CURRICULUM AND SYLLABUS OF B.TECH. DEGREE PROGRAMME IN **ELECTRONICS AND COMMUNICATION ENGINEERING**

तमसो मा ज्योतिर्गमय

Department of
ELECTRONICS AND COMMUNICATION ENGINEERING
National Institute of Technology Calicut

CURRICULUM AND SYLLABUS OF B.TECH. DEGREE PROGRAMME IN ELECTRONICS AND COMMUNICATION ENGINEERING

(Applicable from 2010 admission)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY • CALICUT •

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NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

National Institute of Technology Calicut

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

Program Educational Objectives (PEOs) of B.Tech. (ECE)	
PEO1	Graduates will be provided with a solid foundation in mathematical and engineering fundamentals required to solve engineering problems so that they will be able to apply creatively their understanding of science and engineering principles to the solution of problems arising in whatever career path they choose, in particular in the domain of electronics and communication engineering.
PEO2	Graduates will be sensitive to social, environmental, and economic context in which they work and will be able to inculcate a sense of ethics and professionalism in their approach.
PEO3	Graduates should be able to communicate their ideas clearly and precisely, both orally and in writing.
PEO4	Graduates should have the ability to engage in lifelong learning in electronics and communication engineering and allied fields and need to understand the challenges of a dynamically and globally changing world by adapting their skills through continuous learning and self-improvement.

The Programme Outcomes (POs) of
B. Tech. in Electronics and Communication Engineering

Program Outcomes (POs) of B.Tech. (ECE)	
PO1	Ability to apply the knowledge of mathematics, science and engineering principles for modeling, analyzing and solving problems in the domain of electronics and communication engineering.
PO2	Ability to identify, formulate and analyze real-life problems in the domain of electronics and communication engineering using appropriate tools and standards.
PO3	Ability to design and develop practical solutions for real-life problems in the domain of electronics and communication engineering.
PO4	Ability to design and develop sophisticated equipment and experimental systems for conducting detailed investigations to solve multifaceted problems in the domain of electronics and communication engineering.
PO5	Ability to develop and utilize modern tools for modeling, analyzing and solving problems in the domain of electronics and communication engineering..
PO6	Dedication to work as an electronics and communication engineer who is capable of identifying solutions to various local and global problems faced by the society.
PO7	Understand the impact of engineering solutions in a global, economic, environmental, societal context and ability to design and develop environment and eco friendly engineering systems.
PO8	Willingness and ability to upkeep and demonstrate professional ethics and social values.
PO9	Willingness and ability to think independently, take initiative and lead a team of engineers or researchers, and function as an individual or leader in multidisciplinary teams and project implementations.
PO10	Ability to express ideas clearly and to communicate verbally, in writing, and make presentations.
PO11	Willingness and ability to maintain lifelong learning process by participating in various professional activities and adapt to rapidly changing technologies.
PO12	Demonstrate knowledge and understanding of project management, finance and apply these to projects as individual, team member or leader.

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Curriculum of B.Tech. Degree Programme In Electronics and Communication Engineering

First Semester

S.No.	Code	Course Title	L	T	P	C	Category
1	MA1001	Mathematics I	3	1	0	3	BS
2	PH1001/ CY1001	Physics / Chemistry	3	0	0	3	BS
3	MS1001/ ZZ1003	Professional Communication/ Basic Electrical Sciences	3	0	0	3	HL/ES
4	ZZ1001/ ZZ1002	Engineering Mechanics / Engineering Graphics	3 1	0 0	0 3	3	ES/TA
5	ZZ1004/ EC1001	Computer Programming / Introduction to Electronics Engineering	2	0	0	2	ES/PT
6	ZZ1091/ ZZ1092	Workshop I / Workshop II	0	0	3	2	TA
7	PH1091/ CY1094	Physics Laboratory/ Chemistry Laboratory.	0	0	2	1	BS
8	ZZ1094/ ZZ1093/ ZZ1095	OT (Value Education(1), Physical Education(1), NSS(1)	-	-	-	3*	OT
							Total credits: 17+3*

*Three courses of one credit each is to be credited within the first four semesters.

Second Semester

S.No.	Code	Course Title	L	T	P	C	Category
1	MA1002	Mathematics II	3	1	0	3	BS
2	CY1001/ PH1001	Chemistry / Physics	3	0	0	3	BS
3	ZZ1003/ MS1001	Basic Electrical Sciences/ Professional Communication	3	0	0	3	ES/HL
4	ZZ1002/ ZZ1001	Engineering Graphics/ Engineering Mechanics	1 3	0 0	3 0	3	TA/ES
5	EC1001/ ZZ1004	Introduction to Electronics Engineering/ Computer Programming	2	0	0	2	PT/ES
6	CY1094/ PH1091	Chemistry Laboratory/ Physics Laboratory	0	0	2	1	BS
7	ZZ1092/ ZZ1091	Workshop II / Workshop I	0	0	3	2	TA
							Total Credits: 17

Third Semester

S.No.	Code	Course Title	L	T	P	C	Category
1	MA 2001	Mathematics III	3	1	0	3	BS
2	EC 2011	Network Theory	3	0	0	3	PT
3	EC 2012	Logic Design	4	0	0	4	PT
4	EC 2013	Solid State Devices	4	0	0	4	PT
5	EC 2014	Signals and Systems	3	0	0	3	PT
6	EC 2091	Basic Electronics Laboratory	0	0	3	2	PT
7	EC 2092	Electronics Workshop	0	0	3	2	PT
							Total Credits : 21

Fourth Semester

S.No.	Code	Course Title	L	T	P	C	Category
1	MA 2002	Mathematics IV	3	1	0	3	BS
2	EC 2021	Electronic Circuits - I	4	0	0	4	PT
3	EC 2022	Electromagnetic Field Theory	4	0	0	4	PT
4	EC 2023	Microprocessors and Microcontrollers	3	0	0	3	PT
5	EC 2024	Fundamentals of Communication	4	0	0	4	PT
6	EC 2093	Electronic Circuits Laboratory - I	0	0	3	2	PT
7	EC 2094	Logic Design Laboratory	0	0	3	2	PT
							Total Credits : 22

Fifth Semester

S.No	Code	Course Title	L	T	P	C	Category
1	EC 3011	Electronic Circuits - II	4	0	0	4	PT
2	EC 3012	Digital Communication	4	0	0	4	PT
3	EC 3013	Digital Signal Processing	3	0	0	3	PT
4	EC 3014	Control systems	3	0	0	3	PT
5		Elective 1	3	0	0	3	PT
6	EC 3091	Electronic Circuits Laboratory – II	0	0	3	2	PT
7	EC 3092	Microprocessors and Microcontrollers Laboratory	0	0	3	2	PT
							Total Credits : 21

Sixth Semester

S.No.	Code	Course Title	L	T	P	C	Category
1	ME 4104	Principles of Management	3	0	0	3	HL
2	EC 3021	Computer Organization & Architecture	3	0	0	3	PT
3	EC 3022	Information Theory & Coding	4	0	0	4	PT
4	EC 3023	Computer Networks	3	0	0	3	PT
5		Elective 2	3	0	0	3	PT
6	EC 3024	Environmental Studies for Electronics Engineers	3	0	0	3*	OT
7	EC 3093	Analog Communication Laboratory	0	0	3	2	PT
8	EC 3099	Mini Project	0	0	3	1	PT
							Total Credits : 19+3*

Seventh Semester

S.No.	Code	Course Title	L	T	P	C	Category
1	MS 4003	Economics	3	0	0	3	HL
2	EC 4011	Fundamentals of Wireless Communication	4	0	0	4	PT
3		Elective 3	3	0	0	3	PT
4		Elective 4	3	0	0	3	PT
5	EC 4091	Digital Signal Processing Laboratory	0	0	3	2	PT
6	EC 4092	Digital Communication Laboratory	0	0	3	2	PT
7	EC 4098	Major Project	0	0	6	3	PT
							Total Credits : 20

Eighth Semester

S.No.	Code	Course Title	L	T	P	C	Category
1		Elective 5	3	0	0	3	PT
2		Elective 6	3	0	0	3	PT
3		Elective 7	3	0	0	3	PT
4		Elective 8	3	0	0	3	PT
5	EC 4094	Seminar	0	0	3	1	PT
6	EC 4099	Major Project	0	0	6	4	PT
							Total Credits : 17

Total Credits = 154 + 6 (OT) = 160

LIST OF ELECTIVES

S.No.	Code	Course Title	L	T	P	C	Category
1	EC 3031	Television Engineering	3	0	0	3	PT
2	EC 3032	Power Electronics	3	0	0	3	PT
3	EC 3033	Microelectronics Technology	3	0	0	3	PT
4	EC 3034	Modeling and Testing of Digital Systems	3	0	0	3	PT
5	EC 3035	MOS Device Modeling	3	0	0	3	PT
6	EC 3036	VLSI Circuits and Systems	3	0	0	3	PT
7	EC 3037	Active Network Synthesis	3	0	0	3	PT
8	EC 3038	Embedded Systems	3	0	0	3	PT
9	EC 3039	Multi Rate Systems	3	0	0	3	PT
10	EC 3040	Digital Image Processing	3	0	0	3	PT
11	EC3041	Data structures using C++	3	0	0	3	PT
12	EC 4031	Microwave Communication	3	0	0	3	PT
13	EC 4032	Speech Processing	3	0	0	3	PT
14	EC 4033	Wavelet Theory	3	0	0	3	PT
15	EC 4034	RF Circuits	3	0	0	3	PT
16	EC 4035	High Speed Digital Circuits	3	0	0	3	PT
17	EC 4036	Antenna Theory	3	0	0	3	PT
18	EC 4037	Analog MOS Integrated Circuits	3	0	0	3	PT
19	EC 4038	High Speed Semiconductor Devices	3	0	0	3	PT
20	EC 4039	Nanoelectronics	3	0	0	3	PT
21	EC 4040	Opto-electronic Communication Systems	3	0	0	3	PT
22	EC 4041	Communication Switching Systems	3	0	0	3	PT
23	EC 4042	Radar Engineering	3	0	0	3	PT
24	EC 4043	Cryptography: Theory and Practice	3	0	0	3	PT
25	EC 4044	Opto-electronic Devices and Systems	3	0	0	3	PT
26	EC 4045	Signal Compression	3	0	0	3	PT
27	EC 4046	Microwave Devices and Circuits	3	0	0	3	PT
28	EC 4047	Advanced Wireless Communication	3	0	0	3	PT
29	EC 4048	Signal Estimation and Detection	3	0	0	3	PT
30	EC 4049	Architecture of Advanced Processors	3	0	0	3	PT
31	EC 4050	Radiation and Propagation	3	0	0	3	PT
32	EC 4051	Electronic Instrumentation	3	0	0	3	PT
33	EC 4052	State of the art and Future Memories	3	0	0	3	PT
34	EC 4053	Reliability of Semiconductor Devices	3	0	0	3	PT
35	EC 4054	Silicon on Insulator and Advanced MOSFET based structures	3	0	0	3	PT
36	EC4055	Design of Intelligent Systems	3	0	0	3	PT
37	EC4056	Compressed Sampling: Principles and Algorithms	3	0	0	3	PT

CATEGORY-WISE CREDITS

Category	Credits
Basic Science (BS)	20
Humanities and Languages (HL)	9
Basic Engineering Science(ES)	8
Technical Arts (TA)	7
Professional Theory and Laboratory Practicals (PT)	110
Others (OT)	6
Total	**160**

Syllabus of B. Tech. Degree Programme in Electronics and Communication Engineering

SEMESTER-I & II

MA 1001: MATHEMATICS I

Course Type : Basic Science
Pre-requisites: -NIL-

L	T	P	C
3	1	0	3

Course Outcomes:

- ***CO1:*** *Learn to find the solution of constant coefficient differential equations.*
- ***CO2:*** *Acquire knowledge about the notion of convergence of numerical sequences and series and learn ways of testing convergence.*
- ***CO3:*** *Learn the basic definition and properties of partial differentiation of functions of several variables and to learn to use this to solve problems related to maxima and minima.*
- ***CO4:*** *Learn the basic results about the properties of Fourier transform and Fourier series and its convergence.*
- ***CO5:*** *Learn the properties of Laplace transforms and to learn to use this to solve differential equations.*

Module No	Syllabus
1 (12 hours)	**Preliminary Calculus:** Partial differentiation, Total differential and total derivative, exact differentials, Chain rule, Change of variables, Minima and Maxima of functions of two or more variables. **Infinite Series :** Notion of convergence and divergence of infinite series, Ratio test, Comparison test, Raabe's test, Root test, Series of positive and negative terms, Idea of absolute convergence, Taylor's and Maclaurin's series
2 (17 hours)	**First order ordinary differential equations:** Methods of solution, Existence and uniqueness of solution, Orthogonal Trajectories, Applications of first order differential equations. **Linear second order equations:** Homogeneous linear equations with constant coefficients, fundamental system of solutions, Existence and uniqueness conditions, Wronskian, Non homogeneous equations, Methods of Solutions, Applications.
3 (13 hours)	**Module Fourier analysis:** Periodic functions **-** Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansions, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier Cosine and Sine Transforms, Fourier Transforms.
4 (14 hours)	Gamma functions and Beta functions, Definition and Properties, Laplace Transforms, Inverse Laplace Transforms, shifting Theorem, Transforms of derivatives and integrals, Solution of differential Equations, Differentiation and Integration of Transforms, Convolution, Unit step function, Second shifting Theorem, Laplace Transform of Periodic functions.

Reference:

1. Kreyszig E, 'Advanced Engineering Mathematics' 8th Edition, John Wiley & Sons New York, (1999)
2. Piskunov, 'Differential and Integral Calculus, MIR Publishers, Moscow (1974).
3. Wylie C. R. & Barret L. C 'Advanced Engineering Mathematics' 6th Edition, McGraw Hill, New York, (1995).
4. Thomas G. B. 'Calculus and Analytic Geometry' Addison Wesley, London (1998).

MA 1002: MATHEMATICS II

Course Type : Basic Science
Pre-requisites: -NIL-

L	T	P	C
3	1	0	3

Course Outcomes:

- ***CO1:*** *Acquire knowledge about the ideas and techniques of linear algebra, and to illustrate some of their applications in engineering.*
- ***CO2:*** *Acquire knowledge about the physical interpretation of the gradient, divergence and curl.*
- ***CO3:*** *Acquire knowledge of vector calculus and to apply in electromagnetic field.*
- ***CO4:*** *Prepare to evaluate multiple integrals in rectangular, polar, spherical and cylindrical coordinates.*
- ***CO5:*** *Acquire knowledge about how to use double, triple and line integrals in applications, including Green's theorem, Stoke's theorem and Divergence theorem.*
- ***CO6:*** *Acquire knowledge about ANOVA principles and methods.*

Module No	Syllabus
1 (14 hours)	**Linear Algebra I:** Systems of Linear Equations, Gauss' elimination, Rank of a matrix, Linear independence, Solutions of linear systems: existence, uniqueness, general form. Vector spaces, Subspaces, Basis and Dimension, Inner product spaces, Gram-Schmidt Orthogonalization, Linear Transformations.
2 (14 hours)	**Linear Algebra II:** Eigen values and Eigen vectors of a matrix, Some applications of Eigen value problems, Cayley-Hamilton Theorem, Quadratic forms, Complex matrices, Similarity of matrices, Basis of Eigen vectors – Diagonalization.
3 (13 hours)	**Vector Calculus I:** Vector and Scalar functions and fields, Derivatives, Curves, Tangents, Arc length, Curvature, Gradient of a Scalar Field, Directional derivative, Divergence of a vector field, Curl of a Vector field.
4 (15 hours)	**Vector Calculus II:** Line Integrals, Line Integrals independent of path, Double integrals, Surface integrals, Triple Integrals, Verification and simple applications of Green's Theorem, Gauss' Divergence Theorem and Stoke's Theorem.

Reference:

1. Kreyzig E, Advanced Engineering Mathematics, 8th Edn, John Wiley & Sons, New York (1999).
2. Wylie C. R & Barrret L. C, Advanced Engineering Mathematics, 6th Edn, Mc Graw Hill, New York (1995).
3. Hoffman K & Kunze R, Linear Algebra, Prentice Hall of India, New Delhi (1971).

PH 1001: PHYSICS

Course Type : Basic Science
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1****: Acquire knowledge and understanding of fundamental principles of modern physics relevant to problems of Electronics and Communication Engineering.*
- ***CO2****: Acquire knowledge of basic principles of Quantum Physics and Relativity.*
- ***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 semiconducting and magnetic materials*
- ***CO5****: Acquire knowledge of new emerging areas of Science and Technology like nano-materials.*

Module No	Syllabus
1 (6 hours)	**Theory of Relativity:** Frames of reference, Galilean Relativity, Michelson-Morley experiment, postulates of Special Theory of Relativity, Lorentz transformations, simultaneity, length contraction, time dilation, velocity addition, Doppler effect for light, relativistic mass and dynamics, mass energy relations, massless particles, Description of General Theory of Relativity.
2 (10 hours)	**Quantum Mechanics** (Dual nature of matter, properties of matter waves, wave packets, uncertainty principle, formulation of Schrödinger equation, physical meaning of wave function, expectation values, time-independent Schrödinger equation, quantization of energy – bound states, application of time-independent Schrödinger equation to free particle, infinite well, finite well, barrier potential, tunneling, Simple Harmonic Oscillator, two-dimensional square box, the scanning tunneling microscope.
3 (12 hours)	**Statistical Physics:** Temperature, microstates of a system, equal probability hypothesis, Boltzman factor and distribution, ideal gas, equipartition of energy, Maxwell speed distribution, average speed, RMS speed, applications – Lasers and Masers, Quantum distributions – many particle systems, wave functions, indistinguishable particles, Bosons and Fermions, Bose-Einstein and Fermi-Dirac distribution, Bose-Einstein condensation, Specific heat of a solid, free electron gas and other applications.
4 (14 hours)	**Applications to Solids :** Band theory of solids, conductors, semi-conductors and insulators, metals – Drude model and conductivity, electron wave functions in crystal lattices, E-k diagrams, band gaps, effective mass, semiconductors, Fermi energy, doping of semiconductor, conductivity and mobility of electrons, Hall effect, Fundamentals of mesoscopic physics and nano technology: size effects, interference effect, quantum confinement and Coulomb blockade. Quantum wells, wires, dots, nanotubes, semiconductor nano materials, Magnetism: dipole moments, paramagnetism, Curie's law, magnetization and hysterisis, Ferromagnetism and Anti-Ferromagnetism.

Reference:

1. J. R. Taylor, C.D. Zafiratos and M. A. Dubson, Modern Physics for Scientists and Engineers, , 2nd Ed., Pearson (2007)
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. B. G. Streetman, Solid state Devices, , 5th Ed., Pearson (2006)

CY 1001: CHEMISTRY

Course Type : Basic Science

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1****: To acquire knowledge on the role of chemistry in solving the problems related to electronics and communication engineering.*
- ***CO2****: To acquire knowledge about the fundamental principles of bonding in materials*
- ***CO3****: To acquire knowledge on the characterization of materials by modern tools*
- ***CO4****: To acquire knowledge on the chemistry of bio-molecules*
- ***CO5****: To acquire knowledge on the fundamental mechanisms of reactions*
- ***CO6****: To apply the acquired knowledge in chemistry to solve problems for the benefit of the society*

Module No	Syllabus
1 (8 hours)	**Chemical Bonding** Quantum mechanical methods in chemical bonding: molecular orbital theory, symmetry of molecular orbitals, MOs for homonuclear diatomic molecules, application of MO theory to heteronuclear diatomics, valence bond theory, hybridization, hybridization involving d orbitals, conjugated molecules, Huckel molecular orbital theory of conjugated systems, metallic bonding, band theory .
2 (14 hours)	**Spectroscopy :** General features of spectroscopy, interaction of radiation with matter, theory and application of rotational, vibrational, Raman, electronic, mass, NMR, fluorescence and photoelectron spectroscopy.
3 (12 hours)	**Transition Metal Chemistry:** Bonding in transition metal complexes: coordination compounds, crystal field theory, octahedral, tetrahedral and square planar complexes, crystal field stabilization energies, Jahn-Teller theorem, spectral and magnetic properties. **Bio-Inorganic chemistry:** Trace elements in biology, heme and non-heme oxygen carriers, haemoglobin and myoglobin-cooperativity; Bohr effect, Hill coefficient, oxy and deoxy haemoglobin, reversible binding of oxygen.
4 (8 hours)	**Aromaticity :** Electron delocalization, resonance and aromaticity; molecular orbital description of aromaticity and anti-aromaticity, annulenes; ring current, NMR as a tool, diamagnetic anisotropy; aromatic electrophilic substitutions, aromatic nucleophilic substitutions, benzyne; reaction mechanisms, reactivity and orientation.

Reference:

1. J. E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry, Principles of Structure and Reactivity, Harper Collins, New York 1997.
2. F. A. Cotton and G Wilkinson, Advanced Inorganic Chemistry, 5th Edition, WileyInterscience, New York, 1988.
3. J. D. Lee, Concise Inorganic Chemistry, Chapman & Hall, London, 1996.
4. W. L. Jolly, Modern Inorganic Chemistry, McGraw-Hill International, 2nd Edition, New York, 1991.
5. R. T. Morrison and R N Boyd, Organic Chemistry, 6th Edition, Prentice Hall, New Delhi,1999.
6. P. Bruice, Organic Chemistry, 3rd Edition, Prentice Hall, New Delhi , 2001.
7. F. Carey, Organic Chemistry, 5th Edition, McGraw Hill Publishers, Boston, 2003.
8. J. Mc Murray, Organic Chemistry, 5th Edition, Brooks/ Cole Publishing Co, Monterey,2000.
9. C.N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, McGraw- Hill, International, UK, 1995.
10. William Kemp, Organic Spectroscopy, 3rd edition, Palgrave, New York, 2005.
11. R.M. Silverstein, F.X. Webster and D.J. Kiemle, Spectrometric Identification of Organic Compounds**,** 7th edition**,** John-Wiley and Sons, New York, 2005.
12. D. L. Pavia, GM. Lampman, GS. Kriz and J.R Vyvyan, I, Spectroscopy, Cengage Learning India Pvt. Ltd, New Delhi, 2007.
13. B. R.Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing CO. Delhi, 2008.
14. P.W. Atkins, Physical Chemistry, 6th Edition, Oxford University Press, Oxford, 1998.

MS 1001: PROFESSIONAL COMMUNICATION

Course Type : Humanities and Languages
Pre-requisites: -NIL-

L	T	P	C
3	1	0	3

Course Outcomes:

- ***CO1:*** *Effectively communicate technical material in print.*
- ***CO2:*** *Present technical material orally with confidence and poise, including audiovisual materials.*
- ***CO3:*** *Communicate effectively in ways appropriate to the discipline, audience and purpose.*
- ***CO4:*** *Think critically and creatively to generate innovative and optimum solutions*
- ***CO5:*** *Identify, evaluate and synthesize information from a range of sources to optimize process engineering design and development.*
- ***CO6:*** *Engage in continuous education, training and research, and take control of their own learning and development.*
- ***CO7:*** *Work effectively and efficiently individually and in teams*
- ***CO8:*** *Be 'career ready' for the process engineering profession, demonstrate leadership qualities, and work ethically and professionally*

Module No	Syllabus
1 (11 hours)	**Verbal Communication:** received pronunciation; how to activate passive vocabulary; technical/non-technical and business presentations; questioning and answer skills; soft skills for professionals; role of body postures, movements, gestures, facial expressions, dress in effective communication; Information/ Desk/ Front Office/ Telephone conversation; how to face an interview/press conference; Group discussions, debates, elocution.
2 (9 hours)	**Reading Comprehension:** skimming and scanning; factual and inferential comprehension; prediction; guessing meaning of words from context; word reference; use and interpretation of visuals and graphics in technical writing.
3 (11 hours)	**Written Communication:** note making and note taking; summarizing; invitation, advertisement, agenda, notice and memos; official and commercial letters; job application; resume and curriculum vitae; utility, technical, project and enquiry reports; paragraph writing: General – Specific, Problem – Solution, Process – Description, Data – Comment.
4 (11 hours)	**Short essays:** description and argument; comparison and contrast; illustration; using graphics in writing: tables and charts, diagrams and flow charts, maps and plans, graphs; how to write research paper; skills of editing and revising; skills of referencing; what is a bibliography and how to prepare it.

