B. Tech. Degree

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

SYLLABUS
FOR
CREDIT BASED CURRICULUM
(For students admitted in 2013-14)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015
TAMIL NADU, INDIA

CURRICULUM

The total minimum credits required for completing the B.Tech. Programme in Electronics and Communication Engineering is 185 (45+140)

SEMESTER III

CODE	COURSE OF STUDY	L	T	P	C
MA207	Real Analysis and Partial Differential Equations	3	1	0	4
EC201	Signals and Systems	3	1	0	4
EC203	Network Analysis and Synthesis	3	0	0	3
EC205	Electrodynamics and Electromagnetic Waves	3	1	0	4
EC207	Semiconductor Physics and Devices	3	0	0	3
EC209	Digital Circuits and Systems	3	0	0	3
EC211	Devices and Networks Laboratory	0	0	3	2
EC213	Digital Electronics Laboratory	0	0	3	2
	TOTAL	18	3	6	25

SEMESTER IV

CODE	COURSE OF STUDY	L	T	P	C
MA206	Probability theory and Random Processes	3	1	0	4
EC202	Digital Signal Processing	3	1	0	4
IC218	Control Systems	3	0	0	3
EC204	Transmission Lines and Waveguides	3	0	0	3
EC206	Electronic Circuits	3	0	0	3
EC208	Microprocessors and Micro controllers	3	0	0	3
EC210	Electronic Circuits Laboratory	0	0	3	2
EC212	Microprocessor and Microcontroller Laboratory	0	0	3	2
	TOTAL	18	2	6	24

SEMESTER V

CODE	COURSE OF STUDY	L	T	P	C
EC301	Statistical Theory of Communication	3	1	0	4
EC303	Digital Signal Processors and Applications	3	0	0	3
EC305	Analog Communication	3	0	0	3
EC307	Antennas and propagation	3	0	0	3
EC309	Analog Integrated Circuits	3	0	0	3
	ELECTIVE 1	3	0	0	3
EC313	Analog Integrated Circuits Laboratory	0	0	3	2
EC315	Digital Signal Processing Laboratory	0	0	3	2
	TOTAL	18	1	6	23

SEMESTER VI

CODE	COURSE OF STUDY	L	T	P	C
EC302	Digital Communication	3	0	0	3
EC304	Networks and Protocols	3	0	0	3
EC306	Microwave Components and Circuits	3	0	0	3
EC308	VLSI Systems	3	0	0	3
	ELECTIVE 2	3	0	0	3
	ELECTIVE 3	3	0	0	3
EC312	Communication Engineering Laboratory	0	0	3	2
EC314	VLSI and Embedded System Design Laboratory	0	0	3	2
	INDUSTRIAL LECTURES				1
	INTERNSHIP/INDUSTRIAL TRAINING/ACADEMIC ATTACHMENT [#] (2 to 3 months duration during summer vacation)				2
	TOTAL	18	1	6	25

[#] To be evaluated at the beginning of VII semester by assessing the report and conducting seminar presentations.

SEMESTER VII

CODE	COURSE OF STUDY	L	T	P	C
HM401	Industrial Economics	3	0	0	3
EC401	Wireless Communication	3	0	0	3
EC403	Fiber Optic Communication	3	0	0	3
EC405	Microwave Electronics	3	0	0	3
	ELECTIVE 4	3	0	0	3
	ELECTIVE 5*	3	0	0	3
EC407	Fiber Optic Communication Laboratory	0	0	3	2
EC409	Microwave Laboratory	0	0	3	2
EC447	COMPREHENSIVE EXAMINATION	0	0	0	3
	TOTAL	18	0	6	25

SEMESTER VIII

CODE	COURSE OF STUDY	L	T	P	C
MB790	Management Concepts and Practices	3	0	0	3
	ELECTIVE 6	3	0	0	3
	ELECTIVE 7*	3	0	0	3
	ELECTIVE 8*	3	0	0	3
EC498	PROJECT WORK	0	0	12	6
	TOTAL	12	0	12	18

* GLOBAL ELECTIVES ALSO

LIST OF ELECTIVES

GROUP 1(COMMUNICATION AND SIGNAL PROCESSING STREAM)

1. EC001 Principles of Radar
2. EC002 Satellite Communication
3. EC003 Cognitive Radio
4. EC004 Multimedia Communication Technology
5. EC005 Communication Switching Systems
6. EC006 Broadband Access Technologies
7. EC007 Digital Speech Processing
8. EC008Image Processing
9. EC009Pattern Recognition
10. EC010Signal Processing for Wireless Communication

GROUP 2 (MICROWAVE ENGINEERING STREAM)

1. EC021Microwave Integrated Circuit Design
2. EC022 RF MEMS Circuit Design

GROUP 3 (VLSI CIRCUITS AND EMBEDDED SYSTEMS STREAM)

1. EC041 Computer Architecture and Organization
2. EC042 Embedded Systems
3. EC043 ARM System Architecture
4. EC044 Operating Systems
5. EC045 Display Systems
6. EC046 Electronic Packaging

LIST OF ADVANCED LEVEL COURSES FOR B.Tech. HONOURS

i. For the students with consistent academic record of GPA $\geq$ 8.5 from I to IV semesters, and applied for B.Tech Honours
ii. Can opt to study any 3 of the listed advanced level courses from V semester)

1. EC090Adhoc Wireless Networks
2. EC091 Wireless Sensor Networks
3. EC092 Detection and Estimation
4. EC093 Statistical Signal Processing
5. EC094 RF circuits
6. EC095 Numerical Techniques for MIC
7. EC096Applied Photonics
8. EC097 Advanced Radiation Systems
9. EC098 Bio MEMS
10. EC099Analog IC Design
11. EC100 VLSI System Testing
12. EC101 Electronic Design Automation Tools
13. EC102 Design of ASICs
14. EC103 Digital System Design
15. EC104 Digital Signal Processing structures for VLSI
16. EC105 Low Power VLSI circuits
17. EC106 VLSI Digital Signal Processing Systems
18. EC107 Asynchronous System Design
19. EC108 Physical Design Automation
20. EC109 Mixed - Signal Circuit Design

COURSES OFFERED TO OTHER DEPARTMENTS

DEPT.	CODE	COURSE OF STUDY	L	T	P	C
CSE	EC214	Basics of Communication	3	0	0	3
ICE	EC317	Principles of Communication Systems	3	0	0	3
EEE	EC319	Communication Systems	3	0	0	3
MET	EC215	Applied Electronics	2	0	2	3
MECH	EC217	Applied Electronic Engineering	2	0	2	3
CHE	EC219	Digital Electronics	3	0	0	3

SYLLABUS

MA207 Real Analysis and Partial Differential Equations (L-T-P) C
3 – 0 – 0 - 3

COURSE OBJECTIVE

- To expose the students to the basics of real analysis and partial differential equations required for their subsequent course work.

COURSE CONTENT

Properties of real numbers, Numerical sequences. Cauchy sequences. Bolzano-Weierstrass and Heine-Borel properties.

Functions of real variables, Limits, continuity and differentiability, Taylor's formula, Extrema of functions.

Riemann integral, mean value theorems, Differentiation under integral sign, Change-of-variables formula, Sequences and series of functions, Point wise and uniform convergence.

Method of separation of variables-Fourier series solution applications to one dimensional wave equation and one-dimensional heat flow equation.

Laplace and Helmholtz equations, Boundary and initial value problems, Solution by separation of variables and Eigen Function Expansion.

Text Books

1. *Guenther, R.B. &Lee, J.W., "Partial Differential Equations of Mathematical Physics and Integral Equations", Prentice Hall, 1996.*
2. *W.Rudin, "Introduction to Principles of Mathematical Analysis", McGraw-Hill International Editions, Third Edition, 1976.*

Reference Books

1. *Kreyszig.E., "Advanced Engineering Mathematics", John Wiley, 1999.*
2. *S.C. Malik, Savita Arora, "Mathematical Analysis", New Age International Ltd, 4th Edition, 2012.*
3. *G.B.Gustafson&C.H. Wilcox, "Advanced Engineering Mathematics", Springer Verlag, 1998.*

COURSE OUTCOMES

Students are able to

CO1: Develops an understanding for the construction of proofs and an appreciation for deductive logic.

CO2: Explore the already familiar properties of the derivative and the Riemann Integral, set on a more rigorous and formal footing which is central to avoiding inconsistencies in engineering applications.

CO3: Explore new theoretical dimensions of uniform convergence, completeness and important consequences as interchange of limit operations.

CO4: Develop an intuition for analyzing sets of higher dimension (mostly of the R^n type) space.

CO5: Solve the most common PDEs, recurrent in engineering using standard techniques and understanding of an appreciation for the need of numerical techniques.

EC201	Signals and Systems	(L-T-P) C 3 - 0 - 0 - 3

COURSE OBJECTIVES

The aim of the course is for

- understanding the fundamental characteristics of signals and systems.
- understanding the concepts of vector space, inner product space and orthogonal series.
- understanding signals and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspectives provide.
- development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

COURSE CONTENT

Vector spaces. Inner Product spaces. Schwartzin equality. Hilbertspaces. Orthogonal expansions. Bessel's inequality and Parseval's relations.

Continuous-time signals, classifications. Periodic signals. Fourier series representation, Hilbert transform and its properties.

Laplace transforms. Continuous - time systems: LTI system analysis using Laplace and Fourier transforms.

Sampling and reconstruction of band limited signals. Low pass and band pass sampling theorems. Aliasing. Anti-aliasing filter. Practical Sampling-aperture effect.

Discrete-time signals and systems. Z-transform and its properties. Analysis of LSI systems using Z – transform.

Text Books

1. *A.V.Oppenheim, A. Willsky, S. Hamid Nawab, "Signals and Systems (2/e)", Pearson 200.*
2. *S.Haykin and B.VanVeen "Signals and Systems, Wiley, 1998.*
3. *M.Mandal and A.Asif, "Continuous and Discrete Time Signals and Systems, Cambridge, 2007.*

Reference Books

1. *D.C.Lay, "Linear Algebra and its Applications (2/e)", Pearson, 200.*
2. *K.Huffman&R.Kunz, "Linear Algebra", Prentice- Hall, 1971.*
3. *S.S.Soliman&M.D.Srinath, "Continuous and Discrete Signals and Systems", Prentice- Hall, 1990.*

COURSE OUTCOMES

Students are able to

CO1: apply the knowledge of linear algebra topics like vector space, basis, dimension, inner product, norm and orthogonal basis to signals.

CO2: analyse the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.

CO3: classify systems based on their properties and determine the response of LSI system using convolution.

CO4: analyze system properties based on impulse response and Fourier analysis.

CO5: apply the Laplace transform and Z- transform for analyze of continuous-time and discrete-time signals and systems.

CO6: understand the process of sampling and the effects of under sampling.

EC203 Network Analysis and synthesis (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVES

- To make the students capable of analyzing any given electrical network.
- To make the students to learn synthesis of an electrical network for a given impedance/ admittance function.

COURSE CONTENT

Network concept. Elements and sources. Kirchoff's laws. Tellegen's theorem. Network equilibrium equations. Node and Mesh method. Source superposition. Thevenin's and Norton's theorems. Network graphs.

First and second order networks. State equations. Transient response. Network functions. Determination of the natural frequencies and mode vectors from network functions.

Sinusoidal steady-state analysis. Maximum power-transfer theorem. Resonance. Equivalent and dual networks. Design of equalizers.

Two-port network parameters. Interconnection of two port networks. Barlett's bisection theorem. Image and Iterative parameters. Design of attenuators.

Two-terminal network synthesis. Properties of Hurwitz polynomial and Positive real function. Synthesis of LC, RC and RL Networks, Foster Forms and Cauer Forms.

Text Books

1. *Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw-Hill Publishing Company Ltd.,2008.*
2. *F.F. Kuo, "Network analysis and Synthesis", Wiley International Edition ,2008.*

Reference Books

1. *Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition, 2007.*
2. *B.S.Nair and S.R.Deepa, "Network analysis and Synthesis", Elsevier,2012.*

COURSE OUTCOMES

Students are able to

CO1: analyze the electric circuit using network theorems

CO2: understand and Obtain Transient & Forced response

CO3: determine Sinusoidal steady state response; understand the real time applications of maximum power transfer theorem and equalizer

CO4: understand the two–port network parameters, are able to find out two-port network parameters & overall response for interconnection of two-port networks.

CO5: synthesize one port network using Foster form, Cauer form.

EC205 Electrodynamics and Electromagnetic Waves (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To expose the students to the rudiments of Electromagnetic theory and wave propagation essential for subsequent courses on microwave engineering, antennas and wireless communication

COURSE CONTENT

Electrostatics. Coulomb'slaw. Gauss's law and applications. Electric potential. Poisson's and Laplace equations. Method of images. Multipole Expansion.

Electrostatic fields in matter. Dielectrics and electric polarization. Capacitors with dielectric substrates. Linear dielectrics. Force and energy in dielectric systems.

Magnetostatics. Magnetic fields of steady currents. Biot-Savart's and Ampere's laws. Magnetic vector potential. Magnetic properties of matter.

Electrodynamics. Flux rule for motional emf. Faraday's law. Self and mutual inductances. Maxwell's Equations. Electromagnetic Boundary conditions. Poynting theorem.

Electromagnetic wave propagation. Uniform plane waves. Wave polarization. Waves in matter. Reflection and transmission at boundaries. Propagation in an ionized medium.

Text Books

1. *D.J.Griffiths, "Introduction to Electrodynamics (3/e)", PHI, 2001*
2. *E.C. Jordan & G. Balmain, "Electromagnetic Waves and Radiating Systems", PHI, 1995.*

Reference Books

1. *W.H.Hayt, "Engineering Electromagnetics, (7/e)", McGraw Hill, 2006.*
2. *D.K.Cheng, "Field and Wave Electromagnetics, (2/e)", Addison Wesley, 1999.*
3. *M.N.O.Sadiku,"Principles of Electromagnetics, (4/e)", Oxford University Press, 2011.*
4. *N.NarayanaRao, "Elements of Engineering Electromagnetics, (6/e)", Pearson, 2006.*
5. *R.E.Collin, "Foundations for Microwave Engineering (2/e)", McGraw –Hill, 2002.*
6. *R.E.Collin, "Antennas and Radiowave Propagation", McGraw-Hill, 1985.*

COURSE OUTCOMES

Students are able to

CO1: recognize and classify the basic Electrostatic theorems and laws and to derive them.
CO2: discuss the behavior of Electric fields in matter and Polarization concepts.
CO3: classify the basic Magneto static theorems and laws and infer the magnetic properties of matter.
CO4: summarize the concepts of electrodynamics &to derive and discuss the Maxwell's equations.
CO5: students are expected to be familiar with Electromagnetic wave propagation and wave polarization.

EC207 Semiconductor Physics and Devices (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVES

- To make the students understand the fundamentals of electronic devices.
- To train them to apply these devices in mostly used and important applications.

COURSE CONTENT

Semiconductor materials, crystal growth, film formation, lithography, etching and doping. Conductivity, charge densities, E-K relation, Fermi level, continuity equation, Hall Effect and its applications.

P-N junction diodes, biasing, V-I characteristics, capacitances. Diode model. Various types of diodes. BJT, modes of operation, BJT models, BJT switch, breakdown mechanisms, Photo devices.

MOSFET, operation, V-I characteristics, MOSFET as amplifier and switch, capacitance, equivalent model. CMOS circuits. Bi-CMOS circuits. CCDs.

Power devices, operation and characteristics. Thyristor family. Power diodes. Power transistors. GTOs and IGBTs. Display devices, Operation of LCDs, LED, HDTV, Plasma displays.

Text Books

1. *S.M.Sze, 'Semiconductors Devices, Physics and Technology, (2/e)", Wiley, 2002.*
2. *A.S.Sedra&K.C.Smith, "Microelectronic Circuits (6/e)", Oxford, 2010.*
3. *L.Macdonald&A.C.Lowe, "Display Systems", Wiley, 2003*

Reference Books

1. *J.Millman and C.C.Halkias, "Electronic devices and Circuits", McGraw Hill, 1976.*
2. *A. Bar-Lev, "Semiconductors and Electronic Devices, (3/e)", Prentice Hall, 1993.*
3. *B.G.Streetman, "S.K.Banerjee: Solid state Electronic devices, (6/e)", PHI, 2010.*

COURSE OUTCOMES

Students are able to

CO1: apply the knowledge of basic semiconductor material physics and understand fabrication processes.
CO2: analyze the characteristics of various electronic devices like diode, transistor etc.,
CO3: classify and analyze the various circuit configurations of Transistor and MOSFETs.
CO4: illustrate the qualitative knowledge of Power electronic Devices.
CO5: become Aware of the latest technological changes in Display Devices.

EC209 Digital Circuits and Systems (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To introduce the theoretical and circuit aspects of digital electronics, which is the back bone for the basics of the hardware aspect of digital computers?

COURSE CONTENT

Review of number systems-representation-conversions, error detection and error correction. Review of Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms-minterm and maxterm, Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates.

Combinational logic circuits- adders, subtractors, BCD adder, ripple carry look ahead adders, parity generator, decoders, encoders, multiplexers, demultiplexers, Realization of Boolean expressions- using decoders-using multiplexers. Memories – ROM- organization, expansion. PROMs. Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs.

