L	T	P	C
	3	0	2	4
Pre-requisite: ECE18R274 Electromagnetic Waves and Transmission Lines / equivalent	**Course Category:** Programme Core **Course Type:** Integrated Course			

Course Objective(s):

Students will have: Basic knowledge of Antenna fundamentals and parameters; Knowledge on wire antennas and antenna array; A thorough knowledge about wave propagation and characteristics

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply the properties and parameters of antenna, Friis equation in simple communication system consisting of transmit and receive antenna to predict its received power

CO2: Explain how antenna radiates and capture radio wave energy from the concepts of radiation by dynamic charges and currents and retarded potentials

CO3: Design an antenna system, including the shape of the antenna, the need on the arrangement of the radiating elements in an array by applying the design principles and by selecting proper antenna type for the given specifications

CO4: Describe the mechanism of the atmospheric effects on radio wave propagation

CO5: Grasp the research on advanced topics in antenna and summarise it in writing

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H	L			L	L	L				L	H		
CO2	H												H		
CO3		L	H	M	L	L	L	L				L	H	L	
CO4	H												H		
CO5		H	H			M	H	H	M	M		H			H

Course Topics:

Unit 1: Antenna Fundamentals and Radiation

Fundamental Concepts- Physical concept of radiation – Radiation pattern – near-and far-field regions – reciprocity – directivity and gain – effective aperture – polarization – input impedance – efficiency – Friis transmission equation – radiation integrals and auxiliary potential functions.

Radiation from Wires and Loops- Infinitesimal dipole – finite-length dipole – linear elements near conductors – dipoles for mobile communication – small circular loop.

Unit 2: Aperture and Reflector Antennas

Aperture and Reflector Antennas- Huygens' principle – radiation from rectangular and circular apertures – design considerations – Babinet's principle – Radiation from sectoral and pyramidal horns – design concepts – prime-focus parabolic reflector and Cassegrain antennas.

Unit 3: Broadband and Microstrip Antennas

Broadband Antennas- Log-periodic and Yagi-Uda antennas – frequency independent antennas – broadcast antennas.

Micro strip Antennas- Basic characteristics of micro strip antennas – feeding methods – methods of analysis – design of rectangular and circular patch antennas.

Unit 4: Antenna Arrays and Smart Antenna Basics

Antenna Arrays- Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes – extension to planar arrays – synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method.

Basic Concepts of Smart Antennas- Concept and benefits of smart antennas – fixed weight beam forming basics – Adaptive beam forming.

Unit 5: Propagation

Different modes of Radio Wave propagation used in current practice – sky wave propagation, propagation through ionosphere – critical frequency – effects of earth's magnetic field – effects of dielectric constant and conductivity of the ionosphere – collision frequency – virtual height – Maximum usable frequency – Skip distance, Ionospheric abnormalities – space wave propagation – effective earth's radius – effect of earth's curvature on troposphere propagation – field strength of space or tropospheric wave –duct propagation.

A. Laboratory Experiments (Any 9 experiments):

1. Measurement of Radiation Pattern Parameters
2. Measurement of Antenna Gain
3. Characteristics of the half-wave folded dipole antenna
4. Monopole antenna
5. Radiation pattern of a half-wavelength (lambda/2) dipole antenna at 1 GHz / 10 GHz
6. Radiation pattern of a four-wavelength (4 lambda) dipole antenna at 1 GHz / 10 GHz
7. Impedance Transformation with Baluns
8. Directive Gain of Horn Antenna
9. Radiation pattern of loop antenna at 1 GHz
10. Circularly polarized antenna at 10 GHz
11. Yagi Antenna
12. Planar patch antenna
13. End fire array antenna
14. Reflector antenna
15. 10 GHz Slot Antenna
16. Study the effect of the distance to the ground plane for a vertical infinitesimal dipole with an infinite ground plane below.
17. Simulation of vertical monopole including ground plane. The monopole must be lambda/4 length and connected to the ground plane
18. Microstrip antenna and analyses its parameters with various feeding methods
19. Co-polarisation and cross-polarisation
20. Measurement of antenna parameters using Network Analyser
21. Study of Multi-Beam Array Antenna's Multi-Beam Operation

B. Design Experiment using Antenna Design Software (1 mini project per a batch of 3 or 4 members)

TEXTBOOK(s):

Theory:

1. A.R. Harish, M. Sachidananda, "Antennas and Wave Propagation", Oxford University Press India, 2007(1st Edition), ISBN: 9780195686661
2. Constantine A. Balanis, "Antenna Theory: Analysis and Design", Wiley India, 2016(4th Edition), ISBN: 9788126524228

Reference(s):

1. John D. Kraus, Ronald J. Marhefka and Ahmad Sahid Khan, "Antennas and Wave Propagation", McGraw Hill India, 2010(4th Edition), ISBN: 9780070671553
2. Thomas A. Milligan, "Modern Antenna Design", Wiley U.S., 2005(2nd Edition), ISBN: 9780471457763
3. Constantine A. Balanis, "Modern Antenna Handbook", Wiley India, 2008, ISBN: 9788126539352
4. NPTEL, "Antennas", http://nptel.ac.in/courses/108101092/

ECE18R373 COMPUTER COMMUNICATION AND NETWORKS

ECE18R373 Computer Communication and Networks	L	T	P	C
	3	0	2	4
Pre-requisite: Basic knowledge of computers and communication engineering	**Course Category:** Programme Core **Course Type:** Integrated Course			

Course Objective(s):

To understand the concepts of networking and its layer to use it in applications

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Enumerate the layers of the OSI model and TCP/IP Model.
CO2: Describe the functions of data link layer and explain the protocols.
CO3: Analysis the various routing protocols and identify how to assign the IP addresses for the given network.
CO4: Explain the services and congestion issues of Transport and application layer.
CO5: Grasp the research on advanced topics in antenna and summarise it in writing
CO6: Design as well as conduct experiments, analyse and interpret the results to provide valid conclusions for network engineering with help of appropriate tools and software understanding their limitations and impact on society
CO7: Work as part of a team and as individual effectively in designing the communication systems following the norms and ethics in practice
CO8: Communicate the technical information related to designed communication systems by means of oral and written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H											H		
CO2	H	H	H									H	H		
CO3	H	H	H									H	H		
CO4	H												H		
CO5		H	H				H	H		H		H		H	H
CO6		L	H	H	H	L	L					H		H	
CO7								H	H		L	L		H	M
CO8								L	M	H				M	M

Course Topics:

Unit 1 Basics of Networks and Link layer

Introduction to computer networks and the Internet, Layering and protocols-OSI, TCP/IP. Circuit switched networks, Packet switching, Link layer-error detection and correction- block coding, CRC, Checksum. Link control-layer protocols, PPP, HDLC

Unit 2 Media Access control

Multiple access control protocols – IEEE 802 standards – Local Area Networks – addressing, Ethernet, Hubs, and Switches. Wireless Links and network characteristics – Wi-Fi: Wireless LANs– Mobility Management – Mobile IP – Wireless and Mobility

Unit 3 Network layer

Network layer: Virtual circuit and Datagram networks – Router – Internet Protocol – Routing algorithms – Broadcast and Multicast routing

Unit 4 Transport layer

Transport layer: Connectionless transport - User Datagram Protocol – Connection-oriented transport – Transmission Control Protocol. Congestion Control and Resource Allocation– Queuing Disciplines – TCP congestion Control – Congestion Avoidance Mechanisms and QoS.

Unit 5 Application layer

Application layer: Principles of network applications – The Web and Hyper Text Transfer Protocol – File transfer, Electronic mail, Domain name system – secure shell-Telnet.

A. Laboratory Experiments (Any 9):

1. Study of different transmission media, different types of network cables and implement the cross-wired cable and straight through cable using clamping tool
   Study of Network Devices: HUB, Switch and Routers; Connect two PC network interface cards in LAN
2. Study of Network Commands: Finding IP Address for the local host/given host name and pinging IP Addresses/Host names.
3. PC to PC Communication in Wireless LAN: Study of Wireless Standards; Transfer files between PC in Wired LAN and Wireless LAN
4. Performing an Initial Switch Configuration, Initial Router Configuration using CISCO packet tracer or equivalent
5. Connecting a Switch to a Network using CISCO packet tracer or equivalent
6. Configuring WEP on a Wireless Router using CISCO packet tracer or equivalent
7. Packet tracing using Wireshark software or CISCO packet tracer or equivalent
8. Demonstrating Distribution Layer Functions using CISCO packet tracer or equivalent
9. Implementing an IP Addressing Scheme using CISCO packet tracer or equivalent
10. Examining Network Address Translation (NAT) using CISCO packet tracer or equivalent
11. Study of FTP Server and Client or Web Server and Client
12. Study of Network Simulation Tool like NS-3
13. Simulating a Local Area Network using tool like NS-3: Setting up of various network topologies, Measurement of routing protocols
14. Simulating a Wireless Network using tool like NS-3
15. Measuring Network Performance using tool like NS-3

TEXTBOOK(s):

Theory:

1. Bhushan Trivedi, “Data Communication and Networks”, Oxford University Press India, 2016(1st Edition), ISBN: 9780199455997
2. Behrouz A. Forouzan, “Data Communications and Networking”, McGraw Hill India, 2013(5th Edition), ISBN: 9781259064753

Laboratory:

1. Emad Aboelela, “Network Simulation Experiments Manual”, Morgan Kaufmann Publishers / Elsevier India, 2012, ISBN: 9780123852106

Reference(s):

1. Larry Peterson Bruce Davie, “Computer Networks: A Systems Approach”, Elsevier / Morgan Kaufmann, India, 2011(5th Edition), ISBN: 9780123850591
2. William Stallings, “Data and Computer Communications”, Pearson India, 2018(10th Edition), ISBN: 9789332586932
3. Douglas E. Comer, “Computer Networks and Internet”, Pearson India, 2018(6th Edition), ISBN: 9789352869152
4. Behrouz A. Forouzan, “Data Communications and Networking”, McGraw Hill India, 2013(5th Edition), ISBN: 9781259064753

5. Andrew S. Tanenbaum, David J Wetherall, "Computer Networks", Pearson India, 2014(5th Edition), ISBN: 9789332518742
6. NPTEL, "Computer Networks", http://nptel.ac.in/courses/106105080/
7. NPTEL, "Computer Networks", http://nptel.ac.in/courses/106105081/
8. NPTEL, "Data Communication", http://nptel.ac.in/courses/106105082/
9. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach", Pearson India, 2017(6th Edition), ISBN: 97893325854922.

ECE18R399 COMMUNITY SERVICE PROJECT

ECE18R399 Community Service Project	L	T	P	C
	0	0	6	3

Course Objective(s):

The emphasis of this course is to enable third year engineering students to participate in an interdisciplinary team effort to apply engineering principles to solve open-ended problems that will have some significant societal impact

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Formulate and compose solutions for open-ended, real-life, various small to large scale problems
CO2: Value the concept of applying theory to practice
CO3: Design conduct experiments and interpret the results using various tools and equipment to make a conclusion on the system's working
CO4: Describe and practice professional and ethical responsibility
CO5: Improve written and verbal presentation
CO6: Demonstrate the ability to function in interdisciplinary teams and individually
CO7: Incorporate engineering standards and realistic constraints while working on a societal project. Some of the engineering standards may include:
(a) Economic analysis; (b) Environmental analysis; (c) Sustainability analysis; (d) Ethical issues; (e) Health and Safety analysis; (f) Social Issues; (g) Political issues

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			H										H		
CO2	H	H												H	L
CO3				H	H									H	
CO4						H	H	H	L					M	M
CO5								L	L	H				M	M
CO6								L	H					H	
CO7	L	L	L			H	H	H	H	H	H	H		M	M

ECE18R498, ECE18R499 PROJECT WORK

ECE18R498, ECE18R499 Project Work	C
	(2+8) 10

Course Objective(s):

To introduce students to engineering projects; To provide students an opportunity to exercise their creative and innovative qualities in a group project environment; To excite the imagination of aspiring engineers, innovators and technopreneurs

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply knowledge of Mathematics, Science, Engineering fundamentals and specialisation in electronics and Communication Engineering to the conceptualisation of their project model by identify, formulate, and solve complex problems in the domains of electronics and communication engineering, reaching substantiated conclusions using first principles of Mathematics and Engineering Sciences

CO2: Design and develop an electronics communication engineering system to meet desired specifications with realistic constraints such as manufacturability and sustainability by design and conduct experiments required for their project work, analyse, and interpret data, and synthesise information to provide valid conclusions using simulation techniques and/or numerical methods, graphics

CO3: Select and apply necessary engineering instruments, equipment, tools, software, for their project with an understanding of their limitations and also apply reasoning informed by the contextual knowledge to assess societal, safety, legal, cultural issues, and the consequent responsibilities relevant to their developed model / system

CO4: Demonstrate the knowledge of contemporary issues in the field of Electronics and Communication Engineering required for their project execution and commit to professional ethics and norms of engineering practice in project work

CO5: Work effectively as an individual, and as a member or leader in multicultural and multidisciplinary teams and effectively communicate about their project, with their peer, faculty, and society at large, such as, being able to comprehend and write effective documentation, make effective presentations

CO6: Manage project by applying gained knowledge on Engineering and Management principles and adapt themselves completely to the demands of their project implementation by life-long learning

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H											H		
CO2			H	H									H	M	
CO3					H	H							H	H	H
CO4							H	H							H
CO5									H	H				M	M
CO6											H	H		H	

ECE18R397 INDUSTRY TRAINING / INTERNSHIP

ECE18R397 INTERNSHIP	C
	2
Pre-requisite:	**Course Type:** Practical / Training

Course Objective(s):

The aim of this course is to use the internship experience to enable students to develop their engineering skills and practice. Invited Students will be placed in industry and assessed for academic credit. The internships will be aligned with the aims of the engineering program and its areas of specialisation. Students will experience a real-life engineering workplace and understand how their engineering and professional skills and knowledge can be utilised in industry. They will also be able to demonstrate functioning engineering knowledge, both new and existing, and identify areas of further development for their future careers.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply existing engineering knowledge in similar or new situations and identify when new engineering knowledge is required, and apply it

CO2: Integrate existing and new technical knowledge for industrial application

CO3: Demonstrate the impact of the internship on their learning and professional development

CO4: Develop soft skills in management, team skill, leadership skill and responsibilities in the work environment

CO5: Point out the acquired knowledge and their understanding to dwell with the environmental issue

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H	H									H	H		
CO2				H	H	M	M						H		
CO3						H	H					H		M	
CO4						M	M	M	M	H	H	L		H	
CO5						H	H	M	M	M				M	H

V PROFESSIONAL ELECTIVE COURSES

STREAM: ELECTRONIC PRODUCT DESIGN AND PROGRAMMING

ECE18R236 LINUX AND SHELL PROGRAMMING

ECE18R236 Linux and Shell Programming	L	T	P	C
	3	0	2	4
Pre-requisite: Basics of Computers	**Course Category:** Professional Elective **Course Type:** Integrated Course			

Course Objective(s):

This course grounds you in the basic Linux techniques for searching text files by using regular expressions. Learn how to: Create simple regular expressions, Search files and filesystems using regular expressions, Use regular expressions with sed

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the need for Linux by applying the knowledge of Linux engineering gained
CO2: User the common Linux commands to solve engineering problems with an understanding of the impact of solutions
CO3: Customise the Linux environment to meet desired constraints like sustainability
CO4: Use command to develop shell scripts to achieve automation as part of their experimentation, working individual or as team member and communicate them
CO5: Use sed for text manipulation as part of their experimentation, working individual or as team member and communicate the interpretation
CO6: Understand the different shell scripts supported in Linux

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2		L	H			M	H						M	L	L
CO3		L	H			L	H						M	L	L
CO4			M		H		L	L	H	M		L	M	H	H
CO5			M		H		L	L	H	M		L	M	H	H

Course Topics:

Unit 1: Linux for Beginners

CLI navigation, managing files-Reading files using CLI, managing directories-finding differences between files, printing to a printer, handling large files-File permissions, Redirection, piping, searching within files, filters, searching for files/directories, finding file types

Unit 2: Advanced Linux

Introduction to regular expressions-Shell variables, networking, Process Management-Introduction to VI Text Editor, Shell types, introduction to shell scripting, Virtual terminals-User management, Archiving, compression, Scheduling jobs, finding disk space-finding memory usage, foreground/background jobs, customizing shell

Unit 3: Parsing and Transforming Text with SED

Introduction to sed, sed syntax, loops, branches-Pattern buffer and range-sed commands-Handling special characters and strings in sed-Handling patterns and regular expressions in sed

Unit 4: Text Processing and Data Extraction with AWK

Introduction to awk, syntax, examples-AWK variables and operators -Regular expressions, arrays, if/else statements in AWK-Loops, built in functions in AWK-Output redirection and printing in AWK

Unit 5: SHELL Scripting

Parameters, making executable script, storing shell scripts, shell variables, editing documents with ed editing documents with ed-Parameters, shell variables, debugging shell scripts, loops, variable modifiers-if, else, command line arguments-reading from standard input, using an output from a command, switch

List of Experiments (Minimum 9)

1. Given a list of files, find the one that is different

2. Given a large file, find the line number of a string without using grep command
3. Create a project directory structure for 6th semester students
4. Given a directory structure implement given changes to permissions and locations of files and sub-directories
5. Given a shell start-up file, fix the issues found
6. Create a shell start-up environment file for given specifications
7. Create groups, create, and assign users to the groups, modify user credentials per given requirements
8. Given a text file extract the lines that meet given requirements
9. Given a text file replace a given occurrence of a string
10. Given a text file (Verilog netlist) replace the parenthesis around bus bits
11. Write an AWK script to retrieve the default shell of users
12. Given text file, print the given fields if a matching pattern is found
13. Shell script to test file type and permissions
14. Shell script to detect and act on standard error
15. Shell script to add only a specific type of permission on provided list of files
16. Shell script to parse all files in a directory structure and delete if user says so
17. Shell script that produces file information for all files passed as parameters
18. Shell script to list file sizes for all the files passed as parameters
19. Shell script that uses logical and comparison operators

Textbook(s):

1. David Tansley, "Linux and UNIX Shell Programming", Addison – Wesley / Pearson – 2011
2. Harry Harvey, "Shell Scripting: Learn Linux Shell Programming Step-By-Step (Bash Scripting, Unix)" - CreateSpace Independent Publishing Platform, 2017

Reference(s):

1. Ganesh Sanjiv Naik, "Learning Linux Shell Scripting: Leverage the power of shell scripts to solve real problems" – Packt Publishing, 2018
2. Mokhtar Ebrahim, Andrew Mallett, "Mastering Linux Shell Scripting", Packt – 2018

ECE18R237 C ESSENTIALS

ECE18R237 C Essentials	L	T	P	C
	3	0	2	4
Pre-requisite: Basics of Computers	**Course Category:** Professional Elective **Course Type:** Integrated Course			

Course Objective(s):

To develop C Programs using basic programming constructs. To develop C programs using arrays and strings. To develop applications in C using functions, pointers, and structures. To do input/output and file handling in C.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the basic programming concepts and syntax of C language
CO2: Develop efficient code using pointers, arrays, and dynamic memory allocation techniques
CO3: Create user defined data types and functions to solve given problems.
CO4: Design an efficient algorithm for a given problem
CO5: Build efficient code to solve the real-world problem
CO6: Elucidate the programming constructs of C during interviews

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		

CO2	H	M	M		L								H	M	
CO3	H	M	M		M								H	M	
CO4	H	M	M		M								H	M	
CO5	H	H	M		M								H	M	
CO6						L	L	L		L		L		L	L

Course Topics:

UNIT 1: INTRODUCTION TO PROGRAMMING

Subject Motivation, Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Programing Domain: Scientific Application, Business Applications, Artificial Intelligence, Systems Programming, Categories of Programming Languages: Machine Level Languages, Assembly Level Languages, High Level Languages, Programming Design Methodologies : Top Down and Bottom UP Program Development Cycle with case study, Program Execution and Translation Process, Arithmetic Operators, Unary operators, Relational and Logical Operators, The conditional Operator, Library Functions, Bitwise Operators, The increment and Decrement Operators, The Size of Operator, Precedence of Operators, Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/ Pseudocode with examples, from algorithms to programs; source code, Features of C and its Basic Structure, Simple C programs, Constants, Integer Constants, Real Constants, Character Constants, String Constants, Backslash Character Constants, Concept of an Integer and Variable, Rules for naming Variables and assigning values to variables, Floating-point Numbers, Converting Integers to Floating-point and vice-versa, Mixed-mode Expressions, The type cast Operator, The type char, Keywords, Character Input and Output, Formatted input and output, The gets() and puts() functions, Interactive Programming.Syntax and Logical Errors in compilation, object and executable code, Conditional Branching and Loops: The goto statement, The if statement, The if-else statement, Nesting of if statements, The conditional expression, The switch statement, The while loop, The do…while loop, The for loop, The nesting of for loops, The break statement and continue statement.

UNIT 2: ARRAYS AND STRINGS

Introduction - One dimensional and two-dimensional arrays – Declaration of arrays – Initializing and Accessing array elements – Strings: One dimensional character arrays - Declaration and String Initialization - String Manipulation - Multidimensional Arrays - Arrays of Strings, Memory Representation, accessing array elements, String Manipulation Functions, searching, sorting an array.

UNIT 3: BASIC ALGORITHMS

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs, Euclid's GCD Algorithm, Basic Recursion, Greedy Algorithms, Basic Dynamic Programming, Naive string searching, O(n logn) Sorting, Binary Searching

UNIT 4: FUNCTION

Storage Classes and Visibility, Automatic or local variables, Global variables, Static variables, External variables, Meaning of Terms, Scope - Block scope & file scope, Storage Classes Automatic Storage, Extern Storage, Static, Storage, Register Storage, Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference, Recursion, Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort, Advantages of modular design, prototype declaration, Arguments & local variables, Returning Function Results by reference & Call by value, passing arrays to a function, Recursion

UNIT 5: STRUCTURE, POINTERS & FILE HANDLING

Structures, defining structures and Array of Structures, Idea of pointers, defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), The Pointer operator Application of Pointer, Pointer Expression, Declaration of Pointer, Initializing Pointer, De-referencing Pointer, Void Pointer, Pointer Arithmetic, Precedence of &, * operators Pointer to Pointer, Constant Pointer, Dynamic memory allocation, passing pointer to a function, array of pointers, accessing arrays using pointers, handling strings using pointers, File Inclusion, Macro Definition and Substitution,

Macros with Arguments, Nesting of Macros, Conditional Compilation, Dynamic Memory Allocation and Linked List: Dynamic Memory Allocation, Allocating Memory with malloc, Allocating Memory with calloc, Freeing Memory, Reallocating Memory Blocks, Pointer Safety

List of Experiments (Minimum 9)

1 Lab 1: Familiarization with programming environment
-concept of naming the program files, storing, compilation, execution and debugging.
-Program to print text
-Print the Sum of Given Two Numbers.
Tutorial 2: Variable types and type conversions:

2 Lab 2: Simple computational problems using arithmetic expressions
-An example of implicit conversion with all the types
-Demonstrate explicit type casting
-Develop a program to solve simple computational problems using arithmetic expressions and use of each operator leading to simulation of a commercial calculator. (No built-in math function)
Tutorial 3: Branching and logical expressions:

3 Lab 3: Problems involving if-then-else structures
-An electricity board charges the following rates for the use of electricity: for the first 200 units 80 paise per unit: for the next 100 units 90 paise per unit: beyond 300 units Rs 1 per unit. All users are charged a minimum of Rs. 100 as meter charge. If the total amount is more than Rs 400, then an additional surcharge of 15% of total amount is charged. Write a program to read the name of the user, number of units consumed and print out the charges.
-Score Grade calculation using If and elsif statements
Tutorial 4: Loops, while and for loops:

4 Lab 4: Iterative problems e.g., sum of series
-Loops (Illustration of all the looping structures)
-Fibonacci / factorial series using for loop
-Calculate Armstrong number using while loop
Tutorial 5: 1D Arrays: searching, sorting:

5 Lab 5: 1D Array manipulation
-Program for learning the Data Structure
-Introduce 1D Array manipulation and implement Binary search.
Tutorial 6: 2D arrays and Strings

6 Lab 6: Matrix problems, String operations
-Develop a program to introduce 2D Array manipulation and implement Matrix multiplication and ensure the rules of multiplication are checked.
-Write functions to implement string operations such as compare, concatenate, string length.
-Convince the parameter passing techniques
-Print whether a given word is a Palindrome or not
-Print each letters of the string by extracting it using for loop
-Print whether a word is there in a string or not
Tutorial 7: Functions, call by value:

7 Lab 7: Simple functions
-Function Element search in ordered list
-FUNCTION findMax / Function print reverse string
Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):

8 and 9 Lab 8 and 9: Programming for solving Numerical methods problems
-Develop a program to compute the roots of a quadratic equation by accepting the coefficients. Print appropriate messages.
-Develop a Program to compute Sin(x) using Taylor series approximation. Compare your result with the built-in Library function. Print both the results with appropriate messages.
Tutorial 10: Recursion, structure of recursive calls

10 Lab 10: Recursive functions
-Implement recursive functions for Binary to Decimal Conversion

-Factorial of a given number using a recursive function
-Fibonacci series for a given number using a recursive function
-Sum of Natural Numbers Using Recursion
Tutorial 11: Pointers, structures, and dynamic memory allocation

11 Lab 11: Pointers and structures
-Implement structures to read, write, compute average- marks and the students scoring above and below the average marks for a class of N students.
-Develop a program using pointers to compute the sum, mean and standard deviation of all elements stored in an array of n real numbers.
-Program to calculate the sum of n numbers entered by the user using malloc() and free() read a one-dimensional array, print sum of all elements along with inputted array elements using Dynamic Memory Allocation
Tutorial 12: File handling:

12 Lab 12: File operations
-Program for File open, write and close.
-create a file with the specified name and writes the input character into the file.

TEXTBOOKS

1. Byron Gottfried, “Schaum's Outline of Programming with C”, McGraw Hill India, 2010
2. E. Balagurusamy, “Programming in ANSI C”, McGraw Hill India, 2012

REFERENCE(S)

1. Brian W. Kernighan and Dennis M. Ritchie, “The C Programming Language”, PHI India, 2009

ECE18R238 LINUX AND REGULAR EXPRESSIONS

ECE18R238 Linux and Regular Expressions	L	T	P	C
	3	0	2	4
Pre-requisite: Basics of computers	**Course Category:** Professional Elective **Course Type:** Integrated Course			

Course Objective(s):

This course grounds you in the basic Linux techniques for searching text files by using regular expressions. Learn how to: Create simple regular expressions, Search files and filesystems using regular expressions, Use regular expressions with sed

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the need for Linux by applying the knowledge of Linux engineering gained
CO2: User the common Linux commands to solve engineering problems with an understanding of the impact of solutions
CO3: Customise the Linux environment to meet desired constraints like sustainability
CO4: Use VI text editor to create text files and modify it as part of their experimentation, working individual or as team member
CO5: Use Regular Expressions to write scripts and manipulate data as part of their experimentation, working individual or as team member

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2		L	H			M	H						M	L	L
CO3		L	H			L	H						M	L	L
CO4			M		H		L	L	H	M		L	M	H	H
CO5			M		H		L	L	H	M		L	M	H	H

Course Topics:

Unit 1: Linux for Beginners

CLI navigation, managing files-Reading files using CLI, managing directories-finding differences between files, printing to a printer, handling large files-File permissions, Redirection, piping, searching within files, filters, searching for files/directories, finding file types

Unit 2: Advanced Linux

Introduction to regular expressions-Shell variables, networking, Process Management-Introduction to VI Text Editor, Shell types, introduction to shell scripting, Virtual terminals-User management, Archiving, compression, Scheduling jobs, finding disk space-finding memory usage, foreground/background jobs, customizing shell

Unit 3: Parsing and Transforming Text with SED

Introduction to sed, sed syntax, loops, branches-Pattern buffer and range-sed commands-Handling special characters and strings in sed-Handling patterns and regular expressions in sed

Unit 4: Text Processing and Data Extraction with AWK

Introduction to awk, syntax, examples-AWK variables and operators -Regular expressions, arrays, if/else statements in AWK-Loops, built in functions in AWK-Output redirection and printing in AWK

Unit 5: Regular Expressions

Metacharacters and literals, Any character-Metacharacter, anchors, Bracket Expressions-Negation, Ranges, Alternation-character classes-Quantifiers

List of Experiments (Minimum 9)

1. Given a list of files, find the one that is different
2. Given a large file, find the line number of a string without using grep command
3. Create a project directory structure for 6th semester students
4. Given a directory structure implement given changes to permissions and locations of files and sub-directories
5. Given a shell start-up file, fix the issues found
6. Create a shell start-up environment file for given specifications
7. Create groups, create, and assign users to the groups, modify user credentials per given requirements
8. Given a text file extract the lines that meet given requirements
9. Given a text file replace a given occurrence of a string
10. Given a text file (Verilog netlist) replace the parenthesis around bus bits
11. Write an AWK script to retrieve the default shell of users
12. Given text file, print the given fields if a matching pattern is found
13. Extract lines from a text file having a given string as prefix of any string
14. Extract lines from a text file having given strings as prefix and postfix of any string
15. Changes the case of words matching a given pattern in a text file
16. Remove the leading zeros in each text file
17. Return number of occurrence of words matching a given pattern in a text file
18. Replace a group of whitespace, comma, and dot by a colon in a text file
19. Given a text file, extract values between quotation marks of a string

Textbook(s):

1. David Tansley, “Linux and UNIX Shell Programming”, Addison – Wesley / Pearson – 2011
2. Jeffrey E.F. Friedl, “Mastering Regular Expressions: Understand Your Data and Be More Productive”, O’Reilly - 2016

Reference(s):

1. Richard Blum, Christine Bresnahan, “Linux Command Line and Shell Scripting Bible”, Wiley – 2015(3rd Edition)
2. Jan Goyvaerts, Steven Levithan, “Regular Expressions Cookbook: Detailed Solutions in Eight Programming Languages”, O’Reilly – 2012

ECE18R250 PCB DESIGN

ECE18R250 PCB Design	L	T	P	C
	3	0	1	3.5
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To familiarize the participants with design, fabrication, and quality of printed circuit boards

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basics related to PCB design

CO2: Explain engineering techniques in layout planning and design with exposure to schematics, netlist, and design rules

CO3: Design, fabricate and assemble a PCB for given circuits with ability to test and assess its quality

CO4: Demonstrate their understanding of impact of PCB manufacture on environment

CO5: Work as part of a team and as individual effectively in designing PCB with ability to communicate the process by means of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H	M											H		
CO3		H	H	L	H									H	
CO4		H				H	H	L						H	L
CO5		H							H	H				M	M

Course Topics:

Unit 1: Basics, Layout Planning

Basics: Connectivity in electronic equipment - evolution in PCBs – components of a PCB – classification of PCBs – manufacturing of basic PCBs – challenges in modern PCB design and manufacture – PCBs with embedded components – Standards

Layout Planning and Design: Reading drawings and diagrams – general PCB design consideration – mechanical design consideration – electrical design consideration –component placement rules – fabrication and assembly consideration – environmental factors – layout design – layout design checklist – documentation

Unit 2: Schematics and Netlist, Design Rules

Schematic Entry – Schematic Standards – Schematic Design Check List – Schematic Styles – Sheets and Connectors

Design rules for analog circuits – Design rules for digital circuits – Design rules for HF circuits – EMI/EMC

Unit 3: PCB Design Process

Artwork Generation: Manual artwork – Guidelines – Film master preparation – Automated Artwork Generation – CAD – Basic CAD Operations – Design Automation – Photoplotter – CAM

Image Transfer Techniques: Laminate Surface Preparation – Screen Printing – Pattern Transferring – Printing Process – Photo Printing – Laser Direct Imaging – Standards

Unit 4: PCB Fabrication Process

Plating Process: Electroplating – Plating Techniques – General Problems in Plating and Defects – Special Plating Techniques

Etching: Etching chemical solutions – etching arrangements and parameters – Equipment and Techniques – Economy Optimisation – Etching Problems – Facilities for Etching Area – Electrochemical Etching, Mechanical Etching

Cleaning – Drying – Cutting – Punching – Drilling **(Qualitative Treatment)**

Unit 5: Assembling and Testing

Soldering: Theory, Variables, Material, Tools – Hand Soldering – PCB Assembly process – Mass Soldering – Post-soldering cleaning – Quality control of solder joints – Health and Safety Aspects – Electrostatic Discharge Control
Testing for quality control – quality control methods –testing of PCBs – Reliability testing – Acceptability of PCBs – Recycling of PCBs – Environmental Standards – Safety Precautions – Lead free Soldering

List of Experiments

1. Schematic Design using Software
2. PCB Layout Design and CAM file generation for PCB fabrication using Software
3. PCB Artwork Generation and printing for a power supply section (Bridge Rectifier with Filter)
4. PCB Etching and Drilling for a power supply section (Bridge Rectifier with Filter)
5. PCB Soldering and Testing: Soldering the components of power supply section, fitting with a step-down transformer and testing of the power supply section fabricated

TEXTBOOK(s):

1. R S Khandpur, “Printed Circuit Boards: Design, Fabrication, Assembly and Testing”, McGraw Hill India, 2005, ISBN: 9780070588141
2. Christopher T. Robertson, “Printed Circuit Board Designer's Reference: Basics”, Prentice International U.S., 2004, ISBN: 9780130674814

Reference(s):

1. Kraig Mitzner, “Complete PCB Design Using OrCAD Capture and PCB Editor”, Newnes/Elsevier India, 2009, ISBN: 9780750689717
2. Peter Wilson, “The Circuit Designer's Companion”, Newnes/Elsevier India, 2017(4th Edition), ISBN: 9780081017647

ECE18R251 DATA STRUCTURES

ECE18R251 Data Structures	L	T	P	C
	3	0	2	4
Pre-requisite: Programming Basics	**Course Category:** Professional Elective **Course Type:** Integrated Course			

CO1: Demonstrate the use of Data Structures in C by doing experimentation as individual tor team and communicate them
CO2: Explain the algorithms needed for code development
CO3: Evaluate Abstract Data Types and linear data structures
CO4: Understand how to use data search and sort options available
CO5: Develop an understanding of Graphs and its applications
CO5: Communicate the way of solving problems using data structures by means of oral and written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H	H	H		L	H					H		H	M
CO2	H	M											H		
CO3	H	M											H		
CO4	H	M											H		
CO5	H	M											H		
CO6		M							L	H				H	

Course Topics:

Unit 1: Basics

Introduction to programming methodologies – structured approach, stepwise refinement techniques

Programming style, documentation - Analysis of algorithms: frequency count, definition of Big O notation - Algorithm efficiency and analysis, time and space analysis of algorithms - Basic algorithms: Asymptotic notation - divide-and-conquer paradigm-basic data structures - Fast Fourier Transform
The Role of Algorithms in Computing - Algorithms, Algorithms as a technology - Structures–Arrays Structure, Array as parameters – Pointer to Structures in C – Recursion – Definition, Types, programs for all types- Efficiency of recursion

Unit 2: Stacks, Queues and Hashing

Abstract Data Types- Stacks-Stack applications- Balancing symbols, Infix to postfix expression conversion, Postfix Expression evaluation, - Stack and its implementations (using array, using linked list)-Function calls- Queues- Linked lists, its operations and types-Linked lists- singly linked list, doubly linked list, Circular linked list, operations on linked list, linked list with header nodes, applications of linked list: polynomials -Circular queue de-queue, Implementation of queue- both linear and circular (using array, using linked list)-Principles of recursion - use of stack, tail recursion -Applications - The Tower of Hanoi, Eight Queens Puzzle Hash Tables - Direct-address tables, Hash tables, Hash functions - Open addressing

Unit 3: Trees

Tree Terminologies - Binary tree - Binary tree traversal - Expression tree construction- Binary Search Trees- Querying, Insertion and deletion in BST–AVL trees-rotations, insertion. B-Trees-Definition of B-trees- Basic operations on B-trees- insertion and deletion Threaded binary tree
Binary search tree- operations (creation, insertion, deletion, searching)-Heap(creation, insertion, deletion, searching)-Height balanced binary tree – AVL tree (insertion with examples only)-Height balanced binary tree – AVL tree (deletion with examples only), m –Way Search Tree

Unit 4: Sorting and Searching

Searching: Sequential search – with complexity -Binary search, Interpolation Search– with complexity Collision resolution techniques
Priority Queues (Heaps) – Model – Simple implementations – Binary Heap-Properties. Sorting-Bubble sort, insertion sort, selection sort, shell sort, Heap sort, quick sort, Radix sort, Merge sort. Searching-Linear search, Binary search
Decision tree model and (worst case) lower bound on sorting-Sorting in linear time - bucket sort, counting sort

Unit 5: Graphs

Graph Terminologies - Representations of Graphs, Breadth-first search, Depth-first search, Topological sort, strongly connected components. Applications of Depth-First Search – Undirected Graphs – Biconnectivity - Minimum Spanning Trees- Growing a minimum spanning tree - The algorithms of Kruskal and Prim-Shortest paths in directed acyclic graphs - Definitions – Topological Sort - Dijkstra's algorithm, All Pairs Shortest Paths - The Floyd - Warshall algorithm - Pattern matching and Tries : Pattern matching algorithms-Brute force, the Boyer –Moore algorithm, Knuth-Morris-Pratt algorithm, Standard Tries, Compressed Tries, Suffix tries.

List of Experiments (Minimum 9)

Implement the following in C Language

1. Programs using structures, arrays, pointers to structures and passing them as parameters to functions.
2. Programs for various types of recursion.
3. Program for array implementation of stack and queue.
4. Program for various applications of stack.
5. Program for linked list ad its operations.
6. Program for linked list implementation of stack and queue.
7. Program for binary search tree and its operations.
8. Program for various sorting and searching techniques.
9. Program for Dijkstra’s shortest path algorithms in graphs.
10. Program for finding minimum spanning tree in graphs using Kruskal and Prim algorithms
11. Program to implement B-tree construction (degree 3).
12. Program to implement AVL tree construction.

Textbook(s):

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Pearson India, 2008(2nd Edition), ISBN: 9788177583588

2. Cormen, Thomas H., Leiserson, Charles E., Rivest, Ronald L., Stein, Clifford, "Introduction to Algorithms", PHI India, 2004(3rd Edition), ISBN: 9788120340077

Reference(s):

1. Aaron M. Tannenbaum, "Data structures using C", Pearson India, 2008(1st Edition), ISBN: 9788131702291

ECE18R252 OBJECT-ORIENTED PROGRAMMING WITH C++

ECE18R252 Object-Oriented Programming with C++	L	T	P	C
	3	0	1	3.5
Pre-requisite: Basic Programming skills	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To study the object-oriented programming principles, tokens, expressions, control structures and functions. To introduce the classes, objects, constructors, and destructors. To introduce the operator overloading, inheritance, and polymorphism concepts in C++

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the benefits of object-oriented design and understand when it is an appropriate methodology to use.

CO2: Design object-oriented solutions for small systems involving multiple objects, polymorphism, and inheritance

CO3: Implement, test and debug solutions in C++.

