B. Tech.

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM AND SYLLABI OF COURSES

(I to VIII Semesters)

(Applicable to 2017 admission onwards)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

CALICUT 673601

KERALA, INDIA

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Vision

The Department of Electronics and Communication Engineering is envisioned to be a leading centre of higher learning with academic excellence in the field of electronics and communication engineering.

Mission

The mission of the Department of Electronics and Communication Engineering is to impart high quality technical education by offering undergraduate, graduate and research programs in the domain of electronics and communication engineering with thorough foundation in theory, along with strong hands-on design and laboratory components, tools and skills necessary for the students to become successful major contributors to society and profession.

The Program Educational Objectives (PEOs) of B. Tech. in ELECTRONICS AND COMMUNICATION ENGINEERING

PEO1	Provide solid foundations in mathematical and engineering fundamentals required to solve engineering problems so that the graduates are able to apply their understanding of science and engineering principles creatively to solve problems arising in whatever career path they choose, particularly in the domain of electronics and communication engineering.
PEO2	Make the graduates responsible and sensitive to social, environmental and economic issues in their profession and inculcate the sense of ethics and professionalism in their approach.
PEO3	Make the graduates capable to work in groups, lead teams engaged in system design and communicate their ideas clearly and precisely, both orally and in writing.
PEO4	Engage in lifelong learning of electronics and communication engineering and allied fields and face the challenges of the dynamic world by improving their skills through continuous learning.

The Programme Outcomes (POs) of B. Tech. in ELECTRONICS AND COMMUNICATION ENGINEERING

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**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.
PO4	**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.
PO5	**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.
PO6	**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.
PO7	**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.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**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.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The Programme Specific Outcomes (PSOs) of B. Tech. in ELECTRONICS AND COMMUNICATION ENGINEERING

PSO1	**Product development**: Identify, formulate, and analyze real life problems that are solvable using techniques in electronics and communication engineering and develop innovative, reliable, economic and eco-friendly solutions to such problems.
PSO2	**Research aptitude**: Research on the current problems and advance the knowledge further in the fields of semiconductor devices and circuits, signal processing, telecommunication, data science etc. using scientific knowledge acquired from the programme and state of the art software and hardware tools available.

CURRICULUM

The minimum credits for completing the B. Tech. programme in Electronics and Communication Engineering is **160**

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES

The structure of B.Tech.programmes shall have the following course categories:

Sl. No.	COURSE CATEGORY	Number of Courses	Credits
1.	Mathematics (MA)	4	12
2.	Science (BS)	5	10
3.	Humanities (HL)	3	9
4.	Basic Engineering(BE)	6	15
5.	Professional Core (PC)	27	81
6.	Open Electives (OE)	2	6
7.	Departmental Electives (DE)	7	21
8.	Other Courses (OT)	4	6
	TOTAL	58	160

COURSE REQUIREMENTS

1. MATHEMATICS (MA)

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	MA1001D	Mathematics I	3	1	0	3
2.	MA1002D	Mathematics II	3	1	0	3
3.	MA2001D	Mathematics III	3	1	0	3
4.	MA2002D	Mathematics IV *	3	1	0	3
		Total	12	4	0	12

* Mathematics IV will be branch specific.

2. SCIENCE (BS)

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	PH1001D	Physics	3	0	0	3
2.	PH1091D	Physics Lab	0	0	2	1
3.	CY1001D	Chemistry	3	0	0	3
4.	CY1094D	Chemistry Lab	0	0	2	1
5.	BT1001D	Introduction to Life Science	2	0	0	2
		Total	8	0	4	10

3. HUMANITIES (HL)

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	MS1001D	Professional Communication	3	0	0	3
2.	MS3001D	Engineering Economics	3	0	0	3
3.	ME3104D	Principles of Management	3	0	0	3
		Total	9	0	0	9

4. **BASIC ENGINEERING (BE)**

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	ZZ1001D	Engineering Mechanics	3	0	0	3
2.	ZZ1002D	Engineering Graphics	2	0	2	3
3.	ZZ1003D	Basic Electrical Sciences	3	0	0	3
4.	ZZ1004D	Computer Programming	2	0	0	2
5.	ZZ1091D	Workshop I	0	0	3	2
6.	ZZ1092D	Workshop II	0	0	3	2
		Total	10	0	8	15

5. **OTHER COURSES (OT)**

Sl.No.	Course Code	Course Title	L	T	P	Credits
1.	ZZ1093D	Physical Education	0	0	2	1
2.	ZZ1094D	Value Education	0	0	2	1
3.	ZZ1095D	NSS	0	0	2	1
4.	EC3014D	Environmental Studies for Electronics Engineers	3	0	0	3
		Total	3	0	6	6

6. **PROFESSIONAL CORE (PC)**

Sl.No.	Course Code	Course Title	Pre-requisites	L	T	P	Credits
1.	EC2011D	Electric Circuits and Network Theory	Nil	3	1	0	3
2.	EC2012D	Digital Circuits and Systems	Nil	3	1	0	3

3.	EC2013D	Solid State Devices	Nil	4	0	0	4
4.	EC2014D	Signals and Systems	Nil	4	0	0	4
5.	EC2021D	Electronic Circuits I	EC2011D & EC2013D	4	0	0	4
6.	EC2022D	Electromagnetic Field Theory	Nil	4	0	0	4
7.	EC2023D	Microprocessors and Microcontrollers	EC2012D	3	0	0	3
8.	EC2024D	Communication Theory and Systems I	EC2014D	4	0	0	4
9.	EC3011D	Electronic Circuits II	EC2021D	3	0	0	3
10.	EC3012D	Communication Theory and Systems II	EC2024D	4	0	0	4
11.	EC3013D	Digital Signal Processing	EC2014D	3	0	0	3
12.	EC3021D	Information Theory and Coding	EC3012D	4	0	0	4
13.	EC3022D	Computer Networks	EC2024D	3	0	0	3
14.	EC3023D	Control Systems	EC2014D	3	0	0	3
15.	EC4011D	Wireless Communication	EC3012D	3	0	0	3
16.	EC4012D	Radiation and Antenna Theory	EC2022D	3	0	0	3
17.	EC2091D	Devices and Networks Lab	Nil	0	0	3	2
18.	EC2092D	Digital Circuits and Systems Lab	Nil	0	0	3	2
19.	EC2093D	Electronic Circuits Lab I	Nil	0	0	3	2
20.	EC2094D	Microprocessors and Microcontrollers Lab	Nil	0	0	3	2
21.	EC3091D	Electronic Circuits Lab II	Nil	0	0	3	2
22.	EC3092D	Communication Engineering Lab I	EC2024D	0	0	3	2
23.	EC3093D	Digital Signal Processing Lab	EC3013D	0	0	3	2

24.	EC4091D	Communication Engineering Lab II	EC3021D & EC3022D	0	0	3	2
25.	EC4092D	Seminar	Nil	0	0	3	2
26.	EC4098D	Project: Part I	Nil	0	0	6	3
27.	EC4099D	Project: Part II	EC4098D	0	0	10	5
			Total	55	2	43	81

7. **DEPARTMENTAL ELECTIVES (DE)**

Seven elective courses are to be credited as Departmental Electives from the list given below for B.Tech. programme in Electronics and Communication Engineering. Some of the departmental elective courses will also be offered as **open electives**.

Sl.No.	Course Code	Course Title	Pre-requisites	L	T	P	Credits
1.	EC3051D	Data Structures using C++	Nil	3	0	0	3
2.	EC3052D	Microelectronics Technology	EC2013D	3	0	0	3
3.	EC3053D	Semiconductor Device Modelling	EC2013D	3	0	0	3
4.	EC3054D	Compound Semiconductor Devices	EC2013D	3	0	0	3
5.	EC3055D	Power Semiconductor Devices	EC2013D	3	0	0	3
6.	EC3056D	MEMS	Nil	3	0	0	3
7.	EC3057D	Modelling and Testing of Digital Systems	EC2012D	3	0	0	3
8.	EC3058D	VLSI Circuits and Systems	EC2012D	3	0	0	3
9.	EC3059D	Active Network Synthesis	EC3011D	3	0	0	3
10.	EC3060D	Computer Organization and Architecture	EC2012D	3	0	0	3

11.	EC3061D	Embedded Systems	EC2023D	3	0	0	3
12.	EC3062D	Electronic Instrumentation	Nil	3	0	0	3
13.	EC3063D	Multi Rate Systems	EC3013D	3	0	0	3
14.	EC3064D	Digital Image Processing	EC3013D	3	0	0	3
15.	EC3065D	Statistical Signal Modelling and Processing	EC2014D	3	0	0	3
16.	EC4051D	Microwave Communication	EC2022D	3	0	0	3
17.	EC4052D	Radar Engineering	EC2022D	3	0	0	3
18.	EC4053D	Opto-electronic Communication Systems	EC2022D	3	0	0	3
19.	EC4054D	Communication Switching Systems	EC3022D	3	0	0	3
20.	EC4055D	Signal Estimation and Detection	EC2024D	3	0	0	3
21.	EC4056D	Multicarrier and MIMO Techniques	EC3012D	3	0	0	3
22.	EC4057D	Wireless Technologies and Systems	Nil	3	0	0	3
23.	EC4058D	Speech and Audio Processing	EC3013D	3	0	0	3
24.	EC4059D	Signal Compression	EC3021D	3	0	0	3
25.	EC4060D	Multimedia Systems and Applications	EC2014D	3	0	0	3
26.	EC4061D	Biomedical Signal Processing	EC3013D	3	0	0	3
27.	EC4062D	Wavelet Theory	EC3013D	3	0	0	3
28.	EC4063D	Compressed Sampling: Principles and Algorithms	EC3013D	3	0	0	3
29.	EC4064D	Cryptography: Theory and Practice	Nil	3	0	0	3

30.	EC4065D	Radio Frequency Circuits	EC2021D & EC2022D	3	0	0	3
31.	EC4066D	Nanoelectronics		3	0	0	3
32.	EC4067D	Solid State Image Sensors	EC2013D	3	0	0	3
33.	EC4068D	Analog MOS Integrated Circuits	EC3011D	3	0	0	3
34.	EC4069D	Advanced VLSI Circuits	EC2012D	3	0	0	3
35.	EC4070D	Internet of Things	Nil	3	0	0	3
36.	EC4071D	Architecture of Advanced Processors	EC2023D	3	0	0	3
37.	EC4072D	Architectures for Digital Signal Processing	EC3013D	3	0	0	3
38.	EC4073D	Optimization Techniques	Nil	3	0	0	3
39.	EC4074D	Computer Vision: Algorithms and Applications	Nil	3	0	0	3
40.	EC4075D	Digital Video Processing	EC3013D	3	0	0	3
41.	EC4076D	Pattern Classification		3	0	0	3
42.	EC3066D	Artificial Intelligence: Theory And Practice	EC3051D	3	0	0	3
43.	EC4077D	CAD of High Frequency Circuits	EC2021D, EC2022D	3	0	0	3

8. OPEN ELECTIVES (OE)

Two elective courses are to be credited as Open Elective courses. One of the open electives shall be on any foreign language. [Any elective course offered by the same Department/Centre or any Core/ Elective course offered by other Departments/Centres is termed as Open Elective.]

Course Structure

Semester I

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MA1001D	Mathematics I	3	1	0	3	MA
2	PH1001D/CY1001D	Physics/Chemistry	3	0	0	3	BS
3	MS1001D/ ZZ1003D	Professional Communication/ Basic Electrical Sciences	3	0	0	3	HL/BE
4	ZZ1001D/ ZZ1002D	Engineering Mechanics/ Engineering Graphics	3/2	0	0/2	3	BE
5	ZZ1004D/BT1001D	Computer Programming / Introduction to Life Science	2	0	0	2	BE/BS
6	PH1091D/CY1094D	Physics Lab/ Chemistry Lab	0	0	2	1	BS
7	ZZ1091D/ ZZ1092D	Workshop I/Workshop II	0	0	3	2	BE
8	ZZ1093D/ZZ1094D/ ZZ1095D	Physical Education /Value Education/ NSS	-	-	-	3*	OT
	Total Credits		14/13	1	5/7	17+3*	

*Note: Three courses of 1 credit each has to be credited within the first four semesters.

Semester II

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MA1002D	Mathematics II	3	1	0	3	MA
2	CY1001D/PH1001D	Chemistry/ Physics	3	0	0	3	BS
3	ZZ1003D/MS1001D	Basic Electrical Sciences/ Professional Communication	3	0	0	3	BE/HL
4	ZZ1002D/ ZZ1001D	Engineering Graphics/ Engineering Mechanics	2/3	0	2/0	3	BE
5	BT1001D/ ZZ1004D	Introduction to Life Science./Computer Programming	2	0	0	2	BS/BE
6	CY1094D/PH1091D	Chemistry Lab / Physics Lab	0	0	2	1	BS
7	ZZ1092D/ ZZ1091D	Workshop II/ Workshop I	0	0	3	2	BE
	Total Credits		13/14	1	7/5	17	

Semester III

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MA2001D	Mathematics III	3	1	0	3	MA
2	EC2011D	Electric Circuits and Network Theory	3	1	0	3	PC
3	EC2012D	Digital Circuits and Systems	3	1	0	3	PC
4	EC2013D	Solid State Devices	4	0	0	4	PC
5	EC2014D	Signals and Systems	4	0	0	4	PC
6	EC2091D	Devices and Networks Lab	0	0	3	2	PC
7	EC2092D	Digital Circuits and Systems Lab	0	0	3	2	PC
	Total Credits		17	3	6	21	

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MA2002D	Mathematics IV	3	1	0	3	MA
2	EC2021D	Electronic Circuits I	4	0	0	4	PC
3	EC2022D	Electromagnetic Field Theory	4	0	0	4	PC
4	EC2023D	Microprocessors and Microcontrollers	3	0	0	3	PC
5	EC2024D	Communication Theory and Systems I	4	0	0	4	PC
6	EC2093D	Electronic Circuits Lab I	0	0	3	2	PC
7	EC2094D	Microprocessors and Microcontrollers Lab	0	0	3	2	PC
	Total Credits		18	1	6	22	

Semester V

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MS3001D	Engineering Economics	3	0	0	3	HL
2	EC3011D	Electronic Circuits II	3	0	0	3	PC
3	EC3012D	Communication Theory and Systems II	4	0	0	4	PC
4	EC3013D	Digital Signal Processing	3	0	0	3	PC
5	EC3014D	Environmental Studies for Electronics Engineers	3	0	0	3	OT
6		Elective I	3	0	0	3	DE/OE
7	EC3091D	Electronic Circuits Lab II	0	0	3	2	PC
8	EC3092D	Communication Engineering Lab I	0	0	3	2	PC
	Total Credits		19	0	6	23	

Semester VI

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	ME3104D	Principles of Management	3	0	0	3	HL
2	EC3021D	Information Theory and Coding	4	0	0	4	PC
3	EC3022D	Computer Networks	3	0	0	3	PC
4	EC3023D	Control Systems	3	0	0	3	PC
5		Elective II	3	0	0	3	DE/OE
6		Elective III	3	0	0	3	DE/OE
7	EC3093D	Digital Signal Processing Lab	0	0	3	2	PC
	Total Credits		19	0	3	21	

Semester VII

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	EC4011D	Wireless Communication	3	0	0	3	PC
2	EC4012D	Radiation and Antenna Theory	3	0	0	3	PC
3		Elective IV	3	0	0	3	DE/OE
4		Elective V	3	0	0	3	DE/OE
5		Elective VI	3	0	0	3	DE/OE
6	EC4091D	Communication Engineering Lab II	0	0	3	2	PC
7	EC4092D	Seminar	0	0	3	2	PC
8	EC4098D	Project : Part I	0	0	6	3	PC
	Total Credits		15	0	12	22	

Semester VIII

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	EC4099D	Project : Part II	0	0	10	5	PC
2		Elective VII	3	0	0	3	DE/OE
3		Elective VIII	3	0	0	3	DE/OE
4		Elective IX	3	0	0	3	DE/OE
	Total Credits		9	0	10	14	

Notes:

1. For the successful completion of B.Tech programme, a student must complete the minimum number of courses of each category specified in the curriculum of the specific programme. In addition to the above, the student must have acquired a total of 160 credits.
2. A student who completes all the course requirements (except the project) before the final semester may be permitted to undertake project at an institute/industry outside with the consent of the department.

MA1001D MATHEMATICS I

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

CO1: Find the limits, check for the continuity and differentiability of functions of a single variable as well as several variables.

CO2: Test for the convergence of sequences and series of numbers as well as functions.

CO3: Formulate different mensuration problems as multiple integrals and evaluate them.

CO4: Use techniques in vector differential calculus to solve problems related to curvature, surface normal and directional derivative.

CO5: Find the parametric representation of curves and surfaces in space and will be able to evaluate the integral of functions over curves and surfaces.

Module 1: (13 hours)

Real valued function of real variable: Limit, Continuity, Differentiability, Local maxima and local minima, Curve sketching, Mean value theorems, Higher order derivatives, Taylor's theorem, Integration, Area under the curve, Improper integrals.
Function of several variables: Limit, Continuity, Partial derivatives, Partial differentiation of composite functions, Differentiation under the integral sign, Local maxima and local minima, Saddle point, Taylor's theorem, Hessian, Method of Lagrange multipliers.

Module 2: (13 hours)

Numerical sequences, Cauchy sequence, Convergence, Numerical series, Convergence, Tests for convergence, Absolute convergence, Sequence and series of functions, point-wise and uniform convergence, Power series, Radius of convergence, Taylor series.
Double integral, Triple integral, Change of variables, Jacobian, Polar coordinates, Applications of multiple integrals.

Module 3: (13 hours)

Parameterised curves in space, Arc length, Tangent and normal vectors, Curvature and torsion, Line integral, Gradient, Directional derivatives, Tangent plane and normal vector, Vector field, Divergence, Curl, Related identities, Scalar potential, Parameterised surface, Surface integral, Applications of surface integral, Integral theorems: Green's Theorem, Stokes' theorem, Gauss' divergence theorem, Applications of vector integrals.

References:

1. H. Anton, I. BivensandS. Davis, Calculus, 10th edition, New York: John Wiley & Sons, 2015.
2. G. B. Thomas, M.D. WeirandJ. Hass, Thomas' Calculus, 12th edition, New Delhi, India: Pearson Education, 2015.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, New York: John Wiley & Sons, 2015.
4. Apostol, CalculusVol 1, 1st ed. New Delhi: Wiley, 2014

MA1002D MATHEMATICS II

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes

CO1: Test the consistency of system of linear equations and then solve it.

CO2: Test for linear independence of vectors and perform orthogonalisation of basis vectors.

CO3: Diagonalise symmetric matrices and use it to find the nature of quadratic forms.

CO4: Formulate some engineering problems as ODEs and hence solve them.

CO5: Use Laplace transform and its properties to solve differential equations and integral equations.

Module 1: (16 hours)

System of Linear equations, Gauss elimination, Solution by LU decomposition, Determinant, Rank of a matrix, Linear independence, Consistency of linear system, General form of solution.

Vector spaces, Subspaces, Basis and dimension, Linear transformation, Rank-nullity theorem, Inner-product, Orthogonal set, Gram-Schmidt orthogonalisation, Matrix representation of linear transformation, Basis changing rule.

Types of matrices and their properties, Eigenvalue, Eigenvector, Eigenvalue problems, Cayley-Hamiltonian theorem and its applications, Similarity of matrices, Diagonalisation, Quadratic form, Reduction to canonical form.

Module 2: (13 hours)

Ordinary Differential Equations (ODE): Formation of ODE, Existence and uniqueness solution of first order ODE using examples, Methods of solutions of first order ODE, Applications of first order ODE.

Linear ODE: Homogenous equations, Fundamental system of solutions, Wronskian, Solution of second order non-homogeneous ODE with constant coefficients: Method of variation of parameters, Method of undetermined coefficients, Euler-Cauchy equations, Applications to engineering problems, System of linear ODEs with constant coefficients.

Module 3: (10 hours)

Gamma function, Beta function: Properties and evaluation of integrals.

Laplace transform, Necessary condition for existence, General properties, Inverse Laplace transform, Transforms of derivatives and integrals, Differentiation and Integration of transform, Unit-step function, Shifting theorems, Transforms of periodic functions, Convolution, Solution of differential equations and integral equations using Laplace transform.

References:

1. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, New Delhi, India: Wiley, 2015.
2. G. Strang, Introduction to Linear Algebra, Wellesley MA: Cambridge Press, 2016.
3. R. P. Agarwal and D. O’Regan, An Introduction to Ordinary Differential Equations, New York: Springer, 2008.
4. V. I. Arnold, Ordinary Differential Equations, New York: Springer, 2006.
5. P. Dyke, An Introduction to Laplace Transforms and Fourier Series, New York: Springer,2014.

PH1001D PHYSICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: To enable students to apply relevant fundamental principles of modern physics to problems in engineering.

CO2: To develop knowledge of basic principles of Quantum Physics

CO3: Acquire knowledge of the basic physics of a collection of particles and the emergent macroscopic properties.

CO4: Apply principles of quantum and statistical physics to understand properties of materials

Module 1: (12 hours):

Particle nature of radiation – Photoelectric effect, Compton effect, Wave nature of matter – matter waves, wave packets description, phase and group velocity, uncertainty principle. Formulation of Schrödinger equation, physical meaning of wave function, expectation values, time-independent Schrödinger equation, quantization of energy for bound particles. Application of time-independent Schrödinger equation to free particle, infinite well, finite well, barrier potential, tunneling.

Module 2: (14 hours):

Simple Harmonic Oscillator, two-dimensional square box, the scanning tunneling microscope. Wave function for two or more particles, indistinguishable particles, symmetry and anti-symmetry under exchange of particles, Pauli's exclusion principle, electronic configurations of atoms. Quantum model of a solid – periodicity of potential and bands, E – k diagram, effective mass, band gap.

Module 3: (13 hours):

Microstates and macrostates of a system, equal probability hypothesis, Boltzman factor and distribution, ideal gas, equipartition of energy, Maxwell speed distribution, average speed, RMS speed, Quantum distributions - Bosons and Fermions, Bose-Einstein and Fermi-Dirac distribution, applications.

References:

1. Kenneth Krane, Modern Physics, 2nd Ed., Wiley (2009)
2. Arthur Beiser, Concepts of Modern Physics, 6th Ed., Tata Mc Graw –Hill Publication (2009)
3. Robert Eisberg and Robert Resnick, Quantum Physics of atoms, Molecules, Solids, Nuclei and Particle, 2nd Ed., John Wiley(2006)
4. David Halliday, Robert Resnick and Jearl Walker, Fundamentals of Physics, 6th Ed., Wiley (2004)

CY1001D CHEMISTRY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Acquire knowledge about separation strategies, identification and characterization of molecules

CO2: Understand the causes and mechanism of corrosion and understand its prevention methods

CO3: Attain knowledge about electrochemical reactions and their current applications

CO4: Comprehend the principles of industrial catalytic processes and enzyme catalysis

Module 1: (14 hours)

Spectroscopy – General Principles, Infrared, group frequencies, Electronic spectroscopy of conjugated molecules, Woodward-Fieser Rule.
Chromatography – Retention and Separation factors, Theoretical plates, Instrumentation and uses of Gas Chromatography and High Performance Liquid Chromatography
Thermal analysis – Thermogravimetry, Differential Scanning Calorimetry and Differential Thermal Analysis

Module 2: (12 hours)

Electrochemical corrosion – Mechanisms, control and prevention.
Cyclic voltammetry, Switching potentials, Cathodic and anodic peak currents Potentiometry, Fuel cells – Types and applications
Liquid crystals – Phase types, uses in displays and thermography.

Module 3: (13 hours)

Catalysis – Homogeneous and heterogeneous catalysis, Organometallic compounds, 18-electron rule, Oxidative addition, Reductive elimination, insertion and Elimination reactions, Wilkinson's catalyst in alkene hydrogenation, Zeigler-Natta catalysis in polymerization of olefins.
Enzyme catalysis – Mechanisms, significance of Michaelis – Menten constant, Turnover number, Co-enzymes and cofactors

References:

1. C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th edition, Tata McGraw Hill, New Delhi, 2010.
2. D. A. Skoog and D. M. West, F. J. Holler and S. R. Crouch, *Fundamentals of Analytical Chemistry*, BrooksCole, Florence, 2004.
3. H. H. Williard, L. L. Merrit, J. A. Dean and F. A. Settle, *Instrumental Methods of Analysis*, Wadsworth Publishing Company, Belmont, California, 1986.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry,*Vishal Publishing, New Delhi,2000.
5. J. E. Huheey, E.A. Keiter and R.L. Keiter, *Inorganic Chemistry, Principles of Structure and Reactivity*, 4th Ed, Harper Collins College Publishers, New York, 1993.
6. C. Elschenbroich, *Organometallics*, 3rd edition, Wiley-VCH Verlag GmbH, Weinheim, 2006.

MS1001D PROFESSIONAL COMMUNICATION

Pre-requisites: Nil
.

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes

CO1: Distinguish the different types of meaning for constructive criticism, by developing a comprehensive understanding of the extensive vocabulary and usage in formal English language.

CO2: Learn and practice principles related to good formal writing.

CO3: Develop competence in group activities such as group discussions, debates, mock interviews, etc. by practicing the integration of unique qualities of nonverbal and verbal styles.

CO4: Deliver clear and effective presentation of ideas in the oral / written medium and to acquire the ability to modify it according to the target audience.

Module 1: (12 hours)

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations.

Module 2: (15 hours)

Fundamental grammar, Simple structures, passivizing the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open –ended and close- ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing and good netiquette. Writing for internships and scholarships.

Module 3: (12 hours)

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming and activities on the same. Different types of interviews, and presentation- oral, poster, ppt. Organizing ideas for group discussions, the difference between GD and debates.

References:

1. Duck, Steve and David T. Macmahan. *Communication in Everyday Life*. 3rd Ed. Sage, 2017.
2. Quintanilla, Kelly M. and Shawn T. Wahl. *Business and Professional Communication*. Sage, 2016.
3. Gamble, Kawl Teri and Michael W. Gamble. *The Public Speaking Playbook*. Sage, 2015.
4. Tebeaux, Elizabeth and Sam Dragga. *The Essentials of Technical Communication*, 3rd Ed. OUP, 2015
5. Raman, Meenakshi and Sangeetha Sharma. *Technical Communication: Principles and Practice*, OUP, 2015
6. MacLennan, Jennifer. *Readings for Technical Communication*. OUP, 2007.

ZZ1001D ENGINEERING MECHANICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Determine the resultants of a force system

CO2: Solve rigid body statics problems using equations of equilibrium and principle of virtual work

CO3: Perform kinematic analysis of a particle

CO4: Solve particle dynamics problems using Newton's laws, energy methods and momentum methods

Module 1: Basic Concepts (13 hours)

Introduction: idealizations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics, elements of vector algebra.

Important vector quantities: position vector, moment of a force about a point, moment of a force about an axis, the couple and couple moment, couple moment as a free vector, moment of a couple about a line.

Equivalent force systems: translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems, distributed force systems, reduction of general force system to a wrench.

Module 2: Statics (13 hours)

Equations of equilibrium: free-body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy.

Applications of equations of equilibrium: Trusses: solution of simple trusses using method of joints and method of sections; Friction forces: laws of Coulomb friction, simple contact friction problems; Cables and chains.

Properties of surfaces: first moment and centroid of plane area, second moments and product of area for a plane area, transfer theorems, rotation of axes, polar moment of area, principal axes.

