

B. TECH IN ELECTRONICS & COMMUNICATION ENGINEERING

PEOs

Program Educational Objectives (PEOs) of the B. Tech. in Electronics and Communication Engineering are as follows:

1. To deliver comprehensive education in electronics and communication engineering to ensure that the graduates attain the core competency to succeed in industry or excel in higher studies in different fields like microelectronics engineering, signal processing, and wireless communications.
2. To provide the students with foundation in mathematical and engineering fundamentals required to solve engineering problems and pursue higher studies, research, and innovation.
3. To train and prepare the students to work as teams to comprehend, analyze, design, and create innovative solutions for real-life problems.
4. To inculcate a sense of ethics, professionalism, and effective communication skills amongst graduates.
5. To provide an academic environment that gives adequate opportunity to the students to cultivate lifelong skills needed for a successful professional career.

PSOs

Program Specific Outcomes (PSOs) of the B. Tech. in Electronics and Communication Engineering are as follows:

1. To design, analyze, and interpret data and apply various software and other electronic resources to impact further research and real-life problems in the field of electronics and communication engineering.
2. Taking part in sustainable development, exposure to green electronics, and mitigation of e-waste and its impact on the environment.

POs

The expected Program Outcomes (POs) of the B.Tech. in Electronics and Communication Engineering are as follows:

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**COURSE STRUCTURE FOR B. TECH IN ELECTRONICS & COMMUNICATION
ENGINEERING**
(w.e.f. 2018 batch)

Semester I

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	CH 101	Chemistry	3	1	0	4
2	MA 101	Mathematics I	3	1	0	4
3	CS 101	Introduction to Programming	3	1	0	4
4	EC 101	Basic Electronics	3	1	0	4
5	CE 102	Environmental Science & Engineering	3	0	0	3
6	CH 111	Chemistry Laboratory	0	0	3	2
7	CS 111	Programming Laboratory	0	0	3	2
8	EC 111	Basic Electronics Laboratory	0	0	3	2
9	ME 111	Workshop Practice	0	0	3	2
10		Extra-Curricular Activities (EAA) ¹	0	0	2	0
Total Credit						27

TOTAL CREDIT (Semester I) 27

Semester II

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	PH 101	Physics	3	1	0	4
2	MA 102	Mathematics II	3	1	0	4
3	ME 101	Engineering Mechanics	3	1	0	4
4	EE 101	Basic Electrical Engineering	3	1	0	4
5	HS 101	Communicative English	3	0	0	3
6	CE 101	Engineering Graphics & Design	1	0	3	3
7	PH 111	Physics Laboratory	0	0	3	2
8	EE 111	Basic Electrical Engineering Laboratory	0	0	3	2
9	HS 111	Language Laboratory	0	0	3	2
10		Extra-Curricular Activities (EAA) ¹	0	0	2	0
Total Credit						28

TOTAL CREDIT (Semester II) 28

1 EAA consists of YOGA/Physical Training/NCC/NSS/NSO, where YOGA is compulsory as a one semester course (first or second semesters), while any one from the rest is compulsory as a one semester course. Thus, if YOGA is registered in first semester then any one from the rest four is to be opted in second semester and vice-versa.

Semester-III

Sl. No.	New Course IDs	Course Title	Hours per week			Credit
			L	T	P	C
1	EC-201	Electronic Devices	3	0	0	3
2	MA-201	Mathematics III	3	1	0	4
3	EE-221	Network Analysis & Synthesis	3	1	0	4
4	CS-222	Data Structures and algorithm	3	1	0	4
5	EC-202	Analog Electronic Circuits	3	1	0	4
6	EC-203	Signals and Systems	3	1	0	4
7	EE-222	Circuit Theory Laboratory	0	0	3	2
8	EC-211	Analog Electronic Circuits Laboratory	0	0	3	2
9	CS-223	Data Structure and algorithm Laboratory	0	0	3	2
Total Credit						29

TOTAL CREDIT (Semester III) 29**Semester-IV**

Sl. No.	New Course IDs	Course Title	Hours per week			Credit
			L	T	P	C
1	EC-204	Digital Electronic Circuits	3	0	0	3
2	EC-205	Analog Communication	3	1	0	4
3	EC-206	Control Systems	3	1	0	4
4	EC-207	Probability and Random Process	3	1	0	4
5	EC-208	Electrical & Electronic Materials	3	0	0	3
6	EC-209	Electromagnetic Fields & Wave Propagation	3	1	0	4
7	EC-212	Digital Electronics Laboratory	0	0	3	2
8	EC-213	Control Laboratory	0	0	3	2
9	EC-214	Analog Communication Laboratory	0	0	3	2
Total Credit						28

TOTAL CREDIT (Semester IV) 28

Semester-V

Sl. No.	New Course IDs	Course Title	Hours per week			Credit
			L	T	P	C
1	EC-301	Digital Communication	3	1	0	4
2	EC-302	Microprocessors & Microcontrollers	3	0	0	3
3	EC-303	Analog Integrated Circuits & Technology	3	1	0	4
4	EC-304	Digital Signal Processing	3	1	0	4
5	EC-305	Electronic Measurements and Instrumentation	3	0	0	3
6	EC-306	Principles of Opto-Electronics and Fibre optics	3	0	0	3
7	EC-311	Microprocessor Laboratory	0	0	3	2
8	EC-312	Digital Signal Processing Laboratory	0	0	3	2
9	EC-313	Digital Communication Laboratory	0	0	3	2
Total Credit						27

TOTAL CREDIT (Semester V) 27**Semester-VI**

Sl. No.	New Course IDs	Course Title	Hours per week			Credit
			L	T	P	C
1	EC-307	RF and Microwave Engineering	3	1	0	4
2	EC-308	Data Communication and Network	3	1	0	4
3	EC-309	VLSI Design	3	1	0	4
4	EC-310	Power Electronics	3	1	0	4
5	EC-33X	Professional Core Elective I	3	0	0	3
6	EC-38X	Open Elective I	3	0	0	3
7	EC-314	Design Laboratory	0	0	3	2
8	EC-315	Data & Optical Communication. Laboratory	0	0	3	2
9	EC-316	VLSI Design Laboratory	0	0	3	2
Total Credit						28

TOTAL CREDIT (Semester VI) 28

Semester-VII

Sl. No.	New Course IDs	Course Title	Hours per week			Credit
			L	T	P	C
1	EC-401	Wireless Communication	3	0	0	3
2	EC-43X	Professional Core Elective II	3	0	0	3
3	EC-48X	Open Elective II	3	0	0	3
4	MS-401	Business Management	3	0	0	3
5	EC-498	Project I	0	0	6	4
6		Industrial training				2
Total Credit						18

TOTAL CREDIT (Semester VII) 18**Semester-VIII**

Sl. No.	New Course IDs	Course Title	Hours per week			Credit
			L	T	P	C
1	HS-401	Managerial economics	3	0	0	3
2	EC-45X	Professional Core Elective III	3	0	0	3
3	EC-49X	Open Elective III	3	0	0	3
4	EC-499	Project II	0	0	9	6
Total Credit						15

TOTAL CREDIT (Semester VIII) 15

LIST OF ELECTIVES

Professional Core Elective-I

Code	Name
EC-331	Communication System Modelling and Simulation
EC-332	Materials for Semiconductors
EC-333	Simulation of Devices and Circuits
EC-334	Analog and Digital Filter Design
EC-335	Analog IC Design
EC-336	Medical Electronics
EC-337	Mobile and Cellular Communications
EC-338	Applied Electronic Circuits
EC-339	Multirate Digital Signal Processing and Wavelets

Professional Core Elective-II

EC-431	RADAR Systems
EC-432	RF Circuits and Design
EC-433	Wireless Sensor Network
EC-434	Advanced Communication Technique
EC-435	Advanced VLSI Design
EC-436	Nanoelectronic Devices and Materials for VLSI
EC-437	Satellite Communications

Professional Core Elective-III

EC-451	Applied Optimizations in Wireless Communications
EC-452	Advanced Communication Engineering
EC-453	Advanced Wireless Communications
EC-454	Low Power VLSI Design
EC-455	RF and Microwave Integrated Circuits
EC-456	Antenna & Wave Propagation
EC-457	Telemetry Principles

Open Elective-I

Code	Name
EC-381	Soft Computing
EC-382	Neural Network And Fuzzy Logic
EC-383	Reconfigurable Computing and Hardwares
EC-384	Nanotechnology
EC-385	Microelectromechanical Systems
EC-386	Digital Image Processing
EC-387	Radio Astronomy Techniques
EC-388	Algorithm to VLSI Based Architecture
EC-389	Innovation and IPR

Open Elective-II

EC-481	Machine Learning
EC-482	Information Theory and Coding
EC-483	Biometrics for Network Security
EC-484	Medical Image Processing
EC-485	Selected Topics on VLSI
EC-486	VLSI Physical Design

Open Elective-III

EC-491	Machine Learning in VLSI Cad
EC-492	Mobile Computing
EC-493	Cognitive Radio
EC-494	Nano Structure and Quantum Devices
EC-495	Special Topics on Image Processing

EC-458	Mathematics for Communication Engineers Advanced Optical Communication
EC-459	Networks

CH-101	Chemistry	L	T	P	C
	B. Tech (All Branches): First Semester (Core)	3	1	0	4

Unit 1: Water and its treatment: Sources and types of impurities in water; Hardness: Definition, Causes and its disadvantages, numerical problems of hardness of water. Boiler scale: Definition, Causes and its prevention; Caustic embrittlement: Definition, Causes and its prevention. Boiler corrosion: Definition, Causes and its prevention, Treatment of water at domestic level: Zeolite process: Numerical problems on zeolite process. Lime soda process: Principles, Process, Limitation and numerical problems. Treatment of water at industrial level: Ion Exchange process: Principles, Process, and Limitation; Adsorption and Solvent extraction. Chemical oxygen demand, Biological oxygen demand: Definition, experimental procedure for their determination, limitations, their significance and numerical problems.

Unit 2: Chemical Kinetics: Zero order and pseudo unimolecular reactions; determination of the order of reaction, rate laws kinetics of complex reactions- parallel, consecutive and reversible reactions steady state concept; Arrhenius equation, energy of activation and its experimental determination simple collision theory-mechanism of bimolecular reaction, chain reaction, activated complex theory of reaction rate, ionic reactions.

Unit 3: Petroleum and Fuels: Cracking of hydrocarbon, knocking, cetane number and octane number, Synthetic petrol, petrochemical and bio-fuels. Sources and Classification of Coal, Carbonization of coal, analysis of coal. Determination of Calorific value of coal by Bomb Calorimeter

Unit 4: Polymers and plastics: Introduction to polymers and plastics, Functionality of polymers, Classification of polymers (on the basis of their method of synthesis, structure, on the basis of source, their behavior when heated to processing temperature. Amorphous and crystalline polymers, Determination of Molecular weights of polymers, Bio-polymers, Degradation of polymers. Structural difference between thermoplastics and thermosetting polymers, Different methods for doing polymerization. Commercially important thermoplastics and thermosetting plastics (Polyethylene (LDPE & HDPE), Polyvinyl chloride). Commercially important thermoplastics and thermosetting plastics (Polystyrene, Polytetrafluoroethylene). Recycling of plastics. Conducting polymers (conjugated and doped conducting polymers) and their conducting mechanism, chemical resistance of polymers.

Unit 5: Surface Chemistry: Different forms of adsorptions; energetics of adsorptions; application of adsorptions; adsorption isotherms- Langmuir, Freundlich and BET isotherms; colloids; surfactants; micelles; enzyme catalysis; catalysis in industrial processes.

Unit 6: Corrosion and its control: Introduction to corrosion. Types and mechanism of corrosion. Factors affecting corrosion Methods to control corrosion

Unit 7: Chemistry of nanomaterials: Introduction; different methods of synthesis of nanomaterials- top down and bottom up. Role of surfactant or capping agent in morphology of nanoparticles. Various dimensions of nanoparticles different analytical techniques for characterization of nanomaterials.

Text Books:

1. Jain and Jain, Engineering Chemistry, Dhanpat Rai & Co., 16th Edition, New Delhi (2016)
2. S Chawla, Engineering Chemistry, Dhanpat Rai & Co, New Delhi (2017)
3. S. Ramesh et al. Engineering Chemistry, A textbook of Chemistry for Engineers, Wiley-India, New Delhi (2011)

Reference Books:

1. B. R Puri, L R Sharma and M S Pathania, Principles of Physical Chemistry, Vishal Publishing Co., New Delhi (2008)
2. C N R Rao, Chemistry of Nanomaterials. Wiley-VCH (2014)

Course Outcomes (COs):

At the end of the course students are expected to

1. Explain the aims of physical, chemical and biological processes for water and wastewater treatment. To describe the purpose and operational steps of key water treatment processes used to improve water quality.
2. Understand the different forms of complex chemical reactions and formulation of mechanism for them. Details of Arrhenius equation, energy of activation of chemical reaction and methods and ways for their experimental determination, various theories of the complex reactions, chain reaction etc.
3. Explain various type of fossil fuels available to the mankind. Understand the importance of synthetic petrol, petrochemicals and bio-fuels. Judge the quality of coal and petroleum for their proper utilization and conservation for future use. Understand the basic importance and synthetic procedure different typed of

polymers/ plastics. Understand the behavior of polymers toward electricity, their conduction, methods of preparing conducting polymers and their resistance towards diverse chemicals and environment.

4. Understand the different aspects surface phenomena and relate them different isotherms. Learn the advantages and disadvantages of homogeneous and heterogeneous catalysis, relevance of heterogeneous catalysis in useful industrial processes. Understand the phenomena of colloidal, surfactants and micellar formation and their applicability in chemical and physical processes
5. Learn kind of corrosion metal is undergoing with clear mechanism of corrosion. Select appropriate method for prevention of particular corrosion after understanding the principles of each methods. Understand the importance of different morphologies of nanoparticles and how various surfactants help to tune these morphologies. Gather knowledge about zero, one, two and three-dimensional nanoparticles with examples along with working principles of various analytical tools routinely used for characterization of nanomaterials.

MA101

Mathematics-I
B. Tech (All Branches) First Semester

L T P C
3 1 0 4

- Unit-1** **Infinite Series:** Definition of Sequence & Infinite series, Convergence and Divergence of real Sequence and Infinite Series, Tests of Convergence of positive term infinite series: Comparison Test, D' Alembert's Ratio Test, Raabe's Test, Cauchy's root Test, Integral Test, Alternating Series, Leibnitz's Test (all tests without proofs).
- Unit-2** **Differential & Integral Calculus:** Successive Differentiation, Leibnitz's Theorem, Curvature: Radius & Centre of curvature, Asymptotes and Curve tracing, Partial differentiation, Taylor's & Maclaurin's Theorems with Lagrange's form of remainder for a function of one variable, Euler's theorem, Taylor's theorem for a function of two variables, Jacobian. Improper Integrals: Beta function & Gamma function.
- Unit-3** **Ordinary Differential Equation:** Exact differential equation of first order, Integrating factors, Second & higher order linear differential equations with constant coefficients, Homogeneous (Cauchy's) linear differential equation, Method of variation of parameters. Series Solutions of ODE near ordinary point.
- Unit-4** **Integral Transform:** Basic idea of Integral Transform, Laplace and inverse Laplace transforms & their properties, Convolution Theorem, Solution of ODE by Laplace transform method, Applications in IVP and BVP.

Text Books:

1. Joel R. Hass, Christopher E. Heil and Maurice D. Weir. *Thomas' Calculus*. 14th Edition, Pearson Education, New Delhi (2018).
2. Erwin Kreyszig. *Advanced Engineering Mathematics*. 10th Edition, Wiley India Pvt. Ltd., New Delhi (2015).

Reference Books:

1. S.G. Deo, V. Raghavendra, Rasmita Kar and V. Lakshmikantham. *Text Book of Ordinary Differential Equations*. 3rd Edition, McGraw Hill Education, New York (2017).
2. B.C. Das and B.N. Mukherjee. *Differential Calculus*. 55th Edition, U. N. Dhur & Sons Pvt. Ltd., (1949).

3. B.C. Das and B.N. Mukherjee. ***Integral Calculus***. 57th Edition, U. N. Dhur & Sons Pvt. Ltd., (1938).
4. B.S. Grewal. ***Higher Engineering Mathematics***. 44th Edition, Khanna Publisher, New Delhi (2017).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Apply the concept of series convergence in engineering problems.
2. Apply differentiation, integration and differential equations in engineering and daily life problems.
3. Apply Laplace and its inverse transforms in engineering problems.

CS 101	Introduction to Programming	L	T	P	C
	B.Tech (All branches) First Year (Core)	3	1	0	4

Unit-1 What is a program; Digital computer fundamentals; What is a language; How program executes

Unit-2 C programming: Data types; Operators; Expressions; Scope resolution and variable types; Control flow structures; Functions; Arrays and pointers; Structures and Unions; Stream data processing.

Unit-3 Introduction to Object Oriented Programming: Objects and classes; Object hierarchy

Books:

1. Gottfried B.S., *Programming in C*, TMH
2. Kernighan B.W. and Ritchie D.M., *The C Programming Language*, PHI
3. Balagurusamy E., *Programming in ANSI C*, TMH
4. H. M. Deitel and P. J. Deitel, *C: How to program*, Pearson Ed.
5. A.R. Bradley, *Programming for Engineers*, Springer
6. R. G. Dromey, *How to Solve it by Computer*, PHI
7. Stroustrup B., *The C++ Programming Language*, Addison-Wesley

Course Outcomes (COs):

At the end of the course, students are expected to

1. Learn formulation of simple algorithms for arithmetic and logical problems.
2. Able to translate the algorithms into programs (in C language).
3. Able to use derived types, control structures, functions and pointers for problem solving

EC-101

Basic Electronics

L T P C

First Year All Branches

3 1 0 4

Pre-requisite- None

- Unit 1** Introduction to Electronic devices: passive devices, diode, bipolar junction transistor (BJT), metal oxide semiconductor field-effect transistor (MOSFET);
- Unit 2** Diode: basic structure and operating principle, current-voltage characteristic, large and small-signal models, iterative and graphical analysis; Diode Applications : rectifier circuits (half-wave and full-wave rectifiers, rectifiers with capacitor filter), voltage regulator (using Zener diode), clipper (limiter) circuits, clamper circuits;
- Unit 3** Bipolar Junction Transistors and their Applications: structure and modes of operation; n-p-n and p-n-p transistor in active mode, DC analysis of both transistor circuits; BJT as an amplifier, small-signal equivalent circuits, single-stage BJT amplifier (common-emitter mode); BJT as a switch; concepts of feedback amplifier
- Unit 4** Metal Oxide Semiconductor Field-Effect Transistors and their Applications: structure and physical operation of n-type and p-type MOSFET; DC analysis of MOSFET circuits; MOSFET as an amplifier, small-signal equivalent circuits, single-stage MOSFET amplifier (common-source mode); MOSFET as a switch;
- Unit 5** Operational Amplifier (Op Amp) : ideal op amp; inverting amplifier, amplifier with a T-network, effect of finite gain, summing amplifier; non-inverting configuration, voltage follower; op amp applications like current-to-voltage converter, voltage-to-current converter, difference amplifier, instrumentation amplifier, integrator and differentiator;
- Unit 6** Digital Electronics: Boolean algebra and rules of simplification; combinational circuits like adder, decoder, encoder, multiplexer and demultiplexer; sequential circuits like flip-flops, counters and shift registers.

Text/Reference books:

1. Microelectronic Circuits, 7th Edition, Adel S Sedra and Kenneth C Smith, Oxford University Press
2. Microelectronics, 2nd Edition, Jacob Millman and Arvin Grabel, Tata McGraw Hills
3. Digital Design, 5th Edition, M. Morris Mano and Michael D Ciletti, Pearson
4. Fundamentals of Digital Circuits, 4th Edition, A Anand Kumar, PHI
5. Integrated Electronics, 2nd Edition, Jacob Millman and Christos Halkias, Tata McGraw Hills

Course Outcome (CO): The graduates will be able to

CO1: Understand the working principle of diode, bipolar junction transistor (BJT), metal oxide semiconductor field effect transistor (MOSFET) devices

CO2: Understand the models of diode, BJT, MOSFET

CO3: Design switching circuits and amplifier using diode, BJT, MOSFET devices

CO4: Understand the basic of operational amplifier

CO5: Become familiar with the Boolean algebra, combinational and sequential circuits.

CE 102	Environmental Science & Engineering	L	T	P	C
	B. Tech (All Branch) First & Second Semester(Core)	3	0	0	3

Unit-1 **Introduction:** Environment, Definition, scope and importance, multidisciplinary nature of environmental studies.

Unit-2 **Natural Resources:** Forest Resources –use and over-exploitation of forests, deforestation, timber extraction, mining, dams and their effects on forests and tribal people Water Resources-Use and over utilization of surface and groundwater, floods, droughts, conflicts over water, dams-benefits and problems. Mineral resources-use and exploitation, environmental effects of extracting and using mineral resources. Agriculture land and food resources-Land as resources land degradation, man induce landslides, soil erosion and desertification; World food problems, changes caused agricultural and overgrazing, effects of modern agriculture practices, fertilizers and pesticides problems, water logging, salinity, case studies Energy Resources- Growing energy needs, renewable and non-renewable energy resources, Sources of alternate energy sources, Case studies Energy conservation.

Unit-3 **Ecosystem and Biodiversity:** Ecosystem-Concept of an ecosystem, structure and function of an ecosystem, Food chain, food webs and ecological pyramids, Energy flow in ecosystem producers and consumers Ecological Succession, Biodiversity and its Conservation – introduction, definition, genetic species and ecosystem diversity, value of biodiversity, Consumptive use, productive use, social, ethical aesthetic and optional values, biodiversity at global, national and local values, India as a mega-biodiversity nation, hotspots of biodiversity, threats to biodiversity- habitat loss, poaching of wildlife conflicts, endangered and endemic species in India, conservation of biodiversity – in-situ and ex-situ conservation of biodiversity.

Unit-4 **Environmental Pollution:** Causes, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear radiation hazards, Solid waste management, sources of solid waste effects and control measures of urban industrial wastes: Pollution case studies, disaster management- floods, earthquakes, cyclones and landslides.

Unit-5 **Environment and society:** Role of an individual prevention of pollution, consumerism and waste products, unsustainable to sustainable development, water conservation, rainwater

harvesting, watershed management, wasteland reclamation, observance and popularization of Environmental Protection Act. Air (Prevention and control of pollution) Act. Water (Prevention and control of pollution) Act, Wildlife Protection Act, Forest Conservation Act, issue involved in enforcement of environmental legalizations, population growth, variation among nations, Environment and human health, epidemics, Women and child welfare, Role of information technology in environment and human health.

Text Books / Reference Books:

1. Henry J.G. and Heinke G.W. *Environmental Science and Engineering*. Prentice Hall of India. New Delhi.
2. Chandrasekhar M. *Environmental Science*. Hi-Tech Publishers.
3. Masters G.M. *Environmental Engineering and Science*. Prentice Hall of India, New Delhi.
4. Garg S.K. and Garg R. *Ecological and Environmental Studies*. Khanna Publishers, Delhi.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand environmental problems arising due to developmental activities.
2. Identify the natural resources and suitable methods for conservation and sustainable development.
3. Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
4. Identify the environmental pollutants and abatement devices.

CH-111

Chemistry Laboratory
B. Tech (All Branches): First Semester (Core)

L	T	P	C
0	0	3	2

Experiment 1: To Determine the total hardness of pond water/ supplied water using Standard EDTA Solution

Experiment 2: Estimation of magnesium from supplied solution using standard EDTA

Experiment 3: Estimation of calcium from supplied solution using standard EDTA

Experiment 4: Determination of Dissolved oxygen (D.O) of lake water

Experiment 5: Determination of total alkalinity of supplied aqueous solution.

Experiment 6: To determine the strength of the KMnO_4 solution using standard oxalic acid solution

Experiment 7: To determine amount of Fe(II) present in the supplied solution using Standard KMnO_4 solution

Experiment 8: To determine amount of Fe(III) present in the supplied solution using Standard $\text{K}_2\text{Cr}_2\text{O}_7$

Experiment 9: Quantitative determination of Copper (II) using Standard HYPO ($\text{Na}_2\text{S}_2\text{O}_3$) Solution

Experiment 10: Estimation of calcium in milk powder using standard EDTA solution

Experiment 11: Detection of special elements in supplied organic compounds.

Experiment 12: Determination of functional groups in the supplied organic compounds

Experiment 13: Preparation of Copper (II) glycinato complex

Experiment 14: Determination of relative viscosity of the given organic liquid compound by Ostwald Viscometer

Experiment 15: Determination of surface tension of the given organic liquid compound by stalagmometer.

Text Books:

1. S K Bhasin and Sudha basin, Laboratory manual on Engineering Chemistry, Dhanpat Rai & Co. (2017)
2. G H Jeffrey, J Bassett, J Mendham, R C Denny, Vogel's Text of quantitative Chemical Analysis, Prentice Hall, (2011)

Course Outcomes

After performing these experiments students should be able to

1. Learn about the methods determination of water quality parameters. They will get fair idea about hardness of water and their effects.
2. Understand about the experimental procedure for determination of important physical properties such as surface tension and viscosity.
3. Learn technique for simple method of synthesis of coordination complexes with different ligands
4. Perform chemical reactions to perform detection of elements, functional and halogen and sulfur atoms in an organic compound.

CS 111	Programming Laboratory	L	T	P	C
	B. Tech (All branches) First Year (Core)	0	0	3	2

Basic arithmetic operations, control statements, functions, arrays and pointers, structures and unions, file handling etc.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand a functional hierarchical code organization
2. Attain the ability to define and manage data structures based on problem subject domain
3. Attain the ability work with textual information, characters and string

EC-111	Basic Electronics Laboratory	L	T	P	C
	First Year All Branches	0	0	3	2
	Pre-requisite- None				
	1. Familiarization with electronic components and usage of multimeter				
	2. Familiarization with oscilloscope, signal generator and further usage of multimeters				
	3. Frequency-response and square-wave testing of R-C, C-R and R-L networks				
	4. Studies on Voltage Rectifiers				
	5. Studies on Common-Emitter amplifiers				
	6. Studies on analog circuits using OP-AMP				
	7. Studies on logic gates				
	Course Outcome (CO): The graduates will be able to				
	CO1: Become familiar with electronic characteristic investigating instrumentats				
	CO2: Observe the frequency response of R-L-C network				
	CO3: Analyze the voltage rectifier, amplifier circuits				
	CO4: Realize operational amplifier circuits				
	CO5: Verify the truth tables of logic gates				

ME 111	Workshop Practice	L T P C
	B. Tech (Mechanical Engg.) First/Second Semester (Core)	0 0 3 2

Unit-1	General safety precautions in workshop and introduction.
Unit-2	Carpentry Shop: Safety precaution, Kinds of wood and timber, Application of timber as per their classification, Carpentry hand tools and machines, Different types of carpentry joint, Demonstration of wood working machine like, band saw, circular saw, thickness planner, wood working lathe, surface planners, etc.
Unit-3	Welding Shop: Safety precaution in welding shop, Introduction to gas and arc welding, Soldering and brazing etc. Welding equipment and welding material.
Unit-4	Fitting Shop: Safety precaution, Introduction to fitting shop tools, equipment, Operation and their uses, Marking and measuring practice.
Unit-5	Machine Shop: Safety precautions, Demonstration and working principles of some of the general machines, like lathe, shaper, milling, drilling, grinding, slotting etc., General idea of cutting tools of the machines.

Text Books:

1. S K Hajra Choudhury, A K Hajra Choudhury, N. Roy. *Workshop Technology Vol I & II*, Media Promoters & Publishers Pvt. Ltd; 9/e.

Reference Books:

2. H S Bawa. *Workshop Practice*, McGraw Hill Education; 2nd edition, 2/e.

Course Outcomes (COs):

Upon the completion of this course, the students are expected to:

1. know the importance of general safety precautions on different shop floors.
2. identify the basics of tools and equipments used in fitting, carpentry, sheet metal, machine, welding and smithy.
3. do fabrication of wooden joints and understand joining of metals.
4. make metal joints and sheet metal work.
5. understand the basics of removal of material from work piece surface to attain specific shape.
6. familiarize with the production of simple models in fitting, carpentry, sheet metal, machine, welding and smithy trades.