Reference:

1. Adrian Doff and Christopher Jones: Language in Use – Upper intermediate, self study workbook and classroom book. (Cambridge University Press)[2000]
2. Sarah Freeman: Written Communication (Orient Longman)[1978]
3. Mark Ibbotson: Cambridge English for Engineering (Cambridge University Press) November 2008
4. T Balasubramanian: English Phonetics for Indian Students: A Workbook(Macmillan publishers India) 2000
5. Chris Mounsey: Essays and Dissertation (Oxford University Press) February 2005.
6. Sidney Greenbaum: The Oxford English Grammar (Oxford University Press) March 2005
7. Krishna Mohan and Meera Banerji: Developing Communication Skills (Mac Millan india Ltd)[2000]
8. Krishna Mohan and Meenakshi Raman: Effective English Communication (Tata Mc- Graw Hill)[2000]

ZZ 1003: BASIC ELECTRICAL SCIENCES

Course Type : Basic Science
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1****: Analysis of Resistive Circuits and Solution of resistive circuits with independent sources.*
- ***CO2****: Two Terminal Element Relationships for inductors and capacitors and analysis of magnetic circuits.*
- ***CO3****: Analysis of Single Phase AC Circuits, the representation of alternating quantities and determining the power in these circuits.*
- ***CO4****: To acquire the knowledge about the characteristics and working principles of semiconductor diodes, Bipolar Junction Transistor.*
- ***CO5****: To get an insight about the basic introduction of Digital electronics.*

Module No	Syllabus
1 (11 hours)	**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 Fields-. v-i relationship for Inductance and Capacitance - v-i relationship for Independent Voltage and Current Sources – Magnetic Circuits**:** MMF, Magnetic Flux, Reluctance- Energy Stored in a Magnetic Field-Solution of Magnetic Circuits. Analysis of Resistive Circuits: Solution of resistive circuits with independent sources- Node Analysis and Mesh Analysis-Nodal Conductance Matrix and Mesh Resistance Matrix and symmetry properties of these matrices-Source Transformation- Circuit Theorems - Superposition Theorem-Thevenin's Theorems and Norton's Theorem- Maximum Power Transfer Theorem
2 (10 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.
3 (14 hours)	**Introductory Analog Electronics**: Semiconductor Diode: Principle, Characteristics - Applications: Rectifier Circuits -Zener Diode, LED, Photo diode, IR diode Bipolar Junction Transistor: Principle, Operation, Characteristics (CB, CE, CC) - Principle of working of CE, CB and CC amplifiers, quantitative relations for midband operation, input and output resistance levels – qualitative coverage on bandwidth – cascading considerations. Introductory Digital Electronics: Transistor as a switch – switching delays, inverter operation Digital Electronics: Number Systems and Conversions- Logic Gates and Truth Tables – Boolean Algebra – Basic canonical realizations of combinatorial circuits. Standard Combinatorial Circuit SSI and MSI packages (Adder, Code Converters, 7-Segment Drivers, Comparators, Priority Encoders etc) MUX-based and ROM-based implementation of combinatorial circuits.
4 (7 hours)	**Measuring instruments:** Basics of electronic/digital voltmeter, ammeter, multi-meter, wattmeter and energy meter. Measurement of Voltage, Current and Resistance. Introduction to Cathode Ray Oscilloscope - CRT, Block diagram of CRO

Reference:

1. James W Nilsson and Susan A Riedel, Electric Circuits, Pearson, 8th Edn, 2002
2. Robert L Boylestead & L Nashelsky, Electronic Devices and Circuit Theory, Pearson, 9th Edition, 2007
3. Morris Mano , Digital Design , PHI, 3rd Edition, 2005
4. Golding & Widdis, Electrical Measurements an Measuring Instruments;- Wheeler Publishers, 5th edition, 1999.
5. Rangan, Sarma and Mani, Instrumentation Devices and Systems, Tata McGraw Hill, 1997
6. A.K. Sawhney: A course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Co,16th Edition, 2006
7. Suresh Kumar K.S, Electric Circuits & Networks, Pearson Education, 2009
8. Adel S Zedra and Kennath C Smith, Microelectronics, Oxford University Press, 2004

ZZ 1001: ENGINEERING MECHANICS

Course Type : Technical Arts
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *The student will be able to analyse statically determinate structures including trusses using equations of equilibrium.*
- ***CO2:*** *The student will be able to find space-time relationship (kinematics) of particle.*
- ***CO3:*** *The student will be able to solve dynamic problems of particle using Newton's law, energy method and impulse-momentum approach.*
- ***CO4:*** *The student will be able to solve elementary problems in vibration.*

Module No	Syllabus
Part A **Statics** **1** **(12 hours)**	**Fundamentals of mechanics**: idealisations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics. 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. Equations of equilibrium: Free body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy.
2 **(10 hours)**	**Applications of Equations Equilibrium:** Trusses: solution of simple trusses, method of joints, method of sections; Friction forces: laws of Coulomb friction, simple contact friction problems. Properties of surfaces: First moment, centroid, second moments and the product of a plane area, transfer theorems, rotation of axes, polar moment of area, principal axes, and concept of second order tensor transformation.
Part B **Dynamics** **3** **(10 hours)**	**Kinematics of a particle:** Introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations, rectangular components, velocity and acceleration in terms of cylindrical coordinates simple kinematical relations and applications. Particle dynamics: Introduction, rectangular coordinates, rectilinear translation, Newton's law for rectangular coordinates, rectilinear translation, cylindrical coordinates Newton's law for cylindrical coordinates.
4 **(10 hours)**	**Energy and momentum methods for a particle:** Analysis for a single particle, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, Linear momentum, impulse and momentum relations, moment of momentum. Vibrations: Single degree of freedom systems, free vibration, undamped and damped, forced vibration, sinusoidal loading, introduction to multi degree of freedom systems, illustration using two degree-of-freedom systems.

Reference:

1. 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.

ZZ 1002: ENGINEERING GRAPHICS

Course Type : Technical Arts
Pre-requisites: -NIL-

L	T	P	C
1	0	3	3

Course Outcomes:

- ***CO1:*** *Students' ability in legible writing letters and numbers will be improved.*
- ***CO2:*** *Students' ability to perform basic sketching techniques and instrumental drawing will be improved.*
- ***CO3:*** *Students will be able to draw orthographic projections of different objects irrespective of number of dimensions and to develop pictorial views.*
- ***CO4:*** *Students' ability to present the scale drawings of the visualized objects will be increased.*
- ***CO5:*** *Students' ability to produce engineered drawing of any newly designed object will be improved.*
- ***CO6:*** *Students will become familiar with practice and standards in technical drawing.*
- ***CO7:*** *Students will develop good communication skills and team work.*

Module No	Syllabus
1 (10 hours)	Introduction to Engineering Graphics – Drawing instruments and their use – Different types of lines - Lettering & dimensioning – Familiarization with current Indian Standard Code of Practice for Engineering Drawing. Scales, Plain scales, Diagonal scales, Vernier scales. Introduction to orthographic projections- Horizontal, vertical and profile planes – First angle and third angle projections – Projection of points in different coordinates – Projections of lines inclined to one of the reference planes. **(4Lecture+6drawing hours)**
2 (20 hours)	Projections of lines inclined to both the planes–True lengths of the lines and their angles of inclination with the reference planes–Traces of lines. **(4Lecture+6 drawing hours)** Projection of plane lamina of geometric shapes inclined to one of the reference planes–inclined to both the planes, Traces of planes. **(2Lecture+3 drawing hours)** Projections on auxiliary planes. **(2 lecture +3 drawing hours)**
3 (10 hours)	Projections of polyhedra and solids of revolution, projection of solids with axis parallel to one of the planes and parallel or perpendicular to the other plane – Projections with the axis inclined to one of the planes. Projections of solids with axis inclined to both the planes – Projections of spheres and combination of solids. **(4 Lecture+6 drawing hours)**
4 (17 hours)	Sections of solids by planes perpendicular to at least one of the reference planes – True shapes of sections. **(2 lectures, 3 drawing hours)** Developments, development of the lateral surface of regular solids like, prisms, pyramids, cylinders, cones and spheres, development of truncated solids. **(2 lectures +3 drawing hours)** Isometric projection – Isometric scale – Isometric views – Isometric projection of prisms, pyramids, cylinders, cones, spheres and solids made by combination of the above. **(2 lectures +6 drawing hours)**

Reference:

1. Bhatt N. D**,** Elementary Engineering Drawing, Charotar Publishing House, Anand, 2002
2. Narayana K L & Kannaiah P, Engineering Graphics, Tata McGraw Hill, New Delhi, 1992
3. Luzadder W J, Fundamentals of Engineering Drawing, Prentice Hall of India, New Delhi, 2001
4. Thomas E French & Charkes J V, Engineering Drawing & Graphing Technology, McGraw Hill Book Co, New York, 1993
5. Venugopal K, Engineering Drawing & Graphics, New Age International Pvt. Ltd., New Delhi, 1994

ZZ 1004: COMPUTER PROGRAMMING

Course Type : Basic Engineering Science
Pre-requisites: -NIL-

L	T	P	C
2	0	0	2

Course Outcomes:

- ***CO1:*** *Students are introduced to the concepts of structured programming and there by motivating them to develop good programming skill. Familiarization of the concepts of program flow, functions, using arguments and return values and how to run a C program are also included in the course.*
- ***CO2:*** *The students will be able to develop algorithms to solve basic programming problems. Solving different types of problems need critical analysis of the problem statement which improves the problem analysis skill of the students.*
- ***CO3:*** *The student will be able to apply the computer programming techniques to resolve practical problems. Top-down approach to problem solving is deployed.*
- ***CO4:*** *The way to approach complex problems and the basic solving methodology is introduced. The problems given as assignments not only aims at improving the problem solving skill of the student, but also tries to develop a keen interest in identifying, attempting and solving complex programming problems.*
- ***CO5:*** *The course gives a firm foundation to the programming concepts and problem solving techniques needed in the general engineering discipline.*
- ***CO6:*** *Efficient programming techniques results in reduced consumption of power and other resources.*
- ***CO7:*** *Students are encouraged to program higher level programs both individually and as a team thereby making them realize the effectiveness of team work. The individual and team works in the course will help the students work in an environment similar to the way most companies work.*
- ***CO8:*** *The course helps the students to develop problem analysis skill and identify the best way to solve a problem. Also to write efficient algorithms and implement it in structured language. As an outcome of the course, students will be able to compile, run and debug programs in C language.*
- ***CO9:*** *Group projects help the students to identify the different areas involved in solving a problem and divide the work among them efficiently.*
- ***CO10:*** *Groundwork for a strong programming career in computer science discipline is laid down by understanding the essence of writing efficient, maintainable, and portable code. Solving variety of problems will gradually improve the quality of solutions. Group work will help the students to get rid of inhibition and to develop a bright future in their career.*

Module No	Syllabus
1 (7 hours)	**Data Types, Operators and Expressions:** Variables and constants - declarations - arithmetic, relational and logical operators – Assignment operator and expressions – conditional expressions – precedence and order of evaluation. **Control Flow:** Statements and blocks – if-else, switch, while, for and do-while statements – break and continue statements, goto and labels.
2 (7 hours)	**Functions and Program structure:** Basics of functions, Parameter passing – scope rules - recursion.
3 (7 hours)	**Pointers and Arrays**: Single and multidimensional arrays - Pointers and arrays – address arithmetic - Passing pointers to functions.
4 (7 hours)	**Structures and Unions:** Basics of structures, Structures and functions – Arrays of Structures – Pointers to structures – self referential structures – Type definitions – Unions. **Input and Output:** Standard input and output – Formatted output – variable length argument list – file access.

Reference:

1. B. W. Kernighan and D. M. Ritchie, The C Programming Language (2/e), Prentice Hall, 1988.
2. B.S. GottFried, Schaum's Outline of Programming with C(2/e), McGraw-Hill, 1996.
3. C. L. Tondo and S. E. Gimpel, The C Answer Book(2/e), Prentice Hall, 1988.
4. B. W. Kernighan, The Practice of Programming, Addison-Wesley, 1999.

PH 1091: PHYSICS LABORATORY

Course Type : Basic Science
Pre-requisites: -NIL-

L	T	P	C
0	0	2	1

Course Outcomes:

- ***CO1:*** *To develop experimentation skills and understand importance of measurement practices in Science & Technology.*
- ***CO2:*** *Develop analytical skills for interpreting data and drawing inferences.*
- ***CO3:*** *Understand nature of experimental errors and practical means to estimate 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.*

Syllabus

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 – Milliken 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 l using grating
16. Measurement of Magnetic susceptibility- Quincke's Method / Gouy's balance.
17. Mapping of magnetic field

NOTE: Any 8 experiments to be done.

Reference:

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

CY 1094: CHEMISTRY LABORATORY

Course Type : Basic Science
Pre-requisites: -NIL-

L	T	P	C
0	0	2	1

Course Outcomes:

- ***CO1***: *To acquire practical knowledge on the basic chemistry principles for apply in Electronics and communication engineering*
- ***CO2***: *To acquire practical knowledge on the techniques for the preparation and characterization of materials*
- ***CO3***: *To acquire knowledge on electrochemical techniques*
- ***CO4***: *To acquire training in accurate and precise data collection*

Syllabus

Potentiometric and conductometric titrations, complexometric and iodimetric estimations, polarimetry, determination of pH, single step organic / inorganic preparations, colorimetry, determination of eutectic point.

Reference:

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, Vogel's Text Book of Quantitative Chemical Analysis, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
3. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, Vogel's Text Book of Practical Organic Chemistry, Longman and Scientific Technical, New York, 1989.

CIVIL ENGINEERING WORKSHOP (PART OF ZZ 1091: WORKSHOP PRACTICE I)

Course Type : Technical Arts
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *Acquire knowledge on the basic civil engineering practices of brick and concrete masonry, plumbing and surveying.*
- ***CO2:*** *Get hands on training in basic masonry and surveying.*
- ***CO3:*** *Understand the quality requirements and quality testing procedures of selected building material, viz., cement, fine aggregate, coarse aggregate, concrete, timber and steel.*

Syllabus

1. **Introduction to Construction Materials:** Cement, sand, coarse aggregate, structural steel, brick, timber, concrete – methods of testing **(3 hours)**
2. **Masonry:** English bond – Flemish bond –wall –junction – one brick – one and a half brick - Arch construction. **(6 hours)**
3. **Plumbing:** Study of water supply and sanitary fittings—water supply pipe fitting –tap connections - sanitary fittings. **(3 hours)**
4. **Surveying**: Introduction to land surveying and linear measurements; Introduction to leveling. **(9 hours)**

There will be an evaluation in the last week which will be in the form of a **written test.**

Total duration of the work shop : 24 hours (3×7 = 21 hours (Laboratory work) + 3 hours test).

ELECTRICAL & ELECTRONICS ENGINEERING WORKSHOP (4 weeks)
(Part of ZZ 1091: WORKSHOP PRACTICE I)

Course Type : Technical Arts

Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *Acquire knowledge about various types of wiring systems, wiring tools, lighting & wiring accessories, wiring estimation & costing, etc.*
- ***CO2:*** *Acquire knowledge about household electrical appliances, need of earthing, electric shock, etc.*

Syllabus

Four exercises from the following list of Exercises are to be carried out.

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 types of Fuse, MCB, ELCB etc.
   b. Wiring of fluorescent lamp controlled by one switch from panel with ELCB & MCB.
4. a. Study of estimation and costing of wiring
   b. Domestic appliance – Wiring, Control and maintenance: Mixer machine, Electric Iron, fan motor, pump motor, Battery etc.
5. a. Familiarization of electronic components colour code, multi-meters.
   b. Bread board assembling - Common emitter amplifier
6. a. Study of soldering components, solders, tools, heat sink.
   b. Bread board assembling – phase shift oscillator
7. a. Soldering practice - Common emitter amplifier
   b. Soldering practice - Inverting amplifier circuit
8. a. Study of estimation and costing of soldering –PCB: 3 phase connections
   b. Domestic appliances – Wiring PCB, control, Identification of fault: Electronic Ballast, fan regulator, inverter, UPS etc.

Reference:

1. K B Raina & S K Bhattacharya: Electrical Design Estimating and costing, New Age International Publishers, New Delhi, 2005
2. Uppal S. L., Electrical Wiring & Estimating, Khanna Publishers---5th edition, 2003
3. John H. Watt, Terrell Croft :American Electricians' Handbook: A Reference Book for the Practical Electrical Man - McGraw-Hill, 2002
4. G. Randy Slone **-** Tab Electronics Guide to Understanding Electricity and Electronics, Mc- GrawHill, 2000
5. Jerry C Whitaker - The Resource Handbook of Electronics, CRC Press-2001

ELECTRICAL & ELECTRONICS ENGINEERING WORKSHOP (4 weeks)
(Part of ZZ 1092: WORKSHOP PRACTICE II)

Course Type : Technical Arts

Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *To learn the basic manufacturing processes of Casting, Joining, Forming and machining through hands on experience and use of hand tools.*
- *CO2: To get familiarized with the properties of different materials- metals and non-metals.*
- ***CO3:*** *To learn about the various measuring devices, to know about the importance of sequential plans of action in manufacturing through practice in various sections.*
- ***CO4:*** *Acquire knowledge about electronic components, measuring instruments, bread board assembling, etc.*
- ***CO5:*** *Acquire knowledge about soldering tools & components, estimation & costing of PCB soldering, household electronic appliances, etc.*

Syllabus

Four exercises from the following list of Exercises are to be carried out.

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 Switch and one 3 pin plug socket independently.
3. a. Familiarization of types of Fuse, MCB, ELCB etc.
   b. Wiring of fluorescent lamp controlled by one switch from panel with ELCB & MCB.
4. a. Study of estimation and costing of wiring
   b. Domestic appliance – Wiring, Control and maintenance: Mixer machine, Electric Iron, fan motor, pump motor, Battery etc.
5. a. Familiarization of electronic components colour code , multimeters.
   b. Bread board assembling - Common emitter amplifier
6. a. Study of soldering components, solders, tools, heat sink.
   b. Bread board assembling – phase shift oscillator
7. a. Soldering practice - Common emitter amplifier
   b. Soldering practice - Inverting amplifier circuit
8. a. Study of estimation and costing of soldering –PCB: 3 phase connections
   b. Domestic appliances – Wiring PCB, control, Identification of fault: Electronic Ballast, fan regulator, inverter, UPS etc.

Reference:

1. K B Raina & S K Bhattacharya: Electrical Design Estimating and costing, New Age International Publishers, New Delhi, 2005
2. Uppal S. L., Electrical Wiring & Estimating, Khanna Publishers---5th edition, 2003
3. John H. Watt, Terrell Croft :American Electricians' Handbook: A Reference Book for the Practical Electrical Man - McGraw-Hill, 2002
4. G. Randy Slone **-** Tab Electronics Guide to Understanding Electricity and Electronics, Mc-GrawHill, 2000
5. Jerry C Whitaker - The Resource Handbook of Electronics, CRC Press-2001

ZZ 1092: WORKSHOP PRACTICE II

Course Type : Technical Arts
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- *CO1: To learn the basic manufacturing processes of Casting, Joining, Forming and machining through hands on experience and use of hand tools.*
- *CO2: To get familiarized with the properties of different materials- metals and non-metals.*
- *CO3: To learn about the various measuring devices, to know about the importance of sequential plans of action in manufacturing through practice in various sections.*
- *CO4: Acquire knowledge about electronic components, measuring instruments, bread board assembling, etc.*
- *CO5: Acquire knowledge about soldering tools & components, estimation & costing of PCB soldering, household electronic appliances, etc.*

Syllabus

- **Eight classes of 3 hour duration each**

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

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- one simple exercise of single V joint for welding exercise.
3) Welding: Study of arc and gas welding, accessories, joint preparation, Exercise of a single V joint
4) Smithy: Study of tools, forging of square or hexagonal prism/ chisel/bolt
5) Foundry: Study of tools, sand preparation, moulding practice.
6) Sheet Metal work: Study of tools, selection of different gauge sheets, types of joints, fabrication of a tray or a funnel
7) Plumbing Practice: Study of tools, study of pipe fittings, pipe joints, cutting, and threading
8) Lathe Exercise: Study of the basic lathe operations, a simple step turning exercise.

Reference:

1) Chapman W.A.J., Workshop Technology. Parts 1 & 2, 4th Edition, Viva Books P. Ltd., New Delhi, 2002
2) Hajra Choudhury.Workshop Technology Vol 1 & 2, Media Promoters & Publishers P.Ltd, Bombay, 2004
3) Welding Handbook. Miami, American Welding Society, 2000
4) Metals Handbook. Vol 6, Welding, Brazing & Soldering. Metals Park, Ohio, American Society of Metals, 1998
5) Serope Kalpakjian. Manufacturing Engineering & Technology. Pearson Steven R. Schmid Education (Asia) Inc., Delhi, 2002.
6) Anderson J., Shop Theory. Tata McGraw Hill, New Delhi, 2002
7) Olson D.W., Wood and Wood working. Prentice Hall India. 1992
8) Douglass J.H., Wood Working with Machines. McKnight &McKnight Pub. Co. Illinois, 1995
9) Tuplin W.A., Modern Engineering Workshop Practice Odhams Press, 1996
10) P.L. Jain. Principles of Foundry Technology. 4th Edition, Tata McGraw Hill, 2008.
11) R.K.Singal, Mridul Singal, Rishi Sringal. Basic Mechanical Engineering. 2007

EC 1001: INTRODUCTION TO ELECTRONICS ENGINEERING

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
2	0	0	2

Course Outcomes:

- ***CO1:*** *Understand the role and impact of Electronics and Communication Engineering in Everyday Life*
- ***CO2:*** *Understand the basics of semiconductors, diodes, BJTs, MOSFETS and simple electronic circuits*
- ***CO3:*** *Learn the basics of signal processing*
- ***CO4:*** *Learn the basics of analog and digital communication.*
- ***CO5:*** *Learn the Basics of Amplifiers, Transfer Function, Signal to Noise Ratio etc.*

Module No	Syllabus
1 (7 hours)	Basics of Electronics: Semiconductors, Band structure of Silicon, doping, PN junctions, MOSFET, simple inverter configurations, large scale integration concepts.
2 (7 hours)	Signal Processing basics: Filtering, sampling, simple analog and digital filter configurations.
3 (7 hours)	Communication basics: Signals and noise, ideas of AM and FM, PCM, noise immunity.
4 (7 hours)	**Basics of linear circuit design:** Transfer function, speed and bandwidth, superposition of signals and noise, signal-to-noise ratio.

Reference:

1. Millman & Halkias: Electronic Devices & Circuits, MGH, 2007
2. George Kennedy: Electronic Communication Systems, MGH, 1992
3. B P Lathi: Signal Processing & Linear Systems, Oxford University Press, 2000

SEMESTER: III

MA 2001: MATHEMATICS III

Course Type : Basic Science
Pre-requisites: -NIL-

L	T	P	C
3	1	0	3

Course Outcomes:

- ***CO1:*** *Acquire knowledge about important probability distributions and their properties.*
- ***CO2:*** *Acquire knowledge about statistical parameter estimation.*
- ***CO3:*** *Acquire knowledge about statistical hypotheses tests.*
- ***CO4:*** *Acquire knowledge about regression and correlation analysis.*
- ***CO5:*** *Acquire knowledge about ANOVA principles and methods.*

Module No	Syllabus
1 (11L+4T)	**Probability distributions:-** Random variables, Binomial distribution, Hyper-geometric distribution, Mean and variance of a probability distribution, Chebyshev's theorem, Poisson distribution, Geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution, Weibull distribution. Joint distribution of two random variables.
2 (11L+3 T)	**Sampling distributions and Inference concerning means:-** Population and samples, The sampling distribution of the mean (σ known and σ unknown), Sampling distribution of the variance, Maximum Likelihood Estimation, Point estimation and interval estimation, point estimation and interval estimation of mean and variance, Tests of hypothesis, Hypothesis concerning one mean, Inference concerning two means.
3 (10L + 3T)	**Inference concerning variances proportions:-** Estimation of variances , Hypothesis concerning one variance, Hypothesis concerning two variances , Estimation of proportions , Hypothesis concerning one proportion , Hypothesis concerning several proportions, Analysis of r x c tables, Chi – square test for goodness of fit.
4 (10L+4T)	**Regression Analysis:-** Bi-variate Normal distribution- joint, marginal and conditional distributions. Curve fitting, Method of least squares, Estimation of simple regression models and hypothesis concerning regression coefficients, Correlation coefficient-estimation of correlation coefficient, hypothesis concerning correlation coefficient. Estimation of curvilinear regression models, **Analysis of variance:-** General principles, Completely randomized designs, Randomized block diagram, Latin square designs, Analysis of covariance.

Reference:

1. Johnson, R. A., Miller and Freund's Probability and Statistics for Engineers, 6th edn., PHI, 2004.
2. Levin R. I. & Rubin D. S., Statistics for Management, 7th edn, PHI, New Delhi, 2000.
3. S.M. Ross, Introduction to Probability and statistics for Engineers, 3rd edn, Academic Press(Elsevier), Delhi 2005.

EC 2011: NETWORK THEORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1***: *Obtain basic understanding of circuit and system engineering, design and analysis.*
- ***CO2***: *Use fundamental circuit laws and nodal/mesh circuit analysis methods for linear circuits containing fundamental resistive and reactive circuit elements.*
- ***CO3***: *Perform the steady state and transient analysis of first/second-order circuit systems.*
- ***CO4***: *Use Laplace transforms to find out the steady state response and frequency response of linear circuits and system.*
- ***CO5***: *Describe the two-port networks using different parameter sets.*
- ***CO6***: *Design and analyze symmetrical two-port networks and reactive filters.*
- ***CO7***: *Become familiar to synthesis operations of simple linear circuits and systems.*

Module No	Syllabus
1 (11 hours)	Review of Network Theorems: Thevenin's & Norton's theorem - Superposition theorem - Maximum power transfer theorem – Reciprocity Theorem - Millman's theorem. Introduction to Network Topology: Definition of basic terms – Incidence matrix – Tie-sets - Cut-sets: Analysis and formulation of network equations using tie-set and cut-set. Transients in linear circuits: Initial Conditions - Zero state response - Zero input response - Complete Response – Analysis of RC and RL circuits with impressed DC voltage – RC network as differentiator and integrator - Compensated Attenuators – DC transients in RLC circuits.
2 (11 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-axis - Frequency response from pole-zero plot by geometrical interpretation. Bode plots.
3 (11 hours)	Two port networks: Characterization in terms of impedance - Admittance - 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 - Characteristic impedance and propagation constant of a symmetrical two port network. Symmetrical Two Port Reactive Filters: Filter fundamentals - Pass and stop bands - Constant - k low pass filter - Constant - k high pass filter-m-derived T and π sections and their applications for infinite attenuation and filter terminations - Band pass and band elimination filters.
4 (9 hours)	Synthesis: Positive real functions - Driving point functions - Brune's positive real functions - Properties of positive real functions. Testing driving point functions - Application of maximum modulus theorems - Properties of Hurwitz polynomials - Even and odd functions - Strum's theorem - Driving point synthesis - RC elementary synthesis operations - LC network synthesis - Properties of RC network functions - Foster and Cauer forms of RC and RL networks.