Method of virtual work: principles of virtual work for rigid bodies and its applications.

Module 3: Dynamics (13 hours)

Kinematics of a particle: introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations in rectangular coordinates, velocity and acceleration in terms of path variables and cylindrical coordinates, simple kinematical relations and applications.

Dynamics of a particle: introduction, Newton’s law for rectangular coordinates, rectilinear translation, Newton’s law for cylindrical coordinates, Newton’s law for path variables, energy and momentum methods: introduction, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, impulse and momentum relations, moment-of-momentum equation.

References:

1. I. H. Shames, *Engineering Mechanics—Statics and Dynamics*, 4th Edition, Prentice Hall of India, 1996.
2. F.P. Beer and E.R. Johnston, *Vector Mechanics for Engineers – Statics,* McGraw Hill Book Company, 2000.
3. J.L. Meriam and L.G. Kraige, *Engineering Mechanics – Statics*, John Wiley & Sons, 2002.
4. R.C Hibbler, Engineering Mechanics—Statics and Dynamics, 11th Edition, Pearson, India, 2009

ZZ1002D ENGINEERING GRAPHICS

Pre-requisites: Nil

L	T	P	C
2	0	2	3

Total hours: 52

Course Outcomes:

CO1: Make use of the Indian Standard Code of Practice in Engineering Drawing.

CO2: Represent any engineering object by its orthographic views.

CO3: Convert orthographic viewsof an engineering object into its isometric view.

CO4:Enhance the capacity of visualization of engineering objects.

Module 1: (15 hours)

Introduction; drawing instruments and their uses; lines, lettering and dimensioning; geometrical construction; constructions of plain, diagonal and vernier scales; orthographic projection—first and third angle projections; orthographic projection of points on principal, profile, and auxiliary planes.

Module 2: (17 hours)

Orthographic projection of straight line in simple and oblique positions; application of orthographic projection of line; orthographic projection of planes in simple and oblique position on principal and profile planes; orthographic projection of lines and planes on auxiliary planes.

Module 3: (20 hours)

Orthographic projection of solids in simple and oblique positions on principal and profile planes; orthographic projections of solids in oblique position using auxiliary plane method; orthographic projection of spheres; orthographic projection of solids in section; development of surfaces of solids; method of isometric projection.

References:

1. N. D. Bhatt, Engineering Drawing, 53rd ed. Anand, India: Charotar Publishing House, 2016.
2. Basant Agrawal and C M Agrawal, Engineering Drawing, 2nd ed. New Delhi, India: McGraw Hill Education (India), 2014.

ZZ1003D BASIC ELECTRICAL SCIENCES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Design simple resistive circuits for various applications in Electrical and Electronics engineering.
CO2: Design simple magnetic circuits and inductive components for signal and power processing.
CO3: Carry out design verification calculations, power and power loss calculations, voltage drop calculations etc.
in single phase ac circuits.
CO4: Analyze Amplifiers and Digital Circuits in terms of critical parameters and complexity.
CO5: Design sub modules for systems/ Solutions for real life problems using suitable sensors /transducers, amplifiers, data converters and digital circuits.

Module 1: (11 hours)

Analysis of Resistive Circuits:
v-i relationship for Independent Voltage and Current Sources
Solution of resistive circuits with independent sources- Node Voltage and Mesh Current Analysis, Nodal Conductance Matrix and Mesh Resistance Matrix and symmetry properties of these matrices
Source Transformation and Star-Delta / Delta-Star Conversions to reduce resistive networks
Circuit Theorems - Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.
Magnetic Circuits:
MMF, Magnetic Flux, Reluctance, Energy stored in a Magnetic Field, Solution of Magnetic Circuits.
Two Terminal Element Relationships:
Inductance - Faraday's Law of Electromagnetic Induction, Lenz's Law, Self and Mutual Inductance, Inductances in Series and Parallel, Mutual Flux and Leakage Flux, Coefficient of Coupling, Dot Convention, Cumulative and Differential Connection of Coupled Coils.
Capacitance – Electrostatics, Capacitance, Parallel Plate Capacitor, Capacitors in series and parallel, Energy stored in Electrostatic Field, v-i relationship for Inductance and Capacitance

Module 2: (9 hours)

Single Phase AC Circuits:
Alternating Quantities - Average Value, Effective Value, Form and Peak factors for square, triangle, trapezoidal and sinusoidal waveforms.
Phasor representation of sinusoidal quantities - phase difference, Addition and subtraction of sinusoids, Symbolic Representation: Cartesian, Polar and Exponential forms.
Analysis of a.c circuits - R, RL, RC, RLC circuits using phasor concept, Concept of impedance, admittance, conductance and susceptance.
Power in single phase circuits - instantaneous power, average power, active power, reactive power, apparent power, power factor, complex power, solution of series, parallel and series parallel a.c circuits.

Module 3 (11 hrs)

Sensors and Transducers:
principles of piezoelectric, photoelectric, thermoelectric transducers, thermistors, strain gauge, LVDT, etc, Measurement of temperature, pressure, velocity, flow, pH, liquid level, etc.
Basics of Signal Amplification:

(Explanation based on two port models is only envisaged) – voltage gain, current gain and power gain, amplifier saturation, types of amplifiers (voltage, current, transconductance and transresistance amplifiers) and relationship between these amplifier models, frequency response of amplifiers, single time constant networks.
Operational amplifier basics:
Ideal op-amp, inverting, noninverting, summing and difference amplifiers, integrator, differentiator.

Module 4 (8 hrs)

Digital Electronics:
Review of number systems and Boolean algebra, Logic Gates and Truth Tables, Simplification of Boolean functions using Karnaugh map (upto 4 variable K-maps), Implementation of Simple combinational circuits (Adder, Code Converters, 7-Segment Drivers, Comparators, Priority Encoders, etc) - MUX-based implementation of combinatorial circuits , Sequential circuits: SR,JK, T and D filpflops, counters and registers using D flip flops, Basics of data converters (at least one ADC and DAC).

References:

1. J.W. Nilsson and S.A. Riedel, *Electric Circuits*, 8th ed., Pearson, 2002
2. K.S. Suresh Kumar, *Electric Circuits & Networks*, Pearson Education, 2009
3. C. A. Desoer and E. S. Kuh, *Basic Circuit Theory*, McGraw Hill, 2009
4. J. A. Edminister, *Electric Circuit Theory*, Schaum's Outline series: 6th ed., McGraw Hill, 2014
5. A. D.Helfrick and W. D.Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India, 2003
6. A. S. Sedra and K. C. Smith, *Microelectronics*, 6thed.,Oxford University Press, 2013
7. C.H. Roth and L. L. Kinney, *Fundamentals of Logic Design*,7thed., Cengage Learning,2014

ZZ1004D COMPUTER PROGRAMMING

Pre-requisites: Nil.

L	T	P	C
2	0	0	2

Total hours: 26

Course Outcomes:

CO1: Design of algorithms for simple computational problems.

CO2: Express algorithmic solutions in the C programming language.

Module 1: (10 hours)
Data Types, Operators and Expressions: Variables and constants - declarations - arithmetic and logical operators – Assignment operator – Input/Output.
Control Flow: Statements and blocks – if-else, switch, while, for and do-whilestatements – break and continue – goto and labels.

Module 2: (08 hours)
Functions and Program structure: Basics of functions, Parameter passing – scope rules – recursion.

Module 3: (08 hours)
Aggregate data types: Single and multidimensional arrays, structures and unions – Pointers to arrays and structures – passing arrays and pointers as arguments to functions.

References:

1. B.S. Gottfried, *Programming with C (Schaum's Outline Series)*, 2nd ed. McGraw-Hill,1996.
2. B. W. Kernighan and D. M. Ritchie, *The C Programming Language*, 2nd ed. Prentice Hall, 1988.
3. W. Kernighan, *The Practice of Programming*, Addison-Wesley, 1999.

BT1001D INTRODUCTION TO LIFE SCIENCE

Pre-requisites: Nil

L	T	P	C
2	0	0	2

Total hours: 26

Course Outcomes:

CO1: Comprehend the chemical and molecular basis of life.

CO2: Summarize about the basic molecules of life- proteins, lipids, DNA, and RNA

CO3: Develop idea about cell, its structure, functions and significance of compartmentalization

CO4: Students will describe the concepts in ecology and biodiversity and its impact on global change

Module 1: (09 hours)

Origin and evolution of life, Biogenesis and Louis Pasteur, Oparin-Haldane hypothesis, Darwin's view on natural selection.unity and diversity of life, Chemistry of life, introduction to structure and function of the biological macromolecules like carbohydrates, proteins, lipids, DNA and RNA

Module 2: (09 hours)

Prokaryotic and eukaryotic cells,structure and organization of cells, intracellular compartmentalization, functions of various organelles. Extracellular components and cell-cell communication,overview of Mitosis and Meiosis,basic concepts in energy transformation and photosynthesis.

Module 3: (08 hours)

Principles of Mendelian inheritance and chromosomal basis of heredity, linked genes, genetic disorder.Ecosystems and restoration ecology, energy flow, chemical and nutrient cycling, primary production in ecosystems, conservation of biodiversity.

References:

1. L. A. Urry, M. L. Cain, S. A. Wasserman, P. V. Minorsky, and J. B. Reece, *Campbell Biology*, 11thEdn.Pearson 2017
2. D. L. Nelson, and M. M. Cox, *Lehninger Principles of Biochemistry*, 4thEdn, WH Freeman and Company, 2005.
3. C. Starr, C. Evers, L. Starr, *Biochemistry, Biology: Concepts and Applications*, 10thEdn, 2017.
4. J.M. Berg, J.L. Tymoczko, and L. Stryer, *Biochemistry*, 6thEdn., WH Freeman and Company, 2007.
5. H. Lodish, A. Berk, C. A. Kaiser, and M. Krieger, *Molecular Cell Biology*, 6thEdn.,W. H. Freeman, 2007.

PH1091D PHYSICS LAB

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 26

Course Outcomes:

CO1: Develop experimentation skills and understand importance of measurement practices in Science & Technology.

CO2: Develop analytical skills for interpreting data and drawing inferences.

CO3: Estimate the nature of experimental errors and practical means to obtain errors in acquired data.

CO4: Develop skills for team work and technical communication and discussions.

CO5: Apply theoretical principles of modern physics to analysis and measurements performed in the laboratory.

LIST OF EXPERIMENTS

1. Magnetic Hysteresis loss - Using CRO
2. Band gap using four probe method
3. Hall effect- determination of carrier density, Hall coefficient and mobility
4. Solar cell characteristics
5. Double refraction – measurement of principle refractive indices.
6. Measurement of N.A & Attenuation
7. Measurement of e/m of electron – Thomson's experiment
8. Determination of Planck's constant
9. Measurement of electron charge – Millikan oil drop experiment
10. Determination of magnetic field along the axis of the coil
11. Newton's rings
12. Laurent's Half shade polarimeter –determination of specific rotatory power
13. Study of P-N junction
14. Study of voltage-current characteristics of a Zener diode.
15. Laser – measurement of angle of divergence & determination of λ using grating
16. Measurement of magnetic susceptibility- Quincke's Method / Gouy's balance.
17. Mapping of magnetic field
18. Temperature measurement by using thermocouple

NOTE: Any 8 experiments have to be done.

References:

1. A.C. Melissinos, J. Napolitano, Experiments in Modern Physics,Academic Press (2003)
2. Avadhanulu, Dani and Pokley, Experiments in Engineering physics, S. Chand & Company ltd (2002).
3. S.L. Gupta and V. Kumar, Practical physics, Pragathi Prakash (2005)

CY1094D CHEMISTRY LAB

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 26

Course Outcomes:

CO1: Acquire practical knowledge on the separation of mixtures and their identification

CO2: Understand chirality and the specific rotation of a compound

CO3: Attain practical experience in the synthesis of new molecules

CO4: Apply different techniques to quantitatively determine the amount of components

List of Experiments:

1. Determination of specific rotation by polarimetry
2. Potentiometric titrations
3. Estimation of ions using complexometry
4. Determination of strength of an acid using pH meter
5. Analysis of organic and inorganic compounds
6. Conductometric titrations using acid or mixture of acids
7. Separation of compounds using chromatography
8. Colorimetric estimations
9. Determine the eutectic temperature and composition of a solid two component system
10. Synthesis of organic/inorganic compounds and their characterizations
11. Determination of molecular weight of polymers

Note: Selected experiments from the above list will be conducted

References:

1. G. H. Jeffery, J. Bassett, J. Mendham and R.C. Denny, *Vogel's Text Book of Quantitative Chemical Analysis*, Longmann Scientific and Technical, John Wiley, New York,1989.
2. A. I. Vogel, *Elementary Practical Organic Chemistry – Small Scale Preparations*, Pearson India, New Delhi, 2011.
3. A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hannaford and P. W. G. Smith, *Vogel's Text Book of Practical Organic Chemistr*y, Longman and Scientific Technical, New York, 1989.

ZZ1091D WORKSHOP I

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Perform experiments to ascertain the quality requirements and quality testing procedures of selected building material, viz., cement, fine aggregate, coarse aggregate, concrete, timber and steel.

CO2: Identify and evaluate various driver characteristics as driver of a vehicle.

CO3: Acquire knowledge about basic civil engineering practices of brick masonry, plumbing and surveying.

CO4: Perform wiring estimation and costing for simple building/commercial electrical wiring systems.

CO5: Use commonly employed wiring tools and lighting and wiring accessories.

CO6: Adopt electrical safety measures in using and servicing household appliances.

Civil Engineering Workshop (24 hours)

1. Introduction to Surveying – Linear measurements – Hands on session on Setting out of a small residential building.
2. Introduction to Levelling – Hands on sessions using Dumpy level – Levelling exercise.
3. Introduction to Total Station – Hands on sessions - small exercises.
4. Tests on cement and aggregates: Demonstration of standard consistency, initial and final setting time of cement - Hands on sessions - Compressive strength test on cement mortar cubes and sieve analysis for coarse and fine aggregates.
5. Tests on hardened concrete, brick, timber and steel: Demonstrations on hardness tests (Rockwell hardness), impact tests (Charpy and Izod) on steel specimens-demonstration on properties of timber – Hands on sessions - Compression test on concrete cubes, bricks and tension test on mild steel specimen.
6. Masonry: Hands on sessions - English bond, Flemish bond – wall junction – one brick – one and a half brick - Arch construction.
7. Water supply and sanitation: Study of water supply pipe fittings – tap connections – sanitary fittings
8. Various tests on Driver characteristics – Visual acuity and colour blindness, peripheral vision, depth perception, driver reaction time.

Electrical Engineering Workshop(15 hours)

1. (a) Familiarization of wiring tools, lighting and wiring accessories, various types of wiring systems.
   (b) Wiring of one lamp controlled by one switch.
2. (a) Study of Electric shock phenomenon, precautions, preventions,Earthing.
   (b) Wiring of one lamp controlled by two SPDT Switches and one 3 pin plug socket independently.
3. (a) Familiarization of various types of Fuses, MCBs, ELCBs, etc.
   (b) Wiring of fluorescent lamp controlled by one switch with ELCB & MCB.
4. (a) Study of estimation and costing of wiring.
   (b) Wiring, control and maintenance of domestic appliances like Mixer machine, Electric Iron, fan, motor, etc.

References:

1. T.P. Kanetkar, S.V. Kulkarni, *Surveying and Levelling - Part1*, Pune VidyarthiGrihaPrakashan, Pune, 1994.
2. B.C. Punmia, *Building Construction*, Laxmi Publications, New Delhi1999.
3. SatheeshGopi, R. Sathikumar, N. Madh, *Advnaced Surveying*, Pearson Education,2007.
4. M.S. Shetty, *Concrete Technology*, S. Chand & Company, New Delhi,2005.
5. K. B. Raina & S. K. Bhattacharya, *Electrical Design Estimating and costing*, New Age International Publishers, New Delhi, 2005.
6. Khanna, S. K., and Justo, C. E. G., *Highway Engineering*, Nemchand and Bros, Roorkee,2001.
7. Uppal S. L., *Electrical Wiring & Estimating*, Khanna Publishers---5th edition, 2003.
8. John H. Watt, *Terrell Croft American Electricians' Handbook: A Reference Book for the Practical Electrical Man*, 9th ed. McGraw-Hill, 2002.

ZZ1092D WORKSHOP II

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Ability to select suitable material for a given purpose applying knowledge of material properties and processing.

CO2: Ability to use measuring devices like Vernier Calipers, Micrometers, etc.

CO3: Ability to fabricate simple components using basic manufacturing processes like Casting, Forming, Joining and Machining.

CO4: Ability to sequence various operations so as to execute the task within minimum time.

CO5: Perform diagnostic measurements using analog and digital meters for troubleshooting electronic systems.

CO6: Select appropriate electronic components for a given design task and assemble the prototype on breadboard.

CO7: Troubleshoot electronic boards used in various household appliances.

CO8: Perform cost estimation and costing of PCB soldering and carry out the soldering.

Mechanical Engineering Workshop (24 hours)

The course is intended to expose the student to various manufacturing processes through hands on training in different sections of Central Workshop. During the course, the student learns the properties and selection of different materials and acquires the skill in using various tools and measuring devices.

1. Carpentry: Study of tools and joints –plaining, chiseling, marking and sawing practice, one typical joint-Tee halving/Mortise and Tenon/Dovetail
2. Fitting: Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints. Edge preparation for single V joint.
3. Welding: Study of arc and gas welding, accessories, joint preparation. Welding of a single V joint
4. Smithy: Study of tools. Forging of square or hexagonal prism/chisel/bolt
5. Foundry: Study of tool and preparation. Moulding practice using the given pattern.
6. Sheet Metal: Study of tools, selection of different gauge sheets, types of joints. Fabrication of atrayorafunnel
7. Machine Shop: Study of the basic lathe operations. Simple step turning exercise.

Electronics Engineering Workshop (15 hours)

1. (a) Familiarization of electronic components, colour code, multimeters.
   (b) Bread board assembling-Common emitter amplifier.
2. (a) Study of soldering components, solders, tools, heat sink.
   (b) Bread board assembling-phase shift oscillator.
3. (a) Soldering practice-Common emitter amplifier.
   (b) Soldering practice-Inverting amplifier circuit.
4. (a) Study of estimation and costing of soldering PCB, 3 phase connections.
   (b) PCB wiring and fault Identification of appliances like Electronic Ballast, fan regulator, inverter, UPS, etc.

References:

1. W. A. J. Chapman, Workshop Technology - Parts 1 & 2, 4th ed. New Delhi, India, CBS Publishers & Distributors Pvt. Ltd., 2007.
2. Welding Handbook. 9th ed. Miami, American Welding Society, 2001.
3. J. Anderson, Shop Theory, New Delhi, India, Tata McGraw Hill, 2002.
4. J. H. Douglass, Wood Working with Machines, Illinois, McKnight & McKnight Pub. Co., 1995.
5. W.A. Tuplin, Modern Engineering Workshop Practice, Odhams Press, 1996.
6. P. L. Jain, Principles of Foundry Technology, 5th ed. New Delhi, India, Tata McGraw Hill, 2009.
7. John H. Watt, Terrell Croft, American Electricians' Handbook: A Reference Book for the Practical Electrical Man, 9th ed. McGraw-Hill, 2002.
8. G. Randy Slone, Tab Electronics Guide to Understanding Electricity and Electronics, 2nd ed. McGraw-Hill, 2000.
9. Jerry C Whitaker, The Resource Handbook of Electronics, CRC Press-2001.

ZZ1093D PHYSICAL EDUCATION

Pre-requisites: Nil

L	T	P	C
1	0	1	1

Total hours: 26 (13 L +13 P)

Course Outcomes:

CO1: Select a game/ activity of his/ her choice to pursue on the campus to enjoy/ entertain and thereby develop good health and fitness which he/she would carry over to post-campus life for maintaining health, fitness and wellness.

CO2: Be more proficient in a game, which may lead him/her to a berth in the institute teams.

CO3: Gain exposure to professional training, so as to enable him / her to excel in sports activities.

CO4: Participate in intramural and open mass participation activities.

CO5: Participate and organise in-campus or off-campus sports activities.

UNIT – I - Introduction, definition, aims & objectives of Physical Education. Health, Physical fitness and wellness. Importance, scope and relevance of Physical Education in NITC curriculum.

UNIT – II - Physical fitness and components. Health related Physical fitness and components. Benefits of exercise – physical and physiological.

UNIT – III - Physical exercise and its principles. Activities for developing physical fitness – walking, jogging, running, weight training, stretching, yogasanas. Athletic injuries and their management. Nutritional balance.

UNIT – IV - Motivation and its importance in sports. Stress, anxiety, tension, aggression in sports. Personality, self-confidence and performance. Team cohesion and leadership in sports.

UNIT – V - Lifestyle diseases and its management, Diabetes and Obesity, Hypertension, Osteoporosis Coronary heart diseases and cholesterol. Backpain, Postural deformities and their remedies.

UNIT – VI. - Olympic Values Education. Event & Crisis management.

References

1. Najeeb, A. M., Atul, M., Sumesh, D. and Akhilesh, E. *Fitness Capsule for university curriculum*, 2015

ZZ1094D VALUE EDUCATION

Pre-requisites: Nil

L	T	P	C
1	0	1	1

Total hours: 26 (13 L +13 P)

Course Outcomes:

CO1: Identify the purpose of education and the problems faced by mankind, in terms of socio economic and environmental issues.
CO2: Describe the social and intellectual needs to transform the society to a better one where everyone meets the basic economic and social security, freedom and atmosphere to live a meaningful life.
CO3: Practise a meaningful life avoiding all kinds of corrupt practices and develop unconditional love, universal brotherhood and simulate international peace and prosperity.
CO4: Persuade others to practise a righteous life, which would stimulate a synergy of universal harmony and peace.
CO5: Create an ideal society where everyone enjoys the fruits of love, peace and harmony.

Unit I (2 hours): **Social Justice** Definition –need-parameters of social justice –factors responsible for social injustice –caste and gender –contributions of social reformers.
Unit II (3 hours)**: Human Rights and Marginalized People** Concept of Human Rights-Principles of human rights-human rights and Indian Constitution-Rights of Women and children-violence against women–Rights of marginalized People-like women, children, dalits, minorities, physically challenged etc.
Unit III (3 hours): **Social Issues and Communal Harmony** Social issues–causes and magnitude-alcoholism, drug addiction, poverty, unemployment etc.-communal harmony-concept-religion and its place in public in public domain-separation of religion from politics-secularism role of civil society.

Unit IV (3 hours): **Media Education and Globalized World Scenario** Mass media-functions-characteristics-need and purpose of media literacy-effects and influence –youth and children-media power-socio cultural and political consequences mass mediated culture-consumerist culture-Globalization-new media –prospects and challenges-Environmental ethics

Unit V (2 hours): **Values and Ethics** Personal values –family values-social values-cultural values-professional values-and overall ethics-duties and responsibilities

Project: 13 hours

References:

1. Sharma, B. K., *Human Rights Covenants and Indian Law*, PHI Learning Pvt. Ltd, 2010
2. Law Commission of India, (1971), *Indian Penal code*, (http://lawcommissionofindia.nic.in/1-50/report42.pdf), accessed on February 14, 2018.
3. Srivastava, S. S., *Central Law Agency's Indian Penal Code along with General Principles (IPC)*, Central Law Agency, 2017
4. *Gandhiji on Communal Harmony*,Mani Bhavan Gandhi Sangrahalaya', Mumbai, 2003
5. *Social Impact of Drug Abuse*, UNDCP, ((https://www.unodc.org/pdf/technical_series_1995-03-01_1.pdf, accessed on February 14, 2018).
6. Bryfonski, D., *The Global Impact of Social Media*, Green Heaven Publications**,** 2012
7. Schmidtz, D. &Willott, E., *Environmental Ethics: What Really Matters, What Really Works*, Oxford University Press, 2012
8. Ranganathanda, S., *Eternal Values for a Changing Society: Education for human excellence*, BharatiyaVidyaBhavan, 1987
9. Rokeach, M., *Understanding human values: Individual and Societal*, The New Free Press, 1979

ZZ1095D NSS

Pre-requisites: Nil

L	T	P	C
0	0	3	1

Total hours: 39

Course Outcomes:

CO1: Acquire awareness in social and environmental issues thereby improving social consciousness and commitment towards the community.
CO2: Participate in socially relevant activities that are aimed at betterment of the campus and the society, thereby instilling a helpful attitude
CO3: Develop a positive attitude towards dignity of labour, self-help and the need for combining physical work with intellectual pursuits.
CO4: Improve inter-personal skills and contribute to nation building by serving the local community, thereby promoting a healthy and positive attitude towards life.

NSS activities have been divided in two major groups. These are Regular NSS Activities and Special Camping programme.

(a) Regular NSS Activity: NSS volunteers undertake various activities in adopted villages and slums for community service. The NSS units organise the regular activities as detailed below:
i) Orientation of NSS volunteers: To get the NSS volunteers acquainted with the basics of NSS programmes, for their orientation through lectures, discussions, field visits, audio-visuals etc.
ii) Campus Work: The NSS volunteers may be involved in the projects undertaken for the benefit of the institution and students concerned. Such projects cover maintenance of public properties, tree plantation, waste management and Swach Bharat activities, conservation of water and energy sources, social audits, awareness programmes on drug-abuse, AIDS, population education, and other projects
iii) Community service will be in adopted villages/urban slums independently or in collaboration with others in this field.
iv) Institutional work: The students may be placed with selected voluntary organisations working for the welfare of women, children, aged and disabled outside the campus.
v) Rural Project: The rural projects generally include the working of NSS volunteers in adopted villages for e-governance and digital literacy, watershed management and wasteland development, rainwater harvesting, agricultural operations, health, nutrition, hygiene, sanitation, mother and child care, gender equality sensitization programmes, family life education, gender justice, development of rural cooperatives, savings drives, construction of rural roads, campaign against social evils etc.
vi) Urban Projects: In addition to rural projects other include adult education, welfare of slum dwellers, work in hospitals, orphanages, destitute home, environment enrichment, population education, drug, AIDS awareness, and income generation,
vii) National Days and Celebrations: The National Service Scheme programmes also include the celebration of National days. The purpose of such a provision is to celebrate such occasions in a befitting manner,
viii) Blood Donation Activities,
ix) Campus farming activities,
x) Activities for social inclusion such as organizing programmes for differently – abled children.
Students shall volunteer and contribute to the activities of the National Service Scheme for a minimum duration of 39 hours for the award of credit.

b) Special Camping Programme: Under this, camps of 7 days' duration are organised during vacations with some specific projects by involving local communities.

MA2001D MATHEMATICS III

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

CO1: Handle application problems involving random variables and functions of random variables.

CO2: Identify statistical problems and make use of statistical inference while handling stochastic systems.

CO3: Apply regression and correlation analysis for studying relationship between variables.

CO4: Identify situations where analysis of variance is appropriate and apply it.

CO5: Use probabilistic and statistical analysis in various applications of engineering.