PH-101	Physics	L	T	P	C
	First and Second Semester	3	1	0	4
Introduction to Physics course syllabus, Introducing students to the evaluation/grading procedure, Mark distribution in each examination (Class test, mid-term, end-term)					
Unit-1	<p>Introduction to vibration and oscillation, simple harmonic oscillator: equation of motion, general solution, Characteristic of SHM: amplitude, time period, phase velocity, acceleration, total energy</p> <p>Damped harmonic motion: damping forces, practical examples of damped oscillation, equation of motion for damped oscillation, solution at different damping conditions: weak, large and critical damping, Forced oscillation of a damped harmonic oscillator, general solution to equation of motion,,</p> <p>Steady state solution for forced oscillation, low frequency, high frequency and mid frequency conditions for forced oscillation, Resonance, power of forced oscillator, Coupled oscillation: equation of motion for coupled oscillation, solutions, Introduction of normal modes and normal coordinate</p>				
Unit-2	<p>Maxwell's equation: Electrodynamics before Maxwell, Displacement current, Maxwell's equation in vacuum, Maxwell's equation in matter. Boundary conditions</p> <p>Conservation laws: Continuity equation, Poynting's theorem, Electromagnetic waves: The wave equation, Sinusoidal waves, Polarization, EM waves in vacuum, Monochromatic plane waves, Energy in electromagnetic waves, EM waves in matter, Reflection and transmission at normal incidence, Reflection and transmission at oblique incidence, EM waves in conductors, Reflection at a conducting surface</p>				

Unit-3	<p>Origin and history of quantum mechanics, particle aspect of the wave and vice-versa, matrix and wave mechanics , Particle aspect of wave – blackbody radiation, photo-electric effect, Wave aspect of particle - de Broglie's hypothesis, matter wave, Electron diffraction: Davison-Germer experiment, Particle vs wave: classical scenario & quantum scenario – double slit experiment</p> <p>Wave particle duality, Heisenberg's uncertainty principle, wavefunction, its properties and probabilistic interpretation. Wave packets, group velocity & phase velocity and relation between them in dispersive medium</p> <p>Development of the wave equation, Time dependent Schrödinger equation, Introduction to wave function, Probabilistic interpretation of wave function, Probability density, Quantum mechanical operators (position, momentum, energy), expectation value, correspondence principle, Eigen functions, Eigen value, Stationary states, Time independent Schrödinger equation Infinite square well problem, allowed energies and wavefunctions, Normalization, expectation values</p> <p>Potential barrier problem, tunneling phenomena, example of α-particle decay</p>
Unit-4	<p>Classical theory of electrical conduction, Drude model; Success and failures of classical model;</p> <p>Band theory of solid (Qualitative description); Classification of materials on the basis of band theory of solids (qualitative description); Bloch's quantum theory of electrical conduction (Qualitative);</p> <p>Distribution of electrons between the energy states-the Fermi-Dirac distribution; temperature variation of Fermi-Dirac distribution function;</p> <p>The density of energy states (using free electron model) of metal in 3-D; Estimation of Fermi energy for metals; Fermi surface and Fermi Velocity; Intrinsic and Extrinsic semiconductors; Charge carriers in semiconductor; Concepts of hole; Free electron model applied to semiconductors, The Hall effect, Magnetoresistance</p>

Course Outcome:

CO1:- Learners will be able to relate different kind of oscillations to standard differential equations. They will be able to explain various natural vibration phenomena.

CO2:- To apply the concept of vector operators like gradient, curl and divergence. Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.

CO3. Examine the phenomena of wave propagation in different media and its interfaces.

CO4:- They will be able to solve model problems like particle in a box and tunneling through potential barrier. They can apply these models to physical situations like free electron theory, scanning tunneling microscope (STM).

CO5:- Apply the free electron theory to solids to describe electronic behavior. Understand the origin of energy bands, and how they influence electronic behavior. Learners will be enabled to differentiate semiconductors, conductors and insulators. They can be on a platform to appreciate device physics.

References Books

1. Resnick and Eisberg, *Quantum Physics*, John Willey & Sons
2. A. P. French, *Vibration and waves*, The M.I.T. Introductory Physics Series
3. D. J. Griffiths, *Introduction to Electrodynamics*, Prentice Hall; 3rd edition
4. D. J. Griffiths *Quantum Mechanics*, Pearson Education, New Delhi.
5. A J Dekker *Solid State Physics*, Macmillan India,

MA102	Mathematics-II	L T P C
	B. Tech (All Branches) Second Semester	3 1 0 4

Unit-1 Linear Algebra: Linear dependence and independence of vectors in R^n space; Rank and nullity of a matrix, Elementary transformations, Consistency of a System of linear equations & their solutions by Direct Methods: Gaussian Elimination method, Gauss-Jordan method; Eigenvalues & Eigenvectors, Cayley-Hamilton's theorem & its applications, Diagonalization by Similarity Transformations.

Unit-2 Multiple Integrals: Gradient, Divergence, Curl, Directional derivatives. Double and Triple integrals in Cartesian and Polar form with applications to Volume and Surface Area, Applications of Green's, Stokes' and Gauss Divergence theorems.

Unit-3 Complex Analysis: Function of a Complex Variable, Analytic function, Harmonic function, Cauchy-Riemann equations, Complex line integral, Cauchy-Goursat theorem, Cauchy's Integral formula, Morera's theorem, Liouville's theorem, Singularities and Residues, Cauchy's Residue theorem and its application to evaluate real integrals.

Unit-4 Numerical Analysis: Finite difference, Interpolation: Newton's forward and backward interpolation formulae, Lagrange's formula. Solution of algebraic and transcendental equations: Fixed point Iteration method, Newton-Raphson Method. Solution of system of linear equations by Iterative Methods: Gauss Jacobi's method & Gauss-Seidel method. Solution of ODE: Picard's method, Taylor series method and Runge-Kutta method (Fourth order).

Text Books:

1. Joel R. Hass, Christopher E. Heil and Maurice D. Weir. *Thomas' Calculus*. 14th Edition, Pearson Education, New Delhi (2018).

2. Erwin Kreyszig. *Advanced Engineering Mathematics*. 10th Edition, Wiley India Pvt. Ltd., New Delhi (2015).

Reference Books:

1. Ayres Frank. *Theory and Problems of Matrices*. Schaum's Outline Series, New York (1962).
2. Murry R. Spiegel. *Laplace Transforms*. Schaum's Outline Series, New York (1965).
3. Lars V. Ahlfors. *Complex Analysis*. McGraw-Hill Education, New York (1979).
4. Donald Sarason. *Complex Function Theory*. American Mathematical Society, USA (2007).
5. B.S. Grewal. *Higher Engineering Mathematics*. Khanna Publisher, New Delhi (2017).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Apply the consistency concepts, eigenvalues and eigenvectors concepts in engineering problems.
2. Be capable of finding the surface area and volume using multiple integrals in engineering and daily life problems.
3. Apply basic idea of complex analysis in evaluating real integrals and engineering problems
4. Be capable of solving numerically various types of equations/differential equations arising in engineering problems up to desired degree of accuracy.

ME 101	Engineering Mechanics	L T P C
	B. Tech (Mechanical Engg.) First/Second Semester (Core)	3 1 0 4

Unit-1**STATICS**

Statics of rigid bodies: Classification of force systems- principle of transmissibility of a force Composition and resolution- Resultant of a coplanar force systems and conditions of equilibrium, free body diagrams.

Moment of a force, couple, properties of couple- Varignon's theorem, Concurrent and parallel forces, conditions of equilibrium.

Beams: Types of loading, Support reactions of simply supported and overhanging beams under different types of loading.

Friction: Laws of dry friction - Angle of friction - Cone of friction - Ladder friction, Wedge friction, Belt friction, Simple Screw Jack.

Properties of surfaces: Centroid of simple and composite areas- Theorems of Pappus and Guldinus.

Moment of inertia of areas, Parallel and perpendicular axes theorems- Radius of Gyration, moment of inertia of simple and composite areas.

Plane Truss: Statically determinate trusses; Analysis of a truss and frames - Method of joints, Method of section, Method of Members.

Virtual Work: Degree of freedom, Virtual displacement and virtual work; Principle of virtual work.

Unit-2**DYNAMICS**

Kinematics of Particles: Differential equations of kinematics; Cartesian coordinate system; Normal and tangent co-ordinate system, projectile motion.

Kinetics of Particles: Kinetics of rectilinear and curvilinear motion, D'Alemberts Principle, Principle of impulse and momentum, Work, energy and power, Direct and oblique collision.

Rotation of Rigid Bodies: Moment of inertia of material bodies, Kinematics and Kinetics of rotation equation of motion, Principle of work and energy; Principle of impulse and momentum.

Plane motion of Rigid Bodies: Translation of a rigid body in a plane; Kinematics of plane motion; Instantaneous center of rotation; Kinetics of plane motion – equation of motion, principle of work and energy; Principle of impulse and momentum.

Text Books:

1. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati. *Engineering Mechanics*, McGraw Hill Education; 5/e.
2. J. L. Meriam & L.G. Kraige. *Engineering Mechanics -Statics*, John Wiley & Sons, Inc; 3/e.
3. J. L. Meriam & L.G. Kraige. *Engineering Mechanics -Dynamics*, John Wiley & Sons, Inc; 3/e.
4. F. P. Beer, Jr., E. R. Johnston, E. R. Eisenberg, P. J. Cornwell, D. Mazurek. *Vector Mechanics for Engineers- Statics & Dynamics*, McGraw-Hill Higher Education; 9/e.

Reference Books:

1. R.C. Hibbeler. *Engineering Mechanics - Statics & Dynamics*, Pearson Education, 4/e.
2. Rogers and M A. Nelson. *Engineering Mechanics Statics and Dynamics*, McGraw Hill Education; 1/e.
3. K. L. Kumar, V. Kumar. *Engineering Mechanics*, McGraw Hill Education; 4/e.

Course Outcomes (COs):

Upon the completion of this course, the students are expected to:

1. identify and analyze the problems by applying the fundamental principles of engineering mechanics and proceed to design and development of the mechanical systems.

EE 101	Basic Electrical Engineering	L	T	P	C
	B. Tech (All Branch) First and Second Semester (Core)	3	1	0	4
Unit-1:	Introduction: Definition of active, passive, linear, non-linear, unilateral, bilateral, symmetrical, unsymmetrical network with example. Basic concept of circuit elements and their uses. Sources: current sources and voltage sources, dependent source, independent source, circuit laws (KCL & KVL), commonly used symbol and notations in electrical circuits	(3)			
Unit-2:	A.C. Fundamentals and R, L, C Circuit: Equation of AC Voltage and currents, waveform, time period, frequency, amplitude, different forms of emf equations, phase, phase difference, average value, RMS value, form factor, peak factor. Series and parallel RL, RC, and RLC circuits and their phasor representation; steady state response; Operator j notation of complex quantity in rectangular and polar form. Concept of Impedance and admittance: definition, relation, impedance, and admittance triangle. Complex power: active, reactive and apparent power, power triangle	(10)			
Unit-3:	Network Theorems: Star delta conversions, Node & loop equations, Thevenin's Theorem (AC & DC), Norton's Theorem (AC & DC), Superposition Theorem (AC & DC), Maximum power transfer theorem (AC & DC), Reciprocity Theorem (AC & DC) (All theorems with independent sources only).	(8)			
Unit-4:	Poly-phase Networks: Balanced Star-Delta connections, phase and line currents and voltages and their relations;	(3)			
Unit-5:	Electromechanical Energy conversion: Electromechanical laws: relation between electricity and magnetism, production of emfs (ac & dc), Faraday's law of electromagnetic induction, direction of induced emf, Lenz law, dynamically and statically induced emfs, self-inductances, and mutual inductances.	(4)			
Unit-6:	Electrical Machines: Types of Electrical Machines and their applications; Working principle of DC machines, single phase transformer, and 3-phase induction motor; EMF equation,	(7)			

Unit-7: Measurement: Measurement of voltage, current and Power in single and three phase (3)

Unit-8: Electrical safety: Definition, precautions, concepts of grounding and earthing. (2)

Text and Reference:

1. Del Toro V. *Electrical Engineering Fundamentals*. PHI
2. Theraja B. L. *Electrical Technology*. S Chand
3. Hayt W. H., Kemmerly J. E. *Engineering Circuit Analysis*. McGraw Hill
4. J. B. Gupta. *Basic Electrical Engineering*. Katson

Course Outcomes (Cos):

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

1. Appreciate the consequences of linearity, in particular the principle of superposition, Thevenin-Norton equivalent circuits and Reciprocity theorem.
2. Gain an intuitive understanding of the role of AC power flow in star and delta networks and relationship of line and phase values.
3. Develop the capability to analyse the concept of electromechanical conversion of energy using DC machines and basics of transformer with 3 phase induction machines.
4. Apply various modes and methods of measurement of voltage, current and power in both 1 phase and 3 phase circuits.
5. Demonstrate the common safety practices of using electricity in workplace with knowledge of grounding and earthing.

HS 101	Communicative English	L T P C
	1st and 2nd semester	3 0 0 3
	All Branch	

Unit I Introduction to business communication
Introduction to using the right language
Language and Style

Unit II Introduction to IPA phonemes; Intonation and weak forms
Transcription; Proper Pronunciation and Transcription

Unit III Comprehension Skills; Critical reading Skills
Simulation of interactive speaking environment & Group
Activities: Group Discussions, Debates, Extempore
Activities: Group Discussions, Debates, Extempore

Unit IV Common Grammatical Error,
Phrases and Idioms exercise, Vocabulary exercise, Narration.

Unit V Writing based on Visual Elements: Tables, Figures, Graphs etc.
Speech-Thought Coordination
Citation, Formatting, Stylesheet, Plagiarism etc

Text Book:

1. Nilanjana Gupta, English for All, McMillan, 2000

References

1. Knisely & Knisely, Engineering Communication, Cengage Learning; 2015

2. S. Upendran, Know Your English, Vols. 1 & 2, Universities Press, 2014
3. Seema Miglani & Sikha Goyal, English for Professionals, Vayu Education, 2010

Course Outcome

1. After completion of the course, the students are expected to have basic command over the English language in order to communicate with others in day to day affairs.
2. Understand and respond to lectures delivered in English, read and comprehend relevant materials written in English, and thus go forth into their professional lives beaming with confidence.

CE 101	Engineering Graphics & Design	L	T	P	C
	B. Tech (All Branch) First & Second Semester(Core)	1	0	3	3

- Unit-1 Introduction:** Introduction to Engg. Graphics. General instruction regarding instruments, dimensions and lettering.
- Unit-2 Geometrics Constructions:** Division of lines, angles and curves. Construction of different polygons.
- Unit-3 Conic Sections:** Construction of parabola, ellipse, hyperbola, cycloid, trochoids, epicycloid and hypocycloid.
- Unit-4 Orthographic Projection:** Introduction to orthographic projection, Elements and angles of projections, projection of points, Projection of straight lines, Projection of planes, Conversion of pictorial views of objects into orthographic projections.
- Unit-5 Isometric projection:** Isometric projection and isometric views of different plans and solids, conversion of orthographic projections into isometric views.
- Unit-6 Product design and development software:** Introduction to Auto-CAD and CATIA software, design and development of 2D and 3D models for simple objects.

Text Books / Reference Books:

3. N.D. Bhatt & V. M. Panchal. *Engineering Drawing*. Rupalee Publication, New Delhi.
4. K. Venugopal. *Engineering Drawing and Graphics+AutoCAD*. New Age International, New Delhi
5. Prof. Shyam Tickoo. *CATIA V5-6R, 2016 of Designers*. BPB Publication, ISBN: 9789386551191, 9386551195, Edition: 14th, 2017.
6. Narayana, K.L. & P Kannaiah. *Text book on Engineering Drawing*. Scitech Publishers.

Course Outcomes (COs):

At the end of the course, students are expected to

5. Produce geometric construction, multi-view, dimensioning and detail drawings of typical 3-D engineering objects.
6. Apply the skill for preparing detail drawing of engineering objects.
7. Understand and visualize the 3-D view of engineering objects.

Understand and apply computer software to prepare engineering drawing.

PH 111

Physics Lab

L-T-P-C

Pre-Requisite - None

0-0-3-2

Course objectives:

1. To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
2. To learn the usage of electrical and optical systems for various measurements.
3. Apply the analytical techniques and graphical analysis to the experimental data.
4. To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

List of experiments

1. To calibrate an ammeter with the help of a potentiometer.
2. To study the twist in the thin rod by statical method using Barton's horizontal apparatus and thus to determine the modulus of rigidity of the material of the rod.
3. To study the bending of a beam supported at its ends and loaded at the middle and thus to determine the young's modulus of the material of the beam.
4. To determine the refractive index of the material of a given prism using a spectrometer.
5. To determine frequency of a transverse waves and mass per unit length of given wire by using sonometer apparatus.
6. To study the charging and discharging of a capacitor and hence to determine its time constant
7. To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph.
8. To determine the wavelength of sodium light using single slit diffraction.
9. Comparison of two low resistances by using meter bridge.

Books

1. University Practical Physics, D. C. Tayal
2. B.Sc. Practical Physics, Samir Kumar Ghosh

Course Outcomes (COs)

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

1. Apply the various procedures and techniques for the experiments.
2. Use the different measuring devices and meters to record the data with precision
3. Apply the mathematical concepts/equations to obtain quantitative results
4. Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results

EE 111

Basic Electrical Engineering Laboratory

B. Tech (All Branch) First and Second Semester (Core)

List of Experiments

1. Study and verification of Kirchhoff's Laws applied to direct current circuit.
2. Study the behaviour of AC series circuits.
3. Study the behaviour of AC Parallel circuits.
4. Verification of Superposition theorem.
5. Verification of Thevenin's theorem.
6. Verification of Norton's theorem.
7. Verification of Maximum power transfer theorem.
8. Verification of Reciprocity theorem.
9. Measurement of LC parameters by using 3- Ammeter method.
10. Calibration of milliammeter.
11. Resonance of series RLC circuit.
12. To study the balanced three phase circuit.
13. Speed control DC motor using flux control and armature resistance control methods
14. OC and SC test on Single-phase transformer.
15. Study of balanced three-phase circuit/ measurement of three phase power using two wattmeter method.
16. Reversal of direction of rotation of a three-phase Induction motor/ Load test of three-phase Induction motor

Course Outcomes (Cos):

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

1. Demonstrate the different circuit laws in practical circuits.
2. Apply various network theorems to solve circuit parameters including Series and parallel connections.
3. Gain an intuitive understanding of the role of common measurement methods used for current, voltage and power in 1 phase and 3 phase circuits.

4. Become adept at using various methods calibration of measuring meters.
5. Demonstrate the ability to control of speed of DC motors using flux control and armature resistance control

HS 111	Language Laboratory	L T P C
	1st and 2nd semester	0 0 0 2
	All Branch	

- Unit I** Active and Passive Voice
Common Errors in English, Idioms and Phrases.
Articles, Prepositions, Word Formation-Prefixes & Suffixes, Synonyms & Antonyms
Tense & Number
- Unit II** Introduction to Phonetics - Speech Sounds- Vowels and Consonants
Minimal Pairs- Word Accent and Stress Shifts- Listening Comprehension.
Intonation and Common Errors in Pronunciation
Neutralization of Mother Tongue Influence and Conversation Practice.
- Unit III** Situational Dialogues- Role Play- Expressions in various situations- Self introduction and introducing others- Greetings- Apologies- Requests- Social and Professional Etiquette- Telephone Etiquette etc.
Information Transfer- Oral Presentation Skills Reading Comprehension
- Unit IV** Descriptions- Narrations- Giving directions and guidelines
Extempore- Public Speaking, Group Discussions.

Course Outcome

1. After completion of the course, the students are expected to have good pronunciation.

2. To be better in listening and comprehension, to become more effective communicators by organizing communication coherently, and to articulate ideas in a clear concise manner.
3. The students are able to understand the nuances of language learning and they are encouraged to recognise the need for, and an ability to engage in life-long learning

EC-201	Electronics Devices	L	T	P	C
	III Semester ECE	3	0	0	3
	Pre-requisite- None				
Unit 1	<i>Review of semiconductor Physics:</i> Solids, crystals, energy band, electrons, holes, effective mass, doping, Fermi level, Equilibrium carrier concentration, Direct and indirect semiconductors, Recombination and Generation of carriers, Carrier transport – Drift and Diffusion, mobility, Lifetime Equations of state – Continuity and Poisson equation.				
Unit 2	<i>p-n Junctions:</i> Thermal equilibrium conditions, depletion regions, depletion capacitance, current-voltage characteristics, charge storage and transient behavior, junction breakdown				
Unit 3	<i>Metal-Semiconductor contacts:</i> The Schottky barrier, the ohmic contact and rectifying contacts				
Unit 4	<i>Metal-Insulator-Semiconductor Capacitors:</i> Introduction, Ideal MIS Capacitor, Silicon MOS capacitor, capacitance voltage characteristics of MOS structure				
Unit 5	<i>MOSFET:</i> Introduction, MOSFET structure and basic characteristics, Device Scaling and Short-Channel Effects				
Unit 6	<i>Bipolar Junction Transistor:</i> The transistor action, static characteristics of BJT, frequency response and switching of BJT, the heterojunction BJT.				
Unit 7	<i>Other devices:</i> LEDs, Solar cells, Solid State Memories.				

Text / Reference Books

1. Semiconductor Physics and Devices, Donald A Neamen, McGraw-Hill Education
2. Solid State Electronics Devices, Streetman and Banerjee, PHI
3. Introduction to Semiconductor Materials and Devices, M. S. Tyagi, Wiley India Pvt Ltd
4. Physics of Semiconductor Devices, S. M. Sze and K. K. Ng, John Wiley & Sons

Course Outcomes are

The Graduates will be able to

CO1: Apply the fundamental knowledge in crystal lattice structure of semiconductor device

CO2: Apply the concepts of drift, diffusion, fermilevel, energy density in PN junction devices

CO3: Estimate the current conduction mechanism in Diode, MOSFET, BJT

CO4: Analyse the band engineering in homo and hetero junction device.

CO5: Demonstrate the static characteristics, frequency response, switching and capacitance voltage characteristics of BJT and MOSFET

MA201	Mathematics-III	L T P C
	B. Tech (All Branches) Third Semester	3 1 0 4

Unit-1 Partial Differential Equation: Formation of partial differential equations (PDE), Solution of PDE by direct integration, Lagrange's linear equation, Non-linear PDE of first order, Charpit's Method, Homogeneous and Non-homogeneous linear equations with constant coefficients, Boundary and initial value problems (Dirichlet and Neumann type): Heat, Wave & Laplace's equations (Two dimensional Polar & Cartesian Co-ordinates), Solution by the method of separation of variables.

Unit-2 Fourier Transforms: Introduction to Fourier series, Fourier sine and cosine transforms, Solution of PDE by Fourier transform.

Unit-3 Probability & Statistics: Introduction to probability, Additive & multiplicative Laws of probability, Conditional probability, Independent events, Baye's theorem, Random variable, Probability mass function, Probability density function, Cumulative distribution function, Binomial, Poisson & Normal distributions.
Curve fitting: Fitting of straight lines & parabolas by the method of least squares.
Correlation & Regression analysis: Coefficient of correlation, Coefficient of regression, Lines of regression.

Text Books:

1. Seymour Lipschutz and John J. Schiller. *Introduction to Probability and Statistics*. Schaum's Outline Series, New York (2011).

2. Erwin Kreyszig. *Advanced Engineering Mathematics*. 10th Edition, Wiley India Pvt. Ltd., New Delhi (2015).
3. Ian N. Sneddon. *Elements of Partial Differential Equations*. McGraw-Hill, New York(1988).

Reference Books:

1. Joghee Ravichandran. *Probability and Statistics for Engineers*. Wiley India Pvt. Ltd., New Delhi(2010).
2. B.S. Grewal. *Higher Engineering Mathematics*. Khanna Publisher, New Delhi(2017).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Be capable of solving partial differential equations arising in engineering problems.
2. Be capable to apply Fourier series and transforms in engineering and daily life problems.
3. Apply basic idea of probability and statistics in engineering problems.

EE-221	Network Analysis and Synthesis	L	T	P	C
	Third Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	Network Topology: Graph of a network; Concept of tree; Incidence matrix; Tie-set matrix; Cut-set matrix; Formulation and solution of network equilibrium equations on loop and node basis; Coupled Circuits: Substitution theorem; Tellegen's theorem; Millman's theorem; Coupled Circuits; Dot convention for representing coupled circuits; Coefficient of coupling.				
Unit 2	Laplace Transform & Its Application: Introduction to laplace transform; Laplace transform of some basic function; Laplace transform of periodic functions; Inverse laplace transform; Application of laplace transform:Circuit analysis (Steady State and Transient)				
Unit 3	Two Port Network Functions and Responses:z, y, ABCD, and h parameters; Reciprocity and Symmetry; Interrelation of two port parameters; Interrelation of two port networks; Network functions; Significance of poles and zeroes, Restriction on location of poles and zeroes, Time domain behaviour from Pole-Zero plots.				
Unit 4	Fourier Series and Fourier Transform: Fourier Series, Fourier analysis and evaluation of coefficients; Steady state response of network to periodic signals; Fourier transform and convergence; Fourier transform of some functions; Brief idea about network filters (Low pass, High pass, Band pass, and Band elimination) and their frequency response.				
Unit 5	Network Synthesis: On network syntnesis, Synthesis of passive network, Copncept of stability, Positive real function, and its property, Foster and Cauer form of Synthesis				

Text Book(s)

1. Network Analysis and Synthesis: A Chakraborty
2. Network Analysis, M E Van Valkenburg, PHI, third edition
3. Fundamentals of Electric Circuits, Charles K Alexander & Mathew N.O. Sadiku, Tata McGraw Hill, fifth edition.
4. Network theory, Smarajit Ghosh, first edition (2005).
5. Network Analysis and Synthesis, Franklin F. Kuo, Wiley Student Edition, second edition, 2006.

Course Outcomes are

The Graduates will be able to

CO1: Understanding the various laws and theorems related to electric networks.

CO2: Apply the graph theory and network theorems in circuit analysis.

CO3: Demonstrate the two port network using various parameters

CO4: Analyse the networks in transformed domain.

CO5: Synthesize two port network functions.

CS 222	Data Structure & Algorithm	L	T	P	C
	B.Tech (ECE & EIE) Third Semester (Core)	3	1	0	4

Unit-1 **Introduction:** Introduction to data types, Data structures and Abstract Data Types (ADT), asymptotic notations; algorithms as a technology, designing algorithms, complexity analysis of algorithms.

Unit-2 **Lists:** Linked list, doubly linked list: header list, polynomial arithmetic, stack, recursion and their implementation; evaluation of postfix expression, conversion from infix to postfix expression and their algorithms; queue, circular queue; priority queues; Dequeue; multiple stacks and queues

Unit-3 **Trees:** Introduction, Binary tree, BST, AVL trees, B Trees, B+ Trees; Multiway Search trees: Implementation of dictionary and binary search tree; heap; hashing and hash table.

Unit-4 **Graphs:** Basic concepts; Representation schemes; graph traversals; spanning tree; shortest path algorithm.

Unit-5 **Sorting & Searching:** Different sorting techniques; Tree searching and graph searching techniques.

Books:

8. Tanenbaum A.S., Langsam Y., Augenstein M. J. , *Data Structures using C/C++*, PHI
9. Aho V., Ullman J.D., *Data Structure Addision*, Wesley
10. Knuth D.E , *The Art of Computer Programming (Vol. 1, 2, 3)* , Addison- Wesley
11. Horowitz E., Sahni S. , *Fundamentals of Data Structures*, Galgotia Pub.
12. Wirth N , *Algorithms, Data Structures, Programs* . PHI

Course Outcomes (COs):

At the end of the course, students are expected to

1. be able to select appropriate data structure to be used for specified problem definition.
2. be able to handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures.
3. be able to implement projects requiring the implementation of the learned data structures.
4. be able to analyze running time of algorithms

EC-202	Analog Electronic Circuits	L	T	P	C
	Third Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	<i>Diodes:</i> Basics of diode, Clipper, Clamper, Voltage multiplier, Zener diode and voltage regulator, LED, Photodiode, solar cell.				
Unit 2	<i>BJT and MOSFET:</i> Basics of BJT and MOSFET, Biasing schemes and Bias stability, Mid-frequency small signal analysis of various BJT and MOSFET amplifier configurations using hybrid π -model, Multistage BJT and MOSFET amplifiers, Differential amplifier, Low and High frequency response of BJT and MOSFET circuits.				
Unit 3	<i>Feedback and Stability:</i> Introduction to feedback, Ideal Feedback Topologies, Analysis of MOSFET based feedback amplifiers for Series-Shunt, Series-Series, Shunt-Shunt and Shunt-Series configurations, Stability Analysis, Compensation Technique.				
Unit 4	<i>Op-Amp and Oscillators:</i> Basics of Op-Amp, Log-antilog amplifier, Square-root amplifier, Amplifier with T-network, Instrumentation amplifier, Precision rectifier, Active filters, Schmitt trigger circuits, Wein bridge and Phase shift oscillator, Colpitts, Hartley and Crystal oscillator, The 555 timer Astable and Monostable multivibrators.				
Unit 5	<i>Large Signal and power amplifiers:</i> Introduction to power amplifiers, Harmonic distortion and power output, Class A, Class B, and Class AB amplifiers and their analysis. Thermal design considerations.				