CO4: Work as part of a team and as individual effectively in the context of object-oriented programming following the safety procedures and ethics

CO5: Find, interpret, and communicate documentation related to OOP concepts

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H					L	H						H		L
CO2		H	H									H	H		
CO3		M	H	H	H			L						H	
CO4				H				H	H		L			M	M
CO5								L		H				M	M

Course Topics:

Unit 1: Basics of OOP

Procedure Oriented Programming and Object-Oriented Programming – Characteristics of OOP – Benefits and Applications of OOP – C++ Basics: Structure, Tokens, Keywords, Identifiers and Constants, Variables, Datatypes, Arrays, Operators, Expressions, Loops and Decisions

Unit 2: Functions

Defining a function – function arguments – passing by value – pointers – functions and strings – functions and structures

Unit 3: Classes and Objects

Defining classes and objects – constructors and destructors – function and operator overloading

Unit 4: Inheritance and Polymorphism

Derived class, base class, virtual class – friend functions, static functions, virtual functions – single and multiple inheritance, multilevel inheritance, hybrid inheritance, hierarchical inheritance, polymorphism – pointers and pointers to derived classes

Unit 5: Input/ Output Files

Streams – Buffer and I-O Streams – Header files – redirection – File input and output

List of Experiments (Any 5)

Implement the following in C++ Language

1. Program to implement various control structures

2. Program on simple function concepts like call by value and call by reference
3. Program on constructors and destructors (classes and objects)
4. Program on function overloading
5. Program on implementing inheritance and function overriding
6. Program on operators as member function and non-member function
7. Program on friend function and virtual class
8. Program on using "this" operator and class
9. Program on file handling

TEXTBOOK(s):

1. Reema Thareja, "Object Oriented Programming with C++", Oxford University Press India, 2015(1st Edition), ISBN: 9780199459636
2. E. Balagurusamy, "Object Oriented Programming with C++", McGraw Hill India, 2017(7th Edition), ISBN: 9789352607990

Reference(s):

1. Sourav Sahay, "Object Oriented Programming with C++", Oxford University Press India, 2012 (2nd Edition), ISBN: 9780198065302
2. Robert Lafore, "Object-Oriented Programming in C++", Pearson India / SAMS Publishers – 2002 (4th Edition), ISBN: 9788131722824

ECE18R253 NUMERICAL ANALYSIS USING MATLAB

ECE18R253 Numerical Analysis using MATLAB	L	T	P	C
	3	0	1	3.5
Pre-requisite: Basic Mathematics at HSC Level	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To understand basic representation of Matrices and vectors in MATLAB; To learn various programming structures in MATLAB; To study built in and user defined functions in MATLAB; To become conversant with 2D as well as 3D graphics in MATLAB; To make a Graphical User Interface (GUI) in MATLAB to achieve interactivity

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the various programming structures, functions, and data types in MATLAB
CO2: Apply MATLAB for real time applications with the ability to plot on graphics and design interactive GUI
CO3: Develop an understanding of MATLAB for designing systems as per requirements
CO4: Work as part of a team and as individual effectively in applying MATLAB as a tool following the safety procedures and ethics
CO5: Find, interpret, and communicate documentation related to MATLAB programming

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	L		H		H								H		
CO2		H	H		H		H					H		H	
CO3		M	H	H	H			L				H		H	
CO4				H				H	H		L			M	M
CO5								L		H				M	M

Course Topics:

Unit 1: Scalars and Vectors

Basics: MATLAB IDE – MATLAB Script Files – MATLAB Editor
Scalar variables: Approximation of numbers and discrete mathematical operations – mathematical expressions – Relational and Logical Operations – Complex Scalar Variables

Vector Variables: Vector creation – Relational and Logical Operations – accessing elements – arithmetic operations – plotting vectors

Unit 2: Arrays, Functions

Creating arrays – relational and logical operations – accessing elements – arithmetic operations – plotting arrays

Creating functions – scope of variables

Unit 3: Loops and Decisions, Structures

Conditional statements: 'if 'statements, 'if else' statements, recursive functions, 'if elseif else' statements, 'switch case' statements

Loop Statements: 'for' loop statements, combined 'for' and 'if' statements, 'while' statements, 'nested for' statements, 'try and catch'

Structures: Structures in MATLAB – A vector of structures

Unit 4: Graphics

The plotting process – Graph components – Figure tools – arranging graph within a figure – Selecting the plot types – editing plots – Basic 2D – using subplot for multiple graphs – Interactive plotting – Basic Fitting Interface – Polyfit – 3D plots – Images: reading and writing images – Saving and printing graphs – animation – GUI: Creation Fundamentals – Layout GUIDE – Programming GUIDE –Capturing mouse actions

Unit 5: Applications

Numeric Computation Applications: Linear Algebra – Curve Fitting and Interpolation – Data Analysis and Statistics – Numerical Integration (Quadrature) – Ordinary Differential Equations – Non-linear Algebraic Equations (Roots of a polynomial)

Symbolic Computation Applications: The Symbolic Math Toolbox – Algebraic equations – Differentiation and Integration – Differential Equations – Laplace and Fourier Transforms

Introduction to Simulink

List of Experiments (Any 5)

Implement the following in MATLAB

1. Practicing MATLAB environment with simple exercises to familiarise Command Window, History, Workspace, Current Directory, Figure window, edit window, Shortcuts, Help files.
2. Data types, Constants and Variables, Character constants, operators, Assignment statements.
3. Control Structures: For loops, While, if control structures, Switch, Break, Continue statements.
4. Input-Output functions, Reading and Storing Data.
5. Vectors and Matrices, commands to operate on vectors and matrices, matrix manipulations.
6. Arithmetic operations on Matrices, Relational operations on Matrices, Logical operations on Matrices.
7. Polynomial Evaluation, Roots of Polynomial, Arithmetic operations on Polynomials.
8. Graphics: 2D plots, Printing labels, Grid and Axes box, Text in plot, Bar and Pie chart. Special Plotting: 3D plots
9. Reading and Writing Image files
10. Simulink basics

TEXTBOOK(s):

1. Munther Gdeisat Francis Lilley, "MATLAB by example: Programming Basics", Elsevier India, 2013 (1st Edition), ISBN: 9780124052123
2. Ram N Patel, Ankush Mittal, "Programming in MATLAB: A Problem-Solving Approach", Pearson India, 2014(1st Edition), ISBN: 9789332524811

Reference(s):

1. Raj Kumar Bansal, Ashok Goel, Manoj Kumar Sharma, "MATLAB and its applications in Engineering", Pearson India, 2016(2nd Edition), ISBN: 9789332542099
2. William J. Palm III, "MATLAB for Engineering Applications", McGraw Hill U.S., 2019, ISBN: 9781260215472 / 9781260501575(e-book) / 9781259405389
3. Huei-Huang Lee, "Programming with MATLAB 2016", SDC Publications Korea, 2016(1st Edition), ISBN: 9781630570132
4. Stephen J. Chapman, "MATLAB Programming for Engineers", Cengage Learning U.S. / India, 2015(5th Edition), ISBN: 9781111576714

5. Amos Gilat, "MATLAB: An Introduction with Applications", Wiley India, 2017(5th Edition), ISBN: 9788126537204
6. Stormy Attaway, "MATLAB: A Practical Introduction to Programming and Problem Solving", Elsevier India /Butterworth-Heinemann Publications U.K., 2018(5th Edition), ISBN: 9780128154793
7. Rudra Pratap, "Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers", Oxford University Press India, 2010, ISBN: 9780198069195
8. Quarteroni, Alfio, Saleri, Fausto, Gervasio and Paola, "Scientific Computing with MATLAB And Octave", Springer, 2010(3rd Edition)

ECE18R254 ELECTRONIC SENSORS AND MEASUREMENTS WITH LABVIEW

ECE18R254 Electronic Sensors and Measurements with LABVIEW	L	T	P	C
	3	0	1	3.5
Pre-requisite: EEE18R172 Basic Electrical Engineering / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To understand the basics of measurement, several types of sensors; To learn the concepts of various signal analysers, analog and digital instruments; Instrumentation techniques incorporating computer control, sampling, and data collection and analysis are reviewed in the context of real-world scenarios.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain characteristics of measurement, errors in measurement, characteristics of various measuring instruments and how to apply them in a data acquisition system

CO2: Use LabVIEW to simulate the various types of structures used in LabVIEW and analyse and design different type of programs based on data acquisition

CO3: Demonstrate the use of LabVIEW for measurement of parameters like resistance and frequency

CO4: Select a sensor to suit the needs based on the knowledge gained on working principles and the properties of various sensors

CO5: Perform analysis of measurement data and prepare laboratory report in the stipulated format for the experiments using sensors and measuring instruments

CO6: Work independently as well as in a group and be familiar with and practice laboratory safety rules in the experimentation with sensors and measuring instruments

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H		
CO2		H	L	H	H		H					H		H	H
CO3		M	H	H	H			L						H	
CO4	H											M	H		
CO5								L		H				M	M
CO6				H				H	H		L			H	M

Course Topics:

Unit 1: Measurement and Instrument Basics

Measurement System – Instrumentation, Types of Instrument – Units of measurement – Standards of measurement – Characteristics of measurement systems: Static and Dynamic - Errors in Measurements – Calibration and Standards, Principles of calibration and chain

Digital Meters: Voltage-to-Time Conversion Voltmeter, Dual-Slope Integration Voltmeter, Digital Multimeter

Oscilloscopes: CRO, Digital Storage Oscilloscope, Digital Sampling Oscilloscope, Spectrum Analysers

Unit 2: Data Acquisition

Computer based data acquisition, Virtual instruments and LABVIEW – Graphical Programming in LABVIEW – Logic operations in LABVIEW – Loops in LABVIEW – Case structure in LABVIEW – Data acquisition using LABVIEW – LABVIEW function generation

Unit 3: Measurement and Transmission

Bridge Circuits: Null-type and Deflection-type DC Bridge, AC Bridge

Measurements: D.C. Bridge measurement of resistance – Voltmeter-Ammeter method of resistance – Using Digital voltmeter for resistance measurement – Inductance measurement – Capacitance measurement – Frequency measurement using Digital counter – Frequency measurement using Oscilloscope – Phase measurement using Oscilloscope

Transmission: Electrical transmission, Fibre-Optic transmission, Digital transmission protocols

Unit 4: Basic Sensor Technologies

Resistive sensors – capacitive sensors – magnetic sensors – Hall-effect sensors – Piezoelectric sensors – Strain gauges – Piezoresistive sensors – Optical sensors – LVDT - Thermoelectric effect sensors – RTDs – Thermistors – Semiconductor temperature measurement devices – Proximity sensors

Unit 5: Smart Sensors and Intelligent Instrumentation

Smart sensors – Smart transmitters – Intelligent instruments – Sensors for smart systems: conductometric, magnetostrictive, semiconductor based, acoustic, ultrasonic, polymeric, carbon nanotube: sensors

List of Experiments (Any 5)

Implement the following in Multisim or equivalent

1. Familiarisation of LABVIEW
2. Study of data acquisition
3. Connecting Analog Voltage Signals to a DAQ Device
4. Analog Output Signals (for generating DC and AC voltages)
5. Connecting Current Signals to a DAQ Device
6. Measuring a process variable using DAQ Device
7. Multisim and LABVIEW connectivity
8. Study of Temperature Sensor - Connecting Thermocouple Signals to a DAQ Device
9. Study of Strain gauge - Connecting Strain Gauges to a DAQ Device

TEXTBOOK(s):

1. Alan S Morris, Reza Langari, “Measurement and Instrumentation: Theory and Application”, Elsevier India / Butterworth-Heinemann Publications – 2011(1st Edition), ISBN: 9780123819604
2. Murthy D.V.S, “Transducers and Instrumentation”, PHI India, 2010(2nd Edition), ISBN: 9788120335691
3. Connect Sensors and Signals to a DAQ Device: http://www.ni.com/getting-started/set-up-hardware/data-acquisition/sensors

Reference(s):

1. John Essick, “Hands-on Introduction to LabVIEW for Scientists and Engineers”, Oxford University Press India/US, 2016(3rd Edition), ISBN: 978019021189 / 9780198098645
2. Vijay K. VaradanK. J. Vinoy, S. Gopalakrishnan, “Smart Material Systems and MEMS: Design and Development Methodologies”, Wiley India, 2006, ISBN: 9788126531707, DOI: 10.1002/0470093633
3. Albert D. Helfrick and William D. Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, Pearson India, 2016, ISBN: 9789332556065
4. Ernest Doebelin and Dhanesh N Manik, “Doebelin's Measurement Systems”, McGraw Hill India, 2011(6th Edition), ISBN: 9780070699687
5. K. Lal Kishore, “Electronic Measurements and Instrumentation”, Pearson India, 2012, ISBN: 9788131721995
6. Jeffrey Travis, Jim Kring, “LabVIEW for Everyone: Graphical Programming Made Easy and Fun”, Pearson India/U.S., 2009(3rd Edition), ISBN: 9788131726495

ECE18R310 DISPLAY SYSTEMS

ECE18R310 Display Systems	L	T	P	C
	3	0	0	3
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To expose the students to the basics of the display systems and to illustrate the current design practices of the display systems

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain digital video principles, compression techniques and standards
CO2: Illustrate the components of a digital television transmission and reception
CO3: Explain the working principle of various display systems
CO4: Grasp the research on contemporary trends in display devices

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M					L					H	H	M	
CO2		L					L					L	H		
CO3	M											H	H		
CO4		H	L			L	H	M	M			H		H	H

Course Topics:

Unit 1: Digital Video

Digital Video – Human eye – the RGB and YUV Representation of Video Signals – NTSC, PAL, SECAM systems – the need for Compression, how compression works – Compression formats for video: MPEG-x format, H.26X format.

Unit 2: Digital Television – Transmission and Reception

Digital TV hardware – Signal quantizing and encoding – digital satellite television – Direct- To-Home (DTH) satellite television – Digital TV receiver – Merits of digital TV receivers – Digital Terrestrial Television (DTT) – Introduction to Video on demand – Introduction to CCTV – Introduction to CATV

Unit 3: 3D Televisions

Projection television – Flat panel display TV receivers – Three-Dimensional (3-D) television – HDTV – Extended Definition Television (EDTV)

Unit 4: Displays: LCD and Plasma

LCD technology – LCD matrix types and operation – LCD screens for television – LCD colour receivers – Single LCD receivers – 3-LCD colour receivers – Plasma and conduction of charge – Plasma television screens – Signal processing in Plasma TV receivers – A Plasma colour receiver – comparison of Plasma and LCD televisions – RGB dynamic LEDs – Edge-LEDs – Differences between LED-backlit and Backlit LCD displays – Comparison of Plasma TV and LED TV – New Innovative Displays like OLED

Unit 5: Projection Display Systems, Touch Screens, Emerging Displays

Direct View and rear projection systems – front projection TV system – Transitive type projection systems – Reflective projection systems – Digital Light Processing (DLP) projection system – Projection television for home theatres – Touch Screen technology – flexible displays

TEXTBOOK(s):

1. Joseph A. Castellano, “Handbook of Display Technology”, Elsevier (Academic Press) U.S./India, 1992, ISBN: 9780121634209
2. Janglin Chen, Wayne Cranton, Mark Fihn (Editors), “Handbook of Visual Display Technology”, Springer U.K./ India, 2016(2nd Edition), ISBN: 9783319143453

Reference(s):

1. Lindsay MacDonald (Editor), Anthony C. Lowe (Editor), "Display Systems, Design and Applications", Wiley, U.S./India, 1997, ISBN: 9780471958703
2. E.H. Stupp, M. S. Brennesholtz, "Projection Displays", Wiley U.S./India, 2008(2nd Edition), ISBN: 9780470518038

ECE18R311 ELECTRONIC PRODUCT DESIGN FOR MANUFACTURING

ECE18R311 Electronic Product Design for Manufacturing	L	T	P	C
	3	0	0	3
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To understand the stages of product design and development. To understand the importance of testing in product design cycle. To understand the processes and importance of documentation

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply engineering design to produce solutions recognize the essential design and production procedures of electronic products

CO2: Apply engineering design to design products which can be tested

CO3: Design products which would have high reliability

CO4: Develop and conduct appropriate experimentation to analyse the importance of testing and standards in design

CO5: Illustrate the importance of documentation in a product design

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M									H	M	H	L	L
CO2		H	H									H	H	L	L
CO3		H	H									H	H	L	L
CO4	L	L									L	L		M	L
CO5										H	L			M	M

Course Topics:

Unit 1: Product Design Basics

User-centred design – five elements of successful design – cognition – ergonomics. Packaging and factors Modular design – auto-insertion – surface mount technology – sources of design tips. Basic concepts of Design for Manufacture.

Unit 2: Electronic Circuit Design for Testability

Testability: testing paradigms (in-circuit and functional); test points and accessibility of circuits for testing; principle of product partitioning

Unit 3: Electronic Circuit Design for Reliability

Design for circuit reliability causes of component failure; reliability calculations and its prediction; means of improving circuit reliability. Environmental Stress Screening

Unit 4: Standards and Testing

Inspection and test of components – Simulation – Prototyping and testing – Integration, validation, and verification. EMI and EMC issues - RFI Standards and regulations applicable to the electronic product manufacturing industry

Unit 5: Documentation

Definition – need, and types of documentation. Records – Accountability, and Liability. Audience. Preparation, Presentation, and Preservation of documents. Methods of documentation – Visual techniques – Layout of documentation – Bill of material

TEXTBOOK(s):

1. Kim R. Fowler, "Electronic Instrument Design: Architecting for the Life", Oxford University Press U.K., 2012 Reprint (1996 Edition), ISBN: 9780195083712
2. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, "Product Design for Manufacture and Assembly", CRC Press (Taylor and Francis) U.K./India, 2010(3rd Edition), ISBN: 9781420089271

Reference(s):

1. Mark I. Montrose, "Printed Circuit board design Techniques for EMC Compliance: A Handbook for Designers", Wiley / IEEE Press India, 2015(2nd Edition), ISBN: 9788126557592
2. Jerry C. Whitaker (Editor), "The Electronics Handbook", CRC Press (Taylor and Francis) U.K./India, 2005 (2nd Edition), ISBN: 9780849318894
3. J. A. S Angus, A. E. Ward, "Electronic Product Design", CRC Press (Taylor and Francis)/ Stanley Thornes Publishers U.K./ India, 1996, ISBN: 9780748751709
4. Henry W. Ott, "Electromagnetic Compatibility Engineering", Wiley, U.S., 2009, ISBN: 9780470189306
5. Robert Spence, Randeep Singh Soin, "Tolerance Design of Electronic Circuits", World Scientific (Imperial College Press) U.S., 1997, ISBN: 9781860940408

ECE18R312 COMPUTER ARCHITECTURE

ECE18R312 Computer Architecture	L	T	P	C
	3	1	0	4
Pre-requisite: Digital Circuits and Systems Design / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To learn the fundamentals of architecture of computer

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the understanding of functional units of computer, bus structure and addressing mode
CO2: Apply the knowledge of algorithms to solve arithmetic unit problems.
CO3: Demonstrate single bus, multiple bus Organisation and pipelining concepts
CO4: Analyse RAM, ROM, Cache memory and virtual memory concepts
CO5: Evaluate the various I/O interfaces

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L										H	H		L
CO2	H	H	L									H	H	M	L
CO3	H	M										H	H		L
CO4	L	M										H	H		L
CO5	L	H										H	H		

Course Topics:

Unit 1: Basic Structure of Computers

Functional units - Basic operational concepts - Bus structures - Software performance – Memory locations and addresses – Memory operations – Instruction and instruction sequencing – Addressing modes – Assembly language – Basic I/O operations – Stacks and queues.

Unit 2: Arithmetic Unit

Addition and subtraction of signed numbers – Design of fast adders – Multiplication of positive numbers - Signed operand multiplication and fast multiplication – Integer division – Floating point numbers and operations

Unit 3: Processing Unit

Fundamental concepts – Execution of a complete instruction – Multiple bus Organisation – Hardwired control – Micro programmed control - Pipelining – Basic concepts – Data hazards – Instruction hazards – Influence on Instruction sets – Data path and control consideration – Superscalar operation

Unit 4: Memory System

Basic concepts – Semiconductor RAMs - ROMs – Speed - size and cost – Cache memories - Performance consideration – Virtual memory - Memory Management requirements – Secondary storage

Unit 5: I/O Organisation

Accessing I/O devices – Interrupts – Direct Memory Access – Buses – Interface circuits – Standard I/O Interfaces (PCI, SCSI, USB)

TEXTBOOK(s):

1. Behrooz Parhami, "Computer Architecture: From Microprocessors to Super Computers", Oxford University Press India, 2012(1st Indian Edition), ISBN: 9780198084075
2. Carl Hamachi, Zvonko Vranesic and Safwat Zaky, "Computer Organisation", McGraw Hill India, 2014(5th Edition), ISBN: 9789339212131

Reference(s):

1. William Stallings, "Computer Organisation and Architecture: Designing for Performance", Pearson India, 2016(10th Edition), ISBN: 9789332570405
2. John P. Hayes, "Computer Architecture and Organisation", McGraw Hill India, 2012(3rd Edition), ISBN: 9781259028564
3. David Patterson John Hennessy, "Computer Organisation and Design (MIPS Edition): The Hardware/Software Interface", Elsevier (Morgan Kaufmann) U.S./India, 2013(5th Edition), ISBN: 9780124077263

ECE18R313 SCIENTIFIC COMPUTING

ECE18R313 Scientific Computing	L	T	P	C
	3	1	0	4
Pre-requisite: Basic Mathematics	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To expose the students, about mathematic computing techniques and their applications in science and engineering

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply the knowledge of error computations and number representations in engineering applications

CO2: Apply the knowledge of solving linear equations and least squares methods in engineering applications

CO3: Apply the knowledge of finding eigen values, solving non-linear equations and fast Fourier transforms in engineering applications

CO4: Apply the knowledge of interpolation, integration, and differentiation in engineering applications

CO5: Apply the knowledge of solving differential equations in engineering applications

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H		
CO2	H	L	L										H		
CO3	H	L											H		
CO4	H	L											H		
CO5	H	L											H		

Course Topics:

Unit 1: Basics, Computer Arithmetic

Sources of Approximations – Data Error and Computational, Truncation Error and Rounding Error, Absolute Error and Relative Error – Sensitivity and Conditioning – Backward Error Analysis – Stability and Accuracy

Computer Arithmetic: Floating Point Numbers – Normalization – Properties of Floating-Point System – Rounding, Machine Precision – Subnormal and Gradual Underflow – Exceptional Values – Floating-Point Arithmetic – Cancellation

Unit 2: Linear Equations, Least Square

System of liner equations: Linear Systems, Solving Linear Systems – Gaussian elimination – Pivoting, Gauss-Jordan – Norms and Condition Numbers – Symmetric Positive Definite Systems and Indefinite System – Iterative Methods for Linear Systems

Linear least squares: Data Fitting – Linear Least Squares – Normal Equations Method – Orthogonalization Methods – QR factorization, Gram-Schmidt Orthogonalization – Rank Deficiency, and Column Pivoting

Unit 3: Eigenvalues and Singular Values, Non-Linear Equations, Fast Fourier Transform

Eigenvalues and Eigenvectors – Methods for Computing All Eigenvalues, Jacobi Method, Methods for Computing Selected Eigenvalues – Singular Values Decomposition – Application of SVD

Nonlinear equations: Fixed Point Iteration – Newton's Method – Inverse Interpolation Method

Optimization: One-Dimensional Optimization – Multidimensional Unconstrained Optimization – Nonlinear Least Squares

Fast Fourier Transform, FFT Algorithm, Limitations – DFT – Fast polynomial Multiplication – Wavelets – Random Numbers and Simulation – Stochastic Simulation – Random Number Generators, Quasi-Random Sequences

Unit 4: Interpolation, Numerical Integration and Differentiation

Purpose for Interpolation – Choice of Interpolating – Function, Polynomial Interpolation – Piecewise Polynomial Interpolation

Numerical Integration and Differentiation: Quadrature Rule, Newton-Cotes Rule, Gaussian Quadrature Rule, Finite Difference Approximation

Unit 5: Ordinary Differential Equation, Partial Differential Equation

Initial Value Problems for ODES, Euler's Method, Taylor Series Method, Runge-Kutta Method, Extrapolation Methods – Boundary Value Problems For ODES, Finite Difference Methods, Finite Element Method – Eigenvalue Problems

Partial Differential Equations – Time Dependent Problems – Time Independent Problems – Solution for Sparse Linear Systems – Iterative Methods

TEXTBOOK(s):

1. Heath Michael T., "Scientific Computing: An Introductory Survey", McGraw-Hill, 2002 (2nd Edition)
2. Press William H., Saul A. Teukolsky, Vetterling William T and Brian P. Flannery, "Numerical Recipes: The Art of Scientific Computing", Cambridge University Press, 2007 (3rd Edition)

Reference(s):

1. Xin-she Yang (Editor)., "Introduction to Computational Mathematics", World Scientific Publishing Co., 2008 (2nd Edition)
2. Kiryanov D. and Kiryanova E., "Computational Science", Infinity Science Press, 2006 (1st Edition)
3. Quarteroni, Alfio, Saleri, Fausto, Gervasio and Paola, "Scientific Computing with MATLAB And Octave", Springer, 2010(3rd Edition)

ECE18R323 ELECTRONICS AND COMPUTING IN TEXTILE INDUSTRIES

ECE18R323 Electronics and Computing in Textile Industries	L	T	P	C
	3	1	0	4
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The aim of the course is theoretical familiarisation with application of electronics and computing units in textile industries

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the various techniques involved in wearable electronics
CO2: Explain how to design and integrate circuits into wearable fabrics
CO3: Learn the various methodologies in making of the product
CO4: Understand the usage of different software in developing the wearable electronics
CO5: Learn and know about applications of integrated wearable electronics products

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H						M					H	H		
CO2	H	L					M					H	H	L	
CO3	H						M					H	H	L	
CO4	H	L					M					H	H	M	
CO5	H											H	H		

Course Topics:

Unit 1: Wearable Electronics

Need for Wearable Electronics – Textile Fibres – Sensing Fabrics – Wearable Sensors, Electrode Technologies, Body Sensor Network, Wireless Body Area Sensor Network – Interfacing Circuits and Garments

Unit 2: Design and Integration of Circuits into Wearable Fabrics

Microelectronics for smart textiles – Flexible Wearable Electronics – Wearable Motherboard – Design of Heat generating circuit, signal transferring circuit, bullet wound intimation circuit – Smart Shirt Circuits

Unit 3: Product Development

Core Spun Yarn Production Methods – Development of Copper Core Yarn and Fabric – Development of POF fabric and Yarn - Development of Yarn for Tele intimation Fabric - Heating Garment – Communication garment – Illuminated garment – tele intimation garment – smart shirt

Unit 4: Software Development for Wearable Electronics

Biosensor design and MEMS integration – Health Care monitoring system – Wireless Sensor Networks – Wearable Computer interface and Wireless Brain – Monitoring software using LABVIEW – GPRS based Soldier tracking system

Unit 5: Garment-Integrated Wearable Electronic Products

Wearable Mobihealth Care System - Smart Clothes for Ambulatory Remote Monitoring - Development of Electronic Jerkin - Smart Textile Applications - Development of Heating Gloves - Development of Pneumatic Gloves - Gloves and Mobile Device: Product Design

TEXTBOOK(s):

1. Kumar, L. Ashok Vigneswaran, C, Electronics in textiles and clothing design, products and applications, CRC Press, 2015.ISBN: 978-1-4987-1551-5.

Reference(s):

1. Takao Someya (Editor), “Stretchable Electronics”, Wiley International U.S., 2013, ISBN: 9783527329786

ECE18R350 PYTHON PROGRAMMING FOR ELECTRONICS ENGINEERS

ECE18R350 Python Programming for Electronics Engineers	L	T	P	C
	3	0	2	4
Pre-requisite: Basics of computers	**Course Category:** Professional Elective **Course Type:** Integrated Course			

Develop algorithmic solutions to simple computational problems Read, write, execute by hand simple Python programs. Structure simple Python programs for solving problems. Decompose a Python program into functions. Represent compound data using Python lists, tuples, dictionaries.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Write and execute python programs with understanding of data types, compound data representation like lists, tuples, dictionaries, variables, operators, and expressions,

CO2: Use functions and modules, file handling operations and catch their own errors that happen in python programs

CO3: Apply Python Programming language for Data science applications

CO4: Connect to the database to move the data to/from the application and program in python to send and get data in a network

CO5: Work independently as well as in a group in designing python applications for the requirements following the ethics

CO6: Effectively communicate the python program designed for needs by means of oral / written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M	M		M		L	L				M	M	H	L
CO2	L	H	M		M		L	L				M	M	H	L
CO3			H	M	H							H		H	L
CO4			H	M	H							H	M	H	L
CO5				L				H	H		L			H	L
CO6								L	M	H				M	M

Course Topics:

Unit 1: Python Basics

Understanding the power of Python, Scripting Rules, Installing Python and setting up environment, An Overview of Python Scripting, Python Data Types, Python Data Structures, Interactive sessions – basic syntax, Writing and executing simple program, declaring variables, Operators, Conditional Statements, Logic Development, Decision Making, Looping and Control statements

Unit 2: Functions, Modules

Functions: Defining a function definition and use, arguments, block structure, scope, Strings and its operations, recursion, Types of functions, Calling a function, Function Arguments, Anonymous functions, Global and local variables Modules: Importing modules, Packages – Using Packages in Python, Custom modules, Advanced Argument passing, Lambda, Functions as Objects

Unit 3: Files and Exception

Classes, Class instances, Methods, Multiple inheritance, Properties, Special methods, Emulating built-in types, Iterators and Generators, Decorators, Context Managers, Regular expression, Files: Reading and writing binary data, Reading and Parsing text files, Reading and parsing xml files, format operator command line arguments Exception, Errors and exceptions, handling exceptions – except clause – Try / Finally, clause, user defined exceptions

Unit 4: Data Science

NumPy (ndarray), Scipy, Pandas, Reading Data from External Sources using Pandas, Data Cleansing, Data Preparation, Merge Data Frames (Left, Right, Inner, Outer), MatPlotLib, Using MatPlotLib for

Plotting Data, Basics of Statistics, Types of Variables, Central Tendency Theorem, Measure of Variability, Statistical Approach, Data Distribution, Skewness, Correlation and Covariance

Unit 5: Database connectivity and Internet Programming

Database Access: Python's Database Connectivity, Types of Databases used with Python, MySQL database Connectivity with Python, Data Definition Language (DDL) - Create Database, Create Table, Drop Database, Drop Table, Alter Table, Data Manipulation Language (DML) - Select Statement, Insert, Update, Delete, Where Clause, Having Clause, Logical Operators: And, Or, In, Between, Wildcard Operators (%,_ etc), Functions, Sorting Data, Grouping and Summarizing Data, Aliases, Joins, Left Join, Right Join, Inner Join, Outer Join, Self-Join, handling error Internet Programming: CGI scripts, GET and Post methods, File upload and extracting data from internet: using 'urlib2', parsing JSON APIs, parsing XML APIs

List of Experiments (Minimum 9)

1 Programs based on mathematical operations
-Calculate the area of a trapezoid / parallelogram
-Design a simple Calculator

2 Programs based on lists, tuples and dictionaries
-Program for learning the Data Types
-Program to create the data types for a given set of data.

3 Programs based on decision making statements
-Find Largest number among 3 given numbers
-Score Grade calculation using If and elif statements

4 Programs based on Loops
-Loops (Illustration of all the looping structures)
-Fibonacci / factorial series using for loop
-Calculate Amstrong number using while loop

5 Programs based on string and string methods
-Print whether a given word is a Palidrome or not
-Print each letters of the string by extracting it using for loop
-Print whether a particular word is there in a string or not

6 Functions
-Function Element search in ordered list
-FUNCTION findMax / Function print reverse string

7 Classes
-Create Class named Person. Define Object and Methods for adding, Modifying and deleting objects.
-Create a class named Employee, having an indented block of code defining properties name, designation and age.

8 Iterators / Generators / Decorators
-Create a Class and use the iterator, Generator and Decorator to enhance the code efficiency

9 Programs for parsing an xml file with exception handling

10 Programs on Data Science
-Predict the best car in the Market using the mtcars dataset
-Predict which customer will default using the banking dataset
-Predict the salary of an employee given how many years of experience they have.
-Perform multiple linear regression in Python to Predict the stock index price

11 Program to CRUD (Create, Read, Update and Delete) operations – MySQL database
-Program to demonstrate some of the conditional operations on the Database.

12 Program with a webserver (Apache) and internet programming

Textbook(s):

1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning, ISBN: 978-1111822705.

2. Gowrishankar S, Veena A, **"**Introduction to Python Programming**",** 1st Edition, CRC Press/Taylor and Francis, 2018. ISBN-13: 978-0815394372

Reference(s):

1. Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly Media, 2016, 1st Edition, ISBN-13: 978-1491912058
2. Wesley J Chun, "Core Python Applications Programming", Pearson Education India, 2015, 3rd Edition, ISBN-13: 978-9332555365
3. Allen B. Downey, "Think Python", O'Reilly U.S./Green Tea Press (Online Publishers), 2nd Edition – Free E-Book at: https://greenteapress.com/wp/think-python-2e/
4. Andrew Pratt, "Python Programming and GUIs: For Electronics Engineers", Elektor Electronics Publishing U.S., 2010(1st Edition), ISBN: 9780905705873
5. Dan Nixon, "Getting Started with Python and Raspberry Pi", Packt Publishers India/U.S., 2015, ISBN: 9781783551590
6. Mark Summerfield, "Programming in Python 3: A Complete Introduction to the Python Language (Developer's Library)", Pearson Education India/Addison Wesley, 2018(2nd Edition), ISBN: 9789352869176
7. Paul Gries, Jennifer Campbell, Jason Montojo, "Practical Programming: An Introduction to Computer Science Using Python 3.6", The Progmatic Bookshelf U.S., 2017(3rd Edition), ISBN:

ECE18R401 ELECTRONIC PACKAGING

ECE18R401 Electronic Packaging	L	T	P	C
	3	0	0	3
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To introduce and discuss various issues related to the system packaging

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the functions and applications of packages and materials used for packaging
CO2: Explain the procedure used for evaluating the electrical aspects of packaging including delay, cross talk
CO3: Describe about the single chip and multi-chip packages and techniques
CO4: Explain the techniques for bonding the packages to dies
CO5: Explain the technique used for fabrication and characteristics of single layer and multi-layer PCBs and compare their performances
CO6: Describe about thermal management techniques for packages and reliability of packages

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	H	L										H		
CO3	H	M											H		
CO4	H	M											H		
CO5	H	M											H		
CO6	H	M											H		

Course Topics:

Unit 1: Electronics Packaging Basics

Functions of an Electronic Package – Packaging Hierarchy – IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging – Trends, Challenges – Driving Forces on Packaging Technology – Materials for Microelectronic packaging – Packaging Material Properties – Ceramics, Polymers, and Metals in Packaging – Material for high density interconnect substrates.

Unit 2: Anatomy of Systems Packaging

Electrical Anatomy of Systems Packaging – Signal Distribution, Power Distribution, Electromagnetic Interference – Design Process Electrical Design: Interconnect Capacitance, Resistance, and Inductance fundamentals; Transmission Lines, Clock Distribution, Noise Sources, power Distribution, signal distribution, EMI – Digital and RF Issues. Processing Technologies, Thin Film deposition, Patterning, Metal to Metal joining

Unit 3: IC Packaging

IC Assembly – Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding – Flip Chip – Wafer Level Packaging – reliability, wafer level burn – in and test. Single chip packaging: functions, types, materials processes, properties, characteristics, trends. Multi chip packaging: types, design, comparison, trends. Passives: discrete, integrated, embedded encapsulation and sealing: fundamentals, requirements, materials, processes

Unit 4: Printed Circuit Board

Anatomy, CAD tools for PCB design – Standard fabrication – Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology – Process Control and Design challenges. Thermal Management – Heat transfer fundamentals – Thermal conductivity and resistance – Conduction, convection, and radiation – Cooling requirements

Unit 5: Reliability Testing

Reliability, Basic concepts – Environmental interactions. Thermal mismatch and fatigue – failures – thermos-mechanically induced – electrically induced – chemically induced. Electrical Testing: System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability

TEXTBOOK(s):

1. Glenn R. Blackwell (Editor), "The Electronic Packaging Handbook", CRC Press/ IEEE Press U.K./U.S., 2000, ISBN: 9780849385919
2. Matisoff, Bernard S, "Handbook of Electronics Packaging Design and Engineering", Springer U.S./India, 2012 (1990 Edition Reprint), ISBN: 9789401170499, DOI: 10.1007/978-94-011-7047-5

Reference(s):

1. Tummala, Rao R., "Fundamentals of Microsystems Packaging", McGraw Hill International, 2008(2nd Edition), ISBN: 9781259861550/ 9780071371698
2. Richard K. Ulrich (Editor), William D. Brown (Editor), "Advanced Electronic Packaging", Wiley U.S., 2006(2nd Edition), ISBN: 9780471466093
3. Charles A. Harper, "Electronic Packaging and Interconnection Handbook", McGraw Hill U.S., 2005(4th Edition)
4. Li, Yan, Goyal, Deepak (Editors), "3D Microelectronic Packaging: From Fundamentals to Applications", Springer, 2017, ISBN: 9783319445847, DOI: 10.1007/978-3-319-44586-1
5. Tummala, Rao R., Pymaszewski, Eugene J., Klopfenstein, Alan G. (Editors), "Microelectronics Packaging Handbook: Technology Drivers Part 1", Springer, 1997, ISBN: 9780412084317
6. William J Greig, "Integrated Circuit Packaging, Assembly and Interconnections", Springer, 2007, ISBN: 9781441939234, DOI: 10.1007/0-387-33913-2
7. R.G. Kaduskar and V. B. Baru, "Electronic Product design", Wiley India, 2011(2nd Edition), ISBN: 9788126533169

ECE18R402 RELIABILITY ENGINEERING

ECE18R402 Reliability Engineering	L	T	P	C
	3	1	0	4
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To familiarize the participants with principles, applications, and limitations of the various techniques in Reliability Engineering of Electronic components

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the theory of reliability engineering for electronics
CO2: Explain engineering techniques to estimate the reliability of contemporary designs and analyse reliability data
CO3: Identify and correct the causes of the failures on engineering systems
CO4: Demonstrate their reliability engineering knowledge systematically

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M											H		
CO3	H	H											H		
CO4	H	H											H		

Course Topics:

Unit 1: Reliability Basics

Need for Reliable products and systems – Failure distributions: Bathtub Failure Curve, and its implications and applications, Reliability Mathematics – Reliability and Maintenance of Electronic Systems – Features – Standardisation – Dependability – Affordability

Unit 2: Reliability Building

Reliable design and product quality – Failure Modes, Effects and Criticality Analysis (FMECA) – Process Reliability – Reliability Monitoring and Improving – Screening and Burn-in

Unit 3: Reliability Assessment and Package Reliability

Reliability Testing – Physics of failure – Prediction Methods – Reliability Issues of Various Packages – Reliability Tests – Reliability Predictions -Typical Failure Mechanisms – Reliability of PCBs with PEM

Unit 4: Failure Analysis and Testability

Methods of Analysis – Failure Causes – Failure Reporting, Analysis and Corrective Action Systems (FRACAS) – Case studies – Noise and Reliability – Testability of ICs – Test for microsystems – Tests for memories – Tests for microprocessors – Testability of systems – Input control test for components

Unit 5: Reliability of Electronic Components

Reliability of: Resistors, Capacitors, Inductors, Diodes, Transistors

TEXTBOOK(s):

1. Titu I. Băjenescu, Marius I. Bâzu, "Component Reliability for Electronic Systems", Artech House U.S./U.K., 2009, ISBN: 9781596934368
2. Patrick D. T. O'Connor, "Practical Reliability Engineering", Wiley India, 2008(4th Edition), ISBN: 978812651642

Reference(s):

1. Renyan Jiang, "Introduction to Quality and Reliability Engineering", Springer U.S./India, 2015, ISBN: 9783662472149, DOI: 10.1007/978-3-662-47215-6

ECE18R403 GREEN ELECTRONICS MANUFACTURING

ECE18R403 Green Electronics Manufacturing	L	T	P	C
	3	0	0	3
Pre-requisite: Electronic Devices /equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

This course aims to provide students with knowledge on theories, eco-design concepts, methods for designing a range of sustainable green electronic products.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Adhere to various environmental regulations in electronic product design
CO2: Select materials suitable for environment in electronic product design

CO3: Utilise the electronics product manufacturing and assembly techniques which are environment friendly

CO4: Comparatively assess critical factors in life cycle and recycling of electronic materials and products

CO5: Evaluate the impact of present and future public policies on materials and environment on the further development of technology and production particularly in India

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H				L	L	H						H	M
CO2		H				H	L							H	M
CO3		H				H	L							H	H
CO4		H				H	H	L						H	H
CO5		M				H	H	L				H		H	H

Course Topics:

Unit 1: Green Electronics Basics

Environmental concerns of the modern society – Electronics industry and their relevant regulations in China, European Union, and India. Restriction of Hazardous substances (RoHs) – Waste Electrical and electronic equipment (WEEE) – Energy using Product (EUP) and Registration Evaluation, Authorization and Restriction of Chemical substances (REACH).