Module 1: (15 Hours)

Probability distributions, Random variables, Expectation of a function of a random variable, Mean, Variance and Moment generating function of a probability distribution, Chebyshev's theorem, Binomial distribution, Poisson distribution, Geometric distribution, Hyper- geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution and Weibull distribution. Transformation of a random variable, Probability distribution of a function of a random variable, Jointly distributed random variables, Marginal and conditional distributions, Bi-variate Normal distribution, Joint probability distribution of functions of random variables**.**

Module 2: (14 hours)

Population and samples, The sampling distribution of the mean (σ known and σ unknown), Sampling distribution of the variance, Point estimation, Maximum likelihood estimation, Method of moments,Interval estimation, Point estimation and interval estimation of mean and variance. Tests of hypothesis, Hypothesis tests concerning one mean and two means. Hypothesis tests concerning one variance and two variances, Estimation of proportions, Hypothesis tests concerning one proportion and several proportions, Analysis of$r \times c$contingency tables, Chi – square test for goodness of fit.

Module 3: (10 hours)

Analysis of variance, General principles, Completely randomized designs, Randomized block design. Curve fitting, Method of least squares, Estimation of simple regression models and hypotheses concerning regression coefficients, Correlation coefficient- Estimation of correlation coefficient, Hypothesis concerning correlation coefficient. Estimation of curvilinear regression models.

References:

1. R. A. Johnson, Miller and Freund's *Probability and Statistics for Engineers*, 8th edition., PHI, New Delhi, 2011.
2. W. W. Hines, D. C. Montgomery, D. M. Goldsman and C. M. Borror, *Probability and Statistics in Engineering*, 4th edition, John Wiley & Sons, Inc., 2003
3. S.M. Ross*, Introduction to Probability and statistics for Engineers and Scientists*, 5rd edition, Academic Press (Elsevier), New Delhi, 2014.

EC2011D ELECTRIC CIRCUITS AND NETWORK THEORY

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze linear circuits containing resistive and reactive circuit elements using network theorems and network topology principles.

CO2: Evaluate the steady state and transient performance of first and second-order electric circuits.

CO3: Analyze electric circuits in s-domain and obtain the frequency response of linear circuits and systems

CO4: Model two-port electric networks using two-port network parameters.

Module 1: (13 hours)

Review of two terminal circuit elements and Network Theorems- Star-Delta transformation, substitution theorem, compensation theorem, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Reciprocity Theorem, Millman's theorem.

Transients in linear circuits: Initial Conditions, Natural and forced response, Zero state response, Zero input response, Complete Response, Analysis of RC and RL circuits – Impulse and step responses, RC network as differentiator and integrator, Compensated Attenuators, time domain analysis of RLC circuits.

Steady state in circuits- Sinusoidal steady state response using complex exponential input, Transformation of a circuit into phasor equivalent circuit, Circuit theorems in sinusoidal steady state analysis

Module 2: (13 hours)

s-Domain Analysis of Circuits - Review of Laplace transform, Transformation of a circuit into s-domain, Transformed equivalent of inductance, capacitance and mutual inductance, Impedance and admittance in the transform domain, Node analysis and mesh analysis of the transformed circuit

Network functions - Impulse response and Transfer function, Poles and Zeros, Restriction of pole and zero locations of network functions, Steady state response and Frequency response from Laplace transform, Frequency response by transform evaluation on $j\omega$-axis, Frequency response from pole-zero plot by geometrical interpretation, Bode plots.

Ideal frequency selective filter characteristics, types of filters, pole-zero location and frequency response of first and second order filter functions, first order RC filters, second order RLC filters- Q factor, resonance

Module 3: (13 hours)

Two port networks - Characterization in terms of impedance, admittance, hybrid, inverse hybrid and transmission parameters, Inter relationships among parameter sets, Interconnection of two port networks - Series, parallel and cascade. Symmetrical two port networks - T and π Equivalent of a two port network, Image impedance parameter description of a two port network, Characteristic impedance and propagation constant of a symmetrical two port network.

Introduction to Network Topology: electric circuits and graphs, Incidence matrix, Kirchoff's Laws in incidence matrix form, Tie-sets, Kirchoff's laws in fundamental circuit matrix form, Cut-sets, Kirchoff's laws in fundamental cut set form, Relation between tie-set (circuit), cut-set and incidence matrices of a network, Analysis of networks using tie-set and cut-set, Tellegen’s theorem for lumped parameter network in topological form.

References:

1. K. S. Suresh Kumar, *Electric Circuits And Networks*, Pearson India, 2015
2. M.E. Van Valkenburg, *Network Analysis* 3rd Edition, Pearson India2015.
3. Franklin. F. Kuo, *Network Analysis and Synthesis*, 2nd Edition, Wiley India, 2006.
4. W. H. Hayt,J. Kimmerly& S.M. Durbin*Engineering Circuit Analysis*, 8th Edition., McGraw Hill India, 2013.
5. C. A. Desoer and E. S. Kuh, *Basic Circuit Theory*, McGraw-Hill, 1969.

EC2012D DIGITAL CIRCUITS AND SYSTEMS

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze characteristics of logic gates.

CO2: Design two-level logic functions with minimum gate delays or literals.

CO3: Design optimal synchronous and asynchronous sequential circuits.

CO4: Design basic logic circuits using hardware description language (HDL) at behavioral and gate levels.

Module 1: (10 hours)

Number systems and Boolean algebra - Simplification of functions using Karnaugh map and Quine McCluskey methods - Boolean function implementation. Variable Entered Mapping.Minimization and combinational design.Examples of combinational digital circuits: Arithmetic Circuits, Comparators and parity generators
Expressing combinational digital circuits through HDL – Arithmetic circuits, Multiplexers and demultiplexers, decoders and encoders.Combinational circuit design using Multiplexers.

Module 2: (18 hours)

Sequential circuits: Latches and flip-flops (RS, JK, D, T and Master Slave) - Design of a clocked flip-flop – Flip-flop conversion - Practical clocking aspects concerning flip-flops. Counters: Design of single mode counters and multi-mode counters – Ripple Counters – Synchronous counters - Shift registers – Shift Register counters – Random Sequence Generators.
Design and analysis of sequential circuits: General model of sequential networks – State diagrams – Analysis and design of synchronous sequential Finite Sate Machine – State reduction – Minimization and design of the next state decoder.

Module 3: (11 hours)

Asynchronous sequential logic: Analysis and Design – Race conditions and Cycles – Hazards incombinational circuits – Hazard free realization. Practical design aspects: Timing and triggering considerations in the design of synchronous circuits – Set up time - Hold time – Clock skew
Logic families - Fundamentals of RTL, DTL and ECL gates - TTL logic family – TTL transfer characteristics - TTL input and output characteristics - Tristate logic – MOS gates - MOS inverter - CMOS inverter - Rise and fall time in MOS and CMOS gates.

References:

1. Roth C.H., *Fundamentals of Logic Design*, Jaico Publishers. V Ed., 2009.
2. Stephen Brown, ZvoncoVranesic*, Fundamentals of Digital Logic with Verilog Design*, 2nd Edition, McGraw Hill Education.
3. Stephen Brown, *Fundamentals of Digital Logic with Verilog Design*, 2nd Edition, McGraw Hill Education.

EC2013D SOLID STATE DEVICES

Pre-requisites: Nil

L	T	P	C
4	0	0	4

Total hours: 52

Course Outcomes:

CO1: Analyze and model the physics of semiconductor materials and phenomena.

CO2: Model semiconductor junctions, Metal–Semiconductor junctions and Metal–Oxide–Semiconductor system.

CO3: Interpret and model the Physics of Metal Oxide Semiconductor Field Effect Transistor (MOSFET) and Bipolar Junction Transistor (BJT).

CO4: Analyze the physics and model the operation of MOSFETs and BJTs inAmplifying and switching applications

Module 1: (18 hours)

Solid state devices - History and its relevance in modern world - Preparation of Electronic grade semiconductor materials – Crystal structure - Formation of energy bands in solids - Concept of hole – density of states – Fermi Dirac distribution - Intrinsic and extrinsic semiconductors - Equilibrium Carrier concentration - Direct and indirect band gap semiconductors- Non equilibrium carrier concentration – Recombination and Generation of carriers – Life time - Carrier transport - Drift and diffusion Equations - Continuity equation

Module 2: (18 hours)

Semiconductor junction –Homo and Hetero junctions- p-n junction under equilibrium – Energy band diagram - current under forward bias- Reverse bias – Junction capacitance – Break down– Small signal model of p-n diode - LED, solar cell and photo detector.

Metal-Semiconductor contacts - non-rectifying (ohmic) contacts, Schottky diodes,

Metal-Oxide-Silicon System: ideal MOS structure – Energy band diagram under bias - threshold voltage capacitance curves – effects of work function difference, oxide and interface charges

Module 3: (16 hours)

MOS Field-Effect Transistor – N channel and P channel MOSFET – Complementary MOSFET - threshold voltage – dc characteristics – channel length modulation – large signal and small signal models
Bipolar junction transistor – dc characteristics – early effect – large signal and small signal models

References:

1. R. F. Pierret, *Semiconductor Device Fundamentals*, Addison-Wesley, 2006.
2. Nandita Dasgupta, Amitava Dasgupta, *Semiconductor Devices: Modelling And Technology*, PHI Learning Pvt. Ltd., 2004
3. C. C. Hu, Modern *Semiconductor Devices for Integrated Circuits*, Pearson 2010.
4. D. A. Neaman, *Semiconductor physics and devices*, McGraw Hill, 2003
5. M. S. Tyagi, *Introduction to Semiconductor Materials and Devices*, John Wiley and Sons, 2004.

EC2014D SIGNALS AND SYSTEMS

Pre-requisites: Nil

L	T	P	C
4	0	0	4

Total hours: 52

Course Outcomes:

CO1: Apply the foundation concepts on Signal Theory and System Theory in Communication Engineering, and Signal Processing.

CO2: Analyze and Design using the mathematical framework for Signal Theory and System Theory.

CO3: Design environment-friendly direct applications employing basic concepts.

CO4: Formulate multi-disciplinary applications.

Module 1: (17 hours)
Functions and Continuous-time systems: Functions on a real line, periodic functions; Linear time-invariant causal systems; System model: linear differential equations and their solutions as the system response, The Laplace transform: Region of convergence, Analysis of continuous-time systems, zero-input and zero-state responses, the Impulse response, convolution, the step response, the exponential response, the sinusoidal response and the transfer function of a system; The concept of poles and zeros of a system; stability of a system, Steady state analysis and the Fourier transform; Frequency response from pole-zero plot; Bandwidth of a continuous-time signal and a system; Fourier Series and the analysis of periodic functions.

Module 2: (17 hours)
Discrete-time sequences and systems: Sampling in time, Sampling theorems for lowpass and bandpass band-limited signals; Infinite and finite length sequences, Discrete-time systems and their properties; Linear difference equations and their solutions, Linear shift-invariant systems and convolution; responses of the discrete-time systems to impulse, step, exponential and sinusoidal inputs, and the transfer function of a discrete-time system; the z-transform and its relation to the Laplace transform, inverse z-transform, Linear difference equations and their solutions in the z-domain, Stability of discrete-time systems.

Module 3: (18 hours)
Fourier analysis of discrete-time sequences: Periodic discrete-time sequences and the Discrete-time Fourier series, and its properties; Discrete-time Fourier transform and its properties; Sampling in the Frequency domain: The discrete Fourier transform (DFT); The relation of the *z*-transform of a discrete-time sequence with its discrete-time Fourier transform and the discrete Fourier transform; Properties of the DFT matrix.

References:

1. B. P. Lathi, *Linear Systems and Signals*, Oxford University Press, 2004.
2. Oppenheim A.V., Willsky A.S., and Nawab S.H., *Signals and Systems*, Second edition, PHI Learning Private Limited/Pearson Education 2011.
3. Haykin S. & Veen B.V., *Signals and Systems*, John Wiley, 1999.
4. R.F. Ziemer, W.H. Tranter and D.R. Fannin, *Signals and Systems - Continuous and Discrete*, 4th Edition, Pearson Education, 2014.

EC2091D DEVICES AND NETWORKS LAB

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Familiarize basic electronic equipment and components

CO2: Develop circuits to obtain I-V characteristics of diodes and Transistors.

CO3: Design a basic electronic system to meet desired needs.

Syllabus

1. Familiarization of CRO, Function Generators, Power Supplies and multi-meters.
2. Familiarization and Testing methods of Active and Passive components
3. Design of filter circuits- passive filters- Low pass, high pass and band pass filters
4. Resonance circuits - Series and Parallel resonance.
5. Rectifiers- Half wave, Full wave & Bridge rectifiers.
6. Diode characteristics: silicon, germanium and zener diodes
7. Voltage regulators- Zener regulator
8. Transistor characteristics

References:

1. Robert Boylestad& Louis Nashelsky : *Electronic Devices & Circuit Theory*, 11 edition, Pearson Education, 2015
2. Franklin. F. Kuo*, Network Analysis and Synthesis*, II Ed, John Wiley & sons, 1999.
3. Hayt, Kimmerly*, Engineering Circuit Analysis*, 5th Ed., McGraw Hill, 1993.

EC2092D DIGITAL CIRCUITS AND SYSTEMS LAB

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Design optimal combinational and sequential circuits to perform a specified function

CO2: Apply the concepts of digital system design through projects

CO3: Design basic logic circuits using hardware description language (HDL)

CO4: Develop the ability to work independently and as a team to achieve targeted goals

List of experiments

1. Transfer Characteristics , Measurement of Sinking and Sourcing currents etc. of TTL gates
2. Combinational Logic design using basic gates (Code Converters, Comparators).
3. Combinational Logic design using decoders and MUXs.
4. Arithmetic circuits - Half and full adders and subtractors.
5. Arithmetic circuits – design using adder ICs, BCD adder.
6. Flip flop circuit (RS latch, JK & master slave) using basic gates.
7. Synchronous counters – random sequence counter design, optimization.
8. Asynchronous Counters
9. Sequential Circuit designs - sequence detector.
10. HDL representation of designs.

References:

1. Roth C.H., *Fundamentals of Logic Design*, Jaico Publishers. V Ed., 2009.
2. Stephen Brown, ZvoncoVranesic, *Fundamentals of Digital Logic with Verilog Design*, 2nd Edition, McGraw Hill Education.
3. Stephen Brown*, Fundamentals of Digital Logic with Verilog Design*, 2nd Edition, McGraw Hill Education.

MA2002D MATHEMATICS IV

Pre-requisites: MA1001D Mathematics I
MA1002D Mathematics II

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

CO1: Find solutions of linear differential equations using power series method and Frobenius series method.

CO2: Formulate various engineering problems as partial differential equations and hence solve them.

CO3: Identify analytic functions and find harmonic conjugates.

CO4: Find images of regions under complex transformations.

CO5: Evaluate line integrals in the complex plane

CO6: Apply techniques of complex analysis to evaluate integrals of real valued functions.

Module 1: (11 Hours)
Series Solutions and Special Functions : Power series solutions of differential equations, Theory of power series method, Legendre Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions, Bessel functions of the second kind, Sturm- Liouville's Problems, Orthogonal eigenfunction expansions.

Module 2: (10 Hours)
Partial differential Equations : Basic Concepts, Cauchy's problem for first order equations, Linear Equations of the first order, Nonlinear Partial Differential Equations of the first order, Charpit's Method, Special Types of first order equations, Classification of second order partial differential equations, Modeling: Vibrating String, Wave equation, Separation of variables, Use of Fourier Series, D'Alembert's Solution of the wave equation, Heat equation: Solution by Fourier series, Heat equation: solution by Fourier Integrals and transforms, Laplace equation, Solution of a Partial Differential Equations by Laplace transforms.

Module 3: (9 Hours)
Complex Numbers and Functions: Complex functions, Derivative , Analytic function, Cauchy- Reimann equations, Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear fractional Transformations, Schwarz - Christoffel transformation, Transformation by other functions.

Module 4: (9 Hours)
Complex Integration: Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula,Derivatives of analytic functions.Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue integration method, Evaluation of real Integrals.

References:

1. Kreyszig E*, Advanced Engineering Mathematics*, 8th Edition, John Wiley & Sons, New York, 1999
2. I.N. Sneddon, *Elements of Partial Differential Equations*, Dover Publications, 2006
3. Wylie C. R. & Barret L. C., *Advanced Engineering Mathematics*, 6th Edition, McGraw Hill, NewYork,1995.
4. Donald W. Trim, *Applied Partial Differential Equations*, PWS – KENT publishing company, 1994.

EC2021D ELECTRONIC CIRCUITS I

Pre-requisites: EC2011D Electric Circuits and Network Theory
EC2013D Solid State Devices

L	T	P	C
4	0	0	4

Total hours: 52

Course Outcomes

CO1: Choose suitable frequency compensation schemes to improve stability of multi-stage voltage amplifiers in feedback

CO2: Analyze and design linear and non-linear op amp circuits

CO3: Design active filters

CO4: Make use of block diagrams to develop subsystems

Module 1: (17 hours)

Need for amplification, amplification by controlled sources, concept of transfer gain, BJT and MOSFET as controlled sources with large and small signals, the need for biasing, trans-conductance and output resistance of the controlled sources, load resistance, voltage amplification, transfer function of an amplifier with load capacitance, review of poles and zeros, association of poles with nodes isolated by ideal voltage amplifiers, bandwidth estimation, need for high gain, cascaded stages, the need for accurate gain, negative feedback, properties of negative feedback, ideal feedback topologies, loop gain, feedback factor, Bode approximation, stability, phase margin, gain margin, need for frequency compensation, dominant pole compensation, Miller effect and Miller compensation, conditions for oscillation

Module 2: (18 hours)

Properties of op-amp, op-amp in feedback, virtual short, linear op-amp circuits - inverting and non-inverting configurations - analysis for closed loop gain - input and output impedances, current to voltage and voltage to current converters –review of integrator and differentiator, considerations in the design of practical integrator and differentiator circuits,instrumentation amplifier, differential and common mode operations, common mode rejection ratio - nonlinear op-amp circuits - log and antilog amplifiers - 4 quadrant multipliers and dividers, comparators - astable and mono-stable circuits - linear sweep circuits, RC phase shift oscillator, number of RC stages and frequency of oscillation, Wein bridge oscillators, voltage and current non-idealities of op-amps and their impact on circuit output

Digital to analog converters - binary weighted - R-2R ladder - current steering - charge scaling, - accuracy - resolution - conversion speed - offset and gain error-Analog to digital converters –flash, staircase, successive approximation and dual slope ADCs

Linear voltage regulators, series and shunt configurations, DC-DC converters, Buck, Boost converters

Module 3: (17 hours)

Review of filter characteristics, short comings of RC filters for higher order filters, active filter design, design of first order filter from the locations of pole and zero, second order Sallen key LPF and HPF, Butterworth, Chebychev and Bessel filter approximations to LPF characteristics, normalized pole locations from approximations, filter specifications, estimation of filter order from specifications, normalized filter transfer functions for cascaded realization, de-normalization, design of cascaded section, frequency transformation to achieve HPF, BPF and BEF from normalized prototype LPF, universal active filter - all pass filter (first &second orders) realizations - inductance simulation using Antoniou's gyrator – Switched capacitor filter

Phase Locked Loop – block schematic and analysis of PLL – lock range and capture range – typical applications of PLL

References:

1. Sergio Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, Tata McGraw-Hill, 2002.
2. GobindDaryanani, *Principles of Active Network Synthesis & Design*, Wiley India, 2010.
3. Sedra A.S. & Smith K.C., *Microelectronic Circuits*, Oxford University Press, 2015.
4. R. Schaumann, H. Xiao and M. E. V. Valkenburg, *Analog filter design*, Oxford University Press, 2010
5. Fiore J.M., *Operational Amplifiers and Linear Integrated Circuits*, Jaico Publishing House 2006.
6. Coughlin R.F. & Driscoll F.F., *Operational Amplifiers and Linear Integrated Circuits*, Pearson Education 2002.

EC2022D ELECTROMAGNETIC FIELD THEORY

Pre-requisites: Nil

L	T	P	C
4	0	0	4

Total hours: 52

Course Outcomes:

CO1: Estimate the effects of static electric and magnetic fields in free space/matter.

CO2: Quantify the electromagnetic effects of dynamic charge and current distributions using Maxwell's equations.

CO3: Analyze the propagation of plane waves in unbounded media and incidence of plane waves at interfaces

CO4: Analyze the propagation of electromagnetic waves through transmission lines and waveguides.

Module 1: (18 hours)

Review of Vector Calculus: Orthogonal coordinate systems, Coordinate transformation, Gradient of scalar fields, Divergence and Curl of vector fields.
Electrostatics: Coulomb's law, electric field, flux and Gauss's law, Poisson's equation, Laplace's equation, solutions to electrostatic boundary problems, method of images, work and energy in electrostatics, induced dipoles and polarization, capacitors, surface charge and induced charge on conductors.
Magnetostatics: Biot-Savart law, Ampere's law, magnetic vector potential, magnetization, torque and force on magnetic dipoles, magnetic field inside matter, magnetic susceptibility and permeability, boundary conditions

Module 2: (18 hours)

Electrodynamics: Electromagnetic induction, continuity equation, displacement current, Maxwell's equations, boundary conditions, Poynting's theorem, energy and momentum in electromagnetic field.
Electromagnetic Waves: EM waves in vacuum and in matter, monochromatic plane waves, group velocity, wave polarization, Lorentz gauge, retarded potentials.
Refection and transmission at interfaces: Normal and Oblique incidence of uniform plane electromagnetic waves at conducting boundary, dielectric boundary

Module 3: (16 hours)

Transmission lines: Quasi-TEM analysis, characteristic impedance, standing wave ratio, impedance matching techniques, Smith Chart.
Guided wave: Guided waves between parallel planes, waves in rectangular waveguides, transverse electric (TE) and transverse magnetic (TM) waves and its characteristics, cut-off wavelength and phase velocity, dominant mode in rectangular waveguide, attenuation of TE and TM modes in rectangular waveguides, wave impedances, characteristic impedance, excitation of modes.

References:

5. David J Griffiths, *Introduction to electrodynamics*. Prentice Hall, 4th Edn., 2012.
6. David K Cheng, *Field and wave electromagnetics*, Pearson Education, 2nd Edn., 2001.
7. Matthew N. O. Sadiku, *Elements of Electromagnetics*, Oxford University Press, 4th Edn., 2006.
8. J D Krauss, *Electromagnetics*, McGraw-Hill Series 4th Edn., 1999.
9. Hayt W. H., *Engineering Electromagnetics*, McGraw Hill, 8th Edn.,2017.
10. N Narayana Rao, *Elements of Engineering Electromagnetics*, Pearson Education, 6th Edn., 2006
11. R K Shevgaonkar, Electromagnetics Waves, McGraw Hill, 1st Edn. 2016.

EC2023D MICROPROCESSORS AND MICROCONTROLLERS

Pre-requisites: EC2012D Digital Circuits and Systems

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze the basic building blocks of a computer system and the role of the central processing unit, using 8086 as the sample

CO2: Develop assembly language programs to access the features provided by the 8086 CPU

CO3: Examine the features of the 8051 CPU and peripherals in a programmers point of view

CO4: Illustrate the use of the low power MSP 430 microcontroller for application development

Module 1: (18 hours)

Introduction: History of microprocessors –Basics of computer architecture-Computer languages –CISC and RISC
Intel 8086 processor: The architecture of 8086 —-Addressing modes-use of MASM - Programming concepts- Programming using instructions for data transfer ,arithmetic, logical and shift and rotate operations String manipulations –Procedures-Macros-ASCII operations-high level language constructs –I/O instructions–Modular programming
The hardware of 8086- pin diagram-address demultiplexing-machine cycles –Clock-Timing diagrams-Other processor activities –Interrupts-DMA-Instruction cycles-delay loops
Memory and IO Decoding –Address decoding using gates and block decoders-partial address decoding –IO Address Decoding- Memory banks
Interrupts of 8086 –Interrupt vector Table Hardware and software interrupts –type number -priority
Serial communication principles ,-RS 232C

Module 2: (14 hours)

8051 microcontroller:: architecture Instruction set, Ports of 8051 –port programming and generating square waves using software delays, Generating square waves using timers – counting external events 0 Interrupt based operation of timers, Serial data transmission and reception using polling and interrupts Assembly programming using KeilMicrovision IDE, Interfacing external peripherals to 8051, Interfacing ADC and DAC –Using LCDs and LEDs as display devices for an 8051 system, DC motor interfacing using H bridges, Stepper motor interfacing to 8051

Module 3: (7 hours)

MSP 430 - pinout –functional block diagram, memory map –CPU –peripheral overview-clock generator-interrupts-Introduction to Embedded C programming for MSP 430-Review of processor architecture-Interrupts and low power modes – Digital and analog inputs-other peripherals

References:

1. Lyla B. Das, *The x86 Microprocessors: 8086 to Pentium,, Multicores, Atom , and the 8051 Microcontroller : Architecture ,Programming and Interfacing*, Second Edition , Pearson Education ,India 2014
2. Muhammed Ali Mazidi, Janice GillispieMazidi ,Rolin D Mc Kinlay ,*The 8051 Microcontroller and Embedded Systems Using Assembly and C* , Second Edition ,2008 , Pearson Education
3. John Davies, *MSP 430 Microcontroller Basics*, Elsiever Publictions,2008

EC2024D COMMUNICATION THEORY AND SYSTEMS I

Pre-requisites: EC2014D Signals and Systems

L	T	P	C
4	0	0	4

Total hours: 52

Course Outcomes:

CO1: Analyze techniques for the generation, transmission and reception of amplitude modulation (AM), frequency modulation (FM) and phase modulation (PM) signals

CO2: Evaluate a given analog communications system in terms of the complexity of the required transmitters and receivers and the power and bandwidth requirements of the system.

CO3: Develop an understanding of the statistical characteristics of discrete, continuous random variables and vectors

CO4: Demonstrate sound knowledge of the concept of random processes and the techniques to find the correlation, covariance and power spectral density of stationary random processes

CO5 Analyze the received signal-to-noise power ratio performance of AM, FM and PM systems in the presence of additive white Gaussian noise and explore the trade-off between bandwidth, receiver SNR, and receiver complexity.

Module 1: (16 hours)

Fundamentals of analog communication systems, Block schematic, performance metrics and trade-off- Review of signals and systems: Linear time invariant systems, Fourier series, Fourier Transforms, Energy and Power Spectral Density, Bandwidth, Baseband and pass band signals, Frequency domain relations, Complex envelope, In-phase-quadrature representations of pass band signals

Analog modulation schemes: - Amplitude modulation, Double Sideband (DSB) Suppressed Carrier (SC), Conventional AM, Single Sideband Modulation (SSB), Vestigial Sideband (VSB) Modulation, Quadrature Amplitude Modulation, Power and Bandwidth Relations - Generation of AM signals, modulators and transmitters, product modulators, square-law modulators and balanced modulators - Frequency translation and frequency division multiplexing- Angle Modulation, Frequency modulation (FM) and phase modulation, FM spectrum and transmission bandwidth calculations, Narrowband and Wideband FM, Generation of FM signals- direct and indirect methods for FM generation

Module 2: (18 hours)

Demodulation of conventional AM, DSB-SC and SSB signals- Coherent and non-coherent demodulation/detection techniques, envelope detection of AM signals, synchronous demodulation, design of typical circuits-Demodulation of FM signals - Basic FM demodulators, balanced slope detector, Foster-seely discriminator, ratio detector, PLL based FM detection, Design of typical circuits Pre-emphasis and de-emphasis. Radio Receivers - TRF and super-heterodyne receivers- Image frequency, Intermediate frequency (IF)- Automatic gain control,: Block schematic level treatment of AM and FM radio receivers

Random variables: Discrete and continuous random variables - Probability distribution functions – Expectation –Higher order moments -moment generating function; characteristic functions.
Random vectors: Joint probability distribution functions, joint probability densities, conditional probability distributions functions, conditional probability densities, Correlation and covariance - independence and un-

correlation Transformations of random variables: scalar valued function of one random variable, Functions of several random variables- Fundamental Theorem of expectation

Module 3: (18 hours)

Random processes: Introduction and specification, *n*th order joint distribution, mean and auto-correlation function, auto-covariance function, Cross-correlation and cross-covariance function Stationary processes: Strict-sense stationarity, wide-sense stationarity (WSS), cyclo stationarity - auto-correlation function, cross-correlation function, and power spectral density of a WSS random process - Wiener-Khinchine theorem, low-pass and band-pass processes, power and bandwidth calculations.-Time averaging and ergodicity: Time averages - interpretation, mean and variance; ergodicity: general definition, ergodicity of the mean, ergodicity of the auto-correlation function. Random processes as inputs to linear time invariant systems: Gaussian processes as inputs to LTI systems, white Gaussian noise.