Sequential circuits – latches, flip flops, edge triggering, asynchronous inputs. Shift registers, Universal shift register, applications. Binary counters – Synchronous and asynchronous up/down counters, mod-N counter, Counters for random sequence.

Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams, Modelling- Moore machine and Mealy machine- serial binary adder, sequence recogniser, state table reduction, state assignment. Hazard; Overview and comparison of logic families.

Introduction to Verilog HDL, Structural, Dataflow and behavioral modelling of combinational and sequential logic circuits.

Text Books

1. *Wakerly J F, "Digital Design: Principles and Practices, Prentice-Hall", 2nd Ed., 2002.*
2. *D. D. Givone, "Digital Principles and Design", Tata Mc-Graw Hill, New Delhi, 2003.*
3. *S.Brown and Z.Vranesic, "Fundamentals of Digital Logic with Verilog Design", Tata Mc-Graw Hill, 2008.*

Reference Books

1. *D.P. Leach, A. P. Malvino, GoutamGuha, "Digital Principles and Applications", Tata Mc-Graw Hill, New Delhi, 2011.*
2. *M. M. Mano, "Digital Design", 3rd ed., Pearson Education, Delhi, 2003.*
3. *R.J.Tocci and N.S.Widner, "Digital Systems - Principles& Applications", PHI, 10th Ed., 2007 .*
4. *Roth C.H., "Fundamentals of Logic Design", Jaico Publishers. V Ed., 2009.*
5. *T. L. Floyd and Jain ,"Digital Fundamentals", 8th ed., Pearson Education, 2003.*

COURSE OUTCOMES

Students are able to

CO1: apply the knowledge of Boolean algebra and simplification of Boolean expressions to deduce optimal digital networks.

CO2: study and examine the SSI, MSI and Programmable combinational networks.

CO3: study and investigate the sequential networks suing counters and shift registers; summarize the performance of logic families with respect to their speed, power consumption, number of ICs and cost.

CO4: work out SSI and MSI digital networks given a state di agram based on Mealy and Moore configurations.

CO5: code combinational and sequential networks using Virology HDL.

EC211	**Devices and Networks Laboratory**	**(L-T-P) C** **0 - 0 - 3 - 2**

List of Experiments:

1. Study Experiment
2. PN Junction Diode Characteristics
3. Zener diode characteristics and its application
4. Characteristics study of Bipolar Junction Transistor (BJT)
5. Characteristics study of JFET
6. Response study of Series RLC
7. Constant K High pass Filter
8. Attenuators
9. Equalizers
10. Clippers and Clampers
11. SCR Characteristics
12. LAB view implementation

EC213	**Digital Electronics Laboratory**	**(L-T-P) C** **0 - 0 - 3 - 2**

List of Experiments:

1. Study of logic gates and verification of Boolean Laws.
2. Design of adders and subtractors.
3. Design of code converters.
4. Design of Multiplexers.
5. Design of De-multiplexers.
6. Design of Encoder and Decoder.
7. 2-bit and 8-bit magnitude comparators.
8. Study of flip-flops.
9. Design and implementation of counters using flip-flops.
10. Design and implementation of shift registers.

MA206	Probability Theory and Random Process	(L-T-P) C
		3 – 0 – 0 – 3

COURSE OBJECTIVE

- To expose the students to the basics of probability theory and random processes essential for their subsequent study of analog and digital communication.

COURSE CONTENT

Axioms of probability theory. Probability spaces. Joint and conditional probabilities. Bayes' Theorem-Independent events.

Random variables and random vectors. Distributions and densities. Independent random variables. Functions of one and two random variables.

Moments and characteristic functions. Inequalities of Chebyshev and Schwartz. Convergence concepts.

Random processes. Stationarity and ergodicity. Strict sense and wide sense stationary processes. Covariance functions and their properties. Spectral representation. Wiener-Khinchine theorem.

Gaussian processes. Processes with independent increments. Poisson processes. Low pass and Band pass noise representations.

Text Books

1. *Davenport," Probability and Random Processes for Scientist and Engineers", McGraw-Hill, 1970.*
2. *Papoulis. A.," Probability, Random variables and Stochastic Processes", McGraw Hill, 2002.*

Reference Books

1. *E.Wong, "Introduction to Random Processes", Springer Verlag,1983.*
2. *W.A.Gardner, "Introduction to Random Processes", (2/e), McGraw Hill,1990.*
3. *H.Stark & J.W.Woods, "Probability, Random Processes and Estimations Theory for Engineers", (2/e), Prentice Hall, 1994.*

COURSE OUTCOMES

Students are able to

CO1: understand the axiomatic formulation of modern Probability Theory and think of random variables as an intrinsic need for the analysis of random phenomena.

CO2: characterize probability models and function of random variables based on single & multiples random variables.

CO3: evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits.

CO4: understand the concept of random processes and determine covariance and spectral density of stationary random processes.

CO5: demonstrate the specific applications to Poisson and Gaussian processes and representation of low pass and band pass noise models.

EC202	**Digital Signal Processing**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- The subject aims to introduce the mathematical approach to manipulate discrete time signals, which are useful to learn digital tele-communication.

COURSE CONTENT

Review of VLSI system theory, DTFT, Frequency response of discrete time systems, All pass inverse and minimum phase systems.

DFT, Relationship of DFT to other transforms, FFT, DIT and DIF, FFT algorithm, Linear filtering using DFT and FFT.

Frequency response of FIR filter types, Design of FIR filters, IIR filter design, Mapping formulas, Frequency transformations.

Direct form realization of FIR and IIR systems, Lattice structure for FIR and IIR systems, Finite-word length effects. Limit cycle oscillations.

Sampling rate conversion by an integer and rational factor, Poly phase FIR structures for sampling rate conversion.

Text Books

1. *J.G.Proakis, D.G. Manolakis, "Digital Signal Processing", (4/e) Pearson, 2007.*
2. *A.V.Oppenheim&R.W.Schafer, " Discrete Time Signal processing", (2/e),Pearson Education, 2003.*
3. *S.K.Mitra, "Digital Signal Processing (3/e)", Tata McGraw Hill, 2006.*

Reference Books

1. *P.S.R.Diniz, E.A.B.da Silva and S.L.Netto, " Digital Signal Processing", Cambridge,2002.*
2. *E.C.Ifeachor&B.W.Jervis, "Digital Signal Processing", (2/e), Pearson Education, 2002.*
3. *J.R.Jhonson, "Introduction to Digital Signal Processing", Prentice-Hall, 1989.*

COURSE OUTCOMES

Students are able to

CO1: analyze discrete-time systems in both time & transform domain and also through pole-zero placement.
CO2: analyze discrete-time signals and systems using DFT and FFT.
CO3: design and implement digital finite impulse response (FIR) filters.
CO4: design and implement digital infinite impulse response (IIR) filters.
CO5: understand and develop multirate digital signal processing systems.

IC218	**Control Systems**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVES

- To introduce and teach the iterative nature of most designs in order to achieve working systems.
- To cover a wide variety of methods and techniques, from classical, modern, and digital control theory, and emphasize their interrelation.

COURSE CONTENT

Introduction to Systems, Mathematical Models – Differential Equations, Linear Approximations, Transfer Functions, Block Diagrams and Signal Flow Graphs, Feedback Control System Characteristics, Performance Specifications of Feedback Control Systems, Stability of Linear Feedback Systems – Routh-Hurwitz criterion.

The Root Locus Method, Control System Analysis & Performance Specifications in Time-Domain, Design of Lead, Lag, and PID Controllers using Root Locus.

Frequency Response Methods, Bode Plots, Performance Specifications in Frequency-Domain, Stability Margins, Design of Lag and PID controllers in Frequency Domain.

Modern Control Theory, State Variable Models, Lyapunov Stability Theory for Linear Systems, Controllability & Observability, Design of State Feedback Control Systems, Full-order and Reduced-order Observer Design, Numerical Linear Algebra for Modern Control Theory and Design.

Digital Control Systems, Closed-loop Feedback Sampled-Data Systems, Stability Analysis, Implementation of Digital Controllers.

Text Books

1. *Dorf, R.C., & Bishop, R.H., "Modern Control Systems", 12th edition, Prentice Hall, 2010.*
2. *Franklin. G.F., David Powell. J., & Emami-Naeini. A., "Feedback Control of Dynamic Systems", 6th edition, Prentice Hall, 2009.*

References Books

1. *Nise, N.S., "Control Systems Engineering", 6th edition, Wiley, 2011.*
2. *Dutton, K., Thompson, S., & Barralough, B., "The Art of Control Engineering", Prentice Hall, 1997.*

COURSE OUTCOMES

CO1: The student understands translating physical phenomena into corresponding mathematical descriptions, and applies appropriate tools to analyze the behavior of systems.
CO2: The student learns to deploy graphical tools to analyze and design control systems in time-domain.
CO3: The student understands that the frequency domain is a complementary point of view, and learns to design control systems in frequency-domain.
CO4: The student is exposed to an appropriate modern paradigm for the study of larger scale multi-input-multi-output systems.
CO5: The student learns to implement modern control systems using a digital computer in the loop.

EC204 Transmission Lines and Wave guides (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To expose students to the complete fundamentals and essential feature of waveguides, resonators and microwave components and also able to give an introduction to microwave integrated circuit design

COURSE CONTENT

Classification of guided wave solutions-TE, TM and TEM waves.Field analysis transmission lines.

Rectangular and circular waveguides. Excitation of waveguides. Rectangular and circular cavity resonators.

Transmission line equations.Voltage and current waves.Solutions for different terminations.Transmission-line loading.

Impedance transformation and matching.Smith Chart, Quarter-wave and half-wave transformers.Binomial and Tchebeyshev transformers. Single, double and triple stub matching .

Microstriplines, stripline, slot lines, coplanar waveguide and fin line. Micro strip MIC design aspects. Computer- aided analysis and synthesis.

Text Books

1. *D.M.Pozar, "Microwave Engineering (3/e)" Wiley,2004.*
2. *J.D.Ryder, "Networks, Lines and Fields", PHI, 2003.*

Reference Books

1. *R.E.Collin, "Foundations for Microwave Engineering (2/e)", McGraw-Hill,2002.*
2. *S.Y.Liao , " Microwave Devices and Circuits",(3/e) PHI, 2005.*
3. *J. A. Seeger, "Microwave Theory, Components, and Devices" Prentice-Hall-A division of Simon & Schuster Inc Englewood Cliffs, New Jersy 07632, 1986.*

COURSE OUTCOMES

Students are able to

CO1: classify the Guided Wave solutions -TE, TM, and TEM.

CO2: analyze and design rectangular waveguides and understand the propagation of electromagnetic waves.

CO3: evaluate the resonance frequency of cavity Resonators and the associated modal field.

CO4: analyze the transmission lines and their parameters using the Smith Chart.

CO5: apply the knowledge to understand various planar transmission lines.

EC206	**Electronic Circuits**	**(L-T-P) C** **3 - 0 - 0 - 3**

COURSE OBJECTIVE

- To make the students understand the fundamentals of electronic circuits.

COURSE CONTENT

Rectifier circuits and filters. Transistor and FET Biasing, Low frequency models of BJT and FET.

BJT and FET amplifiers, High frequency models for BJT and FET, Frequency response of CS and CE amplifiers, Cascode amplifiers, Emitter follower.

MOS and BJT Differential amplifiers, CMRR, Differential amplifiers with active load, Two stage amplifiers.

Feedback concept, Properties, Feedback amplifiers, Stability analysis, Condition for oscillation, Sinusoidal oscillators.

Power amplifiers- class A, class B, class AB, Biasing circuits, class C and class D

Text Books

1. *A.S.Sedra&K.C.Smith, "Microelectronic Circuits (5/e)", Oxford, 2004.*
2. *D.L.Schilling&C.Belove,"Electronic Circuits : Discrete and Integrated", (3/e), McGraw Hill, 1989.*

Reference Books

1. *J.Millman&A., "Microelectronics", McGraw Hill, 1987.*
2. *K.V.Ramanan, "Functional Electronics" ,Tata McGraw Hill ,1984.*

COURSE OUTCOMES

Students are able to

CO1: illustrate about rectifiers, transistor and FET amplifiers and its biasing. Also compare the performances of its low frequency models.

CO 2: discuss about the frequency response of MOSFET and BJT amplifiers.

CO 3: illustrate about MOS and BJT differential amplifiers and its characteristics.

CO4: discuss about the feedback concepts and construct feedback amplifiers and oscillators. Also summarizes its performance parameters.

CO 5: explain about power amplifiers and its types and also analyze its characteristics.

EC208 Microprocessors and Microcontrollers (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- This subject deals about the basic 16-bit (8086) processor and an 8-bit (8051) controllers, their architecture, internal organization and their functions, interfacing an external device with the processors/ controllers.

COURSE CONTENT

Microprocessor based personal computer system. Programmer's model for 8086.Segmented memory operation. Instruction set of 8086. Addressing modes supported by 8086 instruction set. Assembly language programming. Programming with DOS and BIOS function calls.

Memory interface to 8086. Interrupts in 8086. Parallel and serial data transfer methods. 8255 PPI chip. I/o interface method.

Hardware detail of 8086.Bus timing. Minimum vs Maximum mode of operation.8259 Interrupt controller.8237 DMA controller.

8051 Microcontroller. Programming model and Instruction set of 8051 Microcontroller. Addressing mode supported by 8051 instruction set. Assembly language programming. Timer operation.

Serial data transfer using 8051. Interrupts in 8051.I/o ports and port expansion. DAC, ADC, Stepper motor, LCD and key board interfacing to 8051 Microcontroller.

Text Books

1. *J.L.Antonakos, "An Introduction to the Intel Family of Microprocessors", Pearson, 1999.*
2. *B.B. Brey, "The Intel Microprocessors, (7/e), Eastern Economy Edition" , 2006.*

Reference Books

1. *K.J. Ayala, "The 8051 Microcontroller ", (3/e), Thomson Delmar Learning, 2004.*
2. *I. S. MacKenzie and R.C.W.Phan., " The 8051 Microcontroller.(4/e)", Pearson education, 2008.*
3. *M.A.Mazidi&J.C.Mazidi " Microcontroller and Embedded systems using Assembly & C. (2/e)", Pearson Education, 2007.*

COURSE OUTCOMES

Students are able to

CO1: recall and apply a basic concept of digital fundamentals to Microprocessor based personal computer system.
CO2: identify a detailed s/w & h/w structure of the Microprocessor.
CO3: illustrate how the different peripherals (8255, 8253 etc.) are interfaced with Microprocessor.
CO4: distinguish and analyze the properties of Microprocessors & Microcontrollers.
CO5: analyze the data transfer information through serial & parallel ports.
CO6: train their practical knowledge through laboratory experiments.

EC210 Electronic Circuits Laboratory (L-T-P) C
0 - 0 - 3 - 2

List of Experiments:

1. Full wave rectifier with filters
2. Stability of Q point
3. Single stage RC coupled CE amplifier
4. Single stage RC coupled Current series CE feedback amplifier
5. Darlington emitter follower
6. Differential Amplifier
7. Single stage CS FET amplifier
8. RC phase shift oscillator
9. Colpitt's Oscillator

EC212 Microprocessor and Microcontroller Laboratory (L-T-P) C
0 - 0 - 3 - 2

List of Experiments

Intel 8086 (16-bit Microprocessor)

1. Addressing modes of 8086 Microprocessor
2. Block move and simple arithmetic operations
3. Array addition and sorting
4. Code conversion and Addition of an array of BCD numbers
5. Identification and displaying the activated key using DOS and BIOS function calls.

Intel 8051 (8-bit Microcontroller)

6. Addressing modes of 8051 Microcontroller
7. Delay generation using
   i) Nested loop and
   ii) Timers
8. Toggling the ports and counting the pulses
9. LCD interfacing
10. Generation of different waveforms using DAC (0808)

EC301 Statistical Theory of Communication (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- The subject aims to make the students to understand the statistical theory of telecommunication, which are the basics to learn analog and digital telecommunication.

COURSE CONTENT

Information measure. Discrete entropy. Joint and conditional entropies. Uniquely decipherable and instantaneous codes. Kraft-Mcmillan inequality. Noiseless coding theorem. Construction of optimal codes.

DMC. Mutual information and channel capacity. Shannon's fundamental theorem. Entropy in the continuous case. Shannon-Hartley law.

Binary hypothesis testing. Baye's, minimax and Neyman-Pearson tests. Random parameter estimation-MMSE,MMAE and MAP estimates. Nonrandom parameters – ML estimation.

Coherent signal detection in the presence of additive white and non-white Gaussian noise.Matched filter.

Discrete optimum linear filtering. Orthogonality principle. Spectral factorization. FIR and IIR Wiener filters.

Text Books

1. *R.B.Ash," Information Theory", Wiley,1965.*
2. *M.D.Srinath, P.K.Rajasekaran&R.Viswanathan, "Statistical Signal Processing with Applications", PHI 1999.*

Reference Books

1. *H.V.Poor, "An Introduction to Signal Detection and Estimation,(2/e)", Spring Verlag.1994.*
2. *M.Mansuripur , " Introduction to Information Theory", Prentice Hall.1987.*
3. *J.G.Proakis, D G Manolakis, " Digital Signal Processing", (4/e), Pearson Education, 2007.*

COURSE OUTCOMES

Students are able to

CO1: show how the information is measured and able to use it for effective coding.
CO2: summarize how the channel capacity is computed for various channels.
CO3: use various techniques involved in basic detection and estimation theory to solve the problem.
CO4: summarize the applications of detection theory in telecommunication.
CO5: summarize the application of estimation theory in telecommunication.

EC303 Digital Signal Processors and Applications (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To give an exposure to the various fixed point & a floating point DSP architectures and to develop applications using these processors.

COURSE CONTENT

Difference between DSP and other microprocessor architectures. An overview of Motorola and Analog Device DSPs.

TMS320C54X fixed point and TMS320C3X floating point DSP architectures, CPU, memory, buses and peripherals. Addressing modes, instruction sets , control operations, interrupts.

Repeat operations. Pipeline operation. Pipeline conflics and programming concepts.

Interfacing, serial interface, parallel interface, DMA operations, A/D and D/A converter interfaces.

DSP tools.DSP applications.MAC, filter design, implementation of DFT, echo cancellation, spectrum analyzer. Speech and video processing. Architecture of other DSPs.

Text Books

1. *B.Venkataramani&M.Bhaskar, "Digital Signal Processor, Architecture, Programming and Applications",(2/e), McGraw- Hill,2010*
2. *S.Srinivasan&Avtar Singh, "Digital Signal Processing, Implementations using DSP Microprocessors with Examples from TMS320C54X", Brooks/Cole, 2004.*

Reference Books

1. *S.M.Kuo&W.S.S.Gan," Digital Signal Processors: Architectures, Implementations, and Applications", Printice Hall, 2004*
2. *C.Marven&G.Ewers, "A Simple approach to digital signal processing", Wiley Inter science, 1996.*
3. *R.A.Haddad&T.W.Parson, "Digital Signal Processing: Theory, Applications and Hardware", Computer Science Press NY, 1991.*

COURSE OUTCOMES

Students are able to

CO1: recognize the fundamentals of fixed and floating point architectures of various DSPs.
CO2: learn the architecture details and instruction sets of fixed and floating point DSPs
CO3: infer about the control instructions, interrupts, and pipeline operations.
CO4: illustrate the features of on-chip peripheral devices and its interfacing along with its programming details.
CO5: analyze and learn to implement the signal processing algorithms in DSPs
CO6: learn the DSP programming tools and use them for applications
CO7: design and implement signal processing modules in DSPs

EC305	Analog Communication	(L-T-P) C
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To develop a fundamental understanding on Communication Systems with emphasis on analog modulation techniques and noise performance

COURSE CONTENT

Basic blocks of Communication System. Amplitude (Linear) Modulation – AM, DSB-SC, SSB-SC and VSB-SC. Methods of generation and detection. FDM. Super Heterodyne Receivers.

Angle (Non-Linear) Modulation - Frequency and Phase modulation. Transmission Bandwidth of FM signals, Methods of generation and detection. FM Stereo Multiplexing.

Noise - Internal and External Noise, Noise Calculation, Noise Figure. Noise in linear and nonlinear AM receivers, Threshold effect.

Noise in FM receivers, Threshold effect, Capture effect, FM Threshold reduction, Pre-emphasis and De-emphasis.

Pulse Modulation techniques – Sampling Process, PAM, PWM and PPM concepts, Methods of generation and detection. TDM. Noise performance.

Text Books

1. *S.Haykins, Communication Systems , Wiley, (4/e), Reprint 2009.*
2. *Kennedy, Davis, Electronic Communication Systems (4/e), McGraw Hill, Reprint 2008.*

Reference Books

1. *B.Carlson, Introduction to Communication Systems, McGraw-Hill, (4/e), 2009.*
2. *J.Smith, Modern Communication Circuits (2/e), McGraw Hill, 1997.*
3. *J.S.Beasley&G.M.Miler, Modern Electronic Communication (9/e), Prentice-Hall, 2008.*

COURSE OUTCOMES

Students are able to

CO1: understand the basics of communication system and analog modulation techniques
CO2: apply the basic knowledge of signals and systems and understand the concept of Frequency modulation.
CO3: apply the basic knowledge of electronic circuits and understand the effect of Noise in communication system and noise performance of AM system
CO4: understand the effect of noise performance of FM system.
CO5: understand TDM and Pulse Modulation techniques.

EC307 Antennas and Propagation (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications.

COURSE CONTENT

Radiation fundamentals. Potential theory. Helmholtz integrals. Radiation from a current element. Basic antenna parameters. Radiation field of an arbitrary current distribution. Small loop antennas.

Receiving antenna. Reciprocity relations. Receiving cross section, and its relation to gain. Reception of completely polarized waves. Linear antennas. Current distribution. Radiation field of a thin dipole. Folded dipole. Feeding methods. Baluns.

Antenna arrays. Array factorization. Array parameters. Broad side and end fire arrays. Yagi-Uda arrays Log-periodic arrays.

Aperture antennas. Fields as sources of radiation. Horn antennas. Babinet's principle. Parabolic reflector antenna. Microstrip antennas.

Wave Propagation: Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, tropospheric propagation, Super refraction.

Text Books

1. *R.E.Collin, "Antennas and Radio Wave Propagation", McGraw – Hill,1985.*
2. *W.L.Stutzman&G.A.Thiele , "Antenna Theory and Design", Wiley.*

Reference Books

1. *K.F.Lee, "Principles of Antenna Theory", Wiley,1984.*
2. *F.E. Terman , "Electronic Radio Engineering (4/e)", McGraw Hill.*
3. *J.R. James, P. S. Hall, and C. Wood, "Microstrip Antenna Theory and Design", IEE, 1981.*
4. *C. A.Balanis, "Modern Antenna Handbook", Wiley India Pvt. Limited, 2008.*

COURSE OUTCOMES

Students are able to

CO1: select the appropriate portion of electromagnetic theory and its application to antennas.

CO2: distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.

CO3: assess the need for antenna arrays and mathematically analyze the types of antenna arrays.

CO4: distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.

CO5: outline the factors involved in the propagation of radio waves using practical antennas.

EC309	**Analog Integrated Circuits**	**(L-T-P) C** **3 - 0 - 0 – 3**

COURSE OBJECTIVE

- To introduce the theoretical & circuit aspects of an Op-amp.

COURSE CONTENT

Operational Amplifiers, DC and AC characteristics. Applications of Op-amp. Precision rectifiers. Log and antilog amplifiers. Four quadrant multipliers. Instrumentation amplifier.

Active filters. Filter classification, Butterworth, Chebyshev and Bessel filters. Switched capacitor filter.

Multi vibrators using opamps. 555 timer. Triggering circuits for bistable and monostablemultivibrators. Programmable timer.

Data converters, A/D and D/A converters. PLL-Applications of PLL.

Voltage regulators. Regulators using opamps. IC regulators. Protection circuits. Fold back current limiting. Current boosting of IC regulators. Switching regulators.

Text Books

1. *S.Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", (3/e) Tata McGraw Hill, 2003.*
2. *R.Gayakwad, "Op-amps and Linear Integrated Circuits (4/e)", PHID.A.Bell, Solidstate Pulse Circuits (4/e), PHI,2009.*

Reference Books

1. *R.F.Coughlin&F.F.Driscoll , "Operational Amplifiers and Linear Integrated circuits", PHI, 1996.*
2. *D.A.Bell, "Solid State pulse circuits", (4/e), PHI, 2002.*
3. *Milman Gravel, "Micro-Electronics", McGraw Hill, 1999.*

COURSE OUTCOMES

Students are able to

CO1: infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.

CO2: elucidate and design the linear and non linear applications of an opamp and special application Ics.

CO3: explain and compare the working of multi vibrators using special application IC 555 and general purpose opamp.

CO4: classify and comprehend the working principle of data converters.

CO5: illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.

EC313 Analog Integrated Circuits Laboratory (L-T-P) C
0 - 0 - 3 - 2

List of Experiments:

1. Inverting and Non-inverting amplifiers
2. Measurement of DC and AC Parameters
3. Schmitt trigger and Comparators
4. Rectifiers using Precision diodes
5. Voltage to Current and Current to Voltage Converters
6. Instrumentation Amplifier
7. Active filters-LPF, HPF, NBPF, WBPF, Wideband Reject filter
8. Multivibrators using opamp
9. Multivibrators using 555 Timer IC
10. LAB View implementation

EC315 Digital Signal Processing Laboratory (L-T-P) C
0 - 0 - 3 - 2

List of Experiments:

MATLAB Experiments
1. Realization of correlation
2. Realization of linear convolution
3. Design and implementation of FIR filter
4. Design and implementation of IIR filter
5. Realization of FFT

TMS320C54X Processor Experiments
6. Study of various addressing modes
7. Sequence generation and number sorting
8. Convolution using overlap add and overlap save methods
9. Wave pattern generation
10. FIR filter implementation

EC302	Digital Communication	(L-T-P) C
		3 - 0 - 0 - 3

COURSE OBJECTIVES

- To understand the key modules of digital communication systems with emphasis on digital modulation techniques.
- To get introduced to the basics of source and channel coding/decoding and Spread Spectrum Modulation.

COURSE CONTENT

Base band transmission. Sampling theorem, Pulse code modulation (PCM), DM, Destination SNR in PCM systems with noise. Matched filter. Nyquist criterion for zero ISI. Optimum transmit and receive filters. Correlative Coding, M-ary PAM. Equalization- zero-forcing and basics of adaptive linear equalizers.

BASK, BFSK, and BPSK- Transmitter, Receiver, Signal space diagram, Error probabilities.

M-ary PSK, M-ary FSK, QAM, MSK and GMSK- Optimum detector, Signal constellation, error probability.

Linear block codes-Encoding and decoding. Cyclic codes – Encoder, Syndrome Calculator. Convolutional codes – encoding ,Viterbi decoding. TCM.

Spread Spectrum (SS) Techniques- Direct Sequence Spread Spectrum modulation, Frequency-hop Spread Spectrum modulation - Processing gain and jamming margin.

Text Books

1. *S.Haykin, "Communication Systems", Wiley,(4/e),2001.*
2. *J.G.Proakis, "Digital Communication" , Tata McGraw – Hill,(4/e),2001.*

Reference Books

1. *B.Sklar, "Digital Communications: Fundamentals & Applications", Pearson Education, (2/e), 2001.*
2. *A.B.Carlson, " Communication Systems", McGraw Hill, 3/e,2002*
3. *R.E.Zimer & R.L.Peterson," Introduction to Digital Communication", PHI,3/e, 2001*

COURSE OUTCOMES

Students are able to

CO1: apply the knowledge of statistical theory of communication and explain the conventional digital communication system.

CO2: apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.

CO3: apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.

CO4: describe and analyze the digital communication system with spread spectrum modulation.

CO5: design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for digital modulators and demodulator using hardware components and communication systems using CAD tool.

EC304 Networks and Protocols (L-T-P) C
3 - 0 - 0 – 3

COURSE OBJECTIVES

- To get an understanding on the fundamentals of networks and issues involved.
- To acquire an understanding on the set of rules and procedures that mediates the exchange of information between communicating devices.

COURSE CONTENT

Network Components, Topologies, Network hardware and software, Network Models: OSI Model & TCP/IP Protocol stack, HTTP FTP, SMTP, POP, SNMP, DNS, Socket programming with TCP and UDP.

Transport Layer services, UDP, TCP, SCTP, Principles of reliable data transfer, Flow control, Congestion Control, Quality of Service.

Network Layer services, Datagram and Virtual circuit service, DHCP, IPV4, IPV6, ICMP, Unicast routing protocols: DV, LS and Path vector routing, Multicast routing.

Data Link Layer services, Overview of Circuit and Packet switches, ARP, Data link control: HDLC & PPP, Multiple access protocols, Wireless LAN, Comparison wired and wireless LAN.

Network security threats, Cryptography, Security in the Internet: IPSecurity & Firewalls, Multimedia: Streaming stored video/ audio, RTP, Network Troubleshooting.

Text Books

1. *J.F.Kurose&K.W.Ross, "Computer Networking: A Top-Down Approach featuring the Internet", Pearson, 5th edition, 2010.*
2. *B.A. Forouzan," Data Communications & Networking", Tata McGraw- Hill, 4th edition, 2006*

Reference Books

1. *W.Stallings, "Data & Computer Communications", PHI, 9th edition, 2011.*
2. *W.Stallings, "Cryptography & Network Security", Pearson, 5th edition, 2011.*
3. *A.S.Tanenbaum & D.J. Wetherall, "Computer Networks", Pearson, 5th edition, 2014.*

COURSE OUTCOMES

Students are able to

CO1: compare and examine, OSI and TCP/IP protocol stacks
CO2: categorize services offered by all layers in TCP/IP protocol stack
CO3: analyze a network under congestion and propose solutions for reliable data transfer
CO4: examine the protocols operating at different layers of TCP/IP model
CO5: assess the cryptographic techniques.
CO6: manage a network and propose solutions under network security threats.

EC306 Microwave Components and Circuits (L-T-P) C
3 - 0 - 0 – 3

COURSE OBJECTIVE

- The subject introduces the essential Microwave Circuit Theory and the design aspects of Microwave Integrated Circuit components.

COURSE CONTENT

Scattering matrix formulation.Passive microwave devices; terminations, bends, corners, attenuators, phase changers, directional couplers and hybrid junctions. Basics and design considerations of Microstripline, strip line, coplanar waveguide, Slot line and Finline.

Microwave measurements; frequency, wavelength, VSWR.I mpedance determination.S-parameter measurements. Network analyzer.

Microwave network parameters. Basic circuit elements for microwaves. Transmission line sections and stubs.Richardtransformation.Kuroda identities.

MIC filter design. Low pass to high pass, band pass and band stop transformations. Realization using microstriplines and strip lines.

Design and realization of MIC components.3 dB hybrid design. Ratrace Hybrid Ring, Backward wave directional coupler, power divider; realization using microstrip lines and strip lines.

Text Books

1. *I.J.Bahl&P.Bhartia, "Microwave Solid state Circuit Design", Wiley, 2003.*
2. *D.M.Pozar, "Microwave Engineering (2/e)", Wiley, 2004.*

Reference Books

1. *A. Das, "Microwave Engineering", Tata McGraw Hill, 2000*
2. *B.Bhat, S. K. Koul,,"Stripline like transmission lines for Microwave Integrated Circuits", New age International Pvt.Ltd. Publishers 2007.*
3. *G. Matthaei , E.M.T. Jones , L. Young , George Matthaei , Leo Young , George L. Matthaei "Microwave filters, Impedance Matching Network, Coupling Structures (Updated)",Hardcover, 1,096 Pages, Published 1980 by Artech House Publishers ISBN-13: 978-0-89006-099-5, ISBN: 0-89006-099-1*

COURSE OUTCOMES

Students are able to

CO1: learn the basics of S parameters and use them in describing the components
CO2: expose to the Microwave Measurements Principle
CO3: realize the importance of the theory of Microwave circuit theory.
CO4: work out the complete design aspects of various M.I.C. Filters
CO5: confidently design all M.I.C. components to meet the industry standard

EC308	**VLSI Systems**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To introduce various aspects of VLSI circuits and their design including testing**.**

COURSE CONTENT

VLSI design methodology, VLSI technology- NMOS, CMOS and BICMOS circuit fabrication. Layout design rules. Stick diagram. Latch up.

Characteristics of MOS and CMOS switches. Implementation of logic circuits using MOS and CMOS technology, multiplexers and memory, MOS transistors, threshold voltage, MOS device design equations. MOS models, small-signal AC analysis. CMOS inverters, propagation delay of inverters, Pseudo NMOS, Dynamic CMOS logic circuits, power dissipation.

Programmable logic devices- antifuse, EPROM and SRAM techniques. Programmable logic cells.Programmable inversion and expander logic. Computation of interconnect delay, Techniques for driving large off-chip capacitors, long lines, Computation of interconnect delays in FPGAs Implementation of PLD, EPROM, EEPROM, static and dynamic RAM in CMOS.

An overview of the features of advanced FPGAs, IP cores, Softcore processors, Various factors determining the cost of a VLSI, Comparison of ASICs, FPGAs , PDSPs and CBICs . Fault tolerant VLSI architectures

VLSI testing -need for testing , manufacturing test principles, design strategies for test, chip level and system level test techniques.

Text Books

1. *N. H. E. Weste, D.F. Harris, "CMOS VLSI design", (3/e), Pearson , 2005.*
2. *J. Smith, "Application Specific Integrated Circuits,Pearson", 1997.*
3. *M.M.Vai, "VLSI design", CRC Press, 2001.*

Reference Books

1. *Pucknell & Eshraghian, "Basic VLSI Design", PHI, (3/e), 2003.*
2. *Uyemura, "Introduction to VLSI Circuits and Systems", Wiley, 2002.*

COURSE OUTCOMES

Students are able to

CO1: describe the techniques used for VLSI fabrication, design of CMOS logic circuits, switches and memory

CO2: describe the techniques used the design of CMOS logic circuits, switches and memory in VLSI

CO3: generalize the design techniques and analyze the characteristics of VLSI circuits such as area, speed and power dissipation

CO4: explain and compare the architectures for FPGA, PAL and PLDs and evaluate their characteristics such as area, power dissipation and reliability

CO4: use the advanced FPGAs to realize Digital signal processing systems

CO5: describe the techniques for fault tolerant VLSI circuits

CO6: explain and compare the techniques for chip level and board level testing

EC 312 Communication Engineering Laboratory (L-T-P) C
0 - 0 - 3 - 2

List of Experiments:

1. AM Modulation and Demodulation
2. DSB-SC Modulation
3. Pulse Amplitude Modulation and Demodulation
4. Pulse Width Modulation and Demodulation
5. Pulse Position Modulation using PLL(IC 565)
6. Amplitude Shift Keying (ASK) Modulation and Demodulation
7. Frequency Shift Keying (FSK) Modulation and Demodulation
8. Frequency Multiplier using PLL
9. Analog and digital modulation using COMMSIM simulation tool
10. Analog and digital modulation using MATLAB
11. Study of wireless communication system using Wi-Comm Kit

EC 314 VLSI and Embedded System Design Laboratory (L-T-P) C
0 - 0 - 3 - 2

List of Experiments:

USING QUARTUS II

1. Adders and subtractors
2. Mux &Demux
3. Encoders & Decoders
4. Flip-Flops
5. Shift-Registers & Counters

USING XILINX

6. Working with RAM
7. Comparators, parity generators & ALU
8. Counters and Shift Registers
9. Carry look ahead adder
10. MULTIPLIERS

WARP DESIGN

Lab1: Introduction to WARP Design Flows
Lab2: Building a Simple Transmitter
Lab3: Building a Simple and Unidirectional MAC
Lab4: Building a single-carrier streaming PHY.

HM401	Industrial Economics	(L-T-P) C
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- This course is intended for the students to understand the economic concepts that are in vogue in industries.

COURSE CONTENT

Microeconomics.Demand and supply.Forecastingtechniques.Cost and revenues.Competitive nature of firms.

Keynesian economics.Aggregate demand and supply. Employment determination.National income.Trade cycle.Inflation.Index numbers.

Capital budgeting. Cash flow analysis. Balance sheet.Risk analysis and decision making.

Impact of liberalization, privatization and globalization.Locating the firm in a global economy.

Fiscal policy. Taxation-principles.Exchange rate determination.Monetarypolicy.Functions of banks.Credit creation by commercial banks.

Text Books

1. *M.Adhikari," Business Economics", Excel Books, 2004.*
2. *S.K.Misra&V.K.Puri, "Economic Environment of Business", HPH, 2003.*

Reference Books

1. *Dewett.K.K, "Modern Economic Theory", Chand.S&co,1998.*
2. *Gupta C.B, "Business Organisation and Management", Chand.S& co,1998.*
3. *P. Kotler,"Marking Management", PHI,1999.*

COURSE OUTCOMES

Students are able to

CO1: gain knowledge about over all functions of the market, Cost, Revenue, Demand and Supply of the firms.

CO2: know what determines the rate of growth of an economy, factors causing low or high unemployment and business cycle.

CO3: exposure the capital budgeting, risk analysis and decision making.

CO4: know the overview of Liberalization, Privatization and Globalization.

CO5: understand the importance of fiscal policy for a nation.

EC401	**Wireless Communication**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To get an understanding of mobile radio communication principles, types and to study the recent trends adopted in cellular and wireless systems and standards**.**

COURSE CONTENT

Introduction to Wireless Communication.Cellularconcept.System design fundamentals.Coverage and Capacity improvement in Cellular system.Technical Challenges.

Mobile Radio Propagation; Reflection, Diffraction, Fading.Multipathpropagation.Statistical characterization of multipath fading.Diversity Techniques.

Path loss prediction over hilly terrain.Practicallink budget design using Path loss models. Design parameters at base station. Antenna location, spacing, heights and configurations.

Multiple access techniques; FDMA, TDMA and CDMA. Spread spectrum. Power control.WCDMA.CDMA network design.OFDM and MC-CDMA.

GSM.3G,4G(LTE), NFCsystems,.WLANtechnology.WLL.HiperLAN. Ad hoc networks. Bluetooth.

Text Books:

T.S.Rappaport, Wireless Communication Principles (2/e), Pearson, 2002.
A.F.Molisch, Wireless Communications, Wiley, 2005.

Reference Books:

P.MuthuChidambaraNathan, Wireless Communications, PHI, 2008.
W.C.Y.Lee, Mobile Communication Engineering. (2/e), McGraw- Hill,1998.
A.Goldsmith, Wireless Communications, Cambridge University Press, 2005.
S.G.Glisic, Adaptive CDMA, Wiley, 2003.

COURSE OUTCOMES

Students are able to

CO1: apply the knowledge of basic communication systems and its principles.
CO2: describe the cellular concept and analyze capacity improvement Techniques.
CO3: mathematically analyze mobile radio propagation mechanisms.
CO4: summarize diversity reception techniques.
CO5: design Base Station (BS) parameters and analyze the antenna configurations.
CO6: analyze and examine the multiple access techniques and its application.
CO7: assess the latest wireless technologies.

EC403 Fiber Optic Communication (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

COURSE CONTENT

Optical Fibers: Structure, Wave guiding. Step-index and graded index optical fibers. Modal analysis.Classification of modes.Single Mode Fibers.

Pulse dispersion. Material and waveguide dispersion.Polarization Mode Dispersion.Absorption, scattering and bending losses. Dispersion Shifted Fibers, Dispersion Compensating Fibers.

Optical Power Launching and Coupling. Lensing schemes for coupling improvement.Fiber-to-fiber joints.Splicingtechniques. Optical fiber connectors.

Optical sources and detectors.Laser fundamentals. Semiconductor Laser basics. LEDs.PIN and Avalanche photodiodes, Optical T_x/R_x Circuits.

Design considerations of fiber optic systems: Analog and digital modulation. Noise in detection process. Bit error rate. Optical receiver operation. Power Budget and Rise time Budget. WDM.

Text Books

1. *G.Keiser, "Optical Fiber Communications (5/e)", McGraw Hill ,2013.*
2. *G.P.Agarwal, "Fiber Optic Communication Systems", (3/e), Wiley, 2002.*

Reference Books

4. *M.M.K.Liu, "Principles and Applications of Optical Communications", Tata McGeaw Hill, 2010.*
5. *A.Ghatak&K.Thygarajan, "Introduction to Fiber Optics", Cambridge, 1999.*
6. *J.Gowar, "Optical Communication Systems", (2/e), PHI, 2001.*
7. *A.Selvarajan, S.Kar and T.Srinivas, "Optical Fiber Communication Principles and Systems", Tata McGraw Hill, 2002.*

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COURSE OUTCOMES

Students are able to

CO1: recognize and classify the structures of Optical fiber and types.
CO2: discuss the channel impairments like losses and dispersion.
CO3: analyze various coupling losses.
CO4: classify the Optical sources and detectors and to discuss their principle.
CO5: familiar with Design considerations of fiber optic systems.

EC405	**Microwave Electronics**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency**.**

COURSE CONTENT

Limitations of conventional vacuum tubes, Klystrons: Reentrant cavities, Two cavity klystron, Velocity modulation process, Bunching process ,Power output and efficiency; Multi-cavity klystron , Reflex klystron-Velocity modulation process, Mode Characteristics ,Electronic admittance spiral.

Travelling-wave tubes: Slow-wave structures, Helix TWT- Amplification process, Convection current, Wave modes and gain; Coupled cavity TWT, Backward wave oscillator.

Crossed -field devices: Magnetrons- Principle of operation, characteristics, Hull cut-off condition; Carcinotron, Gyrotron.

Microwave transistors and FETs: Microwave bipolar transistors-Physical structures, characteristics, Power-frequency limitations; Microwave tunnel diode, Microwave unipolar transistor – Physical structure, principle of operation, characteristics ,High electron-mobility transistors.

Transferred electron and Avalanche transit-time devices : Gunn diode, Gunn diode as an oscillator. IMPATT, TRAPATT and BARITT.

Text Book

1. *S.Y.Liao, "Microwave Devices and Circuits (3/e)", PHI, 2005.*
2. *R. F. Soohoo, "Microwave Electronics", Wesley publication,1971.*

Reference Books

1. *R.E.Collin, "Foundations for Microwave Engineering (2/e)",Wiley India, 2007.*
2. *D.M.Pozar," Microwave Engineering (3/e)", Wiley India, 2009.*
3. *K C Gupta, Indian Institute of Technology, Kanpur," Microwaves", Wiley Eastern Limited, 1995.*

COURSE OUTCOMES

Students are able to

CO1: apply the basic knowledge of waveguide and microwave resonator circuits.
CO2: asses the methods used for generation and amplification of the microwave power.
CO3: distinguish between the linear and cross field electron beam microwave tubes.
CO4: critically analyze the operating principles and performances of the microwave semiconductor devices.
CO5: identify the suitable microwave power sources of given specification for the selected application.
CO6: aware of current technological changes in the engineering aspects of microwave components.

EC407 Fiber Optic Communication Laboratory (L-T-P) C
0 - 0 - 3 - 2

List of Experiments:

1. Handling of Fibers
2. Characteristics of Laser Diode
3. Characteristics of Photo detector
4. Characteristics of APD
5. Numerical Aperture Measurement
6. Measurement of Attenuation and Bending Loss
7. Proximity Sensor
8. Photonics CAD-WDM link
9. LED Modulation
10. Fiber Dispersion Measurement
11. Study of BER and Q-factor estimation in the optical system simulation
12. Study the effect of optical Receiver Characteristics on a system performance

EC409 Microwave Laboratory (L-T-P) C
0 - 0 - 3 - 2

List of Experiments:

1. Characteristics Of Gunn Diode
2. Characteristics Of Reflex Klystron
3. Measurement Of Directional Coupler Parameters
4. Characteristics Of Isolator And Circulator
5. Characteristics of Waveguide Tees
6. Frequency And Wavelength Measurement
7. Impedance Measurement
8. Antenna Measurement
9. Propagation Of Microwaves
10. VSWR measurement

MB790 Management Concepts and Practices (L-T-P) C
3 - 0 - 0 – 3

COURSE OBJECTIVES

- To familiarize the students with the concepts of management.
- To facilitate with the basic concepts of marketing.
- To enrich the learners with fundamentals of financial management.
- To select a methodology for technology and production management.
- To impart the importance of Human Resources in the organizational context.

COURSE CONTENT

Introduction to management, evolution of scientific management, modern management. Principles and Functions of management, HRM & HRP, Recruitment and selection, Training, Performance appraisal, Compensation, Industrial relations.

Core concepts of marketing, marketing mix, Market Segmentation- bases of segmentation, segmentation patterns and procedures, Targeting and Positioning, Buyer behavior - Consumer and Industrial buyers.

Financial management – objectives and scope, Techniques of investment analysis - payback period, accounting rate of return, working capital, cost of capital, Sources of financing.

Product design, production system and its types, production planning and control, Plant location-Selection criteria, Plant layout and its types, Inventory management.

Technology management – Life cycle, Technology forecasting, Technology transfer and IPR.

Text Books

1. *L.M.Prasad," Priciples and Practice of Management", S.Chand & Sons,2006.*
2. *P.Kotler, "Marketing Management (12/e)", Pearson, 2005*

Reference Books

1. *P.Chandra, "Financial Management Theory and Practice (3/e)", Tata McGraw Hill, 2004*
2. *Gerard H.Gaynor 1996, "Handbook of Technology Management", McGraw-Hill*
3. *E.S.Buffa & R.K.Sarin, "Modern Production/Operation Management (8/e)", Wiley, 1994.*
4. *H. Koontz and H. Weihrich "Essentials of Management".Tata Mc Graw-Hill, 1998*
5. *S.Robbins, "Organisational Behaviour", Pearson Education, New Delhi, 2006.*

COURSE OUTCOMES

Students are able to

CO1: get equipped with the managerial selection procedure.
CO2: understand the framework of a business organization.
CO3: gain expertise in analyzing the risk and return of an investment.
CO4: solving ability of the learners gets enhanced.
CO5: face the challenges and become the best manager.

LIST OF ELECTIVES

GROUP 1(COMMUNICATION AND SIGNAL PROCESSING STREAM)

EC001	**Principles of Radar**	**(L-T-P) C** **3 - 0 - 0 - 3**

COURSE OBJECTIVE

- To expose the students to the working principles of a radar from a signal processing perspective.

COURSE CONTENT

Radar equation. Radar cross section. Cross section of small targets. Target scattering matrices. Area and volume targets.

Radar signals. Ambiguity function and its properties. Uncertainty principle. Pulse compression. linear FM pulse. Pulse compression by Costas FM and binary phase coding.

Radar detection. Optimum Bayesian decision rules. Detection criteria for different target models.

Range and Doppler measurements and tracking. Range and Doppler frequency resolutions. Optimum receivers. Optimum filters for Doppler measurements. Coherent and non coherent implementations.

Angle measurement and tracking. Angle measurement and tracking by conical scan and mono pulse. Optimum mono pulse systems.

Text Books

1. *P.Z.Peebles, Radar Principles, Wiley, 1998.*
2. *Merrill I. Skolink, Introduction to Radar Systems, (3/e), Tata MG Graw Hill, 2001*

Reference Books

1. *N.Levanon, Radar Signals, Wiley, 2005.*
2. *D.Wehnar : High Resolution Radar, Artech Hous, 1987.*
3. *D.K.Barton : Radar systems Analysis , Prentice Hall, 1976.*

COURSE OUTCOMES

Students are able to

CO1: Understand the principle behind radar range equation and different types of targets available.
CO2: Appreciate the different compression techniques of radar pulse signals.
CO3: Distinguish between different detection methods of radar signals.
CO4: Appreciate the building blocks for optimum receiver and Doppler measurements.
CO5: Understand the tracking and scanning methods in the mono pulse systems.

EC002 Satellite Communication (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVES

- To introduce and to make understand the radio propagation channel for Earth station to satellite & satellite to Earth station.
- To introduce various aspects in the design of communication & multiple access systems for satellite communication.
- To introduce the concept of launchers and design of Earth station and satellite link.

COURSE CONTENT

Elements of orbital mechanics. Equations of motion. Tracking and orbit determination. Orbital correction/control. Satellite launch systems. Multistage rocket launchers and their performance.

Elements of communication satellite design. Spacecraft subsystems. Reliability considerations. Spacecraft integration.

Multiple access techniques. FDMA,TDMA,CDMA. Random access techniques. Satellite onboard processing.

Satellite link design: Performance requirements and standards. Design of satellite links – DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite - based personal communication.

Earth station design. Configurations. Antenna and tracking systems. Satellite broadcasting. satellite navigation-recent advances

Text Books

1. *D.Roddy, "Satellite Communication (4/e)", McGraw- Hill, 2009.*
2. *T.Pratt&C.W.Bostain, "Satellite Communication", Wiley 2000.*

Reference Books

1. *B.N.Agrawal, "Design of Geosynchrons Spacecraft", Prentice- Hall,1986.*
2. *A.K. Maini, V.Agrawal, "Satellite Communications", Wiley India Pvt Ltd,1999.*

COURSE OUTCOMES

Students are able to

CO1: understand how analog and digital technologies are used for satellite communication networks .
CO2: understand the radio propagation channel for Earth station to satellite.
CO3: learn the dynamics of the satellite
CO4: learn the keplerian elements
CO5: study the design of Earth station and tracking of the satellites

EC003	**Cognitive Radio**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- This subject introduces the fundamentals of multi rate signal processing and cognitive radio.

COURSE CONTENT

Filter banks-uniform filter bank. direct and DFT approaches. Introduction to ADSL Modem. Discrete multitone modulation and its realization using DFT. QMF. STFT.Computation of DWT using filter banks.

DDFS- ROM LUT approach. Spurious signals, jitter. Computation of special functions using CORDIC. Vector and rotation mode of CORDIC.CORDIC architectures.

Block diagram of a software radio. Digital down converters and demodulators Universal modulator and demodulator using CORDIC. Incoherent demodulation - digital approach for I and Q generation, special sampling schemes. CIC filters. Residue number system and high speed filters using RNS. Down conversion using discrete Hilbert transform. Under sampling receivers, Coherent demodulation schemes.

Concept of Cognitive Radio, Benefits of Using SDR, Problems Faced by SDR, Cognitive Networks, Cognitive Radio Architecture. Cognitive Radio Design, Cognitive Engine Design,

A Basic OFDM System Model, OFDM based cognitive radio, Cognitive OFDM Systems, MIMO channel estimation, Multi-band OFDM, MIMO-OFDM synchronization and frequency offset estimation. Spectrum Sensing to detect Specific Primary System, Spectrum Sensing for Cognitive OFDMA Systems.

Text Books

1. *J. H. Reed, "Software Radio", Pearson, 2002.*
2. *U. Meyer – Baese , "Digital Signal Processing with FPGAs", Springer, 2004.*
3. *H. Arslan "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", ,University of South Florida, USA, Springer, 2007.*

Reference Books

1. *S. K. Mitra, "Digital Signal processing", McGrawHill, 1998*
2. *K.C.Chen, R.Prasad , "Cognitive Radio Networks" , Wiley, 2009-06-15.*
3. *T. W. Rondeau, C.W.Bostian, "Artificial Intelligence in Wireless Communications" ,2009.*
4. *Tusi, "Digital Techniques for Wideband receivers", Artech House, 2001.*
5. *T. DarcChiueh, P. Yun Tsai," OFDM baseband receiver design for wireless communications", Wiley, 2007*

COURSE OUTCOMES

Students are able to

CO1: gain knowledge on multirate systems.
CO2: develop the ability to analyze, design, and implement any application using FPGA.
CO3: be aware of how signal processing concepts can be used for efficient FPGA based system design.
CO4: understand the rapid advances in Cognitive radio technologies.
CO5: explore DDFS, CORDIC and its application.

EC004 Multimedia Communication Technology (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To made the students to understand various encoding and decoding techniques of audios and videos in multimedia systems.

COURSE CONTENT

Components of multimedia system, Desirable features, Applications of multimedia systems, Introduction to different types, Multimedia storage device.

Digital audio representation and processing-time domain and transform domain representations. Coding standards, transmission and processing of digital audio. Musical instrument synthesizers.

Still image coding-JPEG. Discrete cosine Transform. Sequential and Progressive DCT based encoding algorithms, lossless coding, hierarchical coding. Basic concepts of discrete wavelet transform coding and embedded image coding algorithms. Introduction to JPEG 2000.

Feature of MPEG 1, structure of encoding and decoding process, MPEG 2 enhancements, different blocks of MPEG video encoder.

Content based video coding-overview of MPEG 4 video, motion estimation and compensation. Different coding techniques and verification models. Block diagram of MPEG 4 video encoder and decoder. An overview of H261 and H263 video coding techniques.

Text Books

1. *Y.Q.Shi&H.Sun, Image and Video Compression for Multimedia Engineering, CRC Press, 2000.*
2. *S.V.Raghavan & S,K,Tripathi, Networked Multimedia Systems, Prentice-Hall, 1998.*

Reference Books

1. *J.F.K.Buford, Multimedia Systems, Pearson, 2000.*

COURSE OUTCOMES

Students are able to

CO1: analyze various components of the multimedia systems and its storage devices.
CO2: appreciate the different coding standards for the digital audio and musical synthesizers.
CO3: understand the various types of DCT based image encoding algorithms
CO4: understand the encoding and decoding process of the MPEG standards
CO5: analyse the different content based video processing techniques.

EC005 Communication Switching Systems (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To understand the working principles of switching systems from manual and electromechanical systems to stored program control systems.

COURSE CONTENT

Basic elements of communication network. Switching systems. Signaling and signaling functions.

Digital telephone network. TDM Principles. PCM primary multiplex group. Plesiochronous digital hierarchy. Synchronous digital hierarchy. Echo cancellers.

Digital transmission and multiplexing. Synchronous versus Asynchronous transmission. Line coding . Error performance. TDM. Framing, TDM loops and rings.

Space division switching. Multiple-stage switching. Design examples. Switching matrix control. Time division switching. Multiple-stage time and space switching.

Timing recovery. Jitter. Network synchronization. Digital subscriber access-ISDN . ADSL. HFC. Traffic analysis.

Text Books

1. *J.C. Bellamy, "Digital Telephony", Wiley, 3rd edition, 2011.*
2. *J.E. Flood, "Telecommunications Switching, Traffic and Networks" Pearson,1st edition, 2012*

Reference Books

1. *T.Viswanathan, "Telecommunication Switching Systems and Networks", PHI, 2006.*
2. *E.Keiser&E.Strange, "Digital Telephony and Network Integration", Springer, 2nd edition, 1995.*
3. *R. L.Freeman, "Fundamentals of Telecommunications" , John Wiley and Sons, 2nd edition,1999.*

COURSE OUTCOMES

Students are able to

CO1: explain the working principle of switching systems involved in telecommunication switching
CO2: assess the need for voice digitization and T Carrier systems
CO3: compare and analyze Line coding techniques and examine its error performance
CO4: design multi stage switching structures involving time and space switching stages
CO5: analyze basic telecommunication traffic theory

EC006 Broadband Access Technologies (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To impart fundamentals and latest technologies related to the design of broadband last mile-Access technologies for multimedia communication

COURSE CONTENT

Wired access technologies using Phone line modem, ISDN modem. Comparison-Cable, DSL, fiber and wireless access technologies.

Last mile copper access, Flavors of Digital subscriber lines,DSL deployment, Common local loop impairments, discrete multitone modulation, VDSL deployment and frequency plans. Standards for XDSL and comparison.

Last mile HFC access, Cable modems. Modulation schemes, DOCSIS.Standards- comparison,physical and MAC layer protocols for HFC networks, ATM and IP-centric modem. Switched digital video.

Fiber access technologies and architectures. ATM passive optical networks,Upstream and downstream transport, Frame format, Ethernet passive optical network, Gigabit passive optical networks.

Survey on emerging broadband wireless access technologies. LMDS,MMDS,WIMAX and WIFI, Satellite technologies serving as last mile solutions, Wireless LAN, Wireless personal area networking, 3G and 4G wireless systems.

Text Books

1. *N.Jayant, "Broadband last mile"-Taylor and Francis group,2005*
2. *N.Ransom& A.A. Azzam, "Broadband Access Technologies", McGraw Hill, 1999.*
3. *M.P. Clarke, "Wireless Access Network", Wiley, 2000.*

Reference Books

1. *T.Starr,M.Sorbara,J.M.Cioffi and P.J.Silverman,"DSLadvances",Prentice Hall,2002*
2. *S. Mervana&C.Le, "Design and Implementation of DSL-based Access Solutions", Cisco Press, 2001.*
3. *W. Vermillion, "End-to-End DSL Architecture", Cisco Press, 2003.*
4. *DOCSIS 2.0 "Radio frequency interface specification" www.cablemodem.com*
5. *ITU-T Rec., G.983.1 "Broadband Optical Access systems based on Passive Optical Networks",1998*

COURSE OUTCOMES

Students are able to

CO1: recall and identify the basics of broadband technology systems and differentiate the differences between the various wired and wireless technology system

CO2: illustrate the aspects of last mile data transport on copper wire networks and flavors of DSL

CO3: summarize the versions of cable network standard and MAC protocols for HFC networks

CO4: distinguish the cost effective broadband services for residential users and ATM based and Ethernet based passive optical networks

CO5: outline the types of broadband wireless access technologies and their characteristics

EC007	Digital speech Processing	(L-T-P) C 3 - 0 - 0 - 3

COURSE OBJECTIVE

- The purpose of this course is to explain how DSP techniques could be used for solving problems in speech communication.

COURSE CONTENT

Speech production model-1D sound waves-functional block of the Vocal tract model –Linear predictive co-efficients (LPC) -Auto-correlation method-Levinson-durbin algorithm-Auto-co-variance method-Lattice structure-Computation of Lattice co-efficient from LPC-Phonetic Representation of speech-Perception ofLoudness - Critical bands – Pitch perception – Auditory masking.

Feature extraction of the speech signal: Endpoint detection-Dynamic time warping- Pitch frequency estimation: Autocorrelation approach- Homomorphic approach-Formant frequency estimation using vocal tract model and Homomorphic approach-Linear predictive co-efficient -Poles of the vocal tract-Reflection co-efficient-Log Area ratio.

Cepstrum- Line spectral frequencies- Functional blocks of the ear- Mel frequency cepstral co-efficients-Spectrogram-Time resolution versus frequency resolution-Discrete wavelet transformation.

Pattern recognition for speech detection: Back-propagation Neural Network-Support Vector Machine-Hidden Markov Model (HMM)-Gaussian Mixture Model(GMM) -Unsupervised Learning system: K-Means and Fuzzy K-means clustering - Kohonen self-organizing map-Dimensionality reduction techniques: Principle component analysis (PCA), Linear discriminant analysis (LDA), Kernel-LDA (KLDA), Independent component analysis (ICA).

Non-uniform quantization for Gaussian distributed data- Adaptive quantization-Differential pulse code modulation- Code Exited Linear prediction (CELP)-Quality assessment of the compressed speech signal Text to Speech (TTS) analysis –Evolution of speech synthesis systems-Unitselection methods - TTS Applications.

Text Books

1. *L.R.Rabiner and R.W.Schafer," Introduction to Digital speech processing",now publishers USA,2007*
2. *E.S.Gopi,"Digital speech processing using matlab", Springer,2014.*

Reference Books

1. *L.R.Rabiner and R.W.Schafer,"Digital processing of speech signals", Prentice Hall,1978*
2. *T.F.Quatieri,"Discrete-time Speech Signal Processing", Prentice-Hall, PTR, 2001*
3. *L.Hanzaetal, "Voice Compression and Communications", Wiley/ IEEE , 2001.*

COURSE OUTCOMES

Students are able to

CO1: illustrate how the speech production is modeled

CO2: summarize the various techniques involved in collecting the features from the speech signal in both time and frequency domain

CO3: summarize the functional blocks of the ear

CO4: compare the various pattern recognition techniques involved in speech and speaker detection

CO5: summarize the various speech compression techniques

EC008	Image Processing	(L-T-P) C
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To treat the 2D systems as an extension of 1D system design and discuss techniques specific to 2D systems.

COURSE CONTENT

Linearity and space-invariance. PSF, Discrete images and image transforms, 2-D sampling and reconstruction, Image quantization, 2-D transforms and properties.

Image enhancement- Histogram modelling, equalization and modification. Image smoothing , Image crispening. Spatial filtering, Replication and zooming, Generalized cepstrum and homomorphic filtering.

Image restoration- image observation models.Inverse and Wiener filtering. Filtering using image transforms. Constrained least-squares restoration. Generalized inverse, SVD and interactive methods. Recursive filtering.Maximum entropy restoration. Bayesian methods.

Image data compression- sub sampling, Coarse quantization and frame repetition. Pixel coding - PCM, entropy coding, runlength coding Bit-plane coding. Predictive coding. Transform coding of images. Hybrid coding and vector DPCM. Interframe hybrid coding.

Image analysis- applications, Spatial and transform features. Edge detection, boundary extraction, AR models and region representation. Moments as features. Image structure.Morphological operations and transforms.Texture.Scene matching and detection. Segmentation and classification.

Text Books

1. *A.K. Jain, " Fundamentals of Digital Image Processing" , PHI, 1995.*
2. *R.C.Gonzalez& R.E. Woods," Digital Image Processing", (2/e), Pearson,2002.*

Reference Books

1. *J.C. Russ, "The Image Processing Handbook", (5/e), CRC, 2006.*
2. *E.S.Gopi,"Digital Image processing using Matlab", Scitech publications,2006.*

COURSE OUTCOMES

Students are able to

CO1: analyze the need for image transforms, types and their properties.
CO2: become skilled at different techniques employed for the enhancement of images both in spatial and frequency domain.
CO3: explore causes for image degradation and to teach various restoration techniques.
CO4: evaluate the image compression techniques in spatial and frequency domain.
CO5: gain knowledge of feature extraction techniques for image analysis and recognition.

EC009 Pattern Recognition (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- The subject aims to make the students to understand the mathematical approach for pattern recognition.

COURSE CONTENT

Polynomial curve fitting – The curse of dimensionality - Decision theory - Information theory - The beta distribution - Dirichlet distribution-Gaussian distribution-The exponent family: Maximum likelihood and sufficient statistics -Non-parametric method: kernel-density estimators - Nearest neighbour methods.

Linear models for regression and classification: Linear basis function models for regression - Bias variance decomposition-Bayesian linear regression-Discriminant functions - Fisher's linear discriminant analysis (LDA) - Principal Component Analysis (PCA) - Probabilistic generative model - Probabilistic discriminative model.

Kernel methods: Dual representations-Constructing kernels-Radial basis function networks-Gaussian process-Maximum margin classifier (Support Vector Machine) –Relevance Vector Machines-Kernel-PCA, Kernel-LDA.

Mixture models: K-means clustering - Mixtures of Gaussian - Expectation-Maximization algorithm-Sequential models: Markov model, Hidden-Markov Model (HMM) - Linear Dynamical Systems (LDS).

Neural networks: Feed- forward Network functions-Network training - Error Back propagation - The Hessian Matrix - Regularization in Neural Network - Mixture density networks – Bayesian Neural Networks

Text Books

1. *C.M.Bishop,"Pattern recognition and machine learning",Springer,2006*
2. *J.I.Tou&R.C.Gonzalez," Pattern Recognition Priciples", Addition –Wesley, 1977.*

Reference Books

1. *P.A.Devijer&J.Kittler, "Pattern Recognition-A Statistical Approach" , Prentice –Hall, 1990.*
2. *R.Schalkoff, "Pattern Recognition –Statistical, Structural and Neural Approaches", John Wiley, 1992.*

COURSE OUTCOMES

Students are able to

CO1: summarize the various techniques involved in pattern recognition
CO2: identify the suitable pattern recognition techniques for the particular applications.
CO3: categorize the various pattern recognition techniques into supervised and unsupervised.
CO4: summarize the mixture models based pattern recognition techniques
CO5: summarize the artificial neural network based pattern recognition techniques

EC010 Signal Processing for Wireless Communication (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- The subject aims to make the students to understand the signal processing approach for wireless communication

COURSE CONTENT

Physical model for wireless channel- Input /Output models for wireless channel: System function and impulse response of LTV system-Doppler spread-Coherence time-Delay spread-Coherence frequency-Base band system functions and impulse response.

Statistical channel model-Binary detection in flat Rayleigh fading- Non-cohernent detection in flat Rician fading-Channel measurement-Use of probing signals to estimate the channel-Rake receiver-Jakes model-Jakes spectrum-Ground reflections-Okumura model-Log normal shadowing- Hata model.

Cellular communication-Frequency reuse- Practical Link budget design using path loss models- Design parameters at base station-Antennal location, spacing, heights and configurations- Tele traffic theory.

Multiple access techniques: TDMA, FDMA, CDMA: PN sequences-Multipath diversity-Rake receiver-Receiver synchronization-Multicarrier modulation. Orthogonal frequency division Multiplexing (OFDM): Cyclic prefix-Frequency offset-Peak to average power ratio problem.

MIMO-Channel capacity-Spatial Multiplexing-Diversity- Beam forming- MIMO-OFDM- Wireless standards: GSM-WCDMA-LTE-IS 95-Wireless networks-Video over wireless.

Text books

1. *D. Tse and P.Viswanath, "Fundamentals of Wireless Communication", Cambridge university press, 2005*
2. *A. Goldsmith, "Wireless Communications", Cambridge University Press, 2005*

Reference Books

1. *T.S.Rappaport, "Wireless Communication Principles (2/e)", Pearson, 2002.*
2. *E. Biglieri, R.Calderbank, A. Constantinides, A. Goldsmith, A.Paulraj, H.Vincent poor, "MIMO Wireless Communications", Cambridge University Press, 2007.*
3. *Robert Gallager, Chapter 9: "Wireless communication", course materials for 6.450 Principles of Digital communication I,Fall 2006.MIT Open courseware http://ocw.mit.edu/.*
4. *A. K.Jagannatham," Advanced 3G and 4G wireless mobile communications"-,IIT Kanpur, NPTEL Video lectures. http://nptel.iitm.ac.in*

COURSE OUTCOMES

Students are able to

CO1: describe the Coherence time, Coherence frequency, Doppler spread and Delay spread
CO2: model the wireless channel using statistical approach
CO3: prepare the link budget for the wireless communication
CO4: describe various multiple access techniques and diversity techniques
CO5: compare various wireless standards

GROUP II (Microwave Engineering Stream)

EC021	**Microwave Integrated Circuit Design**	**(L-T-P) C** **3 - 0 - 0 - 3**

COURSE OBJECTIVE

- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency**.**

COURSE CONTENT

Design and realization of power dividers, hybrids, directional couplers etc using strip lines and microstrip lines.

Filter design; Kuroda identities. K and J inverters. Filter transformations. Realization using strip lines and microstrip lines.

Transistor amplifiers; Power gain equations.Stabilityconsiderations.Analysis.Design using MICs.

Transistor oscillators.Active devices for microwave oscillators. Three port S parameter characterization of transistors. Oscillation and stability conditions.

Diode mixers.Mixer design. Single ended mixer. Balanced mixer.Image rejection mixer. Phase shifter design. PIN diode. Phase shifter.

Text Books

1. *I.J.Bahl&Bhartia, Micrwave Solid State Circuit Design, Wiley, 1987.*
2. *G.D.Vendelin, Design of Amplifiers and Oscillators by the S Parameter Method, Wiley, 1982.*

Reference Books

1. *T.C.Edwards, Foundations for MicrostripCircuir Design (2/e), Wiley, 1992.*

COURSE OUTCOMES

CO1: the topics will make students design of the important and essential M.I.C.components

CO2: Filter is the most needed circuit for many applications and the unit will make the student confident in filter design

CO3:All aspects and different parameters, design factors and properties will me made thorough

CO4: One will be confident to handle any oscillator design

CO5: The student will become familiar and confident in the design of Mixers, the other essential circuits.

EC022	**RF MEMS Circuit Design**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To impart knowledge on basics of MEMS and their applications in RF circuit design.

COURSE CONTENT

Introduction to MichomachiningProcesses.RF MEMS relays and switches. Switch parameters. Actuation mechanisms.Bistable relays and micro actuators.Dynamics of switching operation.

MEMS inductors and capacitors.Micromachinedinductor.Effect of inductor layout. Modeling and design issues of planar inductor. Gap-tuning and area-tuning capacitors.Dielectric tunable capacitors.

MEMS phase shifters. Types.Limitations. Switched delay lines. Fundamentals of RF MEMS Filters.

Micromachined transmission lines.Coplanarlines.Micromachined directional coupler and mixer.

Micromachinedantennas.Microstrip antennas – design parameters.Micromachining to improve performance.Reconfigurable antennas.

Text Book

1. *Vijay.K.Varadanetal, "RF MEMS and their Applications", Wiley-India, 2011.*

Reference Books

1. *H.J.D.Santos, "RF MEMS Circuit Design for Wireless Communications", Artech House, 2002.*
2. *G.M.Rebeiz, "RF MEMS Theory, Design, and Technology", Wiley, 2003.*

COURSE OUTCOMES

Students are able to

CO1: learn the Micromachining Processes
CO2: learn the design and applications of RF MEMS inductors and capacitors.
CO3: learn about RF MEMS Filters and RF MEMS Phase Shifters.
CO4: learn about the suitability of micromachined transmission lines for RF MEMS
CO5: learn about the Micromachined Antennas and Reconfigurable Antennas

GROUP III (Embedded Systems Stream)

EC041	**Computer Architecture and Organization**	**(L-T-P) C** **3 – 0 – 0 - 3**

COURSE OBJECTIVES

- To understand how computers are constructed out of a set of functional units and how the functional units operate, interact, and communicate.
- To make the students to understand the concept of interfacing memory and various I/O devices to a computer system using a suitable bus system.

COURSE CONTENT

Introduction: Function and structure of a computer, Functional components of a Computer, Interconnection of components, Performance of a computer.

Representation of Instructions: Machine instructions, Memory locations & Addresses, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures, Super scalar Architectures, Fixed point and floating point operations.

Basic Processing Unit: Fundamental concepts, ALU, Control unit, Multiple bus organization, Hardwired control, Micro programmed control, Pipelining, Data hazards, Instruction hazards, Influence on instruction sets, Data path and control considerations, Performance considerations.

Memory organization: Basic concepts, Semiconductor RAM memories, ROM, Speed - Size and cost, Memory Interfacing circuits, Cache memory, Improving cache performance, Memory management unit, Shared/Distributed Memory, Cache coherency in multiprocessor, Segmentation, Paging, Concept of virtual memory, Address translation, Secondary storage devices.

I/O Organization: Accessing I/O devices, Input/output programming, Interrupts, Exception Handling, DMA, Buses, I/O interfaces- Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewall and Infini band, I/O peripherals.

Text Books

1. *C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw-Hill, 2002.*
2. *W. Stallings, "Computer Organization and Architecture - Designing for Performance", Prentice Hall of India, 2002.*
3. *B,Parhami, "Computer Architecture, From Microprocessors to Supercomputers," Oxford University Press, Reprint 2014.*

References Books

1. *D. A. Patterson and J. L. Hennessy, "Computer Organization and Design,*
2. *Morgan Kaufmann,"The Hardware/Software Interface", 1998.*
3. *J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.*

COURSE OUTCOMES

Students are able to

CO1: apply the basic knowledge of digital concept to the functional components of a Computer System.

CO2: analyze the addressing mode concepts and design the instruction set Architecture.

CO3: identify the functions of various processing units within the CPU of a Computer System.

CO4: analyze the function of the memory management unit and create suitable memory interface to the CPU.

CO5: recognize the need for recent Bus standards and I/O devices.

EC042	Embedded Systems	(L-T-P) C
		3 - 0 - 0 - 3

COURSE OBJECTIVES

- To introduce students to the modern embedded system concepts.
- To make the students to understand and program modern embedded systems using modern embedded processors.

COURSE CONTENT

Introduction to embedded system. Embedded verses General computing systems. Attributes of embedded systems. Classification of embedded system. Device interface. Device inter connect.
Chip set overview.

Embedded processor Architecture overview. Atom micro architecture. Paging. Hyper Threading. Caches and TLB. Execution pipeline. Interrupts. Embedded platform boot sequence.

Operating systems overview. OS application interface. OS service calls. Processes, Tasks and Threads.
Task states and state transitions. Scheduling. Memory allocation. Device driver models. Bus drivers. Networking.

Embedded Linux. Tools overview. Building a Kernal. Busybox. BOOT sequence. Driver Development.
Memory management. Synchronization. Optimizing software for power performance.

Case study of embedded systems.

Text Books

1. *P. Barry, P.Crowley," Modern Embedded Computing", ELSEVIER. 2012*
2. *R. Kamal ," Embedded Systems Architecture, Programming and Design",Tata McGraw Hill. 2008.*

Reference Books

1. *L.B. Das ," Embedded Systems An Integrated Approach", Pearson, 2013*
2. *B. K. Rao ," Embedded Systems", PHI, 2011*

COURSE OUTCOMES

Students are able to

CO1: get an insight into the overall landscape and characteristics of embedded systems.
CO2: become familiar with the architecture and programming aspects of the embedded processor (ATOM).
CO3: develop application software for embedded systems using the RTOS functions.
CO4: become aware of Linux capabilities and will be able to develop embedded Linux systems.
CO5: analyse various examples embedded systems and become familiar with the design of embedded systems.

EC043 ARM System Architecture (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- The objective of this course is to give the students a thorough exposure to ARM architecture and make the students to learn the ARM programming & Thumb programming models.

COURSE CONTENT

RISC machine.ARM programmer's model. ARM Instruction Set. Assembly level language programming. Development tools.

ARM organization.ARM instruction execution.ARMimplementation.ARM coprocessor interface. . Interrupt response.

Floating point architecture.Expressions.Conditionalstatements.Loops.Functions and procedures. Run time environment.

Thumb programmer's model. Thumb Instruction set. Thumb implementation.

Memory hierarchy.Architectural support for operating system.Memory size and speed.Cache memory management.Operatingsystem.ARM processor chips.

Text Books

1. *S. Furber, "ARM System Architecture", Addison-Wesley,1996.*
2. *A. Sloss, D.Symes& C.Wright, "ARM system Developer's guide", Elsevier.2005.*

Reference Books

1. *Technical reference manual for ARM processor cores, including Cortex, ARM 11, ARM 9 & ARM 7 processor families.*
2. *User guides and reference manuals for ARM software development and modeling tools.*
   David Seal, ARM Architecture Reference Manual, Addison-Wesley.

COURSE OUTCOMES

Students are able to

CO1: describe the programmer's model of ARM processor and create and test assembly level programming.

CO2: analyze various types of coprocessors and design suitable co-processor interface to ARM processor.

CO3: analyze floating point processor architecture and its architectural support for higher level language.

CO4: become aware of the Thumb mode of operation of ARM.

CO5: identify the architectural support of ARM for operating system and analyze the function of memory Management unit of ARM.

EC044	**Operating Systems**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To expose the principles and practice of operating system design and to illustrate the current design practices using DOS and UNIX operating systems.

COURSE CONTENT

Types of operating systems, Different views of the operating system, Principles of Design and Implementation. The process and threads. System programmer's view of processes, Operating system's views of processes, Operating system services for process management. Process scheduling, Schedulers, Scheduling algorithms.Overview of Linux operating system.

Interprocess synchronization, Mutual exclusion algorithms, Hardware support, Semaphores, Concurrent programming using semaphores.

Conditional critical regions, Monitors, Interprocess communication: Messages, Pipes. Deadlocks: Characterization. Prevention.Avoidance.detection and recovery. Combined approach to deadlock handling.

Contiguous allocation. Static and dynamic partitioned memory allocation. Segmentation.Non-contiguous allocation. Paging, Hardware support, Virtual Memory.

Need for files. File abstraction. File naming. File system organization. File system optimization. Reliability.Security and protection.I/O management and disk scheduling.Recent trends and developments.

Text Books

1. *Gary: Operating Systems- A modern Perspective, (2/e), Addison Wesley, 2000.*
2. *M.Milenkovic: Operating systems, Concepts and Design, McGraw Hill, 1992.*

Reference Books

1. *C. Crowley: Operating Systems, Irwin, 1997.*
2. *J.l. Peterson & A.S. Chatz: Operating System Concepts, Addison Wesley, 1985.*
3. *W. Stallings: Operating Systems, (2/e), Prentice Hall, 1995.*
4. *Mattuck,A., Introduction to Analysis, Prentice-Hall,1998.*

COURSE OUTCOMES

Students are able to

CO1:.Understand the different types of Operating systems and scheduling algorithms.
CO2: Understand the synchronization algorithms and semaphores.
CO3: Appreciate the inter process communication and deadlock handling.
CO4: Critically evaluate the different memory allocation techniques.
CO5: Appreciate the importance of file system organization, I/O management and disk scheduling.

EC045	**Display Systems**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To expose the students to the basics of the display systems and to illustrate the current design practices of the display systems.

COURSE CONTENT

Introduction to displays. Requirements of displays. Display technologies, CRT, Flat panel and advanced display technologies. Technical issues in displays.

Head mounted displays. Displays less than and greater than 0.5 m diagonal. Low power and light emitting displays.

Operation of TFTs and MIMS. LCDs, Brightness. Types of LCD displays.

Emissive displays, ACTFEL, Plasma display and Field emission displays, operating principle and performance.

Types of Displays: 3D, HDTV, LED, Touch screen.

Text Books

1. *L.W. Mackonald& A.C. Lowe,Display Systems, Design and Applications, Wiley, 2003.*
2. *E.H. Stupp&M. S. Brennesholtz, Projection Displays, Wiley, 1999*

Reference Books

1. *Peter A. Keller, Electronic Display Measurement: Concepts, Techniques, and Instrumentation, Wiley-Interscience, 1997.*

COURSE OUTCOMES

Students are able to

CO1: appreciate the technical requirement of different types of displays systems
CO2: analyse the various low power lighting systems
CO3: understand the operation of TFTs and LCD displays.
CO4: analyse the various kinds of emissive displays
CO5: critically evaluate the recent advancements in the displays device technology.

EC046 Electronic Packaging (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To introduce and discuss various issues related to the system packaging.

COURSE CONTENT

Functions of an Electronic Package, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends, Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates.

Electrical Anatomy of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Transmission Lines , Clock Distribution, Noise Sources, power Distribution, signal distribution, EMI, Digital and RF Issues. Processing Technologies, Thin Film deposition, Patterning, Metal to Metal joining.

IC Assembly – Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging , reliability, wafer level burn – in and test.Single chip packaging : functions, types, materials processes, properties, characteristics, trends.Multi chip packaging : types, design, comparison, trends. Passives: discrete, integrated, embedded –encapsulation and sealing : fundamentals, requirements, materials, processes.

Printed Circuit Board: Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.Thermal Management, Heat transfer fundamentals, Thermal conductivity and resistance, Conduction, convection and radiation – Cooling requirements.

Reliability, Basic concepts, Environmental interactions. Thermal mismatch and fatigue – failures – thermo mechanically induced – electrically induced – chemically induced. Electrical Testing: System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability.

Text Book

1. *Tummala, Rao R., "Fundamentals of Microsystems Packaging", McGraw Hill, 2001.*

Reference Books

1. *Blackwell (Ed), "The electronic packaging handbook", CRC Press,2000.*
2. *Tummala, Rao R, "Microelectronics packaging handbook", McGraw Hill, 1963.*
2. *Bosshart, "Printed Circuit Boards Design and Technology",TataMcGraw Hill,1983.*
3. *R.G. Kaduskar and V.B.Baru, "Electronic Product design", Wiley India, 2011.*
4. *R.S.Khandpur, "Printed Circuit Board", Tata McGraw Hill, 2005.*

COURSE OUTCOMES

Students are able to

CO1: describe the functions and applications of packages and materials used for packaging.
CO2: explain the procedure used for evaluating the electrical aspects of packaging including delay, cross talk
CO3: apply the design technique and analyse the electrical characteristics of VLSI circuits.
CO3: describe about the single chip and multi chip packages and techniques.
CO4: explain the techniques for bonding the packages to dies.
CO5: explain the technique used for fabrication and characteristics of single layer and multi layer PCBs and compare their performances.
CO6: describe about thermal management techniques for packages and reliability of packages.

LIST OF ADVANCED LEVEL COURSES FOR B.Tech. HONOURS

EC080 Adhoc Wireless Networks (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- To analyse the various design issues and challenges in the layered architecture of Ad hoc wireless networks

COURSE CONTENT

Cellular and ad hoc wireless networks, Applications of ad hoc wireless networks. Issues in ad hoc wireless networks-medium access scheme, routing, transport layer protocols, security and energy management. Ad hoc wireless internet.

Design goals of a MAC protocol, Contention based protocols; Contention based protocols with reservation mechanisms and scheduling mechanisms, MAC protocols using directional antennas.

Table driven routing protocols, On demand routing protocols, hybrid routing protocols, Hierarchical routing protocols, Power aware routing protocols, Tree based and mesh based multicast routing protocols

Network security requirements-Issues and challenges, network security attacks, key management, secure routing protocols

Energy management schemes-Battery management, transmission power management, system power management schemes. Quality of service solutions in ad hoc wireless networks.

Text books

1. *C.Siva ram murthy,B.S. Manoj, "Ad hoc wireless networks-Architectures and protocols" Pearson Education, 2005*
2. *S.Basagni, M.Conti, "Mobile ad hoc networking", Wielyinterscience 2004*
3. *C. E.Perkins ,"Ad hoc networking", Addison Wesley,2001*

References books

1. *X.Cheng, X.Huang ,D.Z. DU ,"Ad hoc wireless networking", Kluwer Academic Publishers,2004*
2. *G. Aggelou,"Mobile ad hoc networks-From wireless LANs to 4G networks", McGraw Hill publishers, 2005*

COURSE OUTCOMES

Students are able to

CO1: compare the differences between cellular and ad hoc networks and the analyse the challenges at various layers and applications
CO2: summarize the protocols used at the MAC layer and scheduling mechanisms
CO3: compare and analyse types of routing protocols used for unicast and multicast routing
CO4: examine the network security solution and routing mechanism
CO5: evaluate the energy management schemes and Quality of service solution in ad hoc networks

EC081	Wireless Sensor Networks	(L-T-P) C 3 - 0 - 0 – 3

COURSE OBJECTIVE

- To overview the various design issues and challenges in the layered architecture of Wireless sensor networks

COURSE CONTENT

Motivation for a network of wireless sensor nodes-Definitions and background-challenges and constraints for wireless sensor networks-Applications. Node architecture-sensing subsystems, processing Subsystems, Communication interfaces, Prototypes.

Physical layer- Introduction, wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication, packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, Energy usage profile, choice of modulation, Power Management

Data link layer- Fundamentals of wireless MAC protocols, Characteristics of MAC protocol in wireless sensor networks contention-based protocols, Contention free MAC protocols .Hybrid MAC protocols

Network layer-routing metrics-Flooding and gossiping, Data centric routing, proactive routing On demand routing, hierarchical routing, Location based routing, QOS based routing. Data Aggregation – Various aggregation techniques.

Case study-Target detection tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Operating System Design Issues. Simulation tools.

Text books

1. *W. Dargie,C. Poellabauer,"Fundamentals of Wireless sensor networks-Theory and Practice",John Wiley & Sons Publication 2010*
2. *K. Sohraby, D.Minoli and T.Znati, " Wireless Sensor Network Technology- Protocols and Applications", John Wiley & Sons, 2007.*
3. *F.Zhao, L.Guibas, "Wireless Sensor Networks: an information processing approach", Elsevier publication, 2004.*
4. *C.S.Raghavendra Krishna, M.Sivalingam and Taribznati, "Wireless Sensor Networks", Springer publication, 2004.*
5. *H. Karl , A.willig, "Protocol and Architecture for Wireless Sensor Networks", John wiley publication, Jan 2006.*

References Books

1. *K.Akkaya and M.Younis, " A Survey of routing protocols in wireless sensor networks", Elsevier Adhoc Network Journal, Vol.3, no.3,pp. 325-349, 2005.*
2. *Philip Levis, " TinyOS Programming", 2006 – www.tinyos.net.*
3. *I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, "Wireless sensor networks: a survey", computer networks, Elsevier, 2002, 394 - 422.*
4. *Jamal N. Al-karaki, Ahmed E. Kamal, "Routing Techniques in Wireless sensor networks: A survey", IEEE wireless communication, December 2004, 6 – 28.*

COURSE OUTCOMES

Students are able to

CO1: analyse the challenges and constraints of wireless sensor network and its subsystems
CO2: examine the physical layer specification, modulation and transceiver design considerations
CO3: analyse the protocols used at the MAC layer and scheduling mechanisms
CO4: compare and analyse the types of routing protocols and data aggregation techniques
CO5: identify the application areas and practical implementation issues.

EC082	Detection and Estimation	(L-T-P) C 3 - 0 - 0 - 3

COURSE OBJECTIVE

- The objective of this course is to make the students conversant with those aspects of statistical decision and estimation which are indispensable tools required for the optimal design of digital communication systems.

COURSE CONTENT

Binary hypothesis testing; Bayes, minimax and Neyman-Pearson tests. Composite hypothesis testing.

Signal detection in discrete time: Models and detector structures. Coherent detection in independent noise. Detection in Gaussian noise. Detection of signals with random parameters. Detection of stochastic signals. Performance evaluation of signal detection procedures.

Bayesian parameter estimation; MMSE, MMAE and MAP estimates. Nonrandom parameter estimation. Exponential families. Completeness theorem. ML estimation. Information inequality. Asymptotic properties of MLEs.

Discrete time Kalman- Bucy filter. Linear estimation. Orthogonality principle. Wiener- Kolmogorov filtering – causal and noncausal filters.

Signal detection in continous time:Detection of deterministic signals in Gaussian noise. Coherent detection in white Gaussian noise.

Text Books

1. *H.V.Poor, "An Introduction to Signal Detection and Estimation (2/e) Springer", 1994.*
2. *B.C.Levy, "Priciples of Signal Detection and Parameter Estimatio"n, Springer, 2008.*

Reference Books

1. *H.L.Vantrees, "Detection, Estimation and Modulation theory", Part I, Wiley,1987.*
2. *M.D.Srinath & P.K.Rajasekaran, "Statistical Signal Processing with Applications", Wiley, 1979.*
3. *J.C.Hancock & P.A. Wintz, "Signal Detection Theory", Mc-Graw Hill, 1966.*

COURSE OUTCOMES

Students are able to

CO1: summarize the fundamental concept on Statistical Decision Theory and Hypothesis Testing
CO2: summarize the various signal estimation techniques with additive noise
CO3: summarizer with Bayesian parameter estimation (minimum mean square error (MMSE), minimum mean absolute error (MMAE), maximum a-posterior probability (MAP) estimation methods).
CO4: compare optimal filtering, linear estimation, and Wiener/Kalman filtering.
CO5: construct Wiener and Kalman filters (time discrete) and state space models.

EC083 Statistical Signal Processing (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVES

- To develop algorithms for optimum filtering (and prediction) and for adaptive filtering for the given observation processes.
- To enable the students understand the frequency analysis and estimation methods

COURSE CONTENT

Random processes: Stationary processes, wide-sense stationary processes, autocorrelation and auto covariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, .Random signal modeling: MA, AR, ARMA models.

Optimum Linear Filtering: Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Non causal IIR Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.

Adaptive Filtering : Principle and Application, Steepest Descent Algorithm, Convergence characteristics; LMS algorithm, convergence, excess mean square error, Leaky LMS algorithm; Application of Adaptive filters. RLS algorithm: Exponentially weighted RLS algorithm derivation, Matrix inversion Lemma, Initialization.

Spectrum Estimation: Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Prametric method, AR spectral estimation.

Frequency Estimation, Eigen decomposition of Autocorrelation matrix, Detection of Harmonic signals: Pisarenko's method, MUSIC algorithm, ESPRIT method, Propagator method.

References Books

1. *M.H. Hayes, "Statistical Digital Signal Processing and Modelling", John Wiley, 1996.*
2. *P.Stroica & R.Moses," Spectral Analysis of signals", Pearson,2005.*

COURSE OUTCOMES

Students are able to

CO1: apply the knowledge of the discrete-time stochastic processes & its measures and understand various stochastic models.

CO2: develop algorithms for optimum linear filtering and prediction for the given observation processes

CO3: develop steepest descent, Least Mean Square (LMS), and Recursive Least Squares (RLS) adaptive filter algorithms

CO4: derive and analyse the statistical properties of the conventional spectral estimators, namely the periodogram, averaged & modified periodogram and Blackman-Tukey methods

CO5: formulate parametric spectral estimators based upon autoregressive (AR), moving average (MA), and autoregressive moving average (ARMA) models, and detail their statistical properties.

CO6: select an appropriate array processing algorithms for frequency estimation based on the observation models.

EC084	**RF Circuits**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVE

- To impart knowledge on basics of IC design at RF frequencies.

COURSE CONTENT

Characteristics of passive IC components at RF frequencies – interconnects, resistors, capacitors, inductors and transformers – Transmission lines. Noise – classical two-port noise theory, noise models for active and passive components

High frequency amplifier design – zeros as bandwidth enhancers, shunt-series amplifier, f_T doublers, neutralization and unilateralization

Low noise amplifier design – LNA topologies, power constrained noise optimization, linearity and large signal performance

Mixers – multiplier-based mixers, subsampling mixers, diode-ring mixers

RF power amplifiers – Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, linearity considerations

Oscillators & synthesizers – describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations.

Text Books

1. *T.homas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", 2nd ed., Cambridge, UK: Cambridge University Press, 2004.*
2. *B.Razavi, "RF Microelectronics",2nd Ed., Prentice Hall, 1998.*

Reference Books

1. *A.A. Abidi, P.R. Gray, and R.G. Meyer, eds., "Integrated Circuits for Wireless Communications", New York: IEEE Press, 1999.*
2. *R. Ludwig and P. Bretchko, "RF Circuit Design, Theory and Applications", Pearson, 2000.*
3. *Mattuck,A., "Introduction to Analysis", Prentice-Hall,1998.*

COURSE OUTCOMES

Students are able to

CO1: Understand the Noise models for passive components and noise theory
CO2: Analyse the design of a high frequency amplifier
CO3 Appreciate the different LNA topologies & design techniques
CO4: Distinguish between different types of mixers
CO5: Analyse the various types of synthesizers, oscillators and their characteristics.

EC085 Numerical Techniques for Microwave Integrated Circuits (L-T-P) C
3 - 0 - 0 - 3

COURSE OBJECTIVE

- This subject will prepare the student to face the challenging problem of the most important component of Research namely the numerical analysis.

COURSE CONTENT

Over view of Numerical Techniques for Microwave I integrated Circuits: Introduction_Quasi Static and Full wave Analysis,Outline if Finite element method, Integral Equation Technique, Planar Circuit Analysis, Spectral Domain Approach, The Method of Lines, The Mode Matching Method, The Transverse Resonance Technique

The Finite Element Method Introduction The Method of Weighted Residuals The Variational Method Using a Variational Expression The Finite Element Method Integral Formulation of Problems Antennas and Scattering from Conductors Waveguides-Hollow,Dielectric and Optical Finite Difference in space and Time Matrix Computations A Finite Element Computer Program for Microstrips

Planar Circuit Analysis Introduction Planar Circuit Analysis' Function Approach Impedence Green's Functions Contour Integral Approach Analysis of Planar Components of Composite Configurations Planar Circuits with Anisotropic Spacing Media Applications of the Planar Circuits Concept Summary

Spectral Domain Approach Introduction General Approach for Shielded Microstrip Lines The Immittance Approach Formulations for Slot lines, Fin lines, and Coplanar Waveguides Numerical Computation

Transverse Resonance Technique Introduction Inhomogeneous Waveguides Uniform Along a Traverse Coordinate Conventional Traverse Resonance Technique for Transversely Discontinuous Waveguides Generalized Transverse Resonance Technique for Transversely Discontinuous Inhomogeneous Analysis of Discontinuities and Junctions by the Generalized Transverse Resonance Technique Examples of Computer Programs

Text Book

1. *T.Itoh, Numerical Techniques for Microwave Integrated Circuits., John Wiley and sons, 1989*

COURSE OUTCOMES

Students are able to

CO1: bring awareness of the need for numerical analysis of M.I.C. And prepare to formulate all popular numerical techniques of M.I.C.
CO2: make one formulate and write coding for Finite Element Method
CO3: prepare a person to be strong in the planar circuit Analysis
CO4: bring awareness of the most popular Quasi state analysis Spectral Domain Techniques
CO5: prepare the student formulate and write coding for the Transverse Resonance Techniques

EC086	**Applied Photonics**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVES

- To prepare the students understand the fundamental principles of light-matter interaction and photonic band gap structures.
- To enable the students appreciate the diverse applications of fiber optic sensors.

COURSE CONTENT

Introduction to photonics; optical waveguide theory; Interference of light waves -numerical techniques and simulation

Photonic waveguide components Optical Modulators and Switches Electro-optics - Acousto-optics - Magneto-optics

Photonic Band gap Structures: Concept of photonic crystal; bandgap and band structures in 1D, 2D and 3D photonic crystal structures;

Photo-refractive materials, non-linear optics, recent trends in bio and nano-photonics

Optical fiber sensors - Sensing using optical fibers - Types:-Amplitude, Interferometric, Wavelength, Polarimetric - Distributed Sensors

Text Books

1. *A. Ghatak and K. Thyagarajan, "Introduction to Fiber Optics", Cambridge University Press, 2006.*
2. *Pochi Yeh and Amnon Yariv Photonics," Optical Electronics in Modern Communications", 2007*

Reference Books

1. *F. T. S. Yu and S.Yin, "Fiber Optic Sensors", Marcel Dekker, Inc 2002*
2. *G. W. Hanson, "Fundamentals of Nanoelectronics ",Pearson Education, 1st edition, 2008*
3. *B. Saleh and M. Teich, "Fundamentals of Photonics", Wiley & Sons (2007)*

COURSE OUTCOMES

Students are able to

CO1: understand the interference of light and optical waveguide theory.
CO2: understand the significance of photonic band gap structures and their application
CO3: analyse the different types of optical modulators.
CO4: compare the merits and demerits of different types of fiber optic sensors.
CO5: understand the application of nonlinear optics in bio and nano photonics.

EC087	**Advanced Radiating Systems**	**(L-T-P) C**
		3 - 0 - 0 - 3

COURSE OBJECTIVES

- To prepare the students understand the operating principles of various RF radiating systems.
- To enable the students appreciate the diverse applications of radiating systems.
- To design the suitable antenna systems to serve a defined application.

COURSE CONTENT

Antenna Fundamentals

Antenna fundamental parameters, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna; Broadband antennas and matching techniques, Balance to unbalance transformer, Introduction to numerical techniques.

Apertures Antennas

Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane; Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration.

Arrays

General structure of phased array, linear array theory, variation of gain as a function of pointing direction, frequency scanned arrays, digital beam forming, MEMS technology in phased arrays-Retro directive and self phased arrays.

Micro Strip Antenna

Radiation Mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, and Ring antenna – radiation analysis from transmission line model, cavity model; input impedance of rectangular and circular patch antenna; Application of microstrip array antenna.

Terahertz Planar Antennas

Electronics band gap materials - Photonic Band-gap Structures- Tera Hertz Patch antennas-Special antenna structures.

Text Books

1. *S. Haykins," Communication Systems", John Wiley, 3rd edition, 1995.*
2. *RR Gulathi, "Monochrome and Colour Television", New Age International Publishers, 2nd edition, 2005.*
3. *J. G. Proakis& M .Salehi," Communication Systems Engineering", Prentice Hall, 2nd edition, 2002.*

Reference Book

1. *Kennedy & Davis," Electronic Communication systems", Tata McGraw Hill, 4th edition, 1999.*

COURSE OUTCOMES

Students are able to

CO1: understand the various antenna parameters and different impedance matching techniques.
CO2: understand the working principle of apertures antennas.
CO3: analyse how the electronic beam formation is done using array of antennas.
CO4: compare the merits and demerits of various microwave patch antenna structures.
CO5: understand the photonic band gap structures and its application in terahertz antennas.

EC088	**Bio MEMS**	**(L-T-P) C** **3 – 0 – 0 – 3**

COURSE OBJECTIVE

- To train the students in the design aspects of Bio MEMS devices and Systems. To make the students aware of applications in various medical specialists especially the Comparison of conventions methods and Bio MEMS usage.

COURSE CONTENT

Introduction-The driving force behind Biomedical Applications-Biocompatibility-Reliability Considerations-Regularity Considerations-Organizations-Education of Bio MEMS-Silicon Micro fabrication-Soft Fabrication techniques

Micro fluidic Principles- Introduction-Transport Processes- Electro kinetic Phenomena-Micro valves –Micro mixers- Micro pumps.

SENSOR PRINCIPLES and MICRO SENSORS: Introduction-Fabrication-Basic Sensors-Optical fibers-Piezo electricity and SAW devices-Electrochemical detection-Applications in Medicine

MICRO ACTUATORS and DRUG DELIVERY: Introduction-Activation Methods-Micro actuators for Micro fluidics-equivalent circuit representation-Drug Delivery

MICRO TOTAL ANALYSIS: Lab on Chip-Capillary Electrophoresis Arrays-cell, molecule and Particle Handling-Surface Modification-Microsphere-Cell based Bioassay Systems
Detection and Measurement Methods-Emerging Bio MEMS Technology-Packaging, Power, Data and RF Safety-Biocompatibility, Standards

Text Book

1. *S.S. Saliterman," Fundamentals of Bio MEMS and Medical Micro devices", Wiley Interscience, 2006.*

Reference Books

1. *A. Folch ,"Introduction to Bio MEMS", CRC Press, 2012*
2. *G.A. Urban, "Bio MEMS", Springer, 2006*
3. *W. wang, S.A. Soper," Bio MEMS" ,2006.*
4. *M. J. Madou, "Fundametal of Micro fabrication",* 2002.
5. *G.T. A. Kovacs, "Micro machined Transducers Sourcebook",1998***.**

COURSE OUTCOMES

Students are able to

CO1: learn and realize the MEMS applications in Bio Medical Engineering
CO2: understand the Micro fluidic Principles and study its applications.
CO3: learn the applications of Sensors in Health Engineering.
CO4: learn the principles of Micro Actuators and Drug Delivery system
CO5: learn the principles and applications of Micro Total Analysis

EC089	**Analog IC Design**	**(L-T-P) C** **3 - 0 - 0 - 3**

COURSE OBJECTIVES

- To develop the ability design and analyze MOS based Analog VLSI circuits to draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
- To develop the skills to design analog VLSI circuits for a given specification.

COURSE CONTENT

Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models.Single StageAmplifiers – Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.

Differential Amplifiers – Single Ended and Differential Operation, Basic Differential Pair, Common-Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors – Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.

Frequency Response of Amplifiers – General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs.

Feedback Amplifiers – General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation.

Bandgap References, Introduction to Switched Capacitor Circuits, Nonlinearity and Mismatch.

Text Books

1. *B.Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill Edition 2002.*
2. *Paul. R.Gray, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley, (4/e), 2001.*

Reference Books

1. *D. A. Johns and K. Martin, "Analog Integrated Circuit Design", Wiley, 1997.*
2. *R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", Wiley, (3/e), 2010.*
3. *P.E.Allen, D.R. Holberg, "CMOS Analog Circuit Design", Oxford University Press, 2002.*

COURSE OUTCOMES

Students are able to

CO1: draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
CO2: design analog VLSI circuits for a given specification.
CO3: Analyse the frequency response of the different configurations of a amplifier.
CO4: Understand the feedback topologies involved in the amplifier design.
CO5: Appreciate the design features of the differential amplifiers.

EC090	**VLSI System Testing**	**(L-T-P) C**
		3 – 0 – 0 – 3

COURSE OBJECTIVE

- To expose the students, the basics of testing techniques for VLSI circuits and Test Economics.

COURSE CONTENT

Basics of Testing: Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing based testing. Classification of sequential ATPG methods. Fault collapsing and simulation

Universal test sets: Pseudo-exhaustive and iterative logic array testing. Clocking schemes for delay fault testing. Testability classifications for path delay faults. Test generation and fault simulation for path and gate delay faults.

CMOS testing: Testing of static and dynamic circuits. Fault diagnosis: Fault models for diagnosis, Cause-effect diagnosis, Effect-cause diagnosis.

Design for testability: Scan design, Partial scan, use of scan chains, boundary scan, DFT for other test objectives, Memory Testing.

Built-in self-test: Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing.

Text Books

1. *N. Jha & S.D. Gupta, "Testing of Digital Systems", Cambridge, 2003.*
2. *W. W. Wen, "VLSI Test Principles and Architectures Design for Testability", Morgan Kaufmann Publishers. 2006*

Reference Books

1. *Michael L. Bushnell &Vishwani D. Agrawal," Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits", Kluwar Academic Publishers. 2000.*
2. *P. K. Lala," Digital circuit Testing and Testability", Academic Press. 1997.*
3. *M. Abramovici, M. A. Breuer, and A.D. Friedman, "Digital System Testing and Testable Design", Computer Science Press, 1990.*

COURSE OUTCOMES

Students are able to

CO1: apply the concepts in testing which can help them design a better yield in IC design.
CO2: tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.
CO3: analyse the various test generation methods for static & dynamic CMOS circuits.
CO4: identify the design for testability methods for combinational & sequential CMOS circuits.
CO5: recognize the BIST techniques for improving testability.

EC091 Electronic Design Automation Tools (L-T-P) C
3– 0 – 0 – 3

COURSE OBJECTIVE

- To make the students exposed to Front end and Back end VLSI CAD tools.

COURSE CONTENT

An overview of OS commands. System settings and configuration. Introduction to UNIX commands. Writing Shell scripts. VLSI design automation tools. An overview of the features of practical CAD tools. Modelsim, Leonardo spectrum, ISE 13.1i, Quartus II, VLSI backend tools.

Synthesis and simulation using HDLs-Logic synthesis using verilog and VHDL. Memory and FSM synthesis. Performance driven synthesis, Simulation- Types of simulation. Static timing analysis. Formal verification. Switch level and transistor level simulation.

Circuit simulation using Spice: Circuit description.AC, DC and transient analysis. Advanced spice commands and analysis. Models for diodes, transistors and opamp. Digital building blocks.A/D, D/A and sample and hold circuits. Design and analysis of mixed signal circuits.

System Verilog- Introduction, Design hierarchy, Data types, Operators and language constructs. Functional coverage, Assertions, Interfaces and test bench structures.

Mixed signal circuit modeling and analysis, Concept of System on chip. Introduction to Cypress Programmable System on Chip (PSoC). Structure of PSoC, PSoC Designer, PSoC Modules, Interconnects, Memory Management, Global Resources, and Design Examples.

Text Books

1. *M.J.S.Smith, "Application Specific Integrated Circuits",Pearson, 2008.*
2. *M.H.Rashid, "Introduction to PSpice usingOrCAD for circuits and electronics",Pearson, 2004.*
3. *S. Sutherland,S.Davidmann, P. Flake,"*System Verilog For Design",(2/e), Springer, 2006.

Reference Books

1. *Z. Dr Mark,"Digital System Design with System Verilog",Pearson, 2010.*
2. *R. Ashby,"Designer's Guide to the Cypress PSoC,Newnes (An imprint of Elsevier)", 2006.*
3. *O. H. Bailey,"The Beginner's Guide to PSoC", Express Timelines Industries Inc.,2007.*

COURSE OUTCOMES

Students are able to

CO1: understand the special features of VLSI back end and front end CAD tools and Unix shell script
CO2: write synthesizable verilog and VHDL code.
CO3: write Pspice code for any electronics circuit and to perform monte-carlo analysis and sensitivity/worst case analysis.
CO4: understand the difference between verilog and system verilog and are able to write system verilog code.
CO5: understand Cypress PSOC structure, modules and interconnects.

EC092	**Design of ASICs**	**(L-T-P) C**
		3 – 0 – 0 – 3

COURSE OBJECTIVES

- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
- To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
- To give the student an understanding of basics of System on Chip and Platform based design.

COURSE CONTENT

Types of ASICs, VLSI Design flow, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells and I/O cells. Programmable interconnects. Latest Version - FPGAs and CPLDs and Soft-core processors.

Trade off issues at System Level: Optimization with regard to speed, area and power, asynchronous and low power system design. ASIC physical design issues, System Partitioning, Power Dissipation, Partitioning Methods.

ASIC floor planning, Placement and Routing.

System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures, On-Chip Communication Architecture Standards, Low-Power SoC Design

High performance algorithms for ASICS/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC, USB controllers, OMAP.

Text Book

1. *M.J.S. Smith,"Application Specific Integrated Circuits", Pearson, 2003*

Reference Books

1. *H.Gerez, "Algorithms for VLSI Design Automation", John Wiley, 1999*
2. *J..M.Rabaey, A. Chandrakasan, and B.Nikolic, "Digital Integrated Circuit Design Perspective (2/e)", PHI 2003*
3. *D. A.Hodges, "Analysis and Design of Digital Integrated Circuits (3/e)", MGH 2004*
4. *Hoi-Jun Yoo, Kangmin Leeand Jun Kyong Kim, "Low-Power NoC for High-Performance SoC Design", CRC Press, 2008*
5. *S.Pasricha and N.Dutt," On-Chip Communication Architectures System on Chip Interconnect, Elsveir", 2008*

COURSE OUTCOMES

Students able to

CO1: demonstrate VLSI tool-flow and appreciate FPGA architecture.

CO2: understand the issues involved in ASIC design, including technology choice, design management, tool-flow, verification, debug and test, as well as the impact of technology scaling on ASIC design.

CO3: understand the algorithms used for ASIC construction

CO4: understand the basics of System on Chip, On chip communication architectures like AMBA,AXI and utilizing Platform based design.

CO5: appreciate high performance algorithms available for ASICs

EC093	Digital System Design	(L-T-P) C 3 – 0 – 0 – 3

COURSE OBJECTIVE

- To get an idea about designing complex, high speed digital systems and how to implement such design.

COURSE CONTENT

Mapping algorithms into Architectures: Datapath synthesis, control structures, critical path and worst case timing analysis. FSM and Hazards.

Combinational network delay. Power and energy optimization in combinational logic circuit. Sequential machine design styles. Rules for clocking. Performance analysis.

Sequencing static circuits. Circuit design of latches and flip-flops. Static sequencing element methodology. Sequencing dynamic circuits. Synchronizers.

Datapath and array subsystems: Addition / Subtraction, Comparators, counters, coding, multiplication and division. SRAM, DRAM, ROM, serial access memory, context addressable memory.

Reconfigurable Computing- Fine grain and Coarse grain architectures, Configuration architectures-Single context, Multi context, Partially reconfigurable, Pipeline reconfigurable, Block Configurable, Parallel processing.

Text Books

1. *N.H.E.Weste, D. Harris, CMOS VLSI Design (3/e), Pearson, 2005.*
2. *W.Wolf, FPGA- based System Design, Pearson, 2004.*
3. *S. Hauck, A.DeHon,"Reconfigurable computing: the theory and practice of FPGA-based computation", Elsevier,2008.*

Reference Books

1. *Franklin P. Prosser, David E. Winkel, Art of Digital Design, . Prentice-Hall, 1987.*
2. *R.F.Tinde," Engineering Digital Design", (2/e), Academic Press, 2000.*
3. *C. Bobda, "Introduction to reconfigurable computing", Springer,2007.*
4. *M. Gokhale,"Paul S. Graham, Reconfigurable computing: accelerating computation with field-programmable gate arrays", Springer, 2005.*
5. *C.Roth, "Fundamentals of Digital Logic Design", Jaico Publishers, V ed., 2009.*

COURSE OUTCOMES

Students are able to

CO1: identify mapping algorithms into architectures.

CO2: summarize various delays in combinational circuit and its optimization methods.

CO3: summarize circuit design of latches and flip-flops.

CO4: construct combinational and sequential circuits of medium complexity, that is based on VLSIs, and programmable logic devices.

CO5: summarize the advanced topics such as reconfigurable computing, partially reconfigurable, Pipeline reconfigurable architectures and block configurable.

EC094 Digital Signal Processing Structures for VLSI (L-T-P) C
3 – 0 – 0 – 3

COURSE OBJECTIVE

- To make an in depth study of DSP structures amenable to VLSI implementation.
- To enable students to design VLSI system with high speed and low power.
- To make the students to implement DSP algorithm in an optimized method.

COURSE CONTENT

An overview of DSP concepts, Representations of DSP algorithms. Loop bound and iteration bound.

Transformation Techniques: Retiming, Folding and Unfolding

Pipelining of FIR filters. Parallel processing of FIR filters. Pipelining and parallel processing for low power, Combining Pipelining and Parallel Processing. Systolic Architecture Design

Pipeline interleaving in digital filters. Pipelining and parallel processing for IIR filters. Low power IIR filter design using pipelining and parallel processing, Pipelined adaptive digital filters.

Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs. Wave pipelining, constraint space diagram and degree of wave pipelining, Implementation of wave-pipelined systems, Asynchronous pipelining.

Text Book

1. *K.K.Parhi, "VLSI Digital Signal Processing Systems", John-Wiley, 2007*

Reference Book

1. *U. Meyer -Baese," Digital Signal Processing with FPGAs", Springer, 2004*
2. *W.Burleson, K. Konstantinides, T.H. Meng," VLSI Signal Processing"",1996.*
3. *R.J. Higgins, "Digital signal processing in VLSI", 1990.*
4. *S.Y.Kung, H.J. Whitehouse, "VLSI and modern signal processing", 1985*

COURSE OUTCOMES

Students are able to

CO1: understand the overview of DSP concepts
CO2: improve the speed of digital system through transformation techniques.
CO3: perform Pipelining and parallel processing in FIR systems to achieve high speed and low power.
CO4: perform Pipelining and parallel processing in IIR systems and adaptive filters
CO5: understand clocking issues and asynchronous system.

EC095	**Low Power VLSI Circuits**	**(L-T-P) C** **3 – 0 – 0 - 3**

COURSE OBJECTIVES

- To expose the students to the low voltage device modeling, low voltage, low power VLSI CMOS circuit design.

COURSE CONTENT

Evolution of CMOS technology.0.25 µm and 0.1 µm technologies. Shallow trench isolation. Lightly-doped drain. Buried channel. BiCMOS and SOI CMOS technologies. Second order effects and capacitance of MOS devices.

CMOS inverters, static logic circuits of CMOS, pass transistor, BiCMOS, SOI CMOS and low power CMOS techniques.

Basic concepts of dynamic logic circuits. Various problems associated with dynamic logic circuits. Differential, BiCMOS and low voltage dynamic logic circuits.

Different types of memory circuits.

Adder circuits, Multipliers and advanced structures – PLA, PLL and Processing unit.

Text Books

1. *Jan Rabaey,"Low Power Design Essentials (Integrated Circuits and Systems)", Springer, 2009*
2. *J.B.Kuo&J.H.Lou,"Low-voltage CMOS VLSI Circuits", Wiley, 1999.*

Reference Book

1. *A.Bellaowar&M.I.Elmasry,"Low power Digital VLSI Design, Circuits and Systems", Kluwer, 1996.*

COURSE OUTCOMES

Students are able to

CO1: acquire the knowledge about various CMOS fabrication process and its modeling.
CO2: infer about the second order effects of MOS transistor characteristics.
CO3: analyze and implement various CMOS static logic circuits.
CO4: learn the design of various CMOS dynamic logic circuits.
CO5: learn the design techniques low voltage and low power CMOS circuits for various applications.
CO6: learn the different types of memory circuits and their design.
CO7: design and implementation of various structures for low power applications.

EC096 VLSI Digital Signal Processing Systems (L-T-P) C
3 – 0 – 0 – 3

COURSE OBJECTIVE

- To give an in-depth coverage of advanced VLSI Digital Signal Processing Systems.
- To provide knowledge about the effect of finite word length.
- To learn regarding the efficient implementation of arithmetic units.

COURSE CONTENT

Algorithms for fast convolution, Algorithmic strength reduction in filters and transforms: Parallel FIR Filters, DCT and inverse DCT, Parallel Architectures for Rank-Order Filters.

Scaling and Round off Noise - State variable description of digital filters, Scaling and Round off Noise computation, Round off Noise in Pipelined IIR Filters, Round off Noise Computation using state variable description, Slow-down, Retiming and Pipelining.

Bit level arithmetic Architectures- parallel multipliers, interleaved floor-plan and bit-plane-based digital filters, Bit serial multipliers, Bit serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic.

Redundant arithmetic -Redundant number representations, carry free radix-2 addition and subtraction, Hybrid radix-4 addition, Radix-2 hybrid redundant multiplication architectures, data format conversion, Redundant to Nonredundant converter.

Numerical Strength Reduction - Subexpression Elimination, Multiple Constant Multiplication, Subexpression Sharing in Digital Filters, Additive and Multiplicative Number Splitting.

Text Book

1. *K.K.Parhi, "VLSI Digital Signal Processing Systems", John-Wiley, 2007*

Reference Book

1. *U. Meyer -Baese, Digital Signal Processing with FPGAs, Springer, 2004*
2. *W.Burleson, Konstantinos Konstantinides, Teresa H. Meng, VLSI Signal Processing,1996.*
3. *R. J. Higgins, Digital signal processing in VLSI, 1990.*
4. *Sun Yuan Kung, Harper J. Whitehouse, VLSI and modern signal processing, 1985*
5. *M. A. Bayoumi, VLSI Design Methodologies for Digital Signal Processing, 2012*
6. *Earl E. Swartzlander, VLSI signal processing systems, 1986.*

COURSE OUTCOMES

Students are able to

CO1: learn various transforms and its corresponding architectures
CO2: acquire the knowledge of effect of round off noise computation
CO3: design Bit level arithmetic Architectures and optimize the implementation of FIR filters and constant multipliers
CO4: design basic arithmetic units and realize their architecture for higher radices
CO5: learn different numerical strength reduction techniques

EC097	**Asynchronous System Design**	**(L-T-P) C** **3 – 0 – 0 – 3**

COURSE OBJECTIVE

- This subject introduces the fundamentals and performance of Asynchronous system
- To familiarize the dependency graphical analysis of signal transmission graphs
- To learn software languages and its syntax and operations for implementing Asynchronous Designs

COURSE CONTENT

Fundamentals: Handshake protocols, Muller C-element, Muller pipeline, Circuit implementation styles, theory. Static data-flow structures: Pipelines and rings, Building blocks, examples

Performance: A quantitative view of performance, quantifying performance, Dependency graphic analysis. Handshake circuit implementation: Fork, join, and merge, Functional blocks, mutual exclusion, arbitration and metastability.

Speed-independent control circuits: Signal Transition graphs, Basic Synthesis Procedure, Implementation using state-holding gates, Summary of the synthesis Process, Design examples using Petrify. Advanced 4-phase bundled data protocols and circuits: Channels and protocols, Static type checking, More advanced latch control circuits.

High-level languages and tools: Concurrency and message passing in CSP, Tangram program examples, Tangram syntax-directed compilation, Martin's translation process, Using VHDL for Asynchronous Design. An Introduction to Balsa: Basic concepts, Tool set and design flow, Ancillary Balsa Tools

The Balsa language: Data types, Control flow and commands, Binary/Unary operators, Program structure. Building library Components: Parameterized descriptions, Recursive definitions. A simple DMA controller: Global Registers, Channel Registers, DMA control structure, The Balsa description.

Text Books

1. *Asynchronous Circuit Design- Chris. J. Myers, John Wiley & Sons,2001.*
2. *Handshake Circuits An Asynchronous architecture for VLSI programming – Kees Van Berkel Cambridge University Press, 2004*

Reference Book

1. *Principles of Asynchronous Circuit Design-Jens Sparso, Steve Furber, Kluver Academic Publishers, 2001.*
2. *Asynchronous Sequential Machine Design and Analysis, Richard F. Tinder, 2009*
3. *A Designer's Guide to Asynchronous VLSI, Peter A. Beerel, Recep O. Ozdag, Marcos Ferretti, 2010*

COURSE OUTCOMES

Students are able to

CO1: understand the fundamentals of Asynchronous protocols
CO2: analyse the performance of Asynchronous System and implement handshake circuits
CO3: understand the various control circuits and Asynchronous system modules
CO4: gain the experience in using high level languages and tools for Asynchronous Design
CO5: learn commands and control flow of Balsa language for implementing Asynchronous Designs

EC098	Physical Design Automation	(L-T-P) C 3 – 0 – 0 – 3

COURSE OBJECTIVES

- Understand the concepts of Physical Design Process such as partitioning, Floorplanning, Placement and Routing.
- Discuss the concepts of design optimization algorithms and their application to physical design automation.
- Understand the concepts of simulation and synthesis in VLSI Design Automation
- Formulate CAD design problems using algorithmic methods

COURSE CONTENT

VLSIdesign automation tools- algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.

Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.

Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.

Simulation and logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis.

High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

Text Books

1. *S.H. Gerez, "A lgorithms for VLSI Design Automation", John Wiley ,1998.*
2. *N.A.Sherwani , "Algorithms for VLSI Physical Design Automation", (3/e), Kluwer,1999.*

Reference Books

1. *S.M. Sait , H. Youssef, "VLSI Physical Design Automation", World scientific, 1999.*
2. *M.Sarrafzadeh, "Introduction to VLSI Physical Design", McGraw Hill (IE), 1996.*

COURSE OUTCOMES

Students are able to

CO1: know how to place the blocks and how to partition the blocks while for designing the layout for IC.

CO2: solve the performance issues in circuit layout.

CO3: analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning, placement and routing

CO4: decompose large mapping problem into pieces, including logic optimization with partitioning, placement and routing

CO5: analyze circuits using both analytical and CAD tools

EC099	**Mixed - Signal Circuit Design**	**(L-T-P) C** **3 – 0 – 0 – 3**

COURSE OBJECTIVE

- To make the students to understand the design and performance measures concept of mixed signal circuit.

COURSE CONTENT

Concepts of Mixed-Signal Design and Performance Measures. Fundamentals of Data Converters. Nyquist Rate Converters and Over sampling Converters.

Design methodology for mixed signal IC design using gm/Id concept.

Design of Current mirrors. References. Comparators and Operational Amplifiers.

CMOS Digital Circuits Design: Design of MOSFET Switches and Switched-Capacitor Circuits, Layout Considerations.

Design of frequency and Q tunable continuous time filters.

Text Books

1. *R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS, Circuit Design, Layout, and Simulation, Wiley-IEEE Press, 1998*
2. *David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley and Sons, 1997.*

COURSE OUTCOMES

Students are able to

CO1: Appreciate the fundamentals of data converters and also optimized their performances.
CO2: Understand the design methodology for mixed signal IC design using gm/Id concept.
CO3: Analyze the design of current mirrors and operational amplifiers
CO4: Design the CMOS digital circuits and implement its layout.
CO5: design the frequency and Q tunable time domain filters.