Unit 2: Green Electronic Materials

Lead (Pb) – free solder pastes, conductive adhesives, halogen-free substrates, and components. Substitution of non-recyclable thermosetting polymer-based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products. Tin Whiskers Growth in Lead-Free Electronic Assemblies – Factors Influence Whisker Growth – Ways to Mitigate Tin Whisker Risk – Use Finite Element Modelling to Assess Tin Whisker Risk

Unit 3: Green Electronic Assembly

Green electronic Assembly – Soldering Process – Lead-Free Solder Tip and Bumps – Mitigate Deterioration of Lead-Free Tin Solder at Low Temperatures – Fatigue Characterisation of Lead-Free Solders – Thermal Fatigue of Solder Joints, Fatigue Design of Lead-Free – Electronics – Fatigue Life Prediction Based on Field Profile, Fatigue Validation of Lead-Free Circuit – Flip-Chip Technology and Assembly process – card Assembly, surface mount technology

Unit 4: Green Electronics Recycling

Management on e-waste recycle system construction – global collaboration and product disassemble technology - Occupational and environmental health perspectives of e-waste recycling

Unit 5: e-Waste Management in India

Shadows of digitization on India, Present practice and systems, disposal methods, Present processing practices – Initiatives to manage e-waste

TEXTBOOK(s):

1. John X. Wang, “Green Electronics Manufacturing: Creating Environmental Sensible Products”, CRC Press (Taylor and Francis) U.K./India, 2013, ISBN: 9781439826645
2. Rakesh Johri (Editor), “E-waste: implications, regulations, and management in India and current global practices “, Teri (The Energy and Resources Institute), 2008, ISBN: 9788179931530

Reference(s):

1. Sammy G. Shina, “Green Electronics Design and Manufacturing”, McGraw Hill International (U.S.), 2008, ISBN: 9780071495943
2. Lee H. Goldberg and Wendy Middleton, Editors, “Green Electronics / Green Bottom Line Environmentally responsible engineering”, Elsevier/Science Direct/Newnes U.S./India, 2000

V PROFESSIONAL ELECTIVE COURSES

STREAM: VLSI DESIGN

ECE18R239 RTL DESIGN USING VERILOG HDL

ECE18R239 RTL Design using VERILOG HDL	L	T	P	C
	3	0	1	4
Pre-requisite: Basics of Digital Electronics	**Course Category:** Professional Elective **Course Type:** Integrated Course			

Course Objective(s):

To design RTL models using Verilog HDL

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the need for HDL programming

CO2: Apply the various Verilog constructs used in RTL Design and able to communicate them in Oral/Written reports

CO3: Apply the coding guidelines as part of their experimentation using Verilog HDL by applying Digital Engineering principles and able to communicate them in Oral/Written reports

CO4: Use design planning techniques to start coding in Verilog RTL and able to communicate them in Oral/Written reports

CO5: Apply the Verilog in finding the solutions by knowing the limitations of Verilog for verifying large designs and able to communicate them in Oral/Written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M	M				H					H	H	L	L
CO3			M	H	H			M	M	M		L	H	M	M
CO4			M	H	H			M	M	M		L	H	M	M
CO5			M	H	H			M	M	M		L	H	M	M

Course Topics:

Unit 1: Verilog Data types, Operators

Importance of HDL - Importance of Verilog - Simulation and Synthesis-Verilog design module-Verilog testbench module-Net, Variable, Integer, Real, Time-Scalar, Vector, bit select, part select-Arrays, memories, parameter, strings-Arithmetic and Logical Operators-Relational and Equality Operators-Bitwise and Reduction Operators-Shift & Concatenation & Replication Operators-Conditional Operators

Unit 2: Levels of Abstraction, Assignments

Switch-level Modelling-Gate level and Structural Modelling-Dataflow Modelling-Behavioural Modelling

Continuous(assign) statements & procedural assignments-Procedural blocks- Initial and always blocks -Combinational and sequential with always-Block statements-sequential & parallel

Unit 3: Loops, Testbench

If-else-Case – casex, casez-For and While Loop-Forever and Repeat loop-Blocking assignments-Non-Blocking Assignments- Non-Blocking Assignments-Synchronous Circuits-Asynchronous Circuits -Introduction to self-checking testbench-Writing self-checking testbench for combinational circuits-Writing self-checking testbench for Sequential circuits

Unit 4: Delay, Task, Function

Explanation of 5 regions -Example code of Verilog stratified event queue-Race Condition-Timescale and delay control-Event control & named events-Inertial Delay-Transport Delay-Task, Function

Unit 5: FSM, Design Planning, Project

Introduction to FSM-Mealy non-overlapped-Mealy overlapped-Moore nonoverlapped-Naming convention-files, model, instance, signals-Comments & reusability-Synthesizability (delays using always and assign)-Synthesizability (blocking/non-blocking, if else, case)-Review of specification-Development of architecture and micro architecture- Design code planning-state optimization, coding guidelines- Testbench code planning -Deliverables of an RTL design engineer - Project-APB Slave and UART- Review of specification -Development of architecture and micro architecture -Design code

planning-state optimization, coding guidelines -Testbench code planning -Project-APB Slave -Review of specification -Development of architecture and micro architecture -Design code planning-state optimization, coding guidelines- Testbench code planning

Experiment:

1. Switch-level modelling -AND, OR, NAND, NOR, XOR, XNOR
2. Gate-level Modelling-Basic gates, MULTIPLEXER, Demultiplexer, Decoder, Encoder
3. Structural Modelling -Combinational circuits-MULTIPLEXER, Demultiplexer, Decoder, Encoder
4. Structural Modelling -Combinational Circuits-Adders, subtractors
5. Dataflow Modelling-Combinational Circuits -MULTIPLEXER, Demultiplexer, Decoder, Encoder
6. Dataflow Modelling-Combinational Circuits -Adders, subtractors, comparators
7. Behavioural Modelling-Combinational Circuits
8. Behavioural Modelling-Sequential Circuits-Flipflops
9. Behavioural Modelling-Sequential Circuits-Counters
10. Behavioural Modelling-Sequential Circuits-Shift Registers
11. Finite state machine-Moore model
12. Finite state machine-Mealy model

Textbook(s):

1. M. Morris R. Mano, Michael D. Ciletti, "Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog", Pearson, U.S., 2018, ISBN: 9780134529561

Reference(s):

1. Samir Palnitkar, "Verilog HDL", Pearson India, 2015(2nd Edition), ISBN: 9780132599702
2. NPTEL, "Digital Circuits and Systems", http://nptel.ac.in/courses/117106086/
3. NPTEL, "Digital System Design", http://nptel.ac.in/courses/117105080/

ECE18R255 ELECTRONIC MATERIAL PHYSICS

ECE18R255 Electronic Material Physics	L	T	P	C
	3	0	1	3.5
Pre-requisite: Basic Physics at School Level	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

The primary aim of this course is to introduce students to the fundamentals underpinning electronic properties of materials. This spans everything from the basics of electron behaviour in solids to the design of magnet and optoelectronic devices.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Analyse the wave-particle (dual) nature of electrons
CO2: Explain how conducting materials are influencing engineering design.
CO3: Analyse how the characteristics of semiconducting materials vary with carrier concentration and temperature
CO4: Describe the fundamentals of polarisable solids, optoelectronic materials and their applications, magnetic materials, and their applications
CO5: Model / Simulate experiments to study the characteristics of materials in a laboratory as an individual and team member with an understanding of their limitations
CO6: Communicate the technical information related to properties and characteristics of electronic material by oral and written reports following ethics

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M	L										H		
CO2	H	M											H		
CO3	H	H	M	L									H		
CO4	H	M											H		

CO5				M	H	L	H	H	H		L			H	H
CO6								M	H	H		L		M	M

Course Topics:

Unit 1:

Concept of thin films, preparation of thin films, Deposition of thin film using sputtering methods

Unit 2:

Crystal directions and planes, crystal properties, defects, and vacancies, two phase solids

Unit 3:

Temperature dependency of carrier concentration, conductivity and mobility, effects of temperature and doping on mobility, high field effects, the hall effect

Unit 4:

Light propagation in a homogeneous medium, absorption, scattering, luminescence, phosphors, LEDs, polarization, LCDs, electro optic effects

Unit 5:

Magnetism in materials, magnetic field and induction, magnetization, magnetic permeability and susceptibility

Experiments (Any 5):

Implement the following in MATLAB (Plot as 2D/3D wherever applicable)

1. Determination of electron concentration versus temperature
2. Determination of electron (μ_n) and hole (μ_p) mobilities versus doping concentration in semiconductor
3. Determination of Fermi function for different temperature
4. Numerical solution of the one-dimensional Schrodinger wave equation of a time independent system
5. Determination of minority carriers in extrinsic semiconductors
6. Determination of Boltzmann function for different temperature
7. Solving non-linear equations
8. Solving ordinary differential equations
9. Introduction to MATLAB commands

TEXTBOOK(s):

1. Rolf E. Hummel, "Electronic Properties of Materials", Springer India / Springer-Verlag New York, 2011(4th Edition), ISBN: 9781489998415, DOI: 10.1007/978-1-4419-8164-6
2. Safa O. Kasap, "Principles of Electronic Materials and Devices", McGraw Hill India / McGraw Hill New York, 2007(3rd Edition – Special Indian Edition) / 2018(4th Edition – U.S. Edition), ISBN: 9780070648203/ 9780078028182

Reference(s):

1. William F. Smith, Javad Hashemi and Ravi Prakash, "Material Science and Engineering (In SI Units)", McGraw Hill India, 2013(5th Edition – Special Indian Edition), ISBN: 9781259062759
2. R. Balasubramaniam, "Callister's Materials Science and Engineering", Wiley India, 2014(2nd Edition), ISBN: 9788126541607

ECE18R256 FPGA BASED SYSTEM DESIGN

ECE18R256 FPGA Based System Design	**L**	**T**	**P**	**C**
	3	**0**	**1**	**3.5**
Pre-requisite: Digital Circuits and Systems Design /equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To learn the fundamentals of FPGA architecture; To familiarise with optimised VLSI circuits design using FPGA; Design circuits using VHDL.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: **S**olve the Complex problems in Digital Circuit/Application implementation through the understanding of FPGAs with Suitable Interfacing Devices

CO2: Analyse the FPGA based digital systems design

CO3: Design and realize the optimised system design using FPGA
CO4: Design, simulate and synthesis digital circuits using modern electronic design automation (EDA) tools and FPGA
CO5: Recognize ethical and professional responsibilities in designing, conducting experiments, performing measurements and computing the parameters of circuits/applications implemented with FPGAs and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
CO6: Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, to designed digital circuits designed using FPGA

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2			M	M	H		H							H	L
CO3			L	H	H	L	H							H	
CO4			L	M	H	L	H							H	L
CO5			L	M	H	L	H							H	L
CO6								H	H	H		L		M	M

Course Topics:

Unit 1: FPGA Architecture

Digital Design and FPGA – FPGA Based System Design – FPGA Fabrics: FPGA Architectures, SRAM Based FPGAs, Permanently Programmed FPGAs – FPGA Chip I/O – Circuit Design and architecture of FPGA Fabrics

Unit 2: VHDL and FPGA Programming

VHDL essentials: Entity, Architecture – Variable types and operators – decisions and loops – Hierarchical design – debugging models – basic data types, simulation and Test benches – libraries – synthesis – physical design flow, place and route, timing analysis – VHDL issues for FPGA design

Unit 3: FPGA System Design

Design using VHDL: Flip-flops, Registers, Counters, Serial to Parallel conversion, Parallel to Serial conversion, ALU function, Decoders, Multiplexers, Fixed point arithmetic, Binary multiplier

Unit 4: FPGA Interfacing

Serial Communication: RS232 – Z- Domain functions in VHDL – Basic LPF in VHDL – Memory and VHDL – PS/2 Mouse Interface – PS/2 Keyboard Interface – VGA Interface

Unit 5: Optimised FPGA Design

Synthesis and VHDL – RTL to Behavioural Modelling in VHDL – Techniques for logic optimisation – VHDL – Optimisation Example: DES using VHDL

Experiments (Any 5):

FPGA implementation (on Altera DE1 or Spartan 3 or Virtex 5 boards) of a complete digital system like

1. Ripple Carry Adder
2. 16-bit Shift and Add Multiplier
3. Pipelined Serial Adder to Add/Subtract 8 Bit Number of Size, 12 Bits Each in 2's Complement
4. Traffic Light Controller as FSM
5. 24 Hours Real Time Clock using FPGA's master crystal clock with HH:MM display on FPGA's 7-Segment LED display
6. FSM Sequence Detector
7. Vending machine controller
8. PRBS application
9. Interfacing devices (Mouse or Keyboard)

TEXTBOOK(s):

1. Peter Wilson, "Design Recipes for FPGAs: Using Verilog and VHDL", Elsevier (Newnes) U.S./India, 2015(2nd Edition), ISBN: 9780080971292
2. Wayne Wolf, "FPGA-Based System Design", Pearson U.S. / Prentice Hall India, 2010(2nd Edition), ISBN: 9788131724651

Reference(s):

1. Seetharaman Ramachandran, "Digital VLSI Systems Design: A Design Manual for Implementation of Projects on FPGAs and ASICs using Verilog", Springer India/Netherlands, 2007(1st Edition), ISBN: 9789401782777, DOI: 10.1007/978-1-4020-5829-5
2. Pong P. Chu – RTL Hardware Design using VHDL: Coding for efficiency, portability and scalability", Wiley-Interscience/IEEE Press, U.S. – 2006, ISBN: 9780471720928
3. Gina R. Smith, "FPGAs 101: Everything you need to know to get started", Elsevier/Newnes India, 2010(1st Edition), ISBN: 9781856177061
4. Cem Unsalan and Bora Tar, "Digital System Design with FPGA: Implementation Using Verilog and VHDL", McGraw Hill India, 2017(1st Edition), ISBN: 9789387067509
5. http://nptel.ac.in/courses/117106092/

ECE18R314 CMOS ANALOG IC DESIGN

ECE18R314 CMOS Analog IC Design	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R203 Analog Integrated Circuits / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To understand the multi-stage transistor circuits; To study the noise modelling and analysis procedure associated with various MOS circuits; To study Op-Amp circuits and its stability conditions; To study in general feedback concept in MOS circuits; To learn the concepts of Op-Amp frequency compensation, capacitor switches and PL

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Analyse the various bonds and crystal structures with the knowledge of mathematics and basic sciences

CO2: Explain the Engineering of the electronic band structure in semiconductor materials

CO3: Explain the concepts of doping, career concentration and their effect in conduction of semiconductors

CO4: Develop an understanding of the optical properties of semiconductor

CO5: Describe the non-equilibrium situations in semiconductor structures

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H	M	L										H		
CO3	H	M											H		
CO4	H	M											H		
CO5	H	M											H		

Course Topics:

Unit 1: Basics

Analog IC Design Flow – Analog Signal Processing – the p-n Junction and characteristics – the MOS transistor and characteristics – passive components

Device Models: Large-Signal and Small-Signal Models of MOS transistor – Subthreshold MOS model – Computer Simulation models

Unit 2: Analog CMOS Sub circuits

MOS Switch – MOS Diode/Active Resistor – Current Sinks and Sources – Current Mirrors – Current and Voltage References – Temperature-Independent References

Unit 3: CMOS Amplifiers

Inverters – Frequency response of CS and CG stages – Noise in CS, CG, Cascode and source follower stages Single ended and differential operation- Basic Differential pair- Common mode response- Differential pair with MOS loads- Gilbert Cell – Differential Amplifiers – Cascode Amplifiers – Current Amplifiers – Output Amplifiers – Miller effect

Unit 4: CMOS Operational Amplifiers

CMOS Operational Amplifiers: Design of CMOS Op Amps – Compensation – Two-Stage Op Amps: gain boosting, common mode feedback, input range limitation, slew rate, power-supply rejection ratio and noise of Two-Stage Op Amps – Cascode Op Amps – Simulation and Measurement of Op-Amps

Unit 5: Comparators

Characteristics – Two-stage open-loop comparators – improving its performance.

TEXTBOOK(s):

1. Phillip E. Allen, Douglas R. Holberg, "CMOS Analog Circuit Design", Oxford University Press India, 2013 (3rd Indian Edition), ISBN: 9780198097389
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill India, 2016(33rd Reprint), ISBN: 9780070529038

Reference(s):

1. R. Jacob Baker, "CMOS Circuit Design Layout and Simulation", Wiley/IEEE Press India/U.S., 2009 (Reprint)
2. Tertulien Ndjountche, "CMOS Analog Integrated Circuits: High-Speed and Power-Efficient Design", CRC Press (Taylor & Francis) U.K./India, 2011, ISBN: 9781439854914
3. Gray, Hurst, Lewis, Meyer, "Analysis and Design of Analog Integrated Circuits (ISV)", Wiley U.S., 2010(5th Edition), ISBN: 9788126521487
4. http://nptel.ac.in/courses/117101105/

ECE18R315 MICROELECTRONICS PHYSICS

ECE18R315 Microelectronics Physics	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R255 Electronic Material Physics / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To expose the students, about basic phenomena and concepts of semiconductor physics, crystal structures, band structures, dopant issues, carrier statistics, optical properties, non-equilibrium situations

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the Engineering of the electronic band structure and crystal structure of semiconductor materials

CO2: Analyse semiconductor band structure and electrical behaviour

CO3: Develop an understanding of the optical properties of semiconductor

CO4: Describe the non-equilibrium situations in semiconductor structures

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M	L										H		
CO3	H	M	H										H		
CO4	H	M											H		

Course Topics:

Unit 1: Bonds and Crystals

Covalent Bonds – Ionic Bonds – Mixed Bonds – Metallic Bond – van-der-Walls Bond – Lattice in Crystals – Reciprocal in Lattice – Crystal Structures

Unit 2: Band Structure

Bloch's Theorem – Free-electron dispersion – Kronig-Penney model – Brillouin Zones – Electrons in a periodic potential – Band structure of selected semiconductors – Alloy semiconductors – Amorphous semiconductors – Semiconductor bandgaps and temperature dependence – Electron mass – Holes

Unit 3: Electronic Defect States

Fermi Distribution – Carrier concentration – Intrinsic conduction – Shallow impurities (doping) – Quasi-fermi levels – deep levels

Unit 4: Optical Properties

Reflection and diffraction – Electron-Photon interaction – Band-Band transitions – impurity absorption – free-carrier absorption

Unit 5: Transport and Recombination

Conductivity – Low-field transport – Hall-effect – High-field transport – High-frequency transport – Diffusion – Continuity equation – Heat conduction – Coupled heat and charge transport

Band-Band Recombination – Free-exciton recombination – Bound-exciton recombination – Donor-Acceptor pair impurity transitions – Inner-impurity recombination – Field effect – Surface recombination – excess-carrier profile

TEXTBOOK(s):

1. Marius Grundmann, "The Physics of Semiconductors: An Introduction Including Nanophysics and Applications", Springer, India, 2016(3rd Edition), ISBN: 9783319238791, DOI: 10.1007/978-3-319-23880-7
2. M. Balkanski and R. F. Wallis, "Semiconductor Physics and Applications", Oxford University Press U.K., 2000, ISBN: 9780198517405

Reference(s):

1. Angus Rockett, "The Materials Science of Semiconductors", Springer/Spring-Verlag India/U.S., 2008(1st Edition), ISBN: 9781441938183, DOI: 10.1007/978-0-387-68650-9
2. S.S. Islam – Semiconductor Physics and Devices", Oxford University Press India -2005, ISBN: 9780195677294

ECE18R351 PROCESS AND DEVICE SIMULATION BY TCAD

ECE18R351 Process and Device Simulation by TCAD	L	T	P	C
	3	0	1	3.5
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To learn the fundamentals of VLSI processes and devices; To model the VLSI processes and devices with TCAD; To better understand the modern technology development and transistor design and optimization through process variation.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basics related to modelling of devices and TCAD
CO2: Design and simulate the processing and characteristics of required devices
CO3: Apply basic trade-off in process influence on device performance, and technology optimisation through computer design of experiments
CO4: Develop practical skills in state-of-the-art technology computer-aided design (TCAD) simulation tools that are routinely used in all semiconductor wafer fabs and apply them for the given problems/experiments following the ethics and safety norms
CO5: Document the experiment process and summarise the experience

Mapping of Course Outcome(s):

CO	PO	PSO

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H	M	
CO2	H	M	H	M	M								H	H	L
CO3		H	M	M	L									H	
CO4				M	H	L	M	H	L		L			H	L
CO5								M	M	M		L		M	M

Course Topics:

Unit 1: Basics

Physical Modelling: Forms of physical modelling: analytical modelling vs. numerical modelling – Design sequence with computation: Process simulation – Device simulation – Compact Modelling or Parameter Extraction and Circuit Simulation

Semiconductor Companies: Pyramid level illustration of semiconductor industry – types of semiconductor companies – IC Development flow: Planning stage, design stage, fabrication and test stage, reliability, and qualification stage

TCAD: What and Why – Process TCAD and Device TCAD – History – TCAD a Finite Element Method Analysis – Compact model vs. TCAD – Hierarchy of transport models – Device simulation sequence – Technology Design flow without and with TCAD – TCAD Design flow – 2D vs. 3D TCAD

Unit 2: Process Simulation

Basic semiconductor processing steps – TCAD Models: Diffusion Model in TCAD – Stress Model – Oxidation Model – Implant Models – Etch Model – Deposit Model

Unit 3: Device Simulation

Numerical solution methods – Non-linear iteration – initial guess requirement – Semiconductor Device Analysis – Field-Effect Structures – Carrier Densities: Equilibrium case and Non-Equilibrium case – Carrier Transport and Conversation – The PN junction: Equilibrium and Non-equilibrium conditions The MOS capacitor – Basic MOSFET I-V Characteristics –Threshold Voltage in Nonuniform Substrate – MOS Device Design by Simulation.

Unit 4: MOSFET Characterisation

Device models for circuit simulation – Threshold voltage characterisation – I-V characterisation – Statistical characterisation

Unit 5: Design Examples

n-type MOSFET simulation – CMOS technology process flow

Experiments (Any 5):

1. Simulate the oxidation process in integrated circuit fabrication (Process Simulation)
2. Simulate the ion implantation in integrated circuit fabrication (Process Simulation)
3. Simulate the diffusion in integrated circuit fabrication (Process Simulation)
4. Design and simulate the processing and characteristics of nMOS transistors for a given 2-um (micrometer) N-well CMOS process - Observe layer structures and profiles at various stages of the process; Visualize MOS transistor operation in terms of doping, potential, field, carrier, current distributions; Observe and relate device performance parameters to process variations; Understand design trade-offs in device performance optimization; Learn data analysis and graphical prediction from numerical data;
5. Extraction of MOSFET SPICE parameters related to gate voltage capacitance, output characteristics, transfer characteristics
6. Extraction of bipolar SPICE Gummel-Poon parameters related to forward Gummel (Ic and Ib vs. Vbe) characteristics; Extraction of bipolar SPICE Gummel-Poon parameters related to reverse Gummel (Ie and Ib vs. Vbc) characteristics

TEXTBOOK(s):

1. Chandan Kumar Sarkar (Editor), "Technology Computer Aided Design: Simulation for VLSI MOSFET", CRC Press/Routledge Taylor and Francis Group India, 2017(Reprint), ISBN: 9781138075757
2. Yannis Tsividis, Colin McAndrew, "Operation and Modelling of the MOS Transistor", Oxford University Press India, 2013(3rd Edition), ISBN: 9780198097372

Reference(s):

1. Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press India, 2012(2nd Edition), ISBN: 9780198084808
2. Chinmay K. Maiti, "Introducing Technology Computer-Aided Design (TCAD): Fundamentals, Simulations, and Applications", CRC Press/Routledge Taylor and Francis Group India, 2017, ISBN: 9789814745512
3. Simon Li, Yue Fu, "3D TCAD Simulation for Semiconductor Processes, Devices and Optoelectronics", Springer / Dordrecht Heidelberg India/ New York London, ISBN: 9781461404804, DOI: 10.1007/978-1-4614-0481-1
4. Robert W. Dutton, Zhiping Yu, "Technology CAD — Computer Simulation of IC Processes and Devices", Springer / Springer Science + Business Media India/ New York, ISBN: 9781461364085, DOI: 10.1007/978-1-4615-3208-8
5. Narain D. Arora, "MOSFET Models for VLSI Circuit Simulation: Theory and Practice (Computational Microelectronics Series)", Springer/Springer-Verlag Wien India/ New York, 2009 (Reprint), ISBN: 9783709192498, DOI: 10.1007/978-3-7091-9247-4
6. Simon M. Sze, Ming-Kwei Lee, "Semiconductor Devices: Physics and Technology", Wiley India, 2012(3rd Edition - ISV), ISBN: 9788126556755
7. https://www.silvaco.com/content/kbase/UMichigan_TCAD.pdf
8. http://www.ntu.edu.sg/home/exzhou/Teaching/EE4613/Notes/Design.pdf
9. http://nptel.ac.in/courses/103106075/

ECE18R352 CMOS DESIGN

ECE18R352 CMOS Design	L	T	P	C
	3	0	1	3.5
Pre-requisite: Digital Circuits and Systems Design / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To learn the fundamentals of VLSI design; To familiarize with VLSI circuits design.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the characteristics of CMOS transistors
CO2: Identify the interactions between process parameters device structures, circuit performance and system design
CO3: Design models of CMOS circuit that realize specified function
CO4: Analyse and Implement various CMOS static and dynamic circuits
CO5: Work as part of a team and as individual effectively in designing, conducting experiments, performing measurements, and computing the parameters of circuits integrated using CMOS technology in laboratory following the safety procedures and ethics

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M	M										H		
CO3	H	M	H	L									H		
CO4		H				H	H	M		H		H		H	H
CO5			M	H	H			M	M	M	L	L		M	M

Course Topics:

Unit 1: MOS Transistor Principle

MOS transistors – CMOS Logic – VLSI design flow – Introduction Fabrication – Packaging and Testing – Circuit and System Representations – Introduction MOS transistor theory – MOS Device design equations – Ideal I-V Characteristics, C-V Characteristics, Non-Ideal I-V effects; Complementary CMOS inverter – DC characteristics – Stick Diagrams

Unit 2: Circuit Characterisation and Performance Estimation

Resistance estimation – Capacitance estimation – Inductance estimation – switching characteristics Delay estimation-introduction, Transient response – RC delay model – Elmore delay model – Linear delay model – CMOS gate transistor sizing – Logical effort and transistor sizing – Timing analysis delay models – Power Dissipation Dynamic power – Static power

Unit 3: Combinational CMOS Logic Circuits

Circuit Families: Static CMOS – Ratioed Circuits – Cascode Voltage Switch Logic – Dynamic Circuits – Pass Transistor Logic – Transmission Gates – Domino – Dual Rail Domino – CPL – DCVSPG – DPL

Unit 4: Sequential CMOS Logic Circuits

Static latches and Registers – Dynamic latches and Registers – Pulse Registers – Sense Amplifier Based Register – Pipelining – Schmitt Trigger – Monostable Sequential Circuits – A-stable Sequential Circuits.

Unit 5: CMOS System Design

Arithmetic Building Blocks and Data Paths: Adders – Multipliers – Shifters – ALUs – power and speed trade-offs

Designing Memory and Array structures: Memory Architectures and Building Blocks – Memory Core – Memory Peripheral Circuitry

Special purpose systems– packages and cooling – Power distribution – clocks

Experiment:

1. Design and Simulation of CMOS inverter and obtaining its transfer characteristics and Noise Margin
2. Layout design of Digital logic circuits
3. Design of a simple combinational circuit in CMOS
4. Design of a simple sequential circuit in CMOS
5. Parasitic extraction, Identification of critical paths, power consumption of Digital Logic circuits

TEXTBOOK(s):

1. Debaprasad Das, "VLSI Design", Oxford University Press India, 2016(2nd Edition), ISBN: 9780198094869
2. Neil H.E. Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson India, 2015(4th Edition), ISBN: 9789332542884

Reference(s):

1. Jan Rabaey, "Digital Integrated circuit – A design perspective", Pearson Education, II Edition
2. http://nptel.ac.in/courses/117101004/

ECE18R353 MEMS TECHNOLOGY AND MODELLING

ECE18R353 MEMS Technology and Modelling	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R254 Electronic Sensors and Measurements with LABVIEW / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

This course is designed to introduce to students about the fundamental knowledge and skills of state-of-the-art MEMS technology. Basic concepts in MEMS design, working principle, analysis, simulation, and fabrication will be introduced. MEMS industrial applications in various areas will be discussed.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Comprehend the significance and role of MEMS in the present contemporary world with an understanding of different aspects of a microsystem

CO2: Design sensors and actuators using the transduction principles knowledge obtained

CO3: Explain the mechanics of components used in a MEMS and model the devices using those principles

CO4: Develop a set of process steps to obtain a desired microfabricated device and analyse device structure and performance from the given set of fabrication steps

CO5: Design and Analyse performance of a microsystem by using the CAD tools in laboratory as individual or as a team member following the ethics and safety procedures

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H							L	M	H				M	M
CO2		M	H										H		
CO3	H	M											H	L	
CO4		M	L											H	L
CO5	H	L												H	M

Course Topics:

Unit 1: Basics of MEMS

Components of a smart system – Scaling effects – Evolution / Historical Background – Application areas of smart system – Materials for MEMS: Silicon, Ceramics, Polymers and Metals – Properties and synthesis of carbon nanotubes

Unit 2: Microsensors and Actuators

Working principle of sensors and actuators – block diagram, sensing, actuating

Sensors for smart systems: conductometric – piezoresistive – magnetostrictive – semiconductor based – acoustic – acoustic – polymeric – carbon nanotube

Actuators for smart systems: Electrostatic, Electromagnetic, Electrodynamic, Piezoelectric, Electro-strictive, Magnetostrictive, Electrothermal transducers – comparison of actuators

Sensors and actuators: Mechanical sensors and actuators – beams and cantilevers, accelerometers, shape memory alloys, Electrostatic sensors and actuators – parallel plate capacitors, comb drive sensor and actuator Piezoelectric sensors and actuators – cantilever based piezoelectric sensor and actuator Thermal actuators – single and bimorph thermal actuators

Unit 3: Applications and Design Examples

Silicon capacitive accelerometer – Conductometric gas sensor – Magnetic micro relay – RF MEMS – Piezoelectric inkjet print head – Micromirror array for video projection

Design of: IDT based accelerometers – Fibre-optic gyroscopes – Piezoresistive pressure sensor – SAW based wireless strain sensor

Unit 4: Mechanics of Solids, Modelling of Systems

Deformable elements: Bar, Beam – Energy methods for elastic bodies – Layered beams – Bimorph effect and Linear Thermal expansion – Bending, Stress and Stress gradients, Strain – Hook's law – Poisson effect and the anticlastic curvature of beams – In-plane stresses – Dynamics – Introduction to Theory of elasticity – Theory of laminated composites – Basic modelling elements in mechanical, electrical and thermal systems – Finite element modelling of a 3-D composite laminate with embedded piezoelectric sensors and actuators – modelling of micro electro mechanical systems

Unit 5: Fabrication, Integration and Packaging

Micromachining Fabrication: Silicon as material, deposition techniques, lithography, doping, etching, silicon micromachining, wafer bonding, LIGA process, special materials like polymers and ceramics for microsystems

Integration and Packaging: Integration of microsystems and microelectronics – MEMS packaging – Packaging techniques and issues in packaging

Experiments (Any 5):

1. Study of MEMS CAD design and simulation software
2. Building a 3D model
3. Model and stress analysis
4. Micromirror design
5. Piezoelectric sensor-based design
6. Gyroscope design
7. Resonator device
8. Micropump design
9. Fabrication process study

TEXTBOOK(s):

1. G.K. Ananthasuresh K.J. Vinoy S. Gopalakrishnan K.N. Bhat V.K. Aatre, "Micro and Smart Systems: Technology and Modelling", Wiley India, 2012, ISBN: 9788126527151

2. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies", Wiley India, 2006, ISBN: 9788126531707

Reference(s):

1. Nitaigour Premchand Mahalik, "MEMS", McGraw Hill India, 2007, ISBN: 9780070634459
2. Stephen D. Senturia, "Microsystem Design", Springer/ Springer Science+Business Media / Kluwer Academic Press India/U.S., 2013(Reprint), ISBN: 9781475774580, DOI: 10.1007/b117574
3. Markku Tilli Mervi Paulasto, Krockel Teruaki Motooka Markku Tilli Veikko Lindroos (Editors), "Handbook of Silicon Based MEMS Materials and Technologies", Elsevier/ William Andrew India, 2015(2nd Edition), ISBN: 9780323299657
4. Roger W. Pryor, "Multiphysics Modelling Using COMSOL: A First Principles Approach - Jones and Bartlett Learning India/U.S., 2011, ISBN: 9780763779993
5. Attilio Frangi, Carlo Cercignani, Subrata Mukherjee, Narayan Aluru (Editors), "Advances in Multiphysics Simulation and Experimental Testing of MEMS (Computational and Experimental Methods in Structures: Volume 2)", Imperial College Press /World Scientific Publishing, ISBN: 9781860948626
6. Tai-Ran Hsu, "MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering", Wiley U.S., 2008(2nd Edition), ISBN: 9780470083017
7. http://nptel.ac.in/courses/117105082/

ECE18R354 DIGITAL LOGIC AND STATE MACHINE DESIGN

ECE18R354 Digital Logic and State Machine Design	L	T	P	C
	3	0	1	3.5
Pre-requisite: Digital Circuits and Systems Design /equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To learn the fundamentals of digital design using state machines and high-level specifications.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Write high level specification of a combinational system
CO2: Design and analyse multilevel gate networks
CO3: Analyse sequential circuit timing characteristics and design sequential networks using state machine concepts
CO4: Design, conduct experiments and analyse the results with respect to sequential networks by applying the concept of state machines
CO5: Work as part of a team and as individual effectively following the safety procedures and ethics
CO6: Communicate the technical information related to analysis and design of digital systems in high-level specifications and using state machines by oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M												H	
CO2		H	M										H	L	
CO3		L	H	H									H		
CO4			H	H	H	L	M						H	H	
CO5								H	H		L			M	M
CO6								L	L	H				M	M

Course Topics:

Unit 1: Specification Levels

Digital Logic and Digital systems: Specifications and implementation, Analysis, and design –Combinational systems: definition and specification levels – High-level specification of combinational systems – data representation and coding – Binary specification of combinational systems

Unit 2: Design of Gate Networks

Definition of gate networks – Description and characteristics of gate networks – sets of gates – Analysis of gate networks – Multilevel gate networks – Derived logical building blocks,

Unit 3: Timing Analysis and Clocking

Canonical form of sequential networks – Synchronous timing analysis/ characteristics – Clock skew – Clock jitter – need for state machines – Flip-flops and metastability – the state machine, Basic concepts in state machine analysis – State changes referenced to clock – Input forming logic – Output forming logic

Unit 4: Design of Synchronous Systems

Generation of state diagram from timing diagram, State reduction – General state machine architecture – State machine reliability and timing considerations – Asynchronous state machines: Fundamental mode model, Problems in asynchronous circuits, Basic design principles

Unit 5: Design Examples

Tester control – Frame counter – Serial adder – Reaction timer – Asynchronous receiver – Fundamental mode design example

Experiments (Any 5 to be designed in VHDL/Verilog and simulated):

1. Vending Machine Controller
2. Traffic Light Controller
3. Frame Counter
4. Serial Adder
5. Asynchronous receiver
6. Reaction Timer
7. Any Fundamental Mode Asynchronous Design

TEXTBOOK(s):

1. Comer, "Digital Logic and State Machine Design", Oxford University Press India, 2012(3rd Edition), ISBN: 9780198092094
2. Milos Ercegovac, Tomas Lang, Jaime H. Moreno, "Introduction to Digital Systems", Wiley India - 2014, ISBN: 9788126522514

Reference(s):

1. Mark Balch, "Complete Digital Design: A Comprehensive Guide to Digital Electronics and Computer System Architecture", McGraw Hill India / U.S., 2014(Reprint)

ECE18R370 PYTHON PROGRAMMING FOR DESIGN AND VERIFICATION ENGINEERS

ECE18R370 Python Programming for Design and Verification Engineers	L	T	P	C
	3	0	2	4
Pre-requisite: RTL Design using Verilog	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To learn the basic python programming. To understand application of python in RTL design and verification.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand basic python constructs.
CO2: Create and execute python programs.
CO3: Understand the concepts of file I/O and able to read data from a text file using python.
CO4: Apply python in RTL design.
CO5: Apply python in RTL verification.
CO6: Communicate the technical information related to python programming for RTL design and verification, by means of oral and written reports.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H							M				L	H		L
CO2		M	L	M	M			M				L	M	H	L
CO3	H					L	L					L	H		L
CO4	L	H	H	M	H	M	L	M	M			M	M	H	M
CO5	L	H	H	M	H	M	L	M	M	L	L	M	M	H	M
CO6				L	L			M	H	M		M	M	H	L

Course Topics:

Unit 1: Python Basics

Introduction to python - Python scripting rules – datatypes – data structures-declaring variables- operators – loops – conditional statements – decision making-Examples.

Unit 2: Functions, Modules

Functions: defining functions, calling functions, function arguments, types of functions – strings and its operations – functions as object.

Unit 3: Files and Exception

Classes: classes instance, methods, properties, multiple inheritance - Iterators and generators – decorators – File operations – Errors and exceptions.

Unit 4: RTL Design in Python

Introduction to MyHDL- Goal of MyHDL - Basic MyHDL simulation, decorators, generators- MyHDL constructs - Signals and concurrency, Parameters, ports and hierarchy - Hardware-oriented types - The intbv class, Bit indexing, Bit slicing, The modbv class , Unsigned and signed representation - Structural modelling : Introduction, Conditional instantiation, Converting between lists of signals and bit vectors , Inferring the list of instances- RTL modelling: Introduction, Combinatorial logic, Sequential logic, FSM - High level modelling-:bus functional procedures, memory with built in types

Unit 5: RTL Verification in Python

Testbench, simulation, waveform tracing for combinational circuit- Testbench, simulation, waveform tracing for sequential circuit- Conversion to Verilog: Introduction, Conversion of lists of signals, Conversion of Interfaces, Assignment issues, conversion of testbench - Conversion to Verilog examples: Combinatorial logic with tool demo, Sequential logic with tool demo- UART explanation- How to design and verify UART.

Experiments:

1. Programs based on mathematical operations
2. Programs based on datatypes
3. Programs based on decision making statements
4. Programs based on Loops
5. Programs based on string and string methods
6. Functions
7. Implementation of classes and objects
8. Implementation of basic gates using MyHDL
9. Implementation of comparator using MyHDL
10. Implementation of counter using MyHDL
11. Implementation of flipflop using MyHDL
12. Implementation of FSM - sequence detector using MyHDL

Textbooks:

1. Jan Decaluwe, “MyHDL manual”, Release 0.11, April 10,2020 (Online book - http://docs.myhdl.org/en/stable/index.html)

Reference(s):

1. Meher Krishna Patel, “FPGA designs with MyHDL”, 2018

2. http://www.myhdl.org/
3. Swapnil Sapre, "Python: A Kids and Hardware Engineer's Perspective", Lulu Press, 2012, ISBN: 9781300339403.

ECE18R376 ASIC DESIGN FLOW

ECE18R376 ASIC Design Flow	L	T	P	C
	3	0	2	4
Pre-requisite: Digital Circuits and Systems Design /equivalent	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To learn about the various ASIC architectures, ASIC design flow; To familiarise with terminologies related to ASIC design flow while interacting with peers; List the various input and output files and its formats for each step in the flow.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain ASIC and its various types.
CO2: Explain the importance of SV & UVM design methodologies.
CO3: Describe the challenges in implementing large ASIC designs and generating the gate level netlist.
CO4: Apply the basic concepts of STA to evaluate the delay of the circuits and analyse the generated report.
CO5: Understand the issues involved in PnR flow of ASIC design.
CO6: Communicate the technical information related to design of digital circuits using Verilog and analyse different timing paths in STA.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H		M	M	H								H	M	
CO2	H				L	L	L						H	M	
CO3		M	M		M			L	L			H	H	M	L
CO4	M				M				L			H	H	M	L
CO5		M		M	M	L	L		L			H	H	M	L
CO6					M			L	M	H	M	H		H	L

Course Topics:

Unit 1: RTL Design, Verification using Verilog

Introduction to ASIC flow, Specification, architecture & micro-architecture RTL design, Arithmetic and Logical Operators, Relational and Equality Operators, Bitwise and Reduction Operators, Conditional Operators, Dataflow, structural & behavioural modelling, Continuous(assign) statements & procedural assignments, Synchronous Circuits theory, Implementation of different modelling methods, Verification plan.

Unit 2: RTL Design using SV, CDC and Linting

Implementation of verification method –Verilog, Introduction to SV & UVM, Verification environment using SV & UVM, Comparison between Verilog & SV constructs - basic data types, Comparison between Verilog & SV constructs – loops, Analysis of GLN, Gate level simulation (GLS), Linting and CDC checks.

Unit 3: Synthesis, Design for Test and Static Timing Analysis

Emulation (prototyping on FPG), Introduction to logic synthesis, preparing for synthesis, compiling a design, Optimisation flow & optimisation techniques, DFT, terminologies, types of scan faults, Implementation of DFT, Introduction to LEC, Introduction to STA, Terminologies in STA, delay calculation in combo path.

Unit 4: Library and Characterisation

Delay calculation in sequential path & combinational path, Introduction to library and characterization, characterization methods & techniques, Modelling of characterised data**.**

Unit 5: Auto Place and Route Flow

Introduction to APR flow, Floorplan & powerplan, Routing concepts & introduction to DFM, LEC post layout, ECO flow, Parasitic Extraction, Post-layout STA & Back-annotation, Physical verification & tape out.

Experiments:

1. Write a Verilog code to implement the specified functionality & verify the functionality
2. Write an RTL code to design a full adder circuit & verify the functionality
3. Write an RTL code to design a comparator circuit & verify the functionality
4. Write an RTL code to design all basic flops & verify the functionality
5. Write an RTL code to design a 3 bit up/down counter & verify the functionality
6. Write an RTL code to design a shift register circuit & verify the functionality
7. Generate the netlist file using the synthesis tool - creating the setup files
8. Generate the netlist file using the synthesis tool - execution
9. Generate a schematic from gate level netlist
10. Load a netlist and understand all the basic commands of STA tool
11. STA - Analyse the timing reports of combo path
12. STA - Apply the constraints to meet the given specification
13. Apply the additional timing constraints related to input & output delays
14. Analyse the setup & hold timing reports of reg-reg timing path
15. Analyse the setup & hold timing reports of in-out, in-reg timing path

Textbook(s):

1. Sandip Kundu, Aswin Sreedhar, “Nanoscale CMOS VLSI Circuits: Design for Manufacturability”, McGraw Hill, 2010, ISBN: 978-0071635196

Reference(s):

1. Harry Bleeker, Peter van den Eijnden, Frans de Jong, “Boundary-Scan Test: A Practical Approach”, Springer, 2011, ISBN: 978-1-4613-6371-2.
2. Himanshu Bhatnagar, “Advanced ASIC Chip Synthesis”, Springer, 2012, ISBN: 0-7923-7644-7
3. Khosrow Golshan, “Physical Design Essentials: An ASIC Design Implementation Perspective”, Springer, 2007, ISBN: 978-0-387-36642-5.

ECE18R377 SYSTEM VERILOG FOR RTL VERIFICATION

ECE18R377 System Verilog for RTL Verification	L	T	P	C
	2	0	2	3
Pre-requisite: RTL Design using Verilog	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To learn the System Verilog constructs and apply constructs to model System Verilog testbench architecture.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe RTL verification and its need.
CO2: Understand different System Verilog constructs to build verification environment.
CO3: Use SystemVerilog specific constructs, randomization, and OOP concepts to run test cases/regressions, for efficient functional and code coverage.
CO4: Perform functional simulations to validate and debug designs using an industry standard RTL simulator.
CO5: Develop the SystemVerilog testbench architecture for a given RTL design.

CO6: Develop a complete and comprehensive verification plan for the given design specifications of a digital design.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H					M		M				M	L		L
CO2	H	M		M	H			M	L			M	M	H	L
CO3	H	M		M	H			M	L			M	M	H	L
CO4	H			M	H			M	L			L	M	H	L
CO5		M	H	M	H		L	M	H		L	M	H	H	L
CO6		M	H	M	H	L	L	M	H	H	L	M	M	H	M

Course Topics:

Unit 1: Fundamentals of System Verilog

Importance of System Verilog– Limitations of Verilog– Features of System Verilog– Datatypes – Arrays-Array manipulation methods.

Unit 2: System Verilog Constructs

Stratified event queue–Procedural constructs: combinational, latched, sequential logic – Loops– Functions, tasks –Parallel blocks: fork_join, fork_join_any, fork_join_none.

Unit 3: System Verilog Constructs – OOPs Concepts

OOP's concepts: Handle & object creation, Parameterized class, Typedef class, Handle assignment, Shallow and deep copy, Static properties and Static methods, Inheritance and super keyword, Encapsulation, Polymorphism, Casting.

Unit 4: Advanced System Verilog Constructs

Interface- Modport- Virtual interface- Clocking block- Program Block-Randomization: Randomization & Disable, Randomization methods, Constraint block & disable constraints, Inclass & Extern constraints, Inside & inverted inside constraints, Weighted distribution, Implication operator & if-else constraints, Foreach constraints & functions, Inline constraints, Unique & bidirectional constraints- Events- Mailboxes- Semaphore

Unit 5: Modelling System Verilog Testbench Blocks and Coverage

Code coverage – Functional coverage – System Verilog architecture: Explanation of different blocks of architecture.

Experiments:

1. Example program for Datatypes -Enumerated type
2. Program implementing Arrays- array manipulation
3. Program demonstrating Loops, break statements
4. Implementation of Functions and tasks
5. Implementation of Interface
6. Implementation of Classes-inheritance
7. Classes-encapsulation example program
8. Classes-polymorphism example program
9. Randomization example program
10. Modelling SV testbench for DUT

Textbooks:

1. Chris Spear and Greg Tumbush, "SystemVerilog for Verification: A Guide to Learning the Testbench Language Features", Springer, 2012 (Third Edition), ISBN:978-1461407140

References

1. "SystemVerilog: Unified Hardware Design, Specification, and Verification Language"–The IEEE 1800-2012 LRM3.

2. Ashok B. Mehta, "System Verilog Assertions and Functional Coverage", Springer, 2020 (Third Edition), ISBN: 9783030247393, DOI: 10.1007/978-3-030-24737-9.
3. Janick Bergeron, "Writing Testbenches Using SystemVerilog", Springer 2006, ISBN: 978-1-4419-3978-4, DOI: 10.1007/0-387-31275-7.

ECE18R380 STATIC TIMING ANALYSIS

ECE18R380 Static Timing Analysis	L	T	P	C
	2	0	2	3
Pre-requisite: ASIC Design Flow	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To apply concepts and perform timing calculations for simple circuits; To familiarise with industry standard timing analysis tools to perform setup timing analysis for complex designs: Use terminologies effectively while communicating with peers in the industry: To analyse timing reports from a timing analysis tool.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the concepts behind Timing Analysis and use of Static Timing Analysis (STA) in context with the ASIC flow.
CO2: Analyse the importance of design constraints.
CO3: Describe the need for timing exceptions.
CO4: Define various steps to fix timing violations.
CO5: Identify different signal integrity issues.
CO6: Communicate the technical information related to analysing different timing paths and reports.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M			M				M				H	M	
CO2	H	M	M	M	M	L	L						H	M	
CO3	H	M	M	M	M			L				H	H	M	L
CO4	H	M	M	M									H	M	
CO5	H	M	M	M				L	M			H	H	M	L
CO6	H	M	M	M					M	M	M	H	H	M	L

Course Topics:

Unit 1: Static Timing Analysis (STA) Basics **6 Hours**

Introduction to timing analysis, Terminologies used in STA, delay calculation in combinational logic, Introduction to design & technology data, Design & library objects, delay calculation in sequential circuit, inputs & outputs of STA.