Performance of analog modulation schemes in the presence of channel noise: Signal to Noise Ratio (SNR) performance of baseband systems – SNR performance of AM systems, Noise in angle modulated systems - SNR performance- threshold effects in angle modulated systems- Fundamental trade off in AM/FM system design.

References:

1. R.E. Ziemer and W.H. Tranter, *Principles of Communications: System, Modulation and Noise*, Wiley; 5th edition (2001)
2. B.P. Lathi and Zhi Ding, *Modern Digital and Analog Communication Systems*, Oxford University Press 4th edition, 2009.
3. UpamanyuMadhow, *Introduction to Communication Systems*, Cambridge University Press; 1st edition, 2014.
4. John G Proakis and M. Salehi, *Communication System Engineering*, Pearson Education, 2nd edition, 2001.
5. H. Stark and J. W. Woods, *Probability and Random Processes with Applications to Signal Processing*, Prentice-Hall, 2003.Nov 24, 2014

EC2093D ELECTRONIC CIRCUITS LAB I

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Test integrated circuits

CO2: Design signal conditioning blocks using integrated circuits

CO3: Demonstrate the working of analog subsystems by integrating/interfacing multiple analog circuits

CO4: Model circuits using software simulators

CO5: Develop the ability to prepare technical reports and oral presentation

Topics:

1. Amplifier design using the small signal parameters of a transistor
2. Measurement of op amp parameters-CMRR, slew rate, open loop gain, unity gain bandwidth, input and output impedances
3. Inverting, non-inverting amplifiers, differentiators and integrators-frequency response
4. Instrumentation amplifier-gain, CMRR and input impedance
5. Astable and monostable multivibrators
6. Universal active filter
7. Characterization of ADC/DAC
8. A simple data acquisition system
9. Voltage regulator
10. PLL applications
11. Introduction to circuit simulators

References:

1. Sergio Franco, *‘Design with Operational Amplifiers and Analog Integrated Circuits*, Tata McGraw-Hill, 2002.
2. Gobind Daryanani, *Principles of Active Network Synthesis & Design*, Wiley India, 2010.
3. Sedra A.S. & Smith K.C., *Microelectronic Circuits*, Oxford University Press, 2015.
4. Fiore J.M., *Operational Amplifiers and Linear Integrated Circuits*, Jaico Publishing House 2006.
5. Coughlin R.F. & Driscoll F.F., *Operational Amplifiers and Linear Integrated Circuits*, Pearson Education 2002.
6. Data sheets of transistors and ICs

EC2094D MICROPROCESSORS AND MICROCONTROLLERS LAB

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Build small electronic systems using 8086/8051/MSP430 for given applications

CO2: Choose appropriate designs for managing constraints in different designs

CO3: Demonstrate the output of the design using technical reports and oral presentations

CO4: Develop the ability to work in professional teams

Topics to be covered:

1. Basic MASM programming for 8086
2. 8051 Assembly language programming
3. Use of Embedded-C for programming 8051
4. Use of GPIO pin as an input and sense the state of the input pin
5. Use of GPIO pin as an output and drive a particular logic output through this pin
6. Interfacing sensors/actuators to 8051 and build a complete system
7. Use of Timer modules of 8051
8. Use of Interrupts in 8051
9. Analog signal interfacing to 8051
10. Interfacing of Relay/display devices/Motor drivers with 8051
11. Designing simple embedded systems using MSP430

Each experiment needs to be prepared as a standalone complete system so that students will get the experience of designing electronic systems for specific applications

References:

1. Lyla B. Das, *The x86 Microprocessors: 8086 to Pentium,, Multicores, Atom , and the 8051 Microcontroller : Architecture ,Programming and Interfacing*, Second Edition , Pearson Education ,India 2014
2. Muhammed Ali Mazidi, Janice Gillispie Mazidi ,Rolin D Mc Kinlay ,*The 8051 Microcontroller and Embedded Systems Using Assembly and C* , Second Edition ,2008 , Pearson Education
3. John Davies.*MSP 430 Microcontroller Basics*, Elsiever Publictions,2008

MS3001D ENGINEERING ECONOMICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total Hours: 39

Course Outcomes:

CO1: Analyse the core concepts of scarcity and value and welfare maximisation

CO2: Apply economic reasoning to firm behaviour and functioning of market

CO3: Evaluate cost behaviour, pricing policies and profit planning of firms

CO4: Analyse the market structure and dynamics and welfare of firms and society

CO5: Create understanding of fundamentals of contemporary banking and monetary system

Module 1: (9 hours)

General Foundations of Economics; Forms of organizations-Objectives of firms-Opportunity principle-Discounting, Marginalism versus Incrementalism-Production Possibility frontier-Central problems of an economy- Two sector, Three sector and Four sector circular flow of income. Demand analysis-Individual, Market and Firm demand, Determinants of demand and supply, Shifts and changes in demand and supply, Market equilibrium, Shortages versus surpluses, Price ceiling ,Price floor- Elasticity of demand and business decision making.

Module 2: (17 hours)

Production functions in the short and long run-Cost concepts- Short run and long run costs- economies and diseconomies of scale-economies and diseconomies of scope-Break even analysis-Vertical & horizontal integration-Product markets- Market structure-Competitive market-Imperfect competition (Monopoly, Monopolistic competition and Oligopoly) and barriers to entry; Pricing in different markets; Price discrimination-Dead weight loss-consumer’s surplus ; Game Theory-Prisoner’s Dilemma-Maximin, Minimax, Saddle point, Nash Equilibrium.

Module 3: (13 hours)

Macroeconomic Aggregates-Gross Domestic Product; Gross national product, net domestic product, Transfer payments, Depreciation, Economic Indicators; Models of measuring national income; Fiscal deficit, primary deficit, Inflation and deflation ; Fiscal and Monetary Policies ; Monetary system; Indian stock market; Development Banks; NBFIs, role of Reserve Bank of India, Money Market, Capital market; NIFTY,SENSEX,Financial ratios.

References:

1. R.S. Pindyck, D.L.Rubinfield and P.L. Mehta,*Microeconomics*,Pearson Education, 9th Edition, 2018.
2. P. A. Samuelson and W.D. Nordhaus, *Economics*, Tata McGraw Hill,19thed., 2015.
3. N. G. Mankiw, *Principles of Microeconomics*, Cengage Publications,7th ed.,2014.
4. S. B. Gupta, *Monetary Economics: Institutions, Theory & Policy*,New Delhi: S. Chand & Company Ltd., 2013.
5. K. E. Case, R. C. Fair and S. Oster, *Principles of Economics*, Prentice Hall, 10th ed., 2011.

Note: Supplementary materials would be suggested / supplied for select topics on financial markets and Indian economy.

EC3011D ELECTRONIC CIRCUITS II

Pre-requisites: EC2021D Electronic Circuits I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze and design single stage and multistage amplifier circuits with transistors.

CO2: Estimate frequency response of single-stage amplifiers using high-frequency transistor models and analyze the methods to improve high frequency response of amplifiers

CO3: Analyze and design transistor based oscillators and negative feedback circuits

CO4: Design the various stages of op-amps and comparators.

Module 1: (13 hours)

Basic amplifiers: Review of small signal model of MOSFET - Biasing schemes - Bias stability - Analyses of common source amplifier, swing limits, Biasing, constant current biasing, current mirrors, bias stabilization, Active load, common drain and common gate amplifier configurations, Multistage amplifiers, Bipolar junction transistor based amplifier configurations. MOSFET/BJT amplifiers as controlled sources (VCVS, VCCS, CCVS, CCS) - Differential amplifier, half circuit analysis, common mode rejection ratio, Methods to improve CMRR, differential amplifier with active load,

Module 2: (13 hours)

Frequency response of amplifiers – Low frequency response of single stage amplifiers, lower cut off frequency - high frequency equivalent circuit of BJT/MOSFET - high frequency response of single stage amplifiers –upper cut off frequency – transition frequency - miller effect Wide band amplifiers - Wide banding techniques – CC–CE /CD-CS cascade, cascode amplifier, frequency response of differential amplifier.
Various stages of an operational amplifier - typical op-amp parameters - slew rate – CMRR, PSRR - open loop gain - unity gain bandwidth - offset current & offset voltage – CMOS op-amps and comparators

Module 3: (13 hours)

Review of negative feedback, Analysis of multistage amplifiers with negative feedback, Positive feedback in amplifiers and oscillators - review of conditions for oscillation, Colpitt's, Hartley and Crystal oscillators
Output stages and Power amplifiers - Class A, B, AB, C, D power amplifiers - voltage follower as power amplifier, Push-pull stage, Improved push-pull stage, push-pull stage with driver, Large signal considerations, Short circuit protection, Harmonic distortion , Power rating of transistors, Conversion efficiency of power amplifiers.

References:

1. A. S. Sedra & K C Smith, *Microelectronic Circuits*, 7th Edition, Oxford University Press.2015
2. D. A. Neamen, *Electronic Circuit Analysis and Design*, 3rd Edition, McGraw-Hill India, 2006
3. B. Razavi, *Fundamentals of Microelectronics*. Jhon Wiley india Pvt. Ltd. 2009
4. J. Millman, C. Halkias and C. D. Parikh, *Integrated Electronics – Analog and Digital Circuits and systems*, Mc Graw Hill India. 2009
5. D L Schilling & C Belove, *Electronic Circuits*, 3rd Edition, Tata McGraw-Hill, 2002
6. R. Boylestad& L. Nashelsky, *Electronic Devices & Circuit Theory*, Pearson India, 2012

EC3012D COMMUNICATION THEORY AND SYSTEMS II

Pre-requisites: EC2024D Communication Theory and Systems I

L	T	P	C
4	0	0	4

Total hours: 52

Course Outcomes:

CO1: Analyze the design of various processing units of a digital communication system such as analog-to digital conversion, line coding, pulse shaping and equalizers

CO2: Demonstrate sound knowledge of various pass band digital modulation schemes and the corresponding demodulation techniques

CO3: Analyze and design optimum digital communication receivers for additive white Gaussian noise channels considering both coherent and non-coherent demodulation techniques

CO4: Develop a strong framework for the performance evaluation of base band and pass band digital communication systems under additive white Gaussian noise channels in terms of bit/symbol error probability and spectral efficiency

CO5: Determine the trade-off between power and bandwidth in digital communication system and demonstrate the ability to design the system for a given requirement.

Module 1: (18 hours)

Review of signals, systems, random variables and processes- Elements of digital communication systems-communication channels and their characterization- Sampling theorem for base-band and pass-band signals, Pulse Amplitude Modulation (PAM), Pulse Position Modulation (PPM), Pulse Width Modulation (PWM) -Digital Pulse modulation: Quantization, PCM, DPCM, Delta modulation, Adaptive delta modulation-Design of typical systems and performance evaluation
Signal space concepts: Geometric structure of the signal space, representing signals as vectors, distance, norm and inner product, orthogonality, Gram-Schmidt orthogonalisation process.

Module 2: (16 hours)

Design for Bandlimited Channels-Inter symbol interference, Pulse Shaping, Nyquist criterion for zero ISI, Signaling with duo-binary pulses, Eye diagram, Equalizers: zero forcing and MMSE based - Scrambling and descrambling.
Review of Gaussian random process, Optimum threshold detection, Optimum Receiver for AWGN channel, Matched filter and Correlation receivers, Decision Procedure: Maximum aposteriori probability detector-Maximum likelihood detector, Error probability performance of binary signaling.

Module 3: (18 hours)

Digital band pass modulation schemes: ASK, FSK, PSK, MSK – Digital M-ary modulation schemes – signal space representation
Detection of signals in Gaussian noise - Coherent & non-coherent detection – Optimal non coherent demodulation - Differential modulation and demodulation – Error performance of coherent binary and M-ary modulation schemes in AWGN channels – Error performance of non-coherent binary and M-ary modulation schemes- Probability of error of binary DPSK – Power spectra of digitally modulated signals,

Performance comparison of digital modulation schemes – Spectral efficiency versus SNR trade-off in digital communication systems

References:

1. John G Proakis and M. Salehi, *Communication System Engineering*, Pearson Education, 2nd edition, 2001.
2. Upamanyu Madhow, *Fundamentals of Digital Communication,* Cambridge University Press; 1st edition, 2008.
3. R.E. Ziemer and W.H. Tranter, *Principles of Communications: System, Modulation and Noise*, Wiley; 5th edition (2001)
4. B.P. Lathi and Zhi Ding, *Modern Digital and Analog Communication Systems*, Oxford University Press 4th edition, 2009.

EC3013D DIGITAL SIGNAL PROCESSING

Pre-requisites: EC2014D Signals and Systems

Total hours: 39

L	T	P	C
3	0	0	3

Course Outcomes:

CO1: Analyze the relations among time and Fourier domain representation of signals and systems

CO2: Design of fast algorithms for digital LTI system implementation.

CO3 Design digital filters from discrete time and continuous time specifications.

CO4: Analyze and choose architectures to efficiently implement the DSP systems taking into consideration the practical aspects.

Module 1: (13 hours)

Fourier analysis of discrete-time signals and systems: Discrete Fourier series, discrete time Fourier transform and discrete Fourier transform (DFT) –Review of properties of the transforms; Interpreting the DFT and approximation of Fourier transform through DFT - Fast algorithms for DFT computation: The Raddix-2 DIT and DIF FFT algorithms and prime factor algorithms, Computation of inverse DFT using FFT algorithms - DSP system implementation using FFT algorithm - Overlap-save and overlap-add methods.

Module 2: (13 hours)

Digital filters: All pass and minimum phase systems - FIR Filters: Impulse response, Transfer function, Linear phase properties - Design: window based design, frequency sampling design and minimax design. Introduction to IIR filters: Impulse response, Transfer function, Pole-zero representation- Structures for FIR and IIR filters - Direct form, cascade form and parallel structures - Lattice Structures.

Module 3: (13 hours)

Design of IIR filters and finite word length effects: Design from analog filters – analogButterworth function for various frequency selective filters- analog to digital transformation - backward -difference and forward - difference approximations - impulse invariant transformation - bilinear transformation -prewarping - design examples. Finite word length effect in DSP- zero-input limit cycles in fixed point realizations of IIRdigital filters-Limit cycles due to overflow.

References:

1. John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 4th Edition, Pearson India, 2007.
2. Oppenheim A. V., Schafer R. W, *Digital Signal Processing*, Pearson India, 2015.
3. Mitra S. K., *Digital Signal Processing: A Computer Based Approach*, McGraw-Hill Publishing Company, 2013.
4. Lonnie C. Ludeman, *Fundamentals of Digital Signal Processing*, Wiley India Pvt. Ltd., 2009.
5. Boaz Porat, *A Course in Digital Signal Processing*, Wiley India Pvt. Ltd., 2012.
6. Emmanuel C. Ifeacher, Barry W. Jervis, *Digital Signal Processing: A Practical Approach*, 2nd Edition, Pearson Education, 2004.

EC3014D ENVIRONMENTAL STUDIES FOR ELECTRONICS ENGINEERS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1. Define a system component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health safety and sustainability.
CO2. Identify fundamental environmental science and engineering principles necessary to solve equitable use of resources and sustainable lifestyles.
CO3. Analyze environmental pollution and methods of prevention
CO4. Analyze the effect of electronic products on environment and human health.

Module 1 (13 Hours)
Definition, scope and importance - renewable and non-renewable resources - Natural resources - forest, water, mineral, food and energy and land resources - study of problems - Role of individual in conservation - equitable use of resources and sustainable lifestyles.
Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies, reducing energy consumption in electronic systems, energy audits, sustainable power generation and energy systems
Eco systems - structure and function - producer, consumer and decomposer - energy flow - ecological succession-

Module 2 (12 Hours)
Food chains- forest, grassland, desert and aquatic ecosystems - Biodiversity and conservation.
Environmental pollution - air, water, soil, marine, thermal, nuclear and noise pollution- methods of prevention - waste management - disaster management - environmental ethics - sustainable development models - water conservation - climate change and global warming - ozone layer depletion - nuclear holocaust - case studies - consumerism and waste products.

Module 3 (14 Hours)
Electronic product life cycle, probable environmental pollution at different stages, electronic waste – materials, waste management, impact of materials and processes used for electronic product manufacturing, recycling electronics, removal of hazardous substances from products
Design for Environment (DFE), need for regulations, impact of work culture in the modern world
Human Population and the Environment: Population growth, variation among nations, Population explosion – Family Welfare Programme, environment and human health, role of Information Technology in environment and human health, case studies, biological impact of materials used in electronic products and manufacturing process, impact of signal radiation from electronic products.

References:

1. E. Bharucha, *Environmental Studies*, Universities Press, 2005.
2. Gurdeep R. Chatwal and Harish Sharma, *A Text Book of Environmental Studies : Environmental Sciences*, Himalaya Publishing House, 2004.
3. Anubha Kaushik and C P Kaushik, *Perspectives in Environmental Studies*, New Age International, 2007.
4. *UGC Syllabus on environmental studies* available at http://www.ugc.ac.in/inside/syllabus.html accessed on 01-12-2010
5. Recent research papers on *E-waste management*

EC3091D ELECTRONIC CIRCUITS LAB II

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Design and implement transistor based analog circuits to meet the given specifications.

CO2: Characterize the circuits and estimate the effects of parasitic of circuit components on the performance of the circuits.

CO3: Design and implement analog subsystems to meet the given specifications.

CO4: Demonstrate the ability to give oral presentation and technical report.

List of Experiments:

1. Biasing schemes
2. Current source and current mirror
3. Voltage follower – frequency and phase response
4. Single stage (single ended input) amplifier – Frequency Response
5. Differential amplifier
6. Power amplifiers – Class A and Class AB
7. Multistage amplifier – Frequency Response
8. Wideband Amplifiers – Frequency Response
9. Feedback amplifiers
10. Phase Shift Oscillator
11. Colpitts/Hartley Oscillators

The experimental results obtained in the lab may be compared with the circuit simulation results.

References:

1. S. Sedra& K C Smith, *Microelectronic Circuits*, 7th Edition, Oxford University Press.2015
2. D. A. Neamen, *Electronic Circuit Analysis and Design*, 3rd Edition, McGraw-Hill India, 2006
3. Razavi, *Fundamentals of Microelectronics*. Jhon Wiley india Pvt. Ltd. 2009
4. J. Millman, C. Halkias and C. D. Parikh, *Integrated Electronics – Analog and Digital Circuits and systems*, Mc Graw Hill India. 2009
5. D L Schilling & C Belove, *Electronic Circuits*, 3rd Edition, Tata McGraw-Hill, 2002
6. R. Boylestad& L. Nashelsky, *Electronic Devices & Circuit Theory*, Pearson India, 2012

EC3092D COMMUNICATION ENGINEERING LAB I

Pre-requisites: EC2024D Communication Theory and Systems I

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Develop the ability to design and experimentally test RF circuits and hardware systems for analog communication systems.

CO2: Demonstrate the ability to design and implement a AM/FM radio system for a given set of specifications

CO3: Assess the theoretical and measured performance of wired analog communications systems

CO4: Develop the ability to work independently and also as a team member to achieve the targeted goals and objectives

CO5: Demonstrate skills for conducting oral presentations and writing good quality report on AM/FM radio system design

List of experiments (Hardware design, implementation and testing):

1. AM generation and envelope detection with simple and delayed AGC
2. Synchronous demodulation of AM signals
3. DSBSC and SSB: generation and demodulation
4. Radio Frequency (RF) Amplifier
5. RF Mixer using JFET/BJT
6. Intermediate frequency (IF) amplifier
7. FM generation (reactance modulator)
8. FM demodulation: Foster-seely discriminator and ratio detector
9. Pre-emphasis and De-emphasis
10. PAM generation and demodulation
11. Generation and demodulation of PWM and PPM
12. Voltage Controlled Oscillator
13. PLL characteristics
14. FM modulation/demodulation using PLL
15. AM/FM based wired communication set up

References:

1. L.W. Couch, *Digital and Analog Communication Systems*, 7/e, Pearson, 2007.
2. W. Tomasi, *Electronics Communication Systems: Fundamentals Through Advanced*, 5/e, Pearson, 2007

ME3104D PRINCIPLES OF MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain the characteristics and functions of management in the contemporary context

CO2: Demonstrate ability in decision making process

CO3: Summarize the functional areas of management

CO4: Comprehend the concept of entrepreneurship and create business plans

Module 1: (15 hours)
Introduction to management, classical, neo-classical and modern management theories, Levels of managers and skill required. Management process – planning – mission – objectives – goals – strategy – policies – programmes – procedures. Organizing, principles of organizing, organization structures, Directing, leadership, motivation, Controlling.

Module 2: (11 hours)
Concept of productivity and its measurement; Competitiveness; Decision making process; decision making under certainty, risk and uncertainty; Decision trees; Models of decision making.

Module 3: (13 hours)
Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management, entrepreneurship, business plans, corporate social responsibility, patents and Intellectual property rights.

References:

1. H. Koontz, and H. Weihrich, *Essentials of Management: An International Perspective.* 8th ed. McGraw-Hill, 2009.
2. R. W. Griffin, *Management: Principles and Applications,* Cengage Learning, 2008.
3. P. Kotler, K. L. Keller, A. Koshy, and M. Jha, *Marketing Management: A South Asian Perspective.* 14th ed. Pearson, 2012.
4. M. Y. Khan, and P. K. Jain, *Financial Management*, Tata-McGraw Hill, 2008.
5. R. D. Hisrich, and M. P. Peters, *Entrepreneurship: Strategy, Developing, and Managing a New Enterprise*, 4th ed. McGraw-Hill Education, 1997.
6. E. B. Roberts, *Entrepreneurs in High Tech-Lessons from MIT and beyond,* Oxford University Press, 1991
7. D. J. Sumanth, *Productivity Engineering and Management*, McGraw-Hill Education, 1985.

EC3021D INFORMATION THEORY AND CODING

Pre-requisites: EC3012D Communication Theory and Systems II

Total hours: 52

L	T	P	C
4	0	0	4

Course Outcomes:

CO1: Analyze the fundamental limits on the error free representation of information signals and the transmission of such signals over a noisy communication channel.

CO2: Design and analyze lossless data compression techniques with varying efficiencies as per problem requirements.

CO3: Analyze the mathematical tools for source coding and error correction coding and design error correction codes.

CO4: Design various decoding strategies for block and convolutional codes.

Module 1: (17 hours)
Entropy and Lossless Source Coding**:** Entropy of discrete random variables **-** Joint, conditional and relative entropy - Chain rule for entropy, Mutual information and conditional mutual information, Relative entropy and mutual Information - Lossless source coding **-** Discrete Memory-less sources**,** Uniquely decodable codes - Instantaneous codes- Kraft's inequality – Average codeword length, Optimal codes- Huffman coding, Arithmetic Coding, Lemplel-Ziv Coding - Shannon's Source Coding Theorem.
Channel Capacity and Coding Theorem for Discrete Channels: Discrete memory-less channels (DMC) and channel transition probabilities, Capacity computation for simple channels- Shannon’s Channel Coding Theorem for DMC (proof is optional), Converse of Channel Coding Theorem.

Module 2: (17 hours)
Channel Capacity and Coding Theorem for Continuous Channels: Entropy of continuous sources and channels: Differential entropy – Entropy maximization results- Waveform channels- Gaussian channels- Shannon-Harley Theorem, Shannon limit, efficiency of digital modulation schemes-power limited and bandwidth limited systems.
Channel Coding Part-I:Introduction - Error detection and correction, Review of vector space, properties, Linear block codes- Construction and decoding, Standard array decoding, Distance properties.

Module 3: (18 hours)
Channel Coding Part-II: Characteristics of Finite fields- Construction and basic properties of Finite Fields- Computations using Galois Field arithmetic- Extension Fields. Cyclic codes – Non-systematic and systematic codes-Construction and Decoding- Minimal Polynomials, Conjugates and Conjugacy classes, BCH codes – Construction and decoding - Reed Solomon codes, Introduction to low density parity check codes.- Convolutional codes: Encoder representations and Types - Maximum likelihood decoding - Viterbi decoding, hard decision and soft decision decoding - Transfer function of convolutional codes, Interleaving, Concatenated codes - Introduction to Turbo codes.

References:

1. Thomas M. Cover and Joy A. Thomas, *Elements of Information Theory*, Wiley India Pvt Ltd, 2nd Edition 2013.
2. Shu Lin and Daniel. J. Costello Jr., *Error Control Coding: Fundamentals and applications*, 2nd Edition, Pearson Education, 2010.
3. John G. Proakis and M. Salehi, *Digital Communication*, 5th Ed., McGraw Hill Education, 2014.
4. David J. C. MacKay, *Information Theory, Inference and Learning Algorithms*, Cambridge University Press, 2005
5. Ranjan Bose, *Information Theory, Coding and Cryptography*, 2nd Edition, McGraw Hill Education, 2008.
6. R. E. Blahut, *Theory and Practice of Error Control Codes*, Addison-Wesley, 1983.

EC3022D COMPUTER NETWORKS

Pre-requisites: EC3012D Communication Theory and Systems II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the basic building blocks of a computer network and visualize the architecture of the global Internet

CO2: Analyze the protocols and algorithms to illustrate the basic principles on which they are designed

CO3: Evaluate performance of various protocols,justify the choice of design parameters, summarize the findings, and recommend improvements

CO4: Modify various existing network technologies for the design and development of more resource efficient and eco-friendly network technologies in the future

Module 1: (13 hours)

Foundation: Building blocks- links, nodes - Layering and protocols - OSI architecture - Internet architecture - Multiplexing -Circuit switching vs packet switching - Datagram Networks - Virtual Circuit networks - Implementing network software – socket programming
Direct Link Networks: Framing - Error detection - Reliable transmission - Multiple access protocols – Ethernet(IEEE 802.3) - wireless LAN (IEEE 802.11) - Bridges and LAN switches.
.

Module 2: (13 hours)

Internetworking: IPv4- addressing, datagram forwarding – ARP - Routing- distance vector (RIP) - Link state(OSPF) - routing for mobile hosts - Global Internet- subnetting – CIDR - inter-domain routing (BGP) - IPv6.
End to End protocols: Simple demultiplexer (UDP) - Reliable byte stream (TCP)- segment format, connection management, sliding window, flow control, adaptive retransmission, congestion control, TCP extension, performance.