Reference:

1. Van Valkenburg M E, Network Analysis 3rd Edition, Prentice Hall 1974.
2. Van Valkenberg M.E., Introduction to Modern Network Synthesis, John Wiley and Sons, Inc, 1960.
3. Franklin. F. Kuo, Network Analysis and Synthesis, II Ed, John Wiley & sons, 1999.
4. Hayt, Kimmerly, Engineering Circuit Analysis, 5th Ed., McGraw Hill, 1993.
5. Desoer C.A. & Kuh E.S., Basic Circuit Theory, McGraw-Hill, 1985.
6. Ryder J.D., Networks, Lines and Fields, Prentice Hall, 2nd Ed., 1991.
7. B. P. Lathi, Linear Systema and Signals, Oxford University Press, 2nd Ed., 2006.
8. Roy Choudhary, Network and Systems, Wiley Eastern, 2nd Ed., 1988.

EC 2012: LOGIC DESIGN

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

CO1: *Apply the principles of Boolean algebra to manipulate and minimize logic expressions.*
CO2: *Use K-maps to minimize and optimize two-level logic functions up to 5 variables.*
CO3: *Study the operation of latches, flip-flops, counters, registers, and register transfers.*
CO4: *Analyze the operation of sequential circuits built with various flip-flops.*
CO5: *Understand the concepts of datapaths, control units, and micro-operations and building blocks of digital systems.*
CO6: *Design two-level logic functions with AND, OR, NAND, NOR and XOR gates with minimum number of gate delays or literals.*
CO7: *Design combinational circuits using decoders, ROM and transmission gates.*
CO8: Use state machine diagrams to design finite state machines using various types of flip-flops and combinational circuits with prescribed functionality.

Module No	Syllabus
1 (14 hours)	Review of number systems and Boolean algebra - Simplification of functions using Karnaugh map and Quine McCluskey methods - Boolean function implementation. . Variable Entered Mapping: VEM plotting theory – VEM Reading theory – Minimization and combinational design. Examples of combinational digital circuits: Arithmetic Circuits, Comparators and parity generators, multiplexers and demultiplexers, decoders and encoders. Combinational circuit design using Multiplexers, Demultiplexers, ROM, PAL, PLA.
2 (14 hours)	Introduction to 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 multimode counters – Ripple Counters – Synchronous counters - Shift registers – Shift Register counters – Random Sequence Generators.
3 (14 hours)	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. Asynchronous sequential logic: Analysis and Design – Race conditions and Cycles – Hazards in combinational circuits – Hazard free realization. Practical design aspects: Timing and triggering considerations in the design of synchronous circuits – Set up time - Hold time – Clock skew.

4 (14 hours)	Logic families - Fundamentals of RTL, DTL and ECL gates - TTL logic family - TTL transfer characteristics - TTL input and output characteristics - Tristate logic – Wired logic and bus oriented structure – Practical aspects - Schottky and other TTL gates - MOS gates - MOS inverter - CMOS inverter - Rise and fall time in MOS and CMOS gates - Speed power product - Interfacing BJT and CMOS gates

Reference:

1. Roth C.H., Fundamentals of Logic Design, Jaico Publishers. V Ed., 2009
2. Taub & Schilling: Digital Integrated Electronics, MGH,1998.
3. W. I. Fletcher, An Engineering Approach to Digital Design, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1980
4. Tocci, R. J. and Widner, N. S., Digital Systems - Principles and Applications, Prentice Hall, 10th Ed., 2007
5. Wakerly J F, Digital Design: Principles and Practices, Prentice-Hall, 2nd Ed., 2002
6. Mano M. M., Computer System Architecture, Prentice Hall 1993.
7. Katz R, Contemporary Logic Design, Addison Wesley, 1993.
8. Lewin D. & Protheroe D., Design of Logic Systems, Chapman & Hall, University and Professional Division, 1992, II Ed.
9. T. L. Floyd, Digital Fundamentals, Prentice Hall, June 2005.

EC 2013: SOLID STATE DEVICES

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

- ***CO1:*** *Understand the impact of wave nature of particles on the performance of the semiconductor devices.*
- ***CO2:*** *Understand the carrier transport mechanisms in semiconductors.*
- ***CO3:*** *Develop a fundamental understanding of the static and dynamic behaviour of P-N junction diodes.*
- ***CO4:*** *Understand the physics, characteristics and models of Bipolar Junction transistors*
- ***CO5:*** *Understand the physics, characteristics and models of Junction Field Effect Transistors and Metal Oxide Semiconductor Field Effect Transistors.*
- ***CO6:*** *Understand the Solid State Device capabilities and limitations on Electronic Circuit Performance.*

Module No	Syllabus
1 (19 hours)	Band theory of solids: Review of quantum mechanics, wave nature of election, time independent Schrödinger Equation, solutions for a free electron, electron tapped in finite potential well, Heisenberg's uncertainty principle, tunnelling phenomenon, KP Model, Band theory of solids, E-k diagram, Electron effective mass, energy band gap- Direct and indirect band gap semiconductors. [9 hours] Carrier Statistics: Charge carriers in semiconductors, Fermi Dirac statistics, intrinsic and extrinsic semiconductors, carrier transport, mobility, conductivity, carrier life time, recombination, steady state carrier generation, quasi Fermi levels, drift and diffusion of carriers, continuity equation [10 hours]
2 (10 hours)	PN Junction: PN junction at equilibrium, Forward and reverse bias junctions, steady state conditions, forward and reverse bias, break down of junctions, transient and AC conditions, non ideal junctions MS contacts: Rectifying and ohmic contacts, current voltage characteristics
3 (12 hours)	Bipolar junction transistor: Fundamentals of BJT operation- saturation, active and cut off characteristics, switching characteristics, minority carrier profiles, BJT models, Frequency limitations of BJTs.

4 (15 hours)	Field Effect Transistors: The Junction FET - Pinch-off and Saturation- Gate control-transfer and drain characteristics. [3hours] Metal Insulator semiconductor devices: The ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, work function difference, interface charge, threshold voltage, MOSFET, Output characteristics, transfer characteristics, sub threshold characteristics, MOSFET scaling [12 hours]

Reference:

1. Ben G Streetman , Solid state devices, 5e, 2002, Pearson Education
2. Donald A Neaman, Semiconductor physics and devices, McGraw Hill, 2003
3. Sheng S. Li, Semiconductor physical electronics, Plenum press, 1993
4. S.M.Sze, Physics of semiconductor devices, McGraw Hill, 2nd ed., 1999,
5. M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley and Sons, 2004.
6. Jean-Pierre Colinge, Physics of Semiconductor Devices, Kluwer Academic Publishers, 2002, access online at (NITC intranet) http://www.springerlink.com/content/978-1-4020-7018-1/
7. Richard S. Muller and Theodore I. Kamins, Device Electronics for Integrated circuits, John Wiley India, 2003.
8. Robert F. Pierret and Gerold W. Neudeck, Modular Series on Solid State Devices: Volume I: Semiconductor Fundamentals, Prentice Hall, 1988.
9. Gerold W. Neudeck, George W. Neudeck, Modular Series on Solid State Devices: Volume II: The PN Junction Diode, Prentice Hall, 1989.
10. Gerold W. Neudeck, George W. Neudeck, Modular Series on Solid State Devices: Volume III: The Bipolar Junction Transistor, Prentice Hall, 1989.
11. Robert F. Pierret and Gerold W. Neudeck, Modular Series on Solid State Devices: Volume IV: Field Effect Devices, Prentice Hall, 1990
12. R. F. Pierret, Modular Series on Solid State Devices: Volume VI: Advanced Semiconductor Fundamentals, Prentice Hall, 2003.

EC 2014: SIGNALS AND SYSTEMS

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Foundation concepts on Signal Theory and System Theory applicable in Communication Engineering and Signal Processing.*
- ***CO2:*** *Mathematical framework for Signal Theory and System Theory: Analysis and Design.*
- ***CO3:*** *Basic concepts that enable designs for environment-friendly direct applications.*
- ***CO4:*** *A foundation subject for multi-disciplinary applications.*

Module No	Syllabus
1 (11 hours)	Elements of signal theory: Signals as functions- Signal taxonomy- basic operations on signals- Some signal models - impulse function, step functions and other singularity functions. Systems : Time-domain representation and analysis of LTI and LSI systems – Convolution -Convolution sum, convolution integral and their evaluation - Causality

	and stability considerations.
2 (12 hours)	Signal analysis: Signals and vectors – inner product of signals – norm- notion of length of signal and distance between signals– orthogonal signal space – Fourier series representation - Fourier Transform and integral – Fourier Transform theorems – power spectral density and energy spectral density – Hilbert Transform – In-phase and quadrature representation of band pass signals Frequency domain analysis of LTI systems: Frequency response Function – signal transmission through a linear system – ideal filters – band width and rise time
3 (8 hours)	Sampling: sampling theorem – sampling with Zero Order Hold and reconstruction – interpolation Frequency analysis of discrete time signals and systems – Discrete time Fourier series and Discrete time Fourier Transform – Frequency response function – Discrete Fourier Transform.
4 (11 hours)	Laplace transform: Region of convergence – Analysis of continuous time systems – Transfer function – Frequency response from pole – zero plot Z-transform: Region of convergence – Properties of ROC and Z transform - Analysis of LSI systems - Transfer function- Frequency response from pole – zero plot

Reference:

1. B. P. Lathi, Linear Systems and Signals, Oxford University Press, 2004.
2. Oppenheim A.V., Willsky A.S. & Nawab S.H., Signals and Systems, Second edition , Tata McGraw Hill, 1996
3. Haykin S. & Veen B.V., Signals & Systems, John Wiley,1999
4. Taylor F.H., Principles of Signals & Systems, McGraw Hill, 1994
5. Lathi B.P., Modern Digital & Analog Communication Systems, Third edition, Oxford University Press, 2001
6. R.F. Ziemer, W.H. Tranter and D.R. Fannin, Signals and Systems - Continuous and Discrete, 4th Edn. Prentice Hall, 1998
7. Douglas K. Lindner, "Introduction to Signals and Systems", Mc-Graw Hill International Edition,1999.
8. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons (SEA) Private Limited, 1995.
9. M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", Tata Mc Graw Hill Edition, 2003

EC 2091: BASIC ELECTRONICS LABORATORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *Ability to apply knowledge of mathematics, science and engineering: Operational principle and analysis of diodes, BJT, FET and UJT.*
- ***CO2:*** *To develop the student's ability on conducting engineering experiments, analyze experimental observations scientifically.*
- ***CO3:*** *Ability to design a basic electronic system, component or process to meet desired needs.*
- ***CO4:*** *To initiate the students the understanding of the concepts, know-how and tools of Electronic Design Automation for circuit analysis and design: Design of fundamental circuits using diodes, BJT, FET and UJT and the simulation of the circuits in software tools.*
- ***CO4:*** *Experience working in teams*
- ***CO5:*** *To develop the student's ability on preparing professional report.*

Syllabus

1. Familiarization of CRO, Function Generators, Power Supplies and multi-meters
2. Diode characteristics: silicon, germanium and zener diodes
3. BJT characteristics; CB & CE; Calculation of h-parameters
4. JFET characteristics; Calculation of FET parameters
5. Uni-junction Transistor characteristics and relaxation oscillator
6. Design of filter circuits- passive filters- Low pass, high pass and band pass filters.
7. Rectifiers- Half wave , Full wave & Bridge rectifiers
8. Resonance circuits - Series and Parallel resonance.
9. Voltage regulators- Zener regulator - Series Voltage Regulator.

Reference:

1. Ben G Streetman , Solid state devices, 5e, 2002, Pearson Education
2. Donald A Neaman, Semiconductor physics and devices, McGraw Hill, 2003
3. Millman & Halkias : `Integrated Electronics', MGH. 1996

EC 2092: ELECTRONICS WORKSHOP

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *Familiarization and Testing methods of Active and Passive components.*
- ***CO2:*** *Implementation of Zener Voltage regulators and Linear Voltage regulators.*
- ***CO3:*** *Implementation of Single stage Amplifier and familiarisation troubleshooting methods.*
- ***CO4:*** *Implementation of Multivibrators using Transistors and ICs.*
- ***CO5:*** *Implementation of Waveform generators using OP Amps.*
- ***CO6:*** *Implementation of Flip flops and oscillators using logic gates.*
- ***CO7:*** *Soldering and troubleshooting of working circuits.*
- ***CO8:*** *PCB fabrication and circuit development.*

Syllabus

1. Familiarisation and Testing methods of Active and Passive components.
2. Voltage Multiplier circuits.
3. Zener Voltage regulators.(Variable and Fixed types)
4. Linear Voltage regulators.(Variable and Fixed types)
5. Single stage Amplifier and troubleshooting methods
6. Multivibrators using Transistors and ICs.
7. Waveform generators using OP Amps.
8. Flip flops and oscillators using logic gates.
9. Soldering and troubleshooting of working circuits.
10. Mini project. (PCB fabrication and circuit development)
11. Assignment. (Project circuit simulation- using simulation tools)

Reference:

1. Millman & Halkias : `Integrated Electronics', MGH. 1996
2. Robert Boylestad & Louis Nashelsky : `Electronic Devices & Circuit Theory', PHI.1995
3. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', McGraw Hill Book Company 1998
4. Jacob Millman & Herbert Taub: Pulse, Digital & Switching Waveforms, TMGH 1995

SEMESTER-IV

MA 2002: MATHEMATICS IV

Course Type : Basic Science
Pre-requisites: -NIL-

L	T	P	C
3	1	0	3

Course Outcomes:

- ***CO1:*** *Acquire the knowledge to solve differential equations using power series and Frobenius method.*
- ***CO2:*** *Acquire knowledge about the ability to solve problems using partial differential equations.*
- ***CO3:*** *To know the properties of analytic and harmonic functions.*
- ***CO4:*** *Understanding Cauchy's integral theorem and its consequences.*
- *CO5: Acquire the knowledge to compute residues and integrals using the residue theorem.*

Module No	Syllabus
1 (11L+4T)	**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.
2 (12L+4T)	**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.
3 (10L+ 3T)	**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.
4 (9L+ 3T)	**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.

Reference:

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, Mc Graw Hill, New York,1995.
4. Donald W. Trim, Applied Partial Differential Equations, PWS – KENT publishing company, 1994.

EC 2021: ELECTRONIC CIRCUITS I

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

- ***CO1:****Analyse and design simple discrete amplifier circuits with BJTs/FETs using the concepts of load lines, operating points and incremental analysis*
- ***CO2:*** *Understand large signal and small signal characteristics of simple amplifier circuits*
- ***CO3:*** *Estimate frequency response of single-stage amplifiers using high-frequency transistor models and derive methods to improve high frequency response of amplifiers.*
- ***CO4:*** *Understand the relevance of both positive and negative feedback in electronic circuits and analyze and design BJT /FET based oscillators and negative feedback circuits*
- ***CO5:*** *Analyze the switching characteristics of transistors and design BJT/FET circuits to generate and process pulse and switching waveforms.*

Module No	Syllabus
1 (16 hours)	Basic BJT amplifiers: Biasing schemes - Load line concept - Bias stability - Analyses and design of CC, CE and CB configurations - RC coupled and transformer coupled multistage amplifiers — Thermal runaway in BJT amplifiers FET amplifiers: Biasing of JFET and MOSFET - Analyses and design of common source, common drain and common gate amplifier configurations – Thermal runaway in MOS amplifiers Power amplifiers - Class A, B, AB, C, D & S power amplifiers - Harmonic distortion – Conversion efficiency and relative performance
2 (12 hours)	Frequency response of amplifiers – Low frequency response of BJT and FET amplifiers, lower cut off frequency - hybrid π equivalent circuit of BJT - high frequency response of BJT amplifiers –upper cut off frequency – transition frequency - miller effect , high frequency response of FET amplifiers. Wide band amplifiers - Wide banding techniques – CC–CE /CD-CS cascade, cascode amplifier, Darlington pair – Wide banding using inductors.
3 (14 hours)	Feedback and stability – Introduction to negative feedback – Basic feedback concepts – Ideal feedback topologies - Voltage shunt, Voltage series, Current series and Current shunt feedback configurations – Loop gain – Stability of feedback circuit – Bode plots – Nyquist stability criterion – Phase and gain margins – Oscillators – Basic principles of oscillators – Analysis of RC Phase Shift, Wein bridge, Colpitts, Hartley and Crystal oscillators
4 (14 hours)	Switching characteristics of a BJT - BJT switches with inductive and capacitive loads - Non saturating switches - Astable, monostable and bistable multivibrators using BJT and negative resistance devices - Voltage and current time base generators - Miller & bootstrap configurations

Reference:

1. A S Sedra & K C Smith : `Microelectronic Circuits’, Oxford University Press.1998
2. Jacob Millman & Herbert Taub: Pulse, Digital & Switching Waveforms, TMGH 1995
3. Donald A. Neamen, Electronic Circuit Analysis and Design, 2nd Edition, MCGraw Hill 2003
4. Millman & Halkias : `Integrated Electronics’, MGH. 1996
5. D L Schilling & C Belove : `Electronic Circuits’, Third Ed; MGH. 2002
6. Robert Boylestad & Louis Nashelsky : `Electronic Devices & Circuit Theory’, PHI.1995
7. William H Hayt Jr : `Electronic Circuit Analysis & Design’.1994
8. Theodore F Bogart : `Electronic Devices & Circuits’.2003
9. Mark N Horenstein : `Microelectronic Circuits & Devices’, PHI.2002
10. Millman & Grabel : Microelectronics : MGH 1989
11. Richard C. Jaeger : Microelectronic circuit design, MGH 2007

EC 2022: ELECTROMAGNETIC FIELD THEORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

- ***CO1****: Define electric and magnetic fields according to their force effect*
- ***CO2****: Calculate the electric field from the stationary charge distributions and magnetic field from stationary current distributions*
- ***CO3****: Solve electromagnetic boundary problems*
- ***CO4****: Analyze how energy and momentum is stored and transported in an electromagnetic field.*
- ***CO5****: Explain the physical meaning of Maxwell's equations for the analysis of electromagnetic fields generated by given dynamic charge/current distributions.*
- ***CO6****: Analyze the propagation, reflection and transmission of plane waves.*

Module No	Syllabus
1 (15 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, curl and divergence of electrostatic fields, electric potential, Poisson's equation, Laplace's equation, solutions to electrostatic boundary problems, method of images, work and energy in electrostatics, induced dipoles and polarization, field inside a dielectric, electric displacement, electric susceptibility, permittivity and dielectric constant, boundary conditions, capacitors, surface charge and induced charge on conductors.
2 (12 hours)	Magnetostatics: Lorentz force, Biot-Savart law, magnetic flux density, divergence and curl of flux density, Ampere's law, magnetic vector potential, magnetization, torque and force on magnetic dipoles, magnetic field inside matter, magnetic field intensity, magnetic susceptibility and permeability, magnetic materials, boundary conditions
3 (16 hours)	Electrodynamics: Electromagnetic induction, inductance, 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
4 (13 hours)	Refection and transmission at interfaces: Normal and Oblique incidence of uniform plane electromagnetic waves at conducting boundary, dielectric boundary Transmission lines: Quasi-TEM analysis, characteristic impedance, standing wave ratio, impedance matching techniques, Smith Chart

Reference:

1. David J Griffiths: Introduction to Electrodynamics, Third edition, PHI,1999
2. David Cheng: Field and Wave Electromagnetics, Second edition, Pearson Education Asia, 2001
3. Nannapaneni Narayana Rao: Elements of Engineering Electromagnetics, Fifth edition, Prentice Hall, 1999
4. Matthew N. O. Sadiku: Elements of Electromagnetics, Fourth Edition, Oxford University Press, 2006
5. J D Krauss: Electromagnetics, Fourth edition, MGH, 1992

EC 2023: MICROPROCESSORS AND MICRO CONTROLLERS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Understanding of the basic building blocks of a computer system and the role of the central processing unit*
- ***CO2:*** *Analysis of the various ways by which a CPU does its functions*
- ***CO3:*** *Learning how to access the services performed by the 8086 CPU, with the use of assembly language programming*
- ***CO4:*** *Learning how a CPU can be used along with external devices*
- ***CO5:*** *Learning how to design appliances for human interface and usage.*

Module No	Syllabus
1 (5 hours)	Introduction: History of microprocessors –Basics of computer architecture-Computer languages –CISC and RISC-Review of binary arithmetic
2 (15 hours)	Intel 8086 processor: The architecture of 8086 —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
3 (12 hours)	Hardware and Interfacing: The pin configuration, clock and power on reset of 8086-minimum and maximum modes. Interfacing chips- PPI 8255 -Timer8253/54 –Keyboard Display Interface 8279-DMA Controller 8237-Programmable Interrupt Controller 8259
4 (10 hours)	Intel 8051 microcontroller**:** architecture –ports, timers, interrupts, serial data transmission instruction set -programming

Reference:

1. Lyla B.Das, The x86 Microprocessors , Pearson Education, 2010
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

EC 2024: FUNDAMENTALS OF COMMUNICATION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

- ***CO1:*** *Obtain basic understanding of different functional blocks in baseband and pass band analog communication system.*
- ***CO2:*** *Use probability models and Fourier transform tools to analyse and model random information signals and communication channels.*
- ***CO3:*** *Derive performance metric of amplitude, frequency and phase modulation schemes such as bandwidth required for communication; signal to noise ratio using tools developed from random signal theory.*
- ***CO4:*** *Design various analog modulation and demodulation circuits efficiently to meet the required specifications.*
- ***CO5:*** *Choose a particular modulation scheme for a real life communication application by looking at the available resources of bandwidth and transmission power and comparing modulation schemes in terms of benchmarks derived using statistical models of signal and channel.*
- ***CO6:*** *Design complete transmitter and receiver for an analog communication system by building all intermediary functional units.*
- ***CO7:*** *Become familiar with challenges on present communication systems in terms of data quality and quantity and availability of methodology to meet those challenges.*

Module No	Syllabus
1 (14 hours)	Fundamental of communication systems, signals and information, system block Diagram, performance metrics and data rate limits. Review of Fourier series and Transforms – Energy/Power Spectral Density. 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.
2 (14 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 banwidth 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.
3 (14 hours)	Introduction to carrier modulation - Amplitude modulation, AM spectrum, power relations, double sideband suppressed carrier (DSBSC) and single sideband modulation (SSB) schemes, DSBSC/SSBSC spectrum, Vestigial sideband modulation and spectrum. Generation of AM signals, modulators and transmitters, product modulators, square-law modulators and balanced modulators - Frequency translation and frequency division multiplexing, Propagation characteristics of AM signals. Frequency modulation (FM), Narrowband FM, Wideband FM, FM spectrum, Transmission bandwidth, Generation of FM signals- direct and indirect methods- Phase modulation-relationship between FM and PM signals.
4 (14 hours)	Radio Receivers - TRF and super-heterodyne receivers- Image frequency, Intermediate frequency (IF)- Automatic gain control. AM demodulation - coherent detection, envelope (non-coherent) detection of AM signals, DSB-SC and SSB demodulation. FM demodulation - Basic FM demodulators, Amplitude limiting, ratio detector, PLL based FM detection, Pre-emphasis and de-emphasis. 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.

Reference:

1. H. Stark, J. W. Woods, Probability and Random Processes with Applications to Signal Processing, Prentice-Hall, 2003.
2. Peyton Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, 4/e, Tata McGraw-Hill, New Delhi, 2002.
3. R.E. Ziemer and W.H. Tranter, Principles of Communications, JAICO Publishing House, 2001
4. B.P. Lathi, Modern Digital and Analog Communication, 3/e, Oxford University Press, 1998.
5. John G Proakis and M. Salehi, Communication System Engineering, 2/e, Pearson Education, 2001.

EC 2093: ELECTRONIC CIRCUITS LABORATORY– I

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *Develop the ability to Design and implement discrete analog amplifiers to meet the given specifications.*
- ***CO2:*** *Understand the effects of parasitic of circuit components on the performance of the circuits and learn how to minimize those effects.*
- ***CO3:*** *Design and implement BJT/FET based harmonic and relaxation oscillators.*
- ***CO4:*** *Learn to alter power level of the signals to feed the available loads.*
- ***CO5:*** *Develop the ability to design and implement analog subsystems based on discrete component design*
- ***CO6:*** *Develop the ability to give both oral presentation and technical report on basic discrete analog circuits.*

Syllabus

1. BJT and JFET Biasing schemes and Bias Stability comparison
2. Emitter follower – frequency and phase response
3. Single stage BJT amplifier – Frequency Response
4. Single stage JFET amplifier – Frequency Response
5. Power amplifier – Class A and Class AB
6. Two stage RC coupled amplier – Frequency Response
7. Cascode Amplifier – Frequency Response
8. Feedback amplifiers
9. Phase Shift Oscillator
10. Colpitts/Hartley Oscillators
11. Astable, Monostable and Bistable Multivibrator with BJT

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

Reference:

1. A S Sedra & K C Smith : `Microelectronic Circuits’, Oxford University Press.1998
2. Jacob Millman & Herbert Taub: Pulse, Digital & Switching Waveforms, TMGH 1995
3. Donald A. Neamen, Electronic Circuit Analysis and Design, 2nd Edition, MCGraw Hill 2003
4. Millman & Halkias : `Integrated Electronics’, MGH. 1996
5. D L Schilling & C Belove : `Electronic Circuits’, Third Ed; MGH. 2002
6. Robert Boylestad & Louis Nashelsky : `Electronic Devices & Circuit Theory’, PHI.1995
7. William H Hayt Jr : `Electronic Circuit Analysis & Design’.1994
8. Theodore F Bogart : `Electronic Devices & Circuits’.2003
9. Mark N Horenstein : `Microelectronic Circuits & Devices’, PHI.2002
10. Millman & Grabel : Microelectronics : MGH 1989
11. Richard C. Jaeger : Microelectronic circuit design, MGH 2007

EC 2094: LOGIC DESIGN LABORATORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *To apply concepts and methods of digital system design techniques introduced in EC2012 class through projects.*
- ***CO2:*** *To learn to design combinational and sequential digital systems starting from a word description that performs a set of specified tasks and functions.*
- ***CO3:*** *To write clear and concise lab reports.*

Syllabus

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

Reference:

1. Roth C.H., Fundamentals of Logic Design, Jaico Publishers. V Ed., 2009
2. Taub & Schilling: Digital Integrated Electronics, MGH, 1998.
3. W. I. Fletcher, An Engineering Approach to Digital Design, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1980
4. Tocci, R. J. and Widner, N. S., Digital Systems - Principles and Applications, Prentice Hall, 10th Ed., 2007
5. Wakerly J F, Digital Design: Principles and Practices, Prentice-Hall, 2nd Ed., 2002
6. Mano M. M., Computer System Architecture, Prentice Hall 1993.
7. Katz R, Contemporary Logic Design, Addison Wesley, 1993.
8. Lewin D. & Protheroe D., Design of Logic Systems, Chapman & Hall, University and Professional Division, 1992, II Ed.
9. T. L. Floyd, Digital Fundamentals, Prentice Hall, June 2005.