Unit 2: Timing Constraints in STA **6 Hours**

Clocks & their characteristics, on reg-reg, in-reg & reg-out delay calculation, Timing constraints, Environmental attributes, Additional timing constraints.

Unit 3: Additional Timing Constraints in STA **6 Hours**

Introduction to timing exceptions, back annotation, PVT variations & their effect on timing, timing reports, in-out path & in-reg path, reg-reg path, reg-out & multi cycle path. Multiple clocks & exceptions, effects of clock skew on timing

Unit 4: Advanced Concepts in STA **6 Hours**

Fixing timing violations, advanced concepts in STA, fixing timing violations, reg-reg with diff clock freq, reg-reg with diff clock edge, reg-reg with slew propagation, multicycle path**.**

Unit 5: Signal Integrity and Back Annotation **6 Hours**

Signal integrity & timing models, reg-reg with CRPR, with inverting clock at capture path, finding max operating freq, latch-reg path, reg-latch path, latch-latch with diff clock edge path, parasitic extraction & back annotation.

Experiments:

1. Load a netlist and understand all the basic commands of STA tool.

2. Using STA tool calculate the cell delay & o/p transition for a given load & given transition.
3. Load a netlist and apply the constraints related to clock and input/output delays in STA tool.
4. Apply the timing constraints to meet the given specification & validate the constraints.
5. Apply the timing constraints related to input transition and load & validate the constraints.
6. Apply the additional timing constraints related to input & output delays.
7. Apply the constraints related to exceptions and analyse the constraints report & timing report.
8. Analyse the setup & hold timing reports of in-out, in-reg timing path.
9. Analyse the setup & hold timing reports of latch-latch, reg-out timing path.
10. Analyse the setup & hold timing reports of reg-reg diff clock edge, generated clock, half cycle timing path.
11. Analyse the setup & hold timing reports of reg-reg multi cycle, positive-negative skew timing path.
12. Analyse the setup & hold timing reports of reg-reg crpr, uncertainty timing path

Textbook(s):

1. Sachin Sapapnekar, "Timing", Springer, 2004, ISBN: 978-1441954084, DOI: 10.1007/b117318

Reference(s):

1. Yuan Taur and Tak H. Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2021 (Third Edition), 9781108480024.
2. Synopsys tool manuals PrimeTime® Fundamentals User Guide λ PrimeTime® Advanced Timing Analysis User Guide Library Compiler ™ Timing, Signal Integrity and Power Modelling User Guide.
3. J. Bhasker, Rakesh Chadha, "Static Timing Analysis for Nanometre Designs: A Practical Approach", Springer, 2009, ISBN: 978-0387938196, DOI: 10.1007/978-0-387-93820-2.

ECE18R404 MIXED SIGNAL DESIGN

ECE18R404 Mixed Signal Design	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R314 CMOS Analog IC Design / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To learn the concepts of mixed circuits like filters, capacitor switches, data converters and PLL

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basic concepts related to CMOS IC design needed for a Mixed Signal IC
CO2: Analyse the characteristics of IC based CMOS filters by applying principles of VLSI design engineering by considering the impact of the filters in economical context
CO3: Design various data converter architecture circuits that meet specified performance needs considering economic factors with an understanding of the characteristics of each type of data converters
CO4: Design switched capacitor filters as per the application requirements
CO5: Design phase lock loop circuits and analyse them with consideration of their impact on performance, economical cost

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3

CO1	H	M											H		
CO2	H	M	L										H		
CO3		M	H										H		
CO4		M	H										H		
CO5		H	H										H		

Course Topics:

Unit 1: Basics of Mixed Signal Design

Review of MOSFET and its characteristics, digital CMOS design and analog CMOS design

Analog Signal Processing – Example of Analog VLSI Mixed-Signal Circuit Design – Mixed-signal layout – Interconnects and data transmission; Voltage-mode signalling and data transmission; Current-mode signalling and data transmission

Unit 2: CMOS Filters

Integrator Building Blocks- low pass filter, Active RC integrators, MOSFET-$_C$ Integrators, gm$_C$ integrators, Discrete time integrators. Filtering Topologies: The Bilinear transfer function, The Biquadratic transfer function, Filters using Noise shaping, Analog continuous time filters: passive and active filters; Basics of analog discrete-time filters and Z-transform

Unit 3: Data Converter Architecture

DAC Architectures- Resistor string, R-2R ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, and Pipeline DAC.

ADC Architectures- Flash, Two-step flash ADC, Pipeline ADC, Integrating ADCs, Successive Approximation ADC.

Unit 4: Data Converter Modelling

Sampling and Aliasing: A modelling approach – Impulse sampling – The sample and Hold – Quantization noise. Data converter SNR: – Clock Jitter – Improving SNR using Averaging – Decimating filter for ADCs – Interpolating filter for DACs – Band pass and High pass sinc filters - Using feedback to improve SNR

Unit 5: Switched Capacitor Circuits and Frequency Synthesisers

Switch Capacitor Circuits: General Considerations- Sampling switches- Switched Capacitor Amplifiers- Switched Capacitor Integrator- Switched Capacitor Common mode feedback, applications.

Frequency Synthesisers: Voltage Controlled Oscillators – Phase Locked Loops-Simple PLL- Charge pump PLLs - Non-ideal Effects in PLLs- Delay locked loops- its Applications

TEXTBOOK(s):

1. R Jacob Baker, “CMOS Mixed Signal Circuit Design”, Wiley/IEEE Press India/U.S., 2012(Reprint)
2. R. Jacob Baker, “CMOS Circuit Design Layout and Simulation”, Wiley/IEEE Press India/U.S., 2009 (Reprint)

Reference(s):

1. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill India, 2016(33rd Reprint)

ECE18R405 NANOELECTRONICS

ECE18R405 Nanoelectronics	L	T	P	C
	3	0	0	3
Pre-requisite: ECE18R315 Microelectronics Physics / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To learn and understand basic concepts of Nanoelectronics. To describe the principle and the operation of nanoelectronic devices so that how they can be effectively used in real-time applications

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply the fundamental science and quantum mechanics in nanoelectronics with a knowledge on limitations of present silicon electronics

CO2: Interpret the knowledge of a free electrons, confined electrons, quantum well, quantum transport and tunnelling effects.
CO3: Explain concepts of coulomb blockade and electron transport
CO4: Apply their knowledge of various nanoelectronic devices to identify how they can be applied in real world
CO5: Comprehend the significance and role of nanoelectronics in the present contemporary world by surveying latest literature on nanoelectronics research

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M											H		
CO3	H	M											H		
CO4		M	M			H	H	L					H	M	
CO5		H	L			H	H	H		L				M	M

Course Topics:

Unit 1: Quantum Mechanics of Electronics

Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence

Why Nano-electronics; Nanotechnology Potential; Dual nature of light and wave – General postulates of quantum mechanics; Time-independent Schrodinger's equation- boundary conditions on the Wave function; Analogies between quantum mechanics and classical electromagnetic; probabilistic current density; Multiple particle systems; Spin and angular Momentum;

Unit 2: Free and Confined Electrons

Free Electrons; Free electron gas theory of metals; Electrons confined to a bounded region of space and quantum numbers; Particle in a box Concepts – Degeneracy; partially confined electrons- finite potential wells; Quantum wells; Quantum wires; Quantum dots; Density of States

Fabrication of nano particle- grinding with iron balls, laser ablation, reduction methods, sol gel, self-assembly, precipitation of quantum dots

Unit 3: Tunnel Junctions

Tunnelling through a potential barrier; Potential energy profiles for material interfaces; Applications of tunnelling; Resonant tunnelling diode.

Nanoelectronic devices- MODFETS, heterojunction bipolar transistors

Unit 4: Single-Electron Transistor

Single-Electron Devices: Coulomb blockade – Quantum cellular automata - Graphene – Single-Electron Transistor Logic – applications of single electron devices to logic circuits and memory

Carbon Nanotubes: Fullerenes - types of nanotubes – material structure and properties – low-T electrical properties - electronic properties – carbon nanotube interconnects – carbon nanotube FETs – room-T properties - memory and other applications

Semiconductor Nanowire Single Electron Transistors – heterostructures – low-T electrical properties – room-T properties and applications,

Unit 5: Molecular Electronics, Spintronics, Foundations of Quantum Computing

Molecular Electronics: Single Molecular devices, SET and FET – Memory devices

Spintronics: Transport of spin – coherent spin transport – spintronic devices – spin-FET – applications spin valves and memory

Quantum Computing: qubits – entanglement and logic operations

TEXTBOOK(s):

1. George W. Hanson, "Foundations of Nanoelectronics", Pearson India, 2009(1st Edition), ISBN: 9788131726792
2. Yuan Taur and Tak H. Ning, "Fundamentals of Modern VLSI Devices", Pearson India, 2016(2nd Edition), ISBN: 9781316649794

Reference(s):

1. Rainer Waser (Editor), "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices", Wiley U.S., 2012(3rd Edition), ISBN: 9783527409273
2. Plummer, Deal, Griffin, "Silicon VLSI Technology: Fundamentals, Practice and Modelling", Pearson India, 2015

ECE18R406 IC LAYOUT DESIGN

ECE18R406 IC Layout Design	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R352 CMOS Design / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To familiarise the students about layout process and make them to design the layout for given specifications

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the steps of fabrication of Integrated Circuits
CO2: Draw the layouts for the circuits given
CO3: Design resistance and capacitance of required values in the integrated environments
CO4: Apply the EDA tools in IC Design with an understanding of their limitations
CO5: Design a chip as per the specifications considering all the constraints, power issues and clocking

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2		M	L											H	
CO3	H	M	H										H		
CO4	H	M	H									L		H	L
CO5		M	M	M		L	M					L	H	H	H

Course Topics:

Unit 1: Fabrication Basics

IC layout – wafer base making – changing layer composition – adding a layer – removing a layer – photolithography – building a chip – self-aligned gates

Unit 2: CMOS in Layout

CMOS layout and device sizing – Source-drain sharing – device connection technique – compact layout – stick diagram, well and substrate ties – the antenna effect – wiring with poly – design rules – double metal MOS process rules – CMOS lambda-based rules – design rules for metal 3 – Scaling parameters and difficulties

Unit 3: Resistance, Capacitance and Diodes in Layout

Resistance basics, measuring resistance, deriving resistance using poly, real world resistor analysis – practical minimum resistor size – options for resistors – current densities – resistor tolerance, diffusion versus poly

Capacitor basics – calculating capacitance – n-well capacitors – metal capacitors

Types of diodes: regular diode – bipolar transistor diode and varactor diode,

Unit 4: IC Design

Design flow: Design process – Market research, specifications and constraints – HDL capture and RTL coding – Logic simulation – Logic synthesis – Logic optimisation – Formal verification – STA – VLSI Physical design – Design verification tools – Design rule check – Tape-out – Yield

Implementation approaches: Full custom, semi-custom, Gate arrays

RTL to GDSII Process: Simulation – Logic synthesis – Logic synthesiser – Constraints – Technology libraries – Functional verification – Place and Route – Post layout timing simulation – Static Timing Analysis – netlist formats

Unit 5: Testing and Low Power Design

Testing: Need, Principles – Controllability and Observability – Design for Test (**Qualitative Treatment**)

Low Poser Design: Sources of power consumption – Solutions and Approaches – Power network – Power optimisation – Chip power usage analysis

Successful Chip Design: Requirements of a successful chip design – System-on-Chip (SoC) – Clock and Clock distribution – Challenges in VLSI Design

TEXTBOOK(s):

1. Christopher Saint, Judy Saint, "IC Layout Basics: A Practical Guide", McGraw Hill U.S., 2012(1st Edition), ISBN: 9780071386258
2. K. Lal Kishore and V.S.V. Prabhakar, "VLSI Design", I. K. International Publishing House India, 2009, ISBN: 9789380026671

Reference(s):

1. Debaprasad Das, "LSI Design", Oxford University Press India, 2016(2nd Edition), ISBN: 9780198094869
2. Neil H.E. Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson India, 2015(4th Edition), ISBN: 9789332542884

ECE18R450 SYSTEMATIC DIGITAL DESIGN

ECE18R450 Systematic Digital Design	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R354 Digital Logic and State Machine Design / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To explain how digital circuit of large complexity can be built in a methodological way, starting from Boolean logic, and applying a set of rigorous techniques.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Design various arithmetic circuits by applying the principles of mathematics and digital engineering in an optimised way to meet the specific requirements with consideration of global, environmental, and economic factors

CO2: Design synchronous sequential circuits by applying the principles of mathematics and digital engineering in an optimised way to meet the specific requirements with consideration of global, environmental, and economic factors

CO3: Design synchronous sequential circuits by applying the principles of mathematics and digital engineering in an optimised way to meet the specific requirements with consideration of global, environmental, and economic factors

CO4: Design a complete a digital system by acquiring new knowledge of various system architectures and design techniques

CO5: Describe various memory architectures commonly used in digital system

CO6: Develop a designed higher-level digital system by conducting appropriate experimentation and interpret the output to judge whether the design met the specific requirements

CO7: Communicate effectively either oral presentations or written reports on the designed digital system

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M	H										H		
CO2	H	M	H										H		
CO3	H	M											H		
CO4		M	H	H	H	L						H	H	H	L

CO5	H	M											H		
CO6								H	H		L			M	M
CO7								L	L	H				M	M

Course Topics:

Unit 1: Arithmetic Circuits

Digital abstraction – Practice of digital system design – Arithmetic circuits – Fixed and floating-point numbers – Fast arithmetic circuits – Arithmetic examples

Unit 2: Synchronous Sequential Logic

Sequential logic – Timing constraints – Data path sequential logic – Factoring FSMs – Microcode

Unit 3: Asynchronous Sequential Logic

Asynchronous sequential circuits –Metastability and synchronisation failure – Synchroniser design

Unit 4: Systems Design

System-level design process – Interface and system-level timing – Pipelines – Interconnect – Clock Distribution – Signal Integrity – Design for success

System Architecture Types (like Von Neumann Architecture, Harvard Architecture, Modern Harvard Like Computer Architectures, DSP Architectures, RISC, CISC)

Unit 5: Memories

Memory systems – High performance memories: SDRAM, DDR SDRAM, SSRAM, DDR and QDR SRAM

Real-time design Experiments (Any 5 to be designed):

1. Alarm Indication System.
2. Simple Waveform Generator.
3. Dice Game.
4. Clocked Watchdog Timer.
5. Fast Arithmetic Unit Design.
6. Pipelined RISC processor design
7. RAM Design
8. Viterbi Decoder
9. Open Ended experiment

TEXTBOOK(s):

1. William J. Dally, R. Curtis Harting, “Digital Design using VHDL: A Systems Approach”, Cambridge University Press India, 2012, ISBN: 9781107098862
2. Mark Balch, “Complete Digital Design: A Comprehensive Guide to Digital Electronics and Computer System Architecture”, McGraw Hill India / U.S., 2014(Reprint)

Reference(s):

1. William J. Dally, R. Curtis Harting, “Digital Design: A Systems Approach”, Cambridge University Press, India, 2012, ISBN: 9780521199506

ECE18R470 UNIVERSAL VERIFICATION METHODOLOGY

ECE18R470 Universal Verification Methodology	L	T	P	C
	2	0	2	3
Pre-requisite: RTL Design using Verilog, System Verilog.	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To learn the UVM constructs and apply constructs to model UVM testbench architecture.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe UVM verification methodology and its requirement.
CO2: Understand different UVM constructs to build verification environment.
CO3: Use UVM specific constructs, and SV OOP concepts to run test cases/regressions, for efficient functional and code coverage**.**

CO4: Perform functional simulations to validate and debug designs using an industry standard RTL simulator.
CO5: Model and develop the UVM testbench architecture for a given RTL design.
CO6: Develop a complete and comprehensive verification plan for the given design specifications of a digital design.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H					M		M				M	L		L
CO2	H	M		M	H			M	L			M	M	H	L
CO3	H	M		M	H			M	L			M	M	H	L
CO4	H			M	H			M	L			L	M	M	L
CO5		M	H	M	H		L	M	H		L	M	M	H	L
CO6		M	H	M	H	L	L	M	H	H	L	M	M	H	M

Course Topics:

Unit 1: UVM and its Constructs: Basics **6 hours**

Importance of UVM- Features of UVM– UVM component hierarchy tree– Phases – Factory - Developing UVM testbench architecture: top, test, environment, agent.

Unit 2: UVM and its Constructs: Sequence **6 hours**

UVM_sequence: `uvm_do & `uvm_do_with macro, `uvm_create & `uvm_send macro, `uvm_rand_send & `uvm_rand_send_with macro - UVM_sequence_item: UVM utility/field macros, Create & copy method, Compare & print method, Clone & pack/unpack method - UVM config_db, UVM reporting.

Unit 3: UVM and its Constructs: Testbench Architecture **6 hours**

Developing UVM testbench architecture: driver, monitor, scoreboard – UVM communication: get, put topology, TLM FIFO, analysis ports.

Unit 4: Advanced UVM Constructs **6 hours**

Events – Callbacks: testbench with and without callbacks, callback class and macros, callback add method.

Unit 5: Modelling UVM Testbench Blocks and UVM RAL **6 hours**

Register model – Register environment – UVM architecture: Explanation of different blocks of architecture.

Experiments:

1. Implementation of different phases of UVM
2. Implementation of UVM phases in hierarchy of components
3. Implementation of factory in UVM- type override
4. Implementation of factory in UVM- instance override
5. Implementation of UVM Sequence_item methods: copy, print & compare
6. Implementation of different UVM Sequence macros
7. Implementation of UVM config_db to pass Interface and set variable value
8. Implementation of UVM reporting: severity, verbosity
9. Implementation of UVM TLM get topology
10. Implementation of UVM TLM FIFO
11. Modelling UVM testbench for DUT APB- environment, testcases, transaction, driver
12. Modelling UVM testbench for DUT APB- reference model, monitor, scoreboard, coverage

Textbooks:

1. Ray Salemi, “The UVM Primer: A Step-by-Step Introduction to the Universal Verification Methodology”, Boston Light Press, 2013, ISBN-13:978-09741649392.

References:

1. Kathleen A. Meade, Sharon Rosenberg, "A Practical Guide to Adopting the Universal Verification Methodology (UVM)", Cadence Design Systems, 2010 (Second Edition)
2. Benjamin Ting, "UVM Testbench Workbook", Lulu Press, 2017,
3. www.chipverify.com
4. www.verificationguide.com

ECE18R473 PHYSICAL DESIGN AND VERIFICATION

ECE18R473 Physical Design and Verification	L	T	P	C
	2	0	2	3
Pre-requisite: ASIC Design Flow	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To understand the concepts of Physical Design Process such as partitioning, Floorplanning, Placement and Routing. Verifying and validating the integrated circuit layout design.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the goals, objectives, measurements, and algorithms of floorplanning & power planning.
CO2: Discover solutions for the congestion issues of physical design flow of an ASIC.
CO3: Define efficient algorithms to synthesize the clock tree and explain the challenges in the flow.
CO4: Apply the algorithms to route the signals efficiently.
CO5: Explain the importance of parasitic extraction and generate GDSII File for fabrication of an ASIC.
CO6: Communicate the technical information related to the different steps in the PnR flow efficiently.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M	M	M	M			L		L			H	M	
CO2	H	M	M	M	M	L	L			L		H	H	M	L
CO3	H	M	M	M	L							H	M	M	L
CO4	H	M	M	M	L			L	L				M	M	
CO5	H	M	M	M	L					L		H	M	M	L
CO6	M	M	M	M				M	M	M	L	H	M	M	L

Course Topics:

Unit 1: APR Flow Basics **6 Hours**

Introduction to PnR flow, design setup, floorplan, Block & chip level floorplan, data required for floorplan, I/O placement, pin placement, I/O bus architecture, Power plan, Analysing floorplan & powerplan.

Unit 2: Floorplan and Placement **6 Hours**

App options and commands related to floorplan and powerplan, STA concepts related to timing path, analysing timing report after floorplan, Placement concepts, Analysing timing report after placement.

Unit 3: CTS Concepts **6 Hours**

CTS concepts, CTS commands, CTS issues & analysis of timing reports, Tcl scripting basics.

Unit 4: Routing and DFM Issues **6 Hours**

Tcl scripting for PnR flow, Routing concepts, DFM & antenna, antenna fix issues, Routing commands, Issues in routing stage.

Unit 5: Parasitic Extraction and Physical Verification **6 Hours**

Signoff, LEC post layout and ECO flow, Parasitic Extraction, Physical verification & tape out, Techniques to extract parasitic and fix physical verification issues, MSCTS.

Experiments:

1. Create a block level floorplan for the given netlist to meet the guidelines of floorplan - analyse the scripts
2. Create a block level floorplan for the given netlist to meet the guidelines of floorplan - execute
3. Create a power plan for the given floorplan block
4. Troubleshoot the DRC errors, analyse the timing report & conduct pre-placement checks
5. Implement the placement stage of the APR flow ---- analyse the setup files
6. Implement the placement stage of the APR flow ---- execute & understand the timing reports
7. Implement the CTS stage of the APR flow ---- analyse the setup files
8. Implement the CTS stage of the APR flow ---- execute & understand the timing reports
9. Run the routing stage of the APR flow ------- analyse the setup files
10. Run the routing stage of the APR flow ----- execute & check for DRC, LVS errors
11. Parasitic extraction and back annotation
12. Physical verification and tape out

Textbook(s):

1. Naveed A Sherwani, “Algorithms for VLSI Physical Design Automation”, Springer, 2013

Reference(s):

1. Harry Veendrick, “Nanometre CMOS ICs: From Basics to ASICs.”, Springer, 2017.
2. https://solvnet.synopsys.com
3. R Drechsler, “Evolutionary Algorithms for VLSI CAD”, Kluwer Academic Publishers, 2010

V PROFESSIONAL ELECTIVE COURSES

STREAM: SIGNAL PROCESSING

ECE18R257 DIGITAL SIGNAL PROCESSING WITH FPGA

ECE18R257 Digital Signal Processing with FPGA	L	T	P	C
	3	0	1	3.5
Pre-requisite: Digital Circuits and Systems Design / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

This course introduces methodologies of FPGA designs for signal processing applications. It provides system design experience using hardware description language (HDL) and commercial EDA tools.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the various processor architectures in which DSP functionality can be implemented
CO2: Analyse and apply the arithmetic concepts related to DSP system design
CO3: Write programs in VHDL for implementation FIR filters, IIR filters and Transforms
CO4: As an individual or a teamwork, implement the designed HDL programs for DSP applications in the targeted FPGA following the safety and ethics
CO5: Comprehend the experiments carried by means of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H		M									H	M	
CO2	H	H	L										H	M	
CO3		M	H		H							M	H	M	
CO4			L	M	M			H	H					M	L
CO5								L	L	H				M	M

Course Topics:

Unit 1: DSP Basics

DSP Systems definition – DSP Transformations – Filters – Adaptive Filtering – DSP Functionality characteristics – DSP Processors and GPU – DSP technology requirements – Design implementation

Unit 2: Computer Arithmetic - I

Number representation – Binary adders – Binary multipliers – Binary dividers – Finding square root – Fixed-point arithmetic implementation – Floating-point arithmetic implementation

Unit 3: Computer Arithmetic - II

Distributed Arithmetic – Reduced coefficient multiplier – MAC and SOP – Computation of special functions using CORDIC – Computational of special functions using MAC – Fast magnitude approximation

Unit 4: FIR filters and DFT with VHDL

Digital Filters – FIR Theory – Designing FIR filters – Constant coefficient FIR design – DFT Algorithms: Fourier Transform approximations using DFT – Properties of DFT – The Goertzel Algorithm – The Bluestein Chirp-z Transform – The Rader Algorithm

Unit 5: IIR filters with VHDL

IIR theory – IIR co-efficient computation – IIR filter implementation – Fast IIR filter – Narrow band IIR filter – All-pass filter design of narrow band IIR filter

Experiments (Any 5):

1. Introduction to Simulink and DSP Builder
2. Number Systems and Quantisation (Objectives: to understand the difference of signed and unsigned number systems, to determine minimum and maximum values in integer and factional number systems, to compute quantisation error, and to design and simulate a circuit using Simulink)
3. Introduction to Signal Flow Graphs (Objectives: to characterise systems by linearity, stability, causality and time invariance; to understand the difference between FIR and IIR systems; and to design and simulate nonlinear, FIR and IIR systems using Simulink).

4. Introduction to MATLAB M-File Scripts (Objectives: to write simple M-file scripts; to define tables and use pre-defined functions; to use the Matlab help, demo, and function library; to design and simulate complex multiplier systems using Simulink).
5. Special functions using CORDIC or MAC
6. Introduction to FIR Filters (Objectives: to design and simulate a moving average filter, to understand the difference between direct- and transpose-form FIR filters, to design and simulate a reduced adder graph FIR filter using Simulink)
7. Introduction to IIR Filters (Objectives: to design and simulate a first order IIR filter; to determine the magnitude, phase, and pole-zero diagram of IIR filters; to design a third order elliptic low pass filter; to compare IIR and FIR design parameters)
8. Introduction to Discrete Fourier Transform (Objectives: to develop a basic Goertzel IIR loop and process test data, to configure a sub design with I/O ports, to instantiate a previously developed block, to design and simulate a selected DFT component).
9. Introduction to Fast Fourier Transform (Objectives: to develop a radix-2 FFT and process test data, to understand the difference between DFT and FFT, to design and simulate an FFT using the principle of decimation-in-frequency using Simulink).

TEXTBOOK(s):

1. Uwe Meyer-Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer India / Springer-Verlag Berlin Heidelberg, 2014(4th Edition), ISBN: 9783662496077, DOI: 10.1007/978-3-642-45309-0
2. Roger Woods, John McAllister, Gaye Lightbody, Ying Yi, "FPGA-based Implementation of Signal Processing Systems", Wiley India, 2017 (1st Edition), ISBN: 9788126561704

Reference(s):

1. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization", Wiley India, 2007, ISBN: 9788126561728
2. Douglas L. Perry, "VHDL: Programming by Example", McGraw Hill India, 2012(4th Edition – Reprint), ISBN: 9780070499447
3. Li Tan and Jean Jiang, "Digital Signal Processing: Fundamentals and Applications", Academic Press, 2013 (2nd Edition), ISBN: 9780124158931
4. Keshab K. Parhi, "VLSI Digital Signal Processing Systems: Design and Implementation", Wiley, 2007, ISBN: 9788126510986

ECE18R258 DIGITAL SIGNAL PROCESSING AND FILTER DESIGN

ECE18R258 Digital Signal Processing and Filter Design	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R202 Signals and Systems / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To give a graduate-level overview of Designing optimum filtering algorithms and apply them to various signals

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply the basic concepts of digital signal processing in filter design
CO2: Design analog signal processing filters as per the requirements
CO3: Design IIR filters as per the requirements with the knowledge gained on various design forms
CO4: Design FIR filters as per the requirements with the knowledge gained on various design forms
CO5: Realise the filters in digital signal processing applications and analyse the quantisation effect on them
CO6: As an individual or a teamwork, implement the designed filter for the required DSP applications following the safety and ethics
CO7: Document effectively the experiments carried by means of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M	H	L	M								H	M	
CO3	H	M	H	L	M								H	M	
CO4	H	M	H	L	M								H	M	
CO5	H	H	H	M	M								H	M	
CO6				L	L			H	H					M	L
CO7								L	L	H				M	L

Course Topics:

Unit 1: Filter Basics

History of filter design – Analog and Digital filters in signal processing – Relations in the time domain – Relations in the frequency domain – Transfer function – All pass transfer function – Stability criterion: Lyapunov definition, Jury-Marden test, Schur–Cohn test – Sampling, Band limited signals – Signal conversion

Unit 2: Analog Filters

Filter Approximations – Butterworth filters – Chebyshev filters – Inverse Chebyshev filters – Elliptic filters – Bessel filters – Filter transformations

Unit 3: Design of IIR Filters

Approximation in time domain – Approximation in frequency domain – All pass filter design – Yule-Walker Approximations

Unit 4: Design of FIR Filters

Linear-Phase filters – Frequency sampling – Minimisation of the mean square error – Chebyshev approximation – Maximally flat design – Equiripple linear phase filter

Unit 5: Filter Realisations and Quantisation Analysis

Filter realisations: Graphical representation of discrete-time networks – FIR filter realisation – IIR filter realisation – Digital ladder filters – All pass filter structures

Quantisation analysis: Number representation: fixed point and floating-point – Quantisation: fixed point and floating point – quantisation analysis of FIR and IIR filters

Introduction to Adaptive filters

Experiments (Any 5):

Implement the following in a DSP Starter Kit (DSK)

1. Introduction to DSK
2. Matrix/Vector Multiplication using DSK; Multiplication of Two Arrays using DSK
3. Sine Generation with Four Points (table look up method) using DSK
4. Pseudorandom Noise Generation using DSK
5. Filtering of mixed sinusoidal signals of different frequency (Generate a mixed signal (using a BNC TEE junction) consisting of two sinusoidal signals of frequency; Implement the DSK as a bandpass filter centred at one of the sinusoidal signal frequencies;)
6. Filtering of sinusoidal signals mixed with random noise (Generate a sinusoidal signal, s(t), using a Signal Generator; Generate a random noise signal, n(t), using a Dynamic Signal Analyzer; Design a digital bandpass filter using DSK with a centre frequency of sinusoidal signal, and suitable bandwidth to filter out the sinusoidal signal s(t) from the noisy signal y(t).)
7. Filtering of sinusoidal signals mixed with random noise (Generate a sinusoidal signal, s(t), using a Signal Generator; Generate a random noise signal, n(t), using a Dynamic Signal Analyzer Design a digital lowpass filter with cut-off frequency more than that of sinusoidal signal, to filter out the sinusoidal signal s(t) from the noisy signal y(t).)
8. Design FIR filter in Simulink and select a DSP chip from manufacturers such as Texas Instruments, Analog Devices, Lucent, or Motorola and program it to work as a digital system of the FIR filter designed using Code Composer Studio or any equivalent software

9. Repeat the above experiment for an IIR filter

TEXTBOOK(s):

1. Dietrich Schlichthärle, "Digital Filters: Basics and Design", Springer India / Springer-Verlag Berlin Heidelberg, 2011(2nd Edition), ISBN: 9783642432859, DOI: 10.1007/978-3-642-14325-0
2. B.A. Shenoi, "Introduction to Digital Signal Processing and Filter Design", Wiley India, 2006(1st Edition), ISBN: 9788126527878

Reference(s):

1. Forester W. Isen, "DSP for MATLAB™ and LabVIEW™ III: Digital Filter Design (Synthesis Lectures on Signal Processing)", Morgan and Claypool India, 2008, Vol. 3, No. 1, Pages 1-239, ISBN: 9781598298963, DOI: 10.2200/S000163ED1V01Y200811SPR006
2. Fred Taylor, "Digital Filters: Principles and Applications with MATLAB", Wiley-IEEE Press U.S., 2011, ISBN: 9781118141144
3. Rajiv J. Kapadia, "Digital Filters", Wiley-VCH U.S., 2012, ISBN: 9783527411481
4. Chi-tsong Chen, "Digital Signal Processing: Spectral Computation and Filter Design", Oxford University Press India, 2007, ISBN: 9780195691467

ECE18R317 BIO-MEDICAL ELECTRONICS

ECE18R317 Bio-Medical Electronics	L	T	P	C
	3	0	0	3
Pre-requisite: Basic Electronics	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The course is designed to make the students acquire conceptual knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance. The relation between electronic concepts and biological concepts is highlighted. The principles of electronic instrumentation that are currently deployed in the clinical side are introduced.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the human physiology needed for bio-medical instrumentation
CO2: Appraise the use of sensors and transducers for bio medical measurements
CO3: Illustrate the working of biomedical equipment.
CO4: Apply Electronic Principles for recording and Monitoring Bio Signals
CO5: Distinguish diagnostic equipment from therapeutic equipment
CO6: Examine the internal organs through imaging

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H					L						L	H		
CO2		M										M		M	
CO3	L	M					L						M	L	
CO4	H	M										M	H	M	
CO5	L						L					M	H	L	
CO6	H	L											H	L	

Course Topics:

Unit 1: Human Physiology and Transducers

Cell and its structure – Resting and Action Potential – Nervous system: Functional Organisation of the nervous system, Structure of nervous system – Neurons – Synapse, Transmitters and Neural Communication – Cardiovascular system – respiratory system – Basic components of a bio-medical system – Transducers -Ultrasonic transducers, Temperature measurements -Fibre optic temperature sensors – Flow sensors – Potential transducers – Dissolved ions and gases

Unit 2: Electro-Physiological Measurements

Electrodes – Limb electrodes – Floating electrodes – pregelled disposable electrodes – Micro, needle, and surface electrodes – Amplifiers – Preamplifiers – differential amplifiers – chopper amplifiers – Isolation amplifier – ECG, EEG, EMG, ERG, Lead systems and recording methods, Typical waveforms

Unit 3: Non-Electrical Bio-Parameters Measurement

Measurement of blood temperature, pressure, and flow. Measurement of Cardiac output, Heart rate, Heart sound – Pulmonary function measurements – Spirometer – Photo Plethysmography – Body Plethysmography – Impedance plethysmography. Blood Gas analysers: pH of blood, Measurement of blood pCO2, pO2, fingertip oximeter, ESR, GSR measurements.

Unit 4: Medical Imaging Devices

Ultrasonic, X-ray and nuclear imaging: Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems and patient monitoring – Introduction to Biometric systems

Unit 5: Prostheses and Aids

Pacemakers – defibrillators – ventilators – nerve and muscle stimulators – diathermy – heart-lung machine – dialysers – artificial kidney – aids for the handicapped. Safety aspects

TEXTBOOK(s):

1. Kim E. Barrett, Heddwen L. Brooks, Scott Boitano and Susan M. Barman (Authors), "Ganong's Review of Medical Physiology (LANGE Medical Book)", McGraw Hill U.S., 2016(25th Edition), ISBN: 9780071825108
2. John G. Webster (Author), Amit J Nimunkar (Author), "Medical Instrumentation Application and Design", Wiley India, 2009(4th Edition), ISBN: 9788126553792

Reference(s):

1. R. S. Khandpur, "Handbook of Bio-Medical instrumentation", McGraw Hill, 2014(3rd Edition), ISBN: 9789339205430
2. Shakti Chatterjee, Aubert Miller, "Bio-Medical Instrumentation Systems", Cengage Learning, 2010
3. Joseph J. Carr, John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson India, 2002(4th Edition), ISBN: 9788177588835

ECE18R318 WAVELETS

ECE18R318 Wavelets	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R273 Digital Signal Processing / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The course makes the students to familiar with wavelets and give an experience to apply in signal processing systems.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Compute wavelet transform in continuous and discrete time domains
CO2: Carry the various decompositions like orthogonal, biorthogonal and semiorthogonal
CO3: Construct wavelets and display graphically
CO4: Carry analysis on wavelet packets in the target applications
CO5: Analyse various filter bank algorithms by applying the knowledge of wavelets and multirate signal processing
CO6: Apply the techniques, design principles, transformations of wavelet theory to real-time systems and analyse their responses

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M					L					L	H	M	
CO2	M	H					L					L	H	M	
CO3		L	M		L								M	L	
CO4	H	M	L										H	M	
CO5	H	M											H	M	

CO6	H	M	L				L					L	H	M	L

Course Topics:

Unit 1: Time Frequency Analysis

Motivation and definition of wavelets: the how, what and why about wavelets – Fourier to Wavelets – Window Function – Short-Time Fourier Transform – Discrete Short-Time Fourier Transform – Discrete Gabor representation – Frames and Frame operators – Uncertainty principle and time-frequency tiling – Continuous wavelet transform – Discrete wavelet transform – wavelet series, interpretations of time-frequency plot – Wigner-Ville transform and its properties

Unit 2: Multiresolution Analysis

Multiresolution spaces – Orthogonal, Biorthogonal and Semiorthogonal Decomposition – Two-scale relation – Decomposition relation – Spline functions and properties – Mapping a function

Unit 3: Construction of Wavelets, Wavelet packet

Ingredients – Construction of semiorthogonal spline wavelets – Construction of orthogonal wavelets – Construction of biorthogonal wavelets – Graphical display of wavelets

Wavelet Packets: Theoretical Basis – Two dimensional wavelets and wavelet packets – Wavelet Packet algorithms / transform, Analysis – Threshold and interference suppression – Wavelet packet applications

Unit 4: Multirate Signal Processing and Filter Bank Algorithms

Foundations of multirate and filter banks: building blocks, decimation and interpolation – Signal representation in the approximation subspace – Wavelet decomposition algorithm, reconstruction algorithm – Change of bases, Signal reconstruction in semiorthogonal subspaces – two-channel filter bank – polyphase representation for filter banks,

Unit 5: Applications

Edge detection – Image and video compression – Signal denoising – Multi-tone digital communication – Transient detection

TEXTBOOK(s):

1. Jaideva C. Goswami, Andrew K. Chan, "Fundamentals of Wavelets: Theory, Algorithms, and Application", Wiley U.S., 2011(2nd Edition), ISBN: 9780470934647
2. Soman, K. P., Resmi, N. G., Ramachandran, K. I., "Insight into Wavelets: From Theory to Practice", PHI India, 2010 (3rd Edition), ISBN: 9788120340534

Reference(s):

1. Lokenath Debnath, Firdous Shah, "Wavelet Transforms and Their Applications", Springer/ Birkhäuser Basel/ Springer Science+Business/ Researchco Book Centre India, 2012, ISBN: 9780817684174 DOI: 10.1007/978-0-8176-8418-1
2. Gerald Kaiser, "A Friendly Guide to Wavelets", Springer / Birkhäuser Basel India, ISBN: 9780817681104, DOI: 10.1007/978-0-8176-8111-1
3. Y. T. Chan, "Wavelet Basics", Springer/Kluwer Academic Press U.S./India, 1st Edition, ISBN: 9781461359296, DOI: 10.1007/978-1-4615-2213-3
4. Charles Chui Editor, "An Introduction to Wavelets, Volume 1", Elsevier/Academic Press U.S./India, 1st Edition, ISBN: 9780121745844

ECE18R355 DIGITAL SIGNAL PROCESSING ARCHITECTURE

ECE18R355 Digital Signal Processing Architecture	L	T	P	C
	3	0	1	3.5
Pre-requisite: Digital Circuits and Systems Design / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To teach students to design architecture for digital signal processing, with accent on the architecture of processors for digital signal processing and their programming.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the fundamentals of fixed and floating-point architectures of various DSPs

CO2: Apply instruction sets of fixed and floating-point DSPs
CO3: Infer about the control instructions, interrupts, and pipeline operations
CO4: Illustrate the features of on-chip peripheral devices and its interfacing
CO5: Work as part of a team and as individual effectively following the safety procedures and ethics in implementing the DSP algorithms in targeted DSP architecture
CO6: Communicate the technical information related to DSP system design using DSP processors by means of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H		
CO2	H	M	L		L								H	M	
CO3		M			M								M	M	
CO4	H	H										H	H	M	
CO5			L	L	L			H	H					M	L
CO6								L	L	H				M	L

Course Topics:

Unit 1: DSP Algorithms

Review of DSP Systems-Computational characteristics of DSP algorithms and applications- their influence on defining a generic instruction-set architecture for DSPs

Unit 2: Architectural Requirement of DSPs

Basic architectural features-High throughput, low cost, low power, small code size – embedded applications – Techniques for enhancing computational throughput parallelism and pipelining

Unit 3: DSP's Data Path

Multiple on-chip memories and buses – dedicated address generator units – specialized processing units (hardware multiplier, ALU, shifter) and on-chip peripherals for communication and control

Unit 4: DSP's Control Unit

Pipelined instruction execution – specialized hardware for zero-overhead looping – interrupts

Unit 5: Fixed Point and Floating-Point DSPs

Brief description of TMS320 C5x /C54x/C3x DSPs- Programmer's model - Architecture of Analog Devices fixed-point and floating-point DSPs- brief description of ADSP 218x / 2106x DSPs- Programmer's model.

Advanced DSPs: TI's TMS 320C6x – ADI's Tiger-SHARC – Lucent Technologies' DSP 16000VLIW processors - Applications - a few case studies of application of DSPs in communication and multimedia

Experiments (Any 5)

1. Introduction to Code Composer Studio
2. Introduction to the architecture of DSP chips
3. Study of various addressing modes
4. Introduction to Interrupts
5. Sequence generation and number sorting
6. Convolution using overlap add and overlap save methods
7. Wave pattern generation
8. FFT and Bit Reversal Operations
9. FIR filter implementation

TEXTBOOK(s):

1. B. Venkataramani and M Bhaskar, "Digital Signal Processors", McGraw Hill India, 2017 (2nd Edition Revised), ISBN: 9780070702561
2. Peter Pirsch, "Architectures for Digital Signal Processing", Wiley India, 2009, ISBN: 9788126523030

Reference(s):

1. Texas Instruments TMSC5x, C54x and C6x User's Manuals (Online)
2. Analog Devices ADSP 2100 -Family and 2106x-Family User's Manuals

3. Keshab K. Parhi, "VLSI Digital Signal Processing Systems: Design and Implementation", Wiley, 2007, ISBN: 9788126510986

ECE18R356 SPEECH AND AUDIO SIGNAL PROCESSING

ECE18R356 Speech and Audio Signal Processing	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R273 Digital Signal Processing / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To introduce the basic concepts and methodologies for analysis, modelling, synthesis and coding of speech and music and to provide a foundation for developing applications and for further study in the field of digital audio standards and its techniques

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Mathematically model the speech signal
CO2: Analyse the quality and properties of speech signal
CO3: Modify and enhance the speech and audio signals
CO4: Implement components of speech processing systems in MATLAB with the knowledge gained on speech recognition, identification, processing, and analysing
CO5: Work as part of a team and as individual effectively following the safety procedures and ethics in implementing the speech processing systems
CO6: Comprehend the processing of speech done by oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M			L							L	H	M	
CO2	H	M			L		L					L	H	M	
CO3		H										H	H		
CO4	L	L	M	H	H								H	M	
CO5						L	L	H	H					M	L
CO6								L	L	H				M	L

Course Topics:

Unit 1: Speech Production and Speech Signal Processing

Speech Production and Modelling – Human Auditory Systems – Sound propagation in the human vocal tract – General structure of speech coders – Classification of speech coding techniques: parametric, waveform and hybrid – Requirements of speech codecs –quality, coding delays, robustness

Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.