Text / Reference Books

1. Microelectronics: Circuit Analysis and Design (4th edition), Donald A. Neamen, McGraw-Hill Education
2. Microelectronic Circuits (7th edition), Adel S. Sedra and Kenneth C. Smith, Oxford University Press
3. Fundamentals of Microelectronics, Behzad Razavi, Wiley India Pvt Ltd
4. Microelectronic Circuits: Analysis and Design, Muhammad H. Rashid, Cengage Learning (2nd edition)

Course Outcomes are

The Graduates will be able to

CO1: Apply the comprehensive knowledge of diode, LED, solar cell as circuit element.

CO2: Design BJT and MOSFET amplifier of desired characteristics considering high and low frequency responses

CO3: Analyse the various feedback topologies to apply its comprehensive knowledge in amplifier and active filter design

CO4: Illustrate op-amp and oscillator circuits.

CO5: Design Class A, Class B, and Class AB amplifiers considering Thermal effect.

EC-203	Signals and Systems	L	T	P	C
	Third Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	Classification of Signals and Systems: Continuous time signals (CT signals)- Discrete time signals (DT signals) – Step, Ramp, Pulse, Impulse, Exponential - classification of CT and DT signals – periodic and a periodic signal, random signals, Energy & Power signals - CT systems and DT systems, Classification of systems.				
Unit 2	Analysis of Continuous Time Signals: Fourier series analysis- Spectrum of Continuous Time (CT) signals- Fourier and Laplace transforms in Signal Analysis.				
Unit 3	Linear Time Invariant–Continuous Time Systems: Differential Equation-Block diagram representation-impulse response, convolution integrals, Fourier and Laplace transforms in Analysis.				
Unit 4	Analysis of Discrete Time Signals: Baseband Sampling of CT signals- Aliasing, Reconstruction of CT signal from DT signal DTFT and properties, Z-transform & properties.				
Unit 5	Linear Time Invariant –Discrete Time Systems: Difference Equations-Block diagram representation-Impulse response-Convolution sum-DTFT and Z Transform analysis of Recursive and Non-Recursive systems				

TEXT BOOKS:

1. Allan V. Oppenheim, S. Willsky and S.H. Nawab, —Signals and Systems, Pearson, Indian Reprint, 2007
2. B. P. Lathi, Principles of Linear Systems and Signals, Oxford, Second Edition, 2009.

REFERENCES:

1. H P Hsu, Signals and Systems, Schaum's Outlines, Tata McGraw Hill, 2006
2. S. Haykin and B. Van Veen, "Signals and Systems", Second Edition, Wiley, 2003.
3. P. Ramakrishna Rao, Signals and Systems, Tata McGraw Hill Publications, 2008.
4. Edward W. Kamen, Bonnie S. Heck, Fundamentals of Signals and Systems Using the Web and MATLAB, Pearson, Indian Reprint, 2007
5. John Alan Stuller, An Introduction to Signals and Systems, Thomson, 2007

6. M.J. Roberts, Signals & Systems, Analysis using Transform methods & MATLAB, Tata McGraw Hill (India), 2007.

Course Outcomes are

The Graduates will be able to

CO1: Identify different types of basic signals and systems.

CO2: Analyze the LTI Systems on the basis of engineering mathematics.

CO3: Apply the knowledge of Fourier analysis to study various signals.

CO4: Analyze the LTI systems using Fourier and Laplace Transform techniques.

CO5: Evaluate discrete-time signals & systems using Z-transform.

CO6: Solve real-time problems using the concepts of Laplace, Z, and Fourier transform techniques

EC-204	Digital Electronic Circuits	L	T	P	C
	Fourth Semester ECE	3	0	0	3
	Pre-requisite- None				
Unit 1	Data and number systems: Binary, Octal and Hexadecimal representation and their conversions; BCD, ASCII, EBCDIC, Gray codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic, An overview of Boolean algebra, Venn diagram, Simplification of logic variable using K-map method, Quine McCluskey method.				
Unit 2	Combinational circuits: Decoder, Comparator, Multiplexer, De-Multiplexer and Parity Generator, Memory Systems: RAM, ROM, EPROM, EEROM, Design of combinational circuits-using ROM, Programming logic devices and gate arrays (PLAs and PLDs).				
Unit 3	Sequential Circuits: Basic memory element-S-R, J-K, D and T Flip Flops and their conversions. Various types of Registers, Counters and their design.				
Unit 4	Analog and Digital Converters: Different types of A/D and D/A conversion techniques.				
Unit 5	Logic families: TTL, ECL, MOS and CMOS, their operation and specifications.				

Text / Reference Books

1. Modern Digital Electronics, R.P.Jain, McGraw-Hill
2. Fundamentals of Digital Circuits, Anand Kumar, PHI
3. Digital Electronics, A.K.Maini, Wiley India
4. Digital Electronics, Kharate, Oxford
5. Digital Design, M. Morris Mano, and Michael D Ciletti, Pearson

Course Outcomes are

The Graduates will be able to

CO1: Understand the basic concepts of data and binary systems.

CO2: Illustrate combinational circuits

CO3: Demonstrate the memory, Flip flops and registers

CO4: Design analog and digital converters

CO5: Demonstrate the different logic families.

EC-205	Analog Communication	L	T	P	C
	Fourth Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	Elements of an electrical communication system; Characteristics of communication channel and their mathematical modeling;				
Unit 2	Signal models: deterministic and random; signal classification; Convolution Integral and response of LTI system; Fourier series representation, Parseval's theorem; Fourier transform; Hilbert transform;				
Unit 3	Random Process: mean, correlation and covariance; stationary and ergodic processes; power spectral density; Gaussian Process				
Unit 4	Concept of modulation and demodulation, Continuous wave (CW) modulation: amplitude modulation (AM) - double sideband (DSB); double sideband suppressed carrier (DSBSC); single sideband suppressed carrier (SSBSC) and vestigial sideband (VSB) modulation, angle modulation - phase modulation (PM) & frequency modulation (FM); narrow and wideband FM.				
Unit 5	Sampling process, sampling theorem for band limited signals; pulse amplitude modulation (PAM); pulse width modulation (PWM); pulse position modulation (PPM), Basics of time division multiplexing,				
Unit 6	Representation of narrowband noise; receiver model, signal to noise ratio (SNR), noise figure, noise temperature, noise in DSB-SC, SSB, AM & FM receivers, pre-emphasis and de-emphasis. Effect of Noise on AM, Effect of Noise on DSB-SCM, Effect of Noise on SSB-AM, Effect of Noise on Angle Modulation, Threshold Effect in Angle Modulation, Pre-emphasis and De-emphasis in FM. noise consideration in PAM and PCM systems.				

Text Books:

1. Communication Systems Simon Haykin, John Wiley & Sons
2. Modern Digital and Analog Communications Systems, B P Lathi & Zhi Ding, Oxford University Press

Reference Books:

1. Communication Systems Engineering, Proakis & Salehi, Pearson Education
2. Communication Systems, A.B. Carlson, TMH/MGH
3. Communication Theory, T.G. Thomas & S Chandrasekhar, TMH/MGH
4. Principle of Communication Systems, H. Taub & D.L. Schilling, TMH/MGH

Course Outcomes are

The Graduates will be able to

CO1: Understand the basic concepts of analog modulation schemes.

CO2: Evaluate analog modulated waveform in time /frequency domain and also find modulation index.

CO3: Calculate bandwidth and power requirements for analog systems.

CO4: Understand pulse modulation schemes.

CO5: Describe different types of noise and their effect on the performance of analog communication systems

EC-206	Control Systems	L	T	P	C
	Fourth Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	Introduction to control system, Basic control system components; block diagrammatic description, Reduction of block diagrams. Open loop and closed loop (feedback) systems, Examples of automatic control system, Basic elements of servo machines models of physical systems, differential equations.				
Unit 2	Signal flow graphs and their use in determining transfer functions of systems; Mason's Gain formula, standard test signals, Order of systems, concept of time constant, dynamic characteristics of a system, transient and steady state analysis of LTI control systems, Definition and significance of Frequency response.				
Unit 3	Time-domain impulse- and step responses of 1- and 2-pole systems; Settling time, over-shoot etc. in terms of damping coefficient and natural frequency; Effect of zero near the origin (and in rhp).;				
Unit 4	Relation between time and frequency-response features (of 2-pole plants); Principles of feedback; transfer function; block diagrams; steady-state errors, Stability of a system, sensitivity, characteristic equation,				
Unit 5	Tools and techniques for LTI control system analysis: Relative stability issues, root loci, Routh-Hurwitz criterion, Characterization of plants: Asymptotic and BIBO stability; Significance of poles and eigenvalues; Routh-Hurwitz test. Bode and Nyquist plots. Pole placement Design				
Unit 6	Control system compensators: Design of phase lead and lag compensators, Proportional-Integral-Derivative (PID) control				
Unit 7	State variable representation and solution of state equation of LTI control systems, state transition matrix, controllability, observability, Introduction to digital control system, adaptive And Fuzzy control, Neural control				

Text Books/References:

1. A Text Book of Control system, K. Ogata, PHI

2. Control System and Design, Nagrath and Gopal , TMH
3. Automatic Control System , B.C Kuo, PHI

Course Outcomes are

The Graduates will be able to

CO1: Understand different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form.

CO2: Demonstrate different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.

CO3: Apply time domain techniques to predict and diagnose transient performance parameters of the system for standard input functions.

CO4: Demonstrate different types of techniques in frequency domain to examine the stability and sensitivity of the system.

CO5: Design different types of controllers and compensator to ascertain the required dynamic response from the system.

EC-207	Probability and Random Process	L	T	P	C
	Fourth Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	Random Variables: Discrete and continuous random variables, Moments, Moment generating functions and their properties. Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and normal distributions, Function of Random Variable.				
Unit 2	Two Dimensional Random Variables: Joint distributions, Marginal and conditional distributions, Covariance, Correlation and Regression, Transformation of random variables, Central limit theorem				
Unit 3	Classification of Random Processes: Definition and examples, first order, second order, strictly stationary, wide sense stationary and ergodic processes, Markov process, Binomial, Poisson and Normal processes, Sine wave process, Random telegraph process.				
Unit 4	Correlation and Spectral Densities: Auto correlation, Cross correlation, Properties, Power spectral density, Cross spectral density, Properties, Wiener- Khintchine relation, Relationship between cross power spectrum and cross correlation function				
Unit 5	Linear Systems with Random Inputs: Linear time invariant system, System transfer function, linear systems with random inputs, Auto correlation and cross correlation functions of input and output, white noise.				

TEXT BOOKS

1. Peebles Jr. P.Z., "Probability Random Variables and Random Signal Principles", Tata McGraw,Hill Publishers, Fourth Edition, New Delhi, 2002.
2. Oliver C. Ibe, "Fundamentals of Applied probability and Random processes", Elsevier, First Indian Reprint (2007)

REFERENCES

1. Miller,S.L and Childers, S.L, "Probability and Random Processes with applications to Signal Processing and Communications", Elsevier Inc., First Indian Reprint 2007.
2. Stark. H., and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", 3rd Edition, Pearson Education, Asia, 2002.

3. Hwei Hsu, “Schaum’s Outline of Theory and Problems of Probability, Random Variables and Random Processes”, Tata Mc Graw Hill Edition, New Delhi, 2004.

Course Outcomes are

The Graduates will be able to

CO1: Apply the fundamental knowledge of random variable

CO2: Analyse the distributions for random variable

CO3: Illustrate the classification of random process

CO4: Analyse the correlation and spectral densities

CO5: Demonstrate the linear system with random inputs.

CO6: Analyse the auto correlation and cross correlation functions

EC-208	Electronic and Electrical Materials	L	T	P	C
	Fourth Semester ECE	3	0	0	3
	Pre-requisite- None				

- Unit 1** Introduction to materials science, classification of materials. Important properties of engineering materials and materials structures. Crystal geometry and structure: crystal structure, crystal symmetry, lattice planes and directions. Important feature of miller indices and interplanar spacing. Structural determination by X-ray diffraction: Bragg’s law of X-ray diffraction.
- Unit 2** Crystal imperfection: introduction, Types of imperfection: point, line, surface and grain boundary defects, Frank-Read source, some salient points in relation to the theory of dislocation.
- Unit 3** Electric and magnetic properties of materials: Introduction, electrical conduction, electrical conductivity, electronic and ionic conduction, band structure of solids. Electrical resistivity of metals. Insulator, dielectrics. Magnetism: Magnetic properties, Basic theory of magnetic material, Hard and soft magnetic materials, Susceptibility, Magnetic Polarization
- Unit 4** Optical properties of materials: Optical properties, interaction of light with solids. Atomic and electronic interactions; optical properties of metal and non-metals. Photoelectric effects and its characteristics. Einstein photoelectric emission, photoelectric cells and their applications.
- Unit 5** Thermal and mechanical properties of materials, Introduction, Heat capacity, thermal expansion, theoretical model, thermal conductivity, Definition of common terms used in mechanical properties, fundamental mechanical properties.

Text/Reference books:

1. Electrical Engineering Materials, A.J. Dekker, Prentice Hall India Learning Private Limited
2. Material Science, G.K. Narula, K. Narula and V. Gupta, McGraw Hill Education, First edition
3. Introduction to Materials Science, H.B. Lal, Dominant Publishers & Distributors
4. Materials Science and Engineering: A First Course, V. Raghavan, Prentice Hall India Learning Private Limited, 6th Revised Edition
5. Material Science, S. L. Kakani and Amit Kakani, New Age International

Course Outcome (CO):The Graduates will be able to

CO1: Understand and apply the fundamentals of crystal geometry and structure, lattice planes and direction, Miller indices and interplanar spacing

CO2: Apply Bragg's law of X-ray diffraction to determine crystal structure

CO3: Analyse various type of defects in crystal and demonstrate mechanism of bond formation in solids

CO4: Analyse the electrical and electronic conduction, resistivity, and band structure of solids

CO5: Demonstrate magnetic properties of hard and soft magnetic materials

CO6: Illustrate the interaction of light with solids, their optical properties, thermal properties, photoelectric effect and its application in photovoltaic cell

EC-209	Electromagnetic Field Theory and Wave Propagation	L	T	P	C
	Fourth Semester ECE	3	1	0	4
	Pre-requisite-None				
Unit 1	<i>Fundamental Concepts of static fields:</i> Physical interpretation of gradient, divergence and curl; Coordinate systems; Review of static fields; Current continuity equation; Displacement current;				
Unit 2	<i>Maxwell's equations and Plane Waves:</i> Maxwell's equations in static & time varying fields, Maxwell's equation in phasor form Wave equation in an isotropic homogeneous medium and its solution, polarization of waves, Poynting vector.				
Unit 3	<i>Reflection of Electromagnetic Waves:</i> Reflection and refraction of plane waves at plane boundaries, Normal incidence, standing waves, laws of reflection, reflection of obliquely incident waves, Brewster's angle.				
Unit 4	<i>Transmission lines:</i> Circuit model for transmission lines, loss less and lossy lines, field analysis of transmission lines, Smith chart, impedance matching.				
Unit 5	<i>Antenna & Wave Propagation:</i> Retarded potential, Hertzian dipole, Antenna parameters, Ground Wave Propagation, Space Wave Propagation, Propagation over Plane Earth and spherical earth, Duct Propagation, Troposphere Propagation.				

Text/Reference Books:

1. Electromagnetic Waves and Radiating Systems, E. C. Jordan & K. G. Balman, PHI
2. Engineering Electromagnetics, W. H. Hayt & J. A. Buck, TMH
3. Elements of Electromagnetics, M. N. O. Sadiku, Oxford Uni. Press
4. Microwave Devices and Circuits, S. Y. Liao, Pearson
5. Antenna Theory: Analysis and Design, Constantine A. Balanis, Wiley

Course Outcomes are

The Graduates will be able to

CO1: Understand the fundamental knowledge of vector analysis in different coordinate systems

CO2: Apply Maxwell's equations.

CO3: Apply the concept of the wave equation in an isotropic homogeneous medium

CO4: Analyse the reflection of Electromagnetic Waves and its properties

CO5: Design the transmission lines and analyze its characteristics

CO6: Design the various types of Antennas and analyze the wave propagation

EE-222

Circuit Theory Laboratory

L T P C

Third Semester ECE

0 0 3 2

Pre-requisites- None

List of Experiments

1. Verification of Network Theorems (Superposition, Thevenin's, Norton's, Maximum Power Transfer). 2. Study of DC and AC Transients.
2. Determination of circuit parameters: Open Circuit and Short Circuit parameters.
3. Determination of circuit parameters: Hybrid and Transmission parameters.
4. Frequency response of Low pass and High Pass Filters.
5. Frequency response of Band pass and Band Elimination Filters.
6. Determination of self-inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.
7. Study of resonance in R-L-C series circuit.
8. Study of resonance in R-L-C parallel circuit.
9. Spectral analysis of a non-sinusoidal waveform

Course Outcomes are

The Graduates will be able to

CO1: Verify the various network theorems

CO2: Determine different network parameters

CO3: Illustrate the Frequency response of different filters

CO4: Demonstrate the resonance in RLC circuits

EC-211	Analog Electronic Circuit Laboratory	L	T	P	C
	Third Semester ECE	0	0	3	2
	Pre-requisite- <i>EC-111</i>				

List of Experiments:

1. To study the multi-stage RC coupled amplifier circuit using CE configuration npn transistor.
2. To design a current-biased emitter follower circuit
3. To measure and understand the current-vs-voltage (I-V) operating curves of the MOSFET
4. To realize Different applications of Op-Amps – Adder, Subtractor, Differentiator, Integrator etc.
5. To study Schmitt's Trigger Circuit
6. To study Phase Shift Oscillator Circuits
7. To design Active filter circuit with IC 741 (Low pass and High pass)
8. To realize Astable Multivibrator circuit using BJT/Op-Amp
9. To realize Monostable Multivibrator circuit using BJT/Op-Amp
10. To design an Analog to Digital Converter (Any one method)
11. To design Digital to Analog Converter(Any one method)
12. One innovative experiment based on electronics circuit

Course outcomes are

The Graduates will be able to

CO1: Understand the design mechanisms of various amplifiers, Oscillators, and Multivibrators.

CO2: Analyse the characteristics of MOSFET

CO3: Realize various Op-Amp based circuits in practical applications

CO4: Design Analog to Digital and Digital to Analog Converters for various specifications and applications.

CO5: Design innovative circuits using the experimental knowledge of various circuits

CS 223	Data Structure & Algorithm Laboratory	L	T	P	C
	B.Tech (ECE & EIE) Third Semester (Core)	0	0	3	2

Use of special data structures for solving real-life problems, Implementation of customized data structures and defining their access & retrieval mechanism, Analyzing merit & demerit of different data structures.

Course Outcome (CO):

At the end of the course, students are expected to

1. Be able to design and analyze the time and space efficiency of the data structure.
2. Be capable to identify the appropriate data structure for a given problem.
3. Able to apply concepts for solving real-life problems.

EC-212

Digital Electronic Circuit Laboratory

Fourth Semester ECE

Pre-requisite- *EC-111*

L T P C

0 0 3 2

List of Experiments:

1. Code conversion circuits- BCD to Excess-3 and vice-versa.
2. Four-bit parity generator and comparator circuits.
3. Construction of simple Decoder and Multiplexer circuits using logic gates.
4. Realization of RS-JK and D flip-flops using Universal logic gates.
5. Realization of Universal Register using JK flip-flops and logic gates.
6. Realization of Universal Register using multiplexer and flip-flops.
7. Construction of Adder circuit using Shift Register and full Adder.
8. Realization of Asynchronous Up/Down counter.
9. Realization of Synchronous Up/Down counter.
10. Design of Sequential Counter with irregular sequences.
11. Realization of Ring counter and Johnson's counter.
12. Any innovative experiment related to digital circuits.

Course outcomes are

The Graduates will be able to

CO1: Design code converter circuits

CO2: Analyse the Decoder and MUX using logic gates

CO3: Realise registers using flipflop, multiplexer

CO4: Design various types of counters.

CO5: Implement innovative electronic circuit

EC-213	Control Laboratory	L	T	P	C
	Fourth semester ECE	0	0	3	2
	Pre-requisite- Nil				

List of Experiments-

1. Familiarization with MATLAB Control System tool BOX, MATLAB-SIMULINK tool box.
2. Determination of step response of 1st order and 2nd order system and calculation of control system specifications for variations of system design using MATLAB.
3. Simulation of Impulse and Step response of TYPE I and TYPE II system with unity feedback.
4. Determination of Root locus, Nyquist plot and Bode plot using Control system toolbox in MATLAB for 2nd order Transfer function and determination of different control system specifications.
5. Design of PI, PD and PID controller.
6. Evaluation of steady state error, settling time, percentage peak overshoot, rise time, peak time for 2nd order systems using MATLAB
7. Determination of Gain margin, Phase margin with addition of Lead compensator / Lag Compensator in forward path Transfer function.
8. Stability analysis of linear systems.
9. Determination of overall Transfer function and time domain specifications using SIMULINK
10. Determination of approximate Transfer function using Bode Plot

Course outcomes are

The Graduates will be able to

CO1: Acquire knowledge of MATLAB for linear control system.

CO2: Understand the concept of type and order of a given system.

CO3: Understand the concept of impulse response and transfer function model of given system.

CO4: Distinguish the difference between impulse response, step response and ramp response of given systems with different order and type.

CO5: Understand the concept of stability of given system using root locus, nyquist and bode plot techniques.

CO6: Understand the design of PI, PD and PID controller and compensation techniques.

EC-214	Analog Communication Laboratory	L	T	P	C
	Fourth semester ECE	0	0	3	2
	Pre-requisite- <i>Nil</i>				

Lists of Experiments-

1. Study of Amplitude modulation and demodulation.
2. Study of DSB-SC Modulator & Detector
3. Study of SSB-SC Modulator & Detector (Phase Shift Method)
4. Study of Frequency modulation and demodulation.
5. Study of VCO and PLL and their application in FM
6. Verification of Sampling Theorem
7. Study of Pulse Amplitude Modulation & Demodulation
8. Study of Pulse Width Modulation & Demodulation
9. Study of Pulse Position Modulation & Demodulation

Course outcomes are

The Graduates will be able to

CO1: Distinguish among the information, carrier and modulated signals.

CO2: Understand the fundamentals in explain the functionality of modulation and demodulation environment.

CO3: Analyze the concepts, write and simulate the AM/DSB-SC/SSB-SC modulation and demodulation models.

CO4: Acquire the idea of generation and detection of AM and FM signals.

CO5: Apply the idea of VCO and PLL in FM.

CO6: Generate and detect the PAM, PWM and PPM signal.

EC-301	Digital Communication	L T P C
	Fifth Semester ECE	3 1 0 4
	Pre-requisite- None	
Unit 1	Introduction: A historical perspective in the development of Digital Communication, elements of a digital communication system, analog versus digital communication system.	
Unit 2	Pulse modulation: Introduction, quantization process, PCM, DPCM, DM, Adaptive DPCM, Quantization noise, output signal power, output SNR in PCM, quantization noise in DM, output SNR in DM and DPCM.	
Unit 3	Base band pulse transmission: Introduction, matched filter, error rate due to noise, inter symbol interference, Nyquist's criterion for distortion less base band binary transmission.	
Unit 4	Digital pass-band transmission: Introduction, pass band transmission model, Gram Schmidt orthogonalization procedure, geometric representation of signals, BPSK, DPSK (Differential Encoded PSK), QPSK, $\pi/4$ QPSK, OQPSK, M-ary PSK, BFSK, Minimum shift keying (MSK), GMSK, QAM, power spectra, bit error rate probability, Comparison of modulation schemes in terms of probability of error and spectral efficiency.	
Unit 5	Source coding: Mathematical models of information sources, a logarithmic measure of information, source coding theorem, source coding algorithms- the Huffman source coding algorithm.	
Unit 6	Channel capacity & coding: Modelling of communication channels, channel capacity, bounds on communication, coding for reliable communication, linear block codes	
Unit 7	Multiplexing: Introduction, frequency division multiplexing (FDM), time division multiplexing (TDM), Introduction to Spread Spectrum Techniques.	

Text Books:

1. Digital Communication, *Simon Haykin*, John Willey & Sons
2. Digital communication, *John G Proakis*, McGraw Hill
3. Communication System, *Simon Haykin*, John Willey - 4th edition

Reference Books:

1. Modern Analog & Digital Communication System, *B.P.Lathi*, Oxford University Press- 4th edition
2. Introduction to Digital Communication, *M.B.Pursley*, PHI
3. Digital and Analog Communication Systems, *L.W.Couch*, Pearson
4. Principles of Communication Systems, *H. Taub & D.L. Schilling*, *G.Saha*, 4th edition, 2013- McGraw Hill

Course Outcomes:

The graduates will be able to:

CO1: Learn the development of communication systems

CO2: Learn different pulse modulation techniques.

CO3: Learn and apply the matched filter concept and find signal-to-noise ratio.

CO4: Study and analyse different digital modulation techniques, should analyse and propose solutions for different real time communication problems.

CO5: Learn different source coding and channel coding techniques, should analyse real time digital communication problems.

CO6: Learn different multiplexing techniques to understand the various advanced communication concepts.

EC-302	Microprocessors and Microcontrollers	L T P C
	Fifth Semester ECE	3 0 0 3
	Pre-requisite- None	
Unit 1	Introduction to 8 bit and 16 bit Microprocessors-H/W architecture: Introduction to microprocessor, computer and its organization, Programming system; Address bus, data bus and control bus, Tristate bus; clock generation; Connecting Microprocessor to I/O devices; Data transfer schemes; Architectural advancements of microprocessors. Introductory System design using microprocessors; 8086 – Hardware Architecture; External memory addressing; Bus cycles; some important Companion Chips; Maximum mode bus cycle; 8086 system configuration; Memory Interfacing; Minimum mode system configuration, Interrupt processing.	
Unit 2	16-bit microprocessor instruction set and assembly language programming: Programmer's model of 8086; operand types, operand addressing; assembler directives, instruction Set-Data transfer group, Arithmetic group, Logical group.	
Unit 3	Microprocessor peripheral interfacing: Introduction; Generation of I/O ports; Programmable Peripheral Interface (PPI)- Intel 8255; Sample-and-Hold Circuit and Multiplexer; Keyboard and Display Interface; Keyboard and Display Controller (8279).	
Unit 4	8-bit microcontroller- H/W architecture instruction set and programming: Introduction to 8051 Micro-Controllers, Architecture; Memory Organization; Special Function register; Port Operation; Memory Interfacing, I/O Interfacing; Programming 8051 resources, interrupts; Programmer's model of 8051; Operand types, Operand addressing; Data transfer instructions, Arithmetic instructions, Logic instructions, Control transfer instructions; Programming.	
Unit 5	Maximum mode system configuration, Direct memory access, Interfacing of D-to-A converter, A-to-D converter, CRT Terminal Interface, Printer Interface, Programming of 8051 timers, 8051 serial interface.	

Text Book(s):

1. Microprocessor Architecture, Programming and application with 8085, R.S. Gaonkar, PRI Penram International publishing PVT. Ltd., 5th Edition
2. The 8051 Microcontroller Architecture, Programming and Application, Kenneth J. Ayala, Cengage Learning, 3rd Ed.
3. Microprocessors and Interfacing, Programming and Hardware, Douglas V Hall, TMH Publication, 2006.

Reference Book(s):

1. Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevananthan and S.K. Shah, Oxford University Press.
2. The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, Pearson Education, Second Edition, 2008.
3. The 8051 Microcontroller, Architecture and Programming and Application

Course Outcomes:

The graduates will be able to:

CO1: Gather knowledge about the fundamentals of assembly level programming of microprocessors and microcontroller. Also, apply the knowledge in practical scenario.

CO2: Understanding different peripherals (8255, 8253 etc.) and it's interfacing with Microprocessor.

CO3: Design of memory interfacing circuits. Analyze the data transfer information through serial and parallel ports.

CO4: Distinguish and analyze the properties of Microprocessors and Microcontrollers.

CO5: Design and implement 8051 microcontroller based systems.

CO6: Troubleshoot interactions between software and hardware.

EC-303	ANALOG INTEGRATED CIRCUITS & TECHNOLOGY	L T P C
	Fifth Semester ECE	3 1 0 4
	Pre-requisite- None	
Unit 1	Overview of IC fabrication Technology: Electronic Grade Silicon preparation, Czochralski technique of crystal growth, wafer preparation and identification, Oxidation, Epitaxy: Molecular beam Epitaxy, Vapour phase Epitaxy, diffusion, ion implantation, deposition, NMOS, CMOS fabrication and BiCMOS Technology.	
Unit 2	Introduction to IC: Difference between discrete circuits and integrated circuits, IC biasing of common MOS and BJT amplifier configurations, Switched capacitor filters.	
Unit 3	Current sources and Active load: Introduction, Two transistor MOS current source, Current steering, Cascode current source, Wilson current source, Active loads.	
Unit 4	Differential And Operational Amplifier: Basics of differential amplifier, Differential amplifier with passive load, Differential amplifier with active load, Calculation of common mode gain, differential mode gain and CMRR using π model, Two stage CMOS Op-Amp, Calculation of common mode gain, differential mode gain and CMRR of two stage CMOS Op-Amp using π model, Problem with more gain stages, output stage, Importance of negative feedback in Op-Amp.	
Unit 5	Non ideal effects in Op-Amp: Practical Op-Amp Parameters, Finite Open-Loop Gain, Offset Voltage, Input Bias Current, Finite Slew rate, Additional Non ideal Effects.	
Unit 6	Analog Multipliers: Introduction, Log-Antilog single quadrant multipliers, Emitter coupled two quadrant multipliers, Gilbert four quadrant current multiplier, Current to voltage conversion, Complete four quadrant voltage multiplier, Applications of multipliers in various communication networks.	