SEMESTER- V

EC 3011: ELECTRONIC CIRCUITS - II

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

- ***CO1:*** *Analyze and design simple differential amplifier circuits with BJTs/FETs for Integrated circuits (IC).*
- ***CO2:*** *Understand the building blocks and performance parameters of an operational amplifier.*
- ***CO3:*** *Analyze and design operational amplifier circuits for linear and non-linear applications.*
- ***CO4:*** *Design analog filters and realize them using operational amplifier based simple filter circuits.*
- ***CO5:*** *Understand the working of mixed signal circuits like Analog to Digital Convertors, Digital to analog Convertors and Phase Locked Loop.*
- ***CO6:*** *Understand the working of a few application specific analog ICs and design circuits based on these ICs.*
- ***CO7:*** *Design circuit/system for simple analog signal processing applications.*

Module No	Syllabus
1 (16 hours)	Basic BJT/FET Differential amplifier – DC transfer characteristics – Small signal analysis –Differential and Common mode gain and input impedance– Concept of CMRR – Methods to improve CMRR – Constant current source – active load - current mirror - Differential and Common mode frequency response, various stages of an operational amplifier - simplified schematic circuit of op-amp 741 - need for compensation – dominant pole compensation - typical op-amp parameters - slew rate – CMRR,PSRR - open loop gain - unity gain bandwidth - offset current & offset voltage – CMOS op-amp with and without compensation
2 (12 hours)	Linear op-amp circuits - inverting and non-inverting configurations - analysis for closed loop gain - input and output impedances - virtual short concept - current to voltage and voltage to current converters - instrumentation amplifier - nonlinear op-amp circuits - log and antilog amplifiers - 4 quadrant multipliers and dividers - phase shift and wein bridge oscillators - comparators - astable and monostable circuits - linear sweep circuits
3 (12 hours)	Butterworth, Chebychev and Bessel approximations to ideal low pass filter characteristics - frequency transformations to obtain HPF, BPF and BEF from normalized prototype LPF - active biquad filters - LPF & HPF using Sallen-Key configuration - BPF realization using the Delyannis configuration - BEF using twin T configuration - all pass filter (first & second orders) realizations - inductance simulation using Antoniou's gyrator – Switched capacitor filter
4 (16 hours)	DACs and ADCs (in depth design is not expected)-Digital to analog converters - Binary weighted - R-2R ladder - Current steering - Charge scaling - Cyclic & pipeline DACs - Accuracy - Resolution - Conversion speed - Offset error - Gain error - Integral and differential nonlinearity - Analog to digital converters – Track and hold operation - Track and hold errors - ADC conversion techniques - Flash converter - Two step flash - Pipeline – Integrating - Staircase converter - Successive approximation converter - Dual slope ADC Phase Locked Loop – Block schematic and analysis of PLL – Lock range and capture range – Typical applications of PLL (eg.565) – Basic principles of operation of VCO (eg. 566) and timer (555) and their applications – Voltage regulator ICs – Fixed and adjustable (723) regulators

Reference:
1. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', McGraw Hill Book Company 1998
2. Jacob Baker R., Li H.W. & Boyce D.E., 'CMOS- Circuit Design, Layout & Simulation', PHI 2007
3. Gobind Daryanani, 'Principles of Active Network Synthesis & Design', John Wiley 2003
4. Sedra A.S. & Smith K.C., "Microelectronic Circuits', Oxford University Press 1998
5. Fiore J.M., 'Operational Amplifiers and Linear Integrated Circuits', Jaico Publishing House 2006
6. Gaykward, Operational Amplifiers, Pearson Education, 1999
7. Coughlin R.F. & Driscoll F.F., 'Operational Amplifiers and Linear Integrated Circuits', Pearson Education 2002
8. Horenstein M.N., 'Microelectronic Circuits & Devices', PHI, 1995

EC 3012: DIGITAL COMMUNICATION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

- ***CO1:*** *Understand the limitations of analog communications for effectively utilizing the fundamental resources for communication namely bandwidth and power and to appreciate the effective use of such resources to achieve exchange of information between people and/or machines by digital means.*
- ***CO2:*** *Systematically analyze the flow and processing of information right from the source to various units at the transmitter side and to understand the inverse operations at the receiver to facilitate the retrieval of transmitted information.*
- ***CO3:*** *Design and analyze various processing units of a digital communication system such as analog to digital conversion, line coding and pulse shaping, various pass modulation techniques, equalization, synchronization and detection.*
- ***CO4:*** *Develop a strong framework for the performance evaluation of base band and pass band digital communication systems under additive white Gaussian noise channels using the concepts of signal space theory and to derive expressions for the probability of error of various modulation schemes.*
- ***CO5:*** *Investigate the performance of various units of a digital communication system individually as well as integrated system through simulation studies using appropriate tools and present the result of such studies through detailed technical reports.*
- ***CO6:*** *Gain awareness on the need to develop communication system designs which conserve bandwidth and/or power without compromising on performance and complexity and to propose such representative solutions with engineering intuitiveness.*
- ***CO7:*** *Understand the power and requirements of various communication platforms, especially wireless communication, as nervous system of the society, country and world at large and focus on the development of appropriate technologies for heterogeneous needs and applications.*

Module No	Syllabus
1 (13 hours)	Analog Pulse Modulation: Sampling theorem for base-band and pass-band signals, Pulse Amplitude modulation: generation and demodulation, PAM/TDM system, PPM generation and demodulation, PWM, Spectra of Pulse modulated signals, SNR calculations for pulse modulation systems. Digital Pulse modulation: Quantization, PCM, DPCM, Delta modulation, Adaptive delta modulation-Design of typical systems and performance analysis.

2 (13 hours)	Signal space concepts: Geometric structure of the signal space, vector representation, distance, norm and inner product, orthogonality, Gram-Schmidt orthogonalization procedure. Matched filter receiver, Inter symbol interference, Pulse Shaping, Nyquist criterion for zero ISI, Signaling with duobinary pulses, Eye diagram, Equalizer, Scrambling and descrambling.
3 (14 hours)	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. Digital band pass modulation schemes: ASK, FSK, PSK, MSK – Digital M-ary modulation schemes – signal space representation
4 (16 hours)	Detection of signals in Gaussian noise - Coherent & non-coherent detection – Differential modulation schemes – Error performance of binary and M-ary modulation schemes – Probability of error of binary DPSK – Performance of M-ary signaling schemes in AWGN channels - Power spectra of digitally modulated signals, Performance comparison of digital modulation schemes.

Reference:

1. Simon Haykin, Communication Systems, 3/e, John Wiley & Sons, 1998.
2. John G Proakis and M. Salehi, Communication System Engineering, 2/e, Pearson Education, 2001.
3. B. Sklar and P.K. Ray, Digital Communication: Fundamentals and Applications, 2/e, Pearson Education, 2003.
4. R.E. Ziemer and W.H. Tranter, Principles of Communications, JAICO Publishing House, 2001.
5. B.P. Lathi, Modern Digital and Analog Communication, 3/e, Oxford University Press, 1998.
6. John G. Proakis, Digital Communications, McGraw Hill, 2001.

EC 3013: DIGITAL SIGNAL PROCESSING

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Analysis and Design of Practical Systems for Communication Engineering and Signal Processing.*
- ***CO2:*** *Analysis and construction of Computation algorithms for ubiquitous applications.*
- ***CO3:*** *Multi-disciplinary applications through Time-series Analysis.*
- ***CO4:*** *Introduces fundamental methods for the design of architecture and data structures for real-time applications having wide range of human needs, like Financial, medical, security, and communication applications.*

Module No	Syllabus
1 (9 hours)	**Fourier** analysis of discrete-time signals and systems: Discrete Fourier Series, Discrete Time Fourier Transform, Discrete Fourier Transform - Properties; Approximation of Fourier transform through DFT, Fast algorithms for DFT: The FFT algorithm – Prime factor algorithms, Convolution; Linear and circular convolution, Practical implementation, Overlap-save and overlap-add methods, Short-time Fourier transform.
2 (9 hours)	Digital filters: FIR Filters: Impulse response, Transfer function, Linear phase properties, Design: window based design, frequency sampling design, minimax design. IIR Filters: Impulse response, Transfer function, Pole-zero representation; Butterworth, Chebyshev, inverse Chebyshev and elliptic filter concepts, Approximation problem for IIR filter design: Impulse in variance method, Bilinear transform method, Matched z-transform method, Minimum mean squared error method; Frequency transformations; Realization structures: Direct form 1 and 2.

3 (8 hours)	(a) Least squares filter design: (4 Hours): Deterministic least squares: Whitening problem: FIR case; Signal modelling: Spectral Factorisation; Lattice structure realization. (b) Digital Signal Processors: (4 Hours): Architecture and types of instructions, Addressing schemes and Interface details of one of the latest, commonly used Digital Signal Processors (e.g. Digital Signal Processors manufactured by Texas Instruments or Analog Devices.)
4 (16 hours)	(a) Internal descriptions of digital filters: (8 Hours): Signal flow graphs, State variable descriptions, State variable descriptions from primitive signal flow graphs, Transfer function from state variable descriptions, The difference equation from state variable description, Co-ordinate transformation, Poles, zeros and the state variable description. (b) Finite length register effects: (8 Hours): Limit cycles, Overflow oscillations, State variable model for overflow, Round-off noise in IIR digital filters, Computation of output round-off noise, Methods to prevent overflow, Scaling rules and scaling operations, Scaling state variable description, Trade-off between round-off and overflow noise, Measurement of coefficient quantization effects through pole-zero movement, Dead-band effects, Constant input limit cycles.

Reference:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications," Prentice Hall of India Pvt. Ltd., 1997.
2. Boaz Porat, "A Course in Digital Signal Processing," Prentice Hall Inc, 1998.
3. Oppenheim A. V., Schafer R. W., "Discrete-Time Signal Processing," Prentice Hall India, 1996.
4. Chi-Tsong Chen, "Digital Signal Processing: Spectral Computation and Filter Design," Oxford University Press, 2001.
5. Mitra S. K., "Digital Signal Processing: A Computer Based Approach," McGraw-Hill Publishing Company, 1998.
6. Lonnie C. Ludeman, "Fundamentals of Digital Signal Processing," John Wiley& Sons, NY, 1986.
7. R. E. Bogner, A. G. Constantinidis, (Editors), "Introduction to Digital Filtering," John Wiley & Sons, NY, 1975.
8. Emmanuel C. Ifeacher, Barry W. Jervis, "Digital Signal Processing: A Practical Approach," 2nd edn., Pearson Education, 2004.
9. 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).

EC 3014: CONTROL SYSTEMS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

<u>Course Outcomes:</u>

- ***CO1**: The students will be able to describe and categorize linear continuous- time control systems.*
- ***CO2:** The students will be able to apply mathematical tool of Laplace transforms with aim of obtaining transfer function representation of a linear continuous-time control system.*
- ***CO3**: Students will develop ability to use the methods of block diagram reduction and signal flow graph for analysis of transfer function of linear continuous time system.*
- ***CO4:** Students will develop the ability to derive transfer function representation of simple physical systems from their governing laws.*
- ***CO5**: Students will be able evaluate parameters like time constant of first order systems and rise time, overshoot, settling time of second order systems and able to determine their responses for standard inputs.*

- ***CO6:*** *Students will be able to carry out stability analysis of a linear continuous- time system using method of Routh-Hurwitz criteria.*
- ***CO7:*** *Students will be able to construct root locus, bode and polar plots for linear continuous-time and discrete-time system and will able to evaluate phase and gain margins.*
- ***CO8:*** *Students will be able to describe the concept of Nyquist stability criteria and the principle of different types of compensators.*
- ***CO9:*** *Students will be able to describe digital control systems with examples and sampling theorem and develop the ability to obtain pulse transfer function representation for a digital control system and able to apply mathematical tool of Z-transforms with aim of obtaining z-transfer function representation.*
- ***CO10:*** *Students will be able to carry out stability analysis of a discrete continuous- time system using method of Jury's criteria and bilinear transformation.*
- ***CO11:*** *Students will be able to design digital controller for continuous time systems*
- ***CO12:*** *Students will be able to model continuous-time and discrete-time systems in state space form in general and also in different standard forms of state space representation and can carry conversion from transfer function representation to state space form and vice-versa for continuous-time and discrete-time systems. CO13: Able to evaluate state-transition matrix and solution for state-space equations for continuous-time and discrete-time systems.*
- ***CO14:*** *Student will be able to carry out controllability and observability analysis form a given state-space representation of a system.*

Module No	Syllabus
1 (10 hours)	General schematic diagram of control systems - open loop and closed loop systems – concept of feedback - modeling of continuous time systems – Review of Laplace transform - transfer function - block diagrams – signal flow graph - mason's gain formula - block diagram reduction using direct techniques and signal flow graphs - examples - derivation of transfer function of simple systems from physical relations - low pass RC filter - RLC series network - spring mass damper
2 (11 hours)	Analysis of continuous time systems - time domain solution of first order systems – time constant - time domain solution of second order systems - determination of response for standard inputs using transfer functions - steady state error - concept of stability - Routh- Hurwitz techniques - construction of bode diagrams - phase margin - gain margin - construction of root locus - polar plots and theory of nyquist criterion - theory of lag, lead and lag-lead compensators
3 (11 hours)	Basic elements of a discrete time control system - sampling - sample and hold - Examples of sampled data systems – pulse transfer function - Review of Z-transforms - system function - mapping between s plane and z plane - analysis of discrete time systems –- examples - stability - Jury's criterion - bilinear transformation – stability analysis after bilinear transformation - Routh-Hurwitz techniques - construction of bode diagrams - phase margin - gain margin - digital redesign of continuous time systems
4 (9 hours)	Introduction to the state variable concept - state space models - phase variable and diagonal forms from time domain - diagonalization - solution of state equations - homogenous and non homogenous cases - properties of state transition matrix - state space representation of discrete time systems - solution techniques - relation between transfer function and state space models for continuous and discrete cases - relation between poles and Eigen values – Controllability and observability

Reference:

1. Ziemer R.E., Tranter W.H. & Fannin D.R., "Signals and Systems",Fourth Edition, Pearson Education Asia, 1998
2. Ogata K., "Modern Control Engineering", Prentice Hall India,1994
3. Dorf R.C. & Bishop R.H., "Modern Control Systems", Nineth Edition, Addison Wesley,2001
4. Kuo B.C., "Digital Control Systems", Second Edition, Oxford University Press, 1992
5. Ogata K., "Discrete Time Control Systems", Pearson Education, 2001
6. Nagarath I.J. & Gopal M., "Control System Engineering", Wiley Eastern Ltd,1995

EC 3091: ELECTRONICS CIRCUIT LABORATORY – II

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *Develop the ability to Design and implement IC based analog circuits to meet the given specifications (for linear and non-linear applications).*
- ***CO2:*** *Understand the effects of each circuit elements on the performance of the circuit.*
- ***CO3:*** *Understand the effects of parasitics of circuit components on the performance of the circuits and learn how to minimize those effects.*
- ***CO4:*** *Implement analog systems using ICs and other discrete components for analog signal processing applications.*
- ***CO5:*** *Get knowledge to interface real life analog signals to the digital computational devices through ADCs and DACs.*
- ***CO6:*** *Develop the ability to give both oral presentation and technical report on IC based design of analog/mixed signal circuits.*

Syllabus

Differential amplifier and Current Source

1. Measurement of Op-Amp parameters – CMRR, Slew rate, Open loop gain, input and output impedances, Unity gain bandwidth
2. Inverting non-inverting amplifiers, Integrator, Differentiator – frequency response
3. Instrumentation Amplifier using Op-amps and IC – Gain, CMRR and Input impedance
4. Op-amp in comparator application
5. Waveform Generators –Sine, square, Triangular and Ramp
6. Astable and Monostable Multivibrators using op-amp and 555IC
7. Low Pass Filter and High Pass Filter realizations using op-amps
8. Band Pass Filter and Band Stop Filter realizations using op-amps
9. DAC and ADC circuits using op-amp/ICs
10. Regulated power supply with 723 IC

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

Reference:

1. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', McGraw Hill Book Company 1998
2. Jacob Baker R., Li H.W. & Boyce D.E., 'CMOS- Circuit Design, Layout & Simulation', PHI 2007
3. Gobind Daryanani, 'Principles of Active Network Synthesis & Design', John Wiley 2003
4. Sedra A.S. & Smith K.C., "Microelectronic Circuits', Oxford University Press 1998
5. Fiore J.M., 'Operational Amplifiers and Linear Integrated Circuits', Jaico Publishing House 2006
6. Gaykward, Operational Amplifiers, Pearson Education, 1999
7. Coughlin R.F. & Driscoll F.F., 'Operational Amplifiers and Linear Integrated Circuits', Pearson Education 2002
8. Horenstein M.N., 'Microelectronic Circuits & Devices', PHI, 1995

EC 3092: MICROPROCESSORS AND MICROCONTROLLERS LABORATORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *To know the fundamentals of microprocessors and microcontrollers programming*
- ***CO2:*** *To understand how C programs are converted into machine instructions,*
- ***CO3****: To become proficient in AVR assembly language programming,*
- ***CO4:*** *To understand typical interface designs between hardware and software,*
- ***CO5****: To know how serial communication works,*
- ***CO6:*** *To develop basic development skills for microprocessor/microcontroller applications*

Syllabus

1. Assembly language programming of 8086 -TSR ,matrix multiplication and Pascal's triangle
2. Stepper board interfacing to 8086
3. Hex keyboard interfacing to 8086
4. Multiplexed ,dynamic LED display interface to 8086
5. 8279 interface to 8086
6. 8255 interface to 8086
7. Assembly language programming of 8051
8. Timer programming of 8051 ,using status check
9. Timer programming of 8051 ,using interrupts
10. External interrupts programming of 8051
11. LCD interfacing to 8051 –project

Reference:

1. Lyla B.Das, The x86 Microprocessors , Pearson Education, 2010
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

SEMESTER- VI

ME 4104: PRINCIPLES OF MANAGEMENT

Course Type : Humanities and Languages
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *To comprehend the evolution, fundamentals and theories of management.*
- ***CO2:*** *To explain the functions of management and levels of management.*
- ***CO3:*** *To describe the functional areas of management such as operations management, marketing management, financial management, and human resources management.*
- ***CO4:*** *To solve decision making problems and project management problems.*

Module No	Syllabus
1 (9 hours)	Introduction to management theory, Characteristics of management, Management as an art – profession, Systems approach to management, Task and responsibilities of a professional manager, Levels of managers and skill required. Management process – planning – mission – objectives – goals – strategy – policies – programmes – procedures.
2 (9 hours)	Organizing – principles of organizing – organization structures, Directing – delegation – span of control – leadership – motivation – communication, Controlling.
3 (12 hours)	Decision making process– decision making under certainty – risk – uncertainty – models of decision making, Project management – critical path method – programme evaluation and review technique – crashing.
4 (12 hours)	Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management.

References:

1. Koontz, H., and Weihrich, H., *Essentials of Management: An International Perspective*, 8th ed., McGraw Hill, 2009.
2. Hicks, *Management: Concepts and Applications*, Cengage Learning, 2007.
3. Mahadevan, B., *Operations Management, Theory and Practice*, Pearson Education Asia, 2009.
4. Kotler, P., Keller, K.L, Koshy, A., and Jha, M., *Marketing Management*, 13th ed., 2009.
5. Khan, M.Y., and Jain, P.K., *Financial Management*, Tata-Mcgraw Hill, 2008.

EC 3021: COMPUTER ORGANIZATION AND ARCHITECTURE

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Understand the basic concepts of Computer Architecture and Organization, and understand the key skills of constructing cost effective computer systems.*
- ***CO2:*** *Learn how to quantitatively evaluate the performance of different designs and organizations of computer*
- ***CO3:*** *Will be able to articulate design issues in the development of CPU especially Control Unit that satisfy design requirements.*
- ***CO4:*** *Understand the impact of instruction set architecture on cost performance of CPU Design.*
- ***CO5:*** *Understand memory hierarchy and its impact on computer performance/cost.*
- ***CO6:*** *Understand ways to take advantage of instruction level parallelism for high performance processor design.*

- ***CO7:*** *Work as a team on a processor design, verbally demonstrate and communicate the various design steps.*

Module No	Syllabus
1 (10 hours)	Introduction to Processor Architecture – Design Methodology- System Representation – Gate level – Register level – Processor level – CPU Organization – Data Representation – Basic Formats – Fixed Point Numbers – Floating Point Numbers – Instruction Sets – Instruction Formats – Instruction Types – Programming Considerations.
2 (12 hours)	Datapath Design – Fixed Point Arithmetic – Addition and Subtraction – Multiplication – Division – Arithmetic Logic Units – Combinational ALUs – Sequential ALUs – Floating Point Arithmetic – Pipeline Processing – Control Design : Basic Concepts – Introduction – Hardwired Control – Design Examples – Microprogrammed Control – Basic Concepts – Multiplier Control Unit – CPU Control Unit – Pipeline Control – Instruction Pipelines – Pipeline Performance – Superscalar Processing
3 (10 hours)	Memory Organisation – Memory Hierarchy – Main memory – RAM and ROM chips – Memory Address Map – Memory Connection to CPU – Auxiliary Memory – Magnetic disks – Magnetic Tape – Associative Memory – Hardware Organization - Read Operation – Write Operation – Cache Memory : Associative Mapping – Direct Mapping – Set Associative Mapping –Virtual Memory – Address Space and Memory Space – Address Mapping Using Pages – Associative Memory Page Table – Page Replacement – Memory Management Hardware – Segmented Page Mapping
4 (10 hours)	System Organization – Communication Methods – Basic Concepts – Bus Control – I/O and System Control – I/O Organization – Isolated Versus Memory Mapped I/O - Programmed I/O – DMA and Interrupts – I/O Processors – Operating Systems – Parallel Processing – Processor Level Parallelism – Multiprocessors – Fault Tolerance.

Reference:

1. Patterson D.A. & Hennessy J.L., "Computer Organization and Design", Morgan Kaufmann Publishers, 2002
2. John.P.Hayes “Computer Architecture and Organization”, McGraw-Hill International Editions, Computer Science Series, 1998.
3. Morris Mano “Computer System Architecture”, Prentice-Hall India, Eastern Economy Edition, 2009
4. Carl Hamacher, Zvonko Vranesic & Safwat Zaky, “Computer Organization”, Mc Graw Hill, 2001
5. Pal Choudhuri P., "Computer Organization and Design", Prentice-Hall India, 2nd Edition, 2003
6. William Stallings, "Computer Organization and Architecture", Pearson Education, 4th Edition, 2006

EC 3022: INFORMATION THEORY AND CODING

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

- ***CO1:*** *Get a concrete idea about the ultimate 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:*** *Conceive a thorough understanding about modulation-coding trade-off by playing with SNR/bit and bandwidth constraints of real world applications with an emphasis on corresponding quality of service metric as defined through bit error rate requirements of such applications.*

- ***CO4:*** *Acquire a strong foundation on the practical ways of performing the journey with an objective of reaching nearer to the ultimate destination as set by Shannon through his limit by designing various block and convolutional encoding schemes*
- ***CO5:*** *Design various decoding strategies for block and convolutional coding that meets design objectives like required protection for detection and correction of errors with constraints on affordable computational complexity of practical applications.*
- ***CO6:*** *Evaluate the achievable performance of digital communication systems with various types of coding schemes through the use of appropriate simulation tools present the observations through technical reports.*
- ***CO7:*** *Choose the required type of source and channel coding techniques for meeting the specific needs of integrated digital communication system for various applications and to propose novel solutions for the design of such systems.*

Module No	**Syllabus**
1 (14 hours)	Entropy and Loss-less Source Coding **:** Entropy, 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.
2 (16 hours)	Channel Capacity and Coding Theorem: Channel Capacity**-** 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 Continuous Sources and Channels: Differential Entropy- Mutual information-Waveform channels- Gaussian channels- Shannon-Harley Theorem, Shannon limit, efficiency of digital modulation schemes-power limited and bandwidth limited systems.
3 (16 hours)	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. 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.
4 (10 hours)	Channel Coding- Part-II**:** 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.