Module 3: (13 hours)

Broadband services and QoS issues: Quality of Service issues in networks-Real Time transport protocol - Integrated service architecture-Queuing Disciplines- Weighted Fair Queuing- Random Early Detection- Differentiated Services- Protocols forQOS support- Resource reservation-RSVP- Multi protocol Label switching – Routing among mobile devices

References:

1. Peterson L.L. & Davie B.S., *Computer Networks: A System Approach*, Elsevier, 5th edition, 2012.
2. James. F. Kurose and Keith.W. Ross, *Computer Networks, A top-down approach featuring the Internet*, Pearson Education, 5th edition, 2015.
3. D. Bertsekas and R. Gallager, *Data Networks*, PHI, 2 nd edition, 2000.
4. S. Keshav, *An Engineering Approach to Computer Networking*, Pearson Education, 2005.

EC3023D CONTROL SYSTEMS

Pre-requisites: EC2014D Signals and Systems

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze system block diagram and estimate performance parameters from system transfer function

CO2: Design stable Control systems using time domain and frequency domain methods

CO3: Analyze and design digital control systems in Z-domain

Module 1: (12 hours)

General Introduction to control systems with examples, Open-loop and closed-loop systems, Introduction to Performance Specifications, Mathematical modelling of control systems – Review of Laplace Transform Concepts, Transfer Function, Impulse Response, Block Diagram, Signal flow graph, Mason’s Rule, Block Diagram reduction techniques, Mathematical modelling of Electrical and Mechanical systems.

Review of Poles and Zeros, Transient and Steady state response of First and Second Order systems for standard inputs, Performance parameters – Time Constant, Rise time, Settling Time, Natural Frequency, and Damping Ratio. Steady state error in unity feedback systems and types of systems.
Concept of Stability, Routh-Hurwitz criterion,

Module 2: (15 hours)

Control System Analysis and Design using Root Locus Method – Rules for plotting Root Locus, Pole sensitivity, Methods to improve Transient and Steady state responses. Lead, Lag and Lag-Lead Compensation.
Polar plots, Nyquist stability criteria, Gain Margin, Phase Margin, Bode Plot, Concept of control system design using frequency response techniques.
Introduction to PID controllers, Tuning Methods, Simple circuit realizations

Module 3: (12 hours)

Modelling of systems using State Space representation, Relation between Laplace Transform and State Space Representation, Eigen values and Transfer function poles, Time domain solution of state equations.Stability in state space, Steady state error for systems in state space. Controller design using pole placement, controllability, Observability
Introduction to Digital Control Systems, sampler, sample and Hold, Review of Z-Transform, Pulse Transfer Function, Block diagram, Bilinear Transformation,Stability, Steady state and Transient response, simple implementations.

References:

1. Norman S.Nise, *Control Systems Engineering,*Sixth Edition, John Wiley & Sons, 2011.
2. Katsuhiko Ogata, *Modern Control, Engineering*, Fifth Edition, Prentice Hall,2010
3. Kuo Benjamin, Colnaraghi Farid, *Automatic Control Systems*, Eighth Edition, John Wiley & Sons, 2003

EC3093D DIGITAL SIGNAL PROCESSING LAB

Pre-requisites: EC3013D Digital Signal Processing

Total hours: 39

L	T	P	C
0	0	3	2

Course Outcomes:

CO1: Visualize the basic concepts of discrete signal processing such as various signals, Fourier transforms, construction of the z-plane, pole-zero plots etc. using programming languages/software such as C, Matlab/Scilab etc.
CO2: Implement signal processing algorithms such as convolution, FFT algorithms etc. in offline and in real time using software/dedicated DSP hardware.
CO3: Design, implement and characterize various digital filers in offline and in real time using software/dedicated DSP hardware.
CO4: Apply DSP algorithms to real life problems through a project work/major laboratory experiment and implement one such application with scientific observations reported in a professional manner working in a group.

The list of experiments is only indicative. A minimum subset of built-in functions in the software (for eg. Matlab) are to be used so that the students develop data structures and algorithms from scratch. Experiments are to be implemented in a combination of software and hardware platforms.

1. Familiarizing experiment involving visualization of signals and systems - impulse response - involved in DSP.
2. Working in the Z-plane, poles and zeros, graphical calculation of phase and magnitude responses.
3. Linear convolution - Response of a LTI system to an arbitrary input.
4. Discrete Fourier transform - Fast Fourier Transform algorithms - Decimation in time and Decimation in frequency FFT algorithms, Inverse discrete Fourier transform.
5. Convolution with DFT - Circular convolution and Linear Convolution.
6. Filtering long signals using FFT algorithms - Overlap-save and overlap-add methods.
7. Frequency response of FIR filters - Minimum Phase filters, Linear phase filters.
8. FIR filter design - Window-based method - impulse response, step response, pulse response, response to sinusoids; FIR filters having arbitrary frequency response - Design using frequency sampling method.
9. IIR filter design - Butterworth and Chebyshev designs, Impulse invariant and Bi-linear transformation methods.
10. Lattice structure realization of digital filters.
11. Finite word length effects - coefficient quantization and rounding of adders/multipliers - in DSP system implementation.
12. Application of DSP algorithms to speech/music and Image processing.
13. A mini project applying DSP algorithms to a relevant problem of current importance.

References:

1. Mitra S. K., *Digital Signal Processing: A Computer Based Approach*, McGraw-Hill Publishing Company, 2013.
2. Emmanuel C. Ifeacher, Barry W. Jervis, *Digital Signal Processing: A Practical Approach*,2nd Edition, Pearson Education, 2004.
3. John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 4th Edition, Pearson India, 2007.
4. Oppenheim A. V., Schafer R. W, *Digital Signal Processing*, Pearson India, 2015.
5. Boaz Porat, *A Course in Digital Signal Processing*,Wiley India Pvt. Ltd., 2012.
6. The Manuals of the Digital Signal Processors manufactured by Texas Instruments or Analog Devices (Available online on the web pages of Texas Instruments or Analog Devices).

EC4011D WIRELESS COMMUNICATION

Pre-requisites: EC3012D Communication Theory and Systems II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain different types of wireless channels, examine the effects of mobile radio propagation environment, and discuss modern wireless systems

CO2: Analyze the effectiveness of different techniques such as diversity reception, RAKE receiver, and spread spectrum in combating / mitigating the multichannel fading effects on received signals

CO3: Evaluate the impact of mobile/wireless channels and performance enhancement techniques on communication systems, and justify the findings

CO4: Modify existing communication technologies or design & developnew technologies for enhanced spectral efficiency and quality of experience, so as to meet the growing demandfor mobile communication

Module 1: (13 hours)

Cellular concept –TDMA, FDMA, CDMA - frequency reuse – cochannel interference -power control for reducing interference - improving capacity in cellular systems – cell splitting - sectoring - hand off strategies - call blocking in cellular networks.

Mobile radio propagation - free space propagation model - ground reflection model – large scale path loss - small scale fading and multipath propagation - impulse response model of a multipath channel - parameters of a mobile multipath channel - multipath delay spread - doppler spread - coherence band width - coherence time - time dispersion and frequency selective fading - frequency dispersion and time selective fading - concepts of level crossing rate and average fade duration

.

Module 2: (13 hours)

Digital communication through fading multipath channels - frequency non selective, slowly fading channels - frequency selective, slowly fading channels- calculation of error probabilities - tapped delay line model - the RAKE receiver performance – diversity techniques for mobile wireless radio systems concept of diversity branch and signal paths -combining methods - selective diversity combining - maximal ratio combining- beam forming - Alamouti scheme - MGFs in diversity analysis - parallel decomposition of MIMO channel.

Module 3: (13 hours)

Fundamental concepts of spread spectrum systems - pseudo noise sequence - performance of direct sequence spread spectrum systems - analysis of direct sequence spread spectrum systems - the processing gain and anti jamming margin – frequency hopped spread spectrum systems – Orthogonal frequency division multiplexing (OFDM) – cyclic prefix – peak-to-average power ratio – OFDMA – single carrier FDMA – case study with LTE/LTE-advanced 4G system.

References:

1. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2005
2. Rappport Thoedore S., *Wireless Communications*, Principles and Practice, 2nded, Pearson, 2010
3. Haykin, S. and Moher M., *Modern Wireless Communications*, Prentice Hall 2005.
4. Proakis J.G., *Digital Communications*, Third Edition, MGH,2001

EC4012D RADIATION AND ANTENNA THEORY

Pre-requisites: EC2022D Electromagnetic Field Theory

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Outline important and fundamental antenna engineering parameters and terminology

CO2: Interpret the basic concepts of electromagnetic wave radiation and reception

CO3: Develop the basic skills necessary for designing a wide variety of practical antennas and antenna arrays.

CO4: Identify the atmospheric and terrestrial effects on radio wave propagation.

Module 1: (15 hours)

Potential functions, radiation from Hertz dipole: near filed, far field, radiated power, radiation resistance, radiation pattern, thin linear dipole antenna, receiving antenna, monopole antenna, half-wavelength dipole antenna, Fourier transform relationship between current and radiation pattern.
Radiation parameters of antenna: half power beam width, directivity, antenna gain, beam solid angle, effective height, radiation efficiency.

Module 2: (15 hours)

Antenna arrays: two element array; Uniform Linear Array: direction of maximum radiation, broadside and end-fire directions, directions of nulls, directions of sidelobes, half power beam width, directivity of uniform array, grating lobe, array synthesis; Special Types of Arrays: binomial array, Chebyshev array, superdirective arrays.
.
Types of antennas: basic principle of beam steering, travelling wave antennas, principle and applications of parabolic dish and rectangular patch antennas and log periodic antenna array, antennas for mobile base station and handsets, basic principle of smart antenna.

Module 3: (9 hours)

Propagation of radio waves: Modes, structure of atmosphere, characteristics of ionized regions, sky wave propagation, effect of earth‘s magnetic field, MUF, skip distance, virtual height, skip distance ionospheric abnormalities and absorption, space wave propagation, LOS distance, effective earth‘s radius, field strength of space wave, duct propagation, VHF and UHF Mobile radio propagation, tropospheric scatter propagation, fading and diversity techniques.

References:

1. John D. Krauss, *Antennas for all Applications*, McGraw-Hill Series 3rdEdn., 1988.
2. Constantine A. Balanis, *Antenna Theory-Analysis and Design*, Wiley-India, 3rd Edn.,2010.
3. Matthew N. O. Sadiku, *Elements of Electromagnetics*, Oxford University Press, 4th Edn., 2006.
4. R K Shevgaonkar, *Electromagnetics Waves*, McGraw Hill, 1stEdn.,2016.
5. Frank Gross, “*Smart Antennas for Wireless Communications*”, McGraw-Hill Series, 2005.
6. Jordan and Balmain: *Electromagnetic waves and radiating systems*, Pearson India, 2ndEdn., 2015.
7. Ronald J Marhefka, A S Khan, John D Krauss, *Antennas & Wave Propagation*, SIE, 4th Edn., 2017.

EC4091D COMMUNICATION ENGINEERING LAB II

Pre-requisites: EC3012D Communication Theory and Systems II
EC3021D Information Theory and Coding

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Acquire the ability to design, implement and test modems for digital communication systems

CO2 Develop the necessary skills for the software implementation and performance evaluation of digital modulation schemes using realistic channel; models

CO3: Acquire the capability to use new software and hardware tools tools effectively and creatively to synthesize digital communication systems.

CO4: Develop the ability to work independently and within a group and make valid contributions to achieve the objectives

CO5: Demonstrate skills for conducting oral presentations and writing good quality technical reports

Hardware Experiments:

1. Pulse code modulation (PCM) and Differential PCM
2. Delta modulation
3. Time division multiplexing
4. Line coding schemes
5. Binary Frequency Shift Keying (BPSK): Modulation and Demodulation
6. Binary Frequency Shift Keying (BFSK): Modulation and Demodulation
7. Binary Differential PSK: Modulation and Demodulation
8. Quadrature PSK: Modulation and Demodulation
9. Linear block codes: Encoder and decoder
10. Cyclic Codes: Encoder and decoder

Simulation Experiments:

1. Bit/symbol error rate evaluation of digital modulation schemes such as BPSK, QPSK, BFSK and DPSK over additive white Gaussian channels
2. Channel Equalizers (Zero forcing and MMSE): Performance evaluation over AWGN channels
3. Convolutional Coders and Viterbi Decoder: Performance evaluation over AWGN channels

References:

1. L.W. Couch, *Digital and Analog Communication Systems*, 7/E, Pearson, 2007.
2. W. Tomasi*, Electronics Communication Systems: Fundamentals Through Advanced, 5/e*, Pearson, 2007
3. J.G. Proakis, and M. Salehi, *Contemporary Communication Systems using MATLAB*, Bookware Companion Series, 2006

EC4092D SEMINAR

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

CO1: Survey the literature on new research areas and propose findings on a particular topic

CO2: Organize and illustrate technical documentation with scientific rigor and adequate literal standards on the chosen topic strictly abiding by professional ethics while reporting results and stating claims.

CO3: Demonstrate communication skillsin conveying the technical documentation via oral presentations using modern presentation tools.

Methodology

The objective of the seminar is to impart training to the students in collecting materials on a specific topic in the broad domain of Engineering/Science from books, journals and other sources, compressing and organizing them in a logical sequence, and presenting the matter effectively both orally and as a technical report. The topic should not be a replica of what is contained in the syllabi of various courses of the B.Tech program. The topic chosen by the student shall be approved by the course Faculty/Seminar evaluation committee. The committee shall evaluate the presentation of students. A seminar report duly certified by the Faculty-in-Charge of the seminar in the prescribed form shall be submitted to the department after the approval from the committee.

EC4098D PROJECT: PART I

Pre-requisites: Nil

L	T	P	C
0	0	6	3

Total hours: 78

Course Outcomes:

CO1: Demonstrate sound technical knowledge in the domain of the selected project topic

CO2: Develop the skills of independent and collaborative learning

CO3: Acquire the knowledge and awareness to carry out cost-effective and environmental friendly designs

CO4: Gain the expertise to use new tools for the design and development

CO5: Develop the ability to write good technical report and to make oral presentation of the work carried out

Syllabus

Final year major projects represent the culmination of study towards the Bachelor of Technology (B. Tech.) degree. The major projects offer the opportunity to apply and extend knowledge acquired throughout the B. Tech. program. The major project can be analytical work, simulation, hardware design or a combination of these in the emerging areas of Electronics and Communication Engineering under the supervision of a faculty from the ECE Department. The specific project topic undertaken will reflect the common interests and expertise of the student(s) and supervisor. Students will be required to:1) perform a literature search to review current knowledge and developments in the chosen technical area; 2) undertake detailed technical work in the chosen area using one or more of:

- Analytical models
- computer simulations
- hardware implementation

The emphasis of major project shall be on facilitating student learning in technical, project management and presentation spheres. Project work can be carried out individually or by a group of maximum of five students. The B. Tech. project evaluation committee of the department shall evaluate the project work during seventh semester, in two phases. The first evaluation shall be conducted in the middle of the semester. This should be followed by the end-semester evaluation. Students are expected to complete the literature review, preliminary design, and learning of the analytical / software / hardware tools. They are also expected to obtain some results and to provide the detailed work plan for the eight semester.

EC4099D PROJECT: PART II

Pre-requisites: successful completion of EC4098D Project: Part I

Total hours: 130

L	T	P	C
0	0	10	5

Course Outcomes:

CO1: Demonstrate sound technical knowledge in the domain of the selected project topic

CO2: Develop the skills of independent and collaborative learning

CO3: Acquire the knowledge and awareness to carry out cost-effective and environmental friendly designs

CO4: Gain the expertise to use new tools for the design and development

CO5: Develop the ability to write good technical report and to make oral presentation of the work carried out

Syllabus

EC4099D Project II is a continuation of EC4098 Project I started in the seventh semester. Students should complete the work planned in the seventh semester and prepare the project report on the complete work done in the two semesters. The B. Tech. project evaluation committee of the department shall evaluate the project work during the eighth semester, in two phases. The first evaluation shall be conducted in the middle of the semester. This should be followed by the end-semester evaluation.

EC3051D DATA STRUCTURES USING C++

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Illustrate the concept of the object oriented approach towards problem solving in the real world.

CO2: Assess the software requirements of the IT enabled world

CO3: Analyze the important components such as algorithms, complexity and specific solutions for modern IT problems

CO4: Develop solutions to problems modeled as trees and graphs

Module 1: (13 hours)

General concepts of object oriented programming C++, Class overview - Class Definition. Access Control, Class Scope, Constructors and Destructors, Inheritance, Polymorphism, Overloading, Encapsulation, Friend functions, dynamic memory allocation and de-allocation. Complexity analysis, asymptotic notation, Recursion Sorting algorithms- Selection Sort, Quick sort, Merge Sort. Abstract data types -Linked lists, Stack and Queue Searching-Linear and Binary search implementation. Implementation of sorting, searching , linked lists ,stack and queues using C++

Module 2: (13 hours)
Binary tree - in-order, pre-order and post-order traversals – representation and evaluation of arithmetic expressions using binary tree, Binary Search trees - insertion, deletion and search- Prefix, Infix and Post fix representation and conversions,-Heaps and heap sort Implementation of tree algorithms using C++

Module 3: (13 hours)
Graph representation-Adjacency matrix, Adjacency lists- Depth First Search (DFS)-Breadth First Search(BFS),Minimum spanning tree problem - Kruskal's algorithm- Prim’s algorithm Shortest path problem - Dijkstra's algorithm -Implementation of graph algorithms using C++and the Standard Template library. Hashing -chaining –linear probing –double hashing

References:

1. D.Ravichandran ,*Programming with C++*,Third Edition,2011,Mc Graw Hill Education
2. D.Corman, Charles E. Leiserson, Ronald L. Rivest , *Introduction to Algorithms*, Third Edition, MIT, 2009.
3. YedidyahLangsam,MosheJ.Augenstein,AaronM.Tanenbaum,, *Data Structures using C++* ,Pearson Education, 2016
4. Larry Nyhoff ,ADTs, *Data Structures and Problem Solving with C++*, Second Edition, Pearson Education 2012
5. Sahni S., *Data Structures, Algorithms, and Applications in C++*, McGraw Hill, Singapore, 1998.

EC3052D MICROELECTRONICS TECHNOLOGY

Pre-requisites: EC2013D Solid State Devices

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain various semiconductor materials used in device fabrication.

CO2: Identify the fabrication steps of various micro devices.

CO3: Evaluate fabricated devices effectively in terms of various performance parameters.

CO4: Build an idea on process integration – NMOS, CMOS and Bipolar process.

Module 1: (15 hours)

Material properties, crystal structure, lattice, basis, planes, directions, angle between different planes, phase diagram and solid solubility, Crystal growth techniques, Epitaxy, Clean room and safety requirements. Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultra thin films, Deal-Grove model and improvements in Deal-Grove method for thin and ultra thin oxide layers, Diffusion process, Ion implantation, modeling of Ion implantation, statistics of ion implantation, damage annealing, thermal budget, rapid thermal annealing, SIMS.

Module 2: (18 hours)

Deposition & Growth: Various deposition techniques CVD, PVD, evaporation, sputtering, spin coating, LPCVD, MBE, ALCVD, Growth of High k and low k dielectrics, Etching - Different types, Photolithography: Positive photo resist, negative photo resist, comparison of photo resists, components of a resist, light sources, exposure, resolution, depth of focus, numerical aperture sensitivity, contrast, proximity and projection lithography, step and scan, optical proximity correction.

Next generation technologies: Immersion lithography, Phase shift mask, EUV lithography, X-ray lithography, e-beam lithography, ion lithography, SCALPEL

Module 3: (6 hours)

Planarization Techniques: Need for planarization, Chemical Mechanical Polishing
Copper damascene process,; Multi-level metallization schemes, Process integration: NMOS, CMOS and Bipolar process.

References:

1. James Plummer, M. Deal and P.Griffin, *Silicon VLSI Technology*, Prentice Hall Electronics, 2010
2. S.M. Sze, Stephen Campbell, *The Science and Engineering of Microelectronics*, Oxford University Press, 1996.
3. S.K. Ghandhi, *VLSI Fabrication Principles*, John Wiley Inc, New York, 1983.

EC3053D SEMICONDUCTOR DEVICE MODELING

Pre-requisites: EC2013D Solid State Devices

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze the basic equations governing physics of semiconductor devices.

CO2: Interpret the models which are used to describe various semiconductor device phenomena.

CO3: Analyze the models used for simulation of MOSFETs.

Module 1: (15 hours)

Introduction to modeling – different approaches of modeling

Basic semiconductor equations- Poisson Equation – Carrier continuity equations – Transport equations – Drift-diffusion transport model – carrier statistics – Effective density of states – Energy Band gap model – Band gap narrowing – incomplete ionization of impurities – Traps and defects –Generation-recombination models –Schottky Contacts - tunneling models

Module 2: (8 hours)

Physical models – mobility modeling – low field mobility models – doping dependence –Perpendicular electric field dependent mobility model – Parallel electric field-dependent mobility- Impact Ionization models

Module 3: (16 hours)

MOSFET Modeling –Review of MOSFET device physics – Substrate bias effects – Sub threshold operation DC model – Pao- Sahmodel – Charge sheet model – small geometry models – dynamic MOSFET model – Modeling of hot carrier effects – sub threshold current - Substrate current model – Gate current model - Model parameter extraction.

References:

1. Narain Arora, *MOSFET modeling for VLSI simulation: Theory and Practice*, World Scientific, 2007.
   M. S. Tyagi, *Introduction to Semiconductor Materials and Devices*, John Wiley and Sons, 2004.
2. S.M.Sze, *Physics of semiconductor devices*, McGraw Hill, 2nd ed., 1999
3. Yuan Taur&Tak H Ning, *Fundamentals of Modern VLSI Devices*, Cambridge University Press, 1998.
4. Ben G Streetman, *Solid state devices*, 5e, 2002, Pearson Education.

EC3054D COMPOUND SEMICONDUCTOR DEVICES

Pre-requisites: EC2013D Solid State Devices

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze and model the physics of compound semiconductor materials.

CO2: Analyze Metal–Semiconductor junctions and Metal–Oxide–Semiconductor system using compound semiconductors.

CO3: Interpret the physics of HEMT and HBT and their application in high speed circuits.

Module 1: (13 hours)

Properties of most widely used compound semiconductors - GaAs, InP, GaN- comparison with silicon - Crystal structure, dopants and electrical properties - Band diagrams of homo and hetero junctions Technology of Compound Semiconductor devices with emphasis on crystal growth, MOCVD, MBE, Ion-implantation, etching and metallization.

Module 2: (13 hours)

Metal semiconductor contacts and Metal Insulator Semiconductor devices: Native oxides of Compound semiconductors for MOS devices and the interface state density related issues- Schottky barrier diode, Metal semiconductor Field Effect Transistors -D.C. characteristics- short channel effects.

Module 3: (13 hours)

Hetero-junction devices- Modulation Doped FET (MODFET) structure for high electron mobility realization. Principle of operation and the unique features of HEMT, InGaAs/InP HEMT structures- Hetero junction Bipolar transistors- Principle of operation and the benefits of hetero junction BJT for high speed applications- GaAs and InP based HBT device structure and the surface passivation for stable high gain high frequency performance- SiGe HBTs and the concept of strained layer devices

References:

1. S.K.Ghandhi,*VLSI Fabrication Principles*, Wiley 2008.
2. Ruediger Quay, *Gallium Nitride Electronics*, Springer 2008.
3. S.M.Sze , *High-Speed Semiconductor Devices* Wiley 1990.
4. Michael Shur , *Physics of Semiconductor Devices* , PHI, 1995.
5. SandipTiwari, *Compound Semiconductor Device Physics*, Academic Press, 1991.

EC3055D POWER SEMICONDUCTOR DEVICES

Pre-requisites: EC2013D Solid State Devices

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze and model the physics of planar power semiconductor diodes, Power Metal Oxide Semiconductor Field Effect Transistor (MOSFET), Power Bipolar Junction Transistor (BJT) and Insulated Gate Bipolar Junction Transistor (IGBT).

CO2: Design edge termination structures to improve the breakdown voltage.

CO3: Analyze the trade-offs in the design of power semiconductor devices.

CO4: Interpret the physics of wide band gap material devices and their use in high power semiconductor applications.

Module 1: (13 hours)

Avalanche Breakdown voltage of planar pn junctions – dependence of breakdown voltage on drift layer doping and thickness – on resistance – edge termination techniques to improve breakdown voltage– floating field rings – junction termination extension - field plates- design trade offs

Module 2: (13 hours)

Power MOSFETs – V Groove (V) MOSFET, U Groove (U)MOSFET and Vertical double diffused (VD) MOSFET – VD MOSFET process –cellular design - IV characteristics -On resistance components – break down voltage – design considerations - safe operating area –edge termination of VDMOSFETs – Lateral double diffused (LD) MOSFET – Power BJT – Blocking characteristics - IGBT–device operation – equivalent circuit - characteristics.

Module 3: (13 hours)

Gallium Nitride (GaN) and Silicon Carbide (SiC) Power devices: Advantage of wide band gap materials-wide band gap material physics- Various GaN/SiC devices-Polytypes of SiC - SiC Double implanted (D) MOSFET – on resistance components – break down voltage - GaN/SiC device manufacturing technology

References:

1. B. J. Baliga, *Gallium Nitride and Silicon Carbide Power Devices*, World Scientific, 2017.
2. Hongyu Yu , Tianli Duan, *Gallium Nitride Power Devices*, Pan Stanford 1e, 2017.
3. B. J. Baliga, *Power Semiconductor Devices*, PWS Publishing Co., Boston, 1996.
4. Benda, Vitezslav, John Gowar, and Duncan A. Grant, Chichester , *Power semiconductordevices: theory and applications*, New York Wiley, 1999.

EC3056D MEMS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Interpret the basic principle of microsensors and actuators.

CO2: Demonstrate the basics of different micro machining technologies.

CO3: Develop knowledge on virtual fabrication based on different MEMS Simulators and different FEA tools

CO4: Analyze various bonding and packaging techniques in MEMS.

Module 1: (06 hours)

An introduction to Micro sensors and MEMS, Classical scaling in CMOS, Moore's Law - Clean room concept, Evolution of Micro sensors & MEMS, Micro sensors & MEMS applications

Module 2: (16 hours)

Microelectronic technologies for MEMS, MEMS Materials, Micromachining Technology, Bulk Micromachining :- Isotropic and anisotropic etching, wet etchants, etch stops, dry etching, comparison of wet and dry etching, Surface Micromachining, general process description, problems associated to surface micromachining, LIGA process, working principle of various micro systems- Micro machined Micro sensors: Mechanical, Inertial, Biological, Chemical, Acoustic, Integrated Smart Sensors.

Module 3: (17 hours)

MEMS Simulators and different FEA tools, Interface Electronics for MEMS, MEMS for RF Applications, Bonding & Packaging of MEMS- Direct bonding, Field assisted bonding, Bonding with an intermediate layer, General considerations in packaging design, The three levels of microsystem packaging, Packaging processing sequence, Conclusions & Future Trends.

References:

1. S. Senturia, *Microsystem Design*. Kluwer Academic Publishers, 2001
2. Tai-ran Hsu, *MEMS and Microsystems: design and Manufacture*.Tata McGraw Hill.2008
3. S.K. Ghandhi, *VLSI Fabrication Principles*. John Wiley Inc., New York, 1983
4. S.M. Sze, *VLSI Technology*, McGraw Hill, 1988

EC3057D MODELING AND TESTING OF DIGITAL SYSTEMS

Pre-requisites: EC2012D Digital Circuits and Systems

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Model complex digital systems using HDL targetting FPGA/ASIC.

CO2: Analyze and optimize the HDL code based on constraints such as area, delay and power

CO3: Perform functional verification using self-checking test benches.