Text/Reference books:

1. Microelectronics: Circuit Analysis and Design, Donald A Neamen, McGraw-Hill Education(4th edition)
2. Microelectronic Circuits, Adel S. Sedra and Kenneth C. Smith, Oxford University Press (7th edition)
3. Design of Analog CMOS Integrated Circuits, Behzad Razavi, Tata McGraw Hill
4. Analog Electronics with Op-Amps, A.J. Peyton and V. Walsh, Cambridge University Press
5. Analysis and Design of Analog ICs, Gray and Meyer, Wiley India Pvt Ltd

6. Silicon VLSI Technology, Plummer, Deal and Griffin, Prentice Hall

Course Outcome:

The graduates will be able to:

CO1: Understand the fundamental concepts and areas of applications for the Integrated Circuits.

CO2: Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.

CO3: Demonstrate the ability to design practical circuits that perform the desired operations.

CO4: Analyze important types of integrated circuits of day-to-day requirements.

CO5: Understand the differences among theoretical, practical & simulated results in integrated circuits

CO6: Choose the appropriate integrated circuit modules to build a given application

EC-304	Digital Signal Processing	L	T	P	C
	Fifth Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	Discrete Fourier Transform: Review of discrete-time signals & systems - DFT and its properties, FFT algorithms & its applications, Overlap-add & overlap-save methods.				
Unit 2	Design of Infinite Impulse Response Filters: Analog filters – Butterworth filters, Chebyshev Type I filters (up to 3 rd . order), Analog Transformation of prototype LPF to BPF /BSF/ HPF. Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method - Realization structures for IIR filters – direct, cascade, parallel forms.				
Unit 3	Design of Finite Impulse Response Filters: Design of linear phase FIR filters windowing and Frequency sampling methods - Realization structures for FIR filters – Transversal and Linear phase structures, Comparison of FIR & IIR.				
Unit 4	Finite Wordlength Effects: Representation of numbers-ADC Quantization noise-Coefficient Quantization error, Product Quantization error-truncation & rounding errors -Limit cycle due to product round-off error- Round off noise power.				
Unit 5	Introduction to Digital Signal Processors: DSP functionalities–TMS320C64xx architecture– Fixed and Floating point architecture principles – addressing modes, instructions, Programming– Application examples.				
Unit 6	Multirate Signal Processing: Introduction to Multirate signal processing- Decimation-Interpolation- Polyphase implementation of FIR filters for interpolator and decimator –Multistage implementation of sampling rate conversion- Design of narrow band filters - Applications of Multirate signal processing.				

TEXT BOOKS:

1. John G Proakis and Manolakis, —Digital Signal Processing Principles, Algorithms and Applications, Pearson, Fourth Edition, 2007
2. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8 th Indian Reprint, Pearson, 2004.
3. Rulph Chassaing and Donald Reay, Digital signal processing and applications with TMS 320C6713 and TMS320C6416, Wiley, 2008.

REFERENCES:

1. Steven W. Smith, —Digital Signal Processing – A practical guide for Engineers and Scientist, Newnes publications, 2003
2. I.C.Ifeachor and B.W. Jervis, Digital Signal Processing- A practical approach, Pearson, 2002.
3. D.J. De Fatta, J.G.Lucas and W.S. Hodgkiss, Digital Signal Processing- A system Design Approach, John Wiley & sons, Singapore, 1988.
4. M. H. Hayes, Digital Signal Processing, Schaums outlines, Tata McGraw Hill, 2007. 5. Sanjit K. Mitra, Digital Signal Processing: A Computer-Based Approach, 4th Edition, Copyright© 2011, The McGraw-Hill Companies, Inc
5. TMS320C64x Technical Overview, Texas Instruments, Dallas, TX, 2001.

Course Outcome: The graduates will be able to:

CO1: Understand the fundamental concepts and mathematical tools required for digital signal processing

CO2: To design the different types of filters.

CO3: Apply the various filter design techniques for solving practical problems.

CO4: Understanding and applying the hardware for solving digital signal processing related problems.

CO5: Foundation for advanced signal processing and its applications.

EC-305	Electronic Measurements and Instrumentation	L T P C
	Fifth Semester ECE	3 0 0 3
	Pre-requisite- None	
Unit 1	Introduction: Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration- Principle and types of analog and digital voltmeters, ammeters.	
Unit 2	Electrical and Electronic Instruments: Principle and types of multi meters – Single and three phase watt meters and energy meters – Magnetic measurements – Determination of B-H curve and measurements of iron loss – Instrument transformers – Instruments for measurement of frequency and phase.	
Unit 3	Comparative Methods of Measurements: D.C potentiometers, D.C (Wheat stone, Kelvin and Kelvin Double bridge) & A.C bridges (Maxwell, Anderson and Schering bridges), transformer ratio bridges, self-balancing bridges. Interference & screening – Multiple earth and earth loops – Electrostatic and electromagnetic Interference – Grounding techniques.	
Unit 4	Storage and Display Devices: Magnetic disk and tape – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & Dot matrix display – Data Loggers	
Unit 5	Transducers and Data Acquisition Systems: Classification of transducers – Selection of transducers – Resistive, capacitive & inductive Transducers – Piezoelectric, Hall effect, optical and digital transducers – Elements of data acquisition system – Smart sensors-Thermal Imagers	

TEXT BOOKS:

1. A D Helfric and W D Cooper, Modern Electronic Instrumentation and Measurement Techniques, PHI
2. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation' Dhanpat Rai and Co 2004.
3. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons, Delhi, 2003
4. Doebelin E.O. and Manik D.N., Measurement Systems – Applications and Design, Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd., 2007.

REFERENCES:

1. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill, II Edition 2004.
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2007.
3. A.J. Bouwens, 'Digital Instrumentation', Tata McGraw Hill, 1997.
4. Martin Reissland, 'Electrical Measurements', New Age International (P) Ltd., Delhi, 2001.

Course Outcome:

The graduates will be able to:

CO1. Illustrate performance characteristics and functional description of instrumentation systems.

CO2. Demonstrate electronic test equipment and display devices.

CO3. Classify various signal conditioning systems, sensors and transducers.

CO4. Design different types of DAC, ADC, amplifiers.

CO5. Design various measurement systems based on transducers.

EC-306	Principles of Opto-Electronics and Fibre optics	L T P C
	Fifth Semester ECE	3 0 0 3
	Pre-requisite- None	
Unit 1	Introduction to Optical Communication: Brief introduction to opto-electronics and optical communication, advantages of optical communication. Ray theory transmission, Electromagnetic mode theory for optical propagation, Cylindrical fiber, Single Mode fibers.	
Unit 2	Transmission characteristics of optical fibers: Attenuation, Material absorption losses in silica glass fiber, linear scattering losses, Rayleigh scattering, Chromatic dispersion, Intermodal dispersion, Overall fiber dispersion, Dispersion modified Single mode fibers, Polarization.	
Unit 3	Fiber Optics Technology: Preparation of optical fibers, liquid phase techniques, Vapor-phase deposition techniques, Optical fiber cable. <i>couplers and isolators:</i> Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers, Optical isolators and circulators.	
Unit 4	Optical Sources : Basic concepts: absorption and emission of radiation, the Einstein relations, population inversion, optical feedback and laser oscillation, threshold condition for laser oscillation. Optical emission from semiconductors, The semiconductor injection laser, Some injection laser structures, Injection laser characteristics. LED power and efficiency, LED structures, LED, Modulation and problems.	
Unit 5	Optical Detectors: Device types, optical detection principles, Absorption, III-V alloys, Quantum efficiency, Responsivity, Long wavelength cut-off, Semiconductor photodiodes without internal gain: p-n photodiode, p-i-n photodiode speed of response and travelling wave photodiode, Noise.	
Unit 6	Receiver Performance: <i>Direct detection receiver performance considerations:</i> Noise: Thermal noise, dark current noise, quantum noise, digital signaling quantum noise, analog signaling transmission quantum noise. Receiver noise: p-n and p-i-n photodiode receiver, APD, Gain bandwidth product	
Unit 7	Optical system design: Point-to- point links- Component choice and considerations, Dispersion and attenuation limited systems, Bit error rate, Link power budget, Rise time budget, WDM, Eye pattern, recent advances.	

Text Books:

1. Optical Fiber communications , J.M.Senior , PEARSON
1. Optical Fiber Communication, Gerd keiser, Mc Graw Hill

Reference Books:

1. Introduction to Fiber Optics, Ajoy Ghatak & K. Thyagarajan , Tata McGraw-Hill
2. An Introduction to fiber optics , Shotwell , PHI
3. Semiconductor Optoelectronic devices , P. Bhattecharjee , PHI
4. Fiber-Optic Communication Systems , G. P. Agrawal , John Wiley & Sons
5. Optical Networks , R.Ramaswami , Elsevier

Course Outcome: The graduates will be able to:

CO1: Apply the fundamental of optical optical communication and optoelectronics devices

CO2: Understand the concept of Ray model and Wave model of optical transmission system and its transmission characteristics.

CO3: Analyse and understand different techniques to prepare the optical fiber

CO4: Classify and evaluate optical sources – Lasers, LEDs and its characteristics

CO5: Analyse and understand optical detection principles and optical receiver characteristics

EC-307	RF and Microwave Engineering	L T P C
	Sixth Semester ECE	3 1 0 4
	Pre-requisite- None	
Unit 1	Introduction: Review of Maxwell's Equations, RF & Microwave Spectrum. Historical Background. Typical applications of RF & Microwaves	
Unit 2	Waveguides and Resonators: Rectangular and Circular Waveguides. Mode structures, Cut-off frequency, Propagation characteristics, Wave current, Attenuation constant, Waveguide excitations. Waveguide Resonators-Rectangular & Cylindrical; Resonant frequencies, Mode structures, Q factor, Co-axial Resonators; Excitation & Coupling of cavities, Design of resonators	
Unit 3	Planar Structures: Strip Lines: Microstrip lines, coplanar structures, Slot lines, Suspended strip lines, Fin lines-configurations, Field patterns, Propagation characteristics, Design considerations. Comparison of characteristics of lines	
Unit 4	Microwave Passive Components: Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters; High Frequency parameters-S parameters, Formulation and Properties of S parameters, Reciprocal and lossless Network	
Unit 5	E-plane, H-plane Tees, Magic Tee, Hybrid ring, Directional couplers, Power dividers, Attenuators, Phase shifter, Circulators and Isolators	
Unit 6	Semiconductor Microwave Components: PIN diode, Tunnel diode, Gunn diode, IMPATT diode, TRAPATT diode, Varactor diode, Schottky diode, Microwave bipolar Transistor, hetero junction bipolar transistor, Microwave field effect transistor.	
Unit 7	Microwave Tubes: Limitations of conventional tubes in microwaves; Multi cavity Klystron, Reflex Klystron; Magnetron; Travelling Wave Tube; Backward Wave Oscillator- working principles and characteristics.	
Unit 7	Basic Microwave Measurements: Measurement of frequency, impedance, SWR, Power, S-parameters, Attenuation, Dielectric Constant	

Text/Reference Books:

1. Microwave Engineering, D.M. Pozar, Wiley India Pvt Ltd
2. Foundations for Microwave Engineering, RE Collin, Wiley India Pvt Ltd

3. Microwave Devices and Circuits, S.M. Liao, Pearson
4. Microwave Engineering: Passive Circuits, Peter A. Rizzi, PHI

Course outcomes (COs): The graduate will be able to

CO1: Understand and analyse transmission line lumped element circuits and waveguide.

CO2: Apply S-parameters and Smith chart for the design of passive circuits

CO3: Analyse the performance parameters of RF passive components

CO4: Able to analyse the applications and limitations of microwave tube Generators and Amplifiers

CO5: Able to analyse and find applications and limitations of microwave Semiconductor devices.

CO6: Gain a basic understanding of microwave measurement techniques based on transmission lines

EC-308	Data Communication and Networks	L	T	P	C
	Sixth Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	Overview of data communication principles: Internet: brief history, internet today, protocols and standards, reference models: OSI reference model, TCP/IP reference model, their comparative study				
Unit 2	Data link layer: Types of errors, framing (character and bit stuffing), error detection & correction methods, flow control, protocols: stop & wait ARQ, go-back-NARQ selective repeat ARQ, HDLC, point to point protocol, token bus, token ring, reservation, polling				
Unit 3	Multiple access protocols: Pure ALOHA, slotted ALOHA, CSMA, CSMA/CD, FDMA, TDMA, CDMA, traditional Ethernet, fast Ethernet				
Unit 4	Network layer: Internetworking & devices: repeaters, hubs, bridges, switches, router, gateway, addressing: Internet address, classful address, subnetting, routing: techniques, static vs. dynamic routing, and routing table for classful address				
Unit 5	Routing algorithms: shortest path algorithm, flooding, distance vector routing, link state routing, protocols: ARP, RARP, IP, ICMP, IPV6, unicast and multicast routing protocols				
Unit 6	Transport layer: Process to process delivery, UDP, TCP, congestion control algorithm: leaky bucket algorithm, token bucket algorithm				
Unit 7	Application layer: DNS, SMTP, SNMP, FTP, HTTP & WWW				

Text Books:

1. Computer Networks, A. S. Tanenbaum, Pearson Education/PHI, 4th Ed.
2. Data and Computer Communications, W. Stallings, PHI/Pearson Education, 5th Ed.
3. Network for Computer Scientists & Engineers, Zheng & Akhtar, Oxford University Press
4. Data Communications and Networking, B.A. Forouzan, TMH, 3rd Ed.

Reference Books:

1. Computer Networking: A top down approach featuring the Internet, Kurose and Rose, Pearson Education

2. Communication Networks, *Leon and Garica*, TMH

3. Communication Networks, *Walrand*, TMH

Course Outcome:

The graduates will be able to:

CO1. Learn overview of data communication and networking aspect.

CO2. Learn and understand the different analog and digital modulation techniques along with different multiplexing schemes used at the physical layer.

CO3. Learn about the error detection and correction schemes to solve real time scenarios.

CO4. Learn the various multiple access techniques to understand the modern communication methodologies

CO5. Learn the different routing algorithms needed.

CO6: Know the different protocols used in transport and application layer.

EC-309	VLSI Design	L T P C
	Sixth Semester ECE	3 1 0 4
	Pre-requisite- None	
Unit 1	<i>Issues and challenges in Digital IC Design:</i> Overview of VLSI Design methodologies, VLSI Design flow, design hierarchy, concepts of regularity, modularity and locality, VLSI design styles, design quality, packaging technology, computer-aided design technology.	
Unit 2	<i>CMOS Inverter-Static Characteristics:</i> MOS device model with sub-micron effects, critical voltage analysis of resistive load inverter, inverters with n-type MOSFET load, CMOS Inverter design, supply voltage scaling and its layouts.	
Unit 3	<i>CMOS Inverter- switching Characteristics and Interconnect Effects:</i> Delay time definitions, calculation of delay times, inverter design with delay constraints, estimation of interconnect parasitics, calculation of interconnect delay, switching power dissipation of CMOS inverters.	
Unit 4	<i>Combinational MOS logic Circuits Design:</i> MOS logic circuits with depletion NMOS loads, CMOS logic circuits, complex logic circuits, CMOS transmission gates (Pass gates)	
Unit 5	<i>Sequential MOS Logic Circuits:</i> Behaviour of bistable elements, SR latch circuit, clocked latch and flip-flop circuits, CMOS D-Latch and edge-triggered Flip-flop	
Unit 6	<i>Dynamic Logic Circuits:</i> Basic principles of pass transistor circuits, voltage bootstrapping, synchronous dynamic circuit techniques, dynamic CMOS circuit techniques, high performance dynamic CMOS circuits.	
Unit 7	<i>Semiconductor Memories:</i> Non-volatile and volatile memory devices, DRAM design, SRAM cell design, Flash memories, Ferroelectric RAM.	
Unit 8	<i>Introduction to hardware description language (HDL)</i> Verilog/VHDL. A logic synthesis example	

Text/References:

1. CMOS Digital Integrated Circuits-*Analysis and Design*, Sung-Mo (Steve) Kang Yusuf Leblebici, TMH, 3rd Ed
2. Digital Integrated Circuits- A Design Perspective, J.M. Rabaey, A. Chandrakasan and B. Nikolic, PHI, 2003, 2/e

3. CMOS VLSI Design: A Circuits and Systems Perspective, N. Weste and D. Harris, Pearson, 2010, 4/e
4. Analysis and Design of Digital Integrated Circuits in Deep submicron Technology, D. A. Hodges, H. G. Jackson, and R. Saleh, TMH, 2003, 3/e
5. Introduction to VLSI Circuits and Systems, J. P. Uyemura, Wiley, 2001, 1/e
6. Modern VLSI Design - System on Chip design, W. Wolf, PHI, 2002, 3/e
7. Verilog HDL, Samir Palnitkar, Pearson

Course Outcomes (CO):

Students will be able to

CO1. Analyze VLSI circuit timing using Logical analysis.

CO2. Estimate and compute the power consumption of a VLSI chip

CO3. Assemble an entire chip and add the appropriate pads to a layout

CO4. Understand the design flow of CMOS circuit and real life complications associated with it.

CO5. Derive basic analytical MOS circuit equations and estimate delay of different input waveforms used in CMOS circuits

EC-310	Power Electronics	L	T	P	C
	Sixth Semester ECE	3	1	0	4
	Pre-requisite- None				
Unit 1	Introduction: need for power conversion with efficient, high frequency, light weight converters; Power electronic converters classifications and scope;				
Unit 2	<i>Power semiconductor switches</i> : Power/fast diodes, BJT, MOSFET, SCR, Triacs, GTOs, IGBT and MCT, Ratings, static and dynamic characteristics, principle of operation, drive and switching aid circuits and cooling; isolation; protection.				
Unit 3	<i>AC-DC converters (Rectifiers)</i> : Diode rectifier, phase control rectifiers; effect of source inductance, single/three phase rectifiers, semi/full rectifiers, power factor, harmonics.				
Unit 4	<i>DC-AC converters (inverters)</i> : Concept of switched mode inverters, PWM switching, voltage and frequency control of single/three phase inverters, harmonics reduction, other switching schemes-square wave pulse switching, programmed harmonic elimination switching, current regulated modulation switching- tolerance band control, fixed frequency control, voltage source inverter (VSI),current source inverter(CSI).				
Unit 5	<i>DC-DC Converter (Chopper)</i> : Principle, buck, boost and buck-boost converters, analysis with continuous and discontinuous loads, flyback converters				
Unit 6	<i>AC voltage controllers</i> : Principle of ON-OFF control and phase control, single/three phase controllers, PWM AC voltage controller. ;Single phase AC static switches; transient-free switching of inductive loads; cycloconverter				
Unit 7	Basic concepts of adjustable speed dc and ac drives and industrial application, Switched mode power supply				

Text/Reference books:

1. Power Electronics- Converters, Application and Design, N. Mohan, John Wiley& Sons
2. Fundamentals of Electrical Drives, G.K Dubey, Narosa Publishing House

Course Outcomes (CO):

The graduates will be able to:

CO1. Classify electronic converters and different power semiconductor switches.

CO2. Analyze AC-DC and DC-AC converters.

CO3. Analyze choppers and AC voltage controllers.

CO4. Design different power electronics systems.

CO5. Analyze AC and DC drives, SMPS.

EC-311	Microprocessors Laboratory	L	T	P	C
	Fifth Semester ECE	0	0	3	2
	Pre-requisite- Nil				

List of Experiments

1. Programs for 16 bit arithmetic operations using 8086.
2. Programs for Sorting and Searching (Using 8086).
3. Programs for String manipulation operations (Using 8086).
4. Programs for Digital clock and Stop watch (Using 8086).
5. Interfacing ADC and DAC.
6. Parallel Communication between two MP Kits using Mode 1 and Mode 2 of 8255.
7. Interfacing and Programming 8279, 8259, and 8253.
8. Serial Communication between two MP Kits using 8251.
9. Interfacing and Programming of Stepper Motor and DC Motor Speed control.
10. Programming using Arithmetic, Logical and Bit Manipulation instructions of
 1. 8051 microcontroller.
11. Programming and verifying Timer, Interrupts and UART operations in 8051
12. Communication between 8051 Microcontroller kit and PC.
13. A design problem using 8051 (A problem like multi-parameter data acquisition system, voltmeter, power meter, frequency counter, traffic simulation, digital clock, etc)

Course Outcomes (CO): The graduates will be able to

CO1: To expose students to the operation of typical microprocessor (8085 & 8086) trainer kit.

CO2: Identify and define Bus, Wires and Ports, Basic Protocols of data transfer, Memory mapped I/O and simple I/O, Parallel I/O and Port Based I/O of 8051.

CO3: Demonstrate ability to handle arithmetic and logical operations using assembly language programming

CO4: Demonstrate ability to handle string instructions using assembly language programming

CO5: Knowledge about various interfacing devices and associated assembly language programming

EC-312	Digital Signal Processing Laboratory	L	T	P	C
	Fifth semester ECE	0	0	3	2
	Pre-requisite- Nil				

List of Experiments-

1. Implementation of various addressing modes using TMS3206713 DSP processor
2. Wave form generation (Sine Wave, Triangular wave, Stair case wave form etc.) using MATLAB and TMS3206713DSP processor
3. Sampling and sampling rate conversion using MATLAB and TMS3206713DSP processor
4. Implementation of Fast Fourier Transform (FFT) using MATLAB and TMS3206713DSP processor
5. Implementation of Linear and Circular Convolutions using MATLAB and TMS3206713 DSP processor
6. Design of Infinite Impulse Response (IIR) filter using MATLAB and TMS3206713 DSP processor
7. Design of Finite Impulse Response (FIR) filter using MATLAB and TMS3206713 DSP processor
8. Implementation of Decimation and Interpolation using MATLAB and TMS3206713 DSP processor
9. Implementation of Quantization using MATLAB and TMS3206713 DSP processor
10. Implementation of difference equations using MATLAB and TMS3206713 DSP processor
11. DTMF Signal Detection using FFT using MATLAB and TMS3206713 DSP processor
12. Beat Detection Using Onboard LEDs using MATLAB and TMS3206713 DSP processor

Course Outcomes (CO): The graduates will be able to

CO1: Understand the software and hardware related to digital signal processing.

CO2: Implement various signal processing techniques using DSP hardware.

CO3: Implement different kinds of filters on hardware platform.

CO4: Apply various techniques for solving communication and signal processing related problems

CO5: Solve and demonstrate the real life problem with DSP hardware.

EC-313	Digital Communication Laboratory	L	T	P	C
	Fifth semester ECE	0	0	3	2
	Pre-requisite-Nil				

List of Experiments-

1. Experiment of Modulation Demodulation Technique on (a) AM (b) DSB-SC (c) SSB-SC (d) FM.
2. Experiment on analog Pulse modulation such as PAM, PWM
3. Experiment on Modulation Demodulation Technique of PCM
4. Experiment on TDM-PCM system
5. Studies of PSK modulator and demodulator, connected by physical channel.
6. Studies on FSK modulator and demodulator, connected by simulated channel
7. Studies on ASK modulator and demodulator, connected by physical channel
8. Studies on QPSK modulator and demodulator, connected by either physical or simulated channel
9. (In all above experiments, nature of the modulated waveform is to be studied by a CRO. The spectrum is to be studied with a spectrum analyzer and the essential bandwidth is to be determined; finally the reception quality is to be analyzed by cross co-relation characteristics and measurement of bit error rate in presence of channel noise).
10. Experiment on channel/source coding.
11. Any innovative or established design of communication (analog/digital) circuit/logic through ASIC/reconfigurable board.
12. Studies on Delta modulator & Demodulator using trainer kits
13. Studies on Adaptive delta modulation using trainer kits
14. Studies on delta signal modulation using trainer kits
15. Studies on PCM/TDM system (Multiplexing/De-multiplexing) (Object is to measure distortion factor of the demodulated signal with variable signal amplitude and frequency, measure the essential B.W. of the modulated signal.
16. Studies of PCM/TDM system (Multiplexer & De-multiplexer) (To study the inter-channel interference and synchronization problem in multiplexer and de-multiplexer system

17. Studies of direct sequence spread spectrum modulation and demodulation
18. Studies of frequency hopped spread spectrum modulation and demodulation (To study spreading and dispersing, effect of channel noise, single tone interference etc)
19. Study of features of ISDN network

Course Outcomes (CO): Students will be able to

CO1: The ability of visualization and practical implementation of baseband modulation techniques

CO2: The skill to analyze and implement analog to digital converters like PCM, DM

CO3: The ability to design pass band digital modulation systems and techniques with desired specifications

CO4: The ability to implement pass band digital demodulation techniques

EC-314	Design Laboratory	L	T	P	C
	Sixth semester ECE	0	0	3	2
	Pre-requisite- Nil				

A student has to do an electronic hardware mini-project in broad areas like communication, electronic systems design, control and instrumentation, computer, power systems and signal processing. The project involves laying down the specifications, design, prototyping and testing. The project must have major hardware modules involving active discrete components and integrated circuits

Course Outcome: The graduates will be able to

CO1: explain the theoretical principles essential for understanding the operation of electronic circuits

CO2: measure the characteristics of electronic circuits and present experimental results

CO3: analyze electrical circuits and calculate the main parameters

CO4: develop, design and create simple and innovative analogue and digital electronic circuits

CO5: choose an engineering approach to solving problems, starting from the acquired knowledge essential for the design of electronic circuits

EC-315	Data & Optical Communication Laboratory	L	T	P	C
	Sixth semester ECE	0	0	3	2
	Pre-requisite- Nil				

List of Experiments-

I. Data Communication-

1. Study of packet transmission among nodes
2. Study the performance of Stop & Wait Protocol, Sliding Window Protocol and Selective Repeat Request Protocol
3. Study of Medium Access Control Protocol– Carrier Sense Multiple Access (CSMA) and CSMA with Collision Avoidance (CSMA/CA)
4. Study of routing protocols- Distance Vector Routing Protocol and Link State Routing Protocol

II. Optical Communication

1. Measurement of numerical aperture of an optical fiber.
2. Measurement of propagation loss, bending loss and connector loss in an optical fiber
3. Studies of LASER characteristics
4. Measurement of wavelength of an optical fiber source.
5. Setting up a fiber optic analog link, study of PAM.
6. Studies of Frequency Division Multiplexing and De multiplexing.
7. Setting up a fiber optic data link and study of TDM.
8. Setting up a PC to PC communication link using optical fiber.

Course Outcome: The graduates will be able to

CO1: Understand different data communication techniques

CO2: Explore various media access control and routing protocols

CO3: Visualize characteristics of Laser diode and LED

CO4: Measure and analyse and implement loss in analog and digital optical fiber link

CO5: Realize and understand the fault measuring technique of optical link.

EC-316	VLSI Design Laboratory	L	T	P	C
	Sixth semester ECE	0	0	3	2
	Pre-requisite-Nil				

List of Experiments:

1. Static characteristics of an inverter in schematic.
2. Static characteristics of two input NAND gate, two input NOR gate, two input AND gate, two input OR gate in schematic.
3. Static characteristics of inverter in layout.
4. Transfer and transient characteristics of two input NAND gate, two input OR gate, two input AND gate and two input NOR gate in layout.
5. Realize a 2-input EXOR gate in schematic and draw its layout and simulate.
6. Realize a 1-bit full adder in CMOS schematic and simulate. Generate layout using tool option and simulate.
7. Realize a Boolean expression $y = \text{NOT}((A+B)(C+D)E)$ in schematic and draw its layout and simulate.
8. 4 x 1 MUX using transmission gates in schematic and layout and simulate.
9. D Flip-Flop, JK Flip-Flop and T Flip-Flop in CMOS schematic and layout.
10. Four bit asynchronous counter using T Flip-Flop as a cell in schematic.
11. Four bit synchronous counter using T Flip-Flop as a cell in schematic.
12. Four bit shift register using D Flip-Flop as a cell in schematic
13. Expressing following electronic circuit using Verilog and verifying their output using testbench:
Half Adder, Full Adder, Eight Bit Full Adder, One Bit Comparator, D Flipflop, Maximum Value Selector, Accumulator, Multiplexer, Encoder, Counter

Course Outcomes: At the end of the laboratory work, students will be able to

- CO1.** Apply switching theory concepts to develop various combinational and sequential circuits.
- CO2.** Perform Transient, DC analysis, and Power analysis of various circuits in CAD tool.
- CO3.** Perform transistor-level schematic design and layout
- CO4.** Efficiently and effectively use various EDA tools for designing circuits to solve real time problems.