Reference:

1. Thomas M. Cover and Joy A. Thomas, “Elements of Information Theory”, John Wiley & Sons, 2006
2. Shu Lin and Daniel. J. Costello Jr., “Error Control Coding: Fundamentals and applications”, 2nd Ed., Prentice Hall Inc, 2004.
3. John G. Proakis and M. Salehi, “Digital Communication”, 5th Ed., MGH, 2008
4. David J. C. MacKay, “Information Theory, Inference and Learning Algorithms”, Cambridge University Press, 2003
5. Robert Gallager, “Information Theory and Reliable Communication”, John Wiley & Sons, 1968.
6. R. E. Blahut, “Theory and Practice of Error Control Codes”, Addison-Wesley, 1983.

EC 3023: COMPUTER NETWORKS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Understanding of the basic building blocks of a computer network and the architecture of the global Internet*
- ***CO2:*** *Analysis of the protocols and algorithms to understand the basic principles on which they are designed*
- ***CO3:*** *Re-engineering various existing network technologies so as to enable design and development of more resource efficient and eco-friendly network technologies in the future*
- ***CO4:*** *Using the software tools available in the Internet to evaluate the performance of various protocols*
- ***CO5:*** *Presenting the findings of the course associated software assignments/projects carried out in groups.*

Module No	Syllabus
1 (8 hours)	Introduction: Building blocks- links, nodes - Layering and protocols - OSI architecture - Internet architecture – Multiplexing -Circuit switching vs packet switching - Datagram Networks - Virtual Circuit networks.
2 (10 hours)	Direct link Networks: Framing - Error detection - Reliable transmission - Multiple access protocols - Ethernet (IEEE 802.3) - Token Rings (IEEE 802.5) - wireless LAN (IEEE 802.11) - Bridges and LAN switches - ATM networks.
3 (14 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.
4 (10 hours)	Broadband services and QoS issues: Quality of Service issues in networks- Integrated service architecture- Queuing Disciplines- Weighted Fair Queuing- Random Early Detection- Differentiated Services- Protocols for QOS support- Resource reservation-RSVP- Multi protocol Label switching- Real Time transport protocol.

Reference:

1. Peterson L.L. & Davie B.S., "Computer Networks: A System Approach", Morgan Kaufman Publishers, 3rd edition, 2003.
2. James. F. Kurose and Keith.W. Ross, "Computer Networks, A top-down approach featuring the Internet", Addison Wesley, 3rd edition, 2005.
3. D. Bertsekas and R. Gallager, "Data Networks", PHI, 2nd edition, 2000.
4. S. Keshav, "An Engineering Approach to Computer Networking", Pearson Education, 2005.

EC 3024: ENVIRONMENTAL STUDIES

Course Type : Other

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Introduce the natural resources and associated problems and to study forest, water and mineral resources.*
- ***CO2:*** *Study food resources, energy resources & land resources and associated environmental problems.*
- ***CO3:*** *Study the fundamental concept of an ecosystem, ecological pyramids, food chains and food webs.*
- ***CO4:*** *Study the biodiversity, threats to biodiversity and conservation.*
- ***CO5:*** *Study the environmental pollution and solid waste management.*
- ***CO6:*** *Study social issues and to introduce environmental ethics.*
- ***CO7:*** *Study on wasteland, environmental protection acts and family welfare programs.*
- ***CO8:*** *To visit and study a local polluted site or environmental asset or ecosystem.*

Module No	Syllabus
1 (8 hours)	Natural Resources: a) Forest resources: Use and over-exploitation, deforestation, case studies- Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) 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. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. g) Role of an individual in conservation of natural resources. h) Equitable use of resources for sustainable lifestyles.
2 (6 hours)	Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids. Characteristic features, structure and function of: forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
3 (8 hours)	Biodiversity and its conservation: Genetic, species and ecosystem diversity, bio-geographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local levels, India as a mega-diversity nation, Hot-spots of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India, conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
4 (8 hours)	Environmental Pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution and nuclear hazards, solid waste management - causes, effects and control measures of urban and industrial wastes, role of an individual in prevention of pollution, pollution case studies, disaster management - floods, earthquake, cyclone and landslides. 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.
5 (7 hours)	Social Issues and the Environment: From Unsustainable to Sustainable development, urban problems related to energy, water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people; its problems and concerns, case studies Environmental ethics : Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies, wasteland reclamation, consumerism and waste products. Issues involved in enforcement of environmental legislation and public awareness. Design for Environment (DFE), need for regulations, impact of work culture in the modern world.
5 (5 hours)	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.

Reference:

1. Gurdeep R. Chatwal and Harish Sharma, “A Text Book of Environmental Studies: Environmental Sciences”, Himalaya Publishing House, 2004.
2. Anubha Kaushik and C P Kaushik, “Perspectives in Environmental Studies”, New Age International, 2007.

EC 3093: ANALOG COMMUNICATION LABORATORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *Demonstrate ability to apply both mathematics and engineering design to analog RF communications*
- ***CO2:*** *Develop ability to design and experimentally test RF circuits and systems such as AM & FM modulator, demodulator, tuned circuits etc. through hands-on experience in system development & debugging.*
- ***CO3:*** *Learn to design and implement a AM/FM radio system, to given specifications emphasizing the use of tools and engineering in practice*
- ***CO4:*** *Critically assess the predicted and measured performance of wired analog communications systems*
- ***CO5:*** *Understand the complexity interplay in communication systems, in terms of circuit and component requirements*
- ***CO6:*** *Develop ability to work as teams both in sub-block level design and overall system design and testing*
- ***CO7:*** *Develop ability to give both oral presentation and written report on radio system*
- ***CO8:*** *Earn some exposure to radio communications evolution, ethical issues (spectrum allocation, licensing…) and related technical/social issues.*

Syllabus

The goals of Analog Communication Laboratory course are: To perform experiments that demonstrate the theory of analog modulation and demodulation techniques learned in the course EC2024 Fundamentals of Communication and to introduce the students to some of the electronic components that make up communication systems.

List of experiments:

1. AM generation
2. AM detection with simple and delayed AGC
3. DSBSC generation
4. RF Mixer using JFET/BJT
5. Implementation of intermediate frequency amplifier
6. FM generation (reactance modulator)
7. FM demodulation: Foster-seely discriminator and ratio detector
8. PAM generation and demodulation
9. Generation and demodulation of PWM and PPM
10. PLL characteristics
11. FM modulation/demodulation using PLL

Reference:

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.

EC 3099: MINI PROJECT

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	1

Course Outcomes:

- ***CO1:*** *Design a hardware solution to a real life problem.*
- ***CO2:*** *Implement the hardware solution using electronic circuit, microcontroller, DSP or PLD.*
- ***CO3:*** *Use tools required for design and implementation of hardware solutions.*
- ***CO4:*** *Communicate the designs and work procedure through presentations and reports.*

Syllabus

The mini project should be on Hardware Design and/or Fabrication in any of the areas in Electronics and Communication Engineering. Microcontroller/DSP/PLD based hardware design is also permitted. Project work can be carried out individually or by a group of maximum of five students under the guidance of a faculty from ECE Department. A committee of the faculty will evaluate the projects during the sixth semester. This course is normally engaged by the department at the beginning of sixth semester.

SEMESTER-VII

MS 4003: ECONOMICS

Course Type : Humanities and Languages
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *To evaluate the economics of the management, operation, and growth and profitability of engineering firms and analyze operations of markets under varying competitive conditions.*
- ***CO2:*** *The course equips a student to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives.*
- ***CO3:*** *To analyze cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis.*
- ***CO4:*** *Produce a constructive assessment of a social problem by drawing the importance of environmental responsibility and demonstrate knowledge of global factors influencing business and ethical issues.*
- ***CO5****: Helps to use models to describe economic phenomena; analyze and make predictions about the impact of government intervention and changing market conditions on consumer and producer behaviour and well-being.*

Module No	Syllabus
1 (9 hours)	General Foundations of Economics; Nature of the firm; Forms of organizations-Objectives of firms-Demand analysis and estimation-Individual, Market and Firm demand, Determinants of demand, Elasticity measures and business decision making, Theory of the firm-Production functions in the short and long run
2 (11 hours)	Cost concepts- Short run and long run costs- economies and diseconomies of scale, real and pecuniary economies; Product Markets; Market Structure- Competitive market; Imperfect competition (Monopoly, Monopolistic & Oligopoly) and barriers to entry and exit -Pricing in different markets
3 (11 hours)	Macro Economic Aggregates-Gross Domestic Product; Economic Indicators; Models of measuring national income; Inflation ; Fiscal and Monetary Policies ; Monetary system; Money Market, Capital market; Indian stock market; Development Banks; Changing role of Reserve Bank of India
4 (11 hours)	International trade - Foreign exchange market- Balance of Payments and Trade-Effects of disequilibrium in BOP on business- Trade regulation- Tariff versus quotas-International Trade and development and role of international institutions (World Bank, IMF and WTO) in economic development.

Reference:

1. Gregory.N.Mankiw, "Principles of Macro Economics", Cengage Learning,4th Edition, 2007.
2. Gregory.N.Mankiw, "Principles of Macro Economics", Cengage Learning,4th Edition, 2007
3. Gupta, S.B."Monetary Economics", S. Chand & Co., New Delhi,4th Edition,1998.
4. Guruswamy,S. "Capital Markets", Tata McGraw Hill, New Delhi,2nd edition ,2009
5. Misra, S.K. and V.K. Puri, "Indian Economy – Its Development Experience", Himalaya Publishing House, Mumbai, 27th Edition,2009
6. Pindyck, R.S,, D.L Rubinfield and P.L. Mehta , "Microeconomics", Pearson Eductaion,6th Edition, 2008
7. Samuelson, P.A. and W.D. Nordhaus , "Economics" ,Tata McGraw Hill, New Delhi. 1998.
8. William .J.Baumol and Alan.S. Blinder, "Micro Economics Principles & Policy", Cengage Learning, Indian Edition 9th edition, 2009.

PN : Supplementary materials would be suggested / supplied for select topics on Indian economy

EC 4011: FUNDAMENTALS OF WIRELESS COMMUNICATION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
4	0	0	4

Course Outcomes:

- ***CO1:*** *Study in a unified way the fundamentals of Mobile radio propagation, physical mechanisms that affect the signal propagation, and characterization of different types of wireless channels*
- ***CO2****: Analysing 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:*** *Enabling the students to think in terms of innovative ideas to improve the existing technology in the field of digital communication through fading multipath channels and improving capacity in cellular systems*
- ***CO4:*** *Motivating them to review the research activities in the field of wireless communication, in particular how to communicate effectively and efficiently over wireless channels.*
- ***CO5:*** *Illustrating the concepts using examples from several modern wireless systems as well as new research developments.*

Module No	Syllabus
1 (15 hours)	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
2 (15 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 - pre-detection and post detection combining - switched combining - maximal ratio combining- equal gain combining
3 (13 hours)	Cellular concept - frequency reuse – cochannel interference - adjacent channel interference -power control for reducing interference - improving capacity in cellular systems – cell splitting - sectoring - hand off strategies - channel assignment strategies - call blocking in cellular networks
4 (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 - time hopped spread spectrum systems - synchronization of spread spectrum systems

Reference:

1. Rapport Thoedore S., Wireless Communications, Principles and Practice, PHI, 2003
2. Haykin, S. and Moher M., Modern Wireless Communications, Prentice Hall 2005.
3. Kamilo Feher, Wireless Digital Communications, PHI, 1995
4. Lee W.C.Y., Mobile Cellular Telecommunication, MGH, 2002
5. Proakis J.G., Digital Communications, Third Edition, MGH,2001

EC 4091: DIGITAL SIGNAL PROCESSING LABORATORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:

- ***CO1:*** *Ability to apply knowledge of mathematics, science and engineering: Construction of tools for visualizing the basic concepts of discrete signal representation such as construction of the z-plane, Fourier transforms, discrete time representations, poles and zeros plots. Implementation of basic signal processing algorithms such as convolution, difference equation implementation and application of them in the construction of FIR and IIR filters*
- ***CO2:*** *To develop the student's ability on conducting engineering experiments, analyze experimental observations scientifically.*
- ***CO3:*** *Ability to program digital signal processing algorithms in C and MATLAB, including the design, implementation, and real-time operation of digital filters, and applications of the fast Fourier transform.*
- ***CO4:*** *Ability to program a DSP chip with a variety of real-time signal processing algorithms, such as filtering for noise reduction, image enhancement or audio effects.*
- ***CO5:*** *Ability to design DSP based real time processing systems to meet desired needs of the society.*
- ***CO6:*** *Experience working in teams*
- ***CO7:*** *To develop the student's ability on preparing professional report.*

Syllabus

The experiments listed below are arranged in a pedagogical order. The instructor shall judiciously choose both simulation experiments using MATLAB/C/C++ and Assembly level implementation on a Digital Signal Processor manufactured by Texas Instruments (TI) or Analog Devices (AD). The first four experiments shall be done using MATLAB/C/C++by simulation. While using MATLAB, elementary commands of MATLAB shall be used, instead of built-in functions, to help the student develop insight in data structures for implementing Signal Processing Algorithms. Experiments from the fourth to the eleventh in the list shall be done both in MATLAB and in the Assembly language of one of the Digital Signal Processors (TI or AD).

1. Construction of the z-plane - Fourier transform, discrete time representations, poles and zeros, graphical calculation of phase and magnitude responses.
2. Linear convolution - Response of a LTI system to an arbitrary input.
3. Frequency response of FIR filters - Minimum Phase filters, Linear phase filters.
4. Convolution of long sequences - Overlap-save and overlap-add methods.
5. FIR Filter Design - Window-based method - Linear phase filters, lowpass, highpass, bandpass, band-reject filters - impulse response, step response, pulse response, response to sinusoids; FIR filters having arbitrary frequency response - Design using frequency sampling method; Least-squares design of FIR filters in time and frequency domains.
6. Discrete Fourier transform - Fast Fourier Transform algorithms - Decimation in time and Decimation in frequency FFT algorithms, Inverse discrete Fourier transform, Convolution with DFT - Circular convolution and Linear Convolution.
7. IIR filter Design - Butterworth and Chebyshev designs, Impulse invariance and Bi-linear transformation methods, pole-zero placements - Integrator, Comb filter.
8. Companding and non-uniform quantization - A-law and μ-law companding – Digital realization.
9. Digital coding of waveforms - Differential pulse code modulation - Adaptive Differential pulse code modulation, Delta modulation, Adaptive Delta modulation and Sigma-delta modulation.
10. Lattice structure realization of digital filters.
11. Linear prediction - Levinson recursion, Levinson-Durbin Algorithm - Lattice realization of prediction error filter; consistent extension of the autocorrelation matrix of a stationary process.

Reference:
1 John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications,” Prentice Hall India Pvt. Ltd., 1997.
2 Boaz Porat, “A Course in Digital Signal Processing,” Prentice Hall Inc, 1998.
3 Oppenheim A. V., Schafer R. W., “Discrete-Time Signal Processing,” Prentice Hall India, 1996.
4 Chi-Tsong Chen, “Digital Signal Processing: Spectral Computation and Filter Design,” Oxford University Press, 2001.
5 Richard A. Roberts, Clifford T. Mullis, “Digital Signal Processing,” Addison-Wesley Publishing Company, 1987.
6 Mitra S. K., “Digital Signal Processing - A Computer Based Approach,” McGraw-Hill Publishing Company, 1998.
7 Lonnie C. Ludeman, “Fundamentals of Digital Signal Processing,” John Wiley& Sons, NY, 1986.
8 R. E. Bogner, A. G. Constantinidis, (Editors), “Introduction to Digital Filtering,” John Wiley & Sons, NY, 1975.
9 Emmanuel C. Ifeacher, Barry W. Jervis, “Digital Signal Processing: A Practical Approach,” 2nd edn., Pearson Education, 2004.
10 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).

EC 4092: DIGITAL COMMUNICATION LABORATORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	2

Course Outcomes:
- ***CO1:*** *Develops skills for performance analysis of practical digital communication systems.*
- ***CO2:*** *Learns to use new tools software and hardware tools effectively and creatively to synthesise digital communication systems.*
- ***CO3:*** *Develops ability to write Technical / Laboratory reports in a professional manner.*
- ***CO4:*** *Develops the ability work in groups for a common goal.*

Syllabus
This laboratory is used for experiments to learn the fundamental concepts for analysis and design of digital and communication systems. Experiments are performed using electronic instrumentation, such as oscilloscopes, noise generators, spectrum analyzers, and network analyzers.

List of experiments:
1. Pulse code modulation
2. Delta modulation
3. Manchester encoder and timing recovery
4. Frequency Shift Keying Modem: Hardware Implementation
5. BPSK Modem: Simulation and Error probability evaluation
6. BPSK generation and detection: Hardware Implementation
7. BPSK Modem: Simulation and Error probability evaluation
8. Linear block codes-generation and detection
9. Cyclic encoder and decoder
10. Differential encoder and decoder
11. Digital microwave links
12. Digital TDM
13. CDMA spreader and de-spreader

Reference:
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.

EC 4098: MAJOR PROJECT

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	6	3

Course Outcomes:

- ***CO1:*** *Envisaging applications for societal needs*
- ***CO2:*** *Develops skills for analysis and synthesis of practical systems*
- ***CO3:*** *Learns to use new tools effectively and creatively*
- ***CO4:*** *Learns to carry out analysis and cost-effective, environmental friendly designs of engineering systems*
- ***CO5:*** *Unfolds creative, scientific thinking and, practices testing designs for quality and standard*
- ***CO6:*** *Develops ability to write Technical / Project reports and oral presentation of the work done to an audience*
- ***CO7:*** *Develops ability to demonstrate a product developed*

Syllabus

The duration of major project is for two continuous semesters from seventh. The 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. Project work can be carried out individually or by a group of maximum of five students. The UG evaluation committee of the department shall evaluate the project during seventh semester for 3 of total of 7 credits assigned for the project.

SEMESTER-VIII

EC 4094: SEMINAR

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	3	1

Course Outcomes:

- ***CO1:*** *Student will get exposure to the recent technical advancements.*
- ***CO2:*** *Student will explore and engage in higher order thinking activities related to a recent topic from their academic area.*
- ***CO3:*** *Student learns to acquire the materials, articulate, create and convey intended meaning of their topics effectively.*
- ***CO4:*** *Student learns to express them clearly and persuasively in exposition and in argument.*
- ***CO5:*** *Student will practice oral and written communication skills.*

Syllabus

Each student shall present a seminar in the eighth semester on a topic relevant to Electronics and Communication Engineering for about 30 minutes. The topic should not be a replica of what is contained in the syllabus. The topic shall be approved by the Seminar Evaluation Committee of the Department. The committee shall evaluate the presentation of students. A seminar report in the prescribed form shall be submitted to the department after the approval from the committee.

EC 4099: MAJOR PROJECT

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
0	0	6	4

Course Outcomes:

- ***CO1:*** *Envisaging applications for societal needs*
- ***CO2:*** *Develops skills for analysis and synthesis of practical systems*
- ***CO3:*** *Learns to use new tools effectively and creatively*
- ***CO4:*** *Learns to carry out analysis and cost-effective, environmental friendly designs of engineering systems*
- ***CO5:*** *Unfolds creative, scientific thinking and, practices testing designs for quality and standard*
- ***CO6:*** *Develops ability to write Technical / Project reports and oral presentation of the work done to an audience*
- ***CO7:*** *Develops ability to demonstrate a product developed*

Syllabus

The duration of major project is for two continuous semesters from seventh. The 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. Project work can be carried out individually or by a group of maximum of five students. The UG evaluation committee of the department shall evaluate the project during eighth semester for 4 of total of 7 credits assigned for the project.

LIST OF ELECTIVES

EC 3031: TELEVISION ENGINEERING

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Learn principles of television, video and sound signal modulation and transmission.*
- *CO2: Familiarise with the television receiver circuits - its working and design.*
- *CO3: Design of IF section, video amplifiers, AGC and tuner.*
- *CO4: Study of color TV principles, color signal modulation and transmission.*
- *CO5: Learn principles of Digital TV and its standards.*
- *CO6: Learn the concept of Cable TV and the distribution system.*

Module No	Syllabus
1 (10 hours)	Principles of television - image continuity - interlaced scanning - blanking - synchronizing - video and sound signal modulation - channel bandwidth - vestigial sideband transmission – television signal propagation –antennas. VSB correction - positive and negative modulation - transmitter block diagram- CCD camera
2 (12 hours)	Television receiver circuits – IF section, video detector-video amplifiers- AGC , Sync processing and AFC-Horizontal and vertical deflection circuits –sound section-tuner.
3 (12 hours)	Colour TV - Colour perception - luminance, hue and saturation - colour TV camera and picture tube - colour signal transmission - bandwidth - modulation - formation of chrominance signal - principles of NTSC, PAL and SECAM coder and decoder
4 (8 hours)	Digital TV - composite digital standards - 4 f sc NTSC standard - general specifications - sampling structure - digital transmission Cable TV - cable frequencies - co-axial cable for CATV - cable distribution system - cable decoders - wave traps and scrambling methods

Reference:

1. Gulati R.R., Modern Television Engineering, Wiley Eastern Ltd, 2002.
2. Michael Robin & Michael Poulin, Digital Television Fundamentals, McGraw Hill, 1998
3. Bernard Grob & Charles E. Herndon, Basic Television and Video Systems, McGraw Hill International, 1999
4. Dhake A.M., Television Engineering, Tata McGraw Hill, 1993
5. Damacher P., Digital Broadcasting, IEE Telecommunications Series, 1996

EC 3032: POWER ELECTRONICS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Explain the basic structure and V-I characteristics of various power devices.*
- ***CO2:*** *Analysis of resistive and inductive loads in line frequency phase controlled rectifiers using SCR.*
- ***CO3****: AC regulators, Cycloconverters and Choppers- basic principle of operation.*
- ***CO4:*** *Introduction on Switching regulators - buck regulators - boost regulators - buck-boost regulators.*
- ***CO5****: Switched mode power supply, Uninterruptible power supply - basic circuit operation.*

Module No	Syllabus
1 (10 hours)	Power diodes - basic structure and V-I characteristics - various types - power transistors - BJT, MOSFET and IGBT - basic structure and V-I characteristics - thyristors - basic structure - static and dynamic characteristics - device specifications and ratings - methods of turning on - gate triggering circuit using UJT - methods of turning off - commutation circuits - TRIAC
2 (10 hours)	Line frequency phase controlled rectifiers using SCR - single phase rectifier with R and RL loads - half controlled and fully controlled converters with continuous and constant currents - SCR inverters - circuits for single phase inverters - series, parallel and bridge inverters - pulse width modulated inverters - basic circuit operation
3 (10 hours)	AC regulators - single phase ac regulator with R and RL loads - sequence control of ac regulators - cycloconverter - basic principle of operation - single phase to single phase cycloconverter - choppers - principle of operation - step-up and step-down choppers - speed control of DC motors and induction motors
4 (12 hours)	Switching regulators - buck regulators - boost regulators - buck-boost regulators - cuk regulators - switched mode power supply - principle of operation and analysis - comparison with linear power supply - uninterruptible power supply - basic circuit operation - different configurations - characteristics and applications

Reference:

1. Ned Mohan et.al, .Power Electronics, John Wiley and Sons, 1989
2. Sen P.C., Power Electronics, Tata Mc Graw Hill,2003
3. Rashid, Power Electronics.,Prentice Hall India,1993
4. G.K.Dubey et.al, Thyristorised Power Controllers, Wiley & Sons, 2001
5. Dewan & Straughen, .Power Semiconductor Circuits, Wiley & Sons, 1984
6. Singh M.D & Khanchandani K.B., Power Electronics, Tata Mc Graw Hill, 1998

EC 3033: MICROELECTRONICS TECHNOLOGY

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Knowledge of the fabrication process of various semiconductor devices.*
- ***CO2:*** *Model various fabrication processes of Semiconductor devices.*
- ***CO3:*** *Development and usage of modern tools to simulate the virtual fabrication process.*
- ***CO4:*** *Capability of working in semiconductor fabrication industries.*

Module No	Syllabus
1 (6 hours)	Material properties, crystal structure, lattice, basis, planes, directions, angle between different planes, characterization of material based on band diagram and bonding, conductivity, resistivity, sheet resistance, phase diagram and solid solubility, Crystal growth techniques, wafer cleaning, Epitaxy, Clean room and safety requirements
2 (15 hours)	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, thickness characterization methods, multi dimension oxidation modeling Diffusion and Ion Implantation: Diffusion process, Solid state diffusion modeling, various doping techniques, Ion implantation, modeling of Ion implantation, statistics of ion implantation, damage annealing, thermal budget, rapid thermal annealing, spike anneal, advanced annealing methods, Implant characterization SIMS, spreading resistance method

3 (15 hours)	Deposition & Growth**:** Various deposition techniques CVD, PVD, evaporation, sputtering, spin coating, LPCVD, epitaxy, MBE, ALCVD, Growth of High k and low k dielectrics Etch and Cleaning**:** materials used in cleaning, various cleaning methods, Wet etch, Dry etch, Plasma etching, RIE etching, etch selectivity/selective etch Photolithography: Positive photo resist, negative photo resist, comparison of photo resists, components of a resist, light sources, exposure, Resolution, Depth of Focus, Numerical Aperture (NA), sensitivity, contrast, need for different light sources, masks, Contact, proximity and projection lithography, step and scan, optical proximity correction, develop(development of resist), Next generation technologies: Immersion lithography, Phase shift mask, EUV lithography, X-ray lithography, e-beam lithography, ion lithography, SCALPEL
4 (6 hours)	Planarization Techniques: Need for planarization, Chemical Mechanical Polishing Metallization and Interconnects: Copper damascene process, Metal interconnects; Multi-level metallization schemes, Process integration: NMOS, CMOS and Bipolar process.