CO4: Develop test strategy for fabricated chips.

Module 1: (15 hours)

Introduction to Logic Design with Verilog - Structural Models of Combinational Logic – Modules – Ports – Vectors, Four-Valued Logic and Signal Resolution – Test benches, Propagation Delay Modeling, Behavioural Modeling, Boolean-Equation-Based Behavioral Models of Combinational Logic, Blocking and Nonblocking Assignments, Propagation Delay and Continuous Assignments, Latches and Level-Sensitive Circuits, Cyclic Behavioral Models of Flip-Flops and Latches, Cyclic Behavior and Edge Detection

Module 2: (14 hours)

Different styles for Behavioral Modeling - Continuous-Assignment Models - Dataflow/RTL Models - Algorithm Based Models, FSM Modeling, IP Reuse and Parameterized Models - Clock Generators, Tasks and Functions

Introduction to synthesis - Logic Synthesis - RTL Synthesis - High-Level Synthesis, Synthesis of Combinational Logic - Synthesis of Priority Structures - Exploiting Logical Don't-Care Conditions, Synthesis of Sequential Logic with Latches and Flip-flops

Module 3: (10 hours)

FPGA architectures - Xilinx FPGAs - Practical design exercises on Verilog simulator/synthesizer
Introduction to Digital Testing - Test Pattern Generation - Fault Equivalence, Fault Dominance, DFT methods – Scan chain - Boundary scan, Built in self test – LFSRs

References:

1. Ciletti M.D., Advanced *digital design with the Verilog HDL*, Second Edition, Prentice Hall, 2010.
2. Palnitkar S., *Verilog HDL: A guide to digital design and synthesis*, Prentice Hall; 2003.
3. Charles Roth, Lizy Kurian John, Byeong Kil Lee, *Digital systems design using Verilog*, First Edition, Cengage Learning, 2014.
4. Bushnell M, Agrawal V., *Essentials of electronic testing for digital, memory and mixed-signal VLSI circuits*, Springer Science & Business Media, 2004.

EC3058D VLSI CIRCUITS AND SYSTEMS

Pre-requisites:EC2012D Digital Circuits and Systems

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze static and dynamic characteristics of digital CMOS circuits

CO2: Design static and dynamic CMOS logic circuits for a given functionality, speed, power consumption and area requirements

CO3: Demonstrate the performance of CMOS logic circuits designed using various logic styles with the help of CAD tools

CO4: Design arithmetic circuits and memories using CMOS

Module 1: (14 hours)

Overview of VLSI Design flow- Review of MOS transistors, Threshold Voltage, MOSFET capacitances-Junction capacitances-Oxide related capacitances – Scaling - Short channel effects -MOSFET as switch-Switch models of inverter- CMOS inverters-DC and Transient analysis-Area, power and noise margin considerations-Stick diagram and layout of CMOS inverter, Simulation analysis of CMOS circuits using CAD tools.

Module 2: (14 hours)

Multiple input static CMOS logic circuits, DC and transient analysis, Pass transistor, Complementary pass transistor and transmission gate logic styles, realization, Area, power and noise margin considerations, Sizing for optimal delay - Logical Effort

Dynamic circuits, Issues with dynamic circuits- Domino logic and its derivatives, C2MOS, TSPC registers, Designing sequential circuits, clocked CMOS circuits

Module 3: (11 hours)

Cell based design, Standard cells and Data path cells, Logic and circuit design of arithmetic circuits-Adders-Ripple carry, Carry look ahead and other high speed adders, Array and tree multipliers-Logarithmic and barrel shifters, 6T SRAM and DRAM cell design

References:

1. Jan M.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, *Digital Integrated Circuits- A Design Perspective*, Prentice Hall, Second Edition, 2003
2. Sung–Mo Kang, Yusuf Leblebici, Chulwoo Kim, *CMOS Digital Integrated Circuits - Analysis & Design*, Mc Graw Hill Education, FourthEdition, 2016
3. John P Uyemura, *Introduction to VLSI Circuits and Systems*, Wiley India, 2002
4. Neil Weste, David Harris, *CMOS VLSI Design: A Circuits and Systems Perspective*, Fourth Edition, Pearson Publication, 2011
5. R.J. Baker, *CMOS: Circuit Design, Layout, and Simulation*, Third Edition, Wiley-IEEE Press, 2010.

EC3059D ACTIVE NETWORK SYNTHESIS

Pre-requisites: EC3011D Electronic Circuits II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Apply the principles and design methods pertaining to analog filters

CO2: Compare & contrast the various filter architectures, their sensitivities to different parameters affecting their performance & the complexity of circuit implementation

CO3: Demonstrate a capability to work with different active elements like opamp, OTA, current conveyor etc to suit different sets of performance criteria

CO4: Develop the ability to put emphasis on realistic implementations of filters.

Module 1:(9 hours)

Network functions - Frequency and impedance denormalization - Types of filters (filter magnitude specs, phase specs, second-order filter functions) - Butterworth, Chebyshev, Elliptic and Bessel filters - Sensitivity - Definition and basic properties - Function sensitivity - Coefficient sensitivity - Q and ω_o sensitivity

Module 2: (14 hours)

Amplifiers and fundamental active building blocks - Opamps, OTAs, CCIIs, Integrators, gyrators and immittance converters

Module 3: (16 hours)

Second-order filters - Single-amplifier RC biquads - Multiple amplifier biquads (Kerwin-Huelsman-Newcomb filter, Tow-Thomas filter, Akerberg-Mossberg filter) - Biquads based on general impedance converter – OTA-based (two-integrator loop) filters - effects of active nonidealities - Higher order filter realization - Cascade realizations, pole-zero pairing - Multiple-loop feedback realizations - LC ladder simulations

Fully integrated high-frequency filter realizations - Transconductance filters - Log-domain filters

References:

1. T Deliyannis, Yichuang Sun & J K Fidler, *Continuous-Time Active Filter Design*, CRC Press, 1999
2. GobindDaryanani, *Principles of Active Network Synthesis and Design*, John Wiley, 1978
3. Rolf Schaumann, Haiqiao Xiao, Mac Elwyn Van Valkenburg, *Analog Filter Design*, 2nd Edition, Oxford University Press, 2010

EC3060D COMPUTER ORGANIZATION AND ARCHITECTURE

Pre-requisites: EC2012D Digital Circuits and Systems

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Evaluate the performance of different designs and organizations of computer

CO2: Develop programs using ARM Instruction Set

CO3: Design CPU that satisfy requirements

CO4: Analyze impact of memory hierarchy and I/O bandwidth on computer performance/cost

Module 1: (15 hours)
Introduction to Computer Abstractions and Technology – Performance – The Power Wall - The Sea Change: The Switch from Uniprocessors to Multiprocessors – Introduction to Instructions – Operations - Operands – Signed and Unsigned Numbers – Representing Instructions– Logical Operations - Instructions for Making Decisions - Supporting Procedures in Computer Hardware - Communicating with People – ARM Addressing Modes

Module 2: (11 hours)
Introduction to Computer Arithmetics - Addition and Subtraction - Multiplication - Division - Floating Point - Parallelism and Computer Arithmetic: Associativity - Introduction to Processors - Logic Design Conventions - Building a Datapath - A Simple Implementation Scheme - Pipelining - Pipelined Datapath and Control - Data Hazards: Forwarding versus Stalling - Control Hazards - Parallelism and Advanced Instruction Level Parallelism

Module 3: (13 hours)
Memory Hierarchy – Introduction - Framework - The Basics of Caches - Measuring and Improving Cache Performance - Virtual Memory - Introduction to Storage and I/O – Dependability, Reliability and Availability – Disk Storage – Flash Storage – Connecting Processors, Memory and I/O Devices – Interfacing I/O Devices to Processor, Memory and Operating System – I/O Performance Measures with Examples - I/O System Designing – Parallelism and I/O: Redundant Arrays of Inexpensive Disks

References:

1. Patterson D.A. & Hennessy J.L., *Computer Organization and Design ARM Edition: The Hardware Software Interface*, Morgan Kaufmann Publishers, 2016.
2. Morris Mano *Computer System Architecture*, Prentice-Hall India, Eastern Economy Edition, 2009
3. Carl Hamacher, ZvonkoVranesic & SafwatZaky, *Computer Organization*, McGraw Hill, 5th Edition, 2011
4. Pal Choudhuri P., *Computer Organization and Design*, Prentice-Hall India, 2nd Edition, 2003
5. William Stallings, *Computer Organization and Architecture*, Pearson Education, 4th Edition, 2006

EC3061D EMBEDDED SYSTEMS

Pre-requisites: EC2023D Microprocessors and Microcontrollers

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Model embedded systems with appropriate hardware and software components

CO2: Analyze, program and use a typical ARM processor and its peripherals

CO3: Categorize and classify operating system tasks with special emphasis on real time systems

CO4: Apply the study of embedded technology to product design

Module 1: (12 hours)

Introduction to Embedded Systems: Application domain, model, figures of merit, classification, desirable features and history.
General aspects of Embedded System hardware MCU internals -Reset types,Timers, Stacks, Interrupts, DMA, Serial Communication etc.
Memory: SRAM ,DRAM and Flash . Pullup, Pulldown and High Z connections, A brief introduction to sensors and actuators, Interfacing sensors and actuators with micro-controllers, Design examples of simple embedded systems
Software Development Tools: IDE, Compilers, Simulators, Buses and protocols: Bus Arbitration,
On Board Buses- I2C and SPI, Off Board buses –USB,CAN,,AMBA, Ethernet, Wi-Fi, Zigbee and Bluetooth,

Module 2: (14 hours)

The ARM Processor: History and architecture , ARM Assembly language- Data Transfer Instructions, Arithmetic instructions, Branch Instructions, Multiple register instruction, Assembly Programming using the ARM Instruction Set in KeilMicrovision IDE, Features of a typical ARM 7 processor –Bus structure Peripherals: GPIO, Timers, Interrupts, Serial Communication, Programming the peripherals of ARM using C and KeilMicrovision IDE. New ARM processors –Introduction to the Cortex Series

Module 3: (13 hours)

Operating System Concepts: Layers and functions of an OS, Task Scheduling algorithms,Threads, Interrupts, Task Synchronization and communication ,Device drivers
Real Time Operating Systems: Hard and Soft real time tasks, Scheduling algorithms: Rate monotonic, Earliest Deadline First
Embedded Product Development: Hardware Software Co-Design, EDLC, Design process in the Product Design Industry –The steps from requirement collection to testing and deployment

References:

1. Lyla B.Das., *Embedded Systems-an integrated approach* ,Pearson Education ,2013
2. ShibuK.N , *Introduction to Embedded Systems*, Tata McGrawhill ,2010.
3. Wayne Wolfe, *Computers as Components*, 2nd Edition, Morgan Kaufmann,2011
4. Ganssle J, Noergaard T, Eady F, Edwards L, Katz DJ, Gentile R, Arnold K, Hyder K, Perrin B. *Embedded Hardware: Know It All*, Newnes, Elseiver Publications, 2007.

EC3062D ELECTRONIC INSTRUMENTATION

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain basic principles of measurement and characteristics of measuring system

CO2: Choose appropriate sensor/transducers for a measurement

CO3: Build data acquisition systems

CO4: Design Electronic instruments for different measurements

Module 1: (8 hours)

Basic principles of measurement – measuring system, instrument, transducers, Performance characteristics – static and dynamic characteristics, Errors in measurement- Sources of error, error propagation, calibration and standards.

Sensors and Transducers – Resistive, Inductive, capacitive, thermoelectric, piezoelectric, Photoelectric, Hall-effect, electromechanical, MEMS.

Module 2: (15 hours)

Measurement of voltage, current, Resistance, Capacitance, Inductance, Time, Frequency, Phase angle, Charge, Pulse Energy.

Bridge Circuits, Digital Multimeters, Digital Storage Oscilloscope.

Module 3: (16 hours)

Principles of Data Acquisition systems- Sampling Concepts, Review of ADC and DAC, Signal Conditioning, Display systems, interfacing to Computers.

Design of Electronic Instruments – The system perspective, Concepts of Human interfacing of systems, Enclosure design, Grounding and Shielding, Power and Thermal Design

References:

1. D.V.S Murty, *Transducers and Instrumentation*, Prentice-Hall, 2000
2. Kim R. Fowler, *Electronic Instrument Design*. Oxford University Press, 2006
3. H S Kalsi, *Electronic Instrumentation*, Tata McGraw-Hill, 2010
4. N.Mathivanan, *PC-Based Instrumentation*, Prentice-Hall,2007
5. Klaas B. Klaassen, *Electronic Measurement and Instrumentation*, Cambridge University Press,2002
6. Nihal Kularatna, *Digital and Analogue Instrumentation Testing and Measurement*, The institution of Electrical Engineers, 2003

EC3063D MULTIRATE SYSTEMS

Pre-requisites: EC3013D Digital Signal Processing

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze sampling rate alteration devices in time and frequency domains and develop efficient polyphase implementations of sampling rate converters.

CO2: Design multirate filter banks which have perfect reconstruction and near perfect reconstruction and assess the computational efficiency of multi rate systems.

CO3: Analyze the quantization effects in filter banks.

CO4: Apply filter banks in Signal Processing and Communication applications.

Module 1:(15 hours)

Multirate System Fundamentals: Basic multirate operations: up sampling and down sampling - time domain and frequency domain analysis; Aliasing and imaging, Interpolator and decimator design, Identities of multi-rate operations, Fractional sampling Rate operation, poly-phase representation.

Multirate Filter Banks: Maximally decimated filter banks: Quadrature mirror filter (QMF) banks - uniform DFT filter bank, Poly-phase representation, Errors in the QMF bank-; Methods of cancelling aliasing error, Amplitude and phase distortions, Perfect reconstruction (PR) QMF bank, Near perfect reconstruction (NPR) filter banks

Module 2: (15 hours)

M-channel Perfect Reconstruction Filter Banks: Filter banks with equal pass bandwidths, filter banks with unequal pass bandwidths –Tree structured uniform and non-uniform filter bank: analysis, - Necessary and sufficient condition for perfect reconstruction, Modified DFT filter banks , Design of PR and NPR systems

Module 3: (9 hours)

Quantization effects - Types of quantization effects in filter banks – Reducing amplitude distortion using optimization techniques, hardware complexity, Implementation, Applications of filter banks in Signal Processing and Communication

References:

1. P. P. Vaidyanathan, *Multirate Systems and Filter Banks*, Pearson Education, 2006.
2. Sanjit K. Mitra, *Digital Signal Processing: A Computer based Approach*, Special Indian Edition, McGraw Hill, 2008.
3. Fredric J Harris, *Multirate Signal Processing For Communication Systems*, 1st Edition, Pearson Education , 2007
4. N.J. Fliege, *Multirate Digital Signal Processing*, John Wiley, 1999.

EC3064D DIGITAL IMAGE PROCESSING

Pre-requisites: EC3013D Digital Signal Processing

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Demonstrate the methods of image acquisition, representation and manipulation to design and develop algorithms for solving image processing problems related to various applications like medicine, industry, communications etc.

CO2: Acquire strong mathematical skills to model image as a 2-D signal and extend the use 1-D signal processing tools to solve problems in image processing that meets the challenges of our age considering its social impacts.

CO3: Analyze various image processing algorithms for preprocessing, restoration, compression and segmentation using various spatial and frequency domain methods

CO4: Identify and solve complex real world problems in image processing using modern signal processing tools, active cooperative learning and be able to demonstrate them effectively.

CO5: Perceive skills to conduct independent study and analysis of image processing problems and techniques that would also engage the scholar in lifelong learning.

Module 1: (10 hours)

Introduction: Digital image, steps of digital image processing systems, elements of visual perception, Imaging Geometry, Coordinate conventions, Sampling and Quantization, Connectivity and relations between pixels. Simple manipulations of pixels - arithmetic, logical and geometric operations, Colour Images. Mathematical preliminaries: Introduction to 2D Signals and 2D LTI systems, 2D convolution, circulant and block circulant matrices, 2D Correlation, 2D random sequence.

Module 2: (14 hours)

Image Enhancement: Spatial domain processing - Simple intensity transformations, Histogram, Histogram based intensity transformations, Smoothing and sharpening filters, Nonlinear filtering; Frequency domain processing - Introduction to Transforms ,2D Discrete Fourier Transform, Spectral domain representation of Images, Filtering in frequency domain – low pass and high pass filters, KL Transform, Discrete Cosine Transform (DCT), Color image processing fundamentals.

Image Restoration: Image observation and degradation model, Estimation of degradation function Inverse filtering, Minimum Mean squared Error (Wiener) filtering, Constrained Least Squares Filtering.

Module 3: (15 hours)

Image compression: Redundancy and compression models; Lossless Compression: Variable-length Coding - Huffman, Arithmetic coding, Compression of binary images – JBIG Standard, Bit-plane coding, Loss less predictive coding; Lossy Compression: Quantization – Scalar and Vector, Transform based coding, JPEG Compression standard, Introduction to Sub band coding.

Morphological Image Processing: The structuring element, Basic operations on sets, Erosion, Dilation, Opening and Closing, Hit-or-Miss Transform, Basic Morphological Algorithms and applications.

Image segmentation: Edge detection, line detection, curve detection, Edge linking and boundary extraction, boundary representation, region representation and segmentation - Thresholding, Otsu's Method, Variable and multi variable thresholding, Region Growing, Region Splitting and merging, Segmentation Using Morphological Watersheds, Use of Motion in Segmentation.

References:

1. R. C. Gonzalez, R. E. Woods, *Digital Image Processing*, Pearson Education. III Ed.,2016
2. Jain A.K., *Fundamentals of Digital Image Processing*, Prentice-Hall, 2002.
3. Jae S. Lim, *Two Dimensional Signal And Image Processing*, Prentice-Hall, Inc, 1990.
4. Pratt W.K., *Digital Image Processing*, John Wiley, IV Edition, 2007.
5. K. R. Castleman, *Digital image processing*, Prentice Hall, 1996.
6. K R Rao, P Yip, Editors, *Transform and data compression handbook*, CRC Press, 2001

EC3065D STATISTICAL SIGNAL MODELLING AND PROCESSING

Pre-requisites: EC2014D Signals and Systems

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Develop a thorough understanding of signal models and methods to apply them for achieving performance requirements in various real life applications.

CO2: Devise statistical filtering solutions for optimizing the cost function indicating error in estimation of parameters

CO3: Design and develop optimum adaptive filtering solutions for real life applications taking care of requirements in terms of complexity and accuracy through rigorous performance analysis

CO4: Design and implement filtering solutions for applications such as channel equalization, interference cancelling and prediction considering present day challenges and recent research development

Module 1: (10 hours)

Review of random variables and processes - Filtering of random processes- Spectral factorization- Signal Modelling – Pole Zero models- Stochastic models- Moving Average(MA), Auto Regressive (AR) and ARMA models – Yule – Walker equations

Module 2: (14 hours)

Linear optimum filtering–Wiener filters – Minimum mean square error- Wiener- Hopf equations – Principle of orthogonality- Error performance surface- Linear prediction and noise cancelling – Levinson Durbin algorithm- Cholesky factorization- Lattice predictors -Spectrum estimation –Frequency estimation

Module 3: (15 hours)

Adaptive filtering- Need for adaptation – Classification- Method of Steepest Descent – Least mean Square adaptive filters – Convergence and stability- Least Squares and Recursive Least Squares- Kalman filtering- Applications of adaptive filters

References:

1. Monson H. Hayes, *Statistical Digital Signal Processing and Modeling*, John Wiley & Sons, Inc, 2009
2. Simon Haykin, *Adaptive Filter Theory*, 5 Ed, Pearson Education, 2014
3. John G. Proakis, Charles M. Rader, Fuyun Ling, Chrysostomos L. Nikias, Marc Moonen and IanK. Proudler, *Algorithms for Statistical Signal Processing*, Pearson Education Asia, 2002
4. Zaknich, *Principles of Adaptive Filters and Self Learning Systems*, Springer-Verlag London, 2005

EC4051D MICROWAVE COMMUNICATION

Pre-requisites: EC2022D Electromagnetic Field Theory

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Choose different types of satellite based communication systems

CO2: Analyze and design practical systems for Microwave Communication

CO3: Design space technology based communication systems

CO4: Analyze long distance communication methods and technologies

Module1: (12 hours)

Satellites and orbits: Communication satellites –Space-craft subsystems, payload – repeater, antenna, attitude and control systems, telemetry, tracking and command, power sub-system and thermal control. Orbital parameters, satellite trajectory, period, geostationary satellites, non-geostationary constellations.

Module 2: (12 hours)

Earth stations and terrestrial links: Antenna and feed systems, satellite tracking system, amplifiers, fixed and mobile satellite service earth stations. Terrestrial microwavelinks, line of sight transmission, Transmitters, receivers and relay towers -distance considerations, digital links.

Module3: (15 hours)

Communication link design: Frequency bands used, antenna parameters, transmission equations, noise considerations, link design, propagation characteristics of fixed and mobile satellite links, channel modeling, very small aperture terminals, VSAT design issues.Multiple access techniques: Frequency division multiple access, time division multiple access, code division multiple access

References:

1. M Richharia, *Satellite Communication Systems*, 2nd. Ed., Macmillan Press Ltd, 1999.
2. Dennis Roddy, *Satellite Communications*, 4th Ed, MGH, 2006
3. Robert M Gagliardi, *Satellite Communication*, Van Nostrand Reinhold, 2004
4. Tri T Ha, *Digital Satellite Communication*, MGH, 2008
5. George M. Kizer, *Digital Microwave Communication*, IEEE Press, 2010

EC4052D RADAR ENGINEERING

Pre-requisites: EC2022D Electromagnetic Field Theory

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze radar systems using radar equation and block diagrams.

CO2: Predict range performance of radar.

CO3: Choose pulse repetition frequency and antenna parameters.

CO4: Analyze CW radar, FM-CW radar, MTI radar and non-coherent MTI pulse Doppler radar.

CO5: Design radar transmitters and receivers.

Module 1:(15 hours)

Introduction-Radar Equation-Block diagram-Radar frequencies- Applications- Prediction of range performance –Pulse Repetition Frequency and Range ambiguities.

CW Radar-The Doppler Effect- FM-CW radar- Multiple frequency radar – MTI Radar- Principle- Delay line cancellers- Staggered PRF – Range gating- Noncoherent MTI-Pulse Doppler radar- Tacking Radar – Sequential lobing-Conical Scan- Monopulse – Acquisition.

Module 2: (12 hours)

Radar Transmitters- Modulators-Solid state transmitters, Radar Antennas- Parabolic-Scanning feed-Lens-Radomes, Electronically steered phased array antenna-Applications, Receivers-Displays-Duplexers.

Module 3: (12 hours)

Detection of Radar signals in noise –Matched filter criterion-detection criterion – Extraction of information and waveform design, Propagation of radar waves –Radar clutter, Special purpose radars-Synthetic aperture radar- HF and over the horizon radar- Air surveillance radar- Height finder and 3D radars – Bistatic radar-Radar Beacons- Radar Jamming and Electronic Counters.

References:

1. Merrill I. Skolnik , *Introduction to Radar Systems* , 3rd Edition, MacGraw Hill, 2008.
2. Merrill.Skolnik , *Radar Handbook* , McGraw Hill Publishers, 1990
3. J. C. Toomay, Paul Hannen, *Radar Principles for the Non-Specialist*, SciTech Publishers, 2004
4. Merrill.Skolnik , *Radar systems*, McGraw Hill Publishers, 2005.

EC4053D OPTO-ELECTRONIC COMMUNICATION SYSTEMS

Pre-requisites: EC2022D Electromagnetic Field Theory

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Adapt to venture deeper into the advances made in the field of optical communication

CO2: Relate to the inventory of optical systems

CO3: Demonstrate an understanding of the language, basic operation and design of basic optical modules

CO4: Apply the understanding to the design of optical systems and other allied fields appreciating the trade-offs between various system parameters & specifications

Module 1: (8 hours)

Optical Fibers: Geometrical optics description - wave propagation - chromatic dispersion - polarization mode dispersion – dispersion induced limitations - fiber losses - nonlinear optical effects

Module 2: (17 hours)

Optical Transmitters: Light emitting diodes & Laser diodes –principles of operation, concepts of line width, phase noise, switching and modulation characteristics – typical LED and LD structures - transmitter design

Optical Receivers: PN detector, pin detector, avalanche photodiode – Principles of operation, concepts of responsivity, sensitivity and quantum efficiency, noise in detection, typical receiver configurations (high impedance and transimpedance receivers).

Optical Amplifiers: Semiconductor amplifiers - Raman amplifiers - Doped fiber amplifiers - parametric amplifiers– principles of operation, amplifier noise, signal to noise ratio, gain, gain bandwidth, gain and noise dependencies, intermodulation effects, saturation induced crosstalk, wavelength range of operation

Module 3: (14 hours)

Multichannel Systems: WDM systems – TDM systems – OFDM systems – CDM systems

Coherent Lightwave Systems: Homodyne and heterodyne detection - optical hybrids and balanced receivers - Modulation formats: ASK, FSK, PSK, QAM - Demodulation schemes – BER & receiver sensitivity

References:

1. G. P. Agrawal, *Fiber-Optic Communication Systems*, 4th Edition., John Wiley & Sons, 2010
2. R. L. Freeman, *Fiber-Optic Systems for Telecommunications*, John Wiley & Sons, 2002
3. Leonid Kazovsky, Sergio Benedetto and Alan Willner, *Optical Fiber Communication Systems*, Artech House, 1996

EC4054D COMMUNICATION SWITCHING SYSTEMS

Pre-requisites: EC3022D Computer Networks

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Explain the basic building blocks of digital telephony and their functioning

CO2: Analyze the signaling principles used in the telecom and data networks

CO3: Analyze the traffic in the network and blocking performance of the switches, using the classical results of Stochastic Modeling and Queuing Theory

CO4: Design resource optimized and eco-friendly switching systems

Module 1: (11 hours)

Electronic switching systems**:** basics of a switching system –stored program control –centralized SPC and distributed SPC– space division switching – strict–sense non-blocking switches - re-arrangeable networks– Clos, Slepian-Duguid, Paull's Theorems – Recursive construction of switching networks – Complexity analysis - Synchronous transfer mode- asynchronous transfer mode – time division switching – TSI operation – Signaling subsystem.

Module 2: (15 hours)

Multi stage switching networks: Two dimensional switching, Multi-stage time and space switching, implementation complexity of the switches – blocking probability analysis of multistage switches – lee approximation – improved approximate analysis of blocking switch – examples of digital switching systems (eg: AT & T No.5 ESS)
Introduction to ATM switching –Fast packet switching – self routing switches – Banyan network – ATM switches – Design of typical switches.

Module 3: (13 hours)

Traffic Analysis: traffic measurements, arrival distributions, Poisson process, holding/service time distributions, loss systems, lost calls cleared – Erlang-B formula, lost calls cleared model with finite sources, delay systems, Little's theorem, Erlang-C formula, M/G/1 model, non-preemptive priority models.

References:

1. John C. Bellamy, *Digital Telephony*, Third edition, Wiley Inter Science Publications, 2000
2. Schwartz M., *Telecommunication Networks - Protocols, Modeling and Analysis*, Pearson Education, 2004
3. Joseph Y Hui, *Switching and Traffic Theory for Integrated Broadband Networks*, Springer, 2001.
4. Bertsekas, Dimitri P.& Robert G. Gallager, *Data networks*, Second Edition. Englewood Cliffs, NJ: Prentice-hall, 1987.
5. Recent research papers on the topics

EC4055D SIGNAL ESTIMATION AND DETECTION

Pre-requisites: EC2024D Communication Theory and Systems I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Apply the concepts of probability, random processes and linear algebra understood through various courses for the design and development of estimators that meet specific constraints.