Unit 2: Speech Prediction

Linear Prediction of Speech- Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction

Unit 3: Speech Quantisation

Speech Quantisation- Scalar quantisation–uniform quantiser, optimum quantiser, logarithmic quantiser, adaptive quantiser, differential quantisers; Vector quantisation – distortion measures, codebook design, codebook types

Unit 4: LPC

Scalar Quantization of LPC- Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF.

Linear Prediction Coding- LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model

Unit 5: CELP and Coding Standards

Code Excited Linear Prediction-CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zero state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP. Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729 standards

Experiments (Any 5 simple experiments)

1. Introduction to Real Time Digital Signal Processing using DSP Kit
2. Classification of Voiced/Unvoiced Speech
3. Wideband and a narrowband spectrogram of speech signals
4. Autocorrelation and Pitch Tracking
5. Echo, Delay, and Reverberation effects in audio signal / Pitch Shifting - Audio Effects and Real-Time Processing
6. 512-point DFT a speech segment, with a window that covers six pitch periods within the voiced region (stDTFT)
7. Formant estimates on the vowel triangle
8. Linear predictive coding (LPC)
9. Speech Coding and Synthesis – Compression of voice signals - LPC vocoder(voice-coder)

TEXTBOOK(s):

1. Vijay Madisetti (Editor), "The Digital Signal Processing Handbook: Video, Speech, and Audio Signal Processing and Associated Standards", CRC Press U.K./India, 2009(2nd Edition), ISBN: 9781420046083
2. Ben Gold, Nelson Morgan, Dan Ellis, "Speech, and Audio Signal Processing: Processing and Perception of Speech and Music", Wiley India, 2011(2nd Edition), ISBN: 9788126508228

Reference(s):

1. A. M. Kondoz, "Digital Speech: Coding for Low Bit Rate Communication Systems", Wiley, 2014 (2nd Edition)
2. W.C. Chu, "Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", Wiley, 2003
3. Shaila D. Apte, "Speech and Audio Processing", Wiley, 2008
4. Sadaoki Furui, "Digital Speech Processing: Synthesis, and Recognition", CRC Press, 2010 (2nd Edition)
5. Purdue University: ECE438 - Digital Signal Processing with Applications - https://engineering.purdue.edu/VISE/ee438L/lab9/pdf/lab9a.pdf

ECE18R357 DIGITAL IMAGE PROCESSING

ECE18R357 Digital Image Processing	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R273 Digital Signal Processing / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To make students Understanding of standard advanced image processing algorithms; Understanding of image processing system development; Understanding of team design techniques; Experience in algorithm development and testing

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Mathematically represent the various types of images and analyse them
CO2: Design frequency domain filters and spatial filters for image enhancement
CO3: Analyse the methodologies for image restoration, image segmentation and image compression
CO4: Work as part of a team and as individual effectively following the safety procedures and ethics in designing and experimenting algorithms for image processing
CO5: Communicate the technical information related to digital image processing by means of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M										M	H		
CO2			H		L							M	H	M	
CO3	L	H					M					L	H	M	
CO4			H	H	H			M	H					M	L
CO5								L	L	H				M	M

Course Topics:

Unit 1: Image Analysis and Image Transforms

Components of an image processing system - image representation – grey scale and colour images – Elements of visual perception – image sensing and acquisition – image sampling and quantization - Basic relationship between pixels – two dimensional orthogonal transforms - DFT, FFT, Haar transform, KLT, DCT, wavelets

Unit 2: Image Enhancement

Image enhancement in the Spatial Domain - background – basic grey level transformations – histogram processing – enhancement using arithmetic/logic operations – basic of spatial filtering – smoothing spatial filters – sharpening spatial filters – combining spatial enhancement methods

Image enhancement in the frequency domain -background – introduction to Fourier transform and frequency domain – smoothing frequency domain filters – sharpening frequency domain filters – homomorphic filters – implementation

Colour image smoothening and sharpening

Unit 3: Image Restoration

Model of the image degradation process – noise models – restoration in the presence of noise - periodic noise reduction by frequency domain filtering – Linear, position invariant degradation – estimating the degrading function – inverse filtering – minimum mean square error filtering – constrained least square filtering – geometric mean filter – geometric transformations

Unit 4: Image Segmentation, Morphological Image Processing

Detection of discontinuities – edge linking and boundary detection – threshold – region-based segmentation – segmentation by morphological watersheds – use of motion in segmentation – colour image segmentation

Morphological Image Processing: Dilation and Erosion: Dilation – Structuring Element Decomposition – Erosion – Combining Dilation and Erosion – Opening and Closing – Hit or Miss Transformation

Unit 5 Image Compression, DIP Applications

Redundancy–inter-pixel and psycho-visual; Image Compression Models – Huffman and Arithmetic Coding – Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000

Image processing applications: Character recognition in a License Plate – Biomedical image processing – CT or MRI image analysis – Water marking – Non-destructive testing – Crack detection

Experiments (Any 5 experiments)

1. Introduction to Image Processing
2. Monochrome Images (Flipping, Negative, Multiply image by a factor)
3. Histogram of a monochrome image and Pointwise Transformation
4. Gamma Correction on a monochrome image
5. Image Smoothing (Filtering noise from a monochrome image)
6. Image Sharpening of Monochrome image
7. Extract each of the colour components from an image (RGB, YCbCr), Transform between RGB and YCbCr, Smooth image using Gaussian Filter (Colour images)
8. Halftoning an image,Ordered Dithering
9. Image segmentation – Edge linking and boundary detection
10. JPEG image compression using DCT coding

TEXTBOOK(s):

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Pearson India, 2016(3rd Edition), ISBN: 9789332570320

2. Anil. K. Jain, "Fundamentals of Digital Image Processing", Pearson India, 2015(1st Edition), ISBN: 9789332551916

Reference(s):

1. Al. Bovik, "The Essential Guide to Image Processing", Academic Press, 2009.
2. William K. Pratt, "Introduction to Digital Image Processing", CRC Press/ Francis and Taylor India, 2014, ISBN: 9781482216691
3. D. Sundararajan, "Digital Image Processing: A Signal Processing and Algorithmic Approach", Springer Singapore/India, 2017, ISBN: 978981101127, DOI: 10.1007/978-981-10-6113-4
4. Purdue University: ECE438 - Digital Signal Processing with Applications - https://engineering.purdue.edu/VISE/ee438L/lab10/pdf/lab10a.pdf, https://engineering.purdue.edu/VISE/ee438L/lab10/pdf/lab10b.pdf

ECE18R358 DIGITAL VIDEO PROCESSING

ECE18R358 Digital Video Processing	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R273 Digital Signal Processing / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

The purpose of this course is to provide an understanding of the theory behind various video processing tasks as well as practical experience in accomplishing them. The course will extend the concepts from still images (spatial) to dynamic imagery (spatio-temporal). At the lowest level, this course introduces the terminology of video processing, analog vs digital, how digital image sequences are captured, dynamic imagery perception, how the video is stored, video file formats; spatio-temporal concepts and video sampling theorem

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the difference between analog and digital video, usage of digital videos, how digital videos are acquired, stored, different video file formats and spatio-temporal imagery

CO2: Perform techniques for motion analysis such as motion detection, estimation, and compensation.

CO3: Apply video processing techniques such as enhancement, segmentation for dynamic imagery to perform higher level analysis.

CO4: Explain the fundamentals of video compression techniques and their applications

CO5: Identify as well as apply these techniques to solve real-world video applications and propose solutions for the same following the ethics

CO6: Communicate the technical information related to digital video processing application carried as individual or as a teamwork by means of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H											H	M	
CO2		H			L							M	H	M	
CO3		H	L		L		M					L	M	M	
CO4	L	H											H		
CO5			L	H	H			H	H			M	H	M	
CO6								L	L	H				M	L

Course Topics:

Unit 1: Multidimensional Signal

Analog versus Digital – Analog to Digital – Analog Video – Digital Video – 3D Video – Digital Video Formation – Digital Video Processing and its applications – Video sampling and interpolation – Image and Video quality – Digital Video Standards and components – Video acquisition – CCD and CMOS

Sensors – Different types of video cameras – IP camera – interlaced and progressive scanning – Video storage: file formats, NVR, DVR

Unit 2: Motion Analysis

Motion detection: hypothesis testing with fixed and adaptive thresholding

Motion estimation: pixel based and block matching approaches – Full-search – Fast search strategies – Motion compensation for videos

Unit 3: Video Enhancements

Video artefacts and spatio temporal noise filtering – order statistics filtering – blotch detection and removal

Unit 4: Video Segmentation and Tracking

Spatio-temporal segmentation: scene change detection – motion segmentation; Hard-cuts and soft-cuts; Video object detection and tracking; frame classification – I, P and B – Video sequence hierarchy – Group of pictures – frames – slices – macro-blocks and blocks; Motion tracking: contour and feature based tracking

Unit 5 Video Compression, DVP Applications

Elements of a video encoder and decoder; Forward and backward prediction – inter frame coding approaches: MPEG-1, MPEG-2, MPEG-4 standards – Low bit rate approaches: H.26X – Inter frame redundancy

Applications: Video surveillance systems – Video indexing summarisation browsing and retrieval – Video shot boundary detection – Video watermarking

Experiments (Any 5 experiments)

1. Content based image retrieval from video
2. Conversion of videos into frames
3. Calculate and show frame difference which is widely used in video compression
4. A simple method of video standards conversion.
5. Motion estimation algorithm for the given video sequence
6. Video dataset collection (2D and 3D)
7. Processing based on background and foreground subtraction process
8. Enhancement process using algorithms
9. Convert back to complete video
10: Video Retrieval algorithms
11. Moving object tracking

TEXTBOOK(s):

1. A. Murat Tekalp, “Digital Video Processing, Pearson Education”, Prentice Hall U.S., 2015, ISBN: 9780133991109
2. Al Bovik, “Essential Guide to Video Processing”, Academic Press, 2009, ISBN 978-0-12-37445

Reference(s):

1. Yao. Wang, Jom Ostermann, and Ya-Oin Zhang, “Video Processing and Communications”, Prentice Hall, 2002, ISBN 0-13-017547-1
2. Al Bovik, “Handbook of Image and Video Processing”, Academic Press, 2000, ISBN: 0121197905
3. Lain E.G. Richardson, “H.264 and MPEG-4 Video Compression: Video Coding for Next Generation Multimedia”, Wiley, 2003, ISBN: 978-0-470-86960-4

ECE18R359 COMPUTER VISION

ECE18R359 Computer Vision	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R273 Digital Signal Processing / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

This course aims to provide students with a basic understanding of the fundamentals and application of computer vision techniques

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain camera geometry fundamentals and image formation.
CO2: Develop feature descriptor for object detection purpose
CO3: Choose an algorithm for object recognition and segmentation
CO4: Select motion estimation technique for the given application.
CO5: Make use of Computer Vision algorithms to solve real-world problems
CO6: Communicate the technical information related to computer vision experiments carried as individual or as a teamwork by means of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L										L	H		
CO2	H	H					M					M	H	M	
CO3	H	H					M					M	H	M	
CO4		H	L		L		M					H	M	M	
CO5			M	M	M							M	H	M	
CO6								H	H	H				M	L

Course Topics:

Unit 1: Computer Vision

Human Vision System; Computer Vision System; Camera Geometry Fundamentals – Probability Distribution Models – Representation – colour spaces – Camera model and Camera calibration – Binocular imaging systems – Sources, Shadows and Shading

Unit 2: Image Formation and Pre-processing

Geometric Primitives and Transformations – Photometric Image Formation – Image Formation Models: Monocular imaging system – Orthographic and Perspective Projection – Digital Camera; Point Operators; Neighbourhood Operators: Linear and Nonlinear Filtering; Pyramids and Wavelets.

Unit 3: Feature Detection and Extraction

Feature Detection – Feature Descriptors – Feature Matching – Feature Tracking – Low Level Feature Extraction – Feature Extraction by Shape Matching – Hough Transform; Edge Linking.

Unit 4: Object Recognition, Segmentation and Classification, Dense Motion Estimation

Global Methods – Active Contours – Split and Merge – Mean Shift and Mode Finding – Normalized Cuts – Support Vector Machine – Histogram of Oriented Gradients – Adaboost Classifiers
Triangulation – Two-Frame Structure from Motion – Factorization – Bundle Adjustment – Translational Alignment – Parametric Motion – Spline-Based Motion – Optical Flow – Tracking – Constrained Structure and Motion – Layered Motion – Stereo Vision

Unit 5 Real-World Systems

Real world systems: Advance Driver Assistance System (ADAS) – Video Surveillance System – Motion Estimation and Tracking Systems – Biometrics Recognition – Computer Vision Face Tracking for Use in a Perceptual User Interface – Computer vision for or people with severe movement restrictions – DARWIN: A Framework for Machine Learning and Computer Vision Research and Development

Experiments (Any 5 simple experiments)

1. Optical Systems, Camera Calibration
2. Lighting and Illumination
3. Image acquisition and Object recognition from the acquired image
4. Develop an algorithm for pre-processing of a real-time captured image. Use appropriate filter for removal of noise present if any
5. Enhancement process using algorithms on a real-time captured image
6. Select and extract features from an input image and represent a feature descriptor to detect object of interest for one of the following applications: Lane images/ face image/ pedestrian detection/ biometrics recognition/ license plate recognition/ plant classification/ medical imaging/ object counting/ object detection or classification

(OR). Develop an application for vision-based security system during day/night-time. The system should trigger an audio- visual alarm upon unauthorized entry

(OR) Develop a motion estimation/ tracking system to recognize object of interest related to one of the following applications: Automobile tracking/ face tracking/ crowd pattern tracking

TEXTBOOK(s):

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011, ISBN: 978-1-84882-934-3, DOI: 10.1007/978-1-84882-935-0
2. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach", Pearson, 2015(2nd Edition), ISBN: 9789332550117

Reference(s):

1. Bernd Jahne and Host HauBecker (Editors), "Computer Vision and Applications: A Guide for Students and Practitioners", Elsevier/Academic Press, 2000, ISBN: 9780123797773
2. Alexander Hornber (Editor), "Handbook of Machine and Computer Vision: The Guide for Developers and Users", Wiley-VCH, 2017(2nd Edition), ISBN: 97873527413393
3. E. R. Davies, "Computer and Machine Vision: Theory, Algorithms and Practicalities", Elsevier/Academic Press, 2012(4th Edition), ISBN: 9780123869081
4. J. R. Parker, "Algorithms for Image Processing and Computer Vison", Wiley, 2010(2nd Edition), ISBN: 978-1-118-02188-0
5. Robert B. Fisher, Toby P. Breckon, Kenneth Dawson-Howe, Andrew Fitzgibbon, Craig Robertson, Emanuele Trucco, Christopher K. I. Williams, "Dictionary of Computer Vision and Image Processing", Wiley, 2014(2nd Edition), ISBN: 978-1-118-75068-1

ECE18R375 STATISTICAL INFERENCE AND MACHINE LEARNING

ECE18R375 Statistical Inference and Machine Learning	L	T	P	C
	3	0	2	4
Pre-requisite: None	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To learn the Statistical inferences to be applies in Machine Learning; To familiarise with Machine Learning Algorithms.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Define statistical models for business analytics and use forecasting methods to support managerial, financial, and operational statistics.
CO2: Understand regression methods.
CO3: Apply the concepts of Factor analysis and Point of Estimation methods to the given data.
CO4: Explain the fundamentals of Machine Learning
CO5: Estimate the work as part of a team and implement various machine learning algorithms.
CO6: Build the technical information related to the design and analysis of Machine learning algorithms applied to datasets.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											M		
CO2			M	M	H		H						L	H	L
CO3			L	H	H	L	H						L	H	
CO4			L	M	H	L	H						L	H	L
CO5								H	H		L				M
CO6								M	H	H		L			M

Course Topics:

Unit 1: Basic Statistics

Basic of Statistics. Data, Context & Business, Data Quality Issues, Measure of Central Tendency, Mathematical & Positional Averages, Measures of Variance, Measures of Shape, Probability, Introduction to Sampling, Hypothesis testing, Parametric and Non-Parametric Testing

Unit 2: Regression

Residuals and Plots, Regression Methods and its Applications, Repeated Measures, Linear and non-linear data handling, Weighted Least Squares, Two Stage Least Squares, Principal components Analysis, large sample inference, monitoring quality

Unit 3: Multi-Variate Analysis and Estimations

Factor analysis: Orthogonal factor model, methods of estimation, factor rotation, factor scores, perspectives, and a strategy for factor analysis, Point estimation, Exponential family of distributions, Finite state Hidden Markov Models, Ancillary statistics, Fisher information measure and its properties

Unit 4: Fundamentals of Machine Learning

Fundamentals of Machine Learning, Types of Learning Supervised Learning Unsupervised Learning Reinforcement Learning, Classification of Machine Learning and the algorithms, least squares optimization - Simulated annealing, The Genetic algorithm

Unit 5: Classification and Clustering Techniques

Classification Algorithms, Ensemble Methods, Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, Lift Curves and Gain Curves, ROC Curves, Misclassification, Hierarchical Methods, Cluster Algorithms, Measuring Clustering Goodness

Experiments:

1. Measures of Central Tendency, Measures of Dispersion, Measures of Skewness
2. Hypothesis Test using one tail Test and two-tail test
3. Univariate Analysis, Bivariate Analysis, Multivariate Analysis
4. Analysis of Variance (ANOVA)
5. Linear Regression
    a. Housing Price Prediction
    b. Air Quality Prediction
6. Logistic Regression
    a. Credit Default Prediction
    b. Heart Disease Prediction
7. Dimensionality Reduction Using Factor Analysis
8. Estimating population statistics with Point Estimation
9. Program to demonstrate k-Nearest Neighbour flowers classification
10. Program to demonstrate Decision Tree – ID3 Algorithm and Random Forest with flowers classification
11. Program to demonstrate Naïve- Bayes Classifier
12. Program to demonstrate k-means clustering algorithm

Textbook(s):

1. T. Veerarajan, “Probability, Statistics and Random Processes” Mc-Graw Hill, 2008 (Third Edition), ISBN: 978-0070699564
2. Kevin P. Murphy, “Machine Learning – A probabilistic Perspective”, MIT Pres, 2016, ***ISBN***: 9780262018029

Reference(s):

1. Robert Stine, Dean Foster, “Statistical for Business: Decision Making and Analysis”. Pearson, 2013 (Second Edition), ISBN: 9780321836519
2. Randal S, “Python Machine Learning”, PACKT Publishing, 2016 (Third Edition), ***ISBN***: 9781789955750
3. Levin Richard and Rubin Davids, “Statistics for Management “, Pearson, 2016 (Eighth Edition), ISBN. 978-9332581180

4. Robert Stine, Dean Foster, “Statistical for Business: Decision Making and Analysis”. Pearson, 2018 (Third edition), ISBN: 9780134497167
5. Ethem Alpaydin, "Machine Learning: The New AI”, MIT Press, 2016, ISBN 13: 9780262529518
6. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2014, ISBN: 9781107298019
7. Sebastian Raschka, “Python Machine Learning”, Packt Publishing, 2019 (Third Edition), ISBN: 9781789955750

ECE18R379 DEEP LEARNING IMPLEMENTATIONS IN TENSOR-FLOW AND KERAS

ECE18R379 Deep Learning Implementations in Tensor-Flow and Keras	L	T	P	C
	2	0	2	3
Pre-requisite: Statistical Modelling and Machine Learning	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To impart knowledge about the concepts of machine learning. To introduce the fundamental concepts of distributed nature of operating system, network, data and processes. To enable the students to understand the concepts of computing environment where computations do not take place at one system and accordingly enable them to solve related problems.
To build the foundation of deep learning. To understand how to build the neural network. To enable the students, develop successful machine learning projects.

Course Outcome(s):

After completing this course, the student will be able to:
CO1: Understand the stochastic process in Time series analysis and survival analysis.
CO2: Understand the fundamentals of ANN and CNN with basic TensorFlow implementations.
CO3: Implement RNN and the LSTM networks.
CO4: Apply GAN Neural networks to a real-world problem.
CO5: Implement the Deep Learning concepts in TensorFlow
CO6: Identify the implementation of Memory Augmented Neural Networks to Temporal Linking of DNC

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M								L		L	M		
CO2	H	M	M	L			H			L		L	H	H	L
CO3	H	H	M	M	M	L	H			L		L	H	H	L
CO4	H	H	H	H	M	L	H			L		L	H	H	L
CO5	H	M	M	L			H			L		L	H	H	L
CO6	H	M								L		L	M		L

Course Topics: **Total 30 hours**

Unit 1: Stochastic Process **6 Hours**

Stochastic process, Time series as a discrete stochastic process, Autoregressive models. Seasonality in Box –Jenkins model, Basic Quantities and Models

Unit 2: Basics of Deep Learning and Convolutional Neural Networks **6 Hours**

Fundamentals of ANN, Tensor flow, ANN in TensorFlow, Implementation of Neural Networks, Classification of Neural Network, Classification Methods, Convolutional Neural Networks and its implementation in Tensor flow

UNIT-3: RNN and LSTM Neural networks **6 Hours**

Recurrent Neural Networks and its implementation in Tensor flow, LSTM Neural Networks and its implementation in Tensor flow, Using LSTMs to synthesize text, Image synthesis with variational auto encoders

Unit 4: Generative Neural Networks and Advanced Neural Networks 6 Hours

Generative Adversarial Networks, MIMO Deep Learning models, Hyper parameter tuning, Ensemble of models, Types of Learning, Various types of Neural Networks and their implementation in Tensor flow. Example from medical diagnostics

Unit 5: Neural Network and its Applications 6 Hours

Memory Augmented Neural Networks, Neural Turing Machines, Attention-Based Memory Access-NTM Memory Addressing Mechanisms, Differentiable Neural Computers-Interference-Free Writing in DNCs-DNC Memory Reuse

Experiments:

1. Print Dimensions of dataset, Calculation of Accuracy Values, Accessing and Manipulation of tensors
2. Understand the mechanism of practically training a binary classifier
3. Access and manipulation of tensors, Regression Data Sampling, Combat Overfitting
4. CNN Training, reuse a model, Reusing a part of an existing model
5. CNN implementation with CIFAR-100 dataset
6. Text Generation, Automatic Image Captioning with Keras
7. Implementing a recurrent neural network (RNN) in TensorFlow
8. RNN that will generate new “Flower” names
9. Stages of the convnet, Sequence Classification Problem, Text-to-Speech synthesis
10. Implementation of GAN network in Keras
11. Bayesian Networks implementation in Keras
12. Implementing Memory Augmented Neural Networks using Keras

Textbook(s):

1. Ethem Alpaydin, “Introduction to Machine Learning”, Pearson / Prentice Hall, 2014, ISBN: 978-8120350786

Reference(s):

1. Stephen Marsland, Chapman, and Hall, “Machine Learning: An Algorithmic Perspective”, CRC Press, 2011, ISBN: 978-1466583283
2. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006, ISBN 978-1-4939-3843-8
3. Tom Mitchell, “Machine Learning”, McGraw Hill, ISBN: 978-1259096952
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press, 2015, ISBN: 978-0262035613
5. T. Hastie, R. Tibshirani, and J. Friedman, “The Elements of Statistical Learning”, Springer, 2013, ISBN 978-0-387-84858-7
6. D. Koller, and N. Friedman, “Probabilistic Graphical Models: Principles and Techniques”, MIT Press, 2009, ISBN: 978-0262013192

ECE18R407 ADAPTIVE SIGNAL PROCESSING

ECE18R407 Adaptive Signal Processing	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R273 Digital Signal Processing and Filter Design / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The course makes the students to familiar with basics of adaptive filtering and advanced topics in digital signal processing.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the non-linear control and the need and significance of changing the control parameters with respect to real-time situations

CO2: Mathematically represent the 'adaptability requirement'

CO3: Explain the mathematical treatment for the modelling and design of the signal processing systems

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H					M					H	H		
CO2	H	H					M					H	H	M	
CO3	H	M											H		

Course Topics:

Unit 1: Basic Concepts

General concept of adaptive filtering and estimation – applications and motivation – Review of probability, random variables, and stationary random processes – Correlation structures – properties of correlation matrices

Unit 2: LMS Algorithm

Optimal FIR (Wiener) filter – Method of steepest descent – extension to complex valued The LMS algorithm (real, complex) – convergence analysis – weight error correlation matrix – excess mean square error and mis-adjustment

Variants of the LMS algorithm: the sign LMS family – normalized LMS algorithm – block LMS and FFT based realization – frequency domain adaptive filters – Sub-band adaptive filtering

Unit 3: Signal Space Concepts

Signal space concepts - introduction to finite dimensional vector space theory – subspace, basis, dimension, linear operators, rank, and nullity – inner product space – orthogonality – Gram Schmidt orthogonalization – concepts of orthogonal projection – orthogonal decomposition of vector spaces

Unit 4: Vector Space

Vector space of random variables – correlation as inner product – forward and backward projections – Stochastic lattice filters – recursive updating of forward and backward prediction errors – relationship with AR modelling – joint process estimator – gradient adaptive lattice

Unit 5: Recursive Least Squares

Introduction to recursive least squares (RLS) – vector space formulation of RLS estimation – pseudo-inverse of a matrix – time updating of inner products – development of RLS lattice filters – RLS transversal adaptive filters. Advanced topics: affine projection and subspace based adaptive filters – partial update algorithms – QR decomposition and systolic array

TEXTBOOK(s):

1. Tulay Adali and Simon Haykin, "Adaptive Signal Processing: Next-Generation Solutions", Wiley/IEEE India, 2010, ISBN: 9788126535675
2. Bernard Widrow, Samuel D. Stearns, "Adaptive Signal Processing", Pearson India, 2012(Reprint), ISBN: 9788131705322

Reference(s):

1. Jacob Benesty, Yiteng Huang, "Adaptive Signal Processing: Applications to Real-World Problems", Springer, 2003, ISBN: 978-3-642-05507-2, DOI: 10.1007/978-3-662-11028-7
2. Mohamed Ibnkahla (Editor), "Adaptive Signal Processing in Wireless Communication", CRC Press, 2008, ISBN: 9781420046014

ECE18R408 VIRTUAL REALITY

ECE18R408 Virtual Reality	L	T	P	C
	3	1	0	4
Pre-requisite: --	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To provide the theoretical knowledge about virtual reality technologies and the fundamental concepts involved in building and displaying virtual worlds

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate an understanding of the underlying enabling technologies of Virtual Reality systems
CO2: Describe the operation of input and output devices for Virtual Reality
CO3: Explain the computing architecture needed for Virtual Reality
CO4: Develop a fuller understanding of social and community issues related to the application of virtual reality system
CO5: Carry a literature survey on the recent happenings with respect to VR

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L					M					M	H	M	
CO2	M	H					M					M	H	M	
CO3		H					H					H	H		
CO4						H	H					H	H	H	M
CO5		H				H	H	M	L	H			H	M	

Course Topics:

Unit 1: Virtual Reality Fundamentals

Definition – 4 Elements of Virtual Reality Experience – Components of a VR system – Comparison of Virtual Reality, Augmented Reality, Telepresence and Cyberspace – Evolution of VR

Unit 2: Input Devices

Position trackers: Parameters, Mechanical tracker, magnetic tracker, ultrasonic tracker, optical tracker, video-metric tracker, hybrid inertial tracker, neural tracker – Body tracking – Gesture Interfaces: Pinch Glove, 5DT Data Glove, The Didjig Glove, Cyber Glove – Navigation and Manipulation Interfaces: Tracker based interfaces, tracker ball, 3D Probes – User interface metaphors – manipulating a virtual world: manipulation methods, properties, selection, manipulation operations - navigating in a virtual world: way finding, travel – interacting with others – interacting with VR

Unit 3: Output Devices

Visual Displays: Properties, Monitor Based, Projection Based, Head Based, See-through head based, Handheld VR Displays

Aural Displays: Properties, Head based and Stationary aural devices

Haptic Displays: Human haptic system, Tactile type, force type

Unit 4: Computing Architectures, VR Design Issues

Visual representation in VR, Aural representation in VR, Haptic representation in VR – Visual Rendering System – Aural Rendering System -Haptic Rendering System – PC Graphics Accelerators and Architecture – Multipipeline synchronisation – collocated rendering pipelines – distributed VR environment – VR Haptic Interface software – Creating a VR application – Designing a VR experience -VR health and safety issues – VR and Society

Unit 5: VR Applications

Medical applications – Educational applications – Entertainment – Military – In Manufacturing – Robotics – Visualisation of Information – Trends and Research in VR – Future of VR

TEXTBOOK(s):

1. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley India, 2003 (2nd Edition), ISBN: 9788126507894
2. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application, and Design", Morgan Kaufmann Publishers (Elsevier) U.S./India, 2017(2nd Edition), ISBN: 9780128009659

Reference(s):

1. Tony Parisi, "Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web and Mobile", O'Reilly, 2016, ISBN: 9781491922835

ECE18R409 AUGMENTED REALITY

ECE18R409 Augmented Reality	L	T	P	C
	3	1	0	4
Pre-requisite: --	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To provide the theoretical knowledge about augmented reality technologies and the fundamental concepts involved in building and displaying virtual worlds

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate an understanding of the underlying enabling technologies of Augmented Reality systems
CO2: Describe the operation of hardware and software programming with respect to augmented reality systems
CO3: Explain the how the interactions with content would take place in AR
CO4: Develop a fuller understanding of social and community issues related to the application of augmented reality system
CO5: Carry a literature survey on the recent happenings with respect to AR

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L					M					M	H	M	
CO2	M	H					M					M	H	M	
CO3		H					H					H	H		
CO4						H	H					H	H	H	M
CO5		H				H	H	M	L	H			H	M	

Course Topics:

Unit 1: Augmented Reality Fundamentals

Definition – Components and Platforms of AR – Ingredients of AR – Working of AR - Difference between AR and other systems – Challenges with AR

Unit 2: AR Hardware

Sensors, Processors, Displays

Unit 3: AR Software

Reality systems, AR applications

Unit 4: Content and Interaction in AR

Creating visual content – creating audio content – creating content for other senses – Manipulation – Navigation -Reality applications and interaction in projected AR environments – Subjective vs. Objective point of view

Unit 5: Mobile AR, AR Applications

Mobile AR, Advantages and Disadvantages – Architecture of mobile AR – Applications: Industry and Construction, Maintenance and Training, Medicine, Personal Information Display, Navigation, Television, Advertising, Games – Trends and Research in AR – Future of AR

TEXTBOOK(s):

1. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles and Practice", Pearson, (Addison Wesley Professional) India, 2015, ISBN: 9789332578494
2. Greg Kipper, Joseph Rampolla, "Augmented Reality: An Emerging Technologies Guide to AR", Syngress (Elsevier), 2013, ISBN: 9781597497336

Reference(s):

1. Alan B. Craig, "Understanding Augmented Reality: Concepts and Applications", Morgan Kaufmann (Elsevier), 2013, ISBN: 9780240824086

ECE18R452 DIGITAL SIGNAL PROCESSING SYSTEM DESIGN

ECE18R452 Digital Signal Processing System Design	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R355 Digital Signal Processing Architecture / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

Apply previous signal processing knowledge in real-time digital signal processing systems

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Design analog to digital converter and digital to analog converters, calculate their performance metrics, architectures, and signal conditioning
CO2: Identify over-sampling theory
CO3: Implement methods of linear time invariant systems (LTI) and effects of finite precision representation on the realization of LTI and fast Fourier transform (FFT)
CO4: Make use of the knowledge in DSP, design and experiment a DSP system which takes an analog signal as input, process it and provides back to the real world
CO5: Communicate the technical information related DSP based system design as individual or as a teamwork by means of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H	L		L							M	H	M	
CO2	H	H											H		
CO3	H	H											H	M	
CO4			H	H	H			M	H			M	H	H	
CO5								L	L	H				M	L

Course Topics:

Unit 1: ADCs, DACs, Sampling Theory

Coding and Quantising – Sampling theory – Data converter AC Errors, specifications

Unit 2: Digital Filters

Complete DSP system – Digital data processing – the running average filter – representation of processing systems – feedback filters.

Unit 3: Frequency Domain Processing

DFT – FFT – STFT – DWT – Signal processing toolset.

Unit 4: DSP Systems Design

Computational structures, Parallel Algorithm expression, Pipeline implementation of DSP systems, Retiming of cellular arrays, Computational cells for arrays

Unit 5 DSP Hardware

DSP theory for hardware designers – Theory, applications, and implementations – DSP applications – DSP implementations – Review of processors and systems – Digital signal processor architecture – Processor hardware units – Fixed point and floating-point representation – FIR, IIR filters in fixed point system – DSP programming examples

Experiments (Any 5 experiments)

1. LabView DSP Integration: DSP Kit - Communication with LabView
2. CCS Automation
3. FIR filter implementation with LabVIEW and DSP Kit
4. IIR Filter implementation with LabVIEW and DSP Kit
5. Fixed point implementation
6. Dual Tone Multi-Frequency System with LabVIEW and DSP Kit
7. Any Communication Modulation/Demodulation System with LabVIEW and DSP Kit

TEXTBOOK(s):

1. Kenton Williston (Editor), "Digital Signal Processing: World Class Designs", Newnes/Elsevier U.S., 2009(1st Edition), ISBN: 9781856176231
2. Nasser Kehtrarnavaz, "Digital Signal Processing System Design: LabVIEW-Based Hybrid Programming", Elsevier/Academic Press, 2008, ISBN: 9780123744906

Reference(s):

1. Winser E. Alexander, Cranos M. Williams, "Digital Signal Processing: Principles, Algorithms and System Design", Elsevier/Academic Press, 2017, ISBN: 9780128045473
2. Nasser Kehtarnavaz, Namjin Kim, "Digital Signal Processing System-Level Design: Using LabVIEW", Elsevier/Newnes, 2005, ISBN: 9780750679145
3. Paulo S. R. Diniz, Eduardo A. B. da Silva, Sergio L. Netto, "Digital Signal Processing: System Analysis and Design", Cambridge University Press, 2010(2nd Edition), ISBN: 9780521887755

ECE18R472 APPLIED DATA MODELLING AND DEEP LEARNING FOR ENGINEERS

ECE18R472 Applied Data Modelling and Deep Learning for Engineers	L	T	P	C
	2	0	2	3
Pre-requisite: Deep Learning implementations in TensorFlow and Keras	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To introduce the concepts of data Mining and its applications. To understand investigation of data using practical data mining tool. To introduce Association Rules Mining. To introduce advanced Data Mining.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Identify the key process of Data mining and Warehousing.
CO2: Apply appropriate techniques to convert raw data into suitable format for practical data mining tasks.
CO3: Compare various Evaluation Techniques.
CO4: Evaluate the performance of various classification methods using performance metrics.
CO5: Build real world applications using Reinforcement learning
CO6: **I**mplement appropriate algorithms and Neural Networks for various applications.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											M		
CO2	H	M			M								M	L	
CO3		H	M	L									L	L	

CO4		H		M									L	L	
CO5	L		M		M	H		H	H		L		M	L	M
CO6	L	H		M			H	M	H	H		L	M	L	M

Course Topics:

Unit 1: Data Understanding and Preparation, Data Transformations 6 Hours

Identifying business objectives, translating business objectives to data mining goals, reading data from various sources – Database/ Excel/ Text/others, data visualization – tabular & graphic

Unit 2: Modelling Techniques 6 Hours

Linear regression, Logistic regression, Discriminant analysis, Bayesian networks, Neural networks, Rule Induction, Support vector machines, Decision trees, Clustering, Association Rules, Sequence Detection

Unit 3: Model Evaluation and Deployment 6 Hours

Model Validation, Determining Model Accuracy, Rule Induction Using CHAID, Automating Models, Evaluation Charts for Model Comparison, Using Propensity Scores, Error Modelling, Deploying Model, Exporting Model Results, Assessing Model Performance

Unit 4: Reinforcement Learning 6 Hours

Reinforcement Learning, Markov decision process (MDP), Bellman expectation equations, Bellman optimality equations, Bellman expectation and optimality operators

Unit 5: Advanced Reinforcement Techniques

Overview of Monte Carlo methods for model free RL, Risk minimization, Gradient MC and Semi-gradient TD (0) algorithms, Experience replay in deep Q-Networks, Deep Reinforcement, Markov Decision Processes (MDP)

Experiments:

1. Fraud detection
2. Risk modelling and investment banking
3. Customer Churn
4. Customer sentiment analysis
5. Online Retail Case Study
6. Energy Efficiency Analysis
7. Liver Disease Prediction
8. Car Price Prediction
9. Implement the Markov decision Process using Reinforcement learning
10. Build a Recommendation System Using Reinforcement Learning
11. Build a system for Dynamic Pricing using Reinforcement Learning
12. Implementation using Q-learning

Textbook(s):

1. Dunham M H, “Data Mining: Introductory and Advanced Topics”, Pearson, ISBN: 978-0130888921.
2. Jaiwei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, Elsevier, 2006, ISBN: 978-9380931913

Reference(s):

1. M Sudeep Elayidom, “Data Mining and Warehousing”, Cengage Learning, 2015, ISBN: 9788131525869.
2. Mehmed Kantardzic, “Data Mining Concepts, Methods and Algorithms”, John Wiley, 2003, ISBN: 978-1-119-51604-0.
3. Pang-Ning Tan and Michael Steinbach, “Introduction to Data Mining”, Addison Wesley, 2006, ISBN: 978-9332571402.