Reference:

1. M. Deal and P.Griffin, Silicon VLSI Technology, James Plummer, Prentice Hall Electronics, 2010.
2. S.M. Sze, Stephen Campbell, The Science and Engineering of Microelectronics Oxford University Press, 1996.
3. VLSI Technology, 2nd Edition, McGraw Hill, 1988.
4. S.K. Ghandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.
5. C.Y. Chang and S.M.Sze , ULSI Technology, McGraw Hill Companies Inc, 1996.

EC 3034: MODELLING AND TESTING OF DIGITAL SYSTEMS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Describe the digital circuits using VHDL*
- ***CO2:*** *Simulation and synthesis of VHDL code*
- ***CO3:*** *Design of digital circuits using FPGA*
- ***CO4:*** *Model different types of faults in the digital circuits using appropriate fault models*
- ***CO5:*** *Generate test patterns required to detect faults*
- ***CO6:*** *Design methods/techniques to increase the testability of digital circuits*

Module No	Syllabus
1 (12 hours)	Introduction to HDL based Digital Design: – Basic VHDL terminology – basic language elements – Data objects and types – Behavioural modelling – Process constructs – Complex signal assignments – Dataflow modelling – delay models – Structural modelling – resolving signal values
2 (12 hours)	Advanced VHDL features: Generics and Configurations – Subprograms and Overloading – Packages and Libraries – Advanced features – simulation semantics – modelling examples – state machine modelling using VHDL- review of FPGA architectures and design using FPGA. Practical design exercises on VHDL simulator /synthesizer
3 (10 hours)	Digital System Testing: Fault models – fault equivalence – fault location fault dominance – single and multiple stuck faults – Testing for single stuck faults – Algorithms – random test generation – Testing for bridging faults

4 (8 hours)	Design for Testability: Ad-hoc design for testability techniques – Classical scan designs – Boundary scan standards – Built-in-self-test – Test pattern generation – BIST architecture examples

Reference:

1. J. Bhasker; A VHDL Synthesis Primer, B.S. Publications 2001
2 VHDL for Engineers ,by Kenneth L Short ,Pearson Education ,2006
3. Miron Abramovici et. al. Digital System Testing and Testable Design, Jaico Publishing House, 2001
4. Charles H. Roth Jr; Digital System Design Using VHDL, Thomson Education,2005

EC 3035: MOS DEVICE MODELING

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Knowledge of the principle of operation of MOS FETs*
- ***CO2:*** *Model the small signal and Large signal behaviour of the MOSFET for various applications.*
- ***CO3:*** *Development of novel MOSFET structures and their models.*

Module No	Syllabus
1 (13 hours)	Semiconductor surfaces, Ideal MOS structure, MOS device in thermal equilibrium, Non-Ideal MOS: work function differences, charges in oxide, interface states, band diagram of non ideal MOS, flatband voltage, electrostatics of a MOS (charge based calculations), calculating various charges across the MOSC, threshold voltage, MOS as a capacitor (2 terminal device), Three terminal MOS, effect on threshold voltage
2 (16 hours)	MOSFET (Enhancement and Depletion MOSFETs), mobility, on current characteristics, off current characteristics, subthrehsold swing, effect of interface states on subthreshold swing, drain conductance and transconductance, effect of source bias and body bias on threshold voltage and device operation, Scaling, Short channel and narrow channel effects- High field effects
3 (5 hours)	MOS transistor in dynamic operation, Large signal Modeling, small signal model for low, medium and high frequencies.
4 (8 hours)	SOI concept, PD SOI, FD SOI and their characteristics, threshold voltage of a SOI MOSFET, Multi-gate SOI MOSFETs, Alternate MOS structures.

Reference:

1. E.H. Nicollian, J. R. Brews, Metal Oxide Semiconductor - Physics and Technology, John Wiley and Sons, 2003
2. Jean- Pierrie Colinge, Silicon-on-insulator Technology: Materials to VLSI Kluwer Academic publishers group, 2004.
3. Yannis Tsividis, Operation and Modeling of the MOS transistor: Oxford University Press, 2010.
4. M.S.Tyagi, Introduction to Semiconductor materials and Devices, John Wiley & Sons, 2004.
5. Donald A Neamen, Semiconductor Physics and Devices: Basic Principles, McGraw-Hill, 2003.
6. Jean-Pierre Colinge, Physics of Semiconductor Devices, Kluwer Academic Publishers, 2002, access online at (NITC intranet) http://www.springerlink.com/content/978-1-4020-7018-1/
7. Y. Taur and T.H. Ning, Fundamentals of Modern VLSI DevicesCambridge University Press, 1998, ISBN:0-521-55959-6

EC 3036: VLSI CIRCUITS & SYSTEMS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Design and Analysis of various MOSFET and CMOS logic circuits with Area, Power and Noise Margin considerations.*
- *CO2: Study of MOS Transistors and its junction and oxide capacitances.*
- *CO3: Realize MOSFET inverters with resistive load, NMOS load and CMOS inverters.*
- *CO4: Design multiple input CMOS logic circuits and perform DC and transient analysis.*
- *CO5: Design dynamic circuits and sequential circuits.*
- *CO6: Design of arithmetic circuits such as adders, multipliers and shifters.*
- *CO7: Study of capacitive loads and various delay models and delay calculation.*
- *CO8: Learn the effect of scaling, short channel, ESD and power supply noise.*

Module No	Syllabus
1 (12 hours)	Overview of VLSI Design flow- Review of MOS transistors, MOSFET capacitances-Junction capacitances-oxide related capacitances-Ideal switches and Boolean operation-MOSFET as switch-Switch models of inverter-MOSFET realization of inverters-Resistive load, NMOS load and CMOS inverters-DC and Transient analysis-Area, power and noise margin considerations-Stick diagram and layout of CMOS inverter
2 (13 hours)	Multiple input CMOS logic circuits, DC and transient analysis, Pseudo NMOS, Pass transistor, Complementary pass transistor and transmission gate logic styles, realization, Area, power and noise margin considerations, Dynamic circuits, Issues with dynamic circuits-Domino and NORA logic, Designing sequential circuits, clocked CMOS circuits
3 (9 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
4 (8 hours)	Driving large capacitive loads, Wire delay models, Lumped C, RC and distributed RC models, Elmore delay model, Delay calculation with distributed circuit elements, Latch up and its prevention, Input and output circuits, ESD protection, power supply noise, Supply voltage scaling and its effect on circuit parameters, Scaling and short channel effects

Reference:

1. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Desing, MGH, Third Ed., 2003
2. John P Uyemura, Introduction to VLSI Circuits and Systems, Wiley India, 2006
3. Neil H.E.Weste, Kamran Eshraghian, Principles of CMOS VLSI Design- A Systems Perspective, Second Edition. Pearson Publication, 2005
4. Jan M.Rabaey, Digital Integrated Circuits- A Design Perspective, Prentice Hall, Second Edition, 2005
5. R.J. Baker, H.W.Li and D.E.Boyce, CMOS Circuit Design, Layout and Simulation, Wiley-IEEE Press, 2007.

EC 3037: ACTIVE NETWORK SYNTHESIS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understand the nature of network functions*
- *CO2: Learn various filter types*
- *CO3: Understand the concept of sensitivity*
- *CO4: Introduce fundamental active blocks*
- *CO5: Design First & Second order filters*
- *CO6: Familiarise with higher order filter realization*
- *CO7: Familiarise with High frequency integrated filter realization*

Module No	Syllabus
1 (10 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_0 sensitivity
2 (9 hours)	Amplifiers and fundamental active building blocks - Opamps, OTAs, CCIIs, Integrators, gyrators and immittance converters
3 (15 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
4 (8 hours)	Fully integrated high-frequency filter realisations - Transconductance filters - Log-domain filters - Switched-capacitor filters

Reference:

1. P V Ananda Mohan: Current mode VLSI Analog filters; Springer, 2004
2. Gobind Daryanani: Principles of Active Network Synthesis and Design, John Wiley, 1978
3. M E Van Valkenberg: Analog Filter Design; Oxford Univ Press, 1995
4. Sedra & Brackett: Filter theory & Design – Active & Passive; Matrix Publishers, 1978

EC 3038: EMBEDDED SYSTEMS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understanding the basic idea regarding the nature of embedded systems*
- *CO2: Understanding the hardware and software aspects of modern embedded systems*
- *CO3: Analyzing the various important components such as processors, sensors and actuators that constitute an embedded system.*
- *CO4: Learning the nature of embedded system design as is done in a product design industry*
- *CO5: Motivating students towards developing embedded systems for the practical applications*

Module No	Syllabus
1 (10 hours)	Introduction to Embedded systems : Embedded system examples, Parts of Embedded System- Processor, Power supply, clock, memory interface, interrupt, I/O ports, Buffers, Programmable Devices, ASIC,etc. interfacing with memory and I/O devices. Memory Technologies – EPROM, Flash, OTP, SRAM,DRAM, SDRAM etc.
2 (8 hours)	Embedded System Design: Embedded System product Development Life cycle (EDLC), Hardware development cycles- Specifications, Component selection, Schematic Design, PCB layout, fabrication and assembly. Product enclosure Design and Development. Embedded System Development Environment – IDE, Cross compilation, Simulators/Emulators, Hardware Debugging. Hardware testing methods like Boundary Scan, In Circuit Testing (ICT) etc. Bus architectures like I^2C, SPI, AMBA, CAN etc.
3 (12 hours)	Operating Systems: Concept of firmware, Operating system basics, Real Time Operating systems, Tasks, Processes and Threads, Multiprocessing and Multitasking, Task scheduling, Task communication and synchronisation, Device Drivers.
4 (12 hours)	System Design Examples : System design using ARM/PSoC/MSP430 processor

Reference:

1. Shibu K.V.: Introduction to Embedded Systems, Tata McGraw Hill, 2009
2. Tim Wilmshurst: An introduction to the design of small-scale embedded systems, Palgrave, 2001.
3. Device data sheets of ARM/PSoC/MSP430
4. Web Resources

EC 3039: MULTIRATE SYSTEMS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: The course provides an in-depth treatment of both the theoretical and practical aspect of multirate signal processing.*
- *CO2: Students can develop methods for decimating, interpolating and changing the sampling rate of the signal and to analyze the effect of sampling rate changes.*
- *CO3: Student learns the design of multi-channel filter banks to decompose a signal into sub bands and synthesize a full band signal from the sub band components and to learn the principles of polyphase filtering.*
- *CO4: The theory can be applied directly to different areas such as subband coding, voice privacy, image processing, multi resolution and wavelet analysis.*
- *CO5: There exists an immense potential for further research and applications.*

Module No	Syllabus
1 (12 hours)	Multirate System Fundamentals: Sampling theorem: Sub-Nyquist sampling, generalization; Basic multirate operations: up sampling and down sampling - time domain and frequency domain analysis; Identities of multirate operations; Interpolator and decimator design; Rate conversion; Polyphase representation of signals and systems; uniform DFT filter bank, decimated uniform DFT filter bank – polyphase representation.

2 (10 hours)	Multirate Filter Banks: Maximally decimated filter banks: Quadrature mirror filter (QMF) banks - Polyphase representation, Errors in the QMF - Aliasing and imaging; Methods of cancelling aliasing error, Amplitude and phase distortions; Prefect reconstruction (PR) QMF bank - PR condition; Design of an alias free QMF bank
3 (10 hours)	M-channel Perfect Reconstruction Filter Banks: Filter banks with equal pass bandwidth, filter banks with unequal pass bandwidth – Errors created by the filter banks system - Aliasing and imaging - Amplitude and phase distortion, polyphase representation - polyphase matrix. Perfect reconstruction system - Necessary and sufficient condition for perfect reconstruction, FIR PR systems, Factorization of polyphase matrices, Design of PR systems
4 (10 hours)	Linear Phase Perfect Reconstruction (LPPR) Filter Banks: Necessary conditions for linear phase property; Lattice structures for LPPR FIR QMF banks - Synthesis, M-channel LPPR filter bank, Quantization effects - Types of quantization effects in filter banks - Implementation - Coefficient sensitivity effects, round off noise and limit cycles, dynamic range and scaling.

Reference:

1. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, PTR, 1993.
2. N. J. Fliege, Multirate Digital Signal Processing, John Wiley, 1994.
3. Sanjit K. Mitra, Digital Signal Processing: A Computer based Approach,3rd Edition,McGraw Hill, 2001.
4. R. E. Crochiere, L. R. Rabiner, Multirate Digital Signal Processing, Prentice Hall Inc, 1983.
5. Fredric J Harris, Multirate signal Processing For Communication Systems, 1st Edition, Pearson Education
6. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications 3rd Edn. Prentice Hall India, 1999.

EC 3040: DIGITAL IMAGE PROCESSING

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	**0**	**0**	**3**

Course Outcomes:

- *CO1: Learn the basic mathematics and theory of linear systems for solving problems in image processing: Basic 2-D signal processing, 2-D Fourier and other transforms, convolution and filtering operations in 2-D.1-2*
- *CO2: Recognize the needs and challenges of our age, and to assess the global and social impacts of image processing solutions: Basic understanding of the widespread use of digital imaging systems; the need for effective use of scarce resources such as storage and bandwidth, and ways to provide that effective use by data compression; social impacts and applications of object recognition systems, such as in security, entertainment and automation fields. 2-1, 3-2, 6-1, 7-1*
- *CO3:Identify, formulate and solve image processing problems: Modeling of digital images and degradations such as noise and motion blur; derivation of conditions for optimal filtering, thresholding, coding and classification of images; analyzing and evaluating systems; the performance of image enhancement, restoration and coding algorithms through the use of both subjective and objective metrics; identifying the source of redundancy in images and exploiting this redundancy for developing efficient coding techniques. 2-1, 3-2, 4-1*
- *CO4:Design and integrate components of image processing systems to satisfy given requirements: Selecting the design parameters for optimal performance of related image processing systems; designing and integrating enhancement and restoration techniques for different applications; integrating different coding tools and selecting the related coding parameters for efficient lossless and lossy image compression; designing simple object segmentation and recognition algorithms. 3-2, 4-2, 6-1, 7-1*

- *CO5: Use the software based modeling, simulation and design tools necessary for practical image processing applications : Design and implementation of image enhancement, restoration, coding, and transformation algorithms in MATLAB/ C++. 5-2,*
- *CO6: Experience working in teams.*
- *CO7: Experience in technical communication by conducting seminars on the latest topics in relevant to the topics covered in the paper.*

Module No	Syllabus
1 (8 hours)	Digital image representation: Basic ideas in digital image processing: problems and applications - Image representation and modeling Sampling and quantization - Basic relationships between pixels - Two dimensional systems - shift in variant linear systems - Separable functions; 2-D convolution; 2-D correlation. Image perception - light, luminance, brightness and contrast - MTF of the visual system - visibility function - monochrome vision models - image fidelity criteria - colour representation - colour matching and reproduction - colour co-ordinate systems - colour difference measures - colour vision models.
2 (8 hours)	Image transforms: 2-D Discrete Fourier transform - properties; Walsh Hadamard, Discrete Cosine, Haar and Slant transforms; The Hotelling transform. Matrix theory - block matrices and Kronecker products - Circulant matrix formulation for complexity reduction; Algebraic methods - random fields - spectral density function -
3 (10 hours)	Image enhancement & Restoration: Image enhancement: Basic gray level transformations – Histogram processing: histogram equalization and modification - Spatial operations - Transforms operations - Multispectral image enhancement - Colour image enhancement Image restoration: Degradation model; Restoration in presence of noise only – Estimating the degradation function - Inverse _filtering - Wiener _filtering – Constrained Least Squares filtering.
4 (9 hours)	Image compression: Fundamental concepts of image compression - Compression models - Information theoretic perspective - Fundamental coding theorem – Lossless Compression: Huffman Coding- Arithmetic coding – Bit plane coding – Run length coding - Lossy compression: Transform coding – Image compression standards.
5 (7 hours)	Image segmentation: Detection of Discontinuities – Edge linking and boundary Description: Local processing – Global processing – Hough transform – Thresholding – Region based segmentation.

Reference:

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education. II Ed.,2002
2. Jain A.K., "Fundamentals of Digital Image Processing,", Prentice-Hall, 1989.
3. Jae S. Lim, Two Dimensional Signal And Image Processing, Prentice-Hall, Inc, 1990.
4. Pratt W.K., "Digital Image Processing", John Wiley, 1991.
5. K. R. Castleman, .Digital image processing., Prentice Hall, 1995.
6. Netravalli A.N. & Hasbell B.G., "Digital Pictures-Representation Compression and Standards", Plenum Press, New York, 1988.
7. Rosenfeld & Kak A.C., "Digital Picture Processing", Vol.1&2, Academic Press, 1982.

*EC 3041: DATA STRUCTURES USING C++

*Offered from 2013 Winter Semester

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Understanding the basic idea regarding the nature of problems and their solutions.*
- ***CO2:*** *Understanding the software aspects of the IT enabled world*

- ***CO3:*** *Analyzing the various important components such as algorithms, complexity and specific solutions for modern IT problems.*
- ***CO4:*** *Learning the implementation of algorithms on a specific language platform.*
- ***CO5:*** *Motivating students towards understanding the complex nature of searching and identifying items in a very vast data set*

Module No	Syllabus
1 (8 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, this pointer, dynamic memory allocation and de-allocation
2 (12 hours)	Searching and Sorting - Searching: Linear and Binary search implementation, Hash Tables Sorting : Heap sort, Quick sort and Merge sort implementation
3 (10 hours)	Linked lists - Stack and Queue, 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- Linear time DFS and BFS implementation with adjacency list representation
4 (12 hours)	Graph representation- Depth First Search (DFS), Breadth First Search(BFS), Minimum spanning tree problem - Kruskal's algorithm - implementation using disjoint set data structure- Prim's algorithm - Shortest path problem - Dijkstra's algorithms - implementation of Prim's and Dijkstra's algorithms using priority queue data structure

References

1. Larry Nyhoff , ADTs, Data Structures and Problem Solving with C++, Second Edition, Pearson Education 2012
2. Yedidyah Langsam, Moshe J Augenstein, Aaron M Tenenbaum, Data Structures Using C and C++ , Second Edition, PHI Publishers,1996
3. Sahni S., Data Structures, Algorithms and Applications in C++, Mc Graw Hill, Singapore, 1998.
4. T. H. Cormen, C. E. Lieserson, R. L. Rivest, C. Stein, Introduction to Algorithms (3/e), MIT Press, 2003
5. S. Dasgupta, C. H. Papadimitriou, U. Vazirani, Algorithms, McGraw Hill, 2006
6. A. V. Aho, J. D. Ullman and J. E. Hopcroft, Data Structures and Algorithms, Addison Wesley, 1983

EC 4031: MICROWAVE COMMUNICATION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Introduces different types of satellite based communication systems*
- *CO2: Analysis and design of practical systems for Microwave Communication*
- *CO3: Enables the student to understand and take up space technology based communication system design projects*
- *CO4: Analysis of long distance communication methods and technologies*

Module No	Syllabus
1 (11 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.

2 (10 hours)	Earth stations and terrestrial links: Antenna and feed systems, satellite tracking system, amplifiers, fixed and mobile satellite service earth stations. Terrestrial microwave links-line of sight transmission, Transmitters, receivers and relay towers -distance considerations, Digital links.
3 (11 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.
4 (10 hours)	Multiple access techniques: Frequency division multiple access, time division multiple access, code division multiple access

Reference:

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, 2000
4. Tri T Ha: 'Digital Satellite Communication', MGH, 2008
5. George M. Kizer: 'Digital Microwave Communication', IEEE Press, 2010

EC 4032: SPEECH PROCESSING

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Student gets the knowledge of basic characteristics of speech signal in relation to production and hearing of speech by humans.*
- *CO2: Student understands how speech signals are processed in three general areas: Analysis, synthesis and recognition.*
- *CO3: Student understands basic algorithms of speech analysis common to many applications.*
- *CO4: Student will be informed about the practical aspects of speech algorithm implementation.*
- *CO5: Student will be able to implement a simple system for speech processing.*

Module No	Syllabus
1 (10 hours)	Digital models for the speech signal - mechanism of speech production - acoustic theory – Portnoff's equations-lossless tube models – complete speech production model- digital models
2 (10 hours)	Speech analysis:-linear prediction of speech - auto correlation - formulation of LPC equation - Solution of LPC equations - Levinson Durbin algorithm - Levinson recursion - Schur algorithm - lattice formulations and solutions – PARCOR coefficients
3 (12 hours)	Speech synthesis - pitch extraction algorithms - Gold Rabiner pitch trackers – autocorrelation pitch trackers - voice/unvoiced detection - homomorphic speech processing – homomorphic systems for convolution - complex Cepstrums - pitch extraction using homomorphic speech processing. Spectral analysis of speech - short time Fourier analysis – STFT interpretations-filter bank summation method of short time synthesis
4 (10 hours)	Automatic speech recognition systems - isolated word recognition - connected word recognition -large vocabulary word recognition systems - pattern classification - DTW, HMM - speaker recognition systems - speaker verification systems - speaker identification Systems.

Reference:

1. Rabiner L.R. & Schafer R.W., “Digital Processing of Speech Signals”, Prentice Hall Inc., 1978.
2. Thomas F. Quatieri, “Discrete-time Speech Signal Processing: Principles and Practice” Prentice Hall, Signal Processing Series, 1st Edn., 2001.
3. O’Shaughnessy, D. “Speech Communication, Human and Machine”. John Wiley & Sons; 2nd Edn, 1999.
4. Deller, J., J. Proakis, and J. Hansen. “Discrete-Time Processing of Speech Signals.” Wiley-IEEE Press, Reprint edition, 1999.
5. Owens F.J., “Signal Processing of Speech”, Macmillan New Electronics, 1993.
6. Saito S. & Nakata K., “Fundamentals of Speech Signal Processing”, Academic Press, Inc., 1985.
7. Papamichalis P.E., “Practical Approaches to Speech Coding”, Texas Instruments, Prentice Hall, 1987.
8. Rabiner L.R. & Gold, “Theory and Applications of Digital Signal Processing”, Prentice Hall of India,1975.
9. Jayant, N. S. and P. Noll. “Digital Coding of Waveforms: Principles and Applications to Speech and Video. Signal Processing Series”, Englewood Cliffs: Prentice-Hall, 2004.
10. Thomas Parsons, “Voice and Speech Processing”, McGraw Hill Series, 1986.
11. Chris Rowden, “Speech Processing”, McGraw-Hill International Limited, 1992.

EC 4033: WAVELET THEORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understand the mathematical basis of the wavelet transform as a tool in signal and image analysis.*
- *CO2: Understand the concepts and properties of Continuous Wavelet Transform, Multi-Resolution Analysis, Discrete Wavelet Transform and Wavelet Packets.*
- *CO3: Learn to implement Discrete Wavelet transform using Filter banks and Fast Lifting Scheme.*
- *CO4: Learn the time domain and frequency domain approaches for the construction of wavelets.*
- *CO5: Learn to design and implement wavelet packet transform & best basis algorithm for a desired application*
- *CO6: Implement Discrete Wavelet Transform and Wavelet Packet Transform for Signal compression, de-noising, Digital hearing aid design etc.*

Module No	Syllabus
1 **(12 hours)**	(1. a) Fourier and Sampling Theory: (6 hours) Generalized Fourier theory, Fourier transform, Short-time(windowed) Fourier transform,Time-frequency analysis - uncertainty relation, Fundamental notions of the theory of sampling. (1. b) Theory of Frames: (6 hours) Bases, Resolution of unity, Definition of frames, Geometrical considerations and the general notion of a frame, Frame projector, Example - windowed Fourier frames.
2 **(12 hours)**	(2. a) Wavelets: (6 hours) The basic functions, Specifications, Admissibility conditions, Continuous wavelet trans- form (CWT), Wavelet frames. (2. b) The multi resolution analysis (MRA) of L2(R): (6 hours) The MRA axioms, Construction of an MRA from scaling functions - The dilation equation and the wavelet equation, Compactly supported orthonormal wavelet bases – Necessary and sufficient conditions for orthonormality.

3 (12 hours)	(3.a) Construction of wavelets (1): (6 hours) Regularity and selection of wavelets - Smoothness and approximation order – Criteria for wavelet selection with examples; Splines, Cardinal B-spline MRA, Subband filtering schemes, Compactly supported orthonormal wavelet bases. (3.b) Wavelet transform: (6 hours) Discrete wavelet transform (DWT) - Wavelet decomposition and reconstruction of functions in L2(R), Fast wavelet transform algorithms - Relation to filter banks, Wavelet packets - Representation of functions, Selection of basis.
4 (6 hours)	(4) Construction of wavelets (2): (6 hours) Biorthogonality and biorthogonal basis, Biorthogonal system of wavelets - construction, The Lifting scheme.

Reference:

1. Stephen G. Mallat, \A Wavelet Tour of Signal Processing" 2nd Edition Academic Press, 2000.
2. M. Vetterli, J. Kovacevic, \Wavelets and Subband Coding" Prentice Hall Inc, 1995.
3. Gilbert Strang and Truong Q. Nguyen, \Wavelets and Filterbanks" 2nd Edition Wellesley-Cambridge Press,1998.
4. Gerald Kaiser, \A Friendly Guide to Wavelets" Birkhauser/Springer InternationalEdition, 1994, Indian reprint 2005.
5. Mark A. Pinsky, \Introduction to Fourier Analysis and Wavelets"Brooks Cole Series in Advanced Mathematics, 2002.
6. Christian Blatter, \Wavelets: A primer" A. K. Peters, Massachusetts, 1998.
7. M. Holschneider, \Wavelets: An Analysis Tool"Oxford Science Publications, 1998.
8. Ingrid Daubechies, \Ten Lectures on Wavelets" SIAM, 1990.