CO2: Design Classical and Bayesian estimation techniques and compare the performance of estimators with standard bounds.

CO3: Develop and analyze detection problems as statistical hypothesis testing problems and apply suitable detection techniques looking at application demands.

CO4: Investigate the applications of estimation and detection techniques by implementing scientific research papers in some chosen area, either individually or as a group, using simulation tools and present the result of such studies through oral presentation with audio visual aids and through technical reports.

Module 1: (10 hours)

Fundamentals of Estimation Theory: Role of Estimation in Signal Processing, Unbiasedness, Minimum variance unbiased (MVU) estimators, Finding MVU Estimators, Cramer-Rao Lower Bound, Linear Modeling-Examples

Module 2: (14 hours)

Deterministic Parameter Estimation: Least Squares Estimation-Batch Processing, Recursive Least Squares Estimation, Matrix Inversion Lemma, Best Linear Unbiased Estimation, Likelihood and Maximum Likelihood Estimation

Random Parameter Estimation: Bayesian Philosophy, Multivariate Gaussian Random Variables, Minimum Mean Square Error Estimator, MAP Estimator, Linear MMSE Estimator, Wiener Filter

Module 3: (15 hours)

Fundamentals of Detection Theory: Hypothesis Testing - General Modeling of Binary Hypothesis Testing Problem, Bayes' Detection, MAP Detection, ML Detection, Minimum Probability of Error Criterion, Min-Max Criterion, Neyman-Pearson Criterion, Receiver Operating Characteristic Curves, Basics of Multiple Hypothesis Testing,Detection of Signals in White Gaussian Noise (WGN): Binary Detection of Known Signals in WGN, M-ary Detection of Known Signals in WGN, Matched Filter Approach.

References:

1. Steven M. Kay, *Statistical Signal Processing: Vol. 1: Estimation Theory*, Vol. 2: Detection Theory, Pearson Education, 2009.
2. Jerry M. Mendel, *Lessons in Estimation Theory for Signal Processing*, Communication and Control, Prentice Hall Inc., 1995
3. Ralph D. Hippenstiel, *Detection Theory- Applications and Digital Signal Processing*, CRC Press, 2002.

EC4056D MULTICARRIER AND MIMO TECHNIQUES

Pre-requisites: EC3012D Communication Theory and Systems II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze the issues with single carrier ad SISO communication systems and identify methods to overcome those using multicarrier and MIMO communication systems.

CO2: Design various OFDM systems, analyze their impairments and quantify performance.

CO3: Analyze the fundamental information theoretic limits of MIMO and multicarrier systems.

CO4: Analyze and choose communication architectures to efficiently implement a given communication problem.

Module 1: (12 hours)
Communication using multiple carries: Modulation with overlapping sub channels- Multicarrier and OFDM systems - Implementation of OFDM systems using DFT techniques -Cyclic Prefix- Matrix representation of OFDM- Vector coding. Challenges in Multicarrier Systems:Synchronization in OFDM -Inter carrier interference- Timing and carrier frequency offset estimation- Channel estimation in OFDM - Pilot arrangements for channel estimation - Clipping in OFDM systems - Nonlinearity of power amplifier - PAPR properties and PAPR reduction techniques- BER analysis of OFDM communication systems.

Module 2: (14 hours)
Multiple access techniques with OFDM: OFDM-TDMA, OFDMA - Carrier assignment strategies, Synchronization and Channel estimation in OFDMA. Modified forms of multicarrier transmission techniques: Single carrier FDMA - Generalized frequency division multiplexing (GFDM) - Universal filtered multicarrier systems (UFMC) - Brief overview on cognitive radio- OFDM based cognitive radio.
Review of SISO fading communication systems - Comparison with MIMO communication systems - MIMO channel models - Precoding designs in MIMO systems- Capacity of MIMO sytems with and without channel state information at the transmitter - Spatially correlated channels and effect of correlation on capacity.

Module 3: (13 hours)
Diversity in MIMO systems - Achieving diversity in MIMO systems with and without channel state information at the transmiter - Alamouti space time code- Reveivers for MIMO systems operating in diversity mode - Matched filter bound - Matched filter receivers - Zero forcing receivers - MMSE receivers - Ordered SIC and BLAST revceivers - Spehre decoding receivers - Generalised space time code design criteria- Space time block codes for more than 2 antenna - Space time trellis codes, Multicarier MIMO systems

References:

1. Ahmad R.S. Bahai, B.R. Saltzberg, M. Ergen, *Multi carrier Digital Communications - Theory and Applications of OFDM*, Second Edition, Springer, 2007
2. R. Prasad, *OFDM for Wireless Communication Systems*, Artech House, 2004.
3. Paulraj A, R. Nabar, D. Gore, *Introduction to Space Time Wireless Communications*, Cambridge University Press, 2015.
4. Hamid Jafarkhani, *Space Time Coding: Theory and Practice*, Cambridge University Press, 2005.
5. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2009.
6. David Tse, Pramod Viswanath, *Fundamentals of Wireless Communication*, Cambridge University Press, 2005.

EC4057D WIRELESS TECHNOLOGIES AND SYSTEMS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Interpret various terminologies in the wireless domain and gain exposure to the various existing and upcoming technologies and systems

CO2: Acquire skills and technology solutions for engineering design that involves wireless information processing

CO3: Choose appropriate wireless modules available in the market to solve communication challenges in multidisciplinary projects

Module 1: (13 hours)

Fundamentals of Wireless Communications, Frequency Allocation, Antennas, Signal Propagation-Multipath Propagation, Basics of Digital Modulation and Error Control Coding, Multiplexing and Multiple Access- Frequency/Time/Code, OFDM and OFDMA, ALOHA, TCP-IP Basics, Diversity and MIMO Systems

Module 2: (14 hours)

Overview of 802.11 Wi-Fi, CSMA/CD and CSMA/CA, Infrastructure and Adhoc Networks, WLAN Architectures, Physical layer and MAC layer, WLAN Standards: IEEE 802.11a/g/n, Vehicular Adhoc Networks, Broadband wireless access-IEEE 802.16 e/m standards, Wireless Sensor networks, Wireless Personal Area Networks, IEEE 802.15.1 Bluetooth, IEEE 802.15.4 Zigbee and IEEE 802.15.6 Wireless Body Area networks

Module 3: (12 hours)

Cellular Wireless Communications: Cellumar architecture, channel re-use, roaming, Evolution, 2G, 3G, 3.5G- Technologies and Standards, 3GPP-LTE and LTE Advanced, Software defined radio, 5G standardization: Cognitive radio, massive MIMO, Device to device communication, Internet of things (IoT) and Internet of Nanothings

References:

1. T. S. Rappaport, *Wireless Communications: Principles and Practice*, Second Edition, Pearson, 2010
2. Aditya K. Jagannatham, *Principles of Modern Wireless Communication Systems Theory and Practice*, McGraw Hill Education, 2017.
3. Sauter, *Beond 3G Bringing Networks, Terminals and Web Together- LTE, WIMAX IMS, 4G Devices and Mobile Web 2.0*, Wiley, 2009.
4. W.Stallings, *Wireless Communications & Networks*, Second Edition, Pearson, 2009.

EC4058D SPEECH AND AUDIO PROCESSING

Pre-requisites:EC3013D Digital Signal Processing

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe quantitatively the mechanisms of human speech production and how the articulation mode of different classes of speech sounds determines their acoustic characteristics.

CO2: Apply programming tools to analyze speech and audio signals in time and frequency domains, and in terms of the parameters of a source-filter production model and harmonic models.

CO3: Analyze, compare and implement methods and systems for coding of speech and audio signals and finally engineer efficient coding solutions.

CO4: Implement methods and systems for speech and audio enhancement, speech and speaker recognition, music synthesizers, speech assisted applications etc.

Module 1: (13 hours)

Introduction - Review Of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – The stochastic parameters of human speech, Gaussian densities and statistical model training, voiced and unvoiced speech, voice-box modeling, pitch-perception models. Articulatory features - Psychoacoustics - Absolute Threshold of Hearing - Critical Bands-Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Non simultaneous Masking - Perceptual Entropy - Basic measuring philosophy -Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.

Module 2: (13 hours)

Linear Predictive Analysis of Speech : Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method –Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis. Cepstral analysis of Speech – Formant and Pitch Estimation – Time frequency analysis of speech and audio – Sinusoidal Analysis of Speech and Audio – Speech coding : Low Bit rate and High Bit Rate Codecs – Perceptual Audio Coding- Speech and Audio Coding Standards.

Module 3: (13 hours)

Speech and Audio Signal Enhancement - minimum mean square error estimation, linear estimation for Gaussian distribution, Wiener filtering, power spectral subtraction methods, spectral band replication - Computational Auditory Speech Analysis (CASA) - Automatic Speech Recognition : Linear and Dynamic Time-warping, connected word recognition, Statistical sequence recognition and model training in speech pattern recognition, HMM training, Viterbi training, MLP architecture and training- Speaker verification-Music synthesizers.

References:

1. Ian McLaughlin*, Applied Speech and Audio processing*, Cambridge University Press, 2009.
2. Ben Gold, Nelson Morgan and Dan Ellis, *Speech and Audio Signal Processing: Processing and Perception of Speech and Music*, 2nd Edition, Wiley, 2011
3. John N. Holmes and Wendy J. Holmes, *Speech Synthesis and Recognition*, Taylor and Francis, 2nd Edition, 2003.
4. Lawrence R. Rabiner and Ronald W. Schafer, *Theory and Applications of Digital Speech Processin*g, Pearson, 2010
5. UdoZölzer, *Digital Audio Signal Processing*, Second Edition, John Wiley& Sons Ltd, 2008.
6. Mark Kahrs and Karlheinz Brandenburg, *Applications of Digital Signal Processing to Audio And Acoustics*, Kluwer Academic Publishers New York, Boston, Dordrecht, London, Moscow, 1998.

EC4059D SIGNAL COMPRESSION

Pre-requisites: EC3021D Information Theory and Coding

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Apply mathematical theory to modeling and coding of data compression algorithms

CO2: Analyze data compression methods for efficiency and utility

CO3: Design of real world data compression methods by considering practical aspects of data management

CO4: Evaluate data compression systems

Module 1: (14 hours)

Compression Techniques – Mathematical Preliminaries for Lossless Compression – Huffman Coding – Minimum Variance Huffman Codes – Extended Huffman Coding – Adaptive Huffman Coding – Arithmetic Coding – Application of Huffman and Arithmetic Coding, Golomb Codes, Run Length Coding, Tunstall Codes

Dictionary Techniques – Static Dictionary – Adaptive Dictionary- LZ77, LZ78, LZW - Applications – Predictive Coding – Prediction with Partial Match – Burrows Wheeler Transform – Sequitur- Lossless Compression Standards (files, text, and images, faxes), Dynamic Markov Compression

Module 2: (13 hours)

Mathematical Preliminaries for Lossy Coding – Rate distortion theory: Motivation; The discrete rate distortion function R(D); Properties of R(D); Calculation of R(D); R(D) for the binary source, and the Gaussian source, Source coding theorem (Rate distortion theorem); Converse source coding theorem (Converse of the Rate distortion theorem) - Design of Quantizers: Scalar Quantization – Uniform & Non-uniform – Adaptive Quantization – Vector Quantization – Linde Buzo Gray Algorithm – Tree Structured Vector Quantizers – Lattice Vector Quantizers – Differential Encoding Schemes.

Module 3: (12 hours)

Mathematical Preliminaries for Transforms , Subbands, and Wavelets – Karhunen Loeve Transform, Discrete Cosine Transform, Discrete Sine Transform, Discrete Walsh Hadamard Transform – Transform coding - Subband coding – Wavelet Based Compression – Analysis/Synthesis Schemes – Speech, Audio, Image and Video Compression Standards.

References:

1. Khalid Sayood, *Introduction to Data Compression*, Morgan Kaufmann Publishers., Fourth Edn., 2012.
2. David Salomon, Giovanni Motta, *Handbook of Data Compression*, Springer-Verlag London, 2010.
3. Toby Berger, *Rate Distortion Theory: A Mathematical Basis for Data Compression*, Prentice Hall, Inc., 1971.
4. K.R.Rao, P.C.Yip, *The Transform and Data Compression Handbook*, CRC Press., 2001.
5. R.G.Gallager, *Information Theory and Reliable Communication*, John Wiley & Sons, Inc., 1968.

EC4060D MULTIMEDIA SYSTEMS AND APPLICATIONS

Pre-requisites: EC2014D Signals and Systems

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Demonstrate the methods of multimedia representation, communication, operating system issues and presentation to design and develop multimedia systems.

CO2: Acquire strong mathematical skills to model and encode multimedia data for efficient communication through various media that meets the challenges of our age considering its social impacts.

CO3: Identify and solve complex real world problems in multimedia applications using modern signal processing tools, active cooperative learning and be able to demonstrate them effectively.

CO4: Perceive skills to conduct independent study and analysis of various challenges related to modern multimedia communication, synchronization, storage and manipulation techniques that would engage the scholar in lifelong learning.

Module 1: (10 hours)

Introduction: An overview of multimedia system: media streams, architecture and components, Multimedia content representation: Audio, Image, Video, Data acquisition: sampling and quantization, human speech, digital model of speech production, analysis and synthesis, psychoacoustics, Image acquisition and representation.
.

Module 2: (14 hours)

Data Compression and Standards: Low bit rate speech compression, MPEG audio compression. Various image and video compression Schemes; Image compression standards: JPEG image compression standards, Bilevel image compression standards Video Compression Standards: MPEG, H.264/AVC, H.265/HEVC video compression standards, Transcoding.

Module 3: (15 hours)

Multimedia Communication: Fundamentals of data communication and networking, Multimedia operating system issues: real-time scheduling, resource management, file and storage systems, Multimedia networking. Multimedia Synchronization- Intra Object Synchronization, Inter object Synchronization, Reference Model for Multimedia – Synchronization. Multimedia database issues such as data organization, indexing and retrieval.
Multimedia applications: Multimedia conferencing, video-on-demand broadcasting issues.

References:

1. Ze-Nian Li, and Mark S. Drew, *Fundamentals of Multimedia*, , Pearson Prentice Hall, October 2003.
2. Ralf Steinmetz and KlaraNahrstedt, *Multimedia: Computing, Communications*, and Application, Pearson Education India, 2012.
3. Fred Halsall, *Multimedia Communications*, Pearson Education, 2009.
4. Khalid Sayood*, Introduction to Data Compression* 3rd Edition, Elsevier, 2006.

EC4061D BIOMEDICAL SIGNAL PROCESSING

Pre-requisites: EC3013D Digital Signal Processing

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Describe the origin, properties and suitable models of important biological signals such as ECG, EEG, and EMG.

CO2: Analyze the practical benefits and limitations of various digital signal processing approaches for evaluating the normal and pathological conditions using biological signals and medical images.

CO3: Design and Implement signal processing algorithms for practical problems involving biomedical signals and systems.

Module 1: (13 hours)

Introduction to Biomedical Signals and Systems – Filtering for Artifact Removal – Event Detection – Wave shape and Waveform Complexity – Frequency Domain Characteristics – Modeling Biomedical Signals and Systems – Analysis of Non Stationary Signals - Pattern classification and diagnostic decisions.

Module 2: (13 hours)

Physiological and mathematical models of bioelectricity: cell membrane, resting and action potentials, Nernst equation, volume conducting, Measurement of bioelectrical signals: electrode properties, measurement systems. Electrocardiography: origin of the ECG, ECG-leads, ECG analysis Neurophysiology: nervous system, muscles, EEG, EP, EMG, ERG, EOG signal analysis, Electro stimulation: defibrillation, pacemakers.

Module 3: (13 hours)

Analysis of Biomedical Images for enhancement, segmentation and registration, Spatial filtering: Feature extraction, edge detection, image enhancement and noise reduction. 2D Fourier Transform - 2D Fourier Filtering, MRI Reconstruction, Morphological Processing: erosion, dilation, opening and closing. Image Segmentation: Region Growing Schemes, Edge Linking and Hough Transforms, Dynamic programming, Registration of PET and MRI Images.

References:

1. Rangayyan R.M., *Biomedical Signal Analysis : A Case Study Approach,* Wiley – IEEE Press, 2001.
2. NYSörnmo L. and Laguna P,*Bioelectrical Signal Processing in Cardiac and Neurological Applications,* Academic Press (Elsevier) , 2005
3. Gonzalez and Woods, *Digital Image Processing,*Prentice Hall, 2008.
4. Eugene N. Bruce*, Biomedical Signal Processing and Modeling,* John Wiley and Sons, Inc., 2000

EC4062D WAVELET THEORY

Pre-requisites: EC3013D Digital Signal Processing

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Apply the mathematical basis of the wavelet transform as a tool in signal and image analysis.

CO2: Apply the concepts and properties of the Continuous Wavelet Transform, the Multi-Resolution Analysis, Discrete Wavelet Transform, and Wavelet Packets.

CO3: Develop Discrete Wavelet transform using Filter banks and Fast Lifting Scheme.

CO4: Construct wavelets using the time domain and the frequency domain approaches.

CO5: Design and implement wavelet packet transform and best basis algorithm for a desired application.

Module 1: (13 hours)

Fourier and Sampling Theory**:** Generalized Fourier theory, Fourier transform, Short-time(windowed) Fourier transform, Time-frequency analysis - uncertainty relation, Fundamental notions of the theory of sampling; Theory of Frames: Bases, Resolution of unity, Definition of frames, Geometrical considerations and the general notion of a frame, Frame projector, Example - windowed Fourier frames.

Module 2: (13 hours)

Wavelets**:** The notion of domain-scaling of a finite energy signal, Representation of finite energy signals in multiple scales of its domain; The notion of multi-rate representation, Filter banks and multi-band decomposition of signals, Continuous wavelet transform (CWT) and inverse CWT: formulation from first principles; The admissibility condition of a wavelet; Wavelet frames. The multi resolution analysis (MRA) of L2(R): The MRA axioms, Construction of an MRA from scaling functions, Discrete wavelets, The dilation equation and the wavelet equation, solution to the dilation equation and the discrete-time representation of wavelets; Compactly supported orthonormal wavelet bases – Necessary and sufficient conditions for an orthonormal system of wavelets. Regularity and selection of wavelets - Smoothness and approximation order – Criteria for wavelet selection with examples; Splines, Cardinal B-spline MRA, Sub-band filtering schemes,

Module 3: (13 hours)

Construction of wavelets**:** Compactly supported orthonormal wavelet bases, Wavelet transform: (Discrete wavelet transform (DWT) - Wavelet decomposition and reconstruction of functions in $L^2(R)$, Fast wavelet transform algorithms - Relation to filter banks, Wavelet packets - Representation of functions, Selection of basis, Construction of wavelets, Bi-orthogonality and bi-orthogonal basis, Construction of bi-orthogonal system of wavelets, The Lifting scheme.

References:

1. S. G. Mallat, *A Wavelet Tour of Signal Processing: The Sparse Way*, Academic Press/Elsevier, 2009.
2. M. Vetterli, J. Kovacevic, *Wavelets and Subband Coding*, Prentice Hall Inc, 1995.
3. Gilbert Strang and Truong Q. Nguyen, *Wavelets and Filter banks*, 2nd Edition, Wellesley-CambridgePress,1998.
4. Christian Blatter, *Wavelets: A primer*, A. K. Peters, Massachusetts, 1998.

EC4063D COMPRESSED SAMPLING: PRINCIPLES AND ALGORITHMS

Pre-requisites: EC3013D Digital Signal Processing

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Appraise foundations on signal representation and the sampling theorem.

CO2: Develop mathematical framework for multi-rate, multi-band, and multiresolution representation of signals.

CO3: Design of compressed sampling devices for energy-efficient applications.

CO4: Apply foundation concepts for multi-disciplinary designs.

CO5: Design environment-friendly direct applications.

Module 1: (13 hours)

Fundamentals of Sampling Analog Signals, and Mathematical Preliminaries**:** Classical sampling theorem for band-limited signals; Bandpass sampling theorem; Sample-rate reduction and multichannel sampling; Sampling of random signals; Sampling as a signal representation problem; Sampling of duration-limited signals and motivation for compressed sampling. Signal spaces**:** normed linear spaces - topology, Convergence, completeness and stable signal synthesis; Hamel basis, Schauder basis and Riesz basis; Linear transformations and change of basis on finite dimensional signal spaces; Separable signal spaces and Decomposition of signals; Orthogonality and bi-orthogonality; Riesz representation theorem; Frames; Under-determined system of equations - methods of solution, sparse solution.

Module 2: (13 hours)

Compressed Sampling**:** Sparse representation of signals; Sparsity and compressibility; Construction of sparsifying basis and the measurement (Sensing) matrix; Null-space conditions and the spark; The Restricted Isometry Property (RIP); RIP and the null-space property; Measurement bounds and condition for stable recovery; Coherence of the measurement matrix; mutual coherence between the sensing matrix and the matrix of representation bases.

Module 3: (13 hours)

Sparse Signal Recovery: The l_0 and l_p for $p \in (0, 1)$, and the l_p-norm for $p \geq 1$; Recovery through l_1-norm minimization; Recovery under noiseless and noisy conditions; Algorithms for sparse recovery - Design requirements; Convex optimization based methods: linear programming; Greedy algorithms: Matching pursuit, Orthogonal matching pursuit, Regularized orthogonal matching pursuit; Compressive sampling matching pursuit; Relaxation on the l_0: The l_p for $p \in (0, 1)$ as a weighted l_2-norm; Iterative re-weighted least squares algorithm; Performance analysis of the recovery algorithms.

References:

1. S. G. Mallat, *A Wavelet Tour of Signal Processing: The Sparse Way*, Academic Press/Elsevier, 2009.
2. Richard G. Baraniuk, Mark A. Davenport, Marco F. Duarte, ChinmayHegde (Collection Editors), *An Introduction to Compressive Sensing*, CONNEXIONS (Publishing) Rice University, Houston, Texas,2012.
3. Michael Elad, *Sparse and Redundant Representations*, Springer, New York, 2010.
4. Yonina C. Eldar and GittaKutyniok, *Compressed Sensing: Theory and Applications*, Cambridge University Press, 2012.
5. Simon Foucart, Holger Rauhut, *A Mathematical Introduction to Compressive Sensing*, Springer/Birkhauser, New York, 2013.

EC4064D CRYPTOGRAPHY: THEORY AND PRACTICE

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify security challenges in modern communication systems and explore the role of cryptographic services such as ensuring confidentiality, data integrity verification and data authentication in fixing them

CO2: Develop the expertise in mathematical fundamentals from abstract algebra and number theory for the design and analysis of various cryptographic primitives such as cipher algorithms, hash function, key exchange algorithms and digital signature algorithms

CO3: Design and cryptographic systems to meet the specifications in terms of security, circuit complexity and power consumption by effectively making use of various primitives

CO4: Investigate latest developments in cryptography and cryptanalysis through most recent publications and develop knowledge on ethical aspects of privacy in communication and social issues associated with lack of efficient systems for protection of privacy

Module 1: (12 hours)
Security issues in communication - Basic cryptographic services- Mathematical fundamentals- Divisibility – Prime numbers –Euclidean Algorithm – Diophantine equations - Congruence –Euler function - Fermat's little theorem – Euler theorem – Finite Groups - Basic operations in groups - Polynomial ring – Field and extension

Module 2: (13 hours)
Classical Cryptography – Shannon's Notion of perfect secrecy– Substitution and Transposition Cipher - Modern Cryptographic Techniques –Private Key Cryptosystems – Block cipher – Standards – Data Encryption Standard – Linear and differential cryptanalysis – Advanced Encryption Standard- Stream cipher – Key stream generators – Linear feedback shift registers and sequences – Attacks on LFSR based stream ciphers

Module 3: (14 hours)
Public key cryptosystems – One way functions – Factorization problem – RSA crypto system – Discrete logarithm problem – Elgamal crypto system – Key management – Diffie Hellmann key exchange – Elliptic curves – arithmetic – cryptographic applications of elliptic curves - Message authentication requirements – Hash function – features of MD5 and SHA algorithms – Security of Hash function – Message Authentication Codes – Digital Signatures – Latest developments and design of cryptographic systems

References:

1. Wade Trappe, Lawrence C. Washington, *Introduction to Cryptography with Coding Theory*, 2nd Edition, Prentice-Hall, Inc. 2005
2. Douglas R. Stinson, *Cryptography: Theory and Practice*, 3rd Edition, Taylor and Francis Group, 2006
3. William Stallings, *Cryptography and Network Security: Principles and Practice*, 7th Edition, Pearson, 2017
4. Johannes Buchmann, *Introduction to Cryptography*, Springer, 2001
5. Alfred Menezes, Paul van Oorschot, and Scott Vanstone, *Handbook of Applied Cryptography*, CRC Press, 2001

EC4065D RADIO FREQUENCY CIRCUITS

Pre-requisites: EC2021D Electronic Circuits I
EC2022D Electromagnetic Field Theory

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Adapt to venture deep into the RF spectrum

CO2: Relate to the inventory of RF device models

CO3: Demonstrate an understanding of the language, basic operation and design of basic RF modules

CO4: Apply the understanding to the design of wireless systems and other allied fields appreciating the trade-offs between noise, linearity, spectral cost etc.

Module 1: (13 hours)

Basics of RF circuit design, Noise: Available noise power, noise figure, Linearity & distortion: Third-order intercept point, second-order intercept point, 1-dB compression point, broadband measures of linearity Modeling of active & passive components at high frequencies
Impedance matching: broadband matching, power matching & noise matching
High frequency amplifiers: bandwidth estimation using open-circuit & short-circuit time constants - using zeros to enhance bandwidth - shunt-series amplifiers, tuned amplifiers & cascaded amplifiers

Module 2: (13 hours)

RF power amplifiers: Design of class A, AB, B, C, D, E, F, G & H amplifiers
Low-noise amplifier (LNA) design: CS, CG & cascode amplifiers, shunt-series feedback amplifiers, noise & linearity of amplifiers, amplifiers using differential configurations, Low voltage topologies for LNA, DC bias networks for LNA, design of broadband LNA
Mixers: Mixing operation, mixing with nonlinearity, mixer noise & linearity, mixer with local oscillator switching, popular mixer configurations like the Moore mixer, mixer with simultaneous noise and power match, mixer employing current reuse for low power applications

Module 3: (13 hours)

Oscillators: Negative resistance-based LC resonator, Colpitts oscillator, differential topologies, phase noise in oscillators, tunable oscillators
Phase-locked loops (PLL) & frequency synthesizers:
PLL: PLL components, continuous-time and transient behavior of PLL, in-band and out-of-band phase noise
Frequency synthesizers: Integer-N & fractional-N synthesizers, spurious components in synthesizers

References:

1. John W M Rogers & Calvin Plett, *Radio Frequency Integrated Circuit Design*, 2nd Edition, Artech House, 2010
2. Richard Chi-Hsi Li, *RF Circuit Design*, John Wiley & Sons, 2009
3. HoomanDarabi, *Radio Frequency Integrated Circuits & Systems*, Cambridge University Press, 2015
4. Behzad Razavi, *RF Microelectronics*", 2nd Edition, Prentice Hall, 2012
5. Thomas H Lee, *The Design of CMOS Radio-Frequency Integrated Circuits*, 2nd Edition,Cambridge University Press, 2004

EC4066D NANOELECTRONICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Illustrate challenges faced by present CMOS VLSI device design and fundamental limits of operation.

