3ECU01	Electronic Devices and Circuits	3L:0T:0P	3 credit

Syllabus

JUNCTION DIODES: V-I Chacteristics , small signal models of diode, Applications of diode in rectifier ,Clipping and Clamping circuits and voltage multipliers ,Breakdown diodes ,Zener diodes as voltage regulator.
TRANSISTORS : Characteristics, Current components, Current gains: alpha and beta. Variation of transistor parameter with temperature and current level, Operating point, Hybrid model, DC model of transistor, h parameter equivalent circuits. CE, CB and CC configuration. DC and AC analysis of single stage CE, CC (Emitter follower) and CB amplifiers AC & DC load line, EbersMoll model. Biasing & stabilization techniques. Thermal runaway, Thermal stability.
JFET & MOSFET: Construction and operation, Noise performances of FET, Parasitic of MOSFET, Small signal models of JFET & MOSFET, Biasing of JFETs & MOSFET's, Low frequency single stage CS and CD (sourcefollower) JFET amplifiers, FET as voltage variable resistor and FET as active load.
SMALL SIGNAL AMPLIFIERS AT LOW FREQUENCY: Analysis of BJT and FET multistage amplifier, DC and RC coupled amplifiers. Frequency response of single and multistage amplifier, midband gain, gains at low and high frequency. Analysis of DC and differential amplifiers, Millers Theorem, use of Miller and bootstrap configuration. Cascade and cascade configuration of multistage amplifiers (CECE, CECB, CSCS and CSCD), Darlington pair.

Text/Reference Books:

1.	G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson,2014.
2.	D. Neamen , D. Biswas "Semiconductor Physics and Devices," McGraw-Hill Education
3.	S. M. Sze and K. N. Kwok, "Physics of Semiconductor Devices," 3rd edition, John Wiley & Sons, 2006.
4.	C.T. Sah, "Fundamentals of solid state electronics," World Scientific Publishing Co. Inc, 1991.
5.	Y. Tsividis and M. Colin, "Operation and Modeling of the MOS Transistor," Oxford Univ.Press, 2011.
6.	M Rashid – Microelectronic circuits : Analysis & Design, Cengage learning, 1999
7.	A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing ,1991

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU01	Electronic Devices and Circuits	CO 1	**Describe** semiconductor physics, basic electronic components and their characteristics. (K2)
		CO 2	**Develop** the different model for basic electronic devices. (K3)
		CO 3	**Analyse** different applications of basic electronics devices. (K4)
		CO 4	**Solve** problems on biasing, stabilization of transistor, multistage amplifier. (K3)
		CO 5	**Explain** basic concepts of amplification, multistage amplification. (K2)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU01 Electronic Devices and Circuits	CO 1	3	2										
	CO 2	3	2	1	1								
	CO 3	2	3	2	1	1							
	CO 4	2	3	2	1								
	CO 5	3	2	1									

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction to Semiconductor Physics
Lecture 3	Introduction to Semiconductor Physics
Lecture 4	Introduction to Semiconductor Physics

Lecture 5	Generation and recombination of charges
Lecture 6	Mobility and conductivity, Charge densities in a semiconductor
Lecture 7	JUNCTION DIODES : V-I Chacteristics ,
Lecture 8	Small signal models of diode
Lecture 9	Applications of diode in rectifier
Lecture 10	Clipping and Clamping circuits
Lecture 11	Clipping and Clamping circuits
Lecture 12	Clipping and Clamping circuits
Lecture 13	voltage multipliers
Lecture 14	Breakdown diode
Lecture 15	Zener Diode as voltage regulater
Lecture 16	Transistor -Construction, Characteristics and operating principle of UJT.
Lecture 17	Transistor - Characteristics, Current components, Current gains: alpha and beta
Lecture 18	Variation of transistor parameter with temperature and current level, Operating point,
Lecture 19	Hybrid model, DC model of transistor, h parameter equivalent circuits.
Lecture 20	CE, CB and CC configuration. DC and AC analysis of single stage CE,
Lecture 21	DC and AC analysis of single stage CC (Emitter follower) and CB amplifiers AC & DC load line,
Lecture 22	EbersMoll model. Biasing & stabilization techniques.
Lecture 23	Thermal runaway, Thermal stability.
Lecture 24	JFET & MOSFET- Construction and operation,
Lecture 25	Noise performances of FET, Parasitic of MOSFET
Lecture 26	Small signal models of JFET & MOSFET,
Lecture 27	Biasing of JFETs & MOSFET’s
Lecture 28	Low frequency single stage CS and CD (sourcefollower) JFET amplifiers,
Lecture 29	FET as voltage variable resistor and FET as active load.
Lecture 30	Analysis of BJT and FET multistage amplifier,
Lecture 31	DC and RC coupled amplifiers
Lecture 32	Frequency response of single and multistage amplifier,

Lecture 33	Mid band gain, gains at low and high frequency
Lecture 34	Analysis of DC amplifiers
Lecture 35	Analysis of differential amplifiers
Lecture 36	Millers Theorem, use of Miller
Lecture 37	bootstrap configuration
Lecture 38	Cascade and cascade configuration of multistage amplifiers (CECE, CECB)
Lecture 39	Cascade and cascade configuration of multistage amplifiers (CSCS and CSCD),
Lecture 40	Darlington pair.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.**	Investigates the input/output characteristics of various diodes?
	Q2.	Investigate the applications of various diodes?
	Q3.	A p-type sample of silicon has a resistivity of 5 Ω-cm. In this sample, the hole mobility, μ_h, is 600 cm^2/V-s and the electron mobility, μ_e, is 1600 cm^2/V-s. Ohmic contacts are formed on the ends of the sample and a uniform electric field is imposedwhich results in a drift current density in the sample is 2 x 10^3 A/cm^2. [1]. What are the hole and electron concentrations in this sample? [2]. What are the hole and electron drift velocities under these conditions? [3]. What is the magnitude of the electric field?
Assignment 2	**Q1.**	Discuss the application of BJT and FET.
	Q2.	Discuss different types of clipper and clamper circuit.
	Q3.	Discuss DC and RC coupled amplifiers.

3ECU03	Digital Electronics	3L:0T:0P	3 credit

Syllabus

NUMBER SYSTEMS, BASIC LOGIC GATES & BOOLEAN ALGEBRA Binary Arithmetic & Radix representation of different numbers. Sign & magnitude representation, Fixed point representation, complement notation, various codes & arithmetic in different codes & their inter conversion features of logic algebra, postulates of Boolean algebra, Theorems of Boolean algebra. Boolean function. Derived logic gates: Exclusive OR, NAND, NOR gates, their block diagrams and truth tables. Logic diagrams from Boolean expressions and vice-versa, Converting logic diagrams to universal logic. Positive, Negative and mixed logic, Logic gate conversion.
DIGITAL LOGIC GATE CHARACTERISTICS TTL logic gate characteristics. Theory & operation of TTL NAND gate circuitry. Open collector TTL. Three state output logic. TTL subfamilies. MOS & CMOS logic families, Realization of logic gates in RTL, DTL, ECL, CMOS & MOSFET, Interfacing logic families to one another.
MINIMIZATION TECHNIQUES Minterm, Maxterm, Karnaugh Map, K-map up to 4 variables, Simplification of logic functions with K-map, conversion of truth tables in POS and SOP form. Incomplete specified functions, Variable mapping. QuinnMc Klusky minimization techniques.
COMBINATIONAL SYSTEMS Combinational logic circuit design, half and full adder, subtractor. Binary serial and parallel adders. BCD adder. Binary multiplier. Decoder. Binary to Gray decoder, BCD to decimal, BCD to 7segment decoder. Multiplexer, Demultiplexer, Encoder. Octal to binary, BCD to excess3 encoder. Diode switching matrix. Design of logic circuits by multiplexers, encoders, decoders and demultiplexers.
SEQUENTIAL SYSTEMS Latches, Flipflops, RS, D, JK, Master Slave flip flops. Conversions of flipflops, Counters: Synchronous & Asynchronous ripple and decade counters, Modulus counter, Skipping state counter, Counter design, State diagrams and state reduction techniques, Ring counter, Counter applications, Registers: Buffer register, Shift register.

Text/Reference Books:

1.	Digital integrated electronics, By Herbert Taub, Donald L. Schilling, TMH,2004
2.	Digital Logic and Computer Design By M. Morris Mano, Pearson,1979
3.	Ghoshal – Digital Electronics, Cengage Learning,2012
4.	Roth – Fundamentals of Logic design, Cengage learning,2014
5.	Pulse and digital Switching waveforms By Millman Taub, TMH ,1984

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU03	Digital Electronics	CO 1	**Describe** basics of digital electronics, digital gates, number system and different codes. (K2)
		CO 2	**Discuss** digital logic gates characteristics and different logic families. (K2)
		CO 3	**Construct** logical expression, and simplify those using different methods. (K3)
		CO 4	**Discuss** sequential and combinational circuits. (K3)
		CO 5	**Analyze** different applications of sequential and combinational circuits. (K5)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU03 Digital Electronics	CO 1	3	2	1									
	CO 2	2	3	1									
	CO 3	3	2	2	2	1							
	CO 4	3	2	1	1								
	CO 5	2	3	2	1	1							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Binary Arithmetic & Radix representation of different numbers. Sign & magnitude representation,

Lecture 3	Fixed point representation, complement notation, postulates of Boolean algebra
Lecture 4	Various codes & arithmetic in different codes & their inter conversion features of logic algebra,
Lecture 5	Theorems of Boolean algebra. Boolean function
Lecture 6	Derived logic gates: Exclusive OR, NAND, NOR gates, their block diagrams and truth tables. Logic diagrams from Boolean expressions and vice-versa
Lecture 7	Converting logic diagrams to universal logic. Positive, Negative and mixed logic, Logic gate conversion
Lecture 8	TTL logic gate characteristics. Theory & operation of TTL NAND gate circuitry.
Lecture 9	Open collector TTL. Three state output logic.
Lecture 10	TTL subfamilies. MOS & CMOS logic families,
Lecture 11	Realization of logic gates in RTL, DTL, ECL, CMOS & MOSFET
Lecture 12	Interfacing logic families to one another.
Lecture 13	Minterm, Maxterm, Karnaugh Map,
Lecture 14	K-map up to 4 variables
Lecture 15	Simplification of logic functions with K-map,
Lecture 16	conversion of truth tables in POS and SOP form.
Lecture 17	Incomplete specified functions, Variable mapping.
Lecture 18	QuinnMc Klusky minimization techniques.
Lecture 19	Combinational logic circuit design, half and full adder, subtractor.
Lecture 20	Binary serial and parallel adders.
Lecture 21	BCD adder.
Lecture 22	Binary multiplier.
Lecture 23	Decoder. Binary to Gray decoder,
Lecture 24	BCD to decimal,
Lecture 25	BCD to 7segment decoder.
Lecture 26	Multiplexer, De-multiplexer,
Lecture 27	Encoder. Octal to binary,
Lecture 28	BCD to excess3 encoder
Lecture 29	Diode switching matrix.

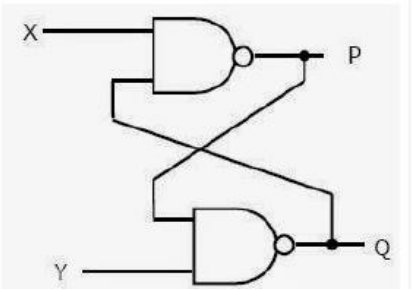
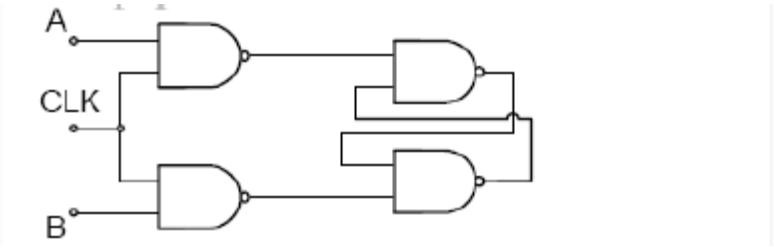
Lecture 30	Design of logic circuits by multiplexers, encoders, decoders and demultiplexers.
Lecture 31	Latches, Flipflops, RS,
Lecture 32	D, JK, Master Slave flip flops
Lecture 33	Conversions of flipflops.
Lecture 34	Counters: Synchronous & Asynchronous ripple and decade counters,
Lecture 35	Modulus counter, Skipping state counter,
Lecture 36	Counter design, State diagrams and state reduction techniques,
Lecture 37	Ring counter,
Lecture 38	Counter applications,
Lecture 39	Registers: Buffer register,
Lecture 40	Shift register.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignment 1	**Q1.** Using K-maps, find the minimal Boolean expression of the following SOP and POS representations. a. f (w,x,y,z)= Σ (7,13,14,15) b. f(w,x,y,z) = Σ (1,3,4,6,9,11,14,15) c. f(w,x,y,z) = Π(1,4,5,6,11,12,13,14,15) d. f(w,x,y,z) = Σ (1,3,4,5,7,8,9,11,15) e. f(w,x,y,z) = Π (0,4,5,7,8,9,13,15)
	Q2. Find the function h(a,b,c,d) such that $f = f^d$. f (a,b,c,d) = a ·b· c + (a · c + b)· d + h(a,b,c,d)
	Q3. Using K-maps of the functions f1 and f2, find the following: (provide the canonical form expression and simplify) a. T1 = f1 · f2 b. T2 = f1 + f2 c. T3 = f1 ⊕ f2 where f1(w,x,y,z) = Σ (0,2,4,9,12,15), f2(w,x,y,z) = Σ (1,2,4,5,12,13)

Assignment 2	**Q1**. Draw the state diagram of a serial adder.
	Q2. In the following circuit, given binary values were applied to the Inputs X and Y inputs of the NAND latch shown in the figure. X = 0, Y = 1; X = 0, Y = 0; X = 1, Y = 1. Find out the corresponding stable output P, Q. 
	Q3. When the race around condition will occur in the circuit given Below: 

3ECU04	Circuit Analysis and Synthesis	3L:1T:0P	4 credit

Syllabus

NETWORK THEOREMS AND ELEMENTS Thevenin's, Norton's, Reciprocity, Superposition, Compensation, Miller's, Tellegen's and maximum power transfer theorems. Networks with dependent sources. Inductively coupled circuits – mutual inductance, coefficient of coupling and mutual inductance between portions of same circuits and between parallel branches. Transformer equivalent, inductively and conductively coupled circuits.
TRANSIENTS ANALYSIS Impulse, Step, Ramp and sinusoidal response analysis of first order and second order circuits. Time domain & transform domain (frequency, Laplace) analysis. Initial and final value theorems. Complex periodic waves and their analysis by Fourier analysis. Different kind of symmetry. Power in a circuit.
NETWORK FUNCTIONS Terminals and terminal pairs, Driving point impedance transfer functions, Poles and zeros, Restrictions on pole and zero location in s-plane. Time domain behavior from pole and zero plot, Procedure for finding network functions for general two terminal pair networks, Stability & causality, Hurwitz polynomial, positive real function.
TWO PORT NETWORKS Two Port General Networks: Two port parameters (impedance, admittance, hybrid, ABCD and S parameters) and their inter relations. Equivalence of two ports. Transformer equivalent, interconnection of two port networks. The ladder network, image impedance, image transfer function, application to L-C network, attenuation and phase shift in symmetrical T and pi networks.
NETWORK SYNTHESIS The four-reactance function forms, specification for reactance function. Foster form of reactance networks. Cauer form of reactance networks Synthesis of R-L and R-C and L-C networks in Foster and Cauer forms.

Text/Reference Books:

1.	Network Analysis & Synthesis, Kuo, Wiley ,2006
2.	Circuits And Networks: Analysis And Synthesis, Sudhakar, TMH ,2006
3.	Sivanagaraju – Electrical circuit analysis, Cengage learning,2009
4.	Robbins – Circuit analysis : Theory and Practice Cengage Learning ,2012
5.	Electrical Networks, Singh, TMH ,2009
6.	Electric Circuits, Nilsson, Pearson ,2009
7	Linear Circuits Analysis, Decarlo, Oxford ,2007
8.	Basic Engineering Circuit Analysis, Irwin, Wiley ,2010
9.	Network Theory: Analysis And Synthesis, Smarjit Ghosh, PHI ,2005

10.	Electric Circuit Analysis, Xavier, S.P. Eugene, New Age ,2007

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU04	**Circuit Analysis and Synthesis**	**CO 1**	**Apply** network theorems to simplify complex circuits in their simpler equivalent forms.
		CO 2	**Analyze** steady state responses and transient response of passive circuit elements
		CO 3	**Evaluation** of stability of linear circuits using frequency domain representation
		CO 4	**Calculate** two port parameters of an electrical network and **investigate** the properties of electric network based upon that.
		CO 5	**Construct** an optimum electrical network based upon transfer functions and circuit behaviour.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU04 Circuit Analysis and Synthesis	**CO 1**	3	2	1									
	CO 2	2	3										
	CO 3	2	3	1									
	CO 4	2	2	3	1								
	CO 5	2	2	3	1	1							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Thevenin's, Norton's, Reciprocity theorems
Lecture 3	Superposition, Compensation, Miller's theorems

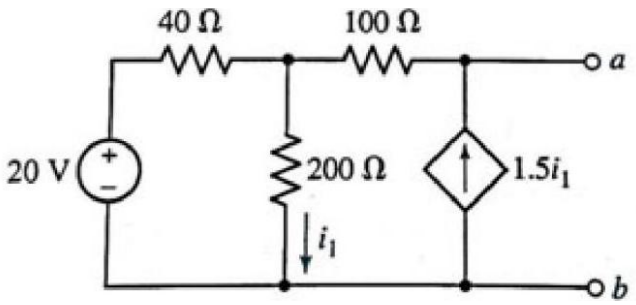
Lecture 4	Tellegen's and maximum power transfer theorems.
Lecture 5	Networks with dependent sources. Inductively coupled circuits – mutual inductance,
Lecture 6	coefficient of coupling and mutual inductance between portions of same circuits and between parallel branches.
Lecture 7	Transformer equivalent circuits
Lecture 8	Inductively and conductively coupled circuits.
Lecture 9	Impulse, Step, Ramp and sinusoidal response analysis of first order circuits
Lecture 10	Impulse, Step, Ramp and sinusoidal response analysis of second order circuits
Lecture 11	Time domain & transform domain (frequency, Laplace) analysis.
Lecture 12	Initial and final value theorems
Lecture 13	Complex periodic waves and their analysis by Fourier analysis.
Lecture 14	Different kind of symmetry. Power in a circuit.
Lecture 15	Terminals and terminal pairs,
Lecture 16	Driving point impedance transfer functions,
Lecture 17	Restrictions on pole and zero location in s-plane.
Lecture 18	Time domain behavior from pole and zero plot,
Lecture 19	Procedure for finding network functions for general two terminal pair networks.
Lecture 20	Stability & causality,
Lecture 21	Hurwitz polynomial,
Lecture 22	positive real function
Lecture 23	Two Port General Networks: Two port parameters (impedance, admittance,)
Lecture 24	Two Port General Networks: Two port parameters (hybrid, ABCD and S parameters)
Lecture 25	inter relations of these networks
Lecture 26	Equivalence of two ports. Transformer equivalent,
Lecture 27	interconnection of two port networks
Lecture 28	The ladder network,
Lecture 29	image impedance,
Lecture 30	image transfer function,
Lecture 31	application to L-C network

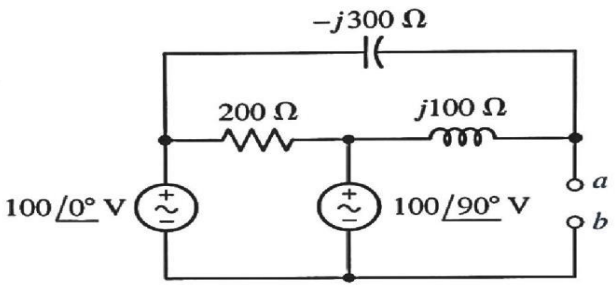
Lecture 32	attenuation in symmetrical T and pi networks
Lecture 33	phase shift in symmetrical T and pi networks
Lecture 34	The four-reactance function forms,
Lecture 35	specification for reactance function.
Lecture 36	Foster form of reactance networks
Lecture 37	Cauer form of reactance networks
Lecture 38	Synthesis of R-L networks in Foster and Cauer forms
Lecture 39	Synthesis of R-C networks in Foster and Cauer forms
Lecture 40	Synthesis of L-C networks in Foster and Cauer forms

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. Hand-outs

Sample Assignments

Assignment 1	**Q1.** Elaborate the significance of source transformation with relevant example
	Q2. State and prove time differentiation theorem in Laplace Transform
	Q3. Find the Thevenin equivalent of the network shown in figure. What power would be delivered to a load of 100 ohms at *a* and *b*? 
Assignment 2	**Q4.** Calculate Thevenin equivalent circuit with respect to terminals *a* and *b*



Q5. Derive transient current and voltage responses of sinusoidal driven RL and RC circuits.

Q6. Specify the restrictions on pole and zero locations for transfer functions and driving-point functions.

3ECU05	Electromagnetic Properties Of Materials	3L:0T:0P	3 credit

Syllabus

DIELECTRICS MATERIALS - Introduction, Polarization, Polarizability, Different types of polarization, Electronic, ionic, Orientation and space polarization, frequency and temperature dependence of different polarization, Dielectric loss and loss tangent, energy store and loss in dynamic polarization, Phenomenon of spontaneous polarization and ferro-electricity, Ferroelectric hysteresis loop, Piezoelectricity, piezoelectric materials: Quartz, Rochelle salt and PZT, Applications of dielectrics.
MAGNETIC MATERIALS - Introduction, magnetization, theory of Dia, Para,Ferro-Ferrimagnetism and antiferromagnetism, Weiss field and magnetic domains, BH hysteresis loop, soft and hard magnetic materials and their applications, magnetic energy. Magnetostriction, giant magnetostriction resistor (GMR) and engineering applications of it. Magnetic spin, new electronic devices based on magnetic spin
SEMI CONDUCTOR MATERIALS - Introduction, Energy band gap structures ofsemiconductors, Classifications of semiconductors, Degenerate and non-degenerate semiconductors, Direct and indirect band gap semiconductors, Electronic properties of Silicon, Germanium, Compound Semiconductor, Gallium Arsenide, Gallium phosphide & Silicon carbide, Variation of semiconductor conductivity, resistance and bandgap with temperature and doping. Thermistors, Sensitors.
CONDUCTIVE & SUPERCONDUCTIVE MATERIALS - Electrical properties of conductive and resistive materials. Energy bandgap structures of metals, resistivity of conductors andmultiphase solids, Matthiessen's rule, Important characteristicsandelectronicapplications of specific conductor &resistance materials, Superconductor phenomenon, Type I and Type II superconductors. Theory of superconductors, High temperature superconductors and their applications.
NANOMATERIALS - Introduction, Change in band structure at nano-stage.Structure of Quantom dots (nano-dots) &Quantom wires, Fabrication & Characterization of nanomaterials, Structure of single wall and multi-wall carbon nanotube (CNT), Change in electrical, Electronic and optical properties at nano stage, Potential applications of nano materials.

Text/Reference Books:

1.	Kasap, Principles of Electronic Materials and Devices, TMH 2005
2.	Robert M Rose, Lawrence A. Shepard and Jhon Wulff, The structure and peroperties of materials vol.4 (Electronic properties), Willey Eastern University press. 2011
3.	Askeland – The science and engineering of materials, Cengage learning 2005
4.	Electronic Materials and Processes, Kaul Bhan & Jain, Genius publications 2013

5.	Allison, Principles of Electronic Materials and Devices, TMH 2005
6.	Neamen, Semiconductor Physics and Devices, TMH 2009
7.	Guozhong Cao, Ying Wang Nanostructures and Nanomaterials Synthesis, Properties and Applications, World Scientific Series in Nanoscience and Nanotechnology 2011
8.	Dekker, Electrical properties of materials 1995

Course Outcome

Course Code	Course Name	Course Outcome	Details
3ECU05	**Electromagnetic Properties of Materials**	**CO 1**	**Understand** dielectric material, Polarization, ferroelectricity and piezoelectricity.
		CO 2	**Distinguish** different properties and application of magnetic materials.
		CO 3	**Describe and analyze** different semiconductor material and their properties.
		CO 4	**Describe and analyze** conductor and superconductor materials and their application.
		CO 5	**Illustrate** fabrication and characteristics of nonmaterial. **Analyse** electric, electronics and optical properties of nanomaterials.

CO –PO Mapping

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU05 Electromagnetic Properties Of Materials	**CO 6**	3	2	1									
	CO 7	3	2	1									
	CO 8	3	2	1									
	CO 9	3	2	1									
	CO 10	2	3	2	1								

3.Strong 2. Moderate 1. Weak

Lecture Plan

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction, Polarization, Polarizability,
Lecture 3	Different types of polarization, Electronic, ionic, Orientation and space polarization,
Lecture 4	frequency and temperature dependence of different polarization,
Lecture 5	Dielectric loss and loss tangent,
Lecture 6	energy store and loss in dynamic polarization,
Lecture 7	Phenomenon of spontaneous polarization and ferro-electricity
Lecture 8	Ferroelectric hysteresis loop,
Lecture 9	Piezoelectricity, piezoelectric materials
Lecture 10	Quartz, Rochelle salt and PZT ,
Lecture 11	Applications of dielectrics.
Lecture 12	Introduction, magnetization,
Lecture 13	theory of Dia, Para,Ferro-
Lecture 14	Ferrimagnetism and antiferromagnetism
Lecture 15	Weiss field and magnetic domains,
Lecture 16	BH hysteresis loop,
Lecture 17	soft and hard magnetic materials and their applications, magnetic energy.
Lecture 18	Magnetostriction, giant magnetostriction resistor (GMR) and engineering applications of it.
Lecture 19	Magnetic spin, new electronic devices based on magnetic spin
Lecture 20	Introduction, Energy band gap structures of semiconductors,
Lecture 21	Classifications of semiconductors,
Lecture 22	Degenerate and non-degenerate semiconductors,
Lecture 23	Direct and indirect band gap semiconductors.
Lecture 24	Electronic properties of Silicon, Germanium,
Lecture 25	Compound Semiconductor, Gallium Arsenide, Gallium phosphide & Silicon carbide
Lecture 26	Variation of semiconductor conductivity, resistance and bandgap with temperature and

	doping.
Lecture 27	Thermistors, Sensitors.
Lecture 28	Electrical properties of conductive and resistive materials.
Lecture 29	Energy bandgap structures of metals, resistivity of conductors and multiphase solids
Lecture 30	Matthiessen's rule, Important characteristics and electronic applications of specific conductor & resistance materials
Lecture 31	Superconductor phenomenon, Type I and Type II superconductors
Lecture 32	Theory of superconductors, High temperature superconductors and their applications.
Lecture 33	NANOMATERIALS :Introduction, Change in band structure at nano-stage.
Lecture 34	Structure of Quantom dots (nano-dots) &Quantom wires
Lecture 35	Fabrication & Characterization of nanomaterials
Lecture 36	Structure of single wall and multi-wall carbon nanotube (CNT)
Lecture 37	Change in electrical properties at nano stage,
Lecture 38	Change in Electronic properties at nano stage,
Lecture 39	Change in optical properties at nano stage,
Lecture 40	Potential applications of nano materials.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	Q 1. Discusses degenerate and non-degenerate semiconductors.
	Q 2. Define dielectric loss and loss tangent.
	Q 3. Define Type I and Type II semiconductors.
Assignment 2	Q1. Discuss the structure of single wall and multiwall carbon Nano tube.
	Q2. Discuss the energy band structure of metal, semiconductor and insulator.
	Q3. Discuss the various potential applications of nanomaterials.

3ECU07	Electronics Instrumentation Workshop	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Identification, Study & Testing of various electronic components : (a) Resistances-Various types, Colour coding (b) Capacitors-Various types, Coding, (c) Inductors (d) Diodes (e) Transistors (f) SCRs (g) ICs (h) Photo diode (i) Photo transistor (j) LED (k) LDR (l) Potentiometers
2.	Study of symbols for various Electrical & Electronic Components, Devices, Circuit functions etc.
3.	To study and perform experiment on CRO demonstration kit.
4.	Soldering & Desoldering practice.
5.	To Design & fabricate a PCB for a Regulated power supply. Assemble the Regulated power supply using PCB and test it.
6.	To study and plot the characteristics of following Opto-Electronic devices –(a) LED (b) LDR (C) Photovoltatic cell (d) Opto-coupler (e) Photo diode (f) Photo transistor (g) Solar cell
7.	To study the specifications and working of a Transistor radio (AM & FM) kit and perform measurements on it.
8.	To study the specifications and working of a Public address System
9.	To prepare design layout of PCBs using software tools.
10.	To fabricate PCB and testing of electronics circuit on PCB
11.	To design and test Switch Mode Power Supply using ICs
12.	To study the specifications and working of a DVD Player.
13.	To study the specifications and working of LCD TV.
14.	To study the specifications and working of LED TV.

COURSE OUTCOME

Course Code	Course Name	Course Outcome	Details
3ECU07	Electronic Instrumentation Workshop	CO 1	**Identify, describe & test** various electronic components like resistor, capacitor, inductor, transistor, SCR, LED, LDR.
		CO 2	**Prepare** design layout of PCBs using software tools and fabricate and test PCB of electronics circuit.
		CO 3	**Measure** characteristics of different opto-electronic devices
		CO 4	**Design** and test switch mode power supply using ICs.
		CO 5	**Illustrate** working of a DVD player, LCD TV, and LED TV.

CO-PO Mapping

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU07 Electronic Instrumentation Workshop	CO 1	2		1		2							
	CO 2	3		1									
	CO 3	1	2	3	1	3							
	CO 4	2	1	1		2							
	CO 5	1	1	2	2	2							

3: Strongly **2: Moderate** **1: Weak**

3ECU08	Computer Programming Lab-I	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Write a simple C program on a 32 bit compiler to understand the concept of array storage, size of a word. The program shall be written illustrating the concept of row major and column major storage. Find the address of element and verify it with the theoretical value. Program may be written for arrays upto 4-dimensions.
2.	Simulate a stack, queue, circular queue and dequeue using a one dimensional array as storage element. The program should implement the basic addition, deletion and traversal operations.
3.	Represent a 2-variable polynomial using array. Use this representation to implement addition of polynomials.
4.	Represent a sparse matrix using array. Implement addition and transposition operations using the representation.
5.	Implement singly, doubly and circularly connected linked lists illustrating operations like addition at different locations, deletion from specified locations and traversal.
6.	Repeat exercises 2, 3 & 4 with linked structures.
7.	Implementation of binary tree with operations like addition, deletion, traversal.
8.	Depth first and breadth first traversal of graphs represented using adjacency matrix and list.
9.	Implementation of binary search in arrays and on linked Binary Search Tree.
10.	Implementation of insertion, quick, heap, topological and bubble sorting algorithms .

COURSE OUTCOME

Course Code	Course Name	Course Outcome	Details
3ECU08	Computer Programming Lab I	CO 1	Design C programs for solving problems.
		CO 2	Write and execute C programs for simple applications.
		CO 3	Familiar with programing in C.
		CO 4	Exposed to the syntax of C.
		CO 5	Learn to use array , string ,functions , pointer, structur and union in C.

CO-PO Mapping

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU08 Computer Programming Lab I	CO 1	3	1	3									
	CO 2	2	2	2	1	1							
	CO 3	2	3		1								
	CO 4	1	2	2	1								
	CO 5	1	2	1	1	3							

3: Strongly **2: Moderate** **1: Weak**

3ECU09	Electronic Devices Lab	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Study the following devices: (a) Analog& digital multimeters (b) Function/ Signal generators (c) Regulated d. c. power supplies (constant voltage and constant current operations) (d) Study of analog and digital CRO, measurement of time period, amplitude, frequency & phase angle using Lissajous figures.
2.	Plot V-I characteristic of P-N junction diode & calculate cut-in voltage, reverse Saturation current and static & dynamic resistances.
3.	Plot V-I characteristic of zener diode and study of zener diode as voltage regulator. Observe the effect of load changes and determine load limits of the voltage regulator.
4.	Plot frequency response curve for single stage amplifier and to determine gain bandwidth product
5.	Plot drain current - drain voltage and drain current – gate bias characteristics of field effect transistor and measure of Idss & Vp
6.	Application of Diode as clipper & clamper
7.	Plot gain- frequency characteristic of two stage RC coupled amplifier & calculate its bandwidth and compare it with theoretical value.
8.	Plot gain- frequency characteristic of emitter follower & find out its input and output resistances.
9.	Plot input and output characteristics of BJT in CB, CC and CE configurations. Find their h-parameters
10.	Study half wave rectifier and effect of filters on wave. Also calculate theoretical & practical ripple factor.
11.	Study bridge rectifier and measure the effect of filter network on D.C. voltage output & ripple factor.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU09	Electronic Devices Lab	CO 1	**Use** basic electronics devices like CRO, multimeter, function generator.
		CO 2	**Measure and analyze** different characteristics of basic electronic device like PN junction diode, Zener diode, BJT and FET.
		CO 3	**Design** small circuits like RC coupled amplifier, emitter follower on bread board.
		CO 4	**Construct** small project using basic electronic devices and measure there characteristics on CRO.
		CO 5	**Construct** Clipper, clampers, half wave rectifier and bridge rectifier.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU09 Electronic Devices Lab	CO 1	3	1										
	CO 2	2	2	3	1								
	CO 3	2	2	2	3								
	CO 4	2	2	2	3								
	CO 5	2	2	2	3								

3: Strongly **2: Moderate** **1: Weak**

3ECU10	Digital Electronics Lab	0L:0T:2P	1 credit

List of Experiments

S. No.	Name of Experiment
1.	To verify the truth tables of basic logic gates: AND, OR, NOR, NAND, NOR. Also to verify the truth table of Ex-OR, Ex-NOR (For 2, 3, & 4 inputs using gates with 2, 3, & 4 inputs).
2.	To verify the truth table of OR, AND, NOR, Ex-OR, Ex-NOR logic gates realized using NAND & NOR gates.
3.	To realize an SOP and POS expression.
4.	To realize Half adder/ Subtractor& Full Adder/ Subtractor using NAND & NOR gates and to verify their truth tables
5.	To realize a 4-bit ripple adder/ Subtractor using basic Half adder/ Subtractor& basic Full Adder/ Subtractor.
6.	To verify the truth table of 4-to-1 multiplexer and 1-to-4 demultiplexer. Realize the multiplexer using basic gates only. Also to construct and 8-to-1 multiplexer and 1-to-8 demultiplexer using blocks of 4-to-1 multiplexer and 1-to-4 demultiplexer
7.	Design & Realize a combinational circuit that will accept a 2421 BCD code and drive a TIL -312 seven-segment display
8.	Using basic logic gates, realize the R-S, J-K and D-flip flops with and without clock signal and verify their truth table.
9.	Construct a divide by 2, 4 & 8 asynchronous counter. Construct a 4-bit binary counter and ring counter for a particular output pattern using D flip flop.
10.	Perform input/output operations on parallel in/Parallel out and Serial in/Serial out registers using clock. Also exercise loading only one of multiple values into the register using multiplexer.

Note: Note: As far as possible, the experiments shall be performed on bread board. However experiment Nos. 1-4 are to be performed on bread board only

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3EC10	Digital Electronics Lab	CO 1	**Validate** truth table of basic logic gates and their realization using universal logic gates (NOR & NAND)
		CO 2	**Minimize** the complexity of digital logic circuits.
		CO 3	**Design and analyse** combinational logic circuits.
		CO 4	**Design and analyse** sequential logic circuits.
		CO 5	**Implement** applications of combinational & sequential logic circuits.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU10 Digital Electronics Lab	CO 1	2	3	1									
	CO 2	2	2	2	3								
	CO 3	2	2	2	3								
	CO 4	2	2	2	3								
	CO 5	2	2	2	3								

3: Strongly **2: Moderate** **1: Weak**

3ECU11	Business Entrepreneurship	0L:0T:2P	2 credits

Syllabus

INTRODUCTION TO ENTREPRENEURSHIP: Concept and need, Entrepreneurship and innovation, Entrepreneurship and economy growth.
ENTREPRENEURIAL COMPETENCIES –Leadership, Decision making, Motivation, Risk taking.
BUSINESS ENTERPRISE PLANNING – Identification of business opportunity, Idea generation, Demand Estimation, preparation of project report, feasibility analysis.
INTELLECTUAL PROPERTY RIGHTS, PATENTS, TAXATION – Central excise & sales tax, VAT.
GOVERNMENT POLICIES – For Entrepreneurs, Entrepreneurial career opportunities for Engineers, case study.

Text \ Reference Books

1.	Rajeev Roy , entrepreneurship Oxford University , 2009
2.	Bouchoux, Intellectual property Cengage learning , 2008
3.	Kuratko Rao , Entrepreneurship : A south Asian perspective.

Course Outcome

Course Code	Course Name	Course Outcome	Details
3ECU11	**Business Entrepreneurship**	**CO 1**	**Ability** to understand the concept and basic idea of entrepreneurship.
		CO 2	**Ability** to know the competencies to start business as an entrepreneurship.
		CO 3	**Ability** to initiate a business with the help of market conditions.
		CO 4	**Ability** to understand the role of IPR
		CO 5	**Ability** to use government policies to start a business.

CO-PO Mapping

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3ECU11 Business Entrepreneurship	**CO 1**	3	2	2									
	CO 2	3	3			2		1					
	CO 3	3	3										
	CO 4	3	2	3	1	2		2					
	CO 5	3	2	3									

3: Strong **2: Moderate** **1: Weak**

4ECU01	ANALOG ELECTRONICS	3L:0T:0P	3 credits

Syllabus

FEEDBACK AMPLIFIERS - Classification, Feedback concept, Feedback Topologies, Transfer gain with feedback, General characteristics of negative feedback amplifiers. Analysis of voltage-series, voltage-shunt, current-series and current-shunt feedback amplifier.
OSCILLATORS & MULTIVIBRATORS- Classification. Criterion for oscillation. Tuned collector, Hartley, Colpitts, RC Phase shift, Wien bridge and crystal oscillators, Astable, monostable and bistable multivibrators. Schmitt trigger.
HIGH FREQUENCY AMPLIFIERS Hybrid Pi model, Conductances and capacitances of hybrid Pi model, high frequency analysis of CE amplifier, gain bandwidth product, unity gain frequency fT, Emitter follower at high frequencies.
TUNED AMPLIFIER - Analysis of Single Tuned Amplifier, Primary & Secondary Tuned Amplifier with BJT, Double Tuned Transformer Coupled Amplifier. Stagger Tuned Amplifier.
POWER AMPLIFIERS - Classification, Power transistors. Output power, power dissipation and efficiency analysis of Class A, class B, class AB, class C. Pushpull amplifiers with and without transformers, Complementary symmetry & quasi complimentary symmetry amplifiers

Text/Reference Books:

1.	Millman, Integrated Electronics, Tl./.H. 1972
2.	A. S. Sedr4 Kenneth C. Smith, Microelectronic Circuits, Oxford University Press. 2007
3.	M. H. Rashid, Microelectronic Circuits Analysis and Design, Cengage Leaming 2010
4.	Salivahnan, Electronics Devices and Circuits, TMH. 1998
5.	Fundamentals of Analog Circuits 2e, Floyd, Pearson 2012
6.	David A. BELI, Electronic Devices and Circuits, Oxford University Press. 2009

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU 01	**ANALOG ELECTRONICS**	**CO 1**	**Describe** wave shaping circuits such as amplifier and oscillators.
		CO 2	**Develop** the understanding of feedback concept, topologies and analysis under various feedback conditions.
		CO 3	**Analyse** the transistor based circuits under high frequency operating conditions.
		CO 4	**Solve** different amplifier configurations..

		CO 5	**Explain** amplifier for various ranges of frequency of operation and operating point (Q-point) to attain different classes of power amplifiers.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4ECU 01 ANALOG ELECTRONICS	**CO 1**	3	1		2	1	1						
	CO 2	3	2	1			2						
	CO 3	2	1		2		1	2					
	CO 4	3	1	1				2					
	CO 5	3	1	1	1	1							2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

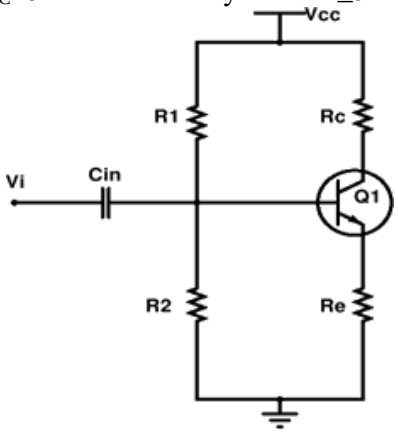
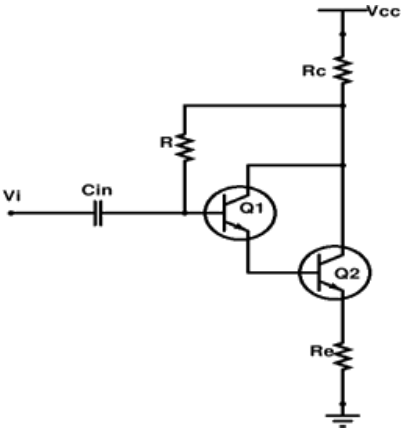
Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Feedback amplifiers - Classification
Lecture 3	Feedback concept
Lecture 4	Feedback Topologies
Lecture 5	Transfer gain with feedback
Lecture 6	General characteristics of negative feedback amplifiers
Lecture 7	Analysis of voltage-series feedback amplifier
Lecture 8	Analysis of voltage-shunt feedback amplifier
Lecture 9	Analysis of current-series feedback amplifier.
Lecture 10	Analysis of current-shunt feedback amplifier
Lecture 11	Oscillators & multivibrators- Classification, Criterion for oscillation
Lecture 12	Tuned collector oscillators
Lecture 13	Hartley oscillators

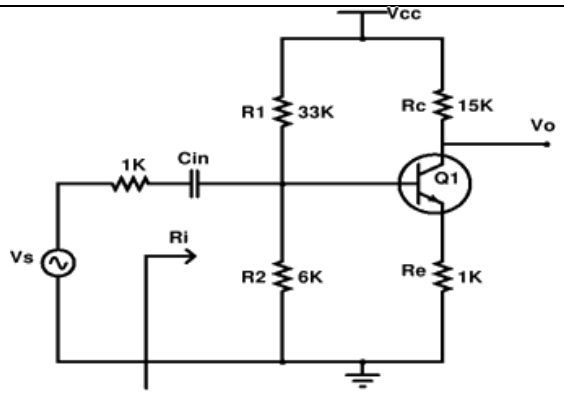
Lecture 14	Wien bridge oscillators
Lecture 15	crystal oscillators
Lecture 16	Astable multivibrators
Lecture 17	monostable multivibrators
Lecture 18	bistable multivibrators
Lecture 19	Schmitt trigger
Lecture 20	High frequency amplifiers: Hybrid Pi model
Lecture 21	Conductances of hybrid Pi model
Lecture 22	capacitances of hybrid Pi model
Lecture 23	high frequency analysis of CE amplifier
Lecture 24	gain bandwidth product, unity gain frequency of Emitter follower at high frequencies
Lecture 25	gain bandwidth product, unity gain frequency of Emitter follower at high frequencies
Lecture 26	Tuned amplifier - Analysis of Single Tuned Amplifier
Lecture 27	Primary Tuned Amplifier with BJT
Lecture 28	Secondary Tuned Amplifier with BJT
Lecture 29	Double Tuned Transformer Coupled Amplifier
Lecture 30	Stagger Tuned Amplifier.
Lecture 31	Power amplifiers - Classification
Lecture 32	Power transistors
Lecture 33	Output power, power dissipation and efficiency analysis of Class A
Lecture 34	Output power, power dissipation and efficiency analysis of class B
Lecture 35	Output power, power dissipation and efficiency analysis of class AB
Lecture 36	Output power, power dissipation and efficiency analysis of class C
Lecture 37	Pushpull amplifiers with transformers
Lecture 38	Pushpull amplifiers without transformers
Lecture 39	Complementary symmetry amplifiers
Lecture 40	quasi complimentary symmetry amplifiers

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.** Assume that a silicon transistor with β =50, $V_{BEactive}$=0.7 V, V_{CC} =15V and R_C=10K is used in the Fig.1.It is desired to establish a Q-point at V_{CE}=7.5 V and I_C=5mA and stability factor S≤5.Find Re,$R_1$and R_2. 
	Q2. In the Darlington stage shown in Fig.2 , V_{CC}=15V , β_1=50, β_2=75,V_{BE}=0.7,R_C=750 Ω and R_E=100 Ω. If at the quiescent point V_{CE2}=6V determine the value of R. 
	Q3. For the amplifier shown in Fig.3 using a transistor whose parameters are h_{ie}=1100,h_{re}=2.5×$10^{-4,}$$h_{fe}$=50,$h_{oe}$=24μA/V.Find A_I, A_V, A_{VS} and R_i.

	
Assignment 2	**Q1.** Draw hybrid-π model of BJT.
	Q2. Write short note on the following: A. Hartley oscillator B. Crystal oscillator
	Q3. Show the classification of power amplifier using output characteristics, load line and operating point.

4ECU02	RANDOM VARIABLES & STOCHASTIC PROCESS	3L:1T:0P	4 credits

Syllabus

PROBABILITY - Introduction, definitions, conditional probability, combined experiments
RANDOM VARIABLES - Introduction, Distribution and density tunctions, Discrete and continuous random variables, (Gaussian), Exponential, Rayleigh' Uniform, Bemoulli, Binominal, Poisson, discrete Uniform and conditional distributions. Functions of one random variable: distribution, mean, variance, moments and characteristics functions
MULTIPLE RANDOM VARIABLES - distributions, Pne f unction of two random variables, Two functions of two random variables, Joint moments, Joint characteristics functions. Conditional distributions, conditional expected values, statistical independence. Multiple random variables: multiple functions of multiple random variables, jointly Gaussian random variables, sums of random variaQe, Central limit theorem
STOCHASTIC PROCESSES - Definitions, Random process concept, Statistics of stochastic processes: mean, autocorrelation, strict and wide sense stationary, random processes and Linear Systems.
STOCHASTIC PROCESSES IN FREQUENCY DOMAIN - Power spectrum of stochastic processes, Transmission over LTI systems, Gaussian and White (9 hours) processes, Properties of power spectral density.

Text/Reference Books:

1.	Probability, Random Variables And Random Signal Principles, Peebles, TMH 2002.
2.	Stochastic Processes, 2ed, Ross, Wiley. 1996
3.	Devore - Probability and statistics for engineering and sciences, Cengage learning 201 I
4.	Mendenhall - Introduction to probability and statistics, Cengage leaming 2012
5.	Probability, Random Variables And Stochastic Processes, Papoulis, TMH 2002
6.	Probability Theory and Stochastic Processes for Engineers, Bhat, Pearson 20ll
7.	Probability and Random Processes with Application to Signal Processing' 3/e, Stark,Pearson,2002
8.	An Introduction to Probability Theory & Its App., Feller, Wiley 1969

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU02	RANDOM VARIABLES & STOCHASTIC PROCESS	CO 1	**Describe** Probability and Random variables & random process.
		CO 2	**Describe** Probability and Random variables & random process.
		CO 3	**Analyse** Correlation functions and Fourier Transforms to understand signal behavior
		CO 4	**Solve** the complex problem of Probability and Random

			variables
		CO 5	**Explain** the practical applications of Random process.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4ECU02 Random Variables & Stochastic Process	**CO 1**	3	2	1									
	CO 2	2	3	1									
	CO 3	3	2	2	2								
	CO 4	3	2	1	1			2					
	CO 5	2	3	2	1	1							2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Probability - Introduction
Lecture 3	Definitions
Lecture 4	conditional probability
Lecture 5	combined experiments
Lecture 6	combined experiments
Lecture 7	Random variables - Introduction
Lecture 8	Distribution and density functions
Lecture 9	Distribution and density functions
Lecture 10	Discrete and continuous random variables,
Lecture 11	Discrete and continuous random variables,
Lecture 12	Gaussian, Exponential distributions

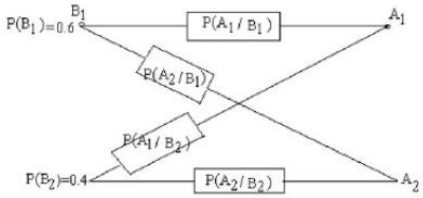
Lecture 13	Rayleigh' Uniform, Bemoulli distributions
Lecture 14	Binominal, Poisson, discrete Uniform and conditional distributions
Lecture 15	Functions of one random variable
Lecture 16	distribution, mean, variance, moments and characteristics functions
Lecture 17	distribution, mean, variance, moments and characteristics functions
Lecture 18	Multiple random variables - distributions
Lecture 19	Pne function of two random variables
Lecture 20	Two functions of two random variables
Lecture 21	Joint moments
Lecture 22	Joint characteristics functions
Lecture 23	Conditional distributions
Lecture 24	conditional expected values
Lecture 25	statistical independence
Lecture 26	Multiple random variables
Lecture 27	multiple functions of multiple random variables
Lecture 28	jointly Gaussian random variables
Lecture 29	sums of random variable
Lecture 30	Central limit theorem
Lecture 31	Stochastic processes - Definitions
Lecture 32	Random process concept
Lecture 33	Statistics of stochastic processes
Lecture 34	mean, autocorrelation, strict and wide sense stationary, random processes and Linear Systems.
Lecture 35	mean, autocorrelation, strict and wide sense stationary, random processes and Linear Systems.
Lecture 36	Stochastic processes in frequency domain
Lecture 37	Power spectrum of stochastic processes
Lecture 38	Transmission over LTI systems
Lecture 39	Gaussian and White processes

Lecture 40	Properties of power spectral density

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.**	Define conditional distribution and density functions and explain their properties. Explain the methods of defining a conditioning event.
	Q2.	Define random variable and give the concept of random variable. State and prove the properties of CDF of X.
	Q3.	In an experiment of rolling a die and flipping a coin. The random variable(X)is choosen such thati. a coin head (H) outcome corresonds to positive values of X that are equal to thenumbers that show upon the die andii. a coin tail (T) outcome corresponds to negative values of X that are equal inmagnitude to twice the number that shows on die. Map the elements of randomvariable X into points on the real line and explain.
Assignment 2	**Q1.**	What is Bayes' theorem? Explain. Write a note on Total Probability.
	Q2.	Determine probabilities of system error and correct system transmission of symbols for an elementary binary communication system shown in figure 1consisting of a transmitter that sends one of two possible symbols (a 1 or a 0) over a channel to a receiver. The channel occasionally causes errors to occur so that a '1' show up at the receiver as a '0', and vice versa. Assume the symbols '1' and '0' are selected for a transmission as 0.6 and 0.4 respectively. 
	Q3.	Prove that irreducible, aperiodic first-order Markov chains, defined by a transition matrix with a nonsymmetric off-diagonal zero entry, are irreversible.

4ECU03	ELECTRONIC MEASUREMENT & INSTRUMENTATION	3L:0T:0P	3 credits

Syllabus

THEORY OF ERRORS - Accuracy & precision, Repeatability, Limits of Time-Hours errors, Systematic & (7 hours) random errors, Modeling of errors, Probable error & standard deviation, Gaussian error analysis, Combination of errors.
ELECTRONIC INSTRUMENTS - Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, and Component Measuring Instruments: Q meter, Vector Impedance meter, RF Power & Voltage Measurements, Introduction to shielding & grounding
OSCILLOSCOPES - CRT Construction, Basic CRO circuits, CRO Probes, Techniques of Measurement of frequency, Phase Angle and Time Delay, Multibeam, multi trace, storage & sampling Oscilloscopes.
SIGNAL GENERATION AND SIGNAL ANALYSIS - Sine wave generators, Frequency synthesized signal generators, Sweep frequency generators. Signal Analysis - Measurement Technique, Wave Analyzers, and Frequency - selective wave analyser, Heterodyne wave analyser, Harmonic distortion analyser, and Spectrum analyser.
TRANSDUCERS - Classification, Selection Criteria Characteristics, Construction, Working Principles and Application of following Transducers:- RTD, Thermocouples, Thermistors, LVDT, Strain Gauges, Bourdon Tubes, Seismic Accelerometers, Tachogenerators, Load Cell, Piezoelectric Transducers, Ultrasonic Flow Meters.

Text/Reference Books:

1.	Electronic Instrument and Measurment, Bell, Oxford . 2007
2.	Electronic Measurements & Instrumentation, Bernard Oliver, TMH. l97l
3.	Instrumentation Measurement Analvsis B.C.NakraK.K. Chaudhry, TMH 2OO4
4.	Electronic Measurements and Instrumentation, Gupta & Soni, Genius pub. 20t4.
5.	Electronic Measurements & Instrumentation, Bernard Oliver, John Cage, TMH I97I
6.	Electronic Measurements and Instrumentation, Lal KiShore, Pearson 2010
7.	Elements of Electronic Instrumentation And Measuiement, Carr, Pearson 1996
8.	Instrumentation for Engineering Measurements, 2ed, Dally, Wiley 1993

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU03	ELECTRONIC MEASUREMENT & INSTRUMENTATION	CO 1	**Describe** the use of various electrical/electronic instruments, their block diagram, applications, dnd principles of operation, standards eorrs and units of measurements.
		CO 2	**Develop** basic skills in the design of electronic equipments
		CO 3	**Analyse** different electrical/electronic parameters using state of equipments of measuring instruments which is require to all types of industries.
		CO 4	**Solve :**Identify electronics/ electrical instruments, understanding associated with the instruments
		CO 5	**Explain** use of transducers in different types of field applications

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4ECU03 ELECTRONIC MEASUREMENT & INSTRUMENTATION	CO 1	3	2	1									
	CO 2	2	2	2	3								
	CO 3	2	3										
	CO 4	2	1	1				2					
	CO 5	3	1										2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Theory of errors
Lecture 3	Accuracy & precision, Repeatability
Lecture 4	Limits of Time-Hours errors
Lecture 5	Systematic & random errors
Lecture 6	Modeling of errors
Lecture 7	Probable error
Lecture 8	standard deviation
Lecture 9	Gaussian error analysis
Lecture 10	Combination of errors
Lecture 11	Electronic instruments - Electronic Voltmeter
Lecture 12	Electronic Multimeters
Lecture 13	Digital Voltmeter
Lecture 14	Component Measuring Instruments: Q meter
Lecture 15	Vector Impedance meter
Lecture 16	RF Power & Voltage Measurements
Lecture 17	Introduction to shielding & grounding
Lecture 18	Oscilloscopes - CRT Construction
Lecture 19	Basic CRO circuits, CRO Probes
Lecture 20	Techniques of Measurement of frequency, Phase Angle and Time Delay
Lecture 21	Multibeam, multi trace, storage & sampling Oscilloscopes
Lecture 22	Multibeam, multi trace, storage & sampling Oscilloscopes
Lecture 23	Signal generation and signal analysis - Sine wave generators,
Lecture 24	Frequency synthesized signal generators
Lecture 25	Sweep frequency generators
Lecture 26	Signal Analysis - Measurement Technique
Lecture 27	Wave Analyzers, and Frequency - selective wave analyser

Lecture 28	Heterodyne wave analyser
Lecture 29	Harmonic distortion analyser
Lecture 30	Spectrum analyser
Lecture 31	Transducers – Classification
Lecture 32	Selection Criteria Characteristics
Lecture 33	Construction, Working Principles and Application of following Transducers:- RTD
Lecture 34	Thermocouples
Lecture 35	Thermistors
Lecture 36	LVDT Strain Gauges, Bourdon Tubes
Lecture 37	Seismic Accelerometers
Lecture 38	Tachogenerators, Load Cell,
Lecture 39	Piezoelectric Transducers
Lecture 40	Ultrasonic Flow Meters

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.**	Write the principal of an AC Bridge used for the measurement of Unknown capacitor
	Q2.	Distinguish Between Accuracy and Precision?
	Q3.	Explain flow measurement with a suitable example.
Assignment 2	**Q1.**	What are primary sensing elements and transducers?
	Q2.	A Wheatstone Bridge requires to change of 7Ω in unknown arm of bridge to change in deflection of 14 mm. of galvanometer deter mine the sensitivity and deflection factor.
	Q3.	Explain the terms static error, static correction, relative error and percentage relative error.

4ECU04	ELECTROMAGNETIC FIELD THEORY	3L:1T:0P	4 credits

Syllabus

INTRODUCTION - Vector Algebr4 different Coordinate system, Relation in rectangular, cylindrical, spherical and general curvilinear coordinates system. Line, Surface and volume integral, Concept and physical interpretation of gradient, Divergence and curl. Divergence, Stoke's and Green's theorems
ELECTROSTATICS - Electric field intensity & flux density (D). Electric field due to various charge configurations. Gauss's law, divergence of electric flux and Maxwell's first equation, The potential functions and gradient of electric potential. Maxwell curl equation for static electric field. Poisson's and Laplace's equation and their solution. Divergence of current density (J) and Continuity equation for current. Duality of J and D, Capacitance and electrostatics energy. Field determination by method of images, Boundary conditions, Field mapping andconceptof field cells.
MAGNETOSTATICS - Bio-Savart's law, Ampere's circuital law Magnetic field intensity H, flux density B & magnetization M, their interrelation. Curl of H. Magnetic scalar and vector potential, Faraday's Law, self & mutual inductance, Energy stored in magnetic field, Boundary conditions, Analogy between electric and magnetic,field, Field maping and concept of field cells
TIME VARYING FIELDS - Displacement currents, displacement vector and equation of continuity. Maxwell's equations, Uniform plane wave in free space, dielectrics and conductors, Depth of penetration-skin effect, Sinusoidal time variations, Reflection & Refraction of Uniform Plane Wave, standing wave ratio. Pointing vector and power considerations.
RADIATION, EMI AND EMC - Retarded Potentials and concepts of radiation, Radiation from a small current element. Radiation Resistance: Introduction to Electromagnetic Interference and Electromagnetic compatibility, EMI error in equipments, EMI standard, EMI coupling modes, Methods of eliminating interference, shielding, grounding, conducted EMI, EMI testing: emission testing, susceptibility testing

Text/Reference Books:

1.	Sadiku, Electromagnetic Field Theory, Oxford . 2000
2.	Mahaoatra- Principles of Electromagnetics, TMH. 2011
3.	Kshetrimeyum - Electromagnetic field theory, Cengage leaming 2012
4.	Hayt, Engineering Electromagnetics, TMH 2007
5.	Jordan Balmain, Electromagnetic Field Theory and Radiations, PHI 1968
6.	Kaduskar ,Principles of Electromagnetics, Wiley 2010
7.	Reitz, Foundations of Electromagnetic Theory, Pearson 2009
8.	Seavganokar, Electromagnetic Waves, TMH 2005
9.	Rao, Electromagnetic Field Theory and Transmission Lines, Wiley 2012
10.	David K. Chang, Electromagnetic Field Theory, Pearson 1999

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU04	ELECTROMAGNETIC FIELD THEORY	CO 1	**Describe** vectors and different coordinate systems and applying them for different mathematical operators
		CO 2	**Develop** the knowledge of the subject for static and dynamic & electric or magnetic field in different situations.
		CO 3	**Analyse** electrical and magnetic interference to improve the Engg. System working
		CO 4	**Solve** Maxwell's Equations in integral and differential form for static field and their modifications in dynamic conditions
		CO 5	**Explain** the properties of static and dynamic & electric and magnetic field conditions.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4ECU04 ELECTROMAGNETIC FIELD THEORY	CO 1	3	2	1									
	CO 2	2	3										
	CO 3	2	3	1									
	CO 4	2	2	3	1								
	CO 5	2	2	3	1								2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	INTRODUCTION - Vector Algebr4 different Coordinate system
Lecture 3	Relation in rectangular, cylindrical, spherical and general curvilinear coordinates system
Lecture 4	Relation in rectangular, cylindrical, spherical and general curvilinear coordinates system

Lecture 5	Line, Surface and volume integral
Lecture 6	Concept and physical interpretation of gradient, Divergence and curl
Lecture 7	Stoke's and Green's theorems
Lecture 8	Electrostatics - Electric field intensity & flux density
Lecture 9	Electric field due to various charge configurations.
Lecture 10	Gauss's law,
Lecture 11	divergence of electric flux and Maxwell's first equation
Lecture 12	The potential functions and gradient of electric potential
Lecture 13	Maxwell curl equation for static electric field
Lecture 14	Poisson's and Laplace's equation and their solution
Lecture 15	Divergence of current density (J) and Continuity equation for current
Lecture 16	Duality of J and D, Capacitance and electrostatics energy
Lecture 17	Field determination by method of images, Boundary conditions
Lecture 18	Field mapping and concept of field cells
Lecture 19	Magnetostatics - Bio-Savart's law
Lecture 20	Ampere's circuit law
Lecture 21	Magnetic field intensity H, flux density B & magnetization M, their interrelation
Lecture 22	Curl of H. Magnetic scalar and vector potential
Lecture 23	Faraday's Law, self & mutual inductance, Energy stored in magnetic field
Lecture 24	Boundary conditions, Analogy between electric and magnetic field
Lecture 25	Field maping and concept of field cells
Lecture 26	Time varying fields - Displacement currents, displacement vector
Lecture 27	equation of continuity. Maxwell's equations
Lecture 28	Uniform plane wave in free space
Lecture 29	dielectrics and conductors
Lecture 30	Depth of penetration-skin effect
Lecture 31	Sinusoidal time variations
Lecture 32	Reflection & Refraction of Uniform Plane Wave
Lecture 33	standing wave ratio. Pointing vector

Lecture 34	power considerations
Lecture 35	Radiation, EMI and EMC - Retarded Potentials and concepts of radiation
Lecture 36	Radiation from a small current element, Radiation Resistance
Lecture 37	Introduction to Electromagnetic Interference and Electromagnetic compatibility
Lecture 38	EMI error in equipments, EMI standard, EMI coupling modes
Lecture 39	Methods of eliminating interference, shielding, grounding, conducted EMI
Lecture 40	EMI testing: emission testing, susceptibility testing

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. Hand-outs

Sample assignments:

Assignment 1	**Q1.**	Derive an expression for magnetic field intensity due to an infinitely long filamentary line current I along the Z-axis by applying Ampere's Law.
	Q2.	State and explain Biot-Savart law for static magnetic fields.
	Q3.	Using, Bio-Savart law determine the field due to a straight current-carrying conductor of finite length Investigate the applications of various diodes?
Assignment 2	**Q1.**	Explain in detail about Maxwell's Equations in point form and integral form.
	Q2.	The magnetic field intensity of a uniform plane wave in air is 20 A/m in the ay direction. The wave is propagating in the az direction at a frequency of 2×109 rad/s. Find (a). The wavelength (b). The frequency (c). The period (d). The amplitude of E.
	Q3.	What is the inductance of a pair of transmission lines separated by 1.868 m, if the diameter of each wire is 0.01 m and the medium between the lines has $\mu = 2\mu 0$. Length of the line is 10m.

4ECU 07	COMPUTER PROGRAMMING LAB-I	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
Programs in C++	
1.	Write a program to perform the complex arithmetic.
2.	Write a program to perform the rational number arithmetic.
3.	Write a program to perform the matrix operations. (Transpose, addition, subtraction, multiplication, test if a matrix is symmetric/ lower triangular/ upper triangular)
4.	Implement Morse code to text conversion and vice-versa.
5.	To calculate Greatest Common Divisor of given numbers.
6.	To implement tower of Hanoi problem.
Programs in Java	
1.	To implement spell checker using dictionary
2.	To implement a color selector from a given set of colors.
3.	To implement a shape selector from a given set of shapes.
4.	To implement a calculator with its functionality.
5.	By mapping keys to pens of different colors, implement turtle graphics.
6.	To implement a graph and display BFS/DFS order of nodes.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU 07	COMPUTER PROGRAMMING LAB-I	CO 1	Gain the basic knowledge on Object Oriented concepts.
		CO 2	understand object oriented programming through C++ & JAVA
		CO 3	develop applications using Object Oriented Programming Concepts
		CO 4	implement features of object oriented programming to solve mathematical problem with computational efficiency
		CO 5	understand and learn various predefined functions and command used in C++ and JAVA

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4ECU 07 COMPUTER PROGRAMMING LAB-I	CO 1	3	2		1								
	CO 2	2	2	2	3	1							
	CO 3	2	3										
	CO 4	2	3	2	1								
	CO 5	3	1										

3: Strongly **2: Moderate** **1: Weak**

4ECU08	ANALOG ELECTRONICS LABORATORY	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Plot gain-frequency characteristics of BJT amplifier with and without feedback in the emitter circuit and determine bandwidths, gain bandwidth products and gains at lkHz with and without negative feedback.
2.	Study of series and shunt voltage regulators and measurement of line regulation and ripple factor.
3.	Plot and study the characteristics of small signal amplifier using FET.
4.	Study of push pull amplifier. Measure variation of output power & distortion with load.
5.	Study Wein bridge oscillator and observe the effect of variation in R oscillator frequency
6.	Study transistor phase shift oscillator and observe the effect of variation in R & C on oscillator frequency and compare with theoretical value.
7.	Study the following oscillators and observe the effect of variation of C on oscillator frequency: (a) Hartley (b) Colpitts.
8.	Study of a Digital Storage CRO and store a transient on it.
9.	To plot the characteristics of UJT and UJT as relaxation.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECUO8	ANALOG ELECTRONICS LABORATORY	CO 1	Understand working of Digital Storage CRO.
		CO 2	Analyze the basic working facts and the critical aspects of various types of oscillators.
		CO 3	Understanding the system as a whole through different electronic circuits.
		CO 4	Hands on experience on gain frequency characteristics of BJT and FET.
		CO 5	Analyze different types of amplifiers e.g. Small signal FET amplifier, push-pull amplifiers.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4ECUO8 ANALOG ELECTRONICS LABORATORY	CO 1	3	2	3	2	1							1
	CO 2	2	3	1	3	3							2
	CO 3	1	3	2	3	2							
	CO 4	3	2	3	2	2							1
	CO 5	3	2	1	2	2							

3: Strongly **2: Moderate** **1: Weak**

4ECU09	MEASUREMENT & INSTRUMENTATION LAB	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Measure earth resistance using fall of potential method.
2.	Plot V-I characteristics & measure open circuit voltage & short circuit current of a solar panel.
3.	Measure unknown inductance capacitance resistance using following bridges (a) Anderson Bridge (b) Maxwell Bridge
4.	To measure unknown frequency & capacitance using Wein's bridge.
5.	Measurement of the distance with the help of ultrasonic transmitter & receiver.
6.	Measurement of displacement with the help of LVDT.
7.	Draw the characteristics of the following temperature transducers (a) RTD (Pt-100) (b) Thermistors.
8.	Draw the characteristics between temperature & voltage of a K type thermocouple
9.	Calibrate an ammeter using D.C. slide wire potentiometer
10.	Measurement of strain/force with the help of strain gauge load cell.
11.	Study the working of Q-meter and measure Q of coils.

12.	Calibrate a single-phase energy meter (Analog and Digital) by phantom loading at different power factor by: (i) Phase shifting transformer (ii) Auto transformer.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU09	**MEASUREMENT & INSTRUMENTATION LAB**	**CO 1**	Understanding of the fundamentals of Electronic Instrumentation. Explain and identify measuring instruments.
		CO 2	Able to measure resistance, inductance and capacitance by various methods.
		CO 3	Design an instrumentation system that meets desired specifications and requirements.
		CO 4	Design and conduct experiments, interpret and analyze data, and report results.
		CO 5	Explain the principle of electrical transducers. Confidence to apply instrumentation solutions for given industrial applications.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4ECU09 MEASUREMENT & INSTRUMENTATION LAB	**CO 1**	3	2	1	2	2							
	CO 2	2	3	1	2	3							
	CO 3	1	3	2	3	2							
	CO 4	1	2	3	2	3							
	CO 5	1	2	3	3	3							

3: Strongly **2: Moderate** **1: Weak**

5ECU01	SIGNALS & SYSTEMS	3L:1T:0P	4 credits

Syllabus

Introduction: Continuous time and discrete time signals and systems, Properties of systems. Linear time invariant systems- continuous time and discrete time, Properties of LTI systems and their block diagrams. Convolution, Discrete time systems described by difference equations.
Fourier series representation of signals: Fourier series representation of continuous periodic signal & its properties. Fourier series representation of Discrete periodic signal & its properties. Continuous time filters & Discrete time filters described by Diff. equation.
Fourier transform: The continuous time Fourier transform for periodic and non-periodic signals, Properties of CTFT. Discrete time Fourier transform for periodic and non-periodic signals, Properties of DTFT.
Z-transform & Laplace transform: The region of convergence for the Z-transform, The Inverse Z-transform and two dimensional Z transform, Properties of Z transform. Laplace transform: Properties of Laplace Transform, Application of Laplace transform to system analysis.
Sampling: Mathematical theory of sampling, Sampling theorem, Ideal & Real sampling, Interpolation technique for the reconstruction of a signal from its samples, Aliasing, Sampling in freq. domain, Sampling of discrete time signals.

Text/Reference Books:

7.	Signals And Systems, Oppenheim, Willsky, Nawab, PHI.(1992)
8.	Signals And Systems M J Roberts, Mc-Graw Hill.(2004)
9.	Principles of Linear Systems And Signals, 2e (Intl. Version), Lathi 2nd, Oxford (2002)
10.	Signal & Systems 3e, Chen 3rd, Oxford (2004)
11.	Fundamentals of Signals And Systems, Wiley (2009)
12.	Signals And Systems, P Rao, Mc-Graw Hill (2011)
13.	Signals And Systems: A Simplified Approach, Ganesh Rao, 4e, Pearson (2012)
14.	Signals And Systems: Continuous And Discrete, Roger E Ziemer, 4e, PHI (1998)
15.	Signals And Systems, Ravi Kumar, PHI (2009)
16.	Signals & Systems, Iyer, Cengage Learning (2009)

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU01	Signals & Systems	CO 1	Analyze different types of signals and system properties
		CO 2	Represent continuous and discrete systems in time and frequency domain using different transforms
		CO 3	Investigate whether the system is stable.
		CO 4	Sampling and reconstruction of a signal.
		CO 5	Acquire an understanding of MIMO systems

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU01 Signals & Systems	CO 1	3	3	1	2	2			1				2
	CO 2	3	1		2	3			1				2
	CO 3	3	2	2	3								2
	CO 4	3	2	3	3	1							
	CO 5	3	2	2	3	1			2				1

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction to signals
Lecture 3	Continuous time and discrete time signals and systems
Lecture 4	Properties of systems.
Lecture 5	Linear time invariant systems
Lecture 6	Continuous time and discrete time
Lecture 7	Properties of LTI systems
Lecture 8	Properties of LTI systems (continue)

Lecture 9	Block Diagrams of LTI systems
Lecture 10	Convolution
Lecture 11	Discrete time systems described by difference equations
Lecture 12	Fourier series representation of signals:
Lecture 13	continuous periodic signal & its properties
Lecture 14	Discrete periodic signal & its properties
Lecture 15	Continuous time filters
Lecture 16	Discrete time filters described by Diff. equation.
Lecture 17	Fourier transform: Introduction
Lecture 18	The continuous time Fourier transform for periodic signals
Lecture 19	The continuous time Fourier transform for non- periodic signals
Lecture 20	Properties of CTFT
Lecture 21	Discrete time Fourier transform for periodic signals
Lecture 22	Discrete time Fourier transform for non- periodic signals
Lecture 23	Numerical Practice
Lecture 24	Properties of DTFT.
Lecture 25	Z-transform & Laplace transform
Lecture 26	The region of convergence for the Z-transform
Lecture 27	The Inverse Z-transform
Lecture 28	Two dimensional Z transform
Lecture 29	Properties of Z transform
Lecture 30	Laplace transform: Properties of Laplace Transform
Lecture 31	Application of Laplace transform to system analysis.
Lecture 32	Sampling: Introduction
Lecture 33	Mathematical theory of sampling
Lecture 34	Sampling theorem
Lecture 35	Ideal & Real sampling
Lecture 36	Interpolation technique for the reconstruction of a signal from its samples
Lecture 37	Aliasing

Lecture 38	Sampling in freq. domain
Lecture 39	Sampling of discrete time signals
Lecture 40	Spill Over Class

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1

Q1.

For each of the following signals, determine whether it is even, odd, or neither.

(a)

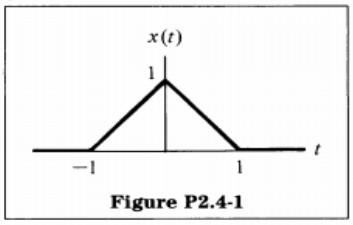


Figure P2.4-1

(b)

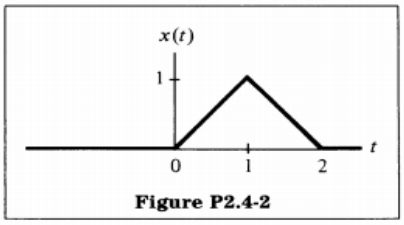


Figure P2.4-2

(c)

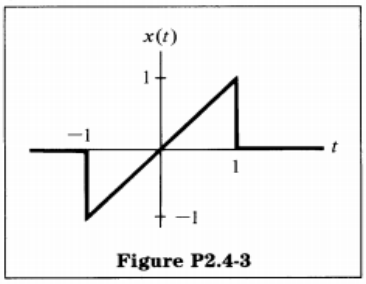


Figure P2.4-3

(d)

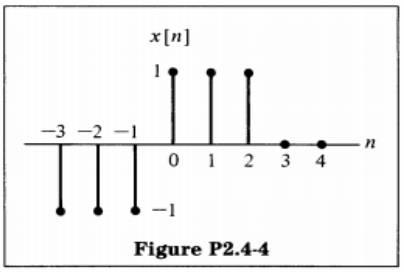


Figure P2.4-4

Q2.

Evaluate the following sums:

(a) $\sum_{n=0}^{5} 2\left(\frac{3}{\alpha}\right)^n$

(b) $\sum_{n=2}^{6} b^n$

(c) $\sum_{n=0}^{\infty} \left(\frac{2}{3}\right)^{2n}$

Hint: Convert each sum to the form

$$C\sum_{n=0}^{N-1} \alpha^n = S_N \quad \text{or} \quad C\sum_{n=0}^{\infty} \alpha^n = S_\infty$$

and use the formulas

$$S_N = C\left(\frac{1-\alpha^N}{1-\alpha}\right), \qquad S_\infty = \frac{C}{1-\alpha} \quad \text{for } |\alpha| < 1$$

	Q3. The first-order difference equation $y[n] - ay[n-1] = x[n]$, $0 < a < 1$, describes a particular discrete-time system initially at rest. **(a)** Verify that the impulse response $h[n]$ for this system is $h[n] = a^n u[n]$. **(b)** Is the system (i) memoryless? (ii) causal? (iii) stable? Clearly state your reasoning. **(c)** Is this system stable if $\|a\| > 1$?
Assignment 2	**Q1.** Consider a discrete-time system with impulse response $h[n] = (\frac{1}{2})^n u[n]$ Determine the response to each of the following inputs: **(a)** $x[n] = (-1)^n = e^{j\pi n}$ for all n **(b)** $x[n] = e^{j(\pi n/4)}$ for all n **(c)** $x[n] = \cos\left(\frac{\pi n}{4} + \frac{\pi}{8}\right)$ for all n
	Q2. Consider two specific periodic sequences $\tilde{x}[n]$ and $\tilde{y}[n]$. $\tilde{x}[n]$ has period N and $\tilde{y}[n]$ has period M. The sequence $\tilde{w}[n]$ is defined as $\tilde{w}[n] = \tilde{x}[n] + \tilde{y}[n]$. **(a)** Show that $\tilde{w}[n]$ is periodic with period MN. **(b)** Since $\tilde{x}[n]$ has period N, its discrete Fourier series coefficients a_k also have period N. Similarly, since $\tilde{y}[n]$ has period M, its discrete Fourier series coefficients b_k also have period M. The discrete Fourier series coefficients of $\tilde{w}[n]$, c_k, have period MN. Determine c_k in terms of a_k and b_k.
	Q3. The sequence $x[n] = (-1)^n$ is obtained by sampling the continuous-time sinusoidal signal $x(t) = \cos \omega_0 t$ at 1-ms intervals, i.e., $\cos(\omega_0 nT) = (-1)^n, \quad T = 10^{-3}$ s Determine three *distinct* possible values of ω_0.

5ECU02	LINEAR INTEGRATED CIRCUITS	3L:0T:0P	3 credits

Syllabus

OPERATIONAL AMPLIFIERS: Basic differential amplifier analysis, Basic structure and principle of operation, Single ended and double ended configurations, calculation of differential gain, common mode gain, Op-amp configurations with feedback, Op-amp parameters, Inverting and Non-Inverting configuration, Comparators, Adder.
OPERATIONAL AMPLIFIER APPLICATIONS: Integrator, Differentiator, Voltage to frequency & Frequency to voltage converters, Oscillators: Phase shift, Wien bridge, Quadrature, precision rectifier, half and full wave rectifiers, square wave, triangular wave, sawtooth oscillators, Voltage controlled oscillators.
ACTIVE FILTERS: Low pass, high pass, band pass and band reject filters, All pass filter, Switched capacitor filter, Butterworth filter design, Chebyshev Filter design.
LINEAR ICs: Four quadrant multiplier & its applications, Basic blocks of linear IC voltage regulators, Three terminal voltage regulators, Positive and negative voltage regulators, A/D and D/A converters, Analog switches, The 555 timer as astable and monostable multivibrators, Zero crossing detector, Schmitt trigger and its applications. NON- LINEAR APPLICATIONS OF OP-AMP: log and antilog amplifiers, and multipliers, Solution of differential equation and analog computer.
PHASE-LOCKED LOOPS: Operating Principles of PLL, Linear Model of PLL, Lock range, Capture range, Applications of PLL as FM detector, signal synchronizer, Building blocks of PLL, LM 565 PLL.

Text/Reference Books:

1.	OP-AMP and linear integrated circuits 2nd edition, PLHI by Ramakant A. Gayakwad. (1992)
2.	Design with operation amplifiers and Analog Integrated circuits by Sergei Franco. (2007)
3.	Integrated Electronics: Analog and Digital circuits & system by Millman & Halkias. (1972)
4.	Linear Integrated Circuits by D.R.Chaudhary (WEL). 2007
5.	Operational amplifier with linear integrated circuits, 4th edition, W.D. Stanley, Pearson. (2002)
6.	Op Amps and Linear Integrated Circuits: Concepts and Applications, Fiore, Cengage learning. (2010)

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU02	Linear Integrated Circuits	CO 1	Understand the terminal characteristics of op-amps and design/analyse fundamental circuits based on op-amps
		CO 2	Analyse feedback and its effect on the performance of op-amp.
		CO 3	Design and analysis of nonlinear circuits.
		CO 4	Design and analysis of active filters.
		CO 5	Design and analysis of various applications using op-amps and IC 555.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU02 Linear Integrated Circuits	CO 1	3	2	1	1	1							
	CO 2	3	3	2	1	1							
	CO 3	3	3	2	1	1							
	CO 4	3	3	2	1	1							
	CO 5	3	3	2	1	1							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Introduction to Operational Amplifiers
Lecture 2	Basic differential amplifier analysis
Lecture 3	Basic structure and principle of operation
Lecture 4	Single ended and double ended configurations
Lecture 5	Calculation of differential gain & Common mode gain
Lecture 6	Op-amp configurations with feedback
Lecture 7	Op-amp parameters

Lecture 8	Comparators & Adder
Lecture 9	Operational amplifier applications: Integrator & Differentiator
Lecture 10	Voltage to frequency Converters
Lecture 11	Frequency to voltage converters
Lecture 12	Oscillators: Phase shift, Wien bridge
Lecture 13	Quadrature & precision rectifiers
Lecture 14	Half and Full wave rectifiers
Lecture 15	Square wave, triangular wave, sawtooth oscillators
Lecture 16	Voltage controlled oscillators
Lecture 17	Low Pass Filters
Lecture 18	High Pass Filters
Lecture 19	Band Pass Filters
Lecture 20	Band Reject Filters
Lecture 21	All Pass Filters
Lecture 22	Switched Capacitor Filters
Lecture 23	Butterworth Filter Design
Lecture 24	Chebyshev Filter Design
Lecture 25	Linear ICs: Four quadrant multiplier & its applications
Lecture 26	Basic blocks of linear IC voltage regulators, Three terminal voltage regulators.
Lecture 27	Positive and negative voltage regulators
Lecture 28	A/D converters
Lecture 29	D/A converters
Lecture 30	Analog switches: The 555 timer as astable and monostable multivibrators
Lecture 31	Non- linear applications of op-amp: log and antilog amplifiers, and multipliers.
Lecture 32	Solution of differential equation and analog computer.
Lecture 33	PHASE-LOCKED LOOPS: Introduction
Lecture 34	Operating Principles of PLL
Lecture 35	Linear Model of PLL
Lecture 36	Lock range, Capture range of PLL

Lecture 37	Applications of PLL as FM detector
Lecture 38	Applications of PLL as signal synchronizer
Lecture 39	Building blocks of PLL
Lecture 40	LM 565 PLL

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.** With a circuit diagram, explain how dc level shifting operation is performed. Why is it needed in op-amp?
	Q2. Draw & explain the working of JFET differential amplifier. Also draw & explain curve between I_D & differential input voltage.
	Q3. Define & explain the following OP-AMP parameters- [1]. CMMR [2]. Bias Current [3]. Slew Rate [4]. Input offset voltage
Assignment 2	**Q1.** Draw the circuit diagram of Wien bridge oscillator & find expression for frequency of oscillation.
	Q2. Explain the working of voltage to frequency converter (V/F).
	Q3. Draw the circuit diagram of Twin-T notch narrow band reject filter & derive expression for cut-off frequencies.

5ECU03	TELECOMMUNICATION ENGINEERING	3L:0T:0P	3 credits

Syllabus

TRANSMISSION LINE: Types of transmission lines, general transmission line equation, line constant, equivalent circuits, Infinite line, and reflection on a line, SWR of line with different type of terminations. Distortion less and dissipation less lines. Coaxial cables, Transmission lines at audio and radio frequencies, Losses in transmission line. Characteristics of quarter wave, half wave and lines of other lengths.
TRANSMISSION LINE APPLICATIONS: Smith chart and its application, Transmission line applications, Impedance matching Network. Single & double Stub matching. Measurement of parameters of transmission line, measurement of attenuation, insertion loss, reflection coefficient and standing wave ratio.
ATTENUATORS & FILTERS: Elements of telephone transmission networks, symmetrical and Asymmetrical two port networks. Different Attenuators, π-section & T-section attenuators, stub matching. Transmission equalizers Filters, constant K-section, Ladder type, π-section, T-section filter, m-derived filter sections, Lattice filter section.
SWITCHING AND SIGNALING FOR ANALOG AND DIGITAL TELEPHONE NETWORKS: Concept for Telephony, introduction to switching Concepts, De-generation, Availability and Grading. Principle of Electronic Exchange, EPABX and SPC Digital telephone Exchange, Fascimile services. Approaches to PCM Switching: Multistage switches, Time Switch, Space Switch, STS and TST Switches. Concept of Supervisory and AC signaling, Essentials of Traffic Engineering, Telephone Traffic Measurements.

Text/Reference Books:

1.	Telecommunication System Engineering, Roger L. Freeman, Wiley (2004)
2.	Telecommunication Switching Systems & Networks, Thiagrajan Vishwanathan, PHI. (1994)
3.	Introduction to Telecommunications, Gokhale, Cengage learning. (2011)
4.	Telecommunication, W.Fraser., PHI 1970 3. Digital Telephony, Bellamy, Wiley. (2000)
5.	Schaum's Outline of Theory and Problems of Transmission Lines, TMH. (2007)
6.	Transmission Lines and Networks, Umesh Sinha, Satya Prakashan. (2010)
7.	E. Keiser & E. Strange, Digital Telephony and Network Integration, (2/e), Van Nostrand. (1995)
8.	Principles of Telephony, N.N. Biswas, Sangam Books Limited. (1993)
9.	Transmission Lines and Networks, Umesh Sinha, Satya Prakashan
10.	Telecommunications Switching, Traffic and Networks, J.E. Flood, Pearson

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU03	Telecommunication Engineering	CO 1	**Understand** - various parameters of Transmission Lines.
		CO 2	**Analyze** networks like filters, attenuators and equalizers to make an efficient Transmission.
		CO 3	**Explain-**fundamentals of a telecom system.
		CO 4	**Describe**-the common switching operations found in the telecommunications industry.
		CO 5	**Understand and Apply**- telecommunication traffic engineering to evaluate network performance.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU03 Telecommunication Engineering	CO 1	3	1										
	CO 2	3	2	2									
	CO 3	3	1										
	CO 4	3	1	1									
	CO 5	3	2	3									

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Transmission Line: Introduction
Lecture 2	Types of transmission lines
Lecture 3	General transmission line equation
Lecture 4	Line constant, equivalent circuits
Lecture 5	Infinite line and reflection on a line

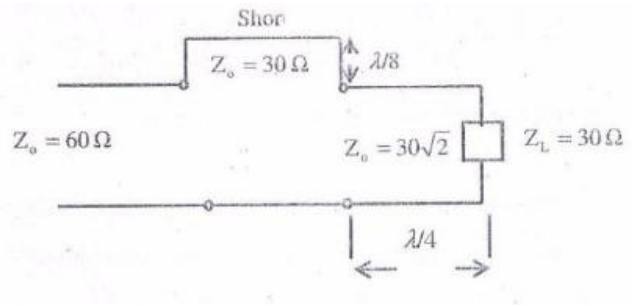
Lecture 6	SWR of line with different type of terminations.
Lecture 7	Distortion less Lines
Lecture 8	Dissipation less lines
Lecture 9	Coaxial cables, Transmission lines at audio and radio frequencies
Lecture 10	Losses in transmission line
Lecture 11	Characteristics of quarter wave
Lecture 12	Characteristics of half wave and lines of other lengths
Lecture 13	Smith chart and its application
Lecture 14	Transmission line applications
Lecture 15	Impedance matching Network
Lecture 16	Single & double Stub matching
Lecture 17	Measurement of parameters of transmission line
Lecture 18	Measurement of attenuation
Lecture 19	Measurement of insertion loss
Lecture 20	Measurement of reflection coefficient & standing wave ratio
Lecture 21	Elements of telephone transmission networks
Lecture 22	Symmetrical and Asymmetrical two port networks.
Lecture 23	Different Attenuators
Lecture 24	π-section & T-section attenuators & stub matching
Lecture 25	Transmission equalizers Filters
Lecture 26	Constant K-section
Lecture 27	Ladder type, π-section, T-section filter
Lecture 28	m-derived filter sections, Lattice filter section
Lecture 29	Concept for Telephony
Lecture 30	Introduction to switching Concepts
Lecture 31	De-generation, Availability and Grading
Lecture 32	Principle of Electronic Exchange
Lecture 33	EPABX and SPC Digital telephone Exchange
Lecture 34	Fascimile services

Lecture 35	Approaches to PCM Switching: Multistage switches
Lecture 36	Time Switch, Space Switch
Lecture 37	STS and TST Switches
Lecture 38	Concept of Supervisory and AC signaling
Lecture 39	Essentials of Traffic Engineering
Lecture 40	Telephone Traffic Measurements

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignment 1	**Q1.** What is the meaning of standing wave patterns? Explain it for lossless transmission line & for transmission line with attenuation.
	Q2. A 20 km long transmission line operating at 500 MHz has following primary constants R=0.5Ω/m, L=250nH/m, C= 100Pf/m, G=10^{-6}S/m. All constants are assumed to be independent of frequency. Calculate characteristics impedance, attenuation coefficient (α) and phase coefficient (β) for the line.
	Q3. Explain the characteristics of transmission line at Radio frequencies and calculate the characteristic impedance.
Assignment 2	**Q1.** In the circuit shown, all the transmission line section are lossless. Calculate the VSWR for the 60Ω line. 
	Q2. Explain a symmetrical lattice attenuator. Write its design equations in terms of characteristics impedance & attenuator factor.
	Q3. Explain the working of two wire or four wire repeaters and compare both of them.

5ECU04	ANALOG COMMUNICATION	3L:1T:0P	4 credits

Syllabus

NOISE EFFECTS IN COMMUNICATION SYSTEMS: Representation of Band Limited and Band Pass Process, Noise Sources and Classification. Resistor noise, Networks with reactive elements, Noise temperature, Noise bandwidth, effective input noise temperature, Noise figure. Noise figure & equivalent noise temperature in cascaded circuits. Narrow band Noise Representation.
AMPLITUDE MODULATION: Frequency translation, Single Tone Modulation, Recovery of base band signal, Spectrum & power relations in AM systems. Methods of Modulation & Demodulation of AM-DSB, DSB-SC and SSB signals. AM BroadcastTransmitters & Receivers, Single Sideband Transmission and Reception, Superheterodyne receivers, Vestigial Sideband Modulation.
FREQUENCY MODULATION: Phase & freq. modulation & their relationship, Spectrum & band width of a Sinusoidal modulated FM signal, Phasor diagram, Narrowband & wide band FM. Generation & demodulation of FM signals. Effect of Channel Non-Linearity. Comparison of AM, FM & PM, Threshold in FM, PLL demodulator. FM Broadcasting transmitters & Receivers.
NOISE IN AM AND FM: Noise in CW modulation systems, SNR calculations for synchronous detection of DSB and SSB and envelope detection of AM, SNR calculations for angle modulation system, Pre-emphasis and de-emphasis, Threshold effect.
PULSE ANALOG MODULATION: Practical aspects of sampling: Natural and flattop sampling. Reconstruction, PAM, PWM, PPM modulation and demodulation methods. Noise Performance of Pulse Analog Modulation Systems.

Text/ Reference Books:

1.	Analog Communications Systems, P RamaKrishna Rao, Mc Graw Hill (2008)
2.	Communications Systems, 5ed-, Haykins, Wiley (2009)
3.	Principles of Communication Systems, Herbert Taub, Donald Schilling, GoutamSaha, TMH. (2009)
4.	Analog and Digital Communication, Schum Series, TMH.(2006)
5.	Digital & Analog Communication Systems, Leon W. Couch, Pearson.(2013)
6.	Analog & Digital Communication Systems, Singal, TMH.(2001)
7	An Introduction To Analog & Digital Communications, Haykins, Wiley.(2009)
8.	Electronic Communication Systems, Kennedy Devis, TMH.(1999)
9.	Digital And Analog Communication Systems, Shanmugam, Wiley.(1994)
10.	Proakis J. G. and Salehi M., "Communication Systems Engineering", PearsonEducation. (2002)

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU04	Analog Communication	CO 1	Explain- about analog communication
		CO 2	Understand and Analyze -AM transmission and reception
		CO 3	Understand and Analyze- About FM and PM transmission and reception.
		CO 4	Understand and Analyze - About pulse modulation.
		CO 5	Understand and Analyze - About noise.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU04 Analog Communication	CO 1	3	2	1									
	CO 2	3	3	3	2	1							
	CO 3	3	3	3	2	1							
	CO 4	3	3	3	2	1							
	CO 5	3	3	2									

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Noise effects in communication systems: Introduction
Lecture 2	Representation of Band Limited and Band Pass Process
Lecture 3	Noise Sources and Classification
Lecture 4	Resistor noise, Networks with reactive elements
Lecture 5	Noise temperature, Noise bandwidth
Lecture 6	Effective input noise temperature, Noise figure.
Lecture 7	Noise figure & equivalent noise temperature in cascaded circuits.
Lecture 8	Narrow band Noise Representation.
Lecture 9	Amplitude modulation: Introduction

Lecture 10	Frequency translation, Single Tone Modulation
Lecture 11	Recovery of base band signal, Spectrum & power relations in AM systems.
Lecture 12	Methods of Modulation & Demodulation of AM-DSB
Lecture 13	Methods of Modulation & Demodulation of DSB-SC and SSB signals.
Lecture 14	AM Broadcast Transmitters & Receivers
Lecture 15	Single Sideband Transmission and Reception
Lecture 16	Superheterodyne receivers, Vestigial Sideband Modulation.
Lecture 17	Frequency modulation: Introduction
Lecture 18	Phase & freq. modulation & their relationship
Lecture 19	Spectrum & band width of a Sinusoidal modulated FM signal
Lecture 20	Phasor diagram, Narrowband & wide band FM.
Lecture 21	Generation & demodulation of FM signals. Effect of Channel Non-Linearity
Lecture 22	Comparison of AM, FM & PM, Threshold in FM
Lecture 23	PLL demodulator.
Lecture 24	FM Broadcasting transmitters & Receivers.
Lecture 25	Noise in AM and FM: Introduction
Lecture 26	Noise in CW modulation systems.
Lecture 27	SNR calculations for synchronous detection of DSB.
Lecture 28	SNR calculations for synchronous detection of SSB.
Lecture 29	Envelope detection of AM.
Lecture 30	SNR calculations for angle modulation system
Lecture 31	Pre-emphasis and de-emphasis.
Lecture 32	Threshold Effect.
Lecture 33	Pulse analog modulation: Introduction
Lecture 34	Practical aspects of sampling: Natural Sampling & reconstruction
Lecture 35	Practical aspects of sampling: Flattop sampling & reconstruction
Lecture 36	PAM Modulation & Demodulation method
Lecture 37	PWM Modulation & Demodulation method
Lecture 38	PPM Modulation & Demodulation method

Lecture 39	Noise Performance of Pulse Analog Modulation Systems
Lecture 40	Spill over Class

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignment 1	**Q1.** Define Following & find- i. Noise bandwidth ii. Noise figure iii. Noise in reactive elements iv. Noise in active elements **Q2.** Define equivalent noise temperature and find its expression in cascaded circuits. **Q3.** Compare AM, FM& PM in respect of Bandwidth & Noise effects.
Assignment 2	**Q1.** Draw the phase diagram of narrow & wide band FM. **Q2.** If a baseband signal $x(f) = 2 \sin 100t + 1.5 \cos 300t$ is amplitude modulated with carrier signal $y(f) = 10 \sin 3 \times 10^6 t$ Then - (i) Draw the frequency spectrum of AM signal (ii) Find the overall modulation index. **Q3.** Define the following & explain - (i) Threshold effect (ii) Synchronous detection (iii) Analog & Digital modulation (iv) Noise in CW and discrete systems.

5ECU05	Microwave Engineering-I	3L:0T:0P	3 credits

Syllabus

WAVEGUIDES: Introduction of Microwaves and their applications. Rectangular and Circular Waveguides: TE and TM wave solutions, Field patterns, Power flow and Microwave Cavities.
MICROWAVE NETWORK ANALYSIS: Impedance and Admittance matrices, Scattering matrix, Parameters of reciprocal and Loss less networks, ABCD Matrix, Equivalent circuits for two-port networks, Conversion between two-port network.
MICROWAVE PASSIVE COMPONENTS: Waveguide Components: E-plane and H- plane Tees, Magic Tee, Directional couplers, Microwave Circulator and Isolators.
MICROWAVE MEASUREMENTS: Detection of microwaves, Microwave power measurement, Impedance measurement, Measurement of VSWR, spectrum analyzer.
PLANAR TRANSMISSION LINES: Introduction of strip lines and micro-strip lines, field patterns and characteristic impedance. Types of micro-strip lines and their comparisons with physical structures. Losses in micro-strip lines, Advantages over waveguides.
MICROWAVE INTEGRATED CIRCUIT TECHNOLOGY: Substrates for Microwave Integrated Circuits (MICs) and their properties. Microwave Monolithic Integrated Circuit (MMIC) technology-Substrates material, MMIC fabrication Techniques and comparison with MIC technology.

Text/Reference Books:

1.	A. Das and S. Das, Microwave Engineering, Tata McGraw-Hill. (2000)
2.	D. M. Pozar, Microwave Engineering, John Wiley & Sons, 1998. (Use the latest version)
3.	B. Bhat and S. K. Koul, Stripline-like Transmission Lines for Microwave Integrated Circuits, Wiley Eastern Ltd. (1989)
4.	T. C. Edwards, Foundations for Microstrip Circuit Design, John Wiley & Sons. (1981)
5.	K. C. Gupta, R. Garg, I.Bahl and P. Bhartia, Microstrip Lines and Slotlines, Second Edition, Artech House. (1996)
6.	K.C Gupta, Microwaves, Wiley Eastern Ltd. (1979)
7.	P.A. Rizzi, Microwave Engineering- Passive Circuits, Prentice Hall. (1988)
8.	Robert E. Collin, Foundations for microwave engineering 2ed (2012)
9.	Microwave Engineering , Raghuvanshi,Cengage learning

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU05	Microwave Engineering-I	CO 1	Understand and Design- Rectangular and circular waveguides, Microwave Cavities.
		CO 2	Design and analysis- the different microwave two/ multi port networks and different waveguide components.
		CO 3	Design and analysis - the structure and field pattern of various planar transmission lines.
		CO 4	Understand- about Microwave Measurements.
		CO 5	Understand and design-the components using MIC technology.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU05 Microwave Engineering-I	CO 1	3	3	1		1							
	CO 2	3	3	1		1							
	CO 3	3	3	1		1							
	CO 4	3	2	1									
	CO 5	3	3	1									

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction of Microwaves and their applications.
Lecture 3	Waveguides: Rectangular waveguides
Lecture 4	Circular Waveguides
Lecture 5	TE & TM wave solutions
Lecture 6	Field patterns

Lecture 7	Power flow
Lecture 8	Microwave Cavities
Lecture 9	Microwave network analysis: Introduction
Lecture 10	Impedance and Admittance matrices
Lecture 11	Scattering matrix
Lecture 12	Parameters of reciprocal networks
Lecture 13	Parameters of Loss less networks
Lecture 14	ABCD Matrix
Lecture 15	Equivalent circuits for two-port networks
Lecture 16	Conversion between two-port networks.
Lecture 17	Microwave passive components: Introduction
Lecture 18	Waveguide Components: E-plane Tees
Lecture 19	Waveguide Components: H-plane Tees
Lecture 20	Waveguide Components: Magic Tee
Lecture 21	Directional couplers
Lecture 22	Microwave Circulator and Isolators.
Lecture 23	Microwave measurements
Lecture 24	Detection of microwaves
Lecture 25	Microwave power measurement
Lecture 26	Impedance measurement
Lecture 27	Measurement of VSWR
Lecture 28	Spectrum Analyzer
Lecture 29	Planar transmission lines
Lecture 30	Introduction of strip lines and micro-strip lines
Lecture 31	Field patterns and characteristic impedance.
Lecture 32	Types of micro-strip lines
Lecture 33	Comparisons of micro-strip lines with physical structures.
Lecture 34	Losses in micro-strip lines
Lecture 35	Advantages over waveguides

Lecture 36	Microwave Integrated Circuit Technology
Lecture 37	Substrates for Microwave Integrated Circuits (MICs) and their properties
Lecture 38	Microwave Monolithic Integrated Circuit (MMIC) technology- Substrates material
Lecture 39	MMIC fabrication Techniques and comparison with MIC technology
Lecture 40	Spill Over Class

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.** Write s-matrix and explain the working of magic tees. **Q2.** Draw the directional coupler and explain return loss, directivity, coupling and isolation. **Q3.** Calculate the VSWR when the distance between half power points is 1mm. Assume the wave is in dominant mode and given that the dimension of the guide are 4*2.5 cm. and frequency is 10GHz.
Assignment 2	**Q1.** Derive the following in terms of S-parameters when the ports are matched terminated in two port network. i. Insertion Loss ii. Transmission Loss iii. Reflection Loss iv. Return Loss
	Q2. Derive the expression for average power flowing into the port-n of a n-port network, in terms of parameters proportional to incident wave and outgoing wave. **Q3.** Describe the MMIC techniques and also list basic materials for MMIC.

5ECU06.1	Biomedical Instrumentation	3L:0T:0P	3 credit

HUMAN BODY SUBSYSTEMS- Brief description of neural, muscular, cardiovascular and respiratory systems; their electrical, mechanical and chemical activities.
TRANSDUCERS AND ELECTRODES- Principles and classification of transducers for Bio-medical applications, Electrode theory, different types of electrodes, Selection criteria for transducers and electrodes.
BIOPOTENTIALS- Electrical activity of excitable cells, ENG, EMG, ECG, ERG,ECG. Neuron potential.
CARDIOVASCULAR SYSTEM MEASUREMENTS- Measurement of blood pressure, blood flow, cardiac output, cardiac rate, heart sounds, Electrocardiograph, phonocardiograph, Plethysmograph, Echocardiograph.
INSTRUMENTATION FOR CLINICAL LABORATORY- Measurement of pH value of blood, ESR measurement, hemoglobin measurement, O2 and CO2 concentration in blood, GSR measurement. Spectrophotomentry, chromatography, Hematology.
MEDICAL IMAGING: Diagnostic X-rays, CAT, MRI, thermography, ultrasonography, medical use of isotopes, endoscopy.
PATIENT CARE, BIOTELEMETRY AND SAFETY MEASURES Elements of Intensive care monitoring basic hospital systems and components, physiological effects of electric current shock hazards from electrical equipment, safety measures, Standards & practices. Biomedical Telemetry: Introduction, block diagram and description of single channel/multi channel telemetry systems.
THERAPEUTIC AND PROSTHETIC DEVICES - Introduction to cardiac pacemakers, defibrillators, ventilators, muscle stimulators, diathermy, heart lung machine, Hemodialysis, Applications of Laser.
APPLICATIONS OF BIOPOTENTIALS: Electrocardiographic diagnostic criteria for Identification of cardiac disorders, Electrocardiographic pattern of ischemia, Atrial abnormalities, Ventricular enlargement, Abnormal ECG patterns, Clinical applications of EEG, EMG, ERG
COMPUTER APPLICATIONS: data acquisition and processing, remote data recording and management. Real time computer applications.

Text/Reference Books:

1.	L. Cromwell, F. J. Weibell, and L. A. Pfeiffer, Biomedical Instrumentation and Measurements, PearsonEducation, Delhi, (1990)
2.	J. J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, 4th ed., Pearson Education,Delhi, (2001)
3.	Biomedical Instrumentation Systems , Chatterjee, Cengage learning.(2011)
4.	Aston, “Principles of Biomedical Instrumentation and measurements”, McGraw Hillpublishing Co. (1990)
5.	L.A. Geddes and L.E. Baker, Principles of Applied Biomedical Instrumentation , JohnWiley & Sons, Inc. (1989)
6.	Richard Aston, Principles of Biomedical Instrumentation and Measurement, MerrillPublishing Company. (1990)

7.	Jacobson B. and Webster J.G., Medical Clinical Engineers , Prentice Hall Inc. (1979)
8.	J. G. Webster, Medical Instrumentation Application and Design, 3rd ed., John Wiley &Sons, N.Y. (1998)
9.	R. S. Khandpur, Handbook of Biomedical Instrumentation, 2nd ed., Tata McGraw Hill.(2003)
10.	R. Anandanatarajan, "Biomedical Instrumentation", PHI Learning. (2009).

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU06.1	**Biomedical Instrumentation**	**CO 1**	Understand and describe- the physical and medical principles used as a basis for biomedical instrumentation.
		CO 2	Understand- the elements of risk for different instrumentation methods and basic electrical safety
		CO 3	Explain- the different medical imaging systems
		CO 4	Explain and describe-different diagnostic measurement methods for identification of humane biopotentials and their necessary instrumentation
		CO 5	Explain and describe- different therapeutic methods of treatment where electrical medical equipment are a vital part of the method and their necessary instrumentation.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU06.1 Biomedical Instrumentation	**CO 1**	1	1	1									
	CO 2	1	1	1	1								
	CO 3	2	1	1	1								
	CO 4	1	2	1	1								

	CO 5	2	2	1									

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Brief description of neural, muscular systems
Lecture 2	Brief description of cardiovascular and respiratory systems
Lecture 3	Electrical, mechanical and chemical activities of different systems
Lecture 4	Transducers and electrodes- Introduction
Lecture 5	Principles and classification of transducers for Bio-medical applications.
Lecture 6	Electrode theory, different types of electrodes
Lecture 7	Selection criteria for transducers and electrodes.
Lecture 8	Biopotentials- Electrical activity of excitable cells
Lecture 9	Study of ENG, EMG, ECG, ERG,ECG, Neuron potential
Lecture 10	Measurement of blood pressure, blood flow
Lecture 11	Measurement of cardiac output, cardiac rate
Lecture 12	Measurement of heart sounds, Electrocardiograph
Lecture 13	Measurement of phonocardiograph, Plethysmograph
Lecture 14	Measurement of Echocardiograph
Lecture 15	Instrumentation for clinical laboratory
Lecture 16	Measurement of pH value of blood
Lecture 17	ESR measurement, hemoglobin measurement
Lecture 18	Measurement of O2 and CO2 concentration in blood, GSR measurement
Lecture 19	Measurement of Spectrophotometry
Lecture 20	Measurement of Chromatography and Hematology
Lecture 21	Medical imaging: Diagnostic X-rays, CAT, MRI
Lecture 22	Thermography and ultrasonography
Lecture 23	medical use of isotopes, endoscopy
Lecture 24	Patient care, biotelemetry and safety measures

Lecture 25	Elements of Intensive care monitoring basic hospital systems and components
Lecture 26	Physiological effects of electric current shock hazards from electrical equipment
Lecture 27	Safety measures, Standards & practices
Lecture 28	Biomedical Telemetry: Introduction
Lecture 29	Block diagram and description of single channel/multi channel telemetry systems.
Lecture 30	Therapeutic and prosthetic devices - Introduction to cardiac pacemakers
Lecture 31	Defibrillators, ventilators, muscle stimulators
Lecture 32	Diathermy, heart lung machine, Hemo-dialysis
Lecture 33	Applications of Laser
Lecture 34	Applications of biopotentials: Electrocardiographic diagnostic criteria for Identification of cardiac disorders
Lecture 35	Electrocardiographic pattern of ischemia, A trial abnormalities
Lecture 36	Ventricular enlargement, Abnormal ECG patterns,
Lecture 37	Clinical applications of EEG, EMG, ERG
Lecture 38	Computer applications: data acquisition and processing
Lecture 39	Remote data recording and management
Lecture 40	Real time computer applications

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.** Explain the principles & classification of transducers for bio-medical applications. **Q2.** What do you mean by Electrical activity of excitable cells, Explain? **Q3.** Explain the following terms incorporated with Cardiovascular system Measurement a) Blood Pressure b) Blood Flow c) Cardiac Output d) Cardiac Rate
Assignment 2	**Q1.** Explain the working principle for measurement of partial pressure of oxygen (PO2) in the blood and describe suitable scheme for it. **Q2.** What is the requirement of Therapeutic and Prosthetic devices?

	Explain the working of cardiac pacemakers, defibrillators in detail. **Q3.** Write short notes on- i. Diagnostic X-Rays ii. MRI iii. Ultrasonography

5ECU07	ELECTRONIC ENGINEERING DESIGN LAB	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Op-Amp characteristics and get data for input bias current measure the output-offsetvoltage and reduce it to zero and calculate slew rate.
2.	Op-Amp in inverting and non-inverting modes.
3.	Op-Amp as scalar, summer and voltage follower.
4.	Op-Amp as differentiator and integrator.
5.	Design LPF and HPF using Op-Amp 741
6.	Design Band Pass and Band reject Active filters using Op-Amp 741.
7.	Design Oscillators using Op-Amp (i) RC phase shift (ii) Hartley (iii) Colpitts
8.	Design (i) Astable (ii) Monostable multivibrators using IC-555 timer
9.	Design Triangular & square wave generator using 555 timer.
10.	Design Amplifier (for given gain) using Bipolar Junction Transistor.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU07	**Electronic Devices Lab**	**CO 1**	To design-the Op-amp based circuits, assemble these on bread board and test them
		CO 2	To design-multi vibrators and wave form generators using IC-555 timer
		CO 3	Validation- of these circuits with the help of appropriate software.
		CO 4	Design and analyze different filters using op-amp 741
		CO 5	Invent various wave generator using 555 timer

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU07 Electronic Devices Lab	**CO 1**	3	2	3									
	CO 2	3	2	3									
	CO 3	2	1			3							
	CO 4	2	3	1									
	CO 5	3	2	1									

3: Strongly **2: Moderate** **1: Weak**

5ECU08	MICROWAVE ENGINEERING LAB	0L:0T:2P	1 credit

List of Experiments

S. No.	Name of Experiment
1.	Study of various microwave components and instruments like frequency meter, attenuator, detector and VSWR meter. (a) Measurement of guide wavelength and frequency using a X-band slotted line setup. (b) Measurement of low and high VSWR using a X-band slotted line setup.
2.	Introduction to Smith chart, measurement of SWR, shift in minimum standing wave with unknown load and calculation of unknown load impedance using Smith chart.
3.	Study the behavior of terminated coaxial transmission lines in time and frequency domain.
4.	(a) Draw the V-I characteristics of a Gunn diode and determine the output power and frequency as a function of voltage. (b) Study the square wave modulation of microwave signal using PIN diode.
5.	Study and measurement of resonance characteristics of a micro-strip ring resonator using power meter and determination of the substrate dielectric constant.
6.	Study and measure the power division and isolation characteristics of a microstrip 3dB power divider.
7.	Study of rat race hybrid ring (equivalent of waveguide Magic-Tee) in micro-strip.
8.	(a) To study the characteristics of micro-strip 3dB branch line coupler, strip line backward wave coupler as a function of frequency and compare their bandwidth. (b)Measure the microwave input, direct, coupled and isolated powers of a backward wave strip line coupler at the centre frequency using a power meter. From the measurements calculate the coupling, isolation and directivity of the coupler.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU08	Microwave Engineering Lab	CO 1	Measure- the various parameters of microwave components.
		CO 2	To understand and analyze- the components and setup of Microwave test bench
		CO 3	Validation- of these circuits with the help of appropriate software
		CO 4	Explain- the characteristics of microwave device

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU08 Microwave Engineering Lab	CO 1	2	2	2									
	CO 2	1	1	2									
	CO 3					3							
	CO 4	2		2									

3: Strongly **2: Moderate** **1: Weak**

5ECU09	Communication Lab-I	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	To generate the different type of waveforms using fundamental frequency and its harmonics and also analysis these waveforms.
2.	Perform the experiment of the amplitude modulation and calculate the modulation index. Also study the DSB, DSB-SC, SSB modulation & demodulation and also observe the effect of AGC.
3.	To Study the properties of Super Heterodyne receiver in AM transmitting & receiving. Sensitivity, selectivity through experimental setup.
4.	To perform the different type of FM modulation & demodulation schemes and study the effect of Amplitude limiter in FM demodulator.
5.	To find the characteristics impedance, input impedance, losses, standing waves, phase shifting in transmission line.
6.	To perform the PAM (natural, flat top, sample & hold sampling), PWM, PPM Modulation & demodulation techniques.
7.	To perform the experiment of and observe the effect of change in type of modulating signal as sine , square, arbitrary and change in frequency of sampling signal in PAM,PWM, PPM modulation and demodulation.
8.	To Study & observation of the four channel analog TDM using DSB-SC through experimental setup.
9.	To Study& observation of the FDM through experimental setup.
10.	To perform the experiment of the various sampling (natural, flat top & sample & hold) of analog signal of type sine, square & arbitrary.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU09	Communication Lab-I	CO 1	Understand-the concept of Modulation and demodulation.
		CO 2	Illustrate-the real time experience to the super heterodyne receiver and response of each stage.
		CO 3	Explain-the applications of Pulse modulation with concept of Multiplexing.
		CO 4	Analyze the types of sampling techniques.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU09 Communication Lab-I	CO 1	2	2	1									
	CO 2	3	2	1									
	CO 3	3	2	1									
	CO 4	2	1		3								

3: Strongly **2: Moderate** **1: Weak**

5ECU10	SIGNAL PROCESSING LAB	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Generation of continuous and discrete elementary signals (periodic and non periodic) using mathematical expression.
2.	Generation of Continuous and Discrete Unit Step Signal.
3.	Generation of Exponential and Ramp signals in Continuous & Discrete domain.
4.	Continuous and discrete time Convolution (using basic definition).
5.	Adding and subtracting two given signals. (Continuous as well as Discrete signals)
6.	To generate uniform random numbers between (0, 1).
7.	To generate a random binary wave.
8.	To generate random sequences with arbitrary distributions, means and variances for following : a) Rayleigh distribution b) Normal distributions: N(0,1). c) Gaussion distributions: N (mx, σ_x^2)
9.	To plot the probability density functions. Find mean and variance for the above distributions.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU10	Signal Processing Lab	CO 1	Understand and Apply-the MATLAB programming to solve practical problems.
		CO 2	Understand and Apply- modeling and simulation in MATLAB environment
		CO 3	Analyze various types of signals using MATLAB
		CO 4	Generate different sequences on MATLAB.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5ECU10 Signal Processing Lab	**CO 1**	3	2	1									
	CO 2	3	2	2		1							
	CO 3	2	3		1								
	CO 4	2	1	3									

3: Strongly **2: Moderate** **1: Weak**

6ECU01	MICROWAVE ENGINERING-II	3L:1T:0P	4 credits

Syllabus

MICROWAVE MEASUREMENTS:
Detection of microwaves, Microwave power measurement, Impedance measurement, Measurement of sca ttering parameters, Frequency measurement, VSWR measurements

Introduction to microstrip lines, Parallel striplines, Coplanar striplines, Shielded striplines, Slot lines, Inte grated Fin line, Non-radiative guide, Transitions, Bends and Discontinuities.

MICROWAVE NETWORK ANALYSIS
Impedance and Admittance matrices, Scattering matrix, Reciprocal networks and Loss less networks para meters, ABCD Matrix, Equivalent circuits for Two-
port Network, Conversions between two port network Signal flow graphs, Discontinuities in waveguides and micro strips.

MICROWAVE SEMICONDUCTOR DEVICES
Construction, Operation and Practical applications of PIN diode, varactor and Tunnel diode, Gunn diode, IMPATT, TRAPTT diodes, BJT, JFET, MESFET, CCD, MASER and LASER.

MONOLITHIC MICOWAVE INTEGRATED CIRCUITS
Introduction, Materials, MMIC Growth, MOSFET fabrication, Thin film formation, Hybrid integrated cir cuit fabrication, Advantages & Difficulties of MICs

Text/Reference Books:

1.	A. Das and S. Das, Microwave Engineering, Tata McGraw-Hill, 2000
2.	S.Y.Liao, Microwave devices and circuits, Prentice Hall, 2nd Edition ,1985
3.	B. Bhat and S. K. Koul, Stripline-like Transmission Lines for Microwave Integrated Circuits, Wiley Eastern Ltd.,1989
4.	K. C. Gupta, R. Garg, I. Bahl and P. Bhartia, Microstrip Lines and Slotlines, Second Edition, Artech House,1996
5.	T. C. Edwards, Foundations for Microstrip Circuit Design, John Wiley & Sons,1981.
6.	P.A. Rizzi, Microwave Engineering- Passive Circuits, Prentice Hall,.1988
7.	D. M. Pozar, Microwave Engineering, John Wiley & Sons,. (Use the latest version),1998
8.	Dennis Roddy, Microwave Technology, Prentice-Hall,1996
9.	Microwave and Radar Engineering, G.S.B. Rao, Pearson,2013
10.	Robert E. Collin, Foundations for microwave engineering 2ed, 2012
11.	Robert E. Collin, Foundations for microwave engineering 2ed, 2013

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU01	Microwave Engineering-II	CO 1	Describe the different parameter of different microwave component
		CO 2	Differentiate the different microwave transmission lines.
		CO 3	Analysis the different microwave two/ multi port networ ks and semiconductor devices of microwave.
		CO 4	Design the semiconductor devices of microwave.
		CO 5	Fabricate and Measure the components using MIC technology

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6ECU01 MICROWAVE ENGINERING-II	CO 1	3	2	1	1								
	CO 2	2	2	1	1								
	CO 3	2	3	1	1								
	CO 4	2	2	3	1								
	CO 5	2	2	1	1								

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction to microwave measurements
Lecture 3	Detection of microwaves, Microwave power measurement
Lecture 4	Impedance measurement,
Lecture 5	Measurement of scattering parameters

Lecture 6	Frequency measurement, .
Lecture 7	VSWR measurements
Lecture 8	Introduction to microstrip lines
Lecture 9	Introduction to microstrip lines
Lecture 10	Parallel striplines
Lecture 11	Coplanar striplines
Lecture 12	Integrated Fine line
Lecture 13	Non-radiative guide
Lecture 14	Shielded striplines
Lecture 15	Introduction toTransitions, Bends and Discontinuities.
Lecture 16	Introduction toTransitions, Bends and Discontinuities.
Lecture 17	Introduction to MICROWAVE NETWORK ANALYSIS
Lecture 18	Impedance and Admittance matrices
Lecture 19	Scattering matrix
Lecture 20	Loss less networks parameters
Lecture 21	ABCD Matrix
Lecture 22	Equivalent circuits for Two- port Network, Conversions between two port network Signal flow graphs
Lecture 23	Introduction to Discontinuities in waveguides and micro-strip
Lecture 24	Introduction to Discontinuities in waveguides and micro-strip
Lecture 25	Introduction to microwave semiconductor devices
Lecture 26	Introduction to microwave semiconductor devices
Lecture 27	Construction, Operation and Practical applications of PIN diode
Lecture 28	Construction, Operation and Practical applications of PIN diode
Lecture 29	Varactor and Tunnel diode,
Lecture 30	Gunn diode
Lecture 31	IMPATT, TRAPTT diodes,
Lecture 32	CCD, MASER and LASER
Lecture 33	BJT, JFET, MESFET

Lecture 34	Introduction to **M**onolithic micowave integrated circuits
Lecture 35	Introduction to Materials
Lecture 36	MMIC Growth
Lecture 37	MOSFET fabrication
Lecture 38	Thin film formation
Lecture 39	Hybrid integrated circuit fabrication,
Lecture 40	Spill over class

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	Q1. Discuss impedance matching with Lumped network.
	Q2. Explain TWT used as microwave amplifier..
	Q3. Beam loading capacitance and show that neglecting it was justified in preceding calculation.
Assignment 2	Q1. **Explain the wave modes of helix type travelling wave tube and show output Power gain of TWT is AP = –9.54 + 47.3 μc dB.**
	Q2. What is the slot line and how do they differ from micro-strip line.
	Q3.What is charge coupled device. Using suitable diagram explain buried CCD.

6ECU02	MICROPROCESSORS AND MICROCONTROLLER	3L:0T:0P	3 credits

Syllabus

MICROPROCESSORS AND MICROCONTROLLER MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU
8085programming techniques. Looping, counting and Indexing, Counters and Time Displays , stacks & subroutines Code Conversion: BCD Arithmetic instructions,16- bit data operation, Arithmetic operation conditional related to memory.
Interrupts: The 8085 Interrupt, vectored interrupts, additional I/O concepts and processes, serial I/O & data communication
Peripheral devices& their interfacing: The 8255 Programmable peripheral interface, interfacing data converter, Interfacing keyboard and Seven Segment display. The 8254(8253) programmable Interval timer, the 8259 programmable Interrupt controller 8259A, DMA and8257 DMA controller.
Overview of advanced microprocessor architecture: 8086,286,486, Pentium processor, concept of virtual memory, cache memory,8051 microcontroller, Introduction to RISC processor, ARM microcontroller, MSP 430 family microcontroller

Text/Reference Books:

1.	Architecture, Programming &Application, Ramesh S. Gaonkar, 2000
2.	A Textbook of Microprocessors and Microcontrollers, R.S. Kaler I.K International Publishing House Pvt. Ltd
3.	Introduction to Microprocessors, A.P. Mathur, Mc Graw Hill ,2002

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU02	Microprocessors and Microcontrollers	CO 1	**Discuss t**he basic knowledge of microprocessor& microcontroller and its need.
		CO 2	**Analysis** of different architecture of microprocessor and microcontroller with application.
		CO 3	**Ability** to write the programming using 8085 microprocessor
		CO 4	**Examine** basic idea of data transfer and their conversion
		CO 5	**Explain** the internal structure and interfacing of different peripheral devices.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6ECU02 Microprocessors and Mi crocontrollers	CO 1	3	2	1	1								
	CO 2	2	3	1	1								
	CO 3	3	2	1	1								
	CO 4	2	2	1	1								
	CO 5	3	2	1	1	1							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction to 8 –bit microprocessor
Lecture 3	8085 architecture, memory
Lecture 4	I/O Devices, Logic devices for interfacing, Memory &I/O Interfacing.

Lecture 5	I/O Devices, Logic devices for interfacing, Memory &I/O Interfacing
Lecture 6	addressing modes,
Lecture 7	Instructions
Lecture 8	Assembly language programming
Lecture 9	Assembly language programming
Lecture 10	BCD Arithmetic instructions,
Lecture 11	Arithmetic operation conditional related to memory
Lecture 12	16- bit data operation
Lecture 13	Looping
Lecture 14	counting and Indexing
Lecture 15	Counters and Time Displays
Lecture 16	Stacks & subroutines
Lecture 17	Introduction to interrupts
Lecture 18	The 8085 Interrupt, vectored interrupts
Lecture 19	The 8085 Interrupt, vectored interrupts
Lecture 20	Serial I/O & data communication.
Lecture 21	Introduction to Peripheral devices& their interfacing
Lecture 22	The 8255 Programmable peripheral interface
Lecture 23	interfacing data converter
Lecture 24	Interfacing keyboard and Seven Segment display
Lecture 25	Interfacing keyboard and Seven Segment display
Lecture 26	The 8254(8253) programmable Interval timer
Lecture 27	The 8254(8253) programmable Interval timer,
Lecture 28	the 8259 programmable Interrupt controller
Lecture 29	8259A, introduction to DMA
Lecture 30	8257 DMA controller.
Lecture 31	Overview of advanced microprocessor architecture:
Lecture 32	8086,286,486,

Lecture 33	8086,286,486,
Lecture 34	Pentium processor
Lecture 35	concept of virtual memory, cache memory
Lecture 36	8051 microcontroller
Lecture 37	Introduction to RISC processor
Lecture 38	ARM microcontroller
Lecture 39	MSP 430 family microcontroller
Lecture 40	MSP 430 family microcontroller

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignment 1	Q1. Is it possible that an output and input port have the same 8 bit address?if yes how does the 8085 MPU differentiate between the ports?if no
	Q2. Define tri-state logic and explain the function of following devices. a) Buffer b) Decoder c) Latches d) Encoder
	Q3. Explain the format the 8 bit and 16 formats.
Assignment 2	Q1. Pack the two BCD unpacked number stored in binary location 2000H and 20001H. store the result in 2500 H. Assume the last bit stored in 20001 H
	Q2. What do you mean by vectored interrupt and non vectored interrupts. Also differentiate mask able and non mask able interrupts.
	Q3. Explain the different type of mode 8259 PIC with diagram

6ECU03	**INDUSTRIAL ELECTRONICS**	**3L:0T:0P**	**3 credits**

Syllabus:

SEMICONDUCTOR POWER DEVICES :Introduction. Basic characteristics & working ofPower Diodes, Diac, Triac, Power Transistor, MOSFETs, IGBT, and GTO, Power transistorand SCR-principal of operation, V-I characteristics, Turn-on mechanism and its applications
CONVERTER & INVERTERS - Basic concept ,Working principles of single phase half wave-bridge converter, single phase full wave bridge converter, three phase bridge converter
INVERTER: Voltage source inverters ,current source inverters, PWM, control of voltage sources-converter and application
INDUSTRIAL POWER SUPPLIES: Principle of operation of choppers. Step up, Step down and reversible choppers, chopper control technique High frequency electronic ballast, Switch Mode Power Supply: Fly back converter, forward/buck converter, Boost converter and buck-boost converter. Uninterruptible Power Supply
MOTOR CONTROL: Introduction to speed control of DC motors using phase controlled converters and choppers, Basic idea of speed control of three phase induction motors using voltage and frequency control methods
STEPPER MOTORS: Variable reluctance, Permanent magnet and hybrid stepper motors. Induction anddielectric heating control

Text/Reference Books:

1.	Power Electronics Principles & Applications, Joseph Vithayathil, TMH 2010
2.	Power Eletronics, Ravish Singh, TMH, 2012
3.	Power Electronics: Converters Applications., Mohan, Robbins, Wiley, 1995
4.	Industrial Electronics And Control, Ttti, TMH,2001
5.	Power Electronics, Moorthi, Oxford,2005

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU03	INDUSTRIAL ELECTRONICS	CO 1	**Discuss** different power electronics devices, converter , inverter and their characterics
		CO 2	**Identify** of outcome of power electronics devices with their particle application
		CO 3	**Ability to understand** and A**nalyze** various single phase and three phase supplies and also the control the speed of DC and stepper motor
		CO 4	**Explain** the basic concept of semiconductor devices, stepper motor and DC motor
		CO 5	**Develop** skills to build and trouble shoot power electronics circuits

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6ECU03 INDUSTRIAL ELECTRONICS	CO 1	3	1	2	1								
	CO 2	2	3	1	1								
	CO 3	3	2	1	1								
	CO 4	3	1	1	1								
	CO 5	2	3	1									

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction. Basic characteristics & working of Power Diodes
Lecture 3	Introduction. Basic characteristics & working of Power Diodes

Lecture 4	characteristics & working DIAC, TRIAC
Lecture 5	Basic characteristics & working Power Transistor
Lecture 6	principal of operation, V-I characteristics MOSFETs
Lecture 7	principal of operation, V-I characteristics IGBT, and GTO
Lecture 8	principal of operation, V-I characteristics of SCR
Lecture 9	Turn-on mechanism and its applications
Lecture 10	Basic concept ,Working principles of single phase half wave-bridge converter
Lecture 11	single phase full wave bridge converter,
Lecture 12	three phase bridge converter
Lecture 13	Voltage source inverters
Lecture 14	Voltage source inverters
Lecture 15	PWM, control of voltage sources converter and application..
Lecture 16	PWM, control of voltage sources converter and application.
Lecture 17	Principle of operation of choppers.
Lecture 18	Step up, Step down choppers,
Lecture 19	reversible choppers
Lecture 20	chopper control technique High frequency electronic ballast
Lecture 21	chopper control technique High frequency electronic ballast
Lecture 22	Boost converter
Lecture 23	buck-boost converter.
Lecture 24	Introduction to Switch Mode Power Supply,
Lecture 25	Fly back converter
Lecture 26	forward/buck converter
Lecture 27	Introduction to speed control of DC motors using phase controlled choppers
Lecture 28	Introduction to speed control of DC motors using phase controlled choppers
Lecture 29	Basic idea of speed control of three phase induction motors using voltage control methods
Lecture 30	Basic idea of speed control of three phase induction motors using voltage control methods
Lecture 31	Basic idea of speed control of three phase induction motors using frequency control

	methods
Lecture 32	Basic idea of speed control of three phase induction motors using frequency control methods
Lecture 33	Introduction to speed control of DC motors using phase controlled converters
Lecture 34	Introduction to Variable reluctance
Lecture 35	Permanent magnet
Lecture 36	hybrid stepper motors
Lecture 37	Introduction to Induction control
Lecture 38	Introduction to Induction control
Lecture 39	Introduction dielectric heating control.
Lecture 40	Introduction dielectric heating control.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. Hand-outs

Sample Assignments:

Assignment 1	Q1.An SCR has half wave surge current rating of 3000A and 50 HZ supply. calculate its one cycle surge and I^2t rating.
	Q2. Describe the evaluation of three phase six pulse diode rectifier 3 phase 3 pulse diode rectifier with appropriate circuits
	Q3. Discuss why PMOSFET has no reverse blocking voltage where as in IGBT.
Assignment 2	Q1. Define the following terms a) Critical rate of rise voltage b) finger voltages
	Q2. Describe the voltage converter technique in technique.
	Q3. Explain the chopper control in dc series motor.

6ECU04	OPTICAL FIBRE AND COMMUNICATION	3L:0T:0P	3 credits

Syllabus

Optical Fiber, Structure: wave guiding step index, graded index optical fiber modal analysis .classifications of modes. single mode fibersPulse Dispersion, material and waveguide dispersion, polarization mode.
Dispersion, absorption, Fiber bend loss, scattering loss, Dispersion Shifted Fibers, Dispersion Compensating Fiber.
Optical power launching and coupling. Lensing schemes for coupling improvement fiber to fiber joints. splicing technique, optical fiber connectors.Optical sources and detector: Laser fundamentals, semiconductor laser basic, LEDs, PIN and avalanche photodiodes, optical Tx/Rx circuits.Optical
Design consideration Optical Fiber systems: analog and digital communication, noise in detector process, bit error rate, optical receiver reception, power budget and rise time budget, WDM Measurements of Fiber Attenuation, Dispersion ,Refractive Index Profile, Cut off Wave Length, Numerical Aperture & Diameter, OTDR

Text/Reference Books:

1.	J. M. Senior, Optical Fiber Communication: Principles and Practice, Pearson Education.2013
2.	R.P. Khare, Fiber Optics & Optoelectronics, Oxford Publications. (2014)
3.	J.Gowar, Optical Communication Systems, PHI.
4.	A.Ghatak & K.Thygarajan, Introduction to Fiber Optics, Cambridge University Press.2006
5.	joseph C Palais, Fiber Optics Communication, PHI, 2010
6.	Harold Kolimbris, Fiber Optics Communication, Pearson Education.2009
7.	D. Anuradha, Optical Fiber and Laser, Principles and Applications, New Age.2008

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU04	Optical Fiber Communication	**CO 1**	**Distinguish** between the various mode of operation of optical fiber and also **Discuss** loss during the design consideration of optical fiber system.
		CO 2	**Identify** the various cause for signal degradations
		CO 3	**Predict** the pulse broadening happening due to effect of dispersion of signal.
		CO 4	**Discuss** the various optical power launching and coupling scheme in optical fibre communication.
		CO 5	**Apply** the basic concept of optical fiber with their practical application

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
6ECU04 Optical Fiber Communication	**CO 1**	3	2	1									
	CO 2	2	3	1									
	CO 3	2	3	2	2								
	CO 4	3	1										
	CO 5	3	2	1									

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Introduction to optical fibre
Lecture 2	Optical Fiber, Structure: wave guiding step index,
Lecture 3	Optical Fiber, Structure: wave guiding step index,

Lecture 4	graded index optical fiber modal analysis
Lecture 5	Classifications of modes. single mode fibers
Lecture 6	Classifications of modes. single mode fibers
Lecture 7	Introduction to Dispersion
Lecture 8	Pulse Dispersion, material and waveguide dispersion
Lecture 9	Polarization mode Dispersion,
Lecture 10	Absorption,
Lecture 11	scattering loss
Lecture 12	Fiber bend loss
Lecture 13	Dispersion Shifted Fibers,
Lecture 14	Dispersion Compensating Fiber
Lecture 15	Introduction to Optical power launching and coupling
Lecture 16	Lensing schemes for coupling improvement fiber to fiber joints
Lecture 17	Lensing schemes for coupling improvement fiber to fiber joints
Lecture 18	splicing technique
Lecture 19	optical fiber connectors.
Lecture 20	Introduction to Optical sources and detector
Lecture 21	Laser fundamentals, semiconductor laser basic
Lecture 22	LEDs,
Lecture 23	PIN and avalanche photodiode
Lecture 24	optical Tx/Rx circuits.
Lecture 25	Design consideration Optical Fiber systems
Lecture 26	Analog and digital communication, noise in detector process
Lecture 27	Analog and digital communication, noise in detector process
Lecture 28	optical receiver reception
Lecture 29	bit error rate, optical receiver reception
Lecture 30	power budget and rise time budget,
Lecture 31	WDM
Lecture 32	WDM

Lecture 33	Measurements of Fiber Attenuation
Lecture 34	Dispersion ,Refractive Index Profile,
Lecture 35	Dispersion ,Refractive Index Profile,
Lecture 36	Cut off Wave Length
Lecture 37	Numerical Aperture & Diameter, OTDR.
Lecture 38	Numerical Aperture & Diameter, OTDR.
Lecture 39	Numerical Aperture & Diameter, OTDR.
Lecture 40	Spill over class

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample asignments:

Assignment 1	Q1. Use the ray equation in paraxial approximation to prove that intermodal dispersion is zero for a graded index fibre with Quadratic index profile.
	Q2.What technique are used to create high intensive light pulse from laser diode
	Q3. The longitudinal mode of GaAs injection Laser emitting at a wavelength of 0.87 μm are separated at frequency by 278 GHz. Determine the length of optical cavity and number of longitudinal mode emitted. The refractive index of GaAs is 3.6.
Assignment 2	Q1. What technique is used to join two optical fibre? Explain in brief? Q2. Explain the holography process?
	Q3. Write down some practical application of optical fibre instrumentation in daily life? Also give its advantages and drawbacks with clarification?

6ECU04	DIGITAL COMMUNICATION	3L:0T:0P	3 credit

Syllabus:

Pulse code modulation (PCM):sampling and quantization process, noise in PCM systems, matched filter: error rate due to noise, time division multiplexing, differential Pulse code multiplexing (DPCM), Delta modulation, adaptive delta modulation(ADM),
Base Band Pulse Transmission: Line codes uni-polar, Bipolar, AMI, Manchester, Inter symbol interference(ISI), Pulse shaping, Nyquist's criterion, Ideal Nyquist channel Raised cosine spectrum
Pass band Digital Transmission: signal space analysis: Geometric representation of signals ,likelihood function, correlation receiver, probability of error. coherent binary amplitude, phase and frequency shift keying, QPSK. MSK, hybrid amplitude/phase modulation schemes: M-ary QAM
Information Theory: Information& Entropy coding theorem , Shannon-fanoTheorem and Huffman coding, discrete memory less channels, mutual information, channel capacity ,differential entropy and mutual information for continuous ensembles, information capacity theorem. **Error Control Coding**: Linear Block code: minimum distance and syndrome decoding, Cyclic code: generator and parity check polynomial ,encoder for cyclic codes and calculation of syndrome , Convolutional code: code tree, trellis and state diagram, maximum likelihood decoding, viterbi algorithm.

Text/Reference Books:

1.	Digital Communications Systems, P RamaKrishna Rao, Mc Graw Hill, 2013
2.	Digital Communications Systems, Simon Haykins, Wiley, 2014
3.	Digital Communications: Fundamentals and Applications, Bernard Sklar, Pearson, Education,2002
4.	Analog and Digital Communication, Schum Series, TMH,2006
5.	Digital & Analog Communication Systems, Leon W. Couch, Pearson,2013
6.	An Introduction To Analog & Digital Communications, Haykins, Wiley, 2010
7.	Digital And Analog Communication Systems, Shanmugam, Wiley, 2004
8.	Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education,2008
9.	Electronic Communication Systems-, Kennedy Devis, TMH, 2013

Course outcomes:

Course Code	Course Name	Course Outcome	Details
6ECU04	Digital communication	CO1	**Describe** the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.(k1)
		CO2	**Classify t**he time and frequency domain analysis of the signals in a digital communication system.(k4)
		CO3	**Analyze** the performance of communication system (k4)
		CO4	**Apply** the basics of Information Theory to calculate chann el capacity and other measurement.(k3)
		CO5	**Explain** basic concept of transmission in digital communication system(k6)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6ECU05 Digital communication	**C01**	3	1										
	CO2	2	3	1	1								
	CO3	2	3	2	1								
	CO4	2	2	1									
	CO5	3	1										

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

lecture No.	Content to be taught
Lecture 1	Introduction to Pulse code modulation
Lecture 2	sampling and quantization process,,
Lecture 3	sampling and quantization process,,