EC 4034: RF CIRCUITS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Learn the nature of passive components at RF*
- *CO2: Understand two port noise theory*
- *CO3: Analyse noise models for active & passive components*
- *CO4: Learn RF amplifier design techniques*
- *CO5: Learn Low noise amplifier design*
- *CO6: Exposure to the design of mixers & oscillators*
- *CO7: learn the design of frequency synthesizers*

Module No	Syllabus
1 (9 hours)	Characteristics of passive IC components at RF frequencies – interconnects, resistors, capacitors, inductors and transformers – Transmission lines (6 hours) Noise – classical two-port noise theory, noise models for active and passive components (3 hours)
2 (13 hours)	High frequency amplifier design – zeros as bandwidth enhancers, shunt-series amplifier, f_T doublers, neutralization and unilateralization (6 hours) Low noise amplifier design – LNA topologies, power constrained noise optimization, linearity and large signal performance (7 hours)
3 (12 hours)	Mixers – multiplier-based mixers, subsampling mixers, diode-ring mixers (5 hours) RF power amplifiers – Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, linearity considerations (7 hours)
4 (8 hours)	Oscillators & synthesizers – describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination

	synthesizers – phase noise considerations.

Reference:

1. Thomas H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, 2nd ed., Cambridge, UK: Cambridge University Press, 2004.
2. Behzad Razavi, RF Microelectronics, Prentice Hall, 1998.
3. A.A. Abidi, P.R. Gray, and R.G. Meyer, eds., Integrated Circuits for Wireless Communications, New York: IEEE Press, 1999.
4. R.Ludwig and P. Bretchko, RF Circuit Design, Theory and Applications, Pearson, 2000

EC 4035: HIGH SPEED DIGITAL CIRCUITS

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Compare the performances and specifications of various logic families*
- *CO2: To solve propagation and termination problems on lossless and lossy transmission lines for digital circuits.*
- *CO3: Calculate losses in power distribution networks*
- *CO4: Design power distribution techniques that reduce noise*
- *CO5: To use signaling and coding strategies to improve signal integrity in high-speed serial links.*
- *CO6: Design clock distribution techniques that ensure clock signal quality*

Module No	Syllabus
1 (10 hours)	Introduction to high-speed digital design: Frequency, time and distance - Capacitance and inductance effects - High seed properties of logic gates - Speed and power - Modelling of wires -Geometry and electrical properties of wires - Electrical models of wires - transmission lines - lossless LC transmission lines - lossy LRC transmission lines - special transmission lines
2 (10 hours)	Power distribution and noise: Power supply network - local power regulation - IR drops - area bonding - onchip bypass capacitors - symbiotic bypass capacitors - power supply isolation - Noise sources in digital system - power supply noise - cross talk - intersymbol interference
3 (10 hours)	Signalling convention and circuits: Signalling modes for transmission lines -signalling over lumped transmission media - signalling over RC interconnect - driving lossy LC lines - simultaneous bi-directional signalling - terminations - transmitter and receiver circuits
4 (12 hours)	Timing convention and synchronisation: Timing fundamentals - timing properties of clocked storage elements - signals and events -open loop timing level sensitive clocking - pipeline timing - closed loop timing - clock distribution - syncronisation failure and metastability - PLL and DLL based clock aligners

Reference:

1. William S. Dally & John W. Poulton; Digital Systems Engineering, Cambridge University Press, 1998
2. Howard Johnson & Martin Graham; High Speed Digital Design: A Handbook of Black Magic, Prentice Hall PTR, 1993
3. Masakazu Shoji; High Speed Digital Circuits, Addison Wesley Publishing Company, 1996
4. Jan M, Rabaey, et all; Digital Integrated Circuits: A Design perspective, Second Edition, 2003

EC 4036: ANTENNA THEORY

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understand the important elements of antenna and propagation theory.*
- *CO2: Understand and apply fundamental antenna parameters*
- *CO3: Be familiar with important classes of antennas and their properties.*
- *CO4: Be able to pick a particular class of antenna for given specifications*
- *CO5: Apply design principles to design an antenna.*
- *CO6: Numerically compute the directivity and power radiated from a generic antenna.*

Module No	Syllabus
1 (8 hours)	Antenna parameters: Radiation pattern, radiation power density, radiation intensity, directivity, gain, antenna efficiency, half-power beamwidth, bandwidth, polarization, input impedance, radiation efficiency, vector effective length and equivalent areas
2 (12 hours)	Potentials and radiation fields: Retarded potentials, Lienard- Wiechert potentials for a moving charge, fields of a moving point charge, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, power radiated by a point charge, Duality theorem, Reciprocity theorem.
3 (12 hours)	Antennas: Part-I: Monopole and Dipole antennas, linear dipole antenna arrays- Broadside and Endfire Arrays, Binomial Array, Dolph-Tschebyscheff Array, loop antenna. Antenna Synthesis- Schelkunoff polynomial method, Fourier transform method
4 (10 hours)	Antennas: Part-II : Helical antenna, Yagi – Uda antenna, parabolic antenna, Frequency independent antennas, RF antennas – Microstrip antenna, Fractal antenna Smart Antennas- Principle, types, array design, antenna beamforming, direction-of-arrival algorithms, adaptive beamforming.

Reference:

1. Constantine A. Balanis, "Antenna Theory-Analysis and Design", 3rd Ed; Wiley-India, 2010
2. John D. Kraus,"Antennas", 2nd Ed; 1988, MGH
3. Robert S. Elliott, "Antenna Theory and Design" Wiley-India, 2007
4. W. L. Stutzman and G. A. Thiele, "Antenna Theory and Design"2nd Ed., Wiley, 1997
5. Frank Gross, "Smart Antennas for Wireless Communications", MGH, 2005.
6. Jordan and Balmain: Electromagnetic waves and radiating systems, PHI, 1968

EC 4037: ANALOG MOS INTEGRATED CIRCUITS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Knowledge of various MOSFET amplifier configurations.*
- *CO2: Study how to incorporate MSFET amplifiers in analogue circuits and systems.*

Module No	Syllabus
1 (8 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

2 (10 hours)	Current sources and sinks, Current mirror, Cascode connection, transient response, Matching considerations in current mirrors, Wilson current mirror, Concept of current steering, Current source self biasing circuits, Threshold voltage and thermal voltage referenced self biasing, Beta multiplier referenced self biasing, Start up circuits, Bandgap referenced biasing, voltage references
3 (12 hours)	Gate-Drain connected load, Current source load, Common source, Common drain and Common gate amplifiers, Frequency response, Push pull amplifier, Cascode amplifier, MOS output stages, Class AB amplifier, Differential amplifier and Operational transconductance amplifiers
4 (12 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

Reference:

1 R.J. Baker, H.W.Li and D.E.Boyce, CMOS CMOS Circuit Design, Layout and Simulation, Wiley-IEEE Press, 2007

2 Gray, Hurst, Lewis and Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley & Sons, Fourth Edition, 2005

3 Geiger, Allen and Strader, VLSI Design Techniques for Analog and Digital Circuits, Circuit Design, McGRAW-Hill international Edition, 1990

4 Franco Maloberti, Analog Design for VLSI System, Kluwer Academic Publishers, 2001

5 Behzad Razavi, Design of Analog CMOS Integrated Circuit, Tata-Mc GrawHill, 2002

6 Philip Allen & Douglas Holberg, CMOS Analog Circuit Design, Oxford University Press, 2002

EC 4038: HIGH SPEED SEMICONDUCTOR DEVICES

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Knowledge of materials (compound semiconductor) used in high speed devices and their properties*
- *CO2: Knowledge of the basic issues related to the high speed and devices*
- *CO3: Knowledge of the advanced technologies for high speed electron devices*
- *CO4: Knowledge of high speed electron devices operation along with their descriptive models*
- *CO5: Basic knowledge of the operation of selected optoelectronic devices*
- *CO6: Ability to exploit small-signal equivalent circuit models of high frequency electron devices (MESFETs, HEMTs, HBTs)*
- *CO7: Ability to exploit physics-based mathematical models for the analysis and the design of high frequency electron devices (MESFETs, HEMTs, HBTs)*
- *CO8: Knowledge of material and device processing techniques of High speed semiconductor devices*

Module No	Syllabus
1 (6 hours)	Important parameters governing the high speed performance of devices and circuits: Transit time of charge carriers, junction capacitances, ON-resistances and their dependence on the device geometry and size, carrier mobility, doping concentration and temperature; important parameters governing the high power performance of devices and circuits: Break down voltage, resistances, device geometries, doping concentration and temperature

2 (16 hours)	Materials properties: Merits of III –V binary and ternary compound semiconductors (GaAs, InP, InGaAs, AlGaAs, SiC, GaN etc.), different SiC structures, silicon-germanium alloys and silicon carbide for high speed devices, as compared to silicon based devices, outline of the crystal structure, dopants and electrical properties such as carrier mobility, velocity versus electric field characteristics of these materials, electric field characteristics of materials and device processing techniques, Band diagrams, homo and hetro junctions, electrostatic calculations, Band gap engineering, doping, Material and device process technique with these III-V and IV – IV semiconductors.
3 (8 hours)	Metal semiconductor contacts and Metal Insulator Semiconductor and MOS devices: Native oxides of Compound semiconductors for MOS devices and the interface state density related issues. Metal semiconductor contacts, Schottky barrier diode, Metal semiconductor Field Effect Transistors (MESFETs): Pinch off voltage and threshold voltage of MESFETs. D.C. characteristics and analysis of drain current. Velocity overshoot effects and the related advantages of GaAs, InP and GaN based devices for high speed operation. Sub threshold characteristics, short channel effects and the performance of scaled down devices.
4 (12 hours)	High Electron Mobility Transistors (HEMT): Hetero-junction devices. The generic 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 (HBTs): 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; High Frequency resonant – tunneling devices, Resonant-tunneling hot electron transistors

Reference:

1. C.Y. Chang, F. Kai, GaAs High-Speed Devices: Physics, Technology and Circuit Applications Wiley
2. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons
3. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams & Co., 1985
4. Avishay Katz, Indium Phosphide and Related materials: Processing, Technology and Devices, Artech House, 1992.
5. S.M. Sze, High Speed Semiconductor Devices, Wiley (1990) ISBN 0-471-62307-5
6. Ralph E. Williams, Modern GaAs Processing Methods, Artech (1990), ISBN 0-89006-343-5
7. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press (1991), ISBN 0-12-691740-X
8. G.A. Armstrong, C.K. Maiti, TCAD for Si, SiGe and GaAs Integrated Circuits, The Institution of Engineering and Technology, London, United Kingdom, 2007,ISBN 978-0-86341-743-6.
9. Ruediger Quay, Gallium Nitride Electronics, Springer 2008, ISBN 978-3-540-71890-1, (Available on NITC intranet in Springer eBook section)
10. Prof. Dr. Alessandro Birolini, Reliability Engineering Theory and PracticeSpringer 2007, ISBN-10 3-540- 40287-X, Available on NITC intranet in Springer eBook section)

EC 4039: NANOELECTRONICS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: To introduce the challenges faced by present CMOS VLSI device design and fundamental limits of operation*
- *CO2: To study novel MOS based silicon devices and various multi gate devices*
- *CO3: To learn about SOI devices and its performance comparison with Silicon devices*

- *CO4: To understand the underlying concepts by setting up and solving the Schrödinger equation for different types of potentials in one dimension as well as in 2 or 3 dimensions for specific cases.*
- *CO5: To understand nanoelectronic systems and building blocks such as: low-dimensional semiconductors, heterostructures, carbon nanotubes, quantum dots, nanowires etc.*
- *CO6: Through the mini-project, students should get familiarized with searching for scientific information in their subject area, practice report writing and presenting their project in a seminar*
- *CO7: To gain knowledge on spin electronic devices*
- *CO8: To familiarize students with the present research front in Nanoelectronics and to be able to critically assess future trends.*

Module No	Syllabus
1 (8 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.
2 (10 hours)	Novel MOS-based devices – Multiple gate MOSFETs, Silicon-on-insulator, Silicon-on-nothing, FinFETs, vertical MOSFETs, strained Si devices
3 (16 hours)	Quantum structures – quantum wells, quantum wires and quantum dots, Single electron devices – charge quantization, energy quantization, Coulomb blockade, Coulomb staircase (8 hours) 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) (8 hours)
4 (8 hours)	Carbon nanotubes based devices – CNFET, characteristics (4 hours) Spintronics - Spin-based devices – spinFET, characteristics (4 hours)

Reference:

1. Mircea Dragoman and Daniela Dragoman: Nanoelectronics – Principles & devices; Artech House Publishers, 2005
2. Karl Goser: Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer 2005
3. Mark Lundstrom and Jing Guo: Nanoscale Transistors: Device Physics, Modeling and Simulation, Springer, 2005
4. Vladimir V Mitin, Viatcheslav A Kochelap and Michael A Stroscio: Quantum heterostructures; Cambridge University Press, 1999
5. S M Sze (Ed): High speed semiconductor devices, Wiley, 1990

EC 4040: OPTO-ELECTRONIC COMMUNICATION SYSTEMS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understand the concept of modes in optical fibers*
- *CO2: Learn the basics of attenuation & dispersion in fibers*
- *CO3: Understand the use of fiber nonlinearity to combat dispersion effects*
- *CO4: Understand the concept of optical soluitons*
- *CO5: Learn the basics of Optical sources & detectors*
- *CO6: Learn semiconductor optical amplifiers*
- *CO7: To familiarize students with the basics of optical fiber amplifiers*

Module No	Syllabus
1 (13 hours)	Optical fiber fundamentals - Solution to Maxwell's equation in a circularly symmetric step index optical fiber, linearly polarized modes, single mode and multimode fibers, concept of V number, graded index fibers, total number of guided modes (no derivation), polarization maintaining fibers, attenuation mechanisms in fibers, dispersion in single mode and multimode fibers, dispersion shifted and dispersion flattened fibers, attenuation and dispersion limits in fibers, Kerr nonlinearity, self phase modulation, combined effect of dispersion and self phase modulation, nonlinear Schrodinger equation (no derivation), fundamental soliton solution
2 (8 hours)	Optical sources - LED and laser diode, principles of operation, concepts of line width, phase noise, switching and modulation characteristics – typical LED and LD structures. Optical detectors - 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). (9 hours)
3 (12 hours)	Optical amplifiers– Semiconductor amplifier, rare earth doped fiber amplifier (with special reference to erbium doped fibers), Raman amplifier, Brillouin amplifier – 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. (12 hours)

Reference:

1. Leonid Kazovsky, Sergio Benedetto and Alan Willner: `Optical Fiber Communication Systems', Artech House, 1996.
2. G.P.Agrawal: `Nonlinear Fiber Optics', 3rd Ed; Academic Press, 2004.
3. G.P.Agrawal : 'Fiber optic communication systems', 3rd Ed; Wiley-Interscience, 2002.

EC 4041: COMMUNICATION SWITCHING SYSTEMS

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understanding the basic building blocks of digital telephony and their functioning.*
- *CO2: Understanding and analyzing the signaling principles used in the telecom and data networks.*
- *CO3: Analyzing the traffic in the network and blocking performance of the switches, using the classical results of Stochastic Modeling and Queuing Theory.*
- *CO4: Examining the internal architectures and design principles of digital exchanges widely used.*
- *CO5: Motivating to design resource optimized and eco-friendly switching systems in the future.*

Module No	Syllabus
1 (10 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 - Synchronous transfer mode- asynchronous transfer mode - time division switching – TSI operation.
2 (12 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)
3 (12 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.

4 (8 hours)	Signaling: customer line signaling - outband signaling - inband signaling - PCM signaling - inter register signaling - common channel signaling principles-CCITT signaling system No: 7 - signaling system performance. Introduction to ATM switching –Fast packet switching – self routing switches – Banyan network – ATM switches – Design of typical switches.

Reference:

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, Kluwer Academic Publishers, 1990.
4. Viswanathan T., Telecommunication Switching Systems and Networks, Prentice Hall of India Pvt. Ltd, 1992
5. Flood J.E., Telecommunications Switching Traffic and Networks, Pearson Education Pvt.Ltd,2001
6. C.Dhas, V.K.Konangi and M.Sreetharan, Broadband Switching, architectures, protocols, design and analysis, IEEE Computer society press, J. Wiely & Sons INC, 1991
7. Freeman R.L., Telecommunication System Engineering, John Wiley & Sons, 1989
8. Das J, Review of Digital Communication 'State of the Art' in Signalling Digital Switching and Data Networks, Wiley Eastern Ltd., New Delhi, 1988.

EC 4042: RADAR ENGINEERING

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: High level design of radar systems using radar equation and block diagrams.*
- *CO2: Prediction of range performance.*
- *CO3: Selection of pulse repetition frequency and antenna parameter.*
- *CO4: Design of CW radar, FM-CW radar, Multiple frequency radar, MTI radar, non coherent MTI pulse Doppler radar.*
- *CO5: Design of radar transmitters.*
- *CO6: Design of radar receivers.*

Module No	Syllabus
1 (10 hours)	Introduction-Radar Equation-Block diagram-Radar frequencies- Applications- Prediction of range performance –Pulse Repetition Frequency and Range ambiguities – Antenna parameters-System losses
2 (12 hours)	CW Radar-The Doppler Effect- FM-CW radar- Multiple frequency radar – MTI Radar-Principle- Delay line cancellors- Staggered PRF – Range gating- Noncoherent MTI-Pulse Doppler radar- Tacking Radar –Sequential lobbing-Conical Scan- Monopulse – Acquisition
3 (10 hours)	Radar Transmitters- Modulators-Solid state transmitters, Radar Antennas- Parabolic-Scanning feed-Lens-Radomes, Electronically steered phased array antenna-Applications, Receivers-Displays-Duplexers
4 (10 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

Reference:
1. Introduction to Radar Systems –Merrill I. Skolnik, 3rd Edition, MacGraw Hill, 2002.
2. Radar Handbook -Merril I.Skolnik , McGraw Hill Publishers, 1990
3. Radar Principles for the Non-Specialist, by J. C. Toomay, Paul Hannen SolTech Publishers, 2004
4. Radar systems- Merril I.Skolnik, McGraw Hill Publishers, 2005.

EC 4043: CRYPTOGRAPHY: THEORY AND PRACTICE

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understand the role of cryptographic techniques in modern communication systems such as ensuring confidentiality, data integrity verification and data authentication*
- *CO2: Learn the 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: Use various mathematical tools to analyze the security of cryptographic primitives when applied to secure communication services*
- *CO4: To design cryptographic systems to meet the specifications in terms of security, circuit complexity and power consumption by effectively making use of various primitives*
- *CO5: Become familiar with security challenges in modern communication systems and devise new methodologies to overcome these challenges*
- *CO6: Investigate latest developments in cryptography and cryptanalysis through most recent publications in small groups and prepare presentations on these topics*
- *CO7: Become aware of ethical aspects of privacy in communication and social issues associated with lack of efficient systems for protection of privacy.*

Module No	Syllabus
1 (12 hours)	Divisibility – Prime numbers –Euclidean Algorithm – Diophantine equations - Congruence – Euler function - Fermat's little theorem – Euler theorem - Groups and fields - Polynomial ring – Field extension
2 (11 hours)	Classical Cryptography – Substitution and Transposition Cipher – Modern Cryptographic Techniques –Private Key Cryptosystems – Block cipher – Standards – Data Encryption Standard – AES – Linear and differential cryptanalysis Stream cipher – Key stream generators – Linear feed back shift registers and sequences – RC4 cryptosystem – Attacks on LFSR based stream ciphers
3 (11 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
4 (8 hours)	Message authentication requirements – Hash function – features of MD5 and SHA algorithms – Security of Hash function – Message Authentication Codes – Digital Signatures – Elgamal DSA – Applications of authentication – Electronic mail security – PGP – Secret sharing

Reference:
1. Douglas A. Stinson, "Cryptography, Theory and Practice", Chapman & Hall, CRC Press Company, Washington, Second Edn., 2002
2. William Stallings, " Cryptography and Network Security", Pearson Education, Second Edn., 2000.
3. Lawrence C. Washington, " Elliptic Curves", Chapman & Hall, CRC Press Company, Washington., 2003
4. David S. Dummit, Richard M. Foote, " Abstract Algebra", John Wiley & Sons, 3rd Edn., 2003
5. Evangelos Kranakis, " Primality and Cryptography", John Wiley & Sons, 1991.
6. Rainer A. Ruppel, " Analysis and Design of Stream Ciphers" , Springer-Verlag,1986

EC 4044: OPTO-ELECTRONIC DEVICES AND SYSTEMS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Learn the fundamentals of optical processes in semiconductors*
- *CO2: Learn working principle of Lasers*
- *CO3: Familiarize with optical energy detectors*
- *CO4: Introduce the theory behind optoelectronic modulation*

Module No	Syllabus
1 (10 hours)	Optical processes in semiconductors – electron hole recombination, absorption, Franz-Keldysh effect, Stark effect, quantum confined Stark effect, deep level transitions, Auger recombination
2 (8 hours)	Lasers – threshold condition for lasing, line broadening mechanisms, axial and transverse laser modes, heterojunction lasers, distributed feedback lasers, quantum well lasers, tunneling based lasers, modulation of lasers
3 (8 hours)	Optical detection – PIN, APD, modulated barrier photodiode, Schottky barrier photodiode, wavelength selective detection, microcavity photodiodes.
4 (8 hours)	Optoelectronic modulation - Franz-Keldysh and Stark effect modulators, quantum well electro-absorption modulators, electro-optic modulators, quadratic electro-optic effect quantum well modulators, optical switching and logic devices
5 (8 hours)	Optoelectronic ICs – hybrid and monolithic integration, materials and processing, integrated transmitters and receivers, guided wave devices

Reference:

1. Pallab Bhattacharya: Semiconductor Optoelectronic Devices, 2nd Ed; Pearson Education, 2002
2. Amnon Yariv & Pochi Yeh– Photonics: Optical Electronics in modern communication, 6th Ed; Oxford Univ. Press, 2006
3. Fundamentals of Photonics : B E Saleh and M C Teich, Wiley-Interscience; 1991

EC 4045: SIGNAL COMPRESSION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Learn the basic mathematics and the theory behind various data compression techniques: Concept of Modeling and Coding, Mathematical Preliminaries for Lossy and Lossless Compression, Rate distortion theory.*
- *CO2: Recognize the needs and challenges of our age, and to assess the global and social impacts of data compression solutions: Basic understanding of the widespread use of multimedia systems; the need for effective use of scarce resources such as storage and bandwidth, and ways to use effective data compression algorithms to facilitate the current needs.*
- *CO3: Identify and formulate compression algorithms for both lossy and lossless data transmission/ storage: Huffman Coding, Arithmetic Coding, Golomb Codes, Run Length Coding, Tunstall Codes, Dictionary based Encoding Techniques, Predictive Coding Techniques, Various Quantization schemes and their application in multimedia data compression, Multimedia compression standards.*

- *CO4: Ability to choose appropriate model for the data to exploit redundancy and hence to meet the required rate constraints for a given application and to design and integrate components: Integrating different coding tools and selecting the related coding parameters for efficient lossless and lossy image compression.*
- *CO5: Ability to implement various signal compression algorithms in MATLAB/ in a high-level language such as C++*
- *CO6: Experience working in teams*
- *CO7: Experience in technical communication by conducting seminars on the upcoming multimedia technologies and standards.*

Module No	Syllabus
1 (9 hours)	Compression Techniques – Lossless and Lossy Compression – Modeling and Coding – 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
2 (9 hours)	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
3 (12 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.
4 (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.

Reference:

1. Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann Publishers., Second Edn., 2005.
2. David Salomon, "Data Compression: The Complete Reference", Springer Publications, 4th Edn., 2006.
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.
6. Ali N. Akansu, Richard A. Haddad, "Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets", Academic Press., 1992
7. Martin Vetterli, Jelena Kovacevic, "Wavelets and Subband Coding", Prentice Hall Inc., 1995.

EC 4046: MICROWAVE DEVICES AND CIRCUITS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Able to apply electromagnetic theory to calculations regarding waveguides and transmission lines.*
- *CO2: Able to describe, analyze and design simple microwave circuits and devices e g matching circuits, couplers, antennas and amplifiers*
- *CO3: Able to describe and coarsely design common systems such as radar and microwave transmission links.*
- *CO4: Able to describe common devices such as microwave vacuum tubes, high-speed transistors and ferrite devices.*
- *CO5: Able to handle microwave equipment and make measurements*

Module No	Syllabus
1 (10 hours)	Modal analysis 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, Strip lines and microstrip lines – analysis, filter implementation with transmission lines and strip lines
2 (8 hours)	Passive microwave components – S matrix formalism, directional coupler, waveguide tees, isolator, circulator, phase shifter, impedance matching – single stub and double stub.
3 (16 hours)	Vacuum tube microwave devices – Klystron - velocity modulation and bunching, Reflex klystron, traveling wave tube - slow wave structure and Brillouin diagram. (8 hours) Semiconductor microwave devices – tunnel diode, Gunn diode, IMPATT diode, TRAPATT diode, heterojunction bipolar transistors – principle, characteristics, noise figure (8 hours)
4 (8 hours)	Low noise microwave amplifiers and oscillators – masers – stimulated emission, noise figure, parametric amplifiers – Manley Rowe relations, up, down and negative resistance parametric amplifier.

Reference:

1. Rajeshwari Chatterji: Microwave, Millimeter wave and sub-millimeter wave vacuum electron devices, Affiliated East - West Press, 1994
2. R E Collin: Foundations for Microwave Engineering, Second Ed, IEEE-Wiley, 2000
3. David M Pozar: Microwave Engineering, Third edition, John Wiley, 2004
4. A S Gilmour: Microwave Tubes, Artech House, 1986
5. P A Rizzi: Microwave Engineering, Prentice Hall, 1988.
6. Sigfrid Yngyesson: Microwave Semiconductor Devices, Kluwer Academic, 1991.
7. Stephen C. C. Harsany: `Principles of Microwave Technology', Prentice Hall, 1997
8. P. Bhartia & I. J. Bahl, Millimetre Wave Engineering and Applications, John Wiley & Sons, 2005.