V PROFESSIONAL ELECTIVE COURSES

STREAM: COMMUNICATION ENGINEERING AND NET-WORKING

ECE18R259 INFORMATION THEORY AND CODING PRINCIPLES

ECE18R259 Information Theory and Coding Principles	L	T	P	C
	3	0	1	3.5
Pre-requisite: --	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To introduce to the students, the concept of information and entropy of Information; Describe the mathematical foundation of compression, error control and security of information

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basic information and entropy

CO2: Explain source coding compression, decoding and error control methods as applied in communication system with an understanding of the limitations of channels and codes

CO3: Calculate the data rate that can be offered by the channel in the presence of AWGN

CO4: As an individual or a team work experimentally implement the coding techniques studied following the ethical norms

CO5: Express to peers/faculty/society about the information theory and coding principles in way of oral/written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M					H					L	H		
CO2		M					H					H	H		
CO3			H			L	H	H				H	H	M	
CO4		L		H	H			L	H		L			M	L
CO5									L	H					

Course Topics:

Unit 1: Information Theory Basics

Measure of Information – Entropy of symbols – Continuous and Discrete Messages – Basic relationship among different entropy

Unit 2: Mutual Information and Coding Theorem

Entropy for discrete ensembles– properties of entropy of a binary memory less source –extension of a binary memory less source – source coding theorem – Shannon fanon coding - Huffman coding

Unit 3: Shannon's and Channel Coding Theorem

Binary symmetric channel – Markov Sources – Shannon noisy and noiseless coding theorem – properties – channel capacity – Hartley, Shannon Law –channel coding theorem - Lempel-Ziv coding

Unit 4: Linear and Cyclic Codes

Linear block codes – generator matrices – parity check matrices – encoder – syndrome and error correction – minimum distance –error correction and error detection capabilities – cyclic codes – coding and decoding

Unit 5: Other Coding Techniques

Convolution codes – encoder – generator matrix – state diagram – distance properties - maximum likelihood decoding – Viterbi decoding – sequential decoding –Hadamard matrices and Hadamard codes – BCH codes – description, decoding – Reed Solomon code

Experiments (Any 5):

Implement the following in C or MATLAB

1. Write a program for determination of various entropies and mutual information of a given channel. Test various types of channel such as a) Noise free channel. b) Error free channel c) Binary symmetric channel d) Noisy channel; Compare channel capacity of above channels
2. Write a program for generation and evaluation of variable length source coding using a) Shannon – Encoding and decoding b) Huffman Coding and decoding c) Lempel Ziv Coding and decoding
3. Write a Program for coding and decoding of Linear block codes

4. Write a Program for coding and decoding of Cyclic codes.
5. Write a program for coding and decoding of convolutional codes
6. Performance of a coded and not-coded communication system. (Calculate the error probability)
7. Simulation program to implement source coding and channel coding for transmitting a text file

TEXTBOOK(s):

1. Ranjan Bose, "Information Theory, Coding, and Cryptography", McGraw Hill India, 2008 (2nd Edition), ISBN: 9780070669017
2. David Mackay, "Information Theory, Interference and Learning Algorithms, Cambridge University Press, 2002

Reference(s):

1. Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory", Wiley India, 2nd Edition, ISBN: 9788126541942
2. Robert B. Ash, "Information Theory", Dover Publications U.S., 2012 (Reprint)

ECE18R319 RADAR AND NAVIGATIONAL AIDS

ECE18R319 RADAR and Navigational Aids	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R274 Electromagnetic Waves and Transmission Lines / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To make the students understand the basic concept in the field of Radar and Navigational aids. Students are taught about several types of Radar Systems

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Define the fundamental working principle of RADAR
CO2: Describe the different types of RADAR and their operations
CO3: Design impedance matching networks and passive RF filters
CO4: Illustrate how RADAR detect their target
CO5: Explain the components used RADAR design
CO6: Analyse the use of RADAR navigation techniques

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H											H	M	
CO2	L	H											H	M	
CO3	L	M	L										M	M	
CO4	M	M											H	M	
CO5		H											H		
CO6	L	M	L										H	M	

Course Topics:

Unit 1: RADAR Types

Basic RADAR concepts – RADAR block diagram – RADAR frequencies – Applications Range parameters – pulsed radars – signal to noise ratio – integration of pluses beam parameters – system losses and propagation effects MTI, CW and pulse-Doppler radar – Delay lines tracking radar – monopulse, sequential, simultaneous, conical scan and monopulse trackers, Beacons

Unit 2: Transmitters, Receivers and Antennas

ECM and ECCM – Klystron, Magnetron, TWT amplifiers and oscillators – crossed fields devices – parabolic Cassegrainian – coefficient squares antennas – Radomes – feeds – receivers – performance figures – Displays scope and PPI duplexers

Unit 3: Signal Detection

RADAR operator – Signal Management – MF, correlation detection – detector characteristics – automatic detection – CFAR receiver – pulse compression and classification of targets with Radar

Unit 4: Wave Propagation, Clutter

Plane earth and spherical earth problem – Refraction, and diffraction – GTD Analysers – Surface and Sea Clutter – Detection of targets – effects of weather on radar – Automatic Detection finder – Range and accuracy of detection finder

Unit 5: Navigational Aids

Synthetic Aperture – Over the Horizon radar – ARSR, ASR, Bistatic and monostatic radars – LORAN, ILS, GCA, direction finder – VOR concepts – airborne Doppler navigation – GPS-Principle of operation – GPS receiver

TEXTBOOK(s):

1. Merrill I. Skolnik, "Introduction to Radar Systems (SIE)", McGraw Hill India, 2006 (2nd Edition), ISBN: 9780070634411
2. G.S.N. Raju, "Radar Engineering and Fundamentals of Navigation Aids", I. K. International Publishers India, 2008, ISBN: 9788190694216

Reference(s):

1. Peyton Z. Peebles, "Radar Principles", Wiley India, 2007, ISBN: 9788126515271
2. N S Nagaraja, "Elements of Electronic Navigation", McGraw Hill India, 2001 (2nd Edition), ISBN: 9780074623015

ECE18R320 RFID AND APPLICATIONS

(Common For B.Tech. E.C.E. and CSE)

ECE18R320 RFID and Applications	L	T	P	C
	3	1	0	4
Pre-requisite: Basic Electronics and Communication Engineering	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

Get acquainted with various protocols, standards associated with RF ID, Address the security and privacy in RF ID

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basic components and applications of RFID systems

CO2: Analyse and characterise RFID reader architectures

CO3: Analyse various antennas and protocols used in RFID systems

CO4: Design RF ID systems with an understanding of guidelines to be followed for security and privacy

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H		
CO2		H				L	L					L	H	M	
CO3		H				L	L					L	H	M	
CO4		H	H		L	H	H	H				H	H	M	

Course Topics:

Unit 1: RFID Basics

History and Practice of RFID – RFID Systems and Terminology – Types of RFID – Frequency Bands for RFID – Tags-Passive, Semi passive, and Active Tags. Radio Basics for UHF RFID -Signal Voltage and Power – Information – Modulation, and Multiplexing – Backscatter Radio Links – Link Budgets – Effect of Antenna Gain and Polarization on Range – Propagation in the Real World

Unit 2: Readers and Tags

UHF RFID Readers: Radio Architectures and Components – RFID Transmitters and RFID Receivers – Digital-Analog Conversion and Signal Processing Packaging and Power

UHF RFID Tags: Power and Powerlessness – RF to DC – Getting Data – Talking Back – Tag IC Overall Design Challenges – Packaging

Unit 3: RFID Antennas

Reader Antennas: Antennas for Fixed Readers – Antennas for Handheld or Portable Readers – Near-field Antennas – Cables, and Connectors

Tag Antennas: Practical challenges of Tag antenna – Impedance Matching and Power Transfer – Di-poles and Derivatives – Tags and the (local) Environment – Near-field and Hybrid Tag Antennas

Unit 4: RFID Protocols

EPC global Generation 1-EPC global Class 0, EPC global Class 1 Generation 1 – ISO 18000-6B (In-tellitag), ISO 18000-6C (EPC global Class 1 Generation 2)

Unit 5: RFID Security, Standards, and Applications

RFID Security: Confidentiality, Integrity, Availability, Threats, Cryptography, and Threat Modelling

RFID Standards, Laws, Regulations, Policies, and Guidelines: EPC global – ISO/IEC Item Manage-ment – Contactless Smart Cards – Animal Identification – FCC Rules for ISM Band – Identity Standards – and Guidelines for Securing RFID Systems

Real-time Demonstration of RFID Tag and Reader Working in a Laboratory

TEXTBOOK(s):

1. Daniel M. Dobkin, "The RF in RFID: UHF RFID in Practice", Elsevier/Newness, U.S./India, 2012(2nd Edition), ISBN: 9780123945839
2. Jari-Pascal Curty, Michel Declercq, Catherine Dehollain, Norbert Joehl, "Design and Optimization of Passive UHF RFID Systems", Springer, 2007, ISBN: 9780387352749

Reference(s):

1. Tom Igoe, "Getting Started with RFID: MAKE-OBJECTS", O'Reilly/Make: makezine.com, 2012, ISBN: 9781449324186
2. Amin Rida, Li Yang, Manos M. Tentzeris, "RFID-Enabled Sensor Design and Applications", Artech House, 2010, ISBN: 9781607839811

ECE18R321 SATELLITE COMMUNICATION

ECE18R321 Satellite Communication	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R275 Analog and Digital Communication / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To teach the working principles, expenditures for communication and applications of satellites

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the basic theories and principles in satellite communication systems including its reliability

CO2: Create link budget for an uplink and downlink carrier to noise rate at an earth terminal receiver

CO3: Analyse modulation and coding scheme in satellite communication systems using knowledge on principles and techniques

CO4: Explain the concepts of satellite networking for applications like GPS, DTH and others

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H		
CO2	H	H	M		L	L	L	L				L	H	M	
CO3	H	H				L	L					L	H	M	
CO4	H	H		H			H					H	H	M	

Course Topics:

Unit 1: Orbital Mechanics and Launchers, Satellite Subsystems

History of satellite communications – General structure of satellite communication – Active and Passive satellites – Importance of 6/4 GHz system – Satellite frequency allocation and band spectrum – Satellite applications – Satellite orbits – Performance characteristics of different altitude satellites – Orbital mechanics – Look angle determination – Orbital perturbations – Orbit determination – Launchers and launch vehicles –Satellite subsystem – Attitude and Orbit Control System – Telemetry, Tracking, Command and Monitoring – Power systems – Communication subsystems – Satellite antennas – Equipment Reliability and Space Qualification

Unit 2: Satellite Link Design

Basic transmission theory – System noise temperature and G/T Ratio – Design of downlink – Satellite system using small earth stations – Uplink design – Design for specified C/N – System design example

Unit 3: Communication Techniques, Propagation Effects

Analog FM transmission by satellite – Digital transmission – On-board processing – DAMA – Random Access – Packet Radio systems and Protocols – CDMA – Implementation of error detection on satellite links – Quantifying attenuation and depolarisation – Rain and ice effects

Unit 4: Navigation Satellite Systems, Direct to Home Systems

Radio and satellite navigation – GPS position location principles – GPS receivers and codes – Satellite signal acquisition – GPS navigation message – GPS receiver operation – GPS C/A code accuracy – Differential GPS – C-Band and Ku-Band Home satellite TV – DBS-TV system design – DBS-TV link budget – Error control in Digital DBS-TV – Master control station and uplink – Installation of DBS-TV antennas

Unit 5: Non-Geostationary Satellite Systems, VSAT Systems

Orbit considerations for non-geo satellites – Coverage and frequency considerations – Delay and throughput considerations – System considerations – Operational NGSO constellation designs – VSAT systems – Network architectures – Access control protocols – Basic techniques – Access control protocols – Basic techniques – VSAT Earth station engineering – Calculation of link margins – System design procedure – Satellite for Mobile communication and INMARSAT systems – Remote Sensing Satellites

Indian Activities in Satellite Communication: History – INSAT, IRS Satellites – Special Small Satellites – Small Earth Stations in India, Collaboration with Industries – ISRO and Phoenix

TEXTBOOK(s):

1. R. N. Mutagi, “Satellite Communication: Principles and Applications”, Oxford University Press India, 2016, ISBN: 9780199452804
2. Timothy Pratt, Charles Bostian, Jeremy Allnutt, “Satellite Communications”, Wiley India, 2006(2nd Edition), ISBN: 9788126508334

Reference(s):

1. Dennis Roddy, “Satellite Communications”, McGraw Hill India, 2008(4th Edition), ISBN: 9780070077850
2. P. Banerjee, “Satellite Communication”, PHI, 2017, ISBN: 9788120352995
3. Monojit Mitra, “Satellite Communication”, PHI, 2007, ISBN: 978-81-203-2786-3
4. K. N. Raja Rao, “Satellite Communication: Concepts and Applications”, PHI, 2013, ISBN: 978-81-203-4725-0

ECE18R322 DATA COMPRESSION

ECE18R322 Data Compression	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R259 Information Theory and Coding / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

To explain the need for compression technique and the different types; To study the basics audio compression technique and the Vocoders; To study the different image compression techniques and JPEG standards; To study the different video compression techniques and MPEG standards

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Define compression and explain compression as an example of representation

CO2: Explain the idea of lossy and lossless compression with respect to data and text

CO3: Classify the most used common compressed techniques for image and explain them with an understanding of their limitations

CO4: Classify the most used common compressed techniques for sound and explain them with an understanding of their limitations

CO5: Classify the most used common compressed techniques for video and explain them with an understanding of their limitations

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H											H		
CO2		H				L	H					L	H	M	
CO3		H				L	H	L				M	H	M	
CO4		H				L	H	L				M	H	M	
CO5		H				L	H	L				M	H	M	

Course Topics:

Unit 1: Compression Basics

Redundancy – need for compression – evolution of data compression - applications –Taxonomy of compression techniques – overview of source coding, source models – coding – uniquely decodable codes – prefix codes- Kraft McMillan Inequality-Rate distortion theory

Unit 2: Data Compression, Text Compression

Scalar quantization theory – overview, uniform, adaptive, non-uniform – Entropy coded Quantization –Text Compression Compaction techniques – Huffman coding – Adaptive Huffman Coding – Arithmetic coding – Shannon - Fano coding – dictionary techniques – LZW family algorithms

Unit 3: Audio Compression

Vector quantization – LBG algorithm –Tree structured vector, structured vector quantisers – rate distribution theory – Evaluation techniques –error analysis and methodologies - Audio signal representation – compression techniques Frequency domain and filtering – Basic sub-band coding – G.722– MPEG audio – progressive encoding for audio – Silence compression – speech compression techniques –Vocoders

Unit 4: Image Compression

Predictive techniques – DM, PCM, DPCM – optimal predictors and optimal quantization – contour-based compression – Quad trees – transform coding – DCT- JPEG Standard – Progressive image compression- Sub-band coding algorithms – Design of Filter banks – Wavelet based compression –EPIC, SPIHT coders – JPEG 2000 standards. –Image transform -JBIG, JBIG2

Unit 5: Video Compression

Video Signal Components-Video compression techniques-MPEG video coding- Motion Compensation- H.261, H.263, MPEG 4 and H.264 Codec

TEXTBOOK(s):

1. Khalid Sayood, “Introduction to Data Compression”, Morgan Kauffman Publishers / Elsevier U.S./India, 2017(5th Edition), ISBN: 9780128094747
2. Ze-Nian Li, Mark S. Drew, Jiangchuan Liu, “Fundamentals of Multimedia”, Springer U.K./India, 2014(4th Edition), ISBN: 9783319052908 – DOI: 10.1007/978-3-319-05290-8

Reference(s):

1. David Salomon, Giovanni Motta, “Handbook of Data Compression”, Springer U.K./India, 2010(5th Edition), ISBN: 9781848829039 – DOI: 10.1007/978-1-84882-903-9
2. Yun Q. Shi, Huifang Sun, “Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms and Standards”, CRC Press (Taylor and Francis) U.K./India, 2008(2nd Edition), ISBN: 9780849373640

ECE18R361 FIBRE OPTIC COMMUNICATION

ECE18R361 Fibre Optic Communication	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R275 Analog and Digital Communication / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To introduce the principle of light propagation through optical fibres; To understand signal distortion mechanisms in the fibre; To introduce optical transmitters and receivers for fibre /free space links; To introduce optical network concepts and components involved

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Recognize and classify the structures of Optical fibre
CO2: Explain the different components of an optical fibre communication link and networks and select the appropriate components required for designing
CO3: Compute optical fibre link design parameters with the knowledge of channel impairments and coupling losses
CO4: Explain optical networking technology concepts
CO5: Conduct experiments to analyse about components of an optical fibre communication link system by following the norms and ethics as an individual and team member
CO6: Communicate effectively about the optical communication by means of oral and written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H	M	
CO2		H	L			L	L	L				L	H		
CO3	M	H	H			L	L	L				L	H	M	
CO4		H					H					H	H		
CO5			H	H	H			H	M		L		H	M	
CO6								L	L	H				M	L

Course Topics:

Unit 1: Optoelectronic Fibres

Basics – vector nature of light – propagation of light – propagation of light in a cylindrical dielectric rod – Ray model, wave model.

Different types of optical fibres – Modal analysis of a step index fibre

Signal degradation on optical fibre due to dispersion and attenuation – Fabrication of fibres and OTDR measurement techniques

Group velocity Dispersion

Unit 2: Optoelectronic Sources and Detectors

Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APD, detector responsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties

Link Power budget analysis and Rise time power budget analysis

Unit 3: Optoelectronic Amplifiers, Optoelectronic Switches

Optical switches - coupled mode analysis of directional couplers, electro-optic switches.

Optical amplifiers - EDFA, Raman amplifier.

Unit 4: WDM

WDM and DWDM systems – Principles of WDM networks

Unit 5: Non-Linear Effects

Nonlinear effects in fibre optic links – Concept of self-phase modulation

Experiments (Any 5)

1. Characterisation of Glass and Plastic Optical Fibres – Measurement of Numerical Aperture, Attenuation and Mode characteristics

2. DC Characteristics of LED and PIN Photodiode. – Determination of External Power Efficiency of LED and Responsivity and Dark current of the PIN photo diode
3. Laser diode Characteristics - Threshold Current Determination
4. APD Characteristics – Determination of Threshold Voltage and Average gain estimation
5. Analog Transmission Characteristics of a Fibre Optic Link – Determination of Operating Range of LED and System Bandwidth determination for Glass and Plastic fibre links and determination of device capacitance of photo diode
6. Determination of Capacity of a Digital Fibre Optic Link – Maximum Bit Rate estimation for Glass and Plastic fibre links
7. Characterisation of optical amplifiers
8. Fibre Optic Link design - power and rise-time budget
9. Study of WDM Link Components – WDM Mux / De-mux, Isolator, Circulator, Fibre Bragg Grating Filters
10. Experiment with OTDR
11. Modelling of optical communication link and devices using simulation tools- VPI/ Simulink/ OPTSIM/ OPTwave/ Equivalent

TEXTBOOK(s):

1. Gerd Keiser, "Optical Fibre Communication", McGraw Hill India, 2013(5th Edition), ISBN: 9781259006876
2. John. M. Senior, "Optical Fibre Communication: Principles and Practice", Pearson, 2017(3rd Edition)

Reference(s):

1. Gupta, S. C., "Textbook on Optical Fibre Communication and Its Applications", PHI India, 2012(2nd Edition), ISBN: 9788120345805
2. Govind P. Agrawal, "Fibre-Optic Communication Systems", Wiley India, 2010(4th Edition), ISBN: 9788126571345
3. Bandyopadhyay M. N., "Optical Communication and Networks", PHI India, 2014, ISBN: 978-81-203-4854-7

ECE18R362 MOBILE COMMUNICATION

ECE18R362 Mobile Communication	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R275 Analog and Digital Communication / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

The objective of this course is to present the techniques in the physical layer aspects of wireless communication systems and determine the performance of wireless systems in terms of capacity and probability of error

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the cellular concept of Wireless Communication Systems
CO2: Determine the capacity of wireless systems in Rayleigh fading and frequency selective fading environments
CO3: Determine the BER performance of digital modulation schemes in fading environment
CO4: Apply the concept of multiple input and multiple output (MIMO) to mitigate fading effect in wireless Communication Systems.
CO5: Conduct experiments to analyse the performance of a given wireless communication system by following the norms and ethics as an individual and team member
CO6: Communicate effectively about the wireless communication by means of oral and written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	L	H					L						H		
CO2	H	H	L				L	L				L	H	M	
CO3	H	H	L				L					L	H	M	
CO4		H					L					H	H	M	
CO5		L	H	H	H			H	H		L	M	H	M	
CO6								L	L	H				M	L

Course Topics:

Unit 1: Wireless Fundamentals, Statistical Multipath Models

Wireless Fundamentals: Cellular concept – Cell structure – frequency reuse – cell splitting – channel assignment – handoff – interference – capacity – power control.

Wireless Standards: Review of 2G and 3G cellular standards.

Path loss and shadowing: Signal Propagation - Propagation mechanism- reflection – refraction – diffraction and scattering – large scale signal propagation and lognormal shadowing – Transmit and Receive Signal Models – Free-Space Path Loss – Ray Tracing – Empirical Path Loss Models – Simplified Path Loss Model – Shadow Fading – Combined Path Loss and Shadowing

Fading channels-Multipath and small-scale fading- Doppler shift – Statistical Multipath Models: Time-Varying Channel Impulse Response – Narrowband Fading Models – Wideband Fading Models – power delay profile – average and rms delay spread – coherence bandwidth and coherence time – flat and frequency selective fading – slow and fast fading – average fade duration and level crossing rate

Unit 2: Capacity Analysis, BER Analysis

Capacity Analysis: Capacity of Flat fading Channels – Channel and system model – Channel Distribution Information (CDI) Known – Channel Side Information at Receiver – Channel Side Information at transmitter and receiver – Capacity of frequency selective fading Channels – Time Invariant Channels – Time varying Channels

BER Analysis: Digital Modulation and Detection: Signal Space analysis – Pass band modulation principles – Amplitude and Phase Modulation – Frequency modulation – Pulse shaping – Error probability analysis in fading channels.

Unit 3: Spatial Diversity, Antennas

Spatial Diversity: Transmit Diversity: Channel known at transmitter – Channel unknown at transmitter-Alamouti scheme – Receive Diversity: Selection combining, Equal Gain combining – Threshold Combining – Maximal Ratio Combining – Spatial Multiplexing in MIMO – Moment Generating functions in diversity analysis

Antennas- Antennas for mobile terminal- monopole antennas – PIFA – base station antennas and arrays

Unit 4: Multiple Access Techniques Multi Carrier Modulation

Multiple Access Techniques: FDMA, TDMA, CDMA and SDMA

Modulation schemes- BPSK, QPSK and variants, QAM, MSK and GMSK

Multi Carrier Modulation: Multi carrier concept – Orthogonal Frequency Division Multiplexing (OFDM) basics – Multiple access for OFDM systems – Orthogonal Frequency Division Multiple Access (OFDMA) – Single Carrier Frequency Division Multiple Access (SCFDMA)

Unit 5: Receiver Structures, Multi Carrier Modulation

Receiver structures: Maximum Likelihood Receiver – Zero forcing receiver – Minimum Mean Square Error Receiver – V-BLAST Receiver

MIMO and space time signal processing – spatial multiplexing – diversity/multiplexing trade-off. Performance measures- Outage – average snr – average symbol/bit error rate. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA.

Experiments (Any 5)

1. Simulation of BER performance of PSK and FSK schemes in Rayleigh frequency flat, slow fading channels
2. Simulation of BER performance of PSK scheme in Rayleigh frequency flat, slow fading channels with L^{th} order receive diversity.

3. Simulation of BER performance of PSK scheme in Rayleigh frequency flat, slow fading channels with Transmit diversity
4. Simulation of BER performance of PSK scheme in 2x2 spatial multiplexing system in Rayleigh frequency flat, slow fading channels.
5. Simulation of BER performance of OFDM system in Rayleigh frequency selective fading channels
6. LS and MMSE channel estimation in OFDM system
7. Carrier frequency offset estimation in OFDM system
8. Timing offset estimation in OFDM system
9. Outage capacity analysis of Rayleigh flat fading channel
10. Outage capacity analysis of Rayleigh flat fading channel with L^{th} order diver

TEXTBOOK(s):

1. Aditya. K. Jegannatham, "Principles of Modern Wireless Communication Systems", McGraw Hill India, 2016
2. Gordon L. Stüber, "Principles of Mobile Communication", Springer U.S./ India, 2017(4^{th} Edition), ISBN: 9783319556147, DOI: 10.1007/978-3-319-55615-4

Reference(s):

1. W. C. Y Lee, "Mobile Communications Design Fundamentals", PHI, 1993
2. Raymond Steele, "Mobile Radio Communications", Wiley/IEEE Press India/New York, 2010
3. W. C. Y. Lee, "Wireless and Cellular Telecommunications", McGraw Hill India, 2003 (3^{rd} Edition)
4. W. C. Y. Lee, "Mobile Cellular Telecommunications Systems", McGraw Hill India, 1990
5. T. G. Palanivelu, R. Nakkeeran, "Wireless and Mobile Communication", PHI, 2009
6. Iti Saha Misra, "Wireless Communications and Networks: 3G and Beyond", McGraw Hill India, 2013
7. Andrea Goldsmith, "Wireless Communication", Cambridge University Press India, 2009, ISBN: 9780521704168

ECE18R363 MICROWAVE THEORY AND TECHNIQUES

ECE18R363 Microwave Theory and Techniques	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R274 Electromagnetic Waves and Transmission Lines / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To inculcate understanding of the circuit representation of RF networks; To deal with the issues in the design of microwave amplifier; To instil knowledge on the various microwave components; To deal with the microwave generation and microwave measurement techniques

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Analyse microwave transmission with the knowledge of mathematical modelling of modes
CO2: Explain the characteristics of various microwave components
CO3: Deign the microwave networks needed for various applications like amplification, oscillations, impedance matching
CO4: Measure various parameters of a microwave system
CO5: Design, conduct experiments, analyse, and interpret the results related to microwave engineering following the safety and ethic as an individual or team member
CO6: Communicate the information related to microwave experiments efficiently by both oral and written reports

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L											H	M	
CO2		H					L					M	H		

CO3		L	H			L	L					M	H	M	
CO4	H				L								H		
CO5		L	H	H	H			H	H				H	M	L
CO6								L		H				M	L

Course Topics:

Unit 1: Mathematical Model

Basics: -History of Microwaves – Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC

Mathematical model: Concept of Mode – Features of TEM, TE and TM Modes – Losses associated with microwave transmission – Concept of Impedance in Microwave transmission

Unit 2: Analysis

Analysis of RF and Microwave Transmission Lines- Coaxial line – Rectangular waveguide – Circular waveguide – Strip line – Micro strip line.

Microwave Network Analysis- Equivalent voltages and currents for non-TEM lines – Network parameters for microwave circuits – Scattering Parameters

Unit 3: Microwave Devices

Passive and Active Microwave Devices- Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. Microwave active components: Diodes, Transistors, Oscillators, Mixers. Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tubes: Klystron, TWT, Magnetron

Unit 4: Microwave Design

Microwave Design Principles- Impedance transformation – Impedance Matching – Microwave Filter Design – RF and Microwave Amplifier Design – Microwave Power Amplifier Design – Low Noise Amplifier Design – Microwave Mixer Design – Microwave Oscillator Design. Microwave Antennas- Antenna parameters – Antenna for ground-based systems – Antennas for airborne and satellite borne systems – Planar Antennas

Unit 5: Microwave Measurement and Applications

Power, Frequency, and impedance measurement at Microwave frequency – Network Analyzer and measurement of scattering parameters – Spectrum Analyzer and measurement of spectrum of a microwave signal – Noise at microwave frequency and measurement of noise figure. Measurement of Microwave antenna parameters

Microwave Systems- Radar – Terrestrial and Satellite Communication – Radio Aids to Navigation – RFID – GPS. Modern Trends in Microwaves Engineering- Effect of Microwaves on human body – Medical and Civil applications of microwaves – Electromagnetic interference and Electromagnetic Compatibility (EMI and EMC) – Monolithic Microwave ICs – RF MEMS for microwave components – Microwave Imaging

Experiments (Any 5)

1. Study of Microwave cables, connectors, adapters, waveguides, components, and passive devices
2. Frequency response of a simple transmission line circuit using CAD (QUCS SPICE)
3. Design a 10-dB direction coupler using CAD (QUCS SPICE)
4. S-matrix characterisation of E-plane Tee, H-plane Tee, Magic Tee
5. Determination of unknown load impedance of a terminated transmission line by measuring SWR and using Smith's Chart
6. Using Klystron source
   - Mode Characteristics
   - Frequency measurement
7. Using Gunn Diode
   - V-I characteristics
   - Frequency and wavelength measurement
8. Attenuation and power measurement
9. Directional Coupler parameters measurement
10. Isolator and Circulator parameters measurement
11. Gain measurement and Radiation pattern for Horn Antenna

TEXTBOOK(s):

1. Sushrut Das, "Microwave Engineering", Oxford University Press India, 2014, ISBN: 9780198094746
2. Samuel Y. Liao, "Microwave Devices and Circuits", Pearson India, 2010(3rd Edition), ISBN: 9788177583533

Reference(s):

1. Robert E. Collin, "Foundations for Microwave Engineering", Wiley India, 2009(2nd Edition), ISBN: 9788126515288
2. David M. Pozar, "Microwave Engineering", Wiley India, 2011(4th Edition), ISBN: 9788126541904
3. Ganesh Prasad Srivastava, Vijay Laxmi Gupta, "Microwave Devices and Circuit Design", PHI India, ISBN: 9788120321953
4. R. S. Rao, "Microwave Engineering", PHI India, 2014(2nd Edition), ISBN: 9788120351592
5. Vasuki S, Helena D Margaret, and R Rajeswari, "Microwave Engineering", McGraw Hill India, 2015, ISBN: 9789339219482
6. Annapurna Das and Sisir K Das, "Microwave Engineering", McGraw Hill India, 2014(3rd Edition), ISBN: 9789332902879

ECE18R364 WIRELESS NETWORK TECHNOLOGIES

ECE18R364 Wireless Network Technologies	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R373 Computer Communication and Networks / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

This course provides a preview of emerging wireless technologies and their architectural impact on the future mobile Internet and to enable the students to revise the curriculum of related courses in future with sufficient flexibility in the design of the course

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the protocol features of the mobile Internet
CO2: Analyse the structure and network architecture of the current Wireless WAN 3G GSM
CO3: Analyse the emerging wireless network technologies WLAN, WPAN, WMAN
CO4: Plan and design of wireless communication systems and verify its working practically
CO5: Communicate effectively about standards, protocols, and architecture with respect to Wireless Communication

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M					H					H	H		
CO2		H					H					H	H	M	
CO3		H					H					H	H	M	
CO4		L	H	H	H			M	H				M	M	L
CO5								L	L	H				M	L

Course Topics:

Unit 1: Mobile IP and Wireless Application Protocol

Reference models – layering and protocols – OSI, Internet Reference and other models – Network types- roadmap-wireless network scenarios future wireless network requirements

Network layer on the Internet – TCP/IP suite – TCP for Wireless networks – Mobile IP and Session Initiation Protocol,

WAP Programming Model – WAP Architecture – WAP networking environment

Unit 2: Wireless Wide-Area Networks – GSM

3G Wireless systems – UMTS reference architecture – Channel structure – Spreading and scrambling – UMTS core network architecture – Adaptive multi rate codec – UMTS bearer service – HSDPA, FOMA, WCDMA.

Unit 3: Wireless Personal Area Network - Bluetooth

Wireless personal area network – Bluetooth (IEEE 802.15.1) – Bluetooth protocol stack – Bluetooth link types – Bluetooth security – Network connection establishment, error correction and topology in Bluetooth – WAP and Bluetooth

Unit 4: Wireless Personal Area Networks – Low Rate and High Rate

Wireless Sensor Network – Wireless sensor network model – WSN Protocol Stack – Zigbee Technology – IEEE 802.15.4 LR -WPAN architecture, IEEE 802.15.3a Ultra-Wideband-WPAN architecture

Unit 5: Wireless Local Area Networks, Wireless ATM Networks

WLAN equipment, topologies, technologies – IEEE 802.11 WLAN – WLAN Security – IEEE 802.11b High Rate DSSS – IEEE 802.11n – Other WLAN standards – Interference between Bluetooth and IEEE 802.11 WLAN – IEEE 802.16 – World Interoperability for Micro Access (WiMAX)

Wireless ATM Networks: WATM for Wireless – Multimedia and Satellite Communication – WATM prototypes

Experiments (Any 5)

1. Introduction to Basic Digital Baseband Communication through MATLAB Simulation
2. Analysis of WAP, WLAN architecture standards, protocols and performance with a simulation software or MATLAB
3. Basics of Network Simulation using a Network Simulator (Defining the different agents and their applications like TCP, FTP over TCP, UDP, CBR over UDP)
4. Simulating a Wi-Fi network using a Network Simulator (Understand about Wi-Fi network, different standards, and related protocols; Analyse the Wi-Fi communication range in the presence of the access point (AP) and the base station (BS); Learn about hidden node and exposed node problems, and their possible solutions)
5. Simulating a Wireless Sensor Network using a Network Simulator (LEACH, a cluster-based routing protocol for WSNs)
6. Simulating a WiMAX Network using a Network Simulator
7. Simulating a Bluetooth / Zigbee Network using a Network Simulator
8. Study of GSM Trainer Kit / Study of Wi-Fi Trainer Kit
9. Study of Bluetooth Trainer Kit / Study of Zigbee Trainer Kit

TEXTBOOK(s):

1. Vijay K. Garg, “Wireless Communications and Networking”, Morgan-Kaufmann Publishers/Elsevier India, 2007, ISBN: 9780123735805
2. Emad Aboelela, “Network Simulation Experiments Manual”, Morgan-Kaufmann Publishers/Elsevier India, 2012, ISBN: 9780123852106

Reference(s):

1. Gary Rogers, John Edwards, “Introduction to Wireless Technology”, Pearson India, 2012, ISBN: 9788131715345
2. William Stallings, “Wireless Communication and Networks”, Pearson India, 2009(2nd Edition), ISBN: 9788131720936
3. Dipankar Raychaudhuri, Mario Gerla, “Emerging Wireless Technologies and the Future Mobile Internet”, ISBN: 978-0-521-11646-6, Cambridge University Press, 2011.
4. Advanced Network Technologies Lab - http://vlabs.iitkgp.ernet.in/ant/

ECE18R410 ERROR CORRECTING CODES

ECE18R410 Error Correcting Codes	L	T	P	C
	3	1	0	4
Pre-requisite:	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The main Objective(s) of the course is to give introduction about the designing of Error Correcting Codes mainly used in digital communication

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain about linear block codes
CO2: Analyse the hamming codes' coding and decoding
CO3: Carry coding and decoding of BCH codes
CO4: Apply the convolution codes in real time applications

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	L	H											H	L	
CO3	L	H											M	M	
CO4		M	M				M					M	H	M	

Course Topics:

Unit 1:

Linear block codes: Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices – Syndrome decoding on symmetric channels.

Unit 2:

Hamming codes; Weight enumerators and the McWilliams identities; Perfect codes – Introduction to finite fields and finite rings; factorization of (X^n-1) over a finite field.

Unit 3:

Cyclic Codes. BCH codes; Idempotents and Mattson-Solomon polynomials; Reed-Solomon codes – Justeen codes – MDS codes – Alterant – Goppa and generalized BCH codes; Spectral properties of cyclic codes.

Unit 4:

Decoding of BCH codes: Berlekamp's decoding algorithm – Massey's minimum shift register synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp - Massey algorithm.

Unit 5:

Convolution codes; Wozencraft's sequential decoding algorithm – Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm.

TEXTBOOK(s):

1. Martin Tomlinson, Cen Jung Tjhai, Marcel A. Ambroze, Mohammed Ahmed, Mubarak Jibril, "Error-Correction Coding and Decoding: Bounds, Codes, Decoders, Analysis and Applications", Springer India, 2017 ISBN: 9789919511023, DOI: 10.1007/978-3-319-51103-0
2. W. Cary Huffman, Vera Pless, "Fundamentals of Error Correcting Codes", Cambridge University Press, 2003, ISBN: 97805217878207

Reference(s):

1. Florence Jessie MacWilliams, Neil James Alexander Sloane, "The Theory of Error-Correcting Codes: Part-I and Part-II", North-Holland Publishing Company, 2007(Reprint)
2. Scott A. Vanstone, Paul C. van Oorschot, "An Introduction to Error Correcting Codes with Applications", Springer, 2001(Reprint), ISBN: 9781441951175, DOI: 10.1007/978-1-4757-2032-7
3. George C. Clark Jr., J. Bibb Cain, "Error-Correcting Coding for Digital Communication", Springer, 1981 (2011 Reprint)

4. Richard E. Blahut, "Theory and Practice of Error Control Codes", Addison-Wesley Publishing Company, 2007(Reprint of 1983)

ECE18R411 HIGH SPEED ELECTRONICS

ECE18R411 High Speed Electronics	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R363 Microwave Theory and Techniques / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The main Objective(s) of the course is to give introduction about the analysis, design and simulation of radio frequency circuits and components for communication systems and industrial applications

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the knowledge of general RF circuits, components, and Systems
CO2 Interpret about the principles of resonant circuits
CO3: Design impedance matching networks and passive RF filters
CO4: Demonstrate about the workings of RF power amplifiers
CO5: Apply RF design tool in RF circuit design

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	H					H					L	H		
CO2	L	M										M	H		
CO3		M	H			L	M	L				M	H	M	
CO4	M	M										M	H	L	
CO5			M	M	H							H	H	M	

Course Topics:

Unit 1: Basics, Noise Analysis

Transmission line theory (basics) crosstalk and nonideal effects; signal integrity: impact of packages – vias, traces, connectors; non-ideal return current paths – high frequency power delivery – methodologies for design of high-speed buses; radiated emissions and minimizing system noise

Noise Analysis: Sources, Noise Figure, Gain compression – Harmonic distortion – Intermodulation – Cross-modulation – Dynamic range

Unit 2: Devices

Passive and active, Lumped passive devices (models) – Active (models, low vs high frequency)

Unit 3: RF Amplifiers

RF Amplifier Design – Stability – Low Noise Amplifiers – Broadband Amplifiers (and Distributed) Power Amplifiers, Class A, B, AB and C, D E Integrated circuit realizations – Cross-over distortion Efficiency RF power output stages

Unit 4: RF Mixer, Oscillator

Mixers –Up conversion Down conversion – Conversion gain and spurious response. Oscillators Principles. PLL Transceiver architectures

Unit 5: RF Design Tools

Design Tool Basics – Design Languages – RF IC Design Flow – RF IC Design Flow Example – Simulation Examples – Modelling – Printed Circuit Board and Packaging Anatomy – CAD tools for PCB design – Standard fabrication – Micro-via Boards. Board Assembly: Surface Mount Technology – Through Hole Technology – Process Control and Design challenges

TEXTBOOK(s):

1. Thomas H. Lee, "Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press, 1998(2013 Reprint), ISBN: 9780521639224
2. Stephen H. Hall, Garrett W. Hall, James A. McCall "High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", Wiley-IEEE Press, 2000

Reference(s):

1. Chris Bowick, "RF Circuit Design", Elsevier, U.S./India, 2007(2nd Edition), ISBN: 9780750685184
2. Behzad Razavi, "RF Microelectronics", Pearson India, 2014(2nd Edition), ISBN: 9789332518636

ECE18R413 NEXT GENERATION MOBILE COMMUNICATION

ECE18R413 Next Generation Mobile Communication	L	T	P	C
	3	1	0	4
Pre-requisite: ECE18R362 Mobile Communication / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The aim of this course is to train in the central aspects of current and next generation mobile broadband technologies and networks, focusing on the 3GPP Long Term Evolution (LTE) and beyond

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the current trends in mobile/wireless communications networks
CO2: Explain the architecture of latest generation wireless communication techniques
CO3: Explain about the mobility, session management handled by the new generation of mobile communication
CO4: Explain the physical layer interfacing with respect to emerging wireless technologies
CO5: Read scientific articles, research papers on latest in mobile communications and comprehend a report on it

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H					H					H	H		
CO2		H					H					H	H	L	
CO3		H	L				H	L				H	H	L	
CO4	L	M					M					M	H	L	
CO5		H				L	H	L	L	M		H	H	L	

Course Topics:

Unit 1: Legacy 3GPP Systems

Evolutionary roadmap: from 1G to 5G - GSM/GPRS systems: Architecture and main functionalities - UMTS/HSPA systems: Architecture and main functionalities

Unit 2: LTE System Architecture

LTE Architecture: Access Network (E-UTRAN) and Core Network (EPC)
LTE service modelling (bearer services) - E-UTRAN: Functional entities, interfaces, and protocols - EPC: Functional entities, interfaces, and protocols - Terminals

Unit 3: Mobility and Session Management

Session Management: IP-based connectivity. PDN connections. EPS Bearer services. Session Management procedures. QoS Model - Mobility Management: Handover and mobility management procedures

Unit 4: LTE Radio Interface

Functional description and protocol stack - Physical layer: Physical Resource Block (PRB) concept and Frame structure - Logical, transport and physical channels - Physical layer basic procedures: Synchronization and initial acquisition - Random Access and Paging procedures - Radio Bearers Service set-up

Unit 5: 5G, Beyond 5G

Cognitive Radio(5G): Cognitive transceiver architecture, Principles of interweaving, Spectrum sensing, Spectrum management, Spectrum sharing, Overlay, Underlay Hierarchical Access (UWB system communications), IEEE 802.15.3 – Relaying, Multi-Hop and Cooperative Communications(5G) – Pervasive Networks, Dynamic Spectrum Access (5G) – Dynamic Adhoc Wireless Networks (DAWN), MANETS (5G) – IEEE 802.21 Media Independent Hand off – IEEE 802.22 Wireless Regional Area Network – IEEE 802.25 Omni-Range Area Network

TEXTBOOK(s):

1. Erik Dahlman Stefan Parkvall Johan Skold Per Beming, "3G Evolution: HSPA and LTE for Mobile Broadband", Academic Press (Elsevier) U.S., 2008(2nd Edition), ISBN: 9780123745385
2. Magnus Olsson Catherine Mulligan Magnus Olsson Stefan Rommer Catherine Mulligan Shabnam Sultana Lars Frid, "SAE and The Evolved Packet core: Driving the Mobile Broadband revolution", Academic Press/Elsevier U.S., 2009(1st Edition), ISBN 9780123748263

Reference(s):

1. Harri Holma, Antti Toskala (Editors), "HSDPA/HSUPA for UMTS: high speed radio access for mobile communications", Wiley International, U.S., 2006, ISBN: 9780470018842
2. Minoru Etoh (Editor), "Next Generation Mobile Systems: 3G and Beyond", Wiley, 2005, ISBN: 9780470091517
3. Xiang, Wei, Zheng, Kan, Shen, Xuemin Sherman (Editors), "5G Mobile Communications", Springer, U.S./India, 2017, ISBN: 9783319342061, DOI: 10.1007/978-3-319-34208-5

ECE18R454 CRYPTOGRAPHY AND NETWORK SECURITY

ECE18R454 Cryptography and Network Security	L	T	P	C
	3	0	2	4
Pre-requisite: Basics of Computer Networks	**Course Category:** Professional Elective **Course Type:** Integrated Course			

This Course focuses on the introduction of network security using various cryptographic algorithms. Underlying network security applications. It also focuses on the practical applications that have been implemented and are in use to provide email and web security.

Course Outcome(s):

At the end of the course, the student will be able to:

CO1: Understand the fundamentals of networks security, security architecture, threats, and vulnerabilities

CO2: Develop the different cryptographic operations of public key cryptography

CO3: Create the Cryptographic and Data Integrity Algorithms

CO4: Design the various Security algorithms

CO5: Build various Security practices and System security standards

CO6: Elucidate the working of the various security techniques

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H		
CO2	H	M	M		L								H	M	
CO3	H	M	M		M								H	M	
CO4	H	M	M		M								H	M	
CO5	H	H	M		M								H	M	
CO6						L	L	L		L		L		L	L

Course Topics:

Course Topics:

Unit 1: Encryption Techniques

Encryption Techniques - OSI Security Architecture, Security Components, Security Attacks, Security Services, Security Mechanisms, Services and Mechanisms Relationship, Model of Network Security, Classical Encryption techniques – Block Cipher Principles, Data Encryption Standard- Basic concepts in number theory and finite fields, Block Cipher Design Principles and Modes of Operation

Unit 2: Public Key Cryptography

Public Key Cryptography Number Theory- Public Key Cryptography, Key Establishment Protocols, Introduction, Key transport based on symmetric encryption, RSA-Key Management, Diffie-Hellman key Exchange, Quantum computers, Shor's algorithm, future demise of RSA, Quantum cryptography, Quantum key distribution and reconciliation.

Unit 3: Cryptographic and Data Integrity

Cryptographic and Data Integrity Algorithms, Interactive protocols, Touch of complexity theory, Interactive proof systems, electronic cash, Private information retrieval, Applications of cryptographic hash functions Requirements and security, Digital Signature Standard, Digital watermarking, digital fingerprinting, Steganography.

Unit 4: Network Security

Network Security Transport Level Security, Web Security, SSL, TLS, HTTPS, SSH, Time Stamping Protocol, Secure Electronic Transaction, 3-D Secure Protocol, Wireless network security, E Mail security, Electronic Money, PGP, S/ MIME, DKIM, IP Security, Introduction, GSM frequency bands, GSM PLMN,

Unit 5: System Security

System Security Intrusion detection, password management, Malicious software, Viruses and related Threats, Virus Counter measures, worms, DDoS attacks, Firewall Design Principles, Trusted Systems, Identity-Based Encryption, Firewalls, virtual private networks (VPNs), VPN Design and Architecture, best practices for effective configuration and maintenance of VPNs, encryption in firewall and VPN architectures.