CO5: Express electronic circuit using Verilog and verify their output using testbench

EC-401	Wireless Communication	L	T	P	C
	Seventh Semester ECE	3	0	0	3
	Pre-requisite- None				
Unit 1	Wireless Channels: Large scale path-loss, path-loss models: free space and two-ray models; small scale fading, parameters of multipath channels, time dispersion parameters, coherence bandwidth, Doppler spread, coherence time, fading due to multi path time delay spread, flat fading, frequency selective fading, fading due to Doppler spread: fast fading and slow fading; outdoor and indoor channel models: Okumara and Hata models				
Unit 2	Introduction to Cellular Communication: Multiple access techniques: FDMA, TDMA, CDMA; cellular concept, hexagonal cell design and its SNR calculation, splitting and sectoring cells, microcell systems, microcell system design, capacity analysis traffic analysis in terms of Erlang				
Unit 3	Digital Signaling for Fading Channels: Structure of a wireless communication link, principle of offset QPSK, $\pi/4$ QPSK, minimum shift keying, Gaussian minimum shift keying, error performance in fading channels, OFDM principle, cyclic prefix, PAPR, windowing				
Unit 4	GSM Technology and Evolution: GSM models and its frequency plan, overview of modulation schemes suitable for cellular communications, spectral efficiency, GPRS, EDGE, CDMA-2000, WCDMA, WiMAX, LTE, emerging techniques for 5G and beyond				

TEXT/REFERENCE BOOKS

1. Fundamentals of Wireless Communications, *D. Tse and P. Viswanath*, Cambridge University Press
2. Wireless Communications, *T. S. Rappaport*, Prentice-Hall
3. Wireless Communications, *Andrea Goldsmith*, Cambridge University Press
4. A First Course in Digital Communications, *Ha H. Nguyen and Ed Shwedyk*, Cambridge University Press
5. Mobile Radio Communications, *R. Steele and L. Manzo*, John Wiley
6. Mobile Cellular Telecommunications, *W. C. Y. Lee*, McGraw Hill

Course Outcomes:

The graduates will be able to:

CO1: Understand channel characteristics and models of wireless channel

CO2: Understand the different multiple access techniques and Cellular system, thereafter measure the traffic intensity in wireless communication

CO3: Investigate different modulation techniques in wireless communication and analyze it by solving associated problems

CO4: Explore GSM models and next-generation wireless communications and understand their practical aspects

MS-401	BUSINESS MANAGEMENT	L	T	P	C
	Seventh Semester ECE	3	0	0	3

Course Contents:

Overview of Management: Definition – Management, Role of managers, Evolution of Management thought, Principles of Management, Planning: Nature and purpose of planning, Planning process, Types of plans, Decision Making, Types of decision, Decision Making Process, Rational Decision Making. Organizing: Nature and purpose of organizing, Organization structure, Formal and informal groups in organization, Line and Staff authority, Span of control, Centralization and Decentralization, Delegation of authority, Staffing: Selection and Recruitment, Training, Performance Appraisal, Directing: Creativity and Innovation, Controlling: Process of controlling, Types of control, Budgetary and non-budgetary control.

Introduction to Marketing: Challenges of modern marketing; Customer value and satisfaction; Market-oriented strategic planning; Marketing Information System. Scanning the marketing environment; Buyer Behaviour; Consumer Behaviour; Market segmentation; Targeting and Positioning (STP).

Organizational Behaviour: Introduction to OB; Foundations of Individual Behaviour; Attitudes and Job Satisfaction; Personality and Emotions; Perception and Individual Decision Making; Motivation & its theories; Understanding Work Teams; Leadership & its theories; Group Dynamics; Foundations of Group Behaviour; Stress Management; Conflict Management, Organization Culture; Elements and types of culture.

Texts books/References:

1. S. P. Robbins and T. A. Judge. *Organizational Behaviour*. 17/e, Prentice-Hall of India Pvt. Ltd., 2017.

2. Charles W.L. Hill, Steven L. Mc Shane. *Principles of Management (SIE)*. Tata McGraw- Hill Education pvt. Ltd., 2007
3. Udai Pareek. *Understanding Organizational Behaviour*. 2/e, Oxford University Press, 2008.
4. T. S. Bateman and S. A. Snell. *Management*. 8/e, TMH, 2008.
5. K. Aswathappa. *Organisational Behaviour*. 12/e, Himalaya Publishing House, 2016.
6. Kotler, P., Keller, K. *Marketing Management*. 15th Global Edition, Pearson Education, 2016
7. Mullins, J., Walker, O., and Harper, B.J. *Marketing Management: A Strategic Decision-Making*. 8th edition McGraw-Hill Education, 2012
8. Ramaswamy & Namakumari. *Marketing Management*. 6th Edition, SAGE Publication, 2018

Course Outcome:

1. The students will get a thorough knowledge of different management concepts and their relevant applications in day to day organizational commitments.
2. Demonstrate how the organizational behaviour can integrate in understanding the motivation (why) behind behaviour of people in the organization.
3. Students will demonstrate effective understanding of relevant functional areas of marketing management and its application

Department of Humanities & Social Sciences

HS 401	Managerial Economics	L	T	P	C
	Eight Semester	3	0	0	3

Course Objective:

The Objective is to impart the basic knowledge about the working of the firms in a competitive environment in regards to optimization of cost, price, output and resource use as well as familiarizing the learners about the macro-economic environment in which the business firms operate.

- Unit-1** Basic concepts: Nature, Scope and Application of Managerial Economics.
- Unit-2** Theory of Consumer Behavior and Demand Analysis: Demand Analysis, Elasticity of Demand, Demand Estimation and Forecasting, Supply, Equilibrium of a firm and industry.
- Unit-3** Cost Estimation: Theory of Cost, Analysis of Economies of Scale.
- Unit-4** Theory of Production: Isoquant, Isocost line, Cobb-Douglas Production Function.
- Unit-5** Market Structure: Perfect Competition, Monopoly and Monopolistic Competition.
- Unit-6** Macroeconomic Issues: National Income, Inflation and Business Cycle.
- Unit-7** International Trade: Comparative advantage and H-O model.

Reference Books:

1. Salvatore, Dominick: Managerial Economics: Principles and Worldwide Applications, Oxford university Press, New Delhi.
2. Pindyck, Robert S. & Daniel L. Rubinfeld: Microeconomics, Prentice-Hall of India Private Limited, New Delhi.
3. Baye, Michael R. & Jeffrey T. Prince: Managerial Economics and Business Strategy, McGraw Hill Education (India) Private Limited, Chennai.
4. Koutsoyiannis, A.: Modern Microeconomics, Macmillan Press Limited, London.
5. Mankiw, N. Gregory: Principles of Economics, Cengage India.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Take better economic decisions in regards to cost, price fixation and determination of optimum level of output.
2. Situate themselves as managers of business entity, within the overall macro-economic environment which will, in turn, help them to take effective economic and managerial decisions.

EC-331	COMMUNICATION SYSTEM MODELING AND SIMULATION	L	T	P	C
	Professional Core Elective-I	3	0	0	3

Course Prerequisite: EC-206, EC-301

- Unit 1 Simulation methodology-** Introduction, Aspects of methodology, Performance Estimation, frequency, Low pass equivalent models for band pass signals, multicarrier signals, Non-linear and time varying systems, Post processing, Basic Graphical techniques and estimations
- Unit 2 Simulation of random variables random process-** Generation of random numbers and sequence, Gaussian and uniform random numbers Correlated random sequences, Testing of random numbers generators, Stationary and uncorrelated noise, Goodness of fit test.
- Unit 3 Modelling of communication systems-** Radio frequency and optical sources, Analog and Digital signals, Communication channel and models, Free space channels, Multipath channel and discrete channel noise and interference.
- Unit 4** Quality of estimator, Estimation of SNR, Probability density function and bit error rate, Monte Carlo method, Importance sampling method, Extreme value theory.
- Unit 5 Simulation and modeling methodology-** Simulation environment, Modelling considerations, Performance evaluation techniques, error source simulation, Validation.

Text Books:

1. Simulation of Communication Systems: Modeling, Methodology and Techniques , MC. Jeruchim, P. Balaban and Sam K Shanmugam, Plenum Press, New York, 2001

Reference Books:

2. Simulation Modeling and Analysis , Averill. M. Law and W. David Kelton, McGraw Hill Inc., 2000
3. Discrete Event System Simulation, Jerry Banks and John S. Carson, Prentice Hall
4. of India
5. Performance Analysis of Digital Communication Systems, W. Turin, Computer Science Press, New York

6. *Principles of Communication Systems Simulation*, William H. Tranter, K. Sam Shanmugam, Theodore S. Rappaport, K. Kurt L. Kosbar, Pearson Education

Course Outcomes:

The graduates will be able to:

CO1: Understand aspects of simulation methodology, performance estimation, non-linear, and time varying systems.

CO2: Study the theory of random variables, random processes, and Gaussian process should be studied by the students.

CO3: Understand modelling of different communication systems.

CO4: Learn about Monte Carlo simulation, PDF, CDF, BER, SNR plots etc.

CO5: Know various simulation and modelling methodology.

EC-332	Materials for Semiconductors	L	T	P	C
	Professional Core Elective-I	3	0	0	3

Course Prerequisite: EC-101, EC-201

- Unit 1** VLSI Environment: Micro-contamination; Contamination Sources; Effects of Contamination; Contamination Control; Clean Room.
- Unit 2** Semiconductor Materials: properties of semiconductors; Crystallography; Extraction of semiconductor grade silicon wafer and characterization; Wafer Surface Cleaning; Doping: Diffusion and Ion-Implantation.
- Unit 3** Insulator Materials: Oxidation: Dry and Wet; Kinetics of SiO₂ growth; High-K Dielectrics; Low-K Dielectrics Conductors or Metals: Role in Semiconductor Devices; Deposition methods; Alloying; Selection of conductors.
- Unit 4** Vacuum Technology: Vacuum basics; Vacuum pumps: Rotary pump, Diffusion Pump, Turbo Molecular pump; Measurement of Vacuum: Pirani and Penning gauges; example of a vacuum system
- Unit 5** Thin Film Deposition: Chemical Vapor Deposition and Atomic Layer Deposition; Physical Vapor Deposition: Sputtering, Thermal Evaporator, e-beam evaporation; Epitaxy
- Unit 6** Lithography: Photoresists: Negative and Positive; Deposition of photoresists; Photomasks; Lithography techniques: Optical, E-beam, and Soft Lithography; Etching: Wet and Dry; Lift-off.
- Unit 7** Device Structures fabrication and electrical characteristics: Metal-Semiconductor Contacts: Ohmic and Schottky, Diode, MOS Capacitor and MOSFET, Memory Devices, Packaging.

Text/Reference books:

1. Silicon VLSI Technology, Plummer, Deal and Griffin, Prentice Hall
2. Fundamentals of Semiconductor Fabrication, S. M. Sze, John Wiley and Sons
3. Fundamentals of Microfabrication: The Science of Miniaturization, Marc Madou, CRC Press
4. Introduction to Microelectronic Fabrication, R.C. Jaeger, Prentice Hall
5. Semiconductor Physics and Devices, Donald A. Neaman, Tata McGraw Hills
6. Semiconductor Material and Device characterization, D. K. Schroder, John Wiley and Sons

Course Outcomes: The students will be able to

CO1: Understand the importance of clean room impact to prevent contaminations on semiconductor processing and preparation and characterization process of silicon wafer and their cleaning process.

CO2: Select suitable dielectric materials (high-K and low-K) and conductor based on their applications and also the growth process of oxides for dielectric applications.

CO3: Understand the basic of different vacuum pumps, gauges, evaporation systems, and chemical vapour deposition and apply them for thin film deposition.

CO4: Apply the suitable photolithography technique for semiconductor processing.

CO5: Understand the fabrication and packaging processes of the electronic devices.

EC-333	SIMULATION OF DEVICES AND CIRCUITS	L	T	P	C
	Professional Core Elective-I	3	0	0	3
	Course Prerequisite: EC-201				

Unit 1 *Review of Semiconductor Devices:* P-N Junction Diode, Schottky diodes, MOS Device operations, Poisson's equation, continuity, drift, diffusion, mobility, trap charges. BJT models - Eber's Moll, Gummel - Poon model. *MOS Models:* LEVEL1, LEVEL2 and LEVEL3, MESFETs, HEMTs and HBTs.

Unit 2 *PSpice:* Introduction - Pspice overview - DC circuit Analysis -AC circuit analysis - Transient and the time domain - Fourier Series and Harmonic components - An introduction to Pspice devices BJT, FET, MOSFET and its model, Amplifiers and Oscillators.

Unit 3 MATLAB simulation for the computation of device characteristics of simple devices.

Unit 4 SUPREM Process simulation

Text/Reference books:

1. Semiconductor Device modeling with SPICE, Massobrio, TMH
2. Computer aided analysis of power electronic systems, Rajagopalan. V, Marcel Dekker
3. Microsim Pspice and circuit analysis, John Keown, Prentice Hall College Div
4. Introduction to Device Modeling and Circuit Simulation, Tor A. Fjeldly, Trond Ytterdal, and Michael Shur, Wiley-Interscience
5. Semiconductor Material and Device Characterization, Dieter K. Schroder, Wiley-Interscience
6. Computer-Aided Circuit Analysis Using PSpice, Walter Banzhaf, Prentice Hall College Div
7. Device Electronics for Integrated Circuits, Richard S. Muller, Theodore I. Kamins, and Mansun Chan, John Wiley & Sons
8. Matlab / Simulink manual, Mathworks

Course Outcomes:

After completion of the course, the students will be able to:

CO1. Analyze various semiconductor devices and circuits operation

CO2. Analyze and modify various models of simple devices

CO3. Use PSPICE for simulation of circuits

CO4. Use MATLAB for the computation of device characteristics

CO5. Perform process simulation to analyze semiconductor devices

EC-334	ANALOG AND DIGITAL FILTER DESIGN	L	T	P	C
	Professional Core Elective-I	3	0	0	3

Course Prerequisite: EC-204, EC-304, EC-203

- Unit 1** Introduction to Filters, Analog Filter Frequency Response
- Unit 2** Analog Filter Implementation with Active Filters
- Unit 3** Analog Filter Approximations, Butterworth approximations, Chebyshev approximations, Inverse Chebyshev approximations, Elliptic approximations
- Unit 4** Introduction to Discrete-Time Systems, Frequency response of discrete-time systems
- Unit 5** Infinite Impulse Response (IIR) Digital Filter Design, Impulse invariance, Bilinear transform design
- Unit 6** Finite Impulse Response (FIR) Digital Filter Design, Windowing techniques to improve design, Frequency sampling

Text/Reference books:

1. S. Orfanidis, Introduction to Signal Processing, Prentice Hall, 1996.
2. B. Lathi, *Signal Processing & Linear Systems*, Oxford University Press, 1998.
3. A. Antoniou, *Digital Filters: Analysis, Design, and Applications*, 2ed, McGraw-Hill, 2000.

Course Outcomes:

After completion of the course, the students will be able to:

- CO1. Understand filter specification and Design analog filters using Butterworth, Chebyshev, and elliptical approximations
- CO2. Determine the filter frequency response with respect to filter specifications
- CO3. Design active filters using operational amplifiers to meet certain application
- CO4. Design digital filters with infinite impulse response to certain specifications
- CO5. Design digital filters with finite impulse response to meet certain specifications for certain applications

EC-335	ANALOG IC DESIGN	L	T	P	C
	Professional Core Elective-I	3	0	0	3

Pre-requisite - EC-203

- Unit 1** *Differential amplifiers:* Single ended and Differential operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads.
- Unit 2** *Passive and Active Current Mirrors:* Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.
- Unit 3** *Operational Amplifiers:* General Considerations, One- Stage Op-Amp, Two- stage Op-Amp, gain Boosting, Common Mode feedback, Input Range limitations, Slew Rate, Power Supply Rejection Ratio, Noise in Op- Amp.
- Unit 4** *Noise:* Statistical characteristics of Noise, Types of noise, Representation of Noise in Circuits, Noise in Single Stage Amplifiers, Noise in Differential Pairs, Noise BW.
- Unit 5** *Stability and Frequency Compensation:* General considerations, Multipole Systems, Phase Margin and Gain Margin, Frequency Compensation : Compensation of Two Stage Op-Amp, Other Compensation Techniques.
- Unit 6** *Wave generators and wave shaping:* Sinusoidal oscillator, Phase shift oscillator, Wein bridge oscillator, Square wave and triangular wave generator, Voltage time base generator, step generator, Modulation of square wave.
- Unit 7** *Filters:* Active RC filters, Butterworth & Chebyshev filter function, switched capacitor filter.

Text/Reference:

1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, TMH
2. Analysis & Design of Analog Integrated Circuits, Gray, Hurst, Lewis, and Meyer, Wiley India Pvt Ltd
3. CMOS Analog Circuit Design, Allen and Holberg, Oxford University Press
4. Analog IC Design, John & Martin, Wiley

Course Outcomes: The graduates will be able to:

CO1: Design differential amplifiers and current mirror circuits

CO2: Analyze the performance of single and multi-stage operational amplifier

CO3: Assess the impact of noise in performance of amplifiers

CO4: Analyze the stability parameters and compensation techniques in operational amplifiers

CO5: Design different wave generator, wave shaping, and filter circuits

EC-336	MEDICAL ELECTRONICS	L	T	P	C
	Professional Core Elective-I	3	0	0	3

Pre-requisite - EC-203

- Unit 1** *Electro-Physiology and Bio-Potential Recording:* The origin of Bio-potentials; biopotential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, lead systems and recording methods, typical waveforms and signal characteristics.
- Unit 2** *Bio-Chemical and Non Electrical Parameter Measurement:* pH, PO₂, PCO₂, colorimeter, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood Cell Counters.
- Unit 3** *Assist Devices:* Cardiac pacemakers, DC Defibrillator, Dialyser, Heart-lung machine.
- Unit 4** *Physical Medicine and Biotelemetry:* Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy Telemetry principles, frequency selection, biotelemetry, radiopill, electrical safety.
- Unit 5** *Recent Trends in Medical Instrumentation:* Thermograph, endoscopy unit, Laser in medicine, cryogenic application, Introduction to telemedicine.

Text/Reference:

1. Leslie Cromwell, Biomedical Instrumentation and Measurement, Prentice Hall of India, New Delhi, 2007.
2. Khandpur, R.S., Handbook of Biomedical Instrumentation, TATA Mc Graw-Hill, New Delhi, 2003.
3. John G.Webster, Medical Instrumentation Application and Design, 3rd Edition, Wiley India Edition, 2007
4. Joseph J.Carr and John M.Brown, Introduction to Biomedical Equipment Technology, John Wiley and Sons, New York, 2004.

Course Outcomes:

The graduates will be able to:

CO1: Analyze and evaluate the effect of different diagnostic and therapeutic methods, their risk potential, physical

principles, opportunities, and possibilities for different medical procedures.

CO2: Understand the medical terminologies, relevant for biomedical instrumentation.

CO3: Understand and describe the physical and medical devices used as a basis for biomedical instrumentation.

CO4: Analyze the elements of risk for different biomedical instrumentation methods and basic electrical safety.

CO5: Design the biomedical equipment in modern hospital care.

EC-337	MOBILE AND CELLULAR COMMUNICATIONS	L	T	P	C
	Professional Core Elective-I	3	0	0	3

Pre-requisite- *Analog and Digital Communications*.

- Unit 1** Fundamentals of Cellular Communications- Introduction, Cellular Systems, Hexagonal Cell Geometry, Co-channel Interference Ratio, Cellular System Design in Worst-Case Scenario with an Omni directional Antenna, Co-channel Interference Reduction, Directional Antennas in Seven-Cell Reuse Pattern, Cell Splitting, Adjacent Channel Interference (ACI), Segmentation.
- Unit 2** An Overview of Wireless Systems- Introduction, First and Second Generation Cellular Systems, Cellular Communications from 1G to 3G, Wireless 4G Systems; Future Wireless Networks Radio Propagation, Propagation Path-Loss Models- Introduction, Free-space Attenuation, Attenuation over Reflecting Surfaces, Radio wave Propagation, Characteristics of Wireless Channel, Signal Fading Statistics, Propagation Path-loss Models, Cost 231 Model.
- Unit 3** Wireless Application and Standards- Fundamentals of WLAN transmission technology, WLAN applications, IEEE 802.11, 802.11 systems performance; WiMAX standards, WiFi standards, Zigbee.
- Unit 4** Multiple Access Techniques- Introduction, Narrowband Channelized Systems, Comparisons of FDMA, TDMA and DS-CDMA, Comparison of DS-CDMA vs. TDMA; System Capacity, Multicarrier DS-CDMA (MC-DS-CDMA).
- Unit 5** Modulation schemes- Introduction to modulation, Phase Shift Keying, Quadrature Amplitude Modulation, M-ary Frequency Shift Keying, Synchronization, Equalization Spread Spectrum(SS) and CDMA Systems- Introduction, Concept of Spread Spectrum, System Processing Gain, Requirements of Direct-Sequence Spread Spectrum, Frequency-Hopping Spread Spectrum Systems.

Text Books:

1. Wireless Communication and Networking, Essential Reading, V K Garg, Morgan Kaufman Publishers India; 2008
2. Wireless communication & networks, Upena Dalal, Oxford University Press, 2014

Reference Books:

1. Wireless Communications- Principles and Practice, T S Rappaport, Pearson Education India
2. Mobile Communication Engineering – Theory and Applications, W C Y Lee, TMH Publication
3. Wireless Communications, T L Singhal Tata McGraw Hill, 2010
4. Wireless Communication, A Goldsmith, Cambridge

Course Outcomes:The graduates will be able to:

CO1: Understand Cellular System for Mobile Communication, investigate interference in the communication, and its mitigation techniques

CO2: Understand the evaluation of mobile communications, free-space propagation model, and losses in the wireless communications

CO3: Explore next-generation wireless communications, understand multiple access techniques and their practical aspects

CO4: Investigate the performance of different modulation techniques in wireless communications and analyze it by solving associated problems

EC-338	Applied Electronic Circuits	L	T	P	C
	Professional Core Elective-I	3	0	0	3

Pre-requisite- EC-203

- Unit 1 Operational Amplifier and its components:** Introduction, Two transistor MOS current source, Current steering, Cascode current source, Wilson current source, Active loads., Basics of differential amplifier, Differential amplifier with passive load, Differential amplifier with active load, Calculation of common mode gain, differential mode gain and CMRR using π model, Two stage CMOS Op-Amp, Calculation of common mode gain, differential mode gain and CMRR of two stage CMOS Op-Amp using π model, Problem with more gain stages, output stage, Importance of negative feedback in Op-Amp.
- Unit 2 Active Filters:** Active versus Passive Filters, Types of Active Filters, First-Order Filters, The Biquadratic Function, Butterworth Filters, Butterworth Function for Higher-Order Filters, Transfer Function Realization, Low-Pass Filters, First and Second-Order Low-Pass Filters, Butterworth Low-Pass Filters, Sallen-Key Low-Pass Filters, High-Pass Filters, First and Second-Order High-Pass Filters, Butterworth High-Pass Filters, Sallen-Key High-Pass Filters Band-Pass Filters, Wide-Band-Pass Filters, Narrow-Band-Pass Filters, Band-Reject Filters, Wide-Band-Reject Filters, Narrow-Band-Reject Filters, All-Pass Filters, Switched-Capacitor Resistors, Switched-Capacitor Resistors, Universal Switched-Capacitor Filters, Filter Design Guidelines.
- Unit 3 Analog Multipliers:** Introduction, Log-Antilog single quadrant multipliers, Emitter coupled two quadrant multipliers, Gilbert four quadrant current multiplier, Current to voltage conversion, Complete four quadrant voltage multiplier, Applications of multipliers in various communication networks.
- Unit 4 Integrated Analog Circuits and Applications:** Precision Peak Voltage Detectors, Precision Half and Full Wave Rectifiers, Precision Clamping Circuits, Fixed-Voltage Limiters, Adjustable Voltage Limiters, Zener Voltage Limiters, Hard Limiters, Threshold Comparators, Zero-Crossing Detectors, Voltage-Controlled Oscillators, Phase-lock loop circuits and their applications, Voltage-to-Frequency and Frequency-to-Voltage Converters

Text / Reference Books

1. Microelectronics: Circuit Analysis and Design, Donald A Neamen, McGraw-Hill Education(4th edition).
2. Microelectronic Circuits, Adel S. Sedra and Kenneth C. Smith Oxford University Press (7th edition).
3. Microelectronic Circuits Analysis and Design, Muhammad H. Rashid, Cengage Learning, Inc; 2nd ed.
4. Design of Analog CMOS Integrated Circuits, Behzad Razavi, Tata McGraw Hill.
5. Analog Electronics with Op-Amps, A.J. Peyton and V. Walsh, Cambridge University Press.
6. Analysis and Design of Analog ICs, Gray and Meyer Wiley India Pvt Ltd.

Course Outcomes:The graduates will be able to:

CO1: Recognize the internal circuitry of operational amplifiers using CMOS.

CO2: Design and analysis of important types of active filter circuits.

CO3: Develop different multiplier circuits for application in communication networks

CO4: understand the working principle and applications of precision circuits, limiter circuits and, integrated circuits

CO5: Design oscillator, phase-lock loop, and converter circuits

EC-339	Multirate Digital Signal Processing and wavelets	L	T	P	C
	Professional Core Elective-I	3	0	0	3

Pre-requisite- Signals and systems, Digital signal processing

- Unit 1** Multirate Digital Signal Processing Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion Multirate Digital Signal Processing Multistage Implementation of Sampling Rate Conversion, Applications of Multirate Signal Processing, Sampling Rate Conversion of Bandpass Signals.
- Unit 2** Introduction Origin of Wavelets Haar Wavelet Dyadic Wavelet Dilates and Translates of Haar Wavelets L2 norm of a function.
- Unit 3** Piecewise Constant Representation of a Function Ladder of Subspaces Scaling Function of Haar Wavelet Demonstration: Piecewise constant approximation of functions Vector Representation of Sequences Properties of Norm Parseval's Theorem.
- Unit 4** Equivalence of functions & sequences Angle between Functions & their Decomposition Additional Information on Direct-Sum Introduction to Filter Bank Haar Analysis Filter Bank in Z-domain Haar Synthesis Filter Bank in Z-domain.
- Unit 5** Moving from Z-domain to frequency domain Frequency Response of Haar Analysis Low pass Filter bank Frequency Response of Haar Analysis High pass Filter bank Ideal Two-band Filter bank Disqualification of Ideal Filter bank Realizable Two-band Filter bank Demonstration: DWT of images.
- Unit 6** Relating Fourier transform of scaling function to filter bank Fourier transform of scaling function Construction of scaling and wavelet functions from filter bank Demonstration: Constructing scaling and wavelet functions.

Text/reference books

1. Proakis JG and Manolakis DG Digital Signal Processing Principles, Algorithms and Application, PHI.
2. Openheim AV & Schafer RW, Discrete Time Signal Processing PHI.

3. Michael W. Frazier, "An Introduction to Wavelets through Linear Algebra", Springer, 1999.
4. Stephane Mallat, "A Wavelet Tour of Signal Processing", Academic Press, Elsevier, 1998, 1999, Second Edition.
5. Barbara Burke Hubbard, "The World according to Wavelets - A Story of a Mathematical Technique in the making", Second edition, Universities Press (Private) India Limited 2003.
6. P.P.Vaidyanathan, "Multirate Systems and Filter Banks", Pearson Education, Low Price Edition.

Course Outcome: Graduate will be able to

CO1: Acquire the basics of Multirate digital signal processing and analyse the signal simultaneously in both the time and frequency domains

CO2: Represent a general finite energy signal by a piecewise constant representation

CO3: Understand the concept of 'approximation' and 'Incremental' subspaces and establish the connection between wavelet analysis and multirate digital systems

CO4: Establish a relation between wavelets and Multirate filter banks, from the point of view of implementation.

CO5: Can apply the Wavelet in audio processing, image enhancement, analysis and processing, geophysics and in biomedical engineering.