EC 4047: ADVANCED WIRELESS COMMUNICATION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Advanced topics in wireless communications to be understood based on previous courses*
- *CO2: Mathematical framework for analysis and design of wireless systems is developed*
- *CO3: Enables the student to come in contact with latest developments happening in wireless communication*
- *CO4: Introduces systematic ways in which state of the art methods can be understood, analysed and improved upon.*

Module No	Syllabus
1 (10 hours)	Capacity of Parallel AWGN Channels – Capacity of Fading Channels - Frequency Selective Channels - Ergodic and Outage capacity - Channel State Information at Transmitter and Receiver - Capacity MIMO Flat Fading Channel – Dirty Paper Coding.
2 (10 hours)	Fundamentals of MIMO communication - Diversity and Spatial Multiplexing Aspects - Uncoded Transmission with ML Detection, ZF Filtering, and MMSE Filtering - VBLAST, and DBLAST Detectors - Alamouti Space-Time Code – Codes for Large Number of Transmit Antennas.
3 (11 hours)	Multiple Access Techniques – Space Division Multiple Access - OFDMA - Combination of MIMO with Multiple Access Techniques - Analysis of Performance and Comparison - Applications in 3rd and 4th Generation Systems
4 (10 hours)	Cooperative Communication – Wireline and Wireless Network Models – Cooperative Strategies and Rates – Network Capacity – AF, CF and DF - Network Coding – 2 Way Relaying – Cooperative Diversity.

Reference:

1. D. Tse, P. Viswanath, Fundamentals of Wireless Communications, Cambridge University Press, 2005.
2. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005.
3. Gerhard Cramer et. al, Cooperative Communications (Foundations and Trends in Networking), Now Publishers Inc

EC 4048: SIGNAL ESTIMATION AND DETECTION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understand the engineering needs and problems involved in one of the most challenging areas of signal processing namely statistical signal processing and to appreciate the depth of applications of the subject.*
- *CO2: Apply the concepts of probability, random processes and linear algebra understood through various courses for understanding the design and development of estimators which meets specific constraints on signal and noise properties and prior knowledge.*
- *CO3: Mathematically derive and analyze Classical and Bayesian estimation techniques such least squares, best liner unbiased, maximum likelihood, minimum mean square error and maxim aposteriori probability and to compare the performance of such estimators with standard bounds.*

- *CO4: Develop and analyze recursive and non-recursive structures of estimators for dealing with real world constraints like computational requirements, performance demands, simplicity of analysis, ease of implementation, cost of the product etc.*
- *CO5: Understand the modeling and characterization of detection problems with single and multiple observations under varying noise conditions and apply them to various practical problems.*
- *CO6: Investigate the applicability 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.*
- *CO7: Appreciate the practical importance of the subject and its possibilities for improving the quality of life of mankind through the development of techniques and technologies, especially with a humanitarian perspective.*

Module No	Syllabus
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.
2 (15 hours)	Estimation Techniques: Deterministic Parameter Estimation **-** Least Squares Estimation-Batch Processing, Recursive Least Squares Estimation, Matrix Inversion Lemma, Best Linear Unbiased Estimation, Likelihood and Maximum Likelihood Estimation (8 Hrs) Random Parameter Estimation: Bayesian Philosophy, Multivariate Gaussian Random Variables, Minimum Mean Square Error Estimator (3 Hrs) State Estimation: Overview of State-Space Modeling, Prediction, Single Stage Predictors, Filtering, The Kalman Filter (4 Hrs)
3 (10 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.
4 (7 hours)	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, Detection of signals with Random Parameters

Reference:

1. Steven M. Kay, "Statistical Signal Processing: Vol. 1: Estimation Theory, Vol. 2: Detection Theory," Prentice Hall Inc., 1998.
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.
4. Monson H. Hayes, "Statistical Digital Signal Processing and Modelling," Wiley India Edn., 2010
5. Harry L. Van Trees, "Detection, Estimation and Modulation Theory, Part 1 and 2," John Wiley & Sons Inc. 1968.
6. Bernard C. Levy, "Principles of Signal Detection and Parameter Estimation", Springer, New York, 2008.
7. Neel A. Macmillan and C. Douglas Creelman, "Detection Theory: A User's Guide (Sec. Edn.)" Lawrence Erlbaum Associates Publishers, USA, 2004.

EC 4049: ARCHITECTURE OF ADVANCED PROCESSORS

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Understanding of the basic building blocks of a CPU.*
- ***CO2:*** *Analysis of the earlier techniques used in CPUs for achieving good performance.*
- ***CO3:*** *Understanding the latest techniques in computer architecture which have made considerable performance advantages for the latest processors.*
- ***CO4:*** *Studying the architectural features of specific processors.*
- ***CO5:*** *Dwelling on the trends of the computer CPU industry and analysing how things will progress in this field.*

Module No	Syllabus
1 (8 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
2 (10 hours)	Features of advanced Intel processors**:** Enhancements of 80386 and Pentium -Hardware Features, PVAM,-Memory management unit-Virtual Memory and concepts of cache - 32 bit programming
3 (14 hours)	Instruction and thread level parallelism: Instruction level parallelism and concepts - - Limitations of ILP- Multiprocessor and thread level parallelism- Pipelining: Issues and solutions- Instruction flow techniques -Program control flow and control dependences
4 (10 hours)	Superscalar and multi core techniques: General principles of superscalar architecture - - Basics ,Pipelining**,** The in-order front end, The out-of-order core, The reorder buffer, Memory subsystem- Multi core processing – facts and figures - Virtualization – concepts

Reference :

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, Architecture, Programming and Interfacing Pearson Education, 2010
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. Jurij Silc, Borut Robic, Th Ungerer: Processor Architecture: From Dataflow to Superscalar and Beyond. Springer-Verlag, June 1999

EC 4050: RADIATION AND PROPAGATION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Fundamentals of radiation*
- ***CO2:*** *Field & power calculation for antennas*
- ***CO3:*** *Antenna parameters*
- ***CO4:*** *Types of antenna elements*
- ***CO5:*** *Analysis & design of antenna arrays*
- ***CO6:*** *Effect of earth's shape, conductivity & magnetic field on EM propagation*
- ***CO7:*** *Interaction of EM field with the ionosphere*

Module No	Syllabus
1 (11 hours)	Some types of practical radiating systems – Field and power calculations with currents assumed on the antenna - electric and magnetic dipole radiators - Radiation patters and antenna gain - radiation resistance – antennas above earth or conducting plane traveling wave on a straight wire – V and rhombic antennas – methods of feeding wire antennas
2 (12 hours)	Radiation from fields over an aperture – fields as sources of radiation – Plane wave sources – Examples of radiating apertures excited by plane waves – electromagnetic horns – arrays of elements – radiation intensity with superposition of effects – array of two half-wave dipoles – linear arrays - Yagi - Uda arrays – frequency-independent arrays
3 (7 hours)	Antenna temperature - signal-to-noise ratio – radar and radar cross section – far field, near field and Fourier transform – receiving antennas and reciprocity – reciprocity relations
4 (12 hours)	Effect of earth's conductivity on antenna pattern, effect of earth's conductivity and shape on surface wave propagation, effect of earth's magnetic field on EM waves in ionosphere, plasma and cyclotron frequencies, skip distance, maximum usable frequency

Reference:

1. Simon Ramo, John R Whinnery, and Theodore Van Duzer, Fields and Waves in Communication Electronics, John Wiley and Sons, Third Edition, 2003.
2. John D. Kraus and Daniel A. Fleisch, Electromagnetics with Applucations, McGraw-Hill, Fifth Edition, 1999.
3. C A Balanis: Antenna Theory, John Wiley, Second Edition, 2003.
4. J D Krauss: Antennas, Tata McGraw Hill, Third Edition, 2002.
5. David J Griffiths: Introduction to Electrodynamics, Third edition, PHI, 2007.
6. Jordan and Balmain: Electromagnetic waves and radiating systems, PHI, Second Edition, PHI, 2002.

EC 4051: ELECTRONIC INSTRUMENTATION

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Describe and model different electrical transducers.*
- *CO2: Design an optimum amplifier for a transducer.*
- *CO3: Design signal conditioning circuits for limiting, filtering, and waveform shaping.*
- *CO4: Specify the performance required from A/D and D/A converters in a design.*
- *CO5: Study on various noises in electronics systems, their effects on operation and remedies.*
- *CO6: Diagnose and solve basic electromagnetic compatibility problems.*
- *CO7: Design electronic systems that function without errors or problems related to electromagnetic compatibility.*

Module No	Syllabus
1 (14 hours)	Measurement of voltage, current, power, noise, resistance, capacitance, inductance, time, frequency, charge and pulse energy
2 (7 hours)	Designing for EMC - EMC regulations, typical noise path, methods of noise coupling, methods of reducing interference in electronic systems.
3 (7 hours)	Capacitive coupling, inductive coupling, effect of shield on capacitive and inductive coupling, effect of shield on magnetic coupling, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, shielding properties of various cable configurations, coaxial cable versus shielded twisted pair, braided shields, ribbon cables

4 (7 hours)	Safety grounds, signal grounds, single-point ground systems, multipoint-point ground systems, hybrid grounds, functional ground layout, practical low frequency grounding, hardware grounds, grounding of cable shields, ground loops, shield grounding at high frequencies, guarded instruments.
5 (7 hours)	Protection Against Electrostatic Discharges: Static generation, human body model, static discharge, ESD protection in equipment design

Reference:

1. Electronic Instrument handbook: Clyde F Jr Coombs, Amazon, 1999
2. Joseph J. Carr: Elements of Electronic Instrumentation and Measurements, 3rd Ed, Prentice Hall, 1995
3. Kim R. Fowler: Electronic Instrument Design, Oxford University Press, 1996.
4. Henry W.Ott : Noise Reduction Techniques in Electronic Systems, 2nd Ed; John Wiley & Sons, 1988.

EC 4052: STATE OF THE ART AND FUTURE MEMORIES

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *To gain knowledge of existing basic building blocks of various semiconductor memory and their properties*
- ***CO2:*** *To classify the existing semiconductor memory topologies and critically study their properties*
- ***CO3:*** *To learn various advantages and disadvantages of various memory systems on the device and circuit level and their operational behaviours*
- ***CO4:*** *To gain in-depth knowledge of volatile and non-volatile semiconductor memory systems along with their applications*
- ***CO5:*** *To learn Advancements in silicon based memory*
- ***CO6:*** *To gain knowledge on next generation memory requirements*
- ***CO7:*** *To study non-silicon based memories like PCRAM, MRAM, FeRAM*
- ***CO 8:*** *Through the mini-project, students should get familiarized with searching for scientific information in their subject area, practice report writing and presenting their project in a seminar*

Module No	Syllabus
1 (10 hours)	Review of MOS based devices, band diagrams, threshold voltage, body bias effect, drain current and gate current characteristics, subthreshold slope, hot electron effect, various leakages in a MOSFET, tunneling phenomenon, direct tunneling, Fowler-Nordheim tunneling, direct band to band tunneling, SOI MOSFET, PDSOI, FDSOI, current characteristics, Classification of memories
2 (10 hours)	Volatile memories: SRAM, functionality, architecture, timing diagrams, performance and timing specifications, Low voltage SRAMs, SOI SRAMs, Content addressable memories (CAM), 3-transistor DRAM, 1 transistor DRAM , functionality, architecture, timing diagrams, performance and timing specifications, sense amplifier, word line driver, leakage mechanisms in a DRAM, retention, retention time calculations
3 (10 hours)	Non volatile memories**:** FLASH Memories, floating gate theory, structure and working of a SONOS cell, structure and working FLOTOX Memories, multi level flash memories, NOR based flash memories, NAND based flash memories
4 (5 hours)	SOI Based RAM: Parasitic BJTs in a SOI, Z-RAM, Thyristor RAM
5 (7 hours)	Non silicon based memories**:** PCRAM, MRAM, FeRAM, array device considerations for non silicon based memories

Reference:

1. Ashok K. Sharma, Semiconductor Memories: Technology, Testing and Reliability, Wiley IEEE Press, 1997, ISBN 0780310004
2. Ashok K. Sharma, Advanced Semiconductor Memories: Architectures, Design and Applications, 2003, Wiley-IEEE Press, ISBN 0471208132
3. William D. Brown, Joe Brewer, Nonvolatile Semiconductor Memory Technology: A Comprehensive Guide to Understanding and Using NVSM Devices, Wiley-IEEE Press, 1997, ISBN: 978-0-7803-1173-2
4. Ehrenfried Zschech, Caroline Whelan and Thomas Mikolajick, Materials for Information Technology Devices, Interconnects and Packaging, Springer, ,2005 available online (NIT Calicut intranet) at http://www.springerlink.com/content/978-1-85233-941-8/contents/
5. Joe Brewer, Nonvolatile Memory Technologies with Emphasis on Flash: A Comprehensive Guide to Understanding and Using Flash Memory Devices, Manzur Gill, Wiley-IEEE Press, 2008, ISBN: 978-0-471 77002-2
6. Jean-Pierre Colinge, Physics of Semiconductor Devices, Kluwer Academic Publishers, 2002,eBook,ISBN:0-306-47622-3, Print ISBN: 1-4020-7018-7, access online at (NITC intranet) http://www.springerlink.com/content/978-1-4020-7018-1/
7. Jean-Pierre Colinge, FinFETs and Other Multi-Gate Transistors Springer, 2008, ISBN 978-0-387-71751-7 e-ISBN 978-0-387-71752-4, http://www.springerlink.com/content/978-0-387-71751-7/contents/
8. Amara Amara and Olivier Rozeau, Planar Double-Gate Transistor, From Technology to Circuit, Springer,2009,ISBN978-1-4020-9327-2,e-ISBN978-1-4020-9341-8, http://www.springerlink.com/content/978-1-4020- 9327-2/contents/
9. Y. Taur and T.H. Ning, Fundamentals of Modern VLSI DevicesCambridge University Press, 1998, ISBN:0-521-55959-6

EC 4053: RELIABILITY OF SEMICONDUCTOR DEVICES

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *To gain knowledge on the requirements of reliability and the relation between reliability of a device, circuit and a system.*
- ***CO2:*** *To study various breakdown mechanisms in materials such as semiconductors, insulators and conductors at smaller dimensions.*
- ***CO3:*** *To study process related effects of breakdown and various structures to monitor a circuit during VLSI processing.*
- ***CO4:*** *To study Physics of reliability of small semiconductor devices.*
- ***CO5:*** *To explore the physics and mathematics regarding how and when things break.*
- ***CO6:*** *To study breakdown when a transistor is stressed and study accelerated testing to estimate life time of device and techniques.*
- ***CO7:*** *To learn various characterization techniques to study the reliability and establish relations to estimate life time of a device and hence circuit.*
- ***CO8:*** *To familiarize ESD phenomenon and learn possible solutions.*

Module No	Syllabus
1 (8 hours)	Introduction to Reliability Physics, Reliability definition, dielectrics, critical field in a dielectric, generation and recombination of carriers, life time of carriers, diffusion length, Types of Defects in a Semiconductor, Avalanche break down, Zener break down, MOSFET scaling, Hot electron effect, velocity saturation, GIDL, Mathematics of Reliability: Weibull statistics, PDF
2 (8 hours)	Kinetics of Negative Bias Temperature Instability: Stress Phase, NBTI: Relaxation, Freq. Independence, and Duty Cycle Dependence, Field Acceleration of Negative Bias

	Temperature Instability, Dispersive vs. Arrhenius Diffusion, Circuit Implications of NBTI
3 (8 hours)	Scaling Theory of Hot Carrier Degradation, Voltage Dependence of Trap Generation: Lucky Electron Model, On-State Hot Carrier Degradation, Off-State Hot Carrier Degradation , Characterization of Interface Traps, Subthreshold and linear drain current Measurements, Charge-pumping, DC-IV, and GIDL Techniques for Interface Traps, Spin-Dependent Recombination
4 (12 hours)	Breakdown mechanisms of thick dielectrics and thin dielectrics, Time-Dependent Dielectric Breakdown, Kinetics of Trap Generation, Field-dependence of TDDB, Statistics of Oxide Breakdown: Cell percolation model, Theory of Soft and Hard Breakdown, Statistics of Soft-breakdown by Markov Chain, Measurement Techniques: VT, SILC, QY, and Floating Probe, TDDB and Circuits, Theory of Thick dielectrics, Spatial and Temporal Characteristics of dielectric breakdown, Theory of Radiation Damage, Sources of radiation flux and its characteristics, Soft error due to radiation effects, Radiation and hard errors, Radiation, error correction, Stress migration, Electro migration
5 (6 hours)	Introduction to Electro static discharge (ESB), human body model, machine model, methods to contain ESD

Reference:

1. Y. Taur and T.H. Ning, Fundamentals of Modern VLSI Devices Cambridge University Press, 1998, ISBN: 0-521-55959-6
2. R.F. Pierret, Semiconductor Device Fundamentals, Addison-Wesley, 1996, ISBN: ISBN 0-201-54393-1
3. D. K. Schroder, Semiconductor Material and Device Characterization, John Wiley and Sons, 1996, ISBN: 0-471-73906-5
4. Steven H. Voldman, ESD: Physics and Devices 2004, John Wiley & Sons, Ltd ISBN: 0-470-84753-0
5. Jean-Pierre Colinge, Physics of Semiconductor Devices, Kluwer Academic Publishers, 2002, eBookISBN:0-306-47622-3, Print ISBN: 1-4020-7018-7, access online at (NITC intranet) http://www.springerlink.com/content/978-1-4020-7018-1/

EC 4054: SILICON ON INSULATOR AND ADVANCED MOSFET BASED STRUCTURES

Course Type : Professional Theory and Laboratory Practicals
Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO 1:*** *To learn various aspects of a MOSFET and scaling theory.*
- ***CO 2:*** *To study the requirements of SOI MOSFET.*
- ***CO 3:*** *To study the physics and technology of SOI MOSFET.*
- ***CO 4:*** *To learn the modelling aspects of SOI MOSFET.*
- ***CO 5:*** *To learn about multiple gate MOSFETS and their requirement.*
- ***CO 6:*** *To study the nano-scale MOSFET.*
- ***CO 7:*** *To study quantum-mechanics phenomenon in a nano-sized MOSFET.*
- ***CO 8:*** *To familiarize students with the present research front in Advance MOSFET structures and to be able to critically assess future trends.*

Module No	Syllabus
1 (11 hours)	Review of MOS device: band diagrams, drain current and subthreshold characteristics, drain conductance, transconductance, substrate bias, mobility, low field mobility, high field mobility, mobility various models, scaling of MOSFET, short channel and narrow channel MOSFET, high-k gate dielectrics, ultra shallow junctions, source and drain

	resistance
2 (15 hours)	The SOI MOSFET: comparison of capacitances with bulk MOSFET, PD and FD SOI devices, short channel effects, current-voltage characteristics: Lim&Fossum model and C-∞ model, transconductance, impact ionization and high field effects: Kink effect and Hot-carrier degradation, Floating body and parasitic BJT effects, self heating
3 (8 hours)	Multiple gate SOI MOSFETs: double gate, FINFET, triple gate, triple-plus gate, GAA, device characteristics, short channel effects, threshold effect, volume inversion, mobility, FINFET
4 (8 hours)	Physical view of nano scale MOSFET, Nator's theory of the ballistic MOSFET, role of quantum capacitance, scattering theory, MOSFET physics in terms of scattering, transmission coefficient under low and high drain biases, silicon nano wires, evaluation of the I-V characteristics, I-V characteristics of non-degenerate and degenerate carrier statistics

Reference:

1. Jean-Pierre Colinge, Physics of Semiconductor Devices, Kluwer Academic Publishers, eBook ISBN: 0-306- 47622-3, Print ISBN: 1-4020-7018-7, access online at (NITC intranet) http://www.springerlink.com/content/978-1-4020-7018-1/
2. Y. Taur and T.H. Ning, Fundamentals of Modern VLSI DevicesCambridge University Press, 1998, ISBN: 0-521-55959-6
3. Jean-Pierre Colinge, FinFETs and Other Multi-Gate Transistors Springer, 2008, ISBN 978-0-387-71751-7 e-ISBN 978-0-387-71752-4, http://www.springerlink.com/content/978-0-387-71751-7/contents/
4. Amara and Olivier Rozeau, Planar Double-Gate Transistor, From Technology to Circuit, Springer, 2009, ISBN 978-1-4020-9327-2,e-ISBN 978-1-4020-9341-8, http://www.springerlink.com/content/978-1-4020-9327-2/contents/
5. Jean- Pierrie Colinge, Silicon-on-insulator Technology: Materials to VLSI Kluwer Academic publishers group, 2004.

*EC 4055: DESIGN OF INTELLIGENT SYSTEMS

*Offered from 2013 Winter Semester

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- *CO1: Understanding of the basic idea of intelligent systems*
- *CO2: Analysis of systems used earlier before the advent of defining 'intelligence ' for a system*
- *CO3: Understanding the latest techniques for realization of systems along with more communication facilities included in it*
- *CO4: Studying the architectural features of specific processors of Intel and ARM*
- *CO5: Dwelling on the trends of the embedded industry and analyzing how things will progress in this field of IoT (Internet of Things)*

Module No	Syllabus
1 (8L+6P)	Intelligent Systems- Computation, Connectivity ,Storage ,Sensors, Integration level , Form factor, Reliability ,Security –Application Specific hardware –User Interfaces Computational tools and techniques – C++ ,web development , Embedded Linux Tool chain, building an embedded kernel Architecture of an advanced embedded platform : Initialization ,Booting and Application programming using OpenCV/ other open source compilers Laboratory1: Installation of OpenCV on an embedded platform

	Laboratory2: Running basic Image processing functions using OpenCV
2 (8L+6P)	Building intelligent systems-An introduction to intelligent systems-Fundamental visual metrics for computer vision-Object detection algorithms and optimization –Optical flow and patch recognition –Data mining –The intelligent advertising framework –Privacy in intelligent systems –Optimising machine learning algorithms on GPUs Lab1 and Lab 2: Running advanced Image processing functions using OpenCV
3 (8L+6P)	Architectural overview IA -32 and IA-64 based Atom SoC platform - OS booting and application development – Project development using an Atom based SoC -Choosing the right operating system –Boot loader choices –Performance Optimization –System Firmware – Debugging -Loading an operating system- Networking - Graphics and multimedia –Cloud computing –virtualization Lab1 and Lab 2: Running video processing functions using OpenCV
4 (8L+6P)	Energy aware design –Power management in modern computing systems –Energy efficient software –Power management standard ACPI –Computing on the go- Smart phones and Tablets Low power design - The MSP 430 architecture –peripherals, communication interfaces and mixed signal systems –Functions, Interrupts and Low Power Modes-Development of applications using the Code composer studio Laboratory1: Programming the basic peripherals of MSP 430 Laboratory2 : Programming the advanced peripherals of MSP 430

References

1. Sanjay Addicam, Shahzad Malik, and Phil Tian, Building Intelligent Systems –Utilising Computer vision ,Data Mining and Machine Learning, Intel Press, 2012
2. Bob Steigerwald ,Chris D Lucero, Chakravarthy Akkela, Abhishek Agarwal, Energy Aware Design –Powerful Approaches for Green Design, Intel Press, 2012
3. John H Davies, MSP 430 Microcontroller Basics, Elseiver Publications, 2008
4. Peter Barry and Patrick Crowley, Modern Embedded Computing –Designing Connected, Pervasive, Media Rich Systems, Elseiver Publications, 2011
5. Ronald Strauss and Andrew Schmidt, Embedded Systems Design with Platform FPGAs, Elseiver publications, 2010
6. Bruce Douglas, Design Patterns for Embedded Systems in C , Elseiver Publications, 2011

*EC 4056: COMPRESSED SAMPLING: PRINCIPLES & ALGORITHMS

*Offered from 2015 Monsoon Semester

Course Type : Professional Theory and Laboratory Practicals

Pre-requisites: -NIL-

L	T	P	C
3	0	0	3

Course Outcomes:

- ***CO1:*** *Foundations on signal representation and the sampling theorem*
- ***CO2:*** *Mathematical framework for multi-rate systems, and multi-band and multi-resolution representation of signals*
- ***CO3:*** *Motivation for compressed sampling for energy-efficient designs*
- ***CO4:*** *A foundation subject for multi-disciplinary applications*
- ***CO5:*** *Basic concepts that enable designs for environment-friendly direct applications*

Module No	Syllabus
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; Orthogonality and bi-orthogonality; Frames; Linear transformations and change of basis; Sampling as an isomorphism; Separable signal spaces and Decomposition of

	signals; Under-determined system of equations - methods of solution, sparse solution.
2 (6 hours)	Multi-resolution analysis - Methods of signal representation and decomposition Principles of Continuous and discrete wavelet transforms; Wavelet packets; Best basis identification, entropy methods; Computation Algorithms; Application in signal compression.
3 (10 hours)	Compressed Sampling Sparse representation of signals - Sparsity and compressibility; Construction of measurement (Sensing) matrix; Null-space conditions and the spark; The Restricted Isometry Property (RIP); RIP and null-space property; Measurement bounds and condition for stable recovery; Coherence of measurement matrix; mutual coherence between sensing matrix and matrix of representation bases.
4 (13 hours)	Sparse Signal Recovery The l_0 and lp for lp {(0, 1)}, and the lp-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 lp for p { (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, Chinmay Hegde (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 Gitta Kutyniok, “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.

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