CO2: Explain novel MOS based silicon devices and various multi gate devices.

CO3: Develop knowledge about SOI devices.

CO4: Examine different nanoelectronic systems and 2D materials and Devices

Module 1: (10 hours)

Challenges going to sub-100 nm MOSFETs – Oxide layer thickness, tunneling, power density, non-uniform dopant concentration, threshold voltage scaling, lithography, hot electron effects, sub-threshold current, velocity saturation, interconnect issues, fundamental limits for MOS operation.

Module 2: (13 hours)

Novel MOS-based devices – Multiple gate MOSFETs, Silicon-on-insulator, FDSOI, vertical MOSFETs, strained Si devices, FinFET, optoelectronic, and spintronics devices, Heterostructure based devices – Type I, II and III heterojunctions, Si-Ge heterostructure, heterostructures of III-V and II-VI compounds - Resonant tunneling devices (diodes & transistors)

Module 3: (16 hours)

Carbon nanotubes based devices – CNFET, characteristics, Hysteresis and device passivation, Single Electron Memory, 2D materials and devices, Spintronics - Spin-based devices – SpinFET, characteristics

References:

1. Waser Ranier, *Nanoelectronics and Information Technology (Advanced Electronic Materials and Novel Devices)*. Wiley-VCH,3rd Edition 2012.
2. R. Saito and M. S. Dresselhus, *Physical properties of Carbon Nanotubes*. Imperial College Press 1998
3. Francois Leonard, *The Physics of Carbon Nanotube Devices*. William Andrew, 2008

EC4067D SOLID STATE IMAGE SENSORS

Pre-requisites: EC2013D Solid State Devices

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze and compare image sensor specifications

CO2: Design pixel circuits

CO3: Develop application specific imagers

CO4: Create test plans to characterize image sensors

Module 1: (12 hours)

Review of MOS capacitor and MOSFET, Photometry and Radiometry, Block diagram of a camera, Introduction to silicon properties and photon absorption, photon to electron conversion, photo diode, photo current, charge collection, CCDs and CMOS image sensors, conversion efficiency, fill factor, full well capacity, noise and non-uniformity in image sensor, noise floor, image lag and blooming, sensitivity, signal-to-noise ratio, dynamic range, quantum efficiency

Module 2: (15 hours)

Passive and active pixel configurations, 3-T pixel, delta double sampling, pinned photo diode, 4-T pixel, correlated double sampling, shared pixel architectures, electronic shutter and global shutter pixels, column amplifier with gain, sensitivity improvement, multiple sampling, dynamic range improvement, synthesis image from dual/multiple readout, lateral overflow capacitor, time mode imaging, logarithmic pixel, limitations of logarithmic pixels, linear-log pixel, analog-to-digital converters for imagers, slope and SAR ADCs

Module 3: (12 hours)

Chip level, column level and pixel level readout architectures, scanning mechanisms, progressive scanning, interline scanning, asynchronous address event representation, compression imagers, high speed imaging, time-delay-integration, time-of-flight and polarization imagers
Characterization of imagers, estimation of photo diode parameters such as dark current, full well capacity, sensitivity etc., characterization based on photon transfer curve, analyzing experimental PTC data, PTC-inspired imagers

References:

1. Junichi Nakamura, *Image Sensors and Signal Processing for Digital Still Cameras*, CRC Press, 2006.
2. Albert Theuwissen, *Solid-State Imaging with Charge-Coupled Devices*, Springer Netherlands, 1995.
3. MukulSarkar and Albert Theuwissen, *A Biologically Inspired CMOS Image Sensor*, Springer Verlag, 2012.
4. James R. Janesick, *Photon Transfer DN* $\rightarrow \lambda$, SPIE press, USA, 2007.
5. Takao Kuroda, *Essential Principles of Image Sensors*, CRC Press, 2015.

EC4068D ANALOG MOS INTEGRATED CIRCUITS

Pre-requisites: EC3011D Electronic Circuits II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Model various components of a CMOS technology to estimate their performance in circuits.

CO2: Analyze the biasing circuits for CMOS amplifiers.

CO3: Design single stage amplifiers and various stages of an operational amplifier.

CO4: Analyze nonlinear analog circuits and switched capacitor circuits.

Module 1: (13 hours)

Review of MOSFET operation, Threshold voltage, Drain current, Body bias effect, Channel length modulation, Low frequency MOSFET model in saturation region, High frequency MOSFET model-Thermal noise and flicker noise in MOS transistors, MOSFET active resistors, Voltage dividers- MOS transistor layout, MOS transistor mismatch, resistors and capacitors available in a CMOS process, Random and systematic mismatch in resistors and capacitors, Layouts to minimize mismatch.

Current sources and sinks, Current mirrors, Cascode connection, Matching considerations in current mirrors, Concept of current steering, Self biasing circuits, Constant G_m biasing, Start-up circuits, Bandgap referenced biasing, voltage references

Module 2: (13 hours)

Review of Common source, Common drain and Common gate amplifiers - Cascode amplifier, Folded cascade amplifier, Differential amplifier- Frequency response of the amplifiers-Operational amplifiers-Review of stability and feedback compensation, Slewing in op-amps, Design of single stage and multistage Operational amplifiers- Noise consideration in amplifiers, Input referred noise

Module 3: (13 hours)

Nonlinear analog circuits, CMOS comparator, Auto zeroing, Analog multiplier, Gilbert cell as multiplier-MOSFET switch, Non ideal effects of MOSFET switch- Switched capacitor circuits, Switched capacitor integrators, First order and second order switched capacitor filters, switch reduction in switched capacitor circuits

References:

1. B.Razavi, *Design of Analog CMOS Integrated Circuit*, 2nd Edition Mc Graw Hill India, 2017
2. P. Allen & D. Holberg, *CMOS Analog Circuit Design*, 3rd Edition, Oxford University Press, 2013
3. R.J. Baker, H.W.Li and D.E.Boyce, *CMOS Circuit Design, Layout and Simulation*, 2nd Edition, Wiley India , 2009
4. Gray, Hurst, Lewis and Meyer, *Analysis and Design of Analog Integrated Circuits*, , 5th Edition, Wiley India, 2011

EC4069D ADVANCED VLSI CIRCUITS

Pre-requisites: EC2012D Digital Circuits and Systems

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Assess the impact of process variation in the design of CMOS logic circuits

CO2: Analyze the performance of logic circuits in submicron CMOS technologies

CO3: Formulate transistor and system level models to estimate the speed of CMOS circuits

CO4: Design I/O circuits

CO5: Adapt power reduction techniques to ensure energy minimization

Module 1: (13 hours)

Review of noise margin, speed and power consumption of CMOS inverter, impact of voltage scaling, optimum supply voltage, temperature and process variation on noise margin, speed and power consumption, technology scaling and circuit specifications, short channel devices and the circuit performance, circuit design in short channel regime

Module 2: (13 hours)

Design of inverter chain for driving large capacitive load and long interconnects, Delay of logic gates, Review of logical effort and path delay, branch effort, input grouping, wide structures, power supply network, on-chip decoupling capacitors, skew and jitter in clock distribution, clock tree network design, I/O circuits, over voltage protection and ESD clamp, noise rejection by Schmitt trigger, Antenna diodes

Module 3: (13 hours)

Transistor sizing for energy minimization, leakage reduction using stack effects, power gating methodologies, sleep transistors, forward and reverse body bias, multiple supply and threshold CMOS circuits, level converters, dynamic supply and threshold voltage circuits, Low power memory design, low power drivers and sense amplifier, energy recovery circuit design

References:

1. David Hodges, Horace Jackson and ResveSaleh, *Digital integrated circuits in deep submicron technologies*, McGraw-Hill, Third edition, 2004.
2. Jan M.Rabaey, *Digital Integrated Circuits- A Design Perspective*, Prentice Hall, Second Edition, 2005
3. Ivan Edward Sutherland, Robert F. Sproull and David F. Harris, *Logical effort: Designing fast CMOS circuits*, Morgan Kaufmann, 1999.
4. John P. Uyemura, *Chip design for Submicron VLSI: CMOS layout and simulation*, Cengage learning, India edition, 2006.
5. Kaushik Roy and Sharat C. Prasad, *Low-power CMOS VLSI circuit design*, Wiley Student Edition, 2009.

EC4070D INTERNET OF THINGS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Survey the market perspective and architectural features of IoT based systems

CO2: Review and research the state of the art in internet protocols

CO3: Discuss and identify the latest short range, low power protocols

CO4: Identify the advanced architectural features of advanced Intel and ARM processors

Module 1: (16 hours)

M2M to IoT – A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT,.
M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed AnIoT architecture outline, standards considerations.
M2M and IoT Technology Fundamentals**-** Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management

Module 2: (10 hours)

Review of internet protocols –Processing platforms for IoT-sensors –actuators-Cloud computing models – low power ,low range protocols –Zigbee –BLE – 6LoWPAN. Applications for IoT-Smart home, city ,agricultureetc, - IoT services. Fog Computing –Internet of Everything.IoT use cases –Industrial IoT –Health care applications, Design and development of an IoT product using hardware.

Module 3: (13 hours)

Architecture of Intel processors from 80286 to Pentium-Microarchitectural techniques of advanced processors –pipelining-superscalar concept –Out of order execution –Speculative execution – branch prediction –register renaming -Multicore processors- Processors beyond Pentium-Atom SoC
Architecture of ARM Cortex-M – NVIC – WIC--Sleep modes

References:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, 1st Edition, Academic Press, 2014.
2. ArshdeepBagha, Vijay Madisetti *, Internet of Things* ,A hands on approach,2015
3. Lyla B. Das, *The x86 Microprocessors: 8086 to Pentium, Multicores, Atom , and the 8051 Microcontroller : Architecture ,Programming and Interfacing*, ,Second Edition , Pearson Education ,India 2014
4. Lyla B. Das, *Architecture, Programming, and Interfacing of Low-power Processors – ARM7, Cortex-M*, Cengage, 2017

EC4071D ARCHITECTURE OF ADVANCED PROCESSORS

Pre-requisites: EC2023D Microprocessors and Microcontrollers

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Analyze and categorize of the basic building blocks of a CPU.

CO2: Formulate new techniques in computer architecture to achieve performance excellence.

CO3: Examine the architectural features of the x86 series of processors

CO4: Summarize the latest trends in the computer industry

Module 1: (10 hours)

Fundamentals: Technology trend -Performance measurement –Comparing and summarizing performance-quantitative principles of computer design –Amdahl's law-Case studies. Principles of processor performance - Processor performance optimization- Performance evaluation methods

Module 2: (14 hours)

Features of advanced Intel processors: Enhancements of 80386 and Pentium –Hardware Features, PVAM,-Memory management unit-Virtual Memory and concepts of cache - processors beyond Pentium-Intel's embedded processor Atom

Module 3: (15 hours)

Instruction and thread level parallelism: Instruction level parallelism and concepts - Limitations of ILP-Pipelining: Issues and solutions- Instruction flow techniques -Program control flow and control dependences- Superscalar techniques-Multiprocessor and thread level parallelism- Dynamic scheduling –OOO concepts –Tomasulo's algorithm – Multicore technology

References:

1. John Shen and Mikko H Lipasti, *Modern Processor Design: Fundamentals of Superscalar Processors*, McGraw Hill Publishers , 2005
2. Lyla B. Das, *The x86 Microprocessors: 8086 to Pentium,, Multicores, Atom , and the 8051 Microcontroller : Architecture ,Programming and Interfacing*, ,Second Edition , Pearson Education ,India 2014
3. Hennessy J. L. & Patterson D. A., *Computer Architecture: A Quantitative approach*, 4/e, Elsevier Publications, 2007
4. Patterson D. A. & Hennessy J. L., *Computer Organisation and Design: The Hardware/ Software Interface*, 3/e, Elsevier Publishers, 2007
5. JurijSilc, BorutRobic, ThUngerer, *Processor Architecture: From Dataflow to Superscalar and Beyond*, Springer-Verlag, June 1999

EC4072D ARCHITECTURES FOR DIGITAL SIGNAL PROCESSING

Pre-requisites: EC3013D Digital Signal Processing

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify the basic resource constraints in a practical DSP system and familiarize various transformations used to map the DSP algorithms to efficient architectures

CO2: Identify, Analyze and solve real world problems in DSP hardware implementations at the algorithmic and structural level using modern signal processing tools, active cooperative learning and be able to demonstrate them effectively.

CO3: Design and develop various architectures using the standard mapping techniques that meet the design requirements for a given DSP system that meets the challenges of our age considering its social impacts.

CO4: Conduct independent study and analysis of various challenges related to the development of VLSI algorithms and architectures for DSP.

Module 1: (15 hours)

DSP Algorithm representations - data-flow, control-flow, and signal-flow graphs, block diagrams; Basic and advanced DSP Filter structures- Recursive, Non-recursive and Lattice.
Fundamentals of DSP algorithm to architecture mapping - Loop bound, Iteration bound, critical path, computation of iteration bound; VLSI performance measures - area, power, and speed; Transformations for improved DSP architectures: Pipelining, Parallel Processing, Folding, Unfolding, Retiming.
Algorithmic simulations of DSP systems in C, behavioural modeling in HDL. System modeling and performance measures

Module 2: (11 hours)

DSP Algorithmic Strength Reduction: Fast convolution algorithms - Cook-Toom, Winograd, Iterated and Cyclic Convolution algorithms; Parallel FIR Filter structures; Architecture transformation for fast DCT and inverse DCT; Parallel structures for rank order filters.
Fixed-point DSP design considerations - A/D precision, coefficient quantization, round-off and scaling.

Module 3: (13 hours)

High performance arithmetic unit architectures (adders, multipliers, dividers), bit-parallel, bit-serial, digit-serial, carry-save architectures
Distributed arithmetic - Advantages, Size reduction of look-up tables, applications to bit level structures.
Canonic signed digit arithmetic - Representation, Implementation of elementary functions Table, oriented methods.
Introduction to redundant number system and examples; Numerical Strength reduction - Introduction to transformations for computational strength reduction with examples.

References:

1. Keshab K. Parhi, "VLSI Signal Processing Systems, Design and Implementation", John Wiley & Sons,1999.
2. Lars Wanhammar, DSP Integrated Circuits, Academic Press, 1999.
3. SenM.Kuo ,Woon-Seng S. Gan, *Digal Signal Processors: Architectures, Implementations, and Applications*, Prentice Hall, 2004.

EC4073D OPTIMIZATION TECHNQUES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Outline an adequate mathematical background on optimization theory.

CO2: Analyze the basic techniques commonly used in linear programming problems.

CO3: Develop the basic skill to address the nonlinear programming problems.

CO4: Analyze the real life problems and formulate them as constrained and unconstrained optimization problems.

Module 1: (13 hours)

Mathematical background: sequences and subsequences, mapping and functions, continuous functions infimum and supremum of functions minima and maxima of functions, differentiable functions. Vectors and vector spaces, matrices, linear transformation, quadratic forms, definite quadratic forms, gradient and Hessian-Linear equations, solution of a set of linear equations basic solution and degeneracy convex sets and convex cones introduction and preliminary definition convex sets and properties convex hulls, extreme point- Separation and support of convex sets, convex and concave functions, differentiable convex functions.

Module 2: (13 hours)

Linear Programming: introduction, optimization model, formulation and applications, classical optimization techniques: single and multi variable problems, types of constraints, linear optimization algorithms: simplex method, basic solution and extreme point, degeneracy, primal simplex method, dual linear programs, primal, dual, and duality theory, dual simplex method, primal-dual algorithm.
Post optimization problems: sensitivity analysis and parametric programming.

Module 3: (13 hours)

Nonlinear Programming: minimization and maximization of convex functions, local & global optimum, convergence. Unconstrained optimization: one dimensional minimization, elimination methods: Fibonacci & Golden section search, gradient methods, steepest descent method. Constrained optimization: Lagrangian method, Kuhn-Tucker optimality conditions, rate of convergence, quadratic programming problems, convex programming problems.

References:

1. David G Luenberger, *Linear and Non Linear Programming*, Addison-Wesley, 2nd Edn., 2001
2. S.S.Rao, *Engineering Optimization; Theory and Practice*, John Wiley, 4th Edn.., 2013,
3. S.M. Sinha, *Mathematical programming: Theory and Methods*, Elsevier, 2006.
4. Hillier and Lieberman, *Introduction to Operations Research*, McGraw-Hill, 8th Ed., 2005.
5. Saul I Gass, *Linear programming*, McGraw-Hill, 5th Edn., 2005.
6. Kalyanmoy Deb, *Optimization for Engineering: Design Algorithms and Examples*, Prentice Hall, 1998.
7. Igor Griva, Ariela Sofer, Stephen G. Nash, *Linear and Nonlinear Optimization*, SIAM, 2009.

EC4074D COMPUTER VISION: ALGORITHMS AND APPLICATIONS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Apply computing algorithms on images utilizing knowledge of theoretical aspects of image formation and analysis

CO2: Design computing algorithms for imaging applications.

CO3: Design object and scene recognition algorithms

CO4: Analyze deep neural networks for classification

CO5: Design computer vision systems for practical applications

Module 1: (13 hours)
Image formation, geometric transformations, camera system
Point operators, neighborhood operators, linear filtering – development of filtering masks
2D Fourier transforms – filtering in frequency domain, homomorphic filtering, Retinex, pyramids and wavelets

Module 2: (13 hours)
Segmentation – edges, lines, active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts and energy-based methods
Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, Constrained structure and motion, Translational alignment, Parametric motion, Spline-based motion, Optical flow, Layered motion
Photometric calibration, High dynamic range imaging, Super-resolution and blur removal, Image matting and compositing, Texture analysis and synthesis

Module 3: (13 hours)

Object detection, Face recognition, Instance recognition, Category recognition, Context and scene understanding, Recognition databases and test sets
Linear discriminants, Bayes rule, maximum likelihood, XOR classification, MLP – back propagation, deep feed forward networks, regularization, optimization, convolutional networks – application.

References:

1. Richard Szeliski, *Computer Vision: Algorithms and Applications*, ISBN 978-1-84882-935-0, Springer 2011.
2. Goodfellow, Bengio, and Courville, *Deep Learning*, MIT Press, 2006.
3. David Forsyth and Jean Ponce, *Computer Vision: A Modern Approach*, Pearson India, 2015.
4. Daniel Lelis Baggio, Khvedchenia Ievgen, Shervin Emam, ,David Millan Escriva, Naureen MahmooJason ,Saragi ,Roy Shilkrot*Mastering OpenCV with Practical Computer Vision Projects*, Packt Publishing Limited, 2012.

EC4075D DIGITAL VIDEO PROCESSING

Pre-requisites:EC3013D Digital Signal Processing

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Demonstrate the methods of video representation, motion estimation and manipulation to design and develop algorithms for solving video processing problems related to various applications fields involving video data.

CO2: Develop mathematical skills to solve video processing problems and apply them to model real life problems in video processing that meets the challenges of our age considering its social impacts.

CO3: Identify and solve complex real world problems in video processing using modern signal processing tools, active cooperative learning and be able to demonstrate them effectively.

CO4: Perceive skills to conduct independent study and analysis of video processing problems and techniques that would also engage the scholar in lifelong learning.

Module 1: (12 hours)

Introduction: Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals.
Video Motion estimation**:** Two dimensional, Optical flow, General methodologies, Pixel based motion estimation, Block matching algorithm, Deformable block matching algorithm, Mesh based motion estimation, Global motion estimation, Region based motion estimation, Multiresolution motion estimation Feature based Motion Estimation, Direct motion Estimation, Iterative model.

Module 2: (15 hours)

Video coding: Basics of video coding, Content dependent video coding, Two dimensional shape coding, Texture coding for arbitrarily shaped region, Joint shape and texture coding, Region based video coding, Object based video coding, Knowledge based video coding, Semantic video coding, Layered coding system, Scalable video coding, Basic modes of scalability, Object based scalability, Wavelet transform based coding, Application of motion estimator in video coding.
Video Standards; MPEG-4 Visual and H.264/AVC: Standards for Modern Digital Video; H.265/HEVC, HEVC Coding tools and extensions.

Module 3: (12 hours)

Video Enhancement and Restoration: Video Quality Assessment, Restoration, Super-resolution; Video Segmentation: Motion Segmentation; Tracking; Motion Tracking in Video: 2D and 3D Motion Tracking in Digital Video, Methods using Point Correspondences, Optical Flow and Direct Methods
Applications: Video Stabilization and Mosaicing, A Unified Framework for Video Indexing, Summarization, Browsing and Retrieval, Video Surveillance

References:

1. Yao Wang, JornOstermann, Ya-Qin Zhang, *Video Processing and Communications*, Prentice Hall, 2002
2. Alan C. Bovik, *The Essential Guide to Video Processing*, Elsevier Science, 2nd Edition, 2009
3. A. Murat Tekalp, *Digital Video Processing,* Prentice Hall, 2nd Edition, 2015.

EC4076D PATTERN CLASSIFICATION

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Apply knowledge of linear systems, probability theory, statistics and optimization theory for data representation

CO2: Analyze basic mathematical and statistical techniques in pattern recognition

CO3: Design pattern recognition algorithms to classify real world data

CO4: Evaluate pattern recognition systems to make sound decisions on real world problems.

CO5: Develop skill to conduct independent research in the area of pattern recognition

Module 1: (11 hours)

Introduction - features, feature vectors and classifiers, Classifiers based on Bayes Decision theory - discriminant functions and decision surfaces, Bayesian classification for normal distributions, Estimation of unknown probability density functions, the nearest neighbour rule. Linear classifiers - Linear discriminant functions and decision hyper planes.

Module 2: (17 hours)

The perceptron algorithm, MSE estimation, Non-Linear classifiers- Two layer and three layer perceptrons, Back propagation algorithm, Networks with Weight sharing, Polynomial classifiers, Radial Basis function networks
Support Vector machines, Decision trees, combining classifiers, Feature selection, Class separability measures, Optimal feature generation, The Bayesian information criterion.
Context dependent classification-Bayes classification, Markov chain models, HMM, Viterbi Algorithm.

Module 3: (11 hours)

Datasets, training and testing methods, accuracy, Receiver Operating Characteristics (ROC) curve

Clustering- Cluster analysis, Proximity measures, Clustering Algorithms - Sequential algorithms. Hierarchical algorithms - Agglomerative algorithms, Divisive algorithms, Probabilistic clustering, K - means algorithm. Clustering algorithms based on graph theory, Competitive learning algorithms, Valley seeking clustering, Clustering validity.

References:

1. C. Bishop, *Pattern Recognition and Machine Learning*, 1st Edition, Springer, 2006
2. Richard O. Duda, Hart P.E, and David G Stork, *Pattern classification* , 2nd Edition., John Wiley & Sons Inc., 2001.
3. S Theodoridis, K Koutroumbas, *Pattern Recogntion*, 4th Edition, Academic Press, 2009.

EC 3066D ARTIFICIAL INTELLIGENCE: THEORY AND PRACTICE

Pre-requisites: EC3051D Data Structures using C++

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Find appropriate idealizations for converting real world problems into AI search problems

CO2: Implement heuristic and iterative deepening search algorithms

CO3: Invent knowledge representation in different formats

CO4: Advocate machine learning as an integral part of AI

Module 1: (18 hours)
Artificial Intelligence: History and Applications, Production Systems, Structures and Strategies for state space search- Data driven and goal driven search, Depth First and Breadth First Search, DFS with Iterative Deepening, Heuristic Search- Best First Search, A* Algorithm, AO* Algorithm, Local Search Algorithms and Optimization Problems, Constraint satisfaction, Using heuristics in games- Minimax Search, Alpha Beta Procedure. Implementation of Search Algorithms in Python

Module 2 (8 Hours)
Knowledge representation - Propositional calculus, Predicate Calculus, Forward and Backward chaining, Theorem proving by Resolution, Answer Extraction, AI Representational Schemes- Implementation of Unification, Resolution and Answer Extraction using Resolution.

Module3 : (13 hours)
Applications of Artificial Intelligence : Cognitive science Applications –Artificial Neural networks –Robotic applications-Visual Perception., Locomotion and Navigation, Natural Interface Applications-Study and Implementation of Machine Learning Algorithms in Python

References:

1. S Russel and P Norvig, *Artificial Intelligence- A Modern Approach*, 3/e, Pearson Education, 2016
2. Nils J Nilsson, *Artificial Intelligence a new Synthesis*, Elsevier,2009
3. George F Luger, *Artificial Intelligence- Structures and Strategies for Complex Problem Solving*, 6/e, 2005, Pearson Education
4. Christopher M.Bishop,*Pattern Recognition and Machine Learning* ,Springer,2016
5. Gareth James , Daniela Witten , Trevor Hastie, Robert Tibshirani, *An Introduction to Statistical Learning* ,Springer,2016

EC4077D CAD OF HIGH FREQUENCY CIRCUITS

Pre-requisites: EC2021D Electronics Circuits-I
EC2022D Electromagnetic Field Theory

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Illustrate the fundamentals of waveguide and other passive components.

CO2: Interpret the basic concepts of microwave circuits network and S-parameters.

CO3: Design microwave filters for communication systems.

CO4: Design and simulate microwave components in EM Simulator.

Module 1: (13 hours)

Review of rectangular and circular metallic waveguides– TE and TM modes, guide wavelength, cut-off, mode excitation, re-entrant cavity, Microwave Resonators – analysis, Q factor of resonators. Transmission lines-concepts of characteristics impedance, reflection coefficient, standing and propagating waves. Different types of transmissions lines strip line, microstrip line, and others. Discontinuities and Bends: Introduction, open-circuit end correction, corners, symmetrical step, T- junction, series gaps, and Bends in microstrip line.

Module 2: (13 hours)

Network analysis: Z, ABCD, Y, T, S-parameters. Smith chart, Impedance matching technique using lumped elements, single stub and double stub. Passive microwave components – S matrix formalism, directional coupler, waveguide tees, magic-tee, isolator, circulator, phase shifter, and Power divider. Design and simulation of the RF microwave components in waveguide technology as rectangular and circular waveguide at a given cut-off frequency, E-plane Tee and H-plane tee magic-tee in EM simulation tool.

Module 3: (13 hours)

RF signal transition Microstrip to CPW transition, Waveguide to microstrip transition, Planar microwave Filter design by the Insertion Loss method, Filter transformations, Filter implementation, Stepped-Impedance Low-Pass filters, open stub low pass filter, Design and simulation of microstrip line of different characteristics impedance, matching the load using micostrpline, and design low pass filter in EM simulation tool.

References:

1. Pozar, D.M., *Microwave Engineering*, 4th Ed., John Wiley & Sons. 2012.
2. Franco di Paolo, *Networks and Devices using Planar Transmission Lines*, CRC Press, 2018.
3. Roberto Sorrentino and Giovanni Bianchi, *Mirowave and RF Engineering* John Wiley & Sons,2010.
4. Ludwig, R. and Bogdanov, G., *RF Circuit Design: Theory and Applications*, 2nd Ed, PearsonEducation, 2011.
5. Collin, R.E., *Foundations for Microwave Engineering*, 2nd Ed., Wiley - India, 2007.
6. Fooks, E.H. and Zakarevicius, R. A., *Microwave Engineering Using Microstrip Circuits*, Prentice-Hall, 1990