EC-431	RADAR Systems	L	T	P	C
	Professional Core Elective-II	3	0	0	3

Course Prerequisite: EC-206, EC-307

- Unit 1** *Introduction to RADAR:* Radar Block Diagram and Operation, Radar Frequencies and Applications, Radar Equation, Radar Cross Section of Targets, Detection Of Signal In Noise; Receiver Noise And S/N Ratio, Transmitter Power, Pulse Repetition Frequency and Range Ambiguities.
- Unit 2** *CW and Frequency Modulated Radar:* Doppler Effect, CW Radar - Block Diagram, Applications; FM-CW Radar - Range and Doppler Measurement, Block Diagram and Characteristics, FM-CW altimeter, Measurement Errors, Multiple Frequency CW Radar.
- Unit 3** *MTI and Pulse Doppler Radar:* Introduction, Principle, Delay Line Cancellers - Filter Characteristics, Blind Speeds, Staggered PRFs, Range Gated Doppler Filters, MTI Radar Parameters, Limitations to MTI Performance, Non-coherent MTI, MTI versus Pulse Doppler Radar.
- Unit 4** *Tracking RADAR:* Tracking with Radar, Sequential Lobing, Conical Scan, Monopulse Tracking Radar - Amplitude Comparison Monopulse (one- and two- coordinates), Phase Comparison Monopulse, Target Reflection Characteristics and Angular Accuracy, Tracking in Range, Acquisition and Scanning Patterns. Comparison of Trackers.
- Unit 5** *RADAR Antennas:* Reflector Antennas, Electronically Steered Phased Array Antennas, Phase Shifters, Frequency Scan Arrays, Mechanically Steered Planar Array Antennas, Radiators.
- Unit 6** *RADAR Receivers:* Noise and Clutter, Superheterodyne Receiver, Duplexers and Receiver Protectors, Radar Displays.

Text/Reference Books:

1. Introduction to Radar Systems, Merrill I. Skolnik, Tata McGraw-Hill
2. Elements of Electronics Navigation, N. S. Nagaraja, Tata McGraw-Hill
3. Modern RADAR System Analysis, D. K. Barton, Artech House

Course Outcomes:

The graduates will be able to:

CO1. Classify various kind of frequency modulated RADAR systems.

CO2. Analyze different characteristics and measurement errors.

CO3. Classify Doppler RADAR systems and illustrate radar parameters and limitation associated with MTI radars.

CO4. Analyze tracking radar systems, RADAR receiver, display and noise.

CO5. Classify different antennas used in radar applications.

CO6. Design duplexer, receiver and protectors.

EC-432	RF Circuits and Design	L	T	P	C
	Professional Core Elective-II	3	0	0	3
	Course Prerequisite: EC-307				

- Unit 1 Introduction to RF and Wireless Technology:** Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology.
- Unit 2 Basic Concepts in RF Design:** Nonlinearity and time variance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.
- Unit 3 Multiple Access:** Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards.
- Unit 4 Transceiver Architectures:** General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.
- Unit 5 Amplifiers, Mixers and Oscillators:** LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.
- Unit 6 Power Amplifiers:** General considerations, linear and nonlinear PA, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques Reading:

Text/Reference Books:

1. Behzad Razavi, RF Microelectronics Prentice Hall of India, 2001
2. Thomas H. Lee, The Design of CMOS Radio Integrated Circuits, Cambridge University Press.

Course Outcomes:

The graduates will be able to:

CO1: Understand the design bottlenecks specific to RF IC design, linearity related issues, ISI

CO2: Identify noise sources, develop noise models for the devices and systems

CO3: Specify noise and interference performance metrics like noise figure, IIP3 and different matching criteria.

CO4: Comprehend different multiple access techniques, wireless standards and various transceiver architectures

CO5: Design various constituents' blocks of RF receiver front end.

EC-433	WIRELESS SENSOR NETWORK	L	T	P	C
	Professional Core Elective-II	3	0	0	3

Course Prerequisite: EC-308, EC-206, EC-301

- Unit 1 Sensor Network Concept:** Introduction, Networked wireless sensor devices, Advantages of Sensor networks, Applications, Key design challenges.
- Unit 2 Network deployment:** Structured versus randomized deployment, Network topology, Connectivity, Connectivity using power control, Coverage metrics, Mobile deployment.
- Unit 3 Localization and Tracking:** Issues and approaches, Problem formulations: Sensing model, collaborative localization. Coarse-grained and Fine-grained node localization. Tracking multiple objects.
- Unit 4 Wireless Communications:** Link quality, shadowing and fading effects
- Unit 5 Medium-access and sleep scheduling:** Traditional MAC protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques, and Contention-free protocols
- Unit 6 Routing:** Metric-based approaches, Multi-path routing, Lifetime-maximizing energy-aware routing techniques, Geographic routing
- Unit 7 Sensor network Databases:** Data-centric routing, Data-gathering with compression
- Unit 8 State space decomposition and Synchronization:** Issues and Traditional approaches, Fine-grained clock synchronization, and Coarse-grained data synchronization; Querying; Data-centric storage and retrieval; the database perspective on sensor networks; Security: Privacy issues, Attacks and countermeasures.

Text Books:

1. Wireless Sensor Networks: An Information Processing Approach, *Feng Zhao, Leonidas*
2. *Guibas*, Morgan Kaufmann Series in Networking 2004
3. Networking Wireless Sensors, *Bhaskar Krismachari*, Cambridge University Press

Reference Books:

1. Wireless Sensor Networks, C.SRaghavendra, KrishnaM, Sivalingam, TaiebZnati, Springer
2. *Wireless Sensor Networks: Technology, Protocols, and Applications*, Kazem Sohraby, Daniel Minoli, Taieb

Znati, Wiley Inter Science

Course Outcomes:

The graduates will be able to:

CO1: Know sensor network concept

CO2: Know the different aspects of network deployment.

CO3: Learn localization and tracking system of wireless sensor networks and to implement these things for real time problems.

CO4: Know about various scheduling algorithms required for medium access control and sleeping process.

CO5: Understand different routing protocols and sensor databases.

CO6: Understand State space decomposition and Synchronization required for wireless sensor networks

EC-434	ADVANCED COMMUNICATION TECHNIQUE	L	T	P	C
	Professional Core Elective-II	3	0	0	3
	Course Prerequisite: EC-206, EC-301, EC-208				
Unit 1	Deterministic and Random Signal Analysis: Bandpass and Lowpass Signal Representation, Signal Space Representation of Waveforms, Limit Theorems for Sums of Random Variables, Random Processes, Series Expansion of Random Processes				
Unit 2	Digital Modulation Schemes: Representation of Digitally Modulated Signals, Memoryless Modulation Methods, Signaling Schemes with Memory, Power Spectrum of Digitally Modulated Signals				
Unit 3	Optimum Receivers for AWGN Channels: Waveform and Vector Channel Models, Waveform and Vector AWGN Channels, Optimal Detection and Error Probability for Band-Limited Signaling, Optimal Detection and Error Probability for Power-Limited Signaling, Optimal Detection in Presence of Uncertainty: Noncoherent Detection				
Unit 4	Carrier and Symbol Synchronization: Signal Parameter Estimation, Carrier Phase Estimation, Symbol Timing Estimation, Joint Estimation of Carrier Phase and Symbol Timing, Performance Characteristics of ML Estimators				
Unit 5	Digital Communication Through Band-Limited Channels: Characterization of Band-Limited Channels, Signal Design for Band-Limited Channels, Optimum Receiver for Channels with ISI and AWGN, Linear Equalization, Decision-Feedback Equalization				
Unit 6	Adaptive Equalization: Adaptive Linear Equalizer, Adaptive Decision-Feedback Equalizer, Adaptive Equalization of Trellis-Coded Signals, Recursive Least-Squares Algorithms for Adaptive Equalization, Self-Recovering (Blind) Equalization				
Unit 7	Multichannel and Multicarrier Systems: Multichannel Digital Communications in AWGN Channels, Multicarrier Communications				

Text Books:

1. Principles of Digital Transmission with Wireless Applications, , *S Benedetto and E Biglieri*, Kluwer Academic
2. Principles of Digital Communication , *R G Gallager*, Cambridge University Press
3. Wireless Communications, *Andreas F. Molisch*, Wiley

Reference Books

4. Digital Communications, , *J G Proakis*, McGraw Hill
5. Fundamentals of Digital Communication, *UMadhow* , Cambridge University Press

Course Outcomes are

The Graduates will be able to

CO1: Study the deterministic and random Signal analysis including random variables and random process.

CO2: Study the power spectrum of different digital modulation techniques, memory less modulation and modulation with memory.

CO3: Study the optimum receivers for the AWGN channel.

CO4: Understand the carrier and symbol synchronization.

CO5: Understand the characteristics of band-limited channels, optimum receivers for channels with ISI and AWGN, linear equalization.

CO6: Learn the adaptive equalization and multi carrier systems.

EC-435	Advanced VLSI Design	L	T	P	C
	Professional Core Elective-II	3	0	0	3
	Course Prerequisite: EC-309				

- Unit 1** *Implementation strategies for Digital ICs:* Custom, semi-custom, structured array design approaches, custom circuit design, cell based system design methodology - standard cell, compiled cell, macro-cell, mega-cell, intellectual property, array based implementation - pre-diffused array, pre-wired array.
- Unit 2** *Interconnect:* Capacitive, resistive and inductive parasitic, advanced interconnect techniques - reduced swing circuits, current mode transmission techniques, Network-on-Chip.
- Unit 3** *Timing Issues:* Timing Classification of digital circuits, synchronous design, self-timed circuit design, synchronizers and arbiters, clock synthesis and synchronization.
- Unit 4** *Design Verification:* Data paths in digital processor architectures, multiplier, shifter, other arithmetic operators, power and speed trade-offs in data path structures.
- Unit 5** *Memory and array structures:* Memory core, memory peripheral structures, power dissipation in memories, case study-PLA, SRAM etc.
- Unit 6** *Validation and test of manufactured circuits:* Design for testability- Ad Hoc testing, scan based test, boundary scan test, built-in-self test (BIST), test pattern generation- fault models, automatic test pattern generation, fault simulation.

Text/Reference books:

1. Digital Integrated Circuits- A Design Perspective, J.M. Rabaey, A. Chandrakasan and B. Nikolic, PHI
2. CMOS VLSI Design: A Circuits and Systems Perspective, N. Weste and D. Harris, Pearson

Course Outcomes (CO):

After completion of the course the students are able to

CO1. Estimate Delay and Power dissipation of VLSI circuits.

CO2. Understand various timing issues in digital circuits

CO3. Learn various approaches of implementing and designing Digital ICs.

CO4. Design various memory peripheral structures

CO5. Acquire knowledge about Technology trends and various interconnect models.

CO6. Apply various testing techniques for real time applications.

EC-436	NANOELECTRONIC DEVICES AND MATERIALS FOR VLSI	L	T	P	C
	Professional Core Elective – II	3	0	0	3

Unit 1 OVERVIEW

Nano devices, Nano materials, Nano characterization. Definition of Technology node, Basic CMOS Process flow. MOS Scaling theory, Issues in scaling MOS transistors: Short channel effects, Description of a typical 65 nm CMOS technology. Requirements for Non classical MOS transistor.

Unit 2 MOS CAPACITOR

MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO₂ vs High-k gate dielectrics. Integration issues of high-k. Interface states, bulk charge, band offset, stability, reliability - Q_{bd} high field, possible candidates, CV and IV techniques. Metal gate transistor: Motivation, requirements, Integration Issues.

Unit 3 MOSFET STRUCTURE

Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot. Metal source/drain junctions - Properties of Schottky junctions on Silicon, Germanium and compound semiconductors –Work function pinning. Germanium Nano MOSFETs: strain, quantization, Advantages of Germanium over Silicon, PMOS versus NMOS. Compound semiconductors - material properties, MESFETs Compound semiconductors MOSFETs in the context of channel quantization and strain, Hetero structure MOSFETs exploiting novel materials, strain and quantization. SOI - PDSOI and FDSOI. Ultrathin body SOI - double gate transistors, integration issues, Vertical transistors – Fin FET and Surround gate FET.

Unit 4 SYNTHESIS AND CHARACTERIZATIONS OF NANOMATERIALS

CVD, Nucleation and Growth, ALD, Epitaxy, MBE. Compound semiconductor hetero-structure growth and characterization: Quantum wells and Thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry. AFM. Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc.

Unit 5 APPLICATIONS

Applications in emerging nano materials: Nanotubes, nanorods and other nano structures, LB technique, Soft lithography etc. Microwave assisted synthesis, Self assembly etc.

TEXT BOOKS

1. Mark Lundstrom and Jing Guo: Nanoscale Transistors: Device Physics, Modeling and Simulation, Springer, 2005
2. Karl Goser: Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer 2005

REFERENCE BOOKS

1. Fundamentals of Modern VLSI Devices, Y. Taur and T. Ning, Cambridge University Press.
2. Silicon VLSI Technology, Plummer, Deal , Griffin , Pearson Education India.
3. Encyclopedia of Materials Characterization, Edited by: Brundle, C.Richard; Evans, Charles A. Jr.; Wilson, Shaun ; Elsevier.

Course Outcome:

The students will be able to:

CO1: Select appropriate materials and manufacturing methods for fabrication of VLSI device

CO2: Understand the physical background of the various phenomena affecting the performance of the VLSI devices

CO3: Select the proper fabrication and characterization methods to investigate the performance of the VLSI device

CO4: Explain the working principles of advanced MOSFET devices

CO5: Interpret the main challenges in integration of gate dielectrics and requirement of non-classical MOSFET.

EC-437		Satellite Communications	L	T	P	C
		Professional Core Elective – II	3	0	0	3
Unit 1	<i>Introduction to Satellites and Their Applications:</i> Introduction to satellite, History of Evolution of Satellites, Applications, Evolution of Launch vehicles, Future Trends					
Unit 2	<i>Orbital Aspects:</i> Orbit and Trajectory, Basic Principles of Orbiting Satellites, Orbital Mechanics, Orbital Parameters, Injection Velocity and Resulting Satellite Trajectories, Types of Orbits.					
Unit 3	<i>Satellite Launch and In-orbit Operations:</i> Acquiring the Desired Orbit, Satellite Launch Sequence, Orbital Perturbations, Satellite Stabilization, Orbital Effects on Satellite's Performance, Eclipses, Sun Transit Outage, Looks Angles of a Satellite, Earth Coverage and Ground Tracks.					
Unit 4	<i>Satellite Hardware and Subsystems:</i> Various Satellite Subsystems, Attitude and Orbit Control, Tracking, Telemetry and Command Subsystem, payload, Antenna Subsystems.					
Unit 5	<i>Satellite Link Design Fundamentals:</i> Transmission Equation, Link Parameters, Link Calculations, C/N, G/T, EIRP, Back-off Calculation.					
Unit 6	<i>Earth Station:</i> Types of Earth Station, Architecture, Design Considerations, Earth Station Hardware, Satellite Tracking.					
Unit 7	<i>Communication Techniques:</i> Amplitude Modulation, Frequency Modulation, Pulse Communication Systems, Sampling Theorem, Digital Modulation Techniques-ASK, FSK, PSK, DPSK, QPSK, Offset QPSK; Multiplexing Techniques-FDM, TDM, OFDM, Spread Spectrum Techniques, Multiple Beam, Spot Beam.					
Unit 8	<i>Multiple Access Techniques:</i> Introduction, FDMA, SCPC Systems, MCPC Systems, TDMA, TDMA Burst, TDMA Frame Structure, Unique Word, Frame Efficiency, Frame Acquisition and Synchronization, FDMA vs. TDMA, CDMA, SDMA.					
Unit 9	<i>Recent Trends:</i> Applications, Challenges of Transponders, VSATS, DTH Television, Satellite Telephony, Satellite Radio					

Texts/References Books:

1. Satellite Communications, Dennis Roddy, TMH
2. Satellite Communications, Timothy Pratt, Charles W. Bostian, Jeremy E. Allnutt Wiley India Pvt Ltd.
3. Digital Satellite Communication, T.T.Ha, MHE

4. Satellite Communications, Maini & Agrawal, Wiley India Pvt Ltd

Course Outcome: The students will be able to:

CO1: Understand the history of satellite communication systems.

CO2: Understand the orbital and functional principles of satellite communication systems.

CO3: Analyse and evaluate a satellite link and suggest enhancements to improve the link performance.

CO4: Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.

EC-451	Applied Optimizations in Wireless Communications	L	T	P	C
	Professional Core Elective-III	3	0	0	3
	Course Prerequisite: <i>EC-208</i>				

- Unit 1** Introduction: Properties of vectors-Positive semi definite matrices-Gaussian random vectors-Convex set-Hyper planes.
- Unit 2** Convex Optimizations: Beamforming-Multi User-Cognitive Radio-Convex Optimization-Linear Program- Application: Power allocations in cooperative OFDM-QCQP, SOCP problems- Application: channel shortening for wireless equalization, robust beamforming in wireless systems
- Unit 3** Practical Applications: Duality principle and KKT framework for optimization-Application: water-filling power allocation-Optimization for MIMO systems-OFDM systems and MIMO OFDM systems. Optimization for signal estimation-LS-WLS Regularization-Application: wireless channel estimation-image reconstruction- deburring-representation of convex optimization problems-Convex optimization for machine learning-principle component analysis-support vector machine-cooperative communication-optimal power allocation-Geometrical program-Compressive sensing-Sparse signal processing-OMP-LASSO for signal estimation

Text/Reference Books:

1. Convex Optimization, Stephen Boyd, Cambridge University Press
2. Convex Optimization in Signal Processing and Communications, Daniel P. Palomar and Yonina C. Eldar, Cambridge University Press
3. QoS-Based Resource Allocation and Transceiver Optimization, Martin Schubert and Holger Boche, Now Publishers

Course Outcome: The students will be able to:

CO1: To make students understand the various properties of vectors

CO2: Students should learn convex optimization process

CO3: To analyze various wireless communication problems using convex optimization

CO4: Students should be able to evaluate the application of convex optimization in various practical real time applications

EC-452	Advanced Communication Engineering	L	T	P	C
	Professional Core Elective-III	3	0	0	3

Course Prerequisite: EC-206, EC-301, EC-208

- Unit 1** Review of Digital Modulation Techniques: Elements of digital communication systems, review of digital modulation schemes and their comparison in terms of bandwidth, SNR, BER, bit-rates in context to wireless communication.
- Unit 2** Receiver Design: Receivers in additive white Gaussian noise channels, CPM, MSK, CPFSK; Inter symbol interference; Adaptive receivers and channel equalization.
- Unit 3** Multipath Mitigation Techniques: MIMO system, linear and non-linear equalization, zero-forcing and LMS algorithms, MMSE, spatial multiplexing and diversity, error probability in fading channel, Rake receiver
- Unit 4** Channel Coding Scheme: Block codes, convolutional codes and their performance evaluation, coded modulation schemes: TCM; Turbo codes.
- Unit 5** Channel Modeling Techniques: Digital transmission over fading channels and performance analysis

TEXT/REFERENCE BOOKS

1. Principles of Digital Transmission with Wireless Applications, S Benedetto and E Biglieri , Kluwer Academic
2. Fundamentals of Wireless Communications, D. Tse and P. Viswanath, Cambridge University Press
3. Digital Communications, J G Proakis , McGraw Hill
4. A First Course in Digital Communications, Ha H. Nguyen and Ed Shwedyk, Cambridge University Press
5. Information theory, Coding and Cryptography, Ranjan Bose, TMH

Course Outcome: The students will be able to:

CO1: Explore the digital communication systems and compare the different modulation techniques in terms of performance metrics

CO2: Investigate the design of digital receivers to mitigate the effect of noise in a noisy channel

CO3: Understand different multipath mitigation techniques and channel coding schemes to improve the performance of wireless communication

CO4: Understand different fading in wireless channels and measurement of performance in fading channels

EC-453	ADVANCED WIRELESS COMMUNICATIONS	L	T	P	C
	Professional Core Elective-III	3	0	0	3

Course Prerequisite: EC-206, EC-301, EC-401

- Unit 1 Review of Propagation & Fading:** Propagation path loss, Free-space propagation model, Indoor propagation models, Multipath fading, time dispersive and frequency dispersive channels, delay spread and coherence bandwidth, LCR and ADF.
- Unit 2 Introduction to MIMO Communications:** MIMO wireless communication, MIMO channel and signal model, fundamental trade-off, MIMO transceiver design, MIMO in wireless networks and standards, Spatial multiplexing, Spatial diversity, Alamouti Coding, Various space-time block codes.
- Unit 3 Precoding and receiver design:** Open-loop MIMO, Closed-loop MIMO, Transmit channel side information, A transmitter structure, Precoding design criteria, Linear precoder designs, Precoder performance analysis, Reception of uncoded signals, MIMO receivers for coded, and uncoded signals.
- Unit 4 OFDM:** Single-Carrier vs. Multi-Carrier Transmission, Basic Principle of OFDM, OFDM Modulation and Demodulation, Resource Allocation, PAPR, PAPR Reduction Techniques, Channel Estimation: Pilot Structure, Different channel estimation methods.
- Unit 5 MIMO Channel Capacity:** Deterministic MIMO Channel Capacity, Channel Capacity with CSIT and without CSIT, Channel Capacity of Random MIMO Channels, Channel Reciprocity, CSI Feedback, Antenna Selection Techniques, Optimum Antenna Selection Technique, Complexity-Reduced Antenna Selection, Antenna Selection for OSTBC, Capacity of MAC, and BC, Channel Inversion, Block Diagonalization, Dirty Paper Coding (DPC).

Text Books:

1. MIMO Wireless Communications, , E. Biglieri, R. Calderbank, A. Constantinides, A. Goldsmith, A. Paulraj, H. V. Poor, CAMBRIDGE
2. Fundamentals of Wireless Communication , *David Tse, Pramod Viswanath*, CAMBRIDGE UNIVERSITY PRESS
3. Principles of Mobile Communication, *G L. Stuber*, Kluwer Academic

Reference Books:

1. Digital Communications, *J G Proakis* , McGraw Hill
2. MIMO-OFDM WIRELESS COMMUNICATIONS WITH MATLAB® , *Y. S. Cho, J. Kim, W. Y. Yang, C. G. Kang*, John Wiley & Sons

3. Wireless Communications, *Andrea Goldsmith*, CAMBRIDGE UNIVERSITY PRESS
4. MIMO Wireless Communications From real-world propagation to space-time code design, *Claude Oestges and Bruno Clerckx*, Academic Press

Course Outcomes are

The Graduates will be able to

CO1: Learn about different propagation models, fading techniques, and digital modulation schemes

CO2: Analyze the performance of wireless cellular system for different techniques

CO3: Understand the multiple antenna systems

CO4: Learn about the precoding and receiver design for multi-antenna systems

CO5: Evaluate the performance of multiple carrier systems

CO6: Model and analyze the system capacity for different multiple antenna systems with and without multiple carrier systems.

EC-454	LOW POWER VLSI DESIGN	L	T	P	C
	Professional Core Elective-III	3	0	0	3
	Course Prerequisite: EC-309				

- Unit 1** *Introduction:* Introduction, Motivation for low power design, need and application low power design, Low power design space: voltage, Physical Capacitance, Switching Activity.
- Unit 2** *Sources of power consumption and Power estimation:* Static power and dynamic power: switching component of power, short circuit component of power, leakage component of power and other component of power consumption. Power estimation considering node transition activity factor, glitching effect and glitching power.
- Unit 3** *Voltage Scaling approaches for low power design:* Reliability driven voltage scaling, technology driven voltage scaling, energy-delay minimum based voltage scaling, voltage scaling through threshold reduction, architecture driven voltage scaling.
- Unit 4** *Adiabatic Switching for low power design:* Concept of adiabatic charging, adiabatic amplification. Adiabatic logic gates, stepwise charging, pulsed power supply.
- Unit 5** *Switching Capacitance minimization for low power design:* Algorithmic approaches, Architecture optimization, Logic optimization, Circuit optimization, physical design optimization.

Text/Reference books:

1. Low Power Digital CMOS Design, Anantha P. Chandrakasan and Robert W. Brodereson, Springer
2. Low Power CMOS VLSI Circuit Design, Kaushik Roy and Sarat C. Prasad, Wiley India Pvt Ltd
3. Low - Voltage, Low - Power VLSI Subsystems, Kiat-Seng Yeo and Kaushik Roy, TMH

Course Outcomes are

The Graduates will be able to

CO1: Understand the need of Low power VLSI design and identify different power dissipations and their sources.

CO2: Understand and analyze the different voltage scaling approaches, adiabatic switching and switching capacitance minimization for low power devices.

CO3: Design different logic circuits using low power design methodologies.

CO4: Interpret the main challenges in VLSI industry associated with reduction of both power dissipation and delay.

EC455	RF and Microwave Integrated Circuits	L	T	P	C
	Professional Core Elective-III	3	0	0	3

Pre-requisite - EC-201, EC-202, EC-210

- Unit 1** *Introduction:* Lower Frequency Analog Design and Microwave Design Versus Radio Frequency Integrated Circuit Design, RFIC used in a Communication Transceiver, Review of Transmission Line Theory, Distributed Transmission Lines, Smith Chart, Impedance Matching, Microstrip and Coplanar Waveguide Implementations, S Parameters, Components and Interconnects at High frequencies.
- Unit 2** *Issues in RFIC Design:* Noise - Thermal Noise, Noise Power, Noise Figure, Phase Noise; Linearity and Distortion in RF Circuits - Third Order Intercept Point, Second Order Intercept Point, 1-dB Compression Point, Relationships between 1-dB compression point and IP3 Points, Broadband Measures of Linearity; Modulated Signals - PM, FM, MSK, QAM, OFDM.
- Unit 3** *LNA Design:* Basic Amplifiers, Feedback Techniques, Noise in Amplifiers, Linearity in Amplifiers, Stability Analysis, Differential Amplifiers, Low Voltage Topologies and Use of on-chip Transformers, DC Bias, Broadband LNA Design, CMOS LNA Example.
- Unit 4** *Mixers:* Basic Mixer Operation, Transconductance Controlled Mixer, Double Balanced Mixer, Mixer Noise, Linearity, Isolation, General Design Comments, Image Reject and Single-Sideband Mixer, Alternative Mixer Designs, CMOS Mixer Example.
- Unit 5** *Voltage Controlled Oscillators:* LC Resonator, Analysis of Oscillator as Feedback System, Negative Resistance Oscillator, Differential Topologies, Colpitts Oscillator, Phase Noise Reduction Techniques, Quadrature Oscillators and Injection Locking. CMOS Example.
- Unit 6** *Frequency Synthesis:* PLL Components, Continuous Time Analysis of PLL Synthesizers, Discrete Time Analysis for PLL Synthesizers, Transient Behaviors, Fractional - N PLL Frequency Synthesizers, CMOS Example.
- Unit 7** *Power Amplifiers:* Introduction, Power Capability, Efficiency, Matching Considerations, Class A,B,C,D,E,F,G amplifiers, AC Load line, Transistor Saturation, Power Combining Techniques, Effects and Implications of Nonlinearity - Cross Modulation, AM - PM Conversion, Spectral Regrowth, Linearization Techniques, Feedforward, Feedback, Predistortion, CMOS Power Amplifier Example.

Text/Reference books:

1. The Design of CMOS Radio-Frequency Integrated Circuits, Thomas H. Lee, Cambridge University Press
2. Radio Frequency Integrated Circuit Design, Rogers and Plett, Artech House Publishers
3. RF Power Amplifiers for Wireless Communications, Steve C. Cripps, Artech House Publishers
4. Analysis and Design of Analog Integrated Circuits, Gray, Hurst, Lewis & Meyer, Wiley India Pvt Ltd
5. Design of Analog CMOS Integrated Circuits, B. Razavi, TMH

Course Outcomes: The Graduates will be able to

CO1: Summary of the design and use of modern RF and microwave integrated circuits (RF&MW IC) in electronic systems.

CO2: To show solutions of RF and microwave circuits in an integrated form.

CO3: To teach students to understand the properties and phenomena existing in the high-frequency technology, focusing on monolithic microwave integrated circuits.

CO4: Students will become familiar with the methods of analysis, design, construction, and characterization of RF&MW IC performance and obtain practical experience employing modeling and simulation.

EC456	ANTENNA & WAVE PROPAGATION	L	T	P	C
	Professional Core Elective-III	3	0	0	3

Pre-requisite - Electromagnetics and Microwave Engineering

- Unit 1** *Radiation Mechanism and Basic Antenna Concept:* Physical concept of radiations, Retarded potentials, Radiation from a short current element, Radiation from small current loop, Radiation from arbitrary current distribution, Concept of antenna impedance; Antenna Parameters- radiation pattern, radiation resistance, gain, directivity, beam width, band width, effective aperture, polarization, reciprocity etc.
- Unit 2** *Antenna Terminology:* Introduction, Networks Theorems- Superposition Theorem, Thevenin's Theorem, Maximum Power Transfer Theorem, Compensation Theorem, Reciprocity Theorem and proof, Application of Network Theorems to Antennas- Equality of Directional Patterns, Equivalence of Transmitting and Receiving Antenna Impedances, Equality of Effective Lengths.
- Unit 3** *Antenna Arrays:* Introduction, Various forms of arrays, Arrays of two point sources, Non isotropic but similar point sources, Pattern Multiplication, Generalized expression of principle of pattern Multiplication, Radiation pattern characteristics, Binomial Arrays, Electronic Phased Arrays, Effect of earth on Vertical patterns and Radiation resistance, Methods of excitation of antennas, Impedance matching techniques.
- Unit 4** *HF, VHF, and UHF Antennas:* Introduction, Isotropic Radiators, Directional Antennas, Omni-directional antennas, Resonant antennas, Non resonant antennas, LF antennas, Antennas for HF, VHF, UHF; linear wire antennas, Dipole arrays, Folded dipole antennas, V-antennas, Inverted V antennas, Rhombic antennas, Yagi-Uda antenna, Log-periodic antenna, Helical antenna, Loop antenna.
- Unit 5** *Microwave Antennas:* Introduction, Rod reflector, Plane reflector, Corner reflector, parabolic reflector, Types of Parabolic reflectors- Cut paraboloid, Parabolic cylinder, Offset paraboloid, Torus antenna; Feed systems for parabolic Reflectors, Shaped beam antennas, Horn antenna, Corrugated Horn, Slot antenna, Babinet's principle, The Method of Moment(MOM), lens antenna, Microstrip or patch antenna.
- Unit 6** *Wave Propagation:* Ground wave, Space wave & Sky wave propagation, Structure of Ionosphere & Ionospheric propagation, Effect of earth magnetic field, Faraday Rotation, line of Sight (LOS) propagation, Tropospheric & Scatter propagation, Duct propagation, Multipath Fading, Ray bending and other propagation phenomenon, indoor propagation, Critical frequency, Virtual height,

MUF, Skip distance, Optimum Working Frequency, Wave angle fading, Selective fading.

Texts/Reference Books:

1. Antenna Theory, Balanis, Wiley India Pvt Ltd
2. Antennas, Kraus & Marhepka, TMH
3. Antenna & Radio Wave Propagation, Collin, McGraw-hill Education (ise Editions)
4. Propagation of Radio Waves, M.Drhekanor
5. Antenna & Wave propagation, R.L.Yadava, Ashirwad Publication
6. Antenna and Wave Propagation, K.D.Prasad, Deepak Handa, Satya Prakashan

Course Outcomes are

The Graduates will be able to

CO1: Define various antenna parameters

CO2: Analyze radiation patterns of antennas

CO3: Evaluate antennas for given specifications

CO4: Illustrate techniques for antenna parameter measurements

CO5: Understand the various applications of antennas CO6 Discuss radio wave propagation

CO6: Design new Antenna to meet specification of certain applications.

EC457	Telemetry Principles	L	T	P	C
	Professional Core Elective-III	3	0	0	3

Pre-requisite - Electromagnetics and Microwave Engineering

- Unit 1** *Introduction to Telemetry Principles:* Classification, Non electrical telemetry systems, Voltage and current Telemetry systems, Frequency Telemetry. Introductory idea about Signal and systems and Transmission basics, Symbols and Codes, brief idea about: FDM & TDM systems, transmitters & receivers, transmission lines, Antennas, Wave propagation and filters.
- Unit 2** *Modem:* Modems, quadrature amplitude modulation, modem protocols.
- Unit 3** *Basic satellite Telemetry:* TT and C services, digital Transmission System in Satellite Telemetry, TDM, Satellite telemetry & communications, MAT techniques.
- Unit 4** *Fiber Optical Telemetry:* Optical fiber cable, Dispersion, Losses, Sources and Detectors, Transmitters and Receiver circuits, wave length division multiplexing.
- Unit 5** *Related Topics:* Remote control, Networking, Internet based Telemaking, Wireless LANs, Introduction to multimedia.

Texts/References Books:

1. Telemetry System, L.E.Foster, J. Wiley
2. Digital Instrumentation, A.J.Bouaens, McGraw-Hill
3. Hand book of Telemetry Remote Control, E.L. Geruenbeng, McGraw-Hill
4. Telemetry Principles, D.Patranabis, TMH

Course Outcomes are

The Graduates will be able to

CO1: Understand the concept of Basic System of Telemetry

CO2: Design Phase Locked Loop, Mixers, Time Division Multiplexed System – TDM/PAM system.

CO3: Realize Modems and modem protocol.

CO4: Formulate Transmission Techniques, and basics of Satellite and Fiber Optic telemetry system.

EC-458	MATHEMATICS FOR COMMUNICATION ENGINEERS	L	T	P	C
	Professional Core Elective-III	3	0	0	3

Course Prerequisite: EC-208, EC-206, EC-301

- Unit 1 Introduction and Foundations:** Mathematical Models, Models for Linear Systems and Signals, Adaptive Filtering, Gaussian Random Variables and Random Processes, Markov and Hidden Markov Models
- Unit 2 Vector Spaces and Linear Algebra:** Metric Spaces, Vector Spaces, Norms and Normed Vector Spaces, Inner Products and Inner Product Spaces, Induced Norms, The Cauchy-Schwarz Inequality, Orthogonal Subspaces, Projections and Orthogonal Projections, Projection Theorem Orthogonalization of Vectors.
- Unit 3 Representation and Approximation in Vector Spaces:** The Approximation Problem in Hilbert Space, The Orthogonality Principle, Matrix Representation of Least-Squares Problems, Linear Regression, Least-Squares Filtering, Minimum Mean-Square Estimation, Minimum Mean-Squared Error (MMSE) Filtering, Comparison of Least Squares and Minimum Mean Squares.
- Unit 4 Some Important Matrix Factorization:** The LU Factorization, The Cholesky Factorization, Unitary Matrices and the QR Factorization.
- Unit 5 Eigenvalues and Eigenvectors:** Eigen Values and Linear Systems, Linear Dependence of Eigenvectors, Diagonalization of a Matrix.
- Unit 6 The Singular Value Decomposition:** Theory of the SVD, Matrix Structure from the SVD, Pseudo-inverses and the SVD, Rank-Reducing Approximations: Effective Rank, System Identification Using the SVD.
- Unit 7 Introduction to Detection and Estimation, and Mathematical Notation:** Detection and Estimation Theory, Some Notational Conventions, Conditional Expectation, Sufficient Statistics, Exponential Families.
- Unit 8 Detection Theory:** Introduction to Hypothesis Testing, Neyman-Pearson Theory, Neyman Pearson testing with Composite Binary Hypotheses, Bayes Decision Theory, Some M-ary Problems, Maximum-Likelihood Detection.
- Unit 9 Estimation Theory:** The Maximum-Likelihood Principle, ML Estimates and Sufficiency, Applications of ML Estimation, Bayes Estimation Theory, Bayes risk

Text Books:

1. Mathematical Methods and Algorithms for Signal Processing, *Todd K. Moon and W. C. Stirling*, Pearson

Education

Reference Books:

2. Probability, Random Variables and Random Process, *P. Z. Peebles*, McGraw Hill Publications
3. Introduction to Linear Algebra, *Gilbert Strang*, Cambridge Press
4. Fundamentals of Statistical Signal Processing, Estimation Theory, *S. M. Kay*, Pearson Publication

Course Outcomes are

The Graduates will be able to

CO1: Understand the foundation for mathematics for communication engineering

CO2: Learn the concepts of vector spaces and linear algebra

CO3: Analyse different estimation and filtering concepts used in wireless communications.

CO4: Implement various important factorization techniques

CO5: Learn the concepts of SVD, Eigen values, Eigen vectors

CO6: Know the detection and estimation theory used by different communication technologies

EC-459	ADVANCED OPTICAL COMMUNICATION NETWORKS	L	T	P	C
	Professional Core Elective-III	3	0	0	3

Course Prerequisite: EC-306, EC-308

- Unit 1** *Introduction to optical networks:* Telecommunication network architecture, services, circuit switching, and packet switching, optical networks, the optical layer, transparency and all-optical networks, optical packet switching, transmission basics, network evolution.
- Unit 2** *Technology: Propagation of signals in optical fiber:* Light propagation in optical fiber, loss and bandwidth, chromatic dispersion, nonlinear effects, solitons and problems.
- Unit 3** *Passive and Active Components:* Couplers, isolators and circulators, multiplexers and filters, optical amplifiers, transmitters, detectors, wavelength converters.
- Unit 4** *Modulation and Demodulation:* Modulation, Subcarrier modulation and multiplexing, spectral efficiency, demodulation, error detection and corrections.
- Unit 5** *Transmission system engineering:* System model, power penalty, transmitter, receiver, optical amplifier, EDFA crosstalk, dispersion, fiber nonlinearities, wavelength stabilization.
- Unit 6** *Networks: Client layers of the optical layer:* SONET/SDH, Multiplexing, SONET/SDH layers, SONET frame structures, SONET/SDH physical layers ATM, IP, storage area networks, ESCON, HIPPI.
- Unit 7** *WDM Network elements:* Optical line terminals, optical line amplifiers, optical add/drop multiplexers, optical crossconnects.
- Unit 8** *WDM Network Design:* Cost trade-offs: A detailed ring network example, LTD and RWA problems, Dimensioning Wavelength-Routing networks, statistical dimensioning models, maximum load dimensioning models.
- Unit 9** *Access Networks:* Network architecture overview, enhanced HFC, FTTC (Fiber to the curb), Passive optical network evolution

Text Books:

1. Optical Networks , R.Ramaswami, K.N.Sivarajan, Galen H. Sasaki , Elsevier

References Books:

1. Optical Communication System , J.Gower , Prentice Hall of India
2. Optical Fiber Communication , John M. Senior , Pearson Education
3. Optical Fiber Communication , Gerd Keiser , Mc Graw Hill

4. Fiber-optic communication systems , Govind P. Agrawal , John Wiley & sons

Course Outcomes are

The Graduates will be able to

CO1: Provide comprehensive understanding of the optical communication networks and its technology

CO2: Analyse and understand different active, passive components and different modulation techniques.

CO3: Understand the transmission system engineering concept associated with transmission technology.

CO4: Realize and understand the design of optical system network

EC-381

SOFT COMPUTING**L T P C****Open Elective-I****3 0 0 3****Course Prerequisite: CS-101**

Open Elective I, B.Tech, Semester - VI

- Unit 1 Introduction to Soft Computing:** Soft Computing Constituents; "Soft" computing versus "Hard" computing, Characteristics of Soft computing, Real time applications of Soft computing techniques, Machine Learning Basics.
- Unit 2 Evolutionary Algorithms:** Genetic Algorithms (GAs): Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, etc., Solving single-objective optimization problems using Gas; Differential Evolution; GA based Machine Learning
- Unit 3 Metaheuristic and Swarm Intelligence:** Ant colony optimization; Particle swarm optimization; Cuckoo Search Algorithm; Bacteria Foraging optimization, Various other optimization algorithms and their applications.
- Unit 4 Artificial Neural Networks (ANN):** Biological neurons and its working, Simulation of biological neurons to problem solving, Different ANNs architectures, Adaptive Networks - Feed Forward Networks - Supervised Learning Neural Networks - Radial Basis Function Networks - Reinforcement Learning - Unsupervised Learning Neural Networks, Applications of ANN.
- Unit 5 Fuzzy logic:** Introduction to Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, reasoning, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Fuzzy Expert Systems - Fuzzy Decision Making, Applications of Fuzzy logic.
- Adaptive Neuro-Fuzzy Inference Systems - Coactive Neuro-Fuzzy Modeling - Classification and Regression Trees - Data Clustering Algorithms - Rule base Structure Identification - Neuro-Fuzzy Control - Case Studies.

Text Books:

1. Neuro-Fuzzy and soft Computing, *J.-S. R. Jang, C.-T. Sun, and E. Mizutani*, PHI Learning, 2009
2. An Introduction to Genetic Algorithms, *Melanie Mitchell*, MIT Press, 2000
3. Introduction to Genetic Algorithms, *S.N. Sivanandam, S.N. Deepa*, Springer, 2008 edition
4. Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering, *Nikola K. Kasabov*,

MIT Press, 1998

5. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, *S. Rajasekaran, and G. A. Vijayalakshmi Pai*, Prentice Hall of India, 2007
6. Fuzzy Logic with Engineering Applications, *Timothy J. Ross*, Willey, 2010
7. Fuzzy Logic: A Pratical approach, *F. Martin, , Mc neill, and Ellen Thro*, AP Professional, 2000

Reference Books:

1. Practical Genetic Algorithms, *Randy L. Haupt and sue Ellen Haupt*, John Willey & Sons, 2002
2. Soft Computing, *D. K. Pratihari*, Narosa, 2008
3. Neuro-Fuzzy and soft Computing, *J.-S. R. Jang, C.-T. Sun, and E. Mizutani*, PHI Learning, 2009
4. Neural Networks and Learning Machines, *Simon Haykin*, PHI Learning, 2011
5. Genetic Algorithms In Search, Optimization And Machine Learning, *David E. Goldberg*, Pearson Education, 2002
6. Fuzzy Logic for Embedded Systems Applications, *Ahmed M. Ibrahim*, Elsevier Press, 2004

Course Outcomes are

The Graduates will be able to

CO1: Learn the introduction to soft computing techniques.

CO2: Understand discussion of evolutionary algorithms. Specific attention can be given to genetic algorithm (GA).
Different processes used in GA and various kind of optimization problems can be solved by GA should be discussed with students.

CO3: Know different heuristic and meta-heuristic methods like ACO, PSO, bacteria foraging etc.

CO4: Learn artificial neural network with various facets

CO5: Understand Fuzzy logic and different methods related to this.

CO6: Solve different case studies and real time optimization problems using different soft computing techniques.

EC-382	Neural Network and Fuzzy Logic	L	T	P	C
	Open Elective-I	3	0	0	3

Course Prerequisite: None

- Unit 1** Introduction to Neural Networks: Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.
- Unit 2** Essentials of Artificial Neural Networks: Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN - Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application
- Unit 3** Single Layer Feed Forward Neural Networks: Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.
- Unit 4** Multilayer Feed forward Neural Networks: Credit Assignment Problem, Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.
- Unit 5** Classical & Fuzzy Sets: Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.
- Unit 6** Fuzzy Logic System Components: Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.
- Unit 7** Applications: Neural network applications: Process identification, control, fault diagnosis and load forecasting. Fuzzy logic applications: Fuzzy logic control and Fuzzy classification.

TEXT BOOK

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai - PHI Publication.

2. Introduction to Neural Networks using MATLAB 6.0 - S.N.Sivanandam, S.Sumathi, S.N.Deepa, TMH, 2006

REFERENCE BOOKS:

1. Neural Networks - James A Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks - Simon Hakins , Pearson Education
3. Neural Engineering by C.Eliasmith and CH.Anderson, PHI
4. Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.

Course Outcomes (CO):

The Graduates will be able to

CO1: Understand about different neural networks, their architecture and training algorithm

CO2: Understand the Concept of Fuzzy logic, Fuzzy Sets, fuzzy rules and fuzzy reasoning

CO3: Understand the applicability of neural networks and fuzzy logic

CO4: Able to design a new module /system using neural networks and fuzzy logic

EC-383	RECONFIGURABLE COMPUTING AND HARDWARES	L	T	P	C
	Open Elective-I	3	0	0	3

Pre-requisite - EC-205, EC-301

- Unit 1** Introduction, Field Programmable Gate Arrays, FPGA Placement, FPGA Routing, Contrasting Processors: Fixed and Reconfigurable, Coarse-grained Reconfigurable Devices, Reconfigurable Systems.
- Unit 2** FPGA Testing Methodology, Functional and gate level testing, SDF file description and usage.
- Unit 3** FPGA Configuration, Different types of FPGA configuration files, Generation of configuration file and its loading into FPGA.
- Unit 4** Multi-FPGA Partitioning, Logic Emulation, Power Reduction Techniques for FPGAs, High-Level Compilation, Reconfigurable Coprocessors, Reconfigurable Memory Security, Network Virtualization, GPGPU on FPGA.
- Unit 5** Reconfigurable Weather Radar Data Processing, Dynamically Reconfigurable Adaptive Viterbi Decoder, High Speed Data Acquisition System for Space Applications

Text/Reference books:

1. Reconfigurable Computing, Scott Hauck and Andre DeHon, Morgan Kaufmann, Elsevier India Pvt. Ltd.-New Delhi
2. FPGA Prototyping by Verilog Examples: Xilinx Spartan-3 Version, Pong P. Chu, Wiley-Interscience
3. Rapid Prototyping of Digital Systems, James O. Hamblen, Tyson S. Hall, Michael D. Furman, Springer
4. The Design Warrior's Guide to FPGAs: Devices, Tools and Flows, Clive Max Maxfield, Reed Elsevier India
5. Advanced FPGA Design: Architecture, Implementation, and Optimization., Steve Kilts, IEEE Computer Society Press

Course Outcomes: The Graduates will be able to

CO1: Create the knowledge of high level VLSI design to carry out research and development in the area of digital IC design.

CO2: Model the digital designs including FSMs to Processor architectures using the knowledge of HDL

Language.

CO3: Apply the knowledge of Reconfigurable architectures like FPGAs in designing and implementing digital ICs.

CO4: Implement practical and state of the art of Digital VLSI design, suitable for real life and Industry applications.

EC-384	Nanotechnology	L	T	P	C
	Open Elective-I	3	0	0	3

Pre-requisite- PH-101

- Unit 1** *Introduction to Quantum Mechanics:* Introduction, matter waves, Heisenberg's Uncertainty Principle, Schrodinger equation, Electron Confinement, Tunnelling of a particle through Potential barrier.
- Unit 2** *Structure and bonding:* Arrangement of atoms, Two dimensional Crystal Structures, Three dimensional Crystal Structures, Some example of Three dimensional crystals, planes in crystal, Crystallographic Directions, Reciprocal Lattice, Quasi crystal, Bonding in solid, electronic structure of solids.
- Unit 3** *Synthesis of Nanomaterial's:* Mechanical methods- Methods based on evaporation, sputter Deposition, Chemical Vapour Deposition, Ion beam technique, and Molecular beam epitaxy.
- Unit 4** *Chemical methods:* Colloids and colloids in Solutions, growth of Nanoparticles,
- Unit 5** *Biological methods:* Synthesis using Microorganism, Synthesis using plant extracts.
- Unit 6** *Analysis techniques:* Microscopes, Electron Microscopes, Scanning Probe Microscopes, diffraction Techniques, Spectroscopies, Magnetic measurement.
- Unit 7** *Properties of Nano material:* Mechanical properties, Structural properties, melting of nanoparticles, Electrical conductivity, Optical properties, Magnetic properties.
- Unit 8** *Some special Nano material:* Carbon Nano tubes, Porous Silicon, Aerogels, Zeolites, self-assembled Nanomaterial's.
- Unit 9** *Applications:* Electronics, Sports and toys, Textiles, Cosmetics, Biotechnology and medical field, Space and defence.

Text/References:

1. Nano- The Next Revolution, Mohan Sunder Rajan, NBTI
2. Introduction To Nano Technology, Charles P. Pode, Springer
3. Quantum Dot Heterostructures, D.Bimberg,M.Grundman, John Wiley & Sons
4. Light and Matter, Yehuda Band, John Wiley & Sons
5. NanoPhotonics, Paras N. Prasad, John Wiley & Sons

6. Quantum Dot Heterostructures, D.Bimberg, M.Grundman, N.N. Ledenstov, John Wiley & Sons
7. Advances in Nano Science and Technology, Sharma Ashutosh, Jayesh, National Institute of Science Communication and Information Resources, Council of Scientific & Industrial Research, 2004

Course Outcomes: The Graduates will be able to

CO1: To understand nanoscience and nanotechnology and its advantages.

CO2: To apply the knowledge of quantum mechanics in nanotechnology.

CO3: To remember crystal structures and its orientations.

CO4: To evaluate and analyze different techniques for the synthesis of nanomaterials.

CO5: To apply the knowledge of nanotechnology in emerging applications.

EC-385	Microelectromechanical Systems	L	T	P	C
	<i>Open Elective-I</i>	3	0	0	3
	<i>Pre-requisite- PH-101</i>				
Unit 1	INTRODUCTION TO MEMS AND MICROFABRICATION: MEMS Roadmap - MEMS markets - MEMS foundries - Benefits of Miniaturization- Benefits of Scaling. Microfabrication: Basic Fabrication Processes - oxidation - film deposition - lithography - etching - ion implantation - diffusion.				
Unit 2	SURFACE MICROMACHINING AND BULK MICROMACHINING: Surface Micromachining: Basic process flow - release - stiction - material choices - residual stress - Electroplating. Bulk Micromachining: wet etch-based - dissolved wafer process - SOI MEMS - Scream - MEMS - RIE - DRIE				
Unit 3	MECHANICS OF MEMS MATERIALS: Stress - strain - material properties - measurement & characterization of mechanical parameters. Microstructural Elements: bending moment and strain - flexural rigidity - residual stress - boundary conditions - spring combinations.				
Unit 4	MEMS DEVICES: Pressure sensors- Accelerometers - Gyroscopes- RF MEMS Switch- Temperature sensors - Humidity sensors. Microactuators: Electrostatic - piezoelectric - SMA - Thermoelectric - electromagnetic.				
Unit 5	FLUID DYNAMICS AND MICROPUMPS: Viscosity - density - surface tension - continuity equation - Newton's second law - Navier-Stokes equation and its interpretation - flow types. Microfluidics: Electrokinetics - electroosmosis - electrophoresis - fabrication methods - Lab on a Chip - micropumps - microvalves.				

Text/References:

1. Foundations of MEMS, Chang Liu
2. MEMS, N P Mahalik
3. Microsystem Design, S. D. Senturia
4. RF MEMS & Their Applications, Varadan, Vinoy, Jose
5. MEMS and Nanotechnology Based Sensors and Devices for Communications, Medical and Aerospace

Applications, A R Jha

Course outcome: The graduates will be able to

CO1: Familiar with the fundamentals, fabrication process and applications of MEMS.

CO2: Understand MEMS-specific design issues and constraints.

CO3: Understand Dynamics and modeling of microsystems.

CO4: Apply knowledge of beam mechanics and material properties for the design of various sensors and actuators.

CO5: Investigate CMOS-MEMS integration in VLSI domain.

EC-386	Digital Image Processing	L	T	P	C
	Open Elective-I	3	0	0	3
	Course Prerequisite: Nil				

- Unit 1** DIGITAL IMAGE FUNDAMENTALS: Elements of digital image processing systems, Vidicon and Digital Camera working principles, - Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, Color image fundamentals - RGB, HSI models, Image sampling, Quantization, dither,
- Unit 2** IMAGE TRANSFORMATION: 2D DFT, DCT, SVD, Walsh-Hadamard transform, KLT, Harr transform and discrete wavelet transform.
- Unit 3** IMAGE ENHANCEMENT: Point processing, Histograms, Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering, Color image enhancement.
- Unit 4** IMAGE RESTORATION: Image Restoration - degradation model, Unconstrained and Constrained restoration, Inverse filtering, Wiener filtering, Geometric transformations-spatial transformations.
- Unit 5** IMAGE SEGMENTATION: Edge detection, Edge linking via Hough transform - Thresholding - Region based segmentation- Region growing - Region splitting and Merging - Segmentation by morphological watersheds - Hybrid methods
- Unit 6** IMAGE COMPRESSION: Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Transform coding, JPEG standard, MPEG

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, , Digital Image Processing^ Pearson, Education, Inc., Second Edition, 2004.
2. Anil K. Jain, Fundamentals of Digital Image Processing^ Pearson Education, Inc., 2002. REFERENCES: 1. Kenneth R. Castleman, —Digital Image Processing!, Pearson, 2006. 2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLABII, Pearson Education, Inc., 2004.
3. D.E. Dudgeon and RM. Mersereau, —Multidimensional Digital Signal Processing!, Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, —Digital Image Processing!, John Wiley, New York, 2002.

5. Milan Sonka et al, —Image Processing, Analysis and Machine vision!, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
6. Alan C. Bovik, —Handbook of image and video processing! Elsevier Academic press, 2005.
7. S.Sridhar, — Digital Image processing! Oxford University press, Edition 2011.

Course outcome: The graduates will be able to

CO1: Understand the fundamental concepts of Digital Image Processing

CO2: Examine the images in Frequency Domain using various transformations

CO3: Apply the various techniques for Image Enhancement and Restoration.

CO4: Apply the various techniques for Image Compression and Segmentation.

CO5: Analyze image processing algorithms for practical applications.

EC-387	Radio Astronomy Techniques	L	T	P	C
	Open Elective-I	3	0	0	3

- Unit 1** General Astronomy Fundamentals: Solar system, Milky Way Galaxy, Extra-galactic systems and the Universe, Coordinate Systems, Measurement of time, distance and motion, Visual, photographic and radio magnitudes
- Unit 2** Radio Astronomy Fundamentals: Introduction, Power, spectral power and brightness, Brightness distribution, Discrete sources, Radiance, Minimum detectable temperature and flux density
- Unit 3** Radio Telescope Receivers: General principles, Receiver types, System noise, Total Power Receiver and its Sensitivity related issues, Dicke Receiver, Interferometer Receiver, Correlation Receiver, Noise Temperature and Noise Figure of a linear two-port, Noise temperature of linear two-ports in series connection
- Unit 4** Major Radio Astronomy Facilities: GMRT – basic advantages offered by India, scientific objectives, system configuration, signal flow, LOFAR, SKA – key drivers, prime characteristics, configuration
- Unit 5** Wave polarization: Polarization Response of an antenna to a radio wave of arbitrary polarization, Ellipse and Poincare sphere, Stokes’ parameters
- Unit 6** Propagation effects affecting radio astronomy observations: Angular refraction, Faraday Rotation, Scintillations

Texts/References Books:

An Introduction to Radio Astronomy, Bernard F. Burke, Francis Graham-Smith, Peter N. Wilkinson, Cambridge University Press

Course outcomes:

At the end of the course the student will be able to:

CO1: Understand the general and radio astronomy fundamentals

CO2: Analyse and evaluate Radio Telescope Receivers

CO3: Major Radio Astronomy Facilities

CO4: Propagation effects on radio astronomy

EC-388	Algorithm to VLSI based architecture	L	T	P	C
	Open Elective-I	3	0	0	3

Course Prerequisite: Basic Electronic Circuits and Digital Logic

Design VLSI Design

Unit 1	Introduction: Review of VLSI Design flow. Goals of VLSI Design: Optimization of speed, power dissipation, cost and reliability.
Unit 2	Algorithm to architecture transformation: Architectural antipodes, transform approach to VLSI architectures, graph based formalism for describing processing algorithms, isomorphic architecture
Unit 3	Equivalence transforms for combinational computations: Common assumptions, pipelining, replication, time sharing, associatively transform and other algebraic transforms.
Unit 4	Architectural Synthesis and Optimization: Circuit specifications for architectural synthesis, fundamental architectural synthesis problems, temporal domain-scheduling, spatial domain-binding, sequencing graphs, hierarchical models, synchronization problem, area and performance estimation, data path and control unit synthesis, constrained and unconstrained scheduling, scheduling of pipelined circuits
Unit 5	Clocking of synchronous circuits: single-phase and two-phase clocking, wave pipelining, collective clock buffer design, distributed clock buffer trees, hybrid clock distribution networks, and impact of clock distribution delay on I/O timing.
Unit 6	Asynchronous data processing architectures: data consistency problem of vectored acquisition-plain bit parallel synchronization, unit distance coding, suppression of cross patterns, handshaking, partial handshaking, data consistency problem of scalar acquisition-synchronization at single place, synchronization at multiple places, synchronization from a slow clock, meta- stable synchronizer behavior
Unit 7	Digital Signal Processing using array architectures: Systolic and wave-front arrays, mapping dependence and signal flow graphs to systolic and wave-front arrays, asynchronous communication protocols for wave-front arrays.
Unit 8	Analog array architectures: Architectural design of field programmable analog array (FPAA), design of switched capacitor and pulsed mode FPAA, scalability of FPAA
Unit 9	Physical VLSI Design: Algorithms for partitioning, floor-planning, placement, routing and

compaction.

Unit 10 Dynamically reconfigurable gate arrays: Static versus dynamic reconfiguration, single context versus multi-context dynamic reconfiguration, full versus partial run time reconfiguration, performance analysis of dynamically reconfigurable systems.

Unit 11 Inexact computing systems: Probabilistic CMOS model based architectures and probabilistic pruning.

Text books:

1. Hubert Kaeslin, “Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication”, Cambridge University Press(2009).
2. Giovanni De Micheli, “Synthesis and Optimization of Digital Circuits”, McGraw Hill(2012).
3. S.Y. Kung, “VLSI Array Processors”, Prentice Hall(2012)

Reference books:

1. A.M. Fahim, “Clock generators for SoC processors: Circuits and Architectures”, Kluwer Academic Publishers(2005).
2. Magdy A. Bayoumi, “VLSI Design Methodologies for Digital Signal Processing Architectures”, Springer(2012).

Course Outcomes (CO): Upon completion of the course, the students will be able to:

CO1: Understand Hardware description languages Verilog/VHDL etc.

CO2: Analyze the issues related to trade-off between cost, speed and accuracy in various VLSI architectures.

CO3: Design efficient architectures, algorithms and circuits improving size, power consumption, and speed and round-off noise

CO4: Translate effective algorithm design to integrated circuit implementations.

CO5: Comprehend various sources of errors in hardware architectures in implementation of algorithms and appropriate means to control those errors.

Code:	Innovation and IPR	L	T	P	C
EC-389	B. Tech (Open Elective)	3	0	0	3

PRE-REQUISITES: No special pre-requisites.

Module 1 Innovation;Analysing the Current Business Scenario, An introduction to Innovation and Creativity, Innovation in Current Environment, Types of Innovation, School of Innovation.