Experiments

1. Implementing Encryption Algorithms
   -Program to understand the work of DES Algorithm
   -Program to understand the work of AES Algorithm
2. Understanding the basis of Key Exchange Algorithms
   -Euclidean and Extended Euclidean algorithm for finding the Greatest Common Divisor of two large integers. Computing the Multiplicative inverses in Z
   -Repeated square and multiply algorithm for modular exponentiation in Zn
   -Chinese remainder theorem
3. Implementing RSA Algorithm
   -Implementing Secure Hash Algorithm (SHA)
   -MD5
   -SHA-1
4. Implement the Signature Scheme - Digital Signature Standard
5. Implementing PGP
6. Study of Cipher using Cryptool Software
   Ceaser Cipher
   -Hill Cipher
   -Vigenère Cipher
7. Study of IP Access Control List using Cisco Packet Tracer or Equivalent
8. Study of Virtual Private Network using Cisco Packet Tracer or Equivalent
9. Study of Firewall using Cisco Packet Tracer or equivalent
10. Eavesdropping Attacks and its prevention using SSH - Comparison between Telnet and SSH
11. Set Up an VPN using OpenVPN Server
12. Demonstrate intrusion detection system (ids) using any tool (snort or any other s/w)

Textbook(s):

1. William Stallings – Cryptography and Network Security: Principles and Practice", Pearson India, 2014(6th Edition), ISBN: 9789332518773

Reference(s):

1. C K Shyamala, N Harini and Dr. T R Padmanabhan, "Cryptography and Network Security" Wiley, 2014
2. Behrouz A. Forouzan, "Cryptography and Network Security", McGraw Hill India, 2015(3rd Edition), ISBN: 9789339220945
3. Charlie Kaufman, Radia Perlman, and Mike Speciner, "Network Security: PRIVATE Communication in a PUBLIC World", Prentice Hall, 2015

ECE18R455 WIRELESS AD-HOC AND SENSOR NETWORKS

ECE18R455 Wireless Ad-Hoc and Sensor Networks	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R373 Computer Communication and Networks/ equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

The objective of this course is to introduce students with fundamental concepts, design issues and solutions to the issues – architectures and protocols- and the state-of-the –art research developments in ad hoc and sensor networks

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Identify the necessity of Ad Hoc and Sensor networks
CO2: Describe the operation of the routing and localization
CO3: Compute the power consumption and Euclidean distance of a sensor network
CO4: Analyse the MAC issues in Ad hoc and sensor networks
CO5: Design sensor network for indoor applications

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	L	M										M	H		
CO2	L	M											H	M	
CO3	H	M					L					M	H	L	
CO4		M										M	H	M	
CO5		M	M	M			M					H	H	L	

Course Topics:

Unit 1: Ad-Hoc MAC Protocols

Design Issues in Ad-Hoc Networks - MAC Protocols – Issues, Classifications of MAC protocols: Contention Based Protocols, Contention Based Protocols with reservation mechanisms – Contention Based Protocols with Scheduling Mechanism – MAC protocol with Directional Antenna - Multi channel MAC & Power control MAC protocol

Unit 2: Ad-Hoc Routing protocols and Ad-Hoc Transport layer

Issues – Classifications of routing protocols: Table Driven Protocols – On-Demand Routing Protocols – Hybrid Routing Protocols – Hierarchical and Power aware Routing Protocols – Ad Hoc Transport Layer Issues – TCP Over Ad Hoc – Feedback based, TCP with explicit link – TCP-Bus, Ad Hoc TCP, and Split TCP

Unit 3: WSN MAC Protocols

Introduction to Sensor Networks – unique constraints and challenges – Advantage of Sensor Networks – Applications of Sensor Networks – Types of wireless sensor networks – Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks – Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks, Design Issues, and challenges – Energy consumption – Clustering of sensors

Unit 4: WSN Routing Protocols

Data Dissemination – Data Gathering – Data Fusion - Routing Challenges and Design Issues in WSN - Routing Strategies in Wireless Sensor Networks: Flooding and Its Variants - Real-time traffic support and security protocols – Sensor Protocols for Information via Negotiation(SPIN) - Low-Energy Adaptive Clustering Hierarchy(LEACH) - Power-Efficient Gathering in Sensor Information Systems(PEGASIS) - Directed Diffusion - Geographical Routing - Location Discovery – QoS – Other issues: Energy Efficient Design – Synchronization – Transport layer issues – Security

Unit 5: WSN Design

Design Principles for WSN – Gateway Concepts Need for gateway – WSN to Internet Communication – and Internet to WSN Communication. Single-node architecture – Hardware components and design constraints

Operating systems and execution environments for WSN, introduction to TinyOS and nesC

Experiments (Any 5 experiments)

1. Study of Network Simulator, WSN Starter Kit
2. Simulating a MANET using Network Simulator
3. Simulating a Wireless Sensor Network using Network Simulator (LEACH Routing Protocol)
4. Creating a Simple Wi-Fi Ad-Hoc Grid using Network Simulator
5. Node Programming – Study of TinyOS
6. Network Applications – Multiple WSN running simultaneously, using the same frequency without any interference
7. WSN – Data routing, single and multi-hop
8. WSN Starter Kit - Calculating Wireless range
9. Sensor Applications – WSN Starter kit with Sensors and using LABVIEW

TEXTBOOK(s):

1. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, Wiley, 2011
2. C. Siva Ram Murthy and B.S. Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004

Reference(s):

1. Jun Zheng and Abbas Jamalipour, “Wireless Sensor Network A Networking Perspective”, Wiley, 2009.
2. KazemSohraby, Daniel Minoli and TaiebZnati, “Wireless Sensor Networks: Technology, Protocols and Applications, Wiley, 2007.
3. Sabrie Soloman, “Sensors Handbook" McGraw Hill. 2009
4. Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks”, Elsevier, 2004
5. Kazem Sohrby, Daniel Minoli, “Wireless Sensor Networks”: Technology, Protocols and Applications, Wiley-
6. Philip Levis, And David Gay "TinyOS Programming” by Cambridge University Press 2009

V PROFESSIONAL ELECTIVE COURSES

STREAM: EMBEDDED SYSTEM DESIGN

ECE18R260 INTERNET OF THINGS

ECE18R260 Internet of Things	L	T	P	C
	3	0	1	3.5
Pre-requisite: Basic Programming skills	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

The objectives of this course are to provide in-depth understanding of the underlying concepts of Internet of things, building blocks, domain specific IoTs, and Design methodology for IOT. Also, the course provides knowledge on Python coding to embed the coding in various open source hardware such as Raspberry Pi and Arduino. Eventually the course extends the students‟ knowledge up to the level of building cost effective IOT system for real world scenario with the open source hardware and software tool chains

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the terms related to Internet of Things
CO2: Explain how the IoT architecture works
CO3: Identify different hardware and software tools for the IOT implementation
CO4: Implement web-based services on IoT devices.
CO5: Design an IOT system for the given scenario and able to evaluate the constraints of the system as an individual or as a team member in laboratory
CO6: Document the process carried in the laboratory which communicates the works effectively to the people

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	H					M					H	H		
CO2		H					M					H	H		
CO3		H			M	L							H	M	
CO4	H	M			L							M	H	L	
CO5		H	H	H	H			L	H		L		H	M	L
CO6								L	L	H				M	L

Course Topics:

Unit 1: Basics

Introduction – Characteristics – Physical design – Protocols – logical design – Enabling technologies and IoT Levels. Domain Specific IoTs. IoT vs M2M

Unit 2: Design Methodology

IoT systems management with NETCONF-YANG. IoT Design Methodology. IOT design Specifications – Model, Level, and view Specifications – Device and Component Integration – Application Development

Unit 3: Logical Design and Physical Devices

Python packages of interest for IoT – Cloud for IoT, python web application framework. Basic building blocks of an IoT Device

Unit 4: Open Source Hardware

Raspberry PI physical devices – Raspberry Pi Interfaces – Programming, APIs / Packages. Web services

Unit 5: IoT Physical Servers and Cloud Offerings

Introduction to cloud storage models and communication APIs, WAMP – AutoBahn for IoT, Xively cloud for IoT- Real time applications of IoT-Connecting IoT to cloud: Smart lighting – Home security intrusion detection – Weather Reporting bot – Smart irrigation – home automation - smart cities - smart environment

Experiments (Any5):

1. Create an Azure IoT Central application (https://docs.microsoft.com/en-us/azure/iot-central/quick-deploy-iot-central)

2. Define a new device type in your Azure IoT Central application (https://docs.microsoft.com/en-us/azure/iot-central/tutorial-define-device-type)
3. Configure rules and actions for your device in Azure IoT Central (https://docs.microsoft.com/en-us/azure/iot-central/tutorial-configure-rules)
4. Customize the Azure IoT Central operator's view (https://docs.microsoft.com/en-us/azure/iot-central/tutorial-customize-operator)
5. Use Azure IoT Central to monitor your devices (https://docs.microsoft.com/en-us/azure/iot-central/tutorial-monitor-devices)
6. Study of Raspberry, Interfacing Wi-Fi Module, Temperature Sensor
7. Cloud Data Logging - To log data (temperature and moisture) measurements in the cloud and display these measurements on an online dashboard using Wi-Fi module
8. Controlling through Cloud - To control devices (LED) through cloud from anywhere in the world using the Wi-Fi module
9. Sending out alerts - To send notifications (email, message or push notifications) using Wi-Fi module

TEXTBOOK(s):

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
2. Peter Waher “Learning Internet of Things”, Packt Publishing, UK, 2015

Reference(s):

1. Miguel de Sousa, “Internet of Things with Intel Galileo”, Packt Publishing, UK, 2015
2. Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014
3. Adrian McEwen, Hakim Cassimally “Designing the Internet of Things”, Wiley, 201
4. Manoel Carlos Ramon, “Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 2014
5. Kshirod Kumar Rout; Sivkumar Mishra; Aurobinda Routray, “Development of an Internet of Things (IoT) Based Introductory Laboratory for Undergraduate Engineering Students”, 2017 International Conference on Information Technology (ICIT), DOI: 10.1109/ICIT.2017.22

ECE18R365 AVR MICROCONTROLLER PROGRAMMING

ECE18R365 AVR MICROCONTROLLER PROGRAMMING	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R371 Microprocessors and Microcontrollers / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

Microcontrollers based embedded systems are involved in almost every facet of modern life. Consumer gadgets, entertainments gadgets, medical devices and automobiles all contain embedded Microcontroller. The tremendous number of applications for embedded computing has given rise to high demand for engineers with experience in designing and implementing embedded systems with microcontroller. This course is designed to introduce microcontroller architecture, internal and external peripherals, assembly language programming and embedded c programming.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the architecture of 8-bit AVR microcontrollers
CO2: Write software for hardware by the knowledge on AVR microcontrollers as per the requirements
CO3: Interface various devices to the AVR microcontroller
CO4: Work effectively in developing AVR microcontroller-based systems following the safety procedures and ethics
CO5: Communicate efficiently the technical information related to designed microcontroller system

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3

CO1	H	L											H		
CO2		H	H		L								H	M	
CO3		M	M	L									H	M	
CO4				H	H	L	L	H	H		L			M	L
CO5								L	L	H				M	L

Course Topics:

Unit 1: Architecture

Microcontroller – Hardware – Programming AVR – AVR and Arduino – Other Hardware Programmers – Blinking LEDs

The AVR RISC Microcontroller Architecture: AVR family architecture – Register File – Memory access and instruction Execution – I/O Memory – I/O Ports

Unit 2: Instruction Set, Hardware Design

AVR Instruction Set: Program and data addressing modes – Arithmetic and Logic Instruction – Program Control Instruction – Data Transfer Instruction

AVR Hardware Design Issues: Power source – Operating clock sources – Reset circuit

Unit 3: Hardware and Software Interfacing

Hardware and Software Interfacing with AVR: Lights and switches – Stack operation in AVR Processors – Implementing Combinational Logic – Connecting the AVR to the PC serial port – Expanding I/O – Interfacing analog to Digital converters and DAC – Interfacing with LED/LCD displays – Stepper motor interface with AVR

Unit 4: Communication Links

Communication links for the AVR Processor: RS-232 Link, RS-422/423 link, SPI and microwave bus, IrDA Data link, CAN

Unit 5: Real World Design

Code assembler – Code simulator – AVR emulator – Device Programmer.

Interfacing of Sensors – Interfacing of Stepper motor – Relays – RTC – Interfacing of Serial ADC and Serial EEPROM Project based learning of embedded system: Temperature controller to maintain the temperature at constant value with tolerance of +/- 20 C using interrupts – traffic light controller – Line tracer robot.

Experiments (Any 5 experiments):

1. Write any 2 simple Data Transfer Instruction programs for AVR microcontroller to familiarise with the AVR programming
2. Spin a DC motor in either direction using H-bridge
3. Interface Temperature Sensor and Display Temperature on 16x2 LCD.
4. Voltmeter that measures in the range 0–15 V with resolution to 10 mV
5. Light meter using LEDs and LDR
6. Stepper motor
7. AVR Emulator
8. Arithmetic and Logic Instruction Example
9. Program Control Instruction Example

TEXTBOOK(s):

1. Dhananjay V. Gadre, “Programming and Customizing the AVR Microcontroller”, McGraw Hill India, 2013.
2. Elliot Williams, “AVR Programming: Learning to Write Software for Hardware”, Maker Media, India, 2014(1st Edition), ISBN: 9781449355784

Reference(s):

1. David J. Russell, “Introduction to Embedded Systems: Using ANSI C and the Arduino Development Environment”, Morgan and Claypool India, 2010, ISBN: 9781608454983, DOI: 10.2200/S00291ED1V01Y201007DCS030
2. Muhammad Ali Mazidi, Sarmad Naimi, and Sepehr Naimi, “The AVR Microcontroller and Embedded Systems: Using Assembly and C”, Pearson India, 2013, ISBN: 97893325184

ECE18R366 EMBEDDED ARM DEVELOPMENT USING BEAGLE-BONE

ECE18R366 Embedded ARM Development using Beagle-Bone	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R371 Microprocessors and Micro-controllers / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

Understand the hardware and software aspects of ARM processor systems

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the architecture of ARM processor
CO2: Demonstrate the knowledge of ARM instruction set
CO3: Explain the basics of embedded operating system
CO4: Design and develop ARM processor-based systems using BeagleBone Black boards
CO5: Work and communicate effectively in designing ARM based systems

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	L					H					H	H		
CO2	H	L					H					H	H	L	
CO3	H	L					H					H	H		
CO4		M	H	L	H			L	H		L		H	M	
CO5								L	L	H				M	L

Course Topics:

Unit 1: ARM Architecture, Instruction Set

ARM as System–on-Chip: Acorn RISC Machine (Advanced RISC Machine) – 3 and 5 stage pipeline Organisation - Instruction execution – ARM Subsystems – Exception – Modes of operation – Vector Table – Memory Management – Technology advances in ARM

Unit 2: ARM Instruction Set

Instruction set - Co-processor instructions

Unit 3: ARM Thumb, NEON Instructions

Thumb Instruction set, implementation – NEON Instructions

Unit 4: Operating System, Compiler Toolchain

GNU/Linux – Bootloader – Kernel – Root File system – Process management – Process environment – Compiler Toolchains – GCC

Unit 5: Embedded ARM Device: BeagleBone Black

Programming on BeagleBone: BoneScript – Hardware Interfacing – Using Capes and Modules

Experiments (Any 5) using BeagleBone:

1. Familiarisation with Cloud 9 IDE for BeagleBone
2. Turning an LED on or off (Controlling an electronic component)
3. Building a surveillance system with a PIR sensor
4. Implement a calculator
5. Simulate a LIFT
6. Parallel Odd or Even Sort algorithm using ARM/ BeagleBone
7. Wave generation using ARM/BeagleBone
8. Traffic Light Simulation
9. Configuring BeagleBone - Introduction

TEXTBOOK(s):

1. James A. Langbridge, “Professional Embedded ARM Development”, Wiley/Wrox India/U.S., 2014, ISBN: 978-1-118-78894-3 / 978-1-118-78901-8 (ebk) / 978-1-118-88782-0 (ebk)
2. Charles A. Hamilton, “BeagleBone Black Cookbook: Quick Answers to Common Problems”, PACKT Publishers U.K., 2015

Reference(s):

1. Alan Holt, Chi-Yu Huang, "Embedded Operating Systems: A Practical Approach", Springer / Zetta Networks India / U.K., 2018(2nd Edition), ISBN: 978-3-319-72976-3/ 978-3-319-72977-0, DOI: 10.1007/978-3-319-72977-0
2. Simon Monk, "Programming the BeagleBone Black: Getting started with JavaScript and Bone-Script", McGraw Hill U.S., 2014, ISBN: 9780071832137
3. Steven F. Barrett, Jason Kridner, "Bad to the Bone: Crafting Electronic Systems with BeagleBone and BeagleBone Black", Morgan and Claypool Publishers India, 2013, ISBN: 9781627051378 / 9781627051385, DOI: 10.2200/S00500ED1V01Y201304DCS041
4. Derek Molloy, "Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux", Wiley U.S., 2014, ISBN: 9781118935125
5. Andrew Sloss Dominic Symes Chris Wright – ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier (Morgan & Kaufmann), U.S. – 2004, ISBN: 9781558608740
6. Cortex Programmer's Guide - ARM, www.arm.com
7. Agus Kurniawan, "BeagleBone Black Programming by Example – E-Book", 2014, ISBN: 9781312778696
8. https://randomnerdtutorials.com/getting-started-with-the-beaglebone-black/
9. https://lucifersengg.com/computer-department/te-comp/sem-6/pl-3-pl-4/

ECE18R367 EMBEDDED C

ECE18R367 Embedded C	L	T	P	C
	3	0	1	3.5
Pre-requisite: Basic Programming skills	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

To expose the students to the fundamentals of embedded Programming; To study the basic concepts of embedded C and embedded OS.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the understanding of embedded programming

CO2: Write C programs targeting 8051 based embedded systems using different features like loops, functions, and appropriate data types to solve various programming problems in Electronics and Communication Engineering

CO3: Explain the principles of embedded OS with respect to a microcontroller

CO4: Apply Embedded C concepts meeting real time constraints to produce solutions meeting the specified needs with appropriate considerations

CO5: Work and communicate effectively in designing and developing embedded systems with C following norms, ethics

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	H				L			L					H	L	
CO3	H	L			L							H	H	L	
CO4		M	M	L	M							M	H	M	
CO5								M	H	H	L			M	L

Course Topics:

Unit 1: Embedded C Programming Basics

History and need of Embedded System - Basic components of Embedded System - Classification of Embedded System - Challenges and design issues in embedded systems - Difference between Microprocessor and Microcontroller - Fundamentals of embedded processor and microcontrollers - CISC vs.

RISC – Fundamentals of Von-Neuman, Harvard architectures - Difference between C and Embedded C – 8085 architecture block diagram and explanation

Unit 2: C Programming Concepts for Embedded System: Datatypes and Operators

Constants, Variables and Data Types: Keywords and Identifiers, Data type and its memory representation, Arrays, and strings

Operators: Types of Operators, Operator precedence, Bitwise Operators

Unit 3: C Programming Concepts for Embedded System: Loops and Functions

Control Structures and Loops: If....else statement, Switch statement, and GOTO statement, The While and Do – While statements, For statement

Functions: Types of functions, Parameter passing, Return values and their types, Recursive functions

Unit 4: Embedded C

Adding structure to C code – OOP with C – Header files for Project and Port – Reading basic input from switches - Meeting real-time constraints: Creating hardware delay – need for timeout mechanism – creating loop timeouts – creating hardware timeouts

Unit 5: Embedded OS

Creating embedded operating system: simple embedded OS, SEOS – using time0, timer1 – portability issue – alternative system architecture – design considerations

Experiments (Any 5):

1. Familiarisation with software – Hello World
2. Reading and writing bytes
3. Reading and writing bits
4. Counting Goats
5. Generating a precise 50ms delay
6. Testing loop timeouts
7. Testing a hardware timeout
8. Keyboard Interfacing
9. LCD Programming

TEXTBOOK(s):

1. Michael Pont, “Embedded C”, Pearson India, 2008(1st Edition), ISBN: 9788131715895
2. Thomas W. Schultz, “C and the 8051”, PageFree, 2004(4th Edition), ISBN: 9780978399504
3. Stephen G. Kochan, “Programming in C”, Pearson India, 2016(4th Edition), ISBN: 9789332554665

Reference(s):

1. Steve Oualine, “Practical C Programming”, O’Reilly, 2011 (3rd Edition Reprint), ISBN: 9781565923065
2. Kai Qian, David Den Haring, Li Cao, “Embedded Software Development with C”, Springer, 2009, ISBN: 9781489984999, DOI: 10.1007/978-1-4419-0606-9
3. Manish K. Patel, “The 8051 Microcontroller Based Embedded Systems”, McGraw Hill, 2014, ISBN: 9789332901254
4. Manuel Jiménez, Rogelio Palomera, Isidoro Couvertier, “Introduction to Embedded Systems: Using Microcontrollers and the MSP430”, Springer, 2014, ISBN: 9781493944286, DOI: 10.1007/978-1-4614-3143-5
5. M. Rafiquzzaman, “Fundamentals of Digital Logic and Microcontrollers”, Wiley U.S., 2014 (6th Edition), ISBN: 9781118855799
6. Dogan Ibrahim, “Microcontroller Projects in C for the 8051”, Elsevier/ScienceDirect/Newnes, 2000, ISBN: 9780750646406
7. UDEMY - https://www.udemy.com/embedded-c-programming-for-embedded-systems/
8. NPTEL - Embedded Systems Design-1 -Video course - https://nptel.ac.in/syllabus/syllabus_pdf/117106110.pdf
9. https://www.javatpoint.com/embedded-system-tutorial

ECE18R374 EMBEDDED SYSTEMS FOR IOT

ECE18R374 Embedded Systems for IoT	L	T	P	C
	3	0	2	4
Pre-requisite: Logic Design, Basics of C programming	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To understand what embedded Systems are, their components, applications, ARM based Microcontroller Architecture, Development of programs to test peripherals.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate the understanding of concepts, applications in IOT, ARM7 Instruction set & Assembly program development.
CO2: Describer about peripherals, timers, and interrupt.
CO3: Develop programs for ARM7 LPC2148, 32-bit microcontroller to interface peripherals.
CO4: Summarise ARM based cortex M4 MCU Architecture and its development environment, peripheral interfacing.
CO5: Demonstrate the understanding of low power Requirements, and RTS support while interfacing peripherals with various functional blocks of MCU`
CO6: Apply the interfacing of peripherals and test the output on target/simulator in a laboratory as a team/individual work.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	L	M	M	M			M					H	H	L
CO2	M	L	M	M	H			M					H	H	L
CO3	M	L	M	M	H			M					H	H	L
CO4	M	L	M	M	H			M					H	H	L
CO5	M	L	M	M	H			M					H	H	L
CO6	M	L	M	H	H			M	H	M		H	H	H	M

Course Topics:

Unit 1: Embedded Systems and ARM Microcontroller Architecture Basics

History and need of Embedded System, Basic components of Embedded System, hardware & Software, Challenges and design issues, Choice of the Microcontroller, Classification of Controller, Single core, Multi core, Introduction to ARM, Features, States, Modes, Comparison between various ARM versions, ARM7 Instruction Set, Implementation of code in Assembly.

Unit 2: Peripherals Interfacing

Basic electronics, Sensors and Actuators, Introduction to LPC2148, LPC 2148 Datasheet and schematics, ARM 7 GPIO Usage of GPIO registers, Pin Configuration and PINSELECT Registers, Code review of various IO devices LED, Switch, Debugging the code flow in Simulator, Timers & Interrupts, PWM and UART, developing and testing programs on LPC2148 board.

Unit 3: Advanced Peripherals Interfacing

RTC and WDT, interfacing keypad, interfacing 7 segment display, interfacing motors, interfacing sensors, case study, developing and testing programs on LPC2148 board.

Unit 4: Cortex-M Microcontroller Architecture

Various CORTEX-M Cores, Architecture, instruction set, memory system, Programmers model: different types of registers and flags, Development suite/ tools for microcontrollers, MSP432 Datasheet and schematics, CMSIS, interfacing various peripherals, Interrupts, and timers, developing and testing programs on MSP432 board.

Unit 5: Cortex-M Peripherals Interfacing

Handling Low Power Requirements, Exception handling, Floating point operations, Embedded OS, Introduction to RTS, Concepts, Scheduling, Constraints, interfacing various peripherals Case study, developing, and testing programs on MSP432 board

Experiments:

1. Develop assembly program for
   a) Adding two register contents
   b) Subtracting two register contents
   c) Multiplication of two register contents
   Use any registers from r0-r6 as registers to store operands and r7 to r10 to store the result.
   Note: Implement the above code using only mov and arithmetic instructions
2. Develop assembly program for implementing the following.
   a) Store a value 1 to R1
   b) Add the value of R1 to R10 and store the result back to R10
   c) Then left shifting R1 by 1, add the shifted value to R10
   d) Then shift R1 by 2, then by 3 and then by 4, each time add the shifted value to R10
   e) Finally check what is the value of R10
   Note: Implement the above code using only mov, add and LSL instructions
3. Develop the program for implementing the following.
   a) Store a value 0xFF to R1
   b) Drop the first nibble using LSR and store the result in R10. What should be the value of R10?
   Note: Implement the above code using only mov and LSR instructions
4. Develop an assembly program for the following using Register indirect with offset.
   a) Store values 1,2,3,4,5 in registers from R1-R5
   b) Store the address 0x4000 0000 in R0
   c) Store the value in R1 to [R0]
   d) Store the value in R2 to [R0+4]
   e) Store the value in R3 to [R0+8]
   f) Store the value in R4 to [R0+12]
   g) Store the value in R5 to [R0+16]
   h) Load the value at [R0] to R8
   I) Load the value at [R0+4] to R9
   j) Load the value at [R0+8] to R10
   k) Load the value at [R0+12] to R11
   l) Load the value at [R0+16] to R12
   m) Store the sum of R8, R9, R10, R11, R12 to R13
   Note: Implement the above code using only mov, add, single load str instructions
5. Develop an assembly program for the following using pre increment.
   a) Store values 1,2,3,4,5 in registers from R1-R5
   b) Store the address 0x4000 0000 in R0
   c) Store the value in R1 – R5 to [R0] – [R0+16] using pre increment
   d) Load the value at [R0] – [R0+16] into R7, R8, R9, R10, R11 using pre-increment
   e) Store the sum of R7, R8, R9, R10, R11 to R13
   Note: Implement the above code using only mov, add, single load, str instructions
6. Write a program to add the numbers from 1 to 15 using Branch instruction.
   Write an algorithm to implement nested sub routine call.
   a) main flow should call subroutine A, Subroutine A should call subroutine B, Subroutine B should return to subroutine A, Subroutine A returns to main flow.
   b) Implement the same in assembly.
   Implement Stack and Queue using Assembly instructions.
7. Write a program for the following.
   a. Toggling ALL the LEDs on the board
   b. use macro to identify the IO pin to be used.
   c. Try the above program with varying delays for ON time and OFF time.

8. Write a program to control the LED's using a switch.
9. Interface LCD with ARM7.
10. Interface PWM with ARM7
11. Interface RTC and WDT with ARM7.
12. Write a program for driving Digital IO on MSP432.

Textbook(s):

1. Steve Furber, "Arm System-On-Chip Architecture", Pearson, 2016 (Second Edition), ISBN: 9789332555570.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier, 2004, ISBN: 978-1-4933-0374-8

Reference(s):

1. ARM Compiler v5.06 for µVision ARM ASM User Guide (Online Book - https://www.keil.com/support/man/docs/armasm/)
2. ARM7TDMI Technical Reference Manual (Online Book - https://developer.arm.com/documentation/ddi0210/c/)
3. Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems" Pearson, 2007 (Second Edition), ISBN: 9788131710265
4. AMBA™ 3 APB Protocol v1.0 Specification (Online Book - https://developer.arm.com/documentation/ihi0024/b/Introduction/About-the-AMBA-3-APB)
5. Ying Bai, "Microcontroller Engineering with MSP432: Fundamentals and Applications", CRC Press, 2017, ISBN: 978149877299.

ECE18R378 SYSTEM DESIGN AND APPLICATIONS FOR IOT

ECE18R378 System Design and Applications for IoT	L	T	P	C
	2	0	2	3
Pre-requisite: Embedded Systems for IoT	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

To understand design of Embedded System, Software Engineering and Embedded Systems Applications in IOT Doman, Understanding of various serial protocols like I2C, SPI, UART & wireless protocols, ARM based Microcontroller Architecture & peripheral interfacing

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Demonstrate understanding of Software Design for Embedded Systems.
CO2: Apply interfacing of advanced peripherals with ARM7 and various serial protocols like I2C, SPI.
CO3: Apply the interfacing of RTC, WDT, ADC, DAC, UART with Cortex-M based Microcontroller.
CO4: Apply the interfacing of I^2C, SPI with Cortex-M based Microcontroller.
CO5: Program the interfacing of Wireless Protocol based devices with Cortex-M.
CO6: Apply the interfacing of peripherals and test the output on target/simulator in a laboratory as a team/individual work.

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	L											M		
CO2	M	M	L	M	H								H	H	
CO3	M	M	M	M	H								H	H	
CO4	M	M	M	M	H								H	H	

CO5	M	L											M		
CO6	M	M	M	M	H			M	M	M		H	H	H	M

Course Topics:

Unit 1: Software Design **6 Hours**

Software Engineering for Embedded Systems, OS concepts and Scheduling algorithms, RTOS concepts and Scheduling, Basic Electronics, Sensors and Actuators

Unit 2: ARM7 Advanced Peripheral Interface **6 Hours**

Interfacing ADC, DAC, UART, I2C, SPI with ARM7 processor based MCU

Unit 3: Cortex-M Peripheral Interface

Interfacing RTC, WDT, ADC, DAC, UART with cortex-M4 processor based MCU

Unit 4: Cortex-M Advanced Peripheral Interface **6 Hours**

I2C Interface, SPI Interface, Interfacing GSM, Interfacing GPS, CAN protocol and Interfacing

Unit 5: Cortex-M Wireless Interface **6 Hours**

ZigBee protocol and Interfacing, Bluetooth protocol and interfacing, Case study

Experiments:

1. Write a program to Display the following message on the first line of the LCD “Embedded” and “Systems” on the second line
2. Develop a program to send and receive data using UART for ARM7.
3. Interface ADC with MCU, read ADC value and print it to LCD.
4. Write a program to read ADC value and print it to UART.
5. Write a program to input the values in the range of 1 – 1023 to DAC and print their corresponding analog output to UART.
6. Write a program to toggle the LEDs, use timers for delay generation.
7. Write a program to toggle the LEDs on interrupt generated on ext3.
8. Interface RTC and print time on UART
9. Write a program to generate PWM signals using PWM1 with 50% duty cycle and PWM2 with 70% duty cycle.
10. Write a program to interface WDT with varying amount of timeout values.
11. Write a program to write data to EEPROM, read from EEPROM and display on LCD.
12. Write a program to write data to EEPROM, read from EEPROM and display on UART.

Textbook(s):

1. Ying Bai, “Microcontroller Engineering with MSP432: Fundamentals and Applications”, CRC Press, 2017, ISBN: 978149877299.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, “ARM System Developer’s Guide Designing and Optimizing System Software”, Elsevier, 2004, ISBN: 978-1-4933-0374-8

Reference(s):

1. Steve Furber, “Arm System-On-Chip Architecture”, Pearson, 2016 (Second Edition), ISBN: 9789332555570.
2. ARM Compiler v5.06 for µVision ARM ASM User Guide (Online Book - https://www.keil.com/support/man/docs/armasm/)
3. ARM7TDMI Technical Reference Manual (Online Book - https://developer.arm.com/documentation/ddi0210/c/)
4. AMBA™ 3 APB Protocol v1.0 Specification (Online Book - https://developer.arm.com/documentation/ihi0024/b/Introduction/About-the-AMBA-3-APB)
5. Cortex-M4 Technical Reference Manual (Online Book - https://developer.arm.com/documentation/ddi0439/b/)
6. MSP432P40 Manual (Online Book - https://www.ti.com/lit/ds/symlink/msp432p401r.pdf)

ECE18R414 FLEXIBLE ELECTRONICS

ECE18R414 Flexible Electronics	L	T	P	C
	3	1	0	4
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The aim of the course is theoretical familiarisation with specific rules of design and manufacture of flexible electronic devices and circuits as well as technological processes used for flexible electronics production

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Develop basic concepts and understanding of thin-film electronic materials and device processing

CO2: Identify the terminology, equipment, and design methodology used in the fabrication, and characterisation of FE systems

CO3: Recognize and discuss the societal and economical significance of FE systems applications, including benefits and potential risks

CO4: Design layouts, exemplary circuits, and flexible electronics devices with the gained knowledge on flexible electronic materials and technology

CO5: Explain basic concepts for integration of thin-film devices on flexible platforms and the advantages and disadvantages of emerging technology used for the heterogeneous integration of disparate materials

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H						M					H	H		
CO2	H	L					M					H	H	L	
CO3	H						M					H	H	L	
CO4	H	L					M					H	H	M	
CO5	H											H	H		

Course Topics:

Unit 1: Flexible Electronics Basics

Introduction to Flexible and Printed Electronics and their Materials Systems – Background and history – emerging technologies – general applications – Review of Semiconductors and Circuit Elements – Carrier transport, doping, band structure – thin-film electronic devices

Unit 2: Flexible Devices Fabrication and Materials

Thin-film Deposition and Processing Methods for Flexible Devices, CVD, ECVD, PVD – etching – photolithography – low-temperature process integration – Materials for Flexible and Printed Electronics: Nanowire and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, paper-based electronics, textile substrates, barrier materials

Unit 3: Thin Film Transistors

Thin Film Transistors device structure and performance: I-V characteristics – Mechanics of Thin-films and Flexible Thin-film Transistors: thin-film mechanics models, neutral plane, conformal electronics, mechanical modelling.

Unit 4: Patterning Process, Interfaces

Solution-based Patterning Processes: Ink-jet printing – gravure – imprint lithography – spray pyrolysis – surface energy effects – multilayer patterning Contacts and Interfaces to Organic and Inorganic Electronic Devices: Schottky contacts – defects – carrier recombination – effect of applied mechanical strain

Unit 5: Applications and Economics

Flexible Electronics Applications: Displays, sensor arrays, memory devices, MEMS, lab-on-a-chip, and photovoltaics – Introduction to Cost Models and Economics of Printed Flexible Electronics: Overview

of display industry cost models, cost advantages and disadvantages for printed electronics, scaling of large-area flexible systems, cost of goods sold for display applications

TEXTBOOK(s):

1. Wong, William S., Salleo, Alberto (Editors), "Flexible Electronics: Materials and Application", Springer U.S./India, 2009, ISBN: 9781441944948, DOI: 10.1007/978-0-387-74363-9
2. Guozhen Shen, Zhiyong Fan (Editor), "Flexible Electronics: From Materials to Devices, "World Scientific U.S., 2016, ISBN: 9789814651981

Reference(s):

1. Takao Someya (Editor), "Stretchable Electronics", Wiley International U.S., 2013, ISBN: 9783527329786

ECE18R456 EMBEDDED SYSTEMS DESIGN AND PROGRAMMING

ECE18R456 Embedded Systems Design and Programming	L	T	P	C
	3	0	1	3.5
Pre-requisite: ECE18R367 Embedded C / equivalent	**Course Category:** Professional Elective **Course Type:** Theory with Practical			

Course Objective(s):

Motivating students towards developing embedded systems for the practical applications

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the differences between the general computing system and embedded system
CO2: Illustrate the significance of various components involved in embedded system design
CO3: Design any application on embedded system with the help of hardware and firmware design concepts
CO4: Work and communicate effective in designing and developing embedded systems with an understanding of their limitations, impact on society and following norms, ethics

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H												H		
CO2	M				L							H	H		
CO3		H	H	H	H						L	H	H	M	
CO4						H	H	H	H	H				M	L

Course Topics:

Unit 1: Embedded System Basics

Differences between the Desktop PC and typical Embedded System - Applications of Embedded System - Embedded Design Life Cycle: Product Specification, Hardware/Software Partitioning, Iteration and Implementation, Detailed Hardware and Software Design, Hardware Software Integration, Product Testing and Release, Maintenance and Upgrading Existing products

Unit 2: Hardware Interfacing Techniques

Microprocessor vs. Microcontroller Analysis – Hardware Initialization – Display and Keyboard Interfacing - ADC, DAC and Sensor Interfacing, Serial Communication Interface: RS232, RS 485, IIC and USB. Real-time clock (RTC) and EEPROM Interface - Relay Interfacing, Stepper Motor, and DC Motor Interfacing

Unit 3: Software Development Tools and Programming Techniques

Cross-Compilers, Cross-Assemblers, Linker/Locator, Debugger, and Simulator - Introduction to Integrated Development Environment (IDE) - Simple Programs using IDE: I/O Port Programming, Timer Programming, Serial Port Programming, Interrupts Programming - Getting Embedded Software into Target System: Up-loaders, ROM Emulators, and In-Circuit Emulators. Debug Kernels: BDM, JTAG and Nexus

Unit 4: Real Time Operating Systems (RTOS)

Tasks and Task States, Tasks and Data, Semaphores and Shared Data, Message Queues, Mailboxes and Pipes, Timer functions, Events, Memory Management, Interrupt Routines in RTOS Environment - MicroC/OS-II: Use of MicroC/OS-II, RTOS System level functions, Task Service, Time delay, Memory allocation, Semaphore, Mailbox and Queue related functions. Other RTOS: VxWorks, Windows CE, RT Linux - Boot loaders

Unit 5: Application Development

Embedded Application Development - for Control Dominated, Data Dominated Systems - Case studies: Vending machine – Digital camera – Smart card reader – Mobile phone software for key inputs

Experiments (Any 5):

1. Introduction to Embedded Kit
2. Study of Real Time Operating Systems
3. Real-time operating system kernel (thread switching and synchronization)
4. Blocking semaphores, priority scheduling, performance measures, dumping RTOS profile data to the PC
5. Interfacing Microphone
6. Relay Interfacing
7. Motor Interfacing
8. Real-time Clock Study
9. Mailbox

TEXTBOOK(s):

1. Raj Kamal, "Embedded Systems: Architecture, Programming, and Design", McGraw Hill India, 2016(3rd Edition), ISBN: 9789332901490

Reference(s):

1. Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", Elsevier (Morgan Kaufmann) U.S., 2008(2nd Edition), ISBN: 9780123743978
2. Jonathan W. Valvano, "Embedded Microcomputer Systems: Real Time Interfacing", Cengage Learning, 2012(3rd Edition), ISBN: 9788131516324
3. K V Shibu, "Introduction to Embedded Systems", McGraw Hill India, 2016(2nd Edition), ISBN: 9789339219680

ECE18R415 SMART TEXTILE TECHNOLOGIES

ECE18R415 Smart Textile Technologies	L	T	P	C
	3	1	0	4
Pre-requisite: Electronic Devices / equivalent	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The aim of the course is theoretical familiarisation with application of electronics and computing units in textile industries

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the conducting fibre techniques in smart clothing

CO2: Explain how to integrate textile antennas into wearable fabrics

CO3: Learn about the processing of textiles and integrate electronics

CO4: Understand the design of wearable sensors

CO5: Explain the various design of various smart clothes used in different applications

Mapping of Course Outcome(s):

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H						M					H	H		
CO2	H						M					H	H		

CO3	H						M					H	H		
CO4	H						M					H	H		
CO5	H						M					H	H		

Course Topics:

Unit 1: Smart Electronics Textiles Basics

History of Wearable computing – Building Smart Textiles – Smart Textiles Applications – Conductive fibres for electronic textiles – Types – Applications

Unit 2: Textile Antenna

Antenna in Textiles – Materials and fabrications – applications – Body Effects, Specific Absorption rate, antenna characteristics – Bending Effects

Unit 3: Textile Processing and Integration of Electronics

Bulk CPYs – Polymer fibres embedded with metallic wires – Conductive fillers – Techniques for processing CPYs – fibre electronics technology – Development of chip encapsulation technique - Electronic integration on fibre level – Integration of electronics at textile level - Integration of electronics at garment level

Unit 4: Design and Manufacture of Textile – based Sensors

Developing sensors for Smart textiles– methodology – Types, capacitance sensors, temperature sensors – manufacturing methods – Applications of textile-based sensors – fibre coated sensors

Unit 5: Smart Clothes

Aesthetics and materiality in interaction research – Case Studies, Ice Hockey youth, motivation, design process, Solar Cell coat, concept, and design approach – Professional and Tech costumes – textile integration for medical and sports applications

Textbook(s):

1. Schneegass, Stefan, and Oliver Amft. "Smart textiles." Cham, Switzerland: Springer (2017). ISBN 978-3-319-50123-9,
2. Dias, Tilak, ed. Electronic textiles: Smart fabrics and wearable technology. Woodhead Publishing, 2015. ISBN 978-1-84569-357-2

Reference(s):

1. Kumar, L. Ashok Vigneswaran, C, Electronics in textiles and clothing design, products and applications, CRC Press, 2015.ISBN: 978-1-4987-1551-5

ECE18R416 IOT FOR SMART AGRICULTURE

ECE18R416 IoT for Smart Agriculture	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: Basics in Internet of Things	**Course Category:** Professional Elective **Course Type:** Theory			

Course Objective(s):

The aim of the course is theoretical familiarisation with applying IoT systems for agriculture

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand what is agricultural IoT

CO2: Explain various techniques of monitoring the data and how to process them

CO3: Learn the decision-making process with multivariate and univariate parameters

CO4: Explain the smart action in implementing the standards and recommendations of smart sensors

CO5: Know the eco-social impact on precision farming

Mapping of Course Outcome(s):

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	H						M					H	H		
CO2	H						M					H	H		
CO3	H						M					H	H		
CO4	H						M					H	H		

CO5	H						M					H	H		

Course Topics:

Unit 1: Agricultural IoT Basics

Precision smart farming from a multidisciplinary perspective - Internet of things architectures and paradigms - Open source internet of things platforms, different components, and sensors – formation of smart objects, cognitive techniques, smart object platforms – developing IOT applications.

Unit 2: Monitoring and Data Processing

Remote sensing technology for agriculture use – Remote sensing for biotic stresses - weed detection, detection of insects, crop disease detection – abiotic stresses – yield potential through remote sensing – proximal sensing – statistical approach to data processing – geostatistical tools – Kriging – cross validation – case studies.

Unit 3: Decision Making Systems

Introduction to decision support functions – embedded vs information intensive decisions – knowledge management – timing of decision making – multicriteria decision making – wrapping up the decision workflow.

Unit 4: Smart Action and Implementation

Introduction to variable rate Application - Methods for variable rate application implementation - Sensors and devices for variable rate application - Implementing variable rate recommendations - Practical examples of variable rate application.

Unit 5: Economic, Environmental, and Social Impacts on Precision farming

Ontology of smart farming technologies and successful innovation processes for their commercialization-Farm management and decision making – case studies across the world - Adoption of precision viticulture in France - Robots and sensors networks - Importance of an exemplary digital wine farm - Methods for designing a pilot digital farm

Textbook(s):

1. Annamaria Castrignano Gabriele Buttafuoco Raj Khosla Dimitrios Moshou Abdul Mouazen Olivier Naud, Agricultural Internet of Things and Decision Support for Smart Farming, 2020, Academic Press, ISBN: 978-0-12-818373-1

Reference(s)

1. https://www.coursera.org/lecture/industrial-iot-markets-security/segment-5-agriculture-E2FGa

ECE18R471 IOT PROTOCOLS AND THEIR APPLICATIONS

ECE18R471 IoT Protocols and their Applications	**L**	**T**	**P**	**C**
	2	**0**	**2**	**3**
Pre-requisite: None	**Course Type:** Professional Elective **Course Category:** Integrated Course			

Course Objective(s):

The purpose of this course is to impart knowledge on IoT Architecture and various protocols, study their implementations.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Summarize the Architectural Overview of IoT.
CO2: Demonstrate the IoT Reference Architecture and Real-World Design Constraints.
CO3: Apply various IoT Protocols (Datalink, Network, Transport, Session, Service).
CO4: Distinguish the various IoT Protocols of the Transport Layer and Session Layer.
CO5: Justify the Service Layer and Security in IoT.
CO6: Build the various protocols for IoT applications in a laboratory.

Mapping of Course Outcome(s):

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	H					L	H					M	M	L	M

CO2		M	M	M		L						M	M	L	L
CO3		L	M	H	M	M		L				M	M	H	L
CO4		L	H	H	H	H	H	H				H	M	H	M
CO5		M	M	M		L						M	M	M	L
CO6		L	M	H	M	M		L				M	M	M	L

Course Topics: **30 hours**

Unit 1: Overview **6 hours**

IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M, IoT Technology Fundamentals- Devices and gateways, Local and wide area networking

Unit 2: Reference Architecture **6 hours**

IoT Architecture-State of the Art – Introduction, State of the art, Reference Model, and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views, Real-World Design Constraints

Unit 3: IoT Data Link Layer and Network Layer Protocols **6 hours**

PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7

Unit 4: Transport and Session Layer Protocols **6 hours**

Transport Layer TCP, MPTCP, UDP, DCCP, SCTP-TLS, DTLS, Session Layer HTTP, CoAP, XMPP, AMQP, MQTT, Toward Web Enhanced Building Automation Systems - heterogeneity between existing installations

Unit 5: Service Layer Protocols and Security **6 hours**

Service Layer -oneM2M, ETSI, M2M, OMA, BBF, Security in IoT Protocols – MAC 802.15.4, 6LoWPAN, RPL, Application Layer, Sustainability Data and Analytics in Cloud-Based M2M Systems

Experiments:

1. Demonstration of the implementation of Wi-Fi protocol (IEEE 802.11 n) using Wi Fi Module on an Arduino Uno Board
2. Implement BLE 4.0 (Bluetooth Low Energy) Protocol
3. Write a program to implement the NFC protocol using NFC reader module
4. Write a program for the implementation of IEEE 802.15.4 Protocol
5. Write a program for the implementation of Z-Wave protocol using RF module
6. Write a program for the implementation of LoRa protocol
7. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker
8. Write a program to subscribe to MQTT broker for temperature data and print it
9. Write program for the implementation of IoT with CoAP and HTTP Protocol
10. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
11. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested (A client-server application using UDP protocol).
12. Write a program for the implementation of 6LoWPAN Protocol

Textbooks:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, Academic Press, 2014. ISBN: 978-0124076846

Reference(s):

1. Peter Waher, “Learning Internet of Things”, PACKT Publishing ISBN: 978-1783553532
2. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, Springer, ISBN 978-3-642-19156-5.

3. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, Wiley Publications
4. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014. ISBN: 978-0996025515
5. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

LIST OF AICTE VIRTUAL LABORATORIES

Sl. No.	Laboratory Name
1	Electronic design using DSP, FPGA, CPLD and Microcontrollers through simulation and direct access of the hardware
2	Digital Electronic Circuits Laboratory
3	Digital Signal Processing Laboratory
4	Speech Signal Processing Laboratory
5	Digital VLSI Design Virtual lab
6	Virtual Electric Circuits Laboratory
7	Fading Channels and Mobile Communications
8	Electromagnetic Theory
9	Signals and Systems Laboratory
10	Transducers and Instrumentation Virtual Laboratory
11	RF and Microwave Characterisation Laboratory
12	Hybrid Electronics Lab
13	Queuing Networks Modeling Lab
14	Engineering Electro-magnets Laboratory
15	Virtual Microwave Lab
16	Basic Electronics
17	Single Board Heater System
18	Systems, communication, and control laboratory for remote users

OPEN ELECTIVES

Department of Automobile Engineering

S. No.	Course Code	Course Name	Course Type	Pre-requi-site	L	T	P	C
1	AUT18R307	Instrumentation and Metrology	T		3	0	0	3
2	AUT18R310	Off road Vehicles	T		3	0	0	3
3	AUT18R312	Tractor and Farm Equipment	T		3	0	0	3
4	AUT18R315	Automotive Materials	T		3	0	0	3
5	AUT18R402	Recent Vehicle Technology	T		3	0	0	3
6	AUT18R405	Automotive Safety	T		3	0	0	3
7	AUT18R412	Experimental Method in Fluids	T		3	0	0	3
8	AUT18R413	Hybrid Electric Vehicle	T		3	0	0	3
9	AUT18R414	Vehicle Maintenance	T		3	0	0	3
10	AUT18R415	Fleet Management	T		3	0	0	3
11	AUT18R416	Automotive Air-conditioning	T		3	0	0	3
12	AUT18R418	Automotive Pollution Control and Alternative Fuels	T		3	0	0	3
13	AUT18R419	Terotechnology	T		3	0	0	3

Department of Biomedical Engineering

S. No.	Course Code	Course Name	Course Type	Pre-requi-site	L	T	P	C
1	BME18R205	Biomaterials and artificial Organs	T		3	0	0	3
2	BME18R301	Biomedical Instrumentation	T		3	0	0	3
3	BME18R302	Hospital Management	T		3	0	0	3
4	BME18R304	Medical Optics and lasers	T		3	0	0	3
5	BME18R305	Computers in Medicine	T		3	0	0	3
6	BME18R306	Rehabilitation Engineering	T		3	0	0	3
7	BME18R310	Occupational Health and Safety	T		3	0	0	3
8	BME18R403	Hospital Engineering	T		3	0	0	3
9	BME18R404	Telemedicine	T		3	0	0	3
10	BME18R405	Nanotechnology in Medicine	T		3	0	0	3
11	BME18R408	Biometric Systems	T		3	0	0	3
12	BME18R409	Wearable systems	T		3	0	0	3
13	BME18R410	Biomedical Waste Management	T		3	0	0	3

Department of Biotechnology

S. No.	Course Code	Course Name	Course Type	Pre-requi-site	L	T	P	C
1	BIT18R307	Environmental Biotechnology	T	CHY18R101	3	0	0	3
2	BIT18R316	Introduction to Computational Biology	T	CSE18R171	3	0	0	3
3	BIT18R317	Biology of Cancer	T		3	0	0	3

S. No.	Course Code	Course Name	Course Type	Pre-requi-site	L	T	P	C
4	BIT18R318	Engineering of crop plants	T		3	0	0	3
5	BIT18R319	Environmental Microbiology	T	CHY18R101	3	0	0	3
6	BIT18R320	Basics in Biotechnology	T		3	0	0	3
7	BIT18R321	Exploring the microbial world	T		3	0	0	3
8	BIT18R428	Human diseases and prevention	T		3	0	0	3
9	BIT18R411	Bioresource Technology	T	BIT18R320	3	0	0	3
10	BIT18R432	Gene Manipulation	T		3	0	0	3
11	BIT18R433	Biological Wastewater treatment	T		3	0	0	3
12	BIT18R434	Bio-corrosion	T	BIT18R320	3	0	0	3
13	BIT18R435	Applications of Plant fibres	T		3	0	0	3

Department of Chemical Engineering

S. No	Course Code	Course Name	Course Type	Pre-requi-site	L	T	P	C
1	CHE18R310	Corrosion Science and Engineering	T		3	0	0	3
2	CHE18R311	Separation Technique	T	CHE18R207	3	0	0	3
3	CHE18R312	Fertilizer Technology	T		3	0	0	3
4	CHE18R313	Membrane Science and technology	T		3	0	0	3
5	CHE18R314	Safety in chemical industries	T		3	0	0	3
6	CHE18R315	Biofuel and Combustion	T		3	0	0	3
7	CHE18R316	Pulp and Paper Technology	T		3	0	0	3
8	CHE18R317	Treatment of Industrial Effluents	T		3	0	0	3
9	CHE18R318	Coal Processing Technology	T		3	0	0	3
10	CHE18R319	Batteries and Fuels Cells	T		3	0	0	3
11	CHE18R321	Mass Transfer	T	CHE18R207	3	0	0	3
12	CHE18R322	Green Technology	T		3	0	0	3
13	CHE18R412	Drugs and Pharmaceutical Engineering	T		3	0	0	3

Department of Civil Engineering

S. No.	Course Code	Course Name	Course Type	Pre-requi-site	L	T	P	C
1	CIV18R325	Introduction to Remote Sensing	T		3	0	0	3
2	CIV18R326	Air Pollution & Control	T	CHY18R171	3	0	0	3
3	CIV18R327	Environmental Management	T		3	0	0	3
4	CIV18R328	Industrial Wastewater Management	T		3	0	0	3
5	CIV18R329	Geo- Environmental Engineering	T		3	0	0	3
6	CIV18R330	Coastal Engineering	T		3	0	0	3
7	CIV18R331	Disaster Management	T		3	0	0	3
8	CIV18R332	Advanced Remote Sensing Techniques	T	CIV18R325	3	0	0	3
9	CIV18R420	Geographic Information systems	T		3	0	0	3
10	CIV18R421	Ecological Engineering	T		3	0	0	3
11	CIV18R422	Environmental Impact Assessment	T		3	0	0	3
12	CIV18R423	Building Services	T		3	0	0	3
13	CIV18R424	Modern Building Materials	T		3	0	0	3
14	CIV18R425	Smart Structures	T		3	0	0	3
15	CIV18R426	Valuation of Engineering Structures	T		3	0	0	3
16	CIV18R427	Seismology & Earthquake Engineering	T		3	0	0	3
17	CIV18R428	Pavement evaluation & management	T		3	0	0	3
18	CIV18R429	Pavement materials and construction	T		3	0	0	3
19	CIV18R430	Smart City	T		3	0	0	3
20	CIV18R431	Transportation economics	T		3	0	0	3
21	CIV18R432	Remote Sensing and GIS In Transport De-velopment	T		3	0	0	3

Department of Computer Science and Engineering

S. No	Course Code	Course Name	Course Type	Pre-requi-site	L	T	P	C
1	CSE18R302	Fundamentals of Networking	T		3	0	0	3
2	CSE18R303	OOPS using C++	T		3	0	0	3

3	CSE18R304	OOPS using JAVA	T		3	0	0	3
4	CSE18R305	Introduction to Data Analytics	T		3	0	0	3
5	CSE18R306	Introduction to Software Engineering	T		3	0	0	3
6	CSE18R307	Fundamentals of operating systems	T		3	0	0	3
7	CSE18R308	Ethical Hacking	T		3	0	0	3
8	CSE18R309	Introduction to Python Programming	T		3	0	0	3
9	CSE18R310	PC and Troubleshooting	T		3	0	0	3
10	CSE18R311	**Data and Word Processing**	T		3	0	0	3
11	CSE18R312	Fundamentals of Computer Architecture	T		3	0	0	3
12	CSE18R313	Bio Inspired Algorithm	T		3	0	0	3
13	CSE18R401	Bio- Python	T	CSE18R303	3	0	0	3
14	CSE18R402	Internet Security and Computer Forensics	T	CSE18R302	3	0	0	3
15	CSE18R403	Introduction to Cloud Computing	T	CSE18R302	3	0	0	3
16	CSE18R404	Programming in C# and .Net	T	CSE18R303	3	0	0	3
17	CSE18R405	Android Programming	T	CSE18R304	3	0	0	3
18	CSE18R406	Introduction to IOT	T	CSE18R302	3	0	0	3
19	CSE18R407	Vehicular Ad -Hoc Network	T	CSE18R302	3	0	0	3
20	CSE18R408	Wireless Sensor Network	T	CSE18R302	3	0	0	3

Department of Electrical and Electronics Engineering

S. No.	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1	EEE18R309	Principles of Power System	T		3	0	0	3
2	EEE18R310	Solar and Wind Energy Conversion	T		3	0	0	3
3	EEE18R311	Principles of Power Electronics	T	ECE18R215	3	0	0	3
4	EEE18R312	Electrical Machines	T		3	0	0	3

S. No.	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
5	EEE18R313	Auto electrical wiring	T		3	0	0	3
6	EEE18R314	Smart Grid Technology	T		3	0	0	3
7	EEE18R315	Electrical wiring Estimation and costing	T		3	0	0	3
8	EEE18R417	Electrical Safety	T		3	0	0	3
9	EEE18R418	Power Generation Systems	T		3	0	0	3
10	EEE18R419	Soft Computing Techniques	T	MAT18R201	3	0	0	3
11	EEE18R420	Industrial Electronics	T		3	0	0	3
12	EEE18R421	Evolutionary algorithm	T	MAT18R201	3	0	0	3
13	EEE18R422	Energy Conservation and Management	T		3	0	0	3
14	EEE18R423	Embedded System Design	T	CSE18R273	3	0	0	3
15	EEE18R424	Hydro power generation	T		3	0	0	3
16	EEE18R425	Building Management System	T		3	0	0	3

Department of Electronics and Instrumentation Engineering

S. No.	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1	EIE18R301	Mechatronics	T		3	0	0	3
2	EIE18R303	Virtual Instrumentation	T		3	0	0	3
3	EIE18R306	PCB Design Engineering	T		3	0	0	3
4	EIE18R308	Instrumentation in Processing Industries	T		3	0	0	3
5	EIE18R309	Electronics Instrumentation	T		3	0	0	3
6	EIE18R310	Environmental Instrumentation	T		3	0	0	3
7	EIE18R311	Instrumentation in Food Processing Industry	T		3	0	0	3
8	EIE18R406	Robotics and Automation	T	EIE18R202	3	0	0	3
9	EIE18R411	Building Automation	T	EIE18R372	3	0	0	3
10	EIE18R412	Programmable Logic controller	T		3	0	0	3
11	EIE18R413	Agricultural Instrumentation.	T		3	0	0	3
12	EIE18R414	Automobile Instrumentation	T	EIE18R372	3	0	0	3
13	EIE18R415	Process Instrumentation	T		3	0	0	3

Department of Food Technology

S. No.	Course Code	Course Name	Course Type	Pre-req-uisite	L	T	P	C
1	FT18R359	Technology of Convenience Foods	T		3	0	0	3
2	FT18R360	Bakery and Confectionary Technology	T		3	0	0	3
3	FT18R320	Foundation of Food and Nutrition	T		3	0	0	3
4	FT18R321	Pollution control in Food Industries	T		3	0	0	3
5	FT18R361	Processing of Marine Products	T		3	0	0	3
6	FT18R322	Food Laws and Standards	T		3	0	0	3
7	FT18R423	Nutraceuticals and Functional Foods	T		3	0	0	3
8	FT18R463	Beverage Technology	T		3	0	0	3
9	FT18R423	Food Biotechnology	T		3	0	0	3
10	FT18R464	Fermented food products	T		3	0	0	3
11	FT18R425	Nanotechnology in Food Processing	T		3	0	0	3
12	FT18R426	Composition, Quality & Safety of Foods	T		3	0	0	3
13	FT18R465	Packaging Technology of Foods	T		3	0	0	3

Department of Mechanical Engineering

S. No.	Course Code	Course Name	Course Type	Pre-req-ui-site	L	T	P	C
1	MEC18R321	Optimization Techniques	T		3	0	0	3
2	MEC18R323	Materials Management	T		3	0	0	3
3	MEC18R403	Mechatronics	T		3	0	0	3
4	MEC18R427	Enterprise Resource Planning	T		3	0	0	3
5	MEC18R428	Productivity management and reengineering	T		3	0	0	3
6	MEC18R432	Nuclear Power generation	T		3	0	0	3
7	MEC18R439	Surface Engineering	T		3	0	0	3
8	MEC18R440	Basic Machining	T		3	0	0	3
9	MEC18R441	Phase Change Materials	T		3	0	0	3
10	MEC18R442	3D Printing	T		3	0	0	3
11	MEC18R443	Maintenance Engineering	T		3	0	0	3
12	MEC18R444	Project Management	T		3	0	0	3
13	MEC18R445	Finite Element Analysis	T		3	0	0	3
14	MEC18R446	Industrial Psychology	T		3	0	0	3
15	MEC18R447	Smart Materials	T		3	0	0	3
16	MEC18R448	Avionics	T		3	0	0	3
17	MEC18R449	Product life cycle management	T		3	0	0	3
18	MEC18R450	Fundamentals of entrepreneurship	T		3	0	0	3
19	MEC18R451	Supply chain management	T		3	0	0	3
20	MEC18R452	Basics in Heat transfer	T		3	0	0	3
21	MEC18R453	Automatic Guided Vehicle	T		3	0	0	3
22	MEC18R454	Thermodynamics	T		3	0	0	3
23	MEC18R455	Process equipment and design	T		3	0	0	3

Open Electives Offered to Other Departments by Electronics and Communication Engineering Department

S.	Code	Course Name	Pre-requi-site	Not for
1.	ECE18R241	Signals and System Basics	Nil	CSE, IT, EEE, EIE
2.	ECE18R242	Electronic Circuit Basics		EEE, EIE, BIO-MEDICAL, CSE, MECH, CIVIL
3.	ECE18R243	Opto-Electronics		
4.	ECE18R341	Linear Integrated Electronics		EEE, EIE
5.	ECE18R342	Digital Electronic Principles		EEE, EIE, CSE, IT, BIO-MEDICAL
6.	ECE18R343	Analog Communication Systems		IT
7.	ECE18R344	Television Engineering		
8.	ECE18R345	Consumer Electronics		
9.	ECE18R346	VLSI Design Basics		CSE
10.	ECE18R441	Microcontrollers (Arduino) Pro-gramming		EEE, EIE, CSE, IT, BIO-MED
11.	ECE18R442	Digital Communication Systems		IT
12.	ECE18R443	Wireless Communication Systems		CSE, IT
13.	ECE18R444	Digital Signal Processing Basics	ECE18R241	CSE, IT, EEE, EIE
14.	ECE18R445	Telecommunication Networks	Nil	IT
15.	ECE18R446	GPS Fundamentals		
16.	ECE18R447	VLSI Fabrication		

ECE18R241 SIGNALS AND SYSTEM BASICS

ECE18R241 SIGNALS AND SYSTEM BASICS	L	T	P	C
	3	0	0	3
Pre-requisite: -- **Not for CSE, IT, EEE, EIE**	**Course Type:** Open Elective **Course Category:** Theory			

Course Outcome(s):

CO1: Understanding the concepts of signals and systems
CO2: Perform the convolution sum
CO3: Understand the Fourier series
CO4: Understand the Fourier Transform
CO5: Understand the Laplace and Z transform

Course Topics:

Unit 1: Signals and Systems

Complex number, Partial fraction analysis, frequency, period, Signals, Representation of signals, Energy and power signals, Transformation of independent variables, Even and odd signals, Unit impulse, unit step, ramp, rectangular functions

Unit 2: LTI Systems

Convolution integral(sum) and Impulse response, Properties of LTI systems, Sampling theorem, Representation of c-t signal by samples

Unit 3: Fourier Series

FS of periodic signals, Convergence of FS, Properties of FS

Unit 4: Fourier Transform

Continuous and discrete time FT of aperiodic signals, Convergence of F.T., Properties of FT

Unit 5: Laplace Transform, z- Transform

Laplace transform and its inverse, Convergence region, Properties of L.T.,
Z transform and its inverse transform, Region of Convergence, Properties

Textbook(s):

1. V. Krishnaveni, A. Rajeswari, Signals and Systems, Wiley, 2012

Reference(s):

1. Tarun Kumar Rawat, Signals and Systems, Oxford Press, 2010.
2. Michael J Roberts and Govind Sharma, Signals and Systems, McGraw Hill, 2010

ECE18R242 ELECTRONIC CIRCUIT BASICS

ECE18R242 Electronic Circuit Basics		L	T	P	C
		3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory				
Not for EEE, EIE, BIO-MEDICAL, CSE, MECH, CIVIL					

Course Outcome(s):

CO1: Understand the working of Diode Circuits
CO2: Understanding the working of BJT
CO3: Understanding the working of FET
CO4: Understand the basic amplifier circuits
CO5: Understand the basic oscillator circuits

Course Topics:

Unit 1: Diodes (Qualitative – Outline Treatment Only)

Conductors, Semiconductors, Insulators - Generation and recombination of carriers – PN junction – Ideal Diode – Characteristics of Junction Diode - – Mechanism of avalanche and Zener breakdown – Zener Diodes – Rectifiers (without filters)

Unit 2: BJT (Qualitative – Outline Treatment Only)

BJT: Structure and Physical Operation (Modes and Configuration) – Current-Voltage Characteristics – Transistor as Amplifier, Switch

Unit 3: FET (Qualitative – Outline Treatment Only)

JFET: Construction, Characteristics – Transfer Characteristics
MOSFET: Structure and Working of n-Channel MOSFET (enhancement) – p-Channel MOSFET

Unit 4: Amplifiers (Qualitative – Outline Treatment Only)

Biasing - BJT Amplifiers - Power Amplifiers – Class A, B, C and class AB amplifiers - Negative feed-back amplifier-characteristics

Unit 5: Oscillators (Qualitative – Outline Treatment Only)

Positive feedback and Oscillators: Clap Oscillator, Colpitts oscillator, Hartley oscillator, RC Phase Shift Oscillator, Wein Bridge oscillator

Textbook(s):

1. David A. Bell, Electronic Devices and Circuits, Oxford Press, 2008

Reference(s):

1. S Salivahanan, N Suresh Kumar, Electronic Devices and Circuits, McGraw Hill, 2016

ECE18R243 OPTO-ELECTRONICS

ECE18R243 Opto-Electronics	L	T	P	C
	3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory			

Course Outcome(s):

CO1: Explain basic concepts of optical fibres and their properties
CO2: Demonstrate knowledge on the application of fibre optic sensors
CO3: Explain the principles and characteristics of several types of Lasers
CO4: Demonstrate knowledge on the application of Lasers in industries
CO5: Illustrate the working of various opto-electronic components

Course Topics:

Unit 1: Fibre Optics

Principles of light propagation through a fibre – Optical Fibres – Intermodal Dispersion – Graded index, Low dispersion fibre – Fibre losses

Unit 2: Fibre Optic Sensors

Passive Multimode fibre sensors – Active fibre optic sensors – Fibre optic gyroscope – Polarisation of light – Polarimetric Fibre Sensors

Unit 3: Lasers

Principle – Characteristics – Operation – Types – Erbium Laser – Tuneable Laser - Laser Diodes – Gas Lasers – Line shape function – Population inversion and Pumping threshold – High intensity Lasers – Q switching

Unit 4: Laser Applications

Scientific, Industrial, Medical, Military Applications – Distance, Velocity Measurement – Holography – Laser Machining – Laser Spectroscopy – Confocal Microscopy – Uranium Enrichment – Laser Printers

Unit 5: Opto-electronic Components

Photodetectors – Solar cells – LEDs – Optocouplers and Opto-isolators

Textbook(s):

1. S. Nagabhushana, N. Sathyanarayana – Laser and Optical Instrumentation – I.K. International Publishing House – 2010

Reference(s):

1. P. Sarah – Laser and Fibre Optic Communications – I.K. International Publishing House – 2009

ECE18R341 LINEAR INTEGRATED ELECTRONICS

ECE18R341 Linear Integrated Electronics		L	T	P	C
		3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory				
Not for: EEE, EIE					

Course Outcome(s):

CO1: Explain the characteristics of ideal and practical op-amp
CO2: Design the linear and non-linear applications of op-amp
CO3: Design waveform generators using op-amp
CO4: Explain the working of 555 Timer and its applications

Course Topics:

Unit 1: Op-Amp (Qualitative – Outline Treatment Only)

Ideal Op-amp – Practical Op-Amp – General operational amplifier stages and internal circuit diagram of OP-Amp – Op-Amp: DC and AC performance characteristics - Open and closed loop configurations

Unit 2: Linear Applications

Sign Changer- Scale Changer- Voltage Follower- V-to-I and I-to-V converters- adder- Instrumentation amplifier

Unit 3: Non-Linear Applications

Logarithmic amplifier- Antilogarithmic amplifier- Comparators- Schmitt trigger - Precision rectifier – Peak detector – Wave shaping circuits: Integrator, Differentiator, Clipper, Clamper

Unit 4: Waveform Generators

Op-amp: Astable multivibrator, Mono-stable multi-vibrator, Triangular wave, Sine wave generator

Unit 5: 555 Timer

555 Timer and its applications

Textbook(s):

1. David A. Bell, Operational Amplifiers and Linear ICs, Oxford Press, 2011

Reference(s):

1. S Salivahanan, V. S. Kanchana Bhaskaran, Linear Integrated Circuits, McGraw Hill, 2016

ECE18R342 DIGITAL ELECTRONIC PRINCIPLES

ECE18R342 Digital Electronic Principles		L	T	P	C
		3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory				
Not for: EEE, EIE, CSE, IT, BIO-MEDICAL					

Course Outcome(s):

CO1: Demonstrate the knowledge of number systems and codes
CO2: Utilize Boolean algebra and K-map to design logic circuits
CO3: Design Combinational Circuits
CO4: Design Sequential Circuits
CO5: Describe the different memories

Course Topics:

Unit 1: Number Systems and Codes

Analog and Digital Representation – Digital Computer Block Diagram –Positional number system, Base conversions, signed numbers, Basic Arithmetic Operations, Weighted and Non-weighted codes, Error Detection and Correction Codes, Alphanumeric Codes

Unit 2: Boolean Algebra

Boolean Algebra and Switching Functions: Boolean functions, Logic gates – Simplification of switching functions: K-map up-to 4 variables, Quine-McCluskey

Unit 3: Combinational Logic

Half adder, Full adder, Magnitude Comparator, Encoders and Decoders, Multiplexer and Demultiplexer, Code Converters, Parity Checkers

Unit 4: Sequential Logic

Basic Bistable Element – Latches – Edge-Triggered Flip-Flops – Interconversion of Flip-flops – Registers – Ripple Counters – Synchronous Counters – Shift register counters

Unit 5: Memories

General Memory Operation, ROM, RAM (Static and Dynamic), PROM, EPROM, EEPROM

Textbook(s):

1. G.K. Kharate -Digital Electronics – Oxford University Press – 2010

Reference(s):

1. Anand Kumar A. – Fundamentals of Digital Circuits – PHI – 2016 (4th Edition)

ECE18R343 ANALOG COMMUNICATION SYSTEMS

ECE18R343 Analog Communication Systems	L	T	P	C
	3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory			
Not for: IT				

Course Outcome(s):

CO1: Identify various elements, processes, and parameters in telecommunications systems
CO2: Design procedure of AM Transmission and Reception
CO3: Describe several types of SSB Transmission and reception.
CO4: Explain basic knowledge of FM Transmission and Reception.

Course Topics:

Unit 1: Communication Systems Basics

Elements of communication system, time and frequency domains, Signal representations and Fourier transforms, Need for modulation, Types of modulation, Noise in communication system, SNR

Unit 2: Amplitude Modulation

Sinusoidal AM modulation index, Average power, Effective V and I, Generation and Detection of AM Waves

Unit 3: Single Side Band Modulation

SSB, DSBSC, VSB Modulation, Generation and Detection

Unit 4: Angle Modulation

Narrow band, Wide band FM, Average Power, Transmission bandwidth - Generation, Detection of FM Waves, Comparison of FM and AM

Unit 5: Receiver

Receiver Types - Tuned radio frequency receiver, Super heterodyne receiver, RF section and Characteristics - Intermediate frequency, AGC, FM Receiver, Comparison with AM Receiver, Amplitude limiting

Textbook(s):

1. V. Chandra Sekar – Analog Communication – Oxford Press – 2010

Reference(s):

1. P Ramakrishna Rao – Analog Communication – Pearson – 2011
2. George Kennedy, Brendan Davis and SRM Prasanna – Electronic Communication Systems – McGraw Hill - 2011

ECE18R344 TELEVISION ENGINEERING

ECE18R344 Television Engineering	L	T	P	C
	3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory			

Course Outcome(s):

CO1: Describe the various components of video systems
CO2: Describe several types of television systems and displays
CO3: Explain about television transmission and reception

Course Topics:

Unit 1: Television Basics

Basic TV broadcasting system – Image continuity – Synchronisation and scanning – Kell factor – Blanking pulse – Video bandwidth – Modulation – Camera tubes: Characteristics, types – CCD cameras – Active pixel sensors

Unit 2: Television Transmission and Reception

TV transmitter – Interference in TV signals – Monochrome TV receiver – RF, VHF, UHF Tuner – Automatic frequency tuning

Unit 3: Colour Television Signal

Compatibility – Colour perception – Three colour theory – Colour Difference signals – Single colour tube camera – Colour signal transmission – Bandwidth modulation of colour difference signal – Weighting factor – Formation of chrominance signal

Unit 4: Colour Television Systems

Colour television systems: NTSC, PAL-D – Colour Burst separation - ACC Amplifier – Reference oscillator – Identification and colour killer circuits –Colour signal matrix – Typical PAL, NTSC colour TV receiver

Unit 5: Digital Television

Transmission and reception –classification – Receiver - HDTV

Textbook(s):

1. R. C. Jaiswal - Audio and Video Engineering - Nirali Prakashan - 2009
2. A. Veera Lakshmi, R Srivel - Television and Video Engineering - Ane Publishers - 2010

Reference(s):

1. K. F. Ibrahim - Newnes Guide to Television and Video Technology - Newnes - 2007

ECE18R345 CONSUMER ELECTRONICS

ECE18R345 Consumer Electronics	L	T	P	C
	3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory			

Course Outcome(s):

CO1: Recognise basic consumer electronic components and devices used for different electronic functions

CO2: Explain the working principle, of consumer electronic devices particularly AV systems, Household appliances and Office appliances

Course Topics:

Unit 1: Audio Systems

Microphones, Loudspeaker, Loudspeaker systems, CD player, CD-ROM, Audio compact discs

Unit 2: Video Systems

Video disc: Record and playback, Remote control

Unit 3: Electronics Gadgets

Calculators, Digital Clocks, In-car computers, Set-top-Box

Unit 4: Home Appliances

Microwave Oven, Washing Machine, Air conditioner, Refrigerator, Dishwasher

Unit 5: Office Appliances

Facsimile, Xerography, Bar coding machines, ATM's

Textbook(s):

1. Bali S. P, Consumer Electronics, Pearson India, 2007

Reference(s):

1. Philip Hoff, Consumer Electronics for Engineers Cambridge University Press, 1998

ECE18R346 VLSI DESIGN BASICS

ECE18R346 VLSI Design Basics		L	T	P	C
		3	0	0	3
Pre-requisite: ---	**Course Type:** Open Elective **Course Category:** Theory				
Not for: CSE					

Course Outcome(s):

CO1: Explain the design flow and styles of VLSI Circuits
CO2: Explain the characteristics of MOS and its design rules
CO3: Demonstrate an understanding of design of analog, digital and mixed signal circuits using CMOS

Course Topics:

Unit 1: VLSI Design Basics

Evolution – Application – Quality metrics – VLSI Design flow – Physical Design Cycle – Design styles – CMOS Logic

Unit 2: CMOS Properties and Circuit Design (Qualitative – Outline Treatment Only)

Characteristics – Second order effects – Scaling – Design process of MOSFET based devices – Design rules – Stick Diagram – Mask Layout

Unit 3: CMOS Based Digital Design

CMOS Inverter - CMOS NAND Gate – CMOS NOR Gate – Combinational Digital Circuit – Sequential Digital Circuit – Transmission Gate - Memory

Unit 4: CMOS Based Analog Design

Passive Components – Current Source/Sink – Voltage Dividers – Amplifiers – Operational Amplifier

Unit 5: CMOS Mixed Signal Design

Adaptive Biasing – CMOS Comparator – Analog Multipliers – Level Shifting – Dynamic Mixed Signal Circuit – Data Converters

Textbook(s):

1. Partha Pratim Sahu, VLSI Design, McGraw Hill, 2013
2. Vikrant Vij, Nidhi Syal, VLSI Design Theory and Practice, University Science Press (Laxmi Publications), 2013

ECE18R441 MICROCONTROLLERS (ARDUINO) PROGRAMMING

ECE18R441 Microcontrollers (Arduino) Programming	L	T	P	C
	3	0	0	3
Pre-requisite: ---	**Course Type:** Open Elective **Course Category:** Theory			
Not for: EEE, EIE, CSE, IT, BIO-MED				

Course Outcome(s):

CO1: Explain the architecture and blocks of a microcontroller
CO2: Interface various sensors and actuators with a microcontroller and program it as per requirements

Course Topics:

Unit 1: Microcontroller Basics (Qualitative – Outline Treatment Only)

Basic microcontroller architecture, internal data handling and control, arithmetic-logic unit (ALU), input-output, timer

Unit 2: Microcontroller Programming (Qualitative – Outline Treatment Only)

Microcontroller programming language -Interfacing

Unit 3: Arduino Microcontroller

Features, Different Architectures of Arduino, Sensors and actuators

Unit 4: Arduino Programming

Comparing Character, Numeric, Comparing Strings, Logical Comparisons, Bitwise Operations, Combining Operations and Assignment, Libraries

Unit 5: Arduino Interfacing

Arduino Interfacing and Applications, blinking an LED, LCD Display, driving a DC and stepper motor, Temperature sensors, Sending Formatted Text and Numeric Data from Arduino, Receiving Serial Data in Arduino

Textbook(s):

1. M. Rafiquzzaman, Fundamentals of Digital Logic and Microcontrollers, Wiley, 2014 (6th Edition)
2. Michael Margolis, Arduino Cookbook, O'Reilly, 2017 (3rd Edition)

References

1. Steven Frank Barrett, Daniel J. Pack, Microcontrollers Fundamentals for Engineers and Scientists, Morgan & Claypool, 2006
2. Andreas Goransson, David Cuartielles Ruiz, Professional Android Open Accessory Programming with Arduino, John Wiley, 2011

ECE18R442 DIGITAL COMMUNICATION SYSTEMS

ECE18R442 Digital Communication Systems		L	T	P	C
		3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory				
Not for: IT					

Course Outcome(s):

CO1: Demonstrate an understanding of Channel capacity and coding
CO2: Demonstrate an understanding of coding the information
CO3: Explain various encoding and multiplexing schemes
CO4: Describe the various multiple access techniques
CO5: Explain the various issues in communication systems

Course Topics:

*** All Units are to be treated Qualitative – Outline Level Only**

Unit 1: Digital Communication Basics

Basic communication system – Analog and Digital Transmission – Entropy of an information – Channel capacity – Shannon's Theorem

Unit 2: Coding of Signals

Coding of text messages, image, Video – coding of voice: Waveform coding, PCM, ADPCM, Vocoding – Error Detection and Correction

Unit 3: Digital Encoding, Multiplexing, Multiple Access

Encoding Requirements and categories – NRZ-I, NRZ-L, Manchester – RS232 – Multiplexing and De-multiplexing – FDM, TDM, WDM
FDMA – TDMA – FDMA/TDMA – CDMA – OFDM – CSMA- Efficiency

Unit 4: Modulation

Modulation – Types of modulation – Digital Modulation: ASK, FSK, PSK

Unit 5: Issues in Communication System Design

Data rates – Performance criteria – Security issues – Standards - Cost

Textbook(s):

1. K.V.K.K. Prasad, Principles of Digital Communication Systems and Computer Networks, Dreamtech (Charles River Media / Delmar Cengage Learning), 2003

ECE18R443 WIRELESS COMMUNICATION SYSTEMS

ECE18R443 Wireless Communication Systems		L	T	P	C
		3	0	0	3
Pre-requisite: --	**Course Type:** Open Elective **Course Category:** Theory				
Not for: CSE, IT					

Course Outcome(s):

CO1: Demonstrate an understanding of fundamentals of mobile wireless networks
CO2: Demonstrate an understanding of coding the information
CO3: Explain various encoding and multiplexing schemes
CO4: Describe the various multiple access techniques
CO5: Explain the various issues in communication systems

Course Topics:

*** All Units are to be treated Qualitative – Outline Level Only**

Unit 1: Transmission fundamentals

Analog and Digital Transmission, channel capacity, transmission media, carrier-based signalling, spread-spectrum signalling

Unit 2: Network Concepts

Communication Networks: LANs, MANs, WANs, circuit switching, packet switching; Cellular Networks: Cells, duplexing, multiplexing

Unit 3: Personal Communication Services

Mobile phone generation – GSM, HSCSD, GPRS, Packet Data Systems

Unit 4: Wireless Communication Services

W-CDMA, CDMA 2000, EDGE, Wi-Fi, WiMAX, OFDM, WAP

Unit 5: Short range networks

Spectrum, WLAN, Cordless telephony, IrDA, Bluetooth

Textbook(s):

1. Andy Dornan, The Essential Guide to Wireless Communications Applications: From Cellular Systems to Wi-Fi, Prentice/Pearson, 2002 (2nd Edition)
2. Iti Saha Misra, "Wireless Communications and Networks: 3G and Beyond", McGraw Hill, 2013 (2nd Edition)

ECE18R444 DIGITAL SIGNAL PROCESSING BASICS

ECE18R444 Digital Signal Processing Basics	L	T	P	C
	3	0	0	3
Pre-requisite: ECE18R241 or equivalent	**Course Type:** Open Elective **Course Category:** Theory			
Not for: CSE, IT, EEE, EIE				

Course Outcome(s):

CO1: Describe signals and systems, z- transform
CO2: Transform time domain into frequency domain and vice versa
CO3: Demonstrate understanding of DFT and Spectrum
CO4: Design the basic FIR and IIR to suit specific requirements
CO5: Describe the concept of decimation, interpolation, sampling rate

Course Topics:

Unit 1: Signals and Systems

Continuous/discrete time signals, Sampling theorem, Quantization, Signals, Classification of systems, Convolution and properties, Impulse response

Unit 2: z- Transform

Direct z-transform, and inverse z-transform, Region of Convergence, Impulse response by z-transform, Direct-form structure for FIR and IIR

Unit 3: DFT and FFT

DFT, Properties of DFT, Inverse DFT, Response of FIR, FFT algorithm

Unit 4: Filter Design

FIR filter for LPF by window functions, IIR filters for LPF by Butterworth and converting to z domain by bi-linear transform

Unit 5: Multi-rate Signal Processing

Representation of numbers, Decimation and interpolation, Sampling rate conversion

Textbook(s):

1. Tarun Kumar Rawat, Digital Signal Processing, Oxford, 2014
2. S. Salivahanan, Digital Signal Processing, McGraw Hill, 2014 (3rd Edition)
3. S. Poornachandra, B. Sasikala, Digital Signal Processing, McGraw Hill, 2009 (2nd Edition)

ECE18R445 TELECOMMUNICATION NETWORKS

ECE18R445 Telecommunication Networks	L	T	P	C
	3	0	0	3
Pre-requisite: --- **Not for IT**	**Course Type:** Open Elective – Theory			

Course Outcome(s):

CO1: Describe basic telecommunication network and its system
CO2: Illustrate the understanding of various network components
CO3: Demonstrate understanding of mobile networks
CO4: Explain the addressing in communication networks

Course Topics:

Unit 1: Networks

Basic Telephony – Telephone network and its working – Other forms of telephone networks – Interconnection of networks – The Internet – Access to the Internet – Networks associated with PSTN

Unit 2: Network Components

Network topologies – Concentrator switching, Route switching, Packet switching and routing – Multiplexing – Grooming – Consolidating – Link Component

Unit 3: Mobile Networks

Characteristics – Cellular networks and access mechanisms – GSM System – GPRS – 3G Mobile Systems – Fixed Mobile Convergence

Unit 4: Network Numbering and Addressing

Numbering and addressing in telephone networks – Data numbering and addressing – IP Numbering and addressing

Unit 5: Telecommunication Network Systems

Architecture – Quality of Service and Network Performance – Operations – Network Evolution – Next Generation Network

Textbook(s):

1. Andy Valdar, Understanding Telecommunication Networks, The Institution of Engineering and Technology (IET, UK), 2006

ECE18R446 GPS FUNDAMENTALS

ECE18R446 GPS Fundamentals				
	L	T	P	C
	3	0	0	3
Pre-requisite: ---	**Course Type:** Open Elective – Theory			

Course Outcome(s):

CO1: Describe the various navigation satellite systems like GPS, GALILEO, GLONASS in terms of constellation and services

CO2: Describe coordinate systems and locating position in navigational satellite systems

Course Topics:

Unit 1: GPS (GNSS) Basics

The Evolution, Development of NAVSTAR GPS, Block I, Block II satellites, GPS working principle, Trilateration, Determination of satellites location, Determining the receiver position in 2D and 3D Plane, Ionospheric effects of GPS signals, GPS - GIS Integration

Unit 2: Other Navigation Systems: GALILEO

GALILEO: Modulation schemes, Galileo and GPS Signal interoperability

Unit 3: Other Navigation Systems: GLONASS

GLONASS: GLONASS constellation details, Comparison of 3 GNSS (GPS, GALILEO, GLONASS) in terms of constellation and services

Unit 4: GPS Satellite constellation and Signals

GPS system segments, Space segment, Control segment, User segment, GPS Signals, Pseudorandom noise (PRN) code, C/A code, P code Navigation data, Signal structure of GPS

Unit 5: Coordinate Systems

Geoid, Ellipsoid, Coordinate Systems, Geodetic and Geo centric coordinate systems, ECEF coordinates, Datums, world geodetic 1984 (WGS 84), Conversion between Cartesian and geodetic coordinate frame, Extract GPS Coordinates for a Google Maps Location

Textbook(s):

1. G.S. Rao, Global Navigation Satellite Systems: With Essentials of Satellite Communications, McGraw Hill, 2010

ECE18R447 VLSI FABRICATION

ECE18R447 VLSI Fabrication				
	L	T	P	C
	3	0	0	3
Pre-requisite: ---	**Course Type:** Open Elective **Course Category:** Theory			

Course Outcome(s):

CO1: Explain the process of crystal growth, wafer preparation in VLSI fabrication
CO2: Explain various lithography techniques and concepts of wafer exposure system in IC fabrication
CO3: Describe the various stages in IC manufacturing like Oxidation, Epitaxy growth, Ion implantation

Course Topics:

Unit 1: Crystal Growth, Wafer Preparation

Electronic Grade Silicon, Czochralski crystal growing, Silicon Shaping

Unit 2: Epitaxy, Oxidation

Vapor Phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation, Thin Oxides, Oxidation Techniques and Systems, Oxide properties, Oxidation of Poly Silicon, Oxidation inducted Defects

Unit 3: Lithography, Plasma Etching

Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, etch mechanism, Relative Plasma Etching

Unit 4: Deposition, Diffusion

Deposition process, Polysilicon, plasma assisted Deposition, film deposition, Models of Diffusion in Solids

Unit 5: Ion Implantation, Metallisation

Implant equipment – High energy implantation – Physical vapours Deposition – Patterning – Metallisation - Packaging

Textbook(s):

1. Gouranga Bose, IC Fabrication Technology, McGraw Hill, 2014
2. S. M. Sze, VLSI Technology, McGraw Hill, 2010
3. James D Plummer, Michael D. Deal, Peter B. Griffin, Silicon VLSI Technology: Fundamentals Practice and Modeling, PHI/ Pearson, 2009

B.Tech. Electronics and Communication Engineering

Curriculum and Syllabus

(Approved in Board of Studies Meeting held on 8th Aug, 2020)