Module 2 Scope of Innovation; Challenges of Innovation, Steps in Innovation Management, Divergent Vs Convergent Thinking, Levers of Idea Management, Innovation in Indian context-Case studies.

- Module 3** **Experimentation in Innovation Management;** Idea Championship, Participation for Innovation, Co-creation for Innovation, Proto typing to Incubation, Technology Innovation Process, Technological Innovation Management.
- Module 4** **Intellectual Property Rights:** Historical Background, Concept, Forms and Relevance, Types of Intellectual Property, Indian Patent Act 1970; Terms and definitions, Patent rights and its scope, Patentability criteria with case studies, Patent application and Registration process,
- Module 5** **Law of Copyrights:** Fundamental of Copy Right law, Different Rights: rights of Reproduction, rights to Distribute, rights to publicly perform, Broadcasting rights, Moral rights, copy right ownership issues, copy right registration, ownership and duration, Case studies related to Infringements, remedies and penalties. Plagiarism: types and forms
- Module 6** **Trademark, Designs, Geographical Indication and other IPR laws:** Purpose and function of trademarks, Scope of Industrial Design Protection, Current scenario of Geographical Indications, Issues and Challenges, Legal protection of GI, Trade secret law.

Text Books:

1. Boutellier, R., Gassmann, O., & Von Zedtwitz, M. (2008). *Managing Global Innovation: Uncovering the Secrets of Future Competitiveness* (3rd Ed.). Springer.
2. Melissa, A. S. (2010). *Strategic Management of Technological Innovation* (2nd ed.). Tata McGrawHill.
3. Iansiti, M. (1997). *Technology Integration: Making Critical Choices in a Dynamic World* Harvard Business School Press.
4. Conway, S., & Steward, F. (2009). *Managing and Shaping Innovation*. Oxford University Press
5. Ganguly, Prabuddha. *Intellectual Property Rights, Unleashing the Knowledge Economy*. Tata McGraw Hill Publishing company Ltd. (2008).
6. Ramappa, T. *Intellectual Property Rights Under WTO*. S. Chand 4 (2008).
7. Gopalakrishnan, NS, KN Chandrasekharan Pillai, and T. G. Agitha. *Principles of Intellectual Property*. Eastern Book Company (2014).
8. Khader, Feroz Ali. *The law of patents - With a special focus on pharmaceuticals in India*. LexisNexis Butterworths Nagpur (2009).
9. Alka Chawla. *Law of Copyright: Comparative Perspectives*. LexisNexis (2013).
10. Ahuja, Virendra Kumar. *Law Relating to Intellectual Property Rights*. LexisNexis Butterworths (2007).
11. Robert P. Merges, Peter S. Menell & Mark A. Lemley *Intellectual Property in the new Technological Age*. Aspen Publishers (2017).

EC-481	Machine Learning	L	T	P	C
	Open Elective-II	3	0	0	3

Course Prerequisite: None

- Unit 1** INTRODUCTION: Machine Learning - Machine Learning Foundations -Overview - Design of a Learning system - Types of machine learning -Applications Mathematical foundations of machine learning - random variables and probabilities - Probability Theory - Probability distributions - Decision Theory- Bayes Decision Theory - Information Theory
- Unit 2** SUPERVISED LEARNING: Linear Models for Regression - Linear Models for Classification - Naive Bayes - Discriminant Functions -Probabilistic Generative Models -Probabilistic Discriminative Models - Bayesian Logistic Regression. Decision Trees - Classification Trees-egression Trees - Pruning. Neural Networks - Feed-forward Network Functions - Back- propagation. Support vector machines - Ensemble methods- Bagging-Boosting
- Unit 3** UNSUPERVISED LEARNING: Clustering- K-means - EM Algorithm- Mixtures of Gaussians. The Curse of Dimensionality - Dimensionality Reduction - Factor analysis - Principal Component Analysis - Probabilistic PCA Independent components analysis
- Unit 4** PROBABILISTIC GRAPHICAL MODELS: Graphical Models - Undirected graphical models - Markov Random Fields - Directed Graphical Models -Bayesian Networks - Conditional independence properties - Inference - Learning Generalization - Hidden Markov Models - Conditional random fields(CRFs)
- Unit 5** ADVANCED LEARNING: Sampling -Basic sampling methods - Monte Carlo. Reinforcement Learning- K- Armed Bandit Elements - Model-Based Learning- Value Iteration- Policy Iteration. Temporal Difference Learning Exploration Strategies- Deterministic and Non-deterministic Rewards and Actions Computational Learning Theory - Mistake bound analysis, sample complexity analysis, VC dimension. Occam learning, accuracy and confidence boosting

REFERENCES:

1. Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2007.
2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
3. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2014.
4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
5. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning",Springer,

Second Edition, 2011.

6. Stephen Marsland, “Machine Learning - An Algorithmic Perspective”, Chapman and Hall/CRC Press, Second Edition, 2014.

Course Outcomes: Upon completion of the course, the students will be able to:

CO1: Distinguish between, supervised, unsupervised and semi-supervised learning.

CO2: Apply the apt machine learning strategy for any given problem.

CO3: Suggest supervised, unsupervised, or semi-supervised learning algorithms for any given problem.

CO4: Design systems that use the appropriate graph models of machine learning.

CO4: Modify existing machine learning algorithms to improve classification efficiency.

EC-482	INFORMATION THEORY AND CODING	L	T	P	C
	Open Elective-II	3	0	0	3

Course Prerequisite: EC-301, EC-208

- Unit 1** Entropy and Mutual Information: Uncertainty and information, average mutual information and entropy, joint entropy and conditional entropy, relative entropy, chain rules
- Unit 2** Source Coding: Information measures for continuous random variables, Kraft inequality, source coding theorem, Huffman codes, Lempel-Ziv codes
- Unit 3** Channel Capacity: Channel models, channel capacity, channel coding, information capacity theorem, The Shannon limit
- Unit 4** Linear Block Codes: Matrix description of linear block codes, equivalent codes, parity check matrix, decoding of a linear block code, perfect codes, Hamming codes
- Unit 5** Cyclic Codes: Polynomials, division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, Golay codes
- Unit 6** BCH Code: Primitive elements, minimal polynomials, generator polynomials in terms of minimal polynomials, examples of BCH codes
- Unit 7** Convolutional Codes: Tree codes, trellis codes, polynomial description of convolutional codes, distance notions for convolutional codes, the generating function, matrix representation of convolutional codes, decoding of convolutional codes (Viterbi Decoding), distance and performance bounds for convolutional codes, examples of convolutional codes
- Unit 8** Introduction to Turbo coding: Turbo coding, turbo decoding

TEXT/REFERENCE BOOKS

1. Elements of Information Theory, T.M. Cover and J.A. Thomas, Wiley Student Edition
2. Information theory, Coding and Cryptography, Ranjan Bose, TMH
3. Error Control Coding, Shu Lin and D J Costello Jr, Prentice Hall
4. Information and Coding , N Abramson , McGraw Hill
5. Information Theory, R B Ash, Prentice Hall

Course Outcome: Upon completion of the course, the students will be able to:

CO1: Understand the basic idea of source coding and channel coding

CO2: Learn and design efficient linear error-correcting block codes

CO3: Learn and design cyclic codes and BCH code

CO3: Perform convolutional codes and Viterbi decoding process

CO4: Apply turbo coding and turbo decoding

CO5: Understand cryptography and different security algorithms and protocols

EC-483	Biometrics for Network Security	L	T	P	C
	Open Elective-II	3	0	0	3

Course Prerequisite: None

- Unit 1** INTRODUCTION TO BIOMETRICS: Introduction and background - biometric technologies - passive biometrics - active biometrics - Biometric systems - Enrollment - templates - algorithm - verification - Biometric applications - biometric characteristics - Authentication technologies - Need for strong authentication - Protecting privacy and biometrics and policy - Biometric applications - biometric characteristics.
- Unit 2** FINGERPRINT TECHNOLOGY: History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques - fingerprint sensors and RF imaging techniques - finger point quality assessment - computer enhancement and modeling of fingerprint images - finger print enhancement - Feature extraction - fingerprint classification - fingerprint matching.
- Unit 3** FACE RECOGNITION AND HAND GEOMETRY: Introduction to face recognition, Neural networks for face recognition - face recognition from correspondence maps - Hand geometry - scanning - Feature Extraction - Adaptive Classifiers - Visual-Based Feature Extraction and Pattern Classification - feature extraction - types of algorithm - Biometric fusion.
- Unit 4** MULTIMODAL BIOMETRICS AND PERFORMANCE EVALUATION: Introduction to multimodal biometric system - Integration strategies - Architecture - level of fusion - combination strategy - training and adaptability - examples of multimodal biometric systems - Performance evaluation - Statistical Measures of Biometrics - FAR - FRR - FTE - EER - Memory requirement and allocation.
- Unit 5** BIOMETRIC AUTHENTICATION: Introduction - Biometric Authentication Methods – BiometricAuthentication Systems - Biometric authentication by fingerprint - Biometric Authentication by Face Recognition - Expectation - Maximization theory - Support Vector Machines. Biometric authentication by fingerprint - biometric authentication by hand geometry - Securing and trusting a biometric transaction - matching location - local host - authentication server - match on card (MOC) - Multibiometrics and Two- Factor Authentication

REFERENCES:

1. Paul Reid, —Biometrics for Network Security!, Pearson Education, 2004.
2. Nalini K. Ratha, Rund Bolle,—Automatic fingerprint recognition system, Springer!, 2003.
3. L C Jain, I Hayashi, S B Lee, U Haleci, —Intelligent Biometric Techniques in Fingerprint and Face Recognition!.
4. S.Y.Kung,S.H.Lin,M.W.,—MakBiometricAuthentication:A Machine Learning Approach!.
5. John Chirillo, Scott Blaul, —Implementing Biometric Security!, John Wile, 2003.

Course Outcomes: Upon completion of the course, the students will be able to:

Upon completion of this course, the students will be able to:

CO1: Explain the key issues and importance of biometric systems for security concerns.

CO2: Recognize physical and behavior biometric characteristics.

CO3: Describe the security and privacy aspects of biometric systems.

CO4: Identify different authentication services along with biometric verification mechanisms.

CO5: Explain various biometric template protection schemes.

EC-484	Medical Image Processing	L	T	P	C
	Open Elective-II	3	0	0	3

Course Prerequisite: None

- Unit 1** INTRODUCTION TO MEDICAL IMAGE RETRIEVAL: Need for Intelligent Databases - Significance of Feature Space Selection - Towards Advanced Image Retrieval - Multimedia Systems and Image Retrieval Systems - Wavelet Transforms.
- Unit 2** IMAGE RETRIEVAL SYSTEMS: Systems Using Edge Points - Colour Histograms - Textures, Fuzzy Based Image Retrieval - System Clustering Based Image Retrieval System - Texture Based and Content based Image Retrieval Systems - Meta data based image retrieval system - Web based image retrieval system - Neural based approaches for image retrieval system.
- Unit 3** CONTENT BASED IMAGE AND VIDEO RETRIEVAL SYSTEMS: Feature Extraction and representation - Feature classification and selection - Colour based - Features - Color models - Representation of colors properties - Texture based features - Shape based features - Specialized features - Video Parsing - Shot boundary Detection - Scene boundary detection - Video abstraction and summarization Keyframe extraction - Highlight sequences - Video content representation indexing and retrieval - video browsing schemes.
- Unit 4** ONTOLOGY BASED MEDICAL IMAGE RETRIEVAL SYSTEM: Digital Image management in biomedicine - Ontologies and models for the handling of medical images - Advances in Image Databases languages - Indexing Large collections of medical Images - Telematics in Health care - Wavelet based medical Image distribution - Understanding and using DICOM - The data interchange standard for Bio medical Imaging.
- Unit 5** APPLICATIONS AND CURRENT TRENDS: Image retrieval in pathology - mammography - Biomedical applications - Web related applications - ADL (Alexandria Digital Library) - AMORE (Advanced Multimedia Oriented Retrieval Engine) - BDLP (Berkeley Digital Library Project) - Blobworld CANDID (Comparison Algorithm for navigating digital image databases) - CBVQ (content based visual query) - CHROMA (colour hierarchical Representation Oriented Management Architecture).

REFERENCES:

1. Gong Yihong Gong, Intelligent Image Databases: Towards Advanced Image Retrieval, Springer, USA,

1997.

2. James Z Wang, Integrated Region - Based Image Retrieval, Springer USA, 2001.
3. Remco C Veltkamp, Hans Burkhardt, Hans-Peter Kriegel, State-Of-The-Art in Content-Based Image and Video Retrieval, Springer, USA, 2001.
4. Milan Petkovic, Willem Jonker, Content-Based Video Retrieval, Springer, USA, 2003.
5. C. Brodley, A. Kak, C. Shyu, J. Dy, L. Broderick, and A. M. Aisen. Content-Based Retrieval from Medical Image Databases: A Synergy of Human interactions, Machine Learning and Computer Vision, In Proc. of the Sixteenth National Conference on Artificial Intelligence (AAAI'99), Orlando Florida, July 1999.
6. C.H. Wei, C-Li and R. Wilson. A General Framework for Content-Based Medical Image Retrieval with its Application to Mammograms. In Proc. SPIE Int'l Symposium on Medical Imaging, San Diego, February, 2005.
7. Tagore, D.H., Jaffe, C.C., & Duncan, J. Medical Image Databases: A Content-based retrieval approach. Journal of American Medical Informatics Association, 4(3), 1997, pp.184-198.

Course Outcomes: The graduates will be able to:

CO1: Understand the fundamentals of medical image processing techniques

CO2: Learn medical image acquisition devices.

CO3: Apply image processing concepts for medical images.

CO4: Analyse Morphology, Segmentation techniques and implement these in medical images.

CO5: Develop computational methods and algorithms to analyse and quantify biomedical data.

EC-485	Selected Topics on VLSI	L	T	P	C
	Open Elective-II	3	0	0	3

Pre-requisite - EC-101, EC-201

- Unit 1** Introduction to Semiconductor Industry and VLSI Technology: Clean Room, Materials for semiconductor Industry, crystallography, extraction of semiconductor grade silicon wafer and identification, Doping: Diffusion and Ion-implantation.
- Unit 2** Thin Film Technology: Vacuum basics, Conditions for formation of thin films, Physical Vapor Deposition: Sputtering, Thermal Evaporator, e-beam evaporation, Oxidation, and Chemical Vapor Deposition.
- Unit 3** Lithography: Photoresists: Negative and Positive, Deposition of photoresists, Photomasks, Lithography Techniques: Optical, E-beam, X-Ray and Soft Lithography, Etching: Wet and Dry, Lift-off.
- Unit 4** Device Fabrication: Salient steps for fabrication: diode, MOS Capacitor, MOSFET devices.
- Unit 5** VLSI Design Perspectives: Data path analysis and timing analysis
- Unit 6** Emerging Areas in VLSI: VLSI in IOT, Embedded Systems, Challenges of Nanoelectronics, and MEMS/NEMS.

Text/Reference:

1. Silicon VLSI Technology, Plummer, Deal and Griffin, Prentice Hall
2. Fundamentals of Semiconductor Fabrication, S. M. Sze, John Wiley and Sons
3. Fundamentals of Microfabrication: The Science of Miniaturization, Marc Madou, CRC Press
4. Introduction to Microelectronic Fabrication, R.C. Jaeger, Prentice Hall
5. Semiconductor Physics and Devices, Donald A. Neaman, Tata McGraw Hills

Course Outcomes:The graduates will be able to:

CO1: Understand the preparation steps of electronic grade silicon wafers and their characterization

CO2: Understand the principle of thin film growth and necessary deposition processes

CO3: Recognize the role of lithography in salient step of device fabrication

CO4: Analyze the data path and timing diagram

CO5: Identify the challenges in Nanoelectronics, MEMS/NEMS and VLSI in IOT.

EC-486	VLSI Physical Design	L	T	P	C
	Open Elective-II	3	0	0	3

Pre-requisite - EC-201, EC-309

- Unit 1** *Introduction:* VLSI design flow, challenges.
- Unit 2** *Verilog/VHDL:* Introduction and use in synthesis, modeling combinational and sequential logic, writing test benches.
- Unit 3** *Logic synthesis:* Two-level and multilevel gate-level optimization tools, state assignment of finite state machines.
- Unit 4** *Basic concepts of high-level synthesis:* Partitioning, scheduling, allocation and binding. Technology mapping. Testability issues: fault modeling and simulation, test generation, design for testability, built-in self-test. Testing SoC's. Basic concepts of verification. Physical design automation.
- Unit 5** *VLSI design styles:* Full-custom, standard-cell, gate-array and FPGA.
- Unit 6** *Physical design automation algorithms:* Floor-planning, placement, routing, compaction, design rule check, power and delay estimation, clock and power routing, etc. Special considerations for analog and mixed-signal designs.

Text/Reference Books:

1. Synthesis and Optimization of Digital Circuits, Giovanni De Micheli, TMH
2. Algorithms for VLSI Design Automation, S. H. Gerez, John Wiley & Sons
3. High Level Synthesis: Introduction to Chip and System Design, D. D Gajski et al, Springer
4. Algorithms for VLSI Physical Design Automation, N. A. Sherwani, Springer
5. An Introduction to VLSI Physical Design, M. Sarrafzadeh and C.K. Wong, McGraw-Hill
6. Logic Synthesis, S. Devadas, A. Ghosh, K. Keutzer, McGraw-Hill

Course Outcomes: At the end of the course, students will be able to

- CO1.** Simulate and synthesis of various combinational and sequential circuits using Verilog/VHDL.
- CO2.** Understand various concepts of high-level synthesis such as Partitioning, scheduling, allocation and binding.
- CO3.** Analyze various physical design automation algorithms for Full-custom/ Semi-custom IC design.
- CO4.** Convert the circuit design to a geometric representation for manufacturing the integrated circuit (IC).

EC-491	Machine Learning in VLSI CAD	L	T	P	C
	Open Elective-III	3	0	0	3

Pre-requisite - EC-309

Unit 1 A Preliminary Taxonomy for Machine Learning in VLSI CAD

Machine learning taxonomy, VLSI CAD Abstraction levels

Machine Learning for Compact Lithographic Process Models

Introduction, Lithographic Patterning Process, Representation of Lithographic Patterning Process – Mask, Imaging, Resist & Etch Transfer Function

Unit 2 Machine Learning of Compact Lithographic Process Models

Compact process model machine learning problem statement, CPM Task, CPM Training

Experience, Performance metrics, Supervised learning of a CPM

Neural Network Compact Patterning Models

Neural Network Mask Transfer Function, Neural Network Image Transfer Function, Neural Network Resist Transfer Function, Neural Network Etch Transfer Function

Unit 3 Machine Learning for Mask Synthesis

Introduction, Machine Learning guided OPC, MLP Construction, ML-EPC, EPC Algorithm

Machine Learning in Physical Verification

Introduction, Machine Learning in Physical Verification – layout feature extraction & encoding, models for hotspot detection.

Unit 4 Machine Learning in Mask Synthesis and Physical Design

Machine Learning in Mask Synthesis – mask synthesis flow, Machine Learning for sub-resolution assist features, Machine Learning for optical proximity correction.

Machine Learning in Physical Design - for datapath placement, routability driven placement, clock optimization, lithography friendly routing

Machine Learning for Manufacturing

Gaussian process-based wafer-level correlation modeling, and its applications

Unit 5 Machine Learning for Yield and Reliability

High-volume manufacturing yield estimation – Histogram with random sampling, Histogram with GPST-PS, Kernel density estimation, Machine learning based aging analysis, Learning from limited data in VLSI CAD, Iterative feature search, Comparative study of Assertion mining algorithms in GoldMine.

Text books

1. Machine Learning in VLSI Computer Aided Design, Ibrahim (Abe) M Elfadel, Duane SBoning, Xin Li, Springer International Publishing, 2019.

Books

1. Machine Learning, Tom M Mitchell, McGraw-Hill, 1997.
2. Machine Learning, Anuradha Srinivasaraghavan, Vincy Joseph Wiley 2019.

Course outcomes:

At the end of the course the student will be able to:

CO1: Use machine learning technologies in VLSI CAD to further automate the design, verify and implement most advanced chips.

CO2: Apply machine learning algorithms for compact Lithographic process models.

CO3: Solve existing CAD problems such as hotspot detection, efficient test generation, and post-silicon measurement minimization using machine learning methods.

CO4: Predict the Yield and Reliability of VLSI chips using machine learning methods.

CO5: Comprehend the appropriate application of the various supervised, unsupervised, and statistical learning in the various layers of chip design hierarchy.

EC-492	MOBILE COMPUTING	L	T	P	C
	Open Elective-III	3	0	0	3

Course Prerequisite: EC-401

- Unit 1 Introduction to Personal Communications Services (PCS):** PCS Architecture, mobility management, Networks signaling; Global System for Mobile Communication (GSM) System.
- Unit 2 Overview:** GSM Architecture, Mobility management, Network signaling; General Packet Radio Services (GPRS): GPRS Architecture, GPRS Network Nodes, Mobile Data Communication; WLANs (Wireless LANs) IEEE 802.II standard.
- Unit 3 Wireless Application Protocol (WAP):** The Mobile Internet standard, WAP Gateway and Protocols, wireless mark up Languages (WML).
- Unit 4 Wireless Local Loop (WLL):** Introduction to WLL Architecture, wireless Local Loop Technologies.
- Unit 5 Third Generation (3G) Mobile Services:** Introduction to International Mobile Telecommunications 2000 (IMT 2000) Vision.
Global Mobile Satellite Systems; case studies of the IRIDIUM, ICO and GLOBALSTAR systems.
- Unit 6 Wireless Enterprise Networks:** Introduction to Virtual Networks, Blue tooth technology, Blue tooth Protocols; Server-side programming in Java, Pervasive web application architecture, Device independent example application
Wideband Code Division Multiple Access (W-CDMA) and CDMA 2000; Mobile IP.

Text Books:

1. Mobile Communication , *J. Schiller*, Pearson Education
2. Mobile Computing, *Talukder*, TMH
3. Pervasive Computing, *Burkhardt*, Pearson Education
4. Mobile Computing, *Raj Kamal*, Oxford University Press

Reference Books:

1. Principles of Mobile Computing , *Hansmann, Merk*, Springer
2. Wireless Communication & Networking, *Garg*, Elsevier
3. The Wireless Application Protocol, Pearson Education, Pearson Education

Course Outcomes are

The Graduates will be able to

CO1: Study Personal Communications Services (PCS)

CO2: Review the different wireless communication standards like GSM, GPRS, WLAN etc.

CO3: Understand different aspects related to WAP

CO4: Understand WLL, 2G, 3G, 4G, 5G, WCDMA, and CDMA 2000 communication systems

CO5: Study various aspects of Wireless Enterprise Network

CO6: Learn different server-side programming, web application architectures

EC-493

COGNITIVE RADIO

L T P C

Open Elective-III

3 0 0 3

Course Prerequisite: EC-401

- Unit 1** INTRODUCTION TO COGNITIVE RADIOS Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio
- Unit 2** SPECTRUM SENSING Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geolocation database and spectrum sharing business models.
- Unit 3** OPTIMIZATION TECHNIQUES OF DYNAMIC SPECTRUM ALLOCATION Linear programming, convex programming, non-linear programming, integer programming, dynamic programming and stochastic programming.
- Unit 4** DYNAMIC SPECTRUM ACCESS AND MANAGEMENT Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access.
- Unit 5** SPECTRUM TRADING Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA, classification of auctions.

Text / Reference Books

1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
3. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
4. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007
5. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009
6. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009

Course Outcome: Upon completion of the course, the students will be able to:

CO1: Understand the basic idea of cognitive radio (CR) architecture

CO2: Understand and apply the concept of spectrum sensing

CO3: Learn different spectrum sensing techniques

CO3: Apply the optimization techniques in cognitive radio operations

CO4: Explore different techniques for dynamic spectrum access and management

CO5: Get familiar with different spectrum trading mechanisms

EC-494	Nano structure and Quantum Devices	L	T	P	C
	Open Elective-III	3	0	0	3

Course Prerequisite: PH-101, EC-201

- Unit 1** Semiconductor Heterojunctions, Nano-CMOS devices, Low-dimensional semiconductor structures, Semiconductor Superlattices and minibands,
- Unit 2** Optical properties of nanostructures, Resonant tunneling phenomena, Coulomb blockade and quantum transport. Metallic superlattices
- Unit 3** Self-assembled nanostructures, Nanofabrication, Probing of nanostructures.
- Unit 4** Quantum devices: Single Electron Devices, Quantum cascade lasers, ultra-fast switching devices, high density memories, Giant Magneto Resistance and Josephson devices, Long wavelength IR detectors, photonic integrated circuits

Text/Reference Books

1. Nano structure and Quantum Devices, Science Direct
2. Nanoscale Materials and Devices for Electronics, Photonics and Solar Energy (Nanostructure Science and Technology), Springer

Course Outcomes are

The graduates will be able to

CO1: Illustrate the knowledge of Hetero junction semiconductor devices

CO2: Demonstrate the optical properties of semiconductor

CO3: Illustrate resonant tunnelling, Coulomb blockade and Quantum Transport Phenomena

CO4: Apply the nano fabrication techniques, probing of nano structures

CO5: Analyse various quantum devices like single electron, quantum cascade lasers, ultra-fast switching devices.

CO6: Design photonic integrated circuits

EC-495	Special Topics on Image Processing	L	T	P	C
	Open Elective-III	3	0	0	3

Course Prerequisite: None

- Unit 1** REGISTRATION METHODOLOGY: Introduction. Concepts and algorithms - notation and terminology, Types of transformation, Registration algorithms, Image transformation. Correcting for scanner errors in CT, MRI, SPECT and 3D Ultrasound - geometric distortion in CT, spatial inaccuracies in MRI, SPECT and 3D US.
- Unit 2** Detecting failure, assessing success - measure and alignment of errors, methods for estimating error, gold standards and Registration circuits, accounting for error in the standard, independent validation
- Unit 3** TECHNIQUES AND APPLILCATIONS OF RIGID BODY REGISTRATION: Registration and subtraction of serial MRI of the Brain: Image interpretation and clinical applications - Regional and tissue-specific appearances on different images, artifacts and failed registration, physiological changes, contrast enhancement, pediatrics, adult infarction, multiple sclerosis, tumors, schizophrenia, alzheimer's disease, postoperative changes, bone marrow transplantation, quantization of brain change. Role of registration in fMRI- motion correction, geometric distortion. Structural registration- Registration of MRI and PET images, Registration of MR and CT images, Image registration in nuclear medicine. Guiding therapeutic procedures
- Unit 4** TECHNIQUES AND APPLILCATIONS OF NON-RIGID BODY REGISTRATION: Non rigid registration: concepts, algorithms and applications - registration using splines, FEM and mechanical models, optical flow, elastic registration, fluid registration, intra subject and inter subject registration. Analysis of motion and deformation using non rigid registration. Registration based analysis of normal brain anatomy and metabolism in multiple sclerosis. Biomechanical modeling for image registration: Application in image guided neuro surgery. Future applications of image registration.
- Unit 5** OPTIMIZATION METHODS FOR MEDICAL IMAGE REGISTRATION: Optimization methods - Gradient descent (GDD & GDL) method, Non linear conjugate (NCG) method, stochastic gradient descent (SGD) method, Preconditioned SGD method and Adaptive SGD method. Quasi newton (QN) method, Evolution strategy (ES) method, Preconditioned Monomodal registration method. Label image fusion in detail.
- Unit 6** ELASTIX - TOOL
Image registration with elastix, Registration frame work, software characteristics, Registration components, Registration set up. Transformation models. Sampling strategies and Multiresolution

strategies. Artificial motions. Rigid registration of fMRI series and Non rigid registration of CT chest scans. Adaptive vs Nonadaptive. Maximum voxel displacement. Evaluation measures.

REFERENCES:

1. Joseph. V. Hajnal, Derek L.G. Hill, David J. Hawkes, — Medical image registration!, The Biomedical engineering series, CRC Press, 2001.
2. Stefan Klein, — Optimization Methods for Medical image registration!, Uitgeverij BOX press, the Netherlands, 2008.
3. Isaac N. Bankman, —Handbook of Medical Imaging processing and analysis!, Academic Press, 2000.
4. Steve Webb, —The Physics of Medical Imaging!, Taylor & Francis, New York.1988.
5. Stefan Klein, Marius Staring, Keelin Murphy, Max A. Viergever and Josien P. W. Pluim,! elastix: A Toolbox for Intensity-Based Medical Image Registration, IEEE Transactions on Medical Imaging, VOL. 29, NO. 1, January 2010.

Course Outcomes: The graduates will be able to

CO1: Understand the fundamental concepts of Image Registration.

CO2: Interpreting the different techniques used for rigid and non-rigid image registration.

CO3: Explaining the Optimization methods in image registration.

CO4: Apply various image registration techniques on MRI, CT and PET medical images.

CO5: Analyze the role of registration in motion correction, geometric distortion of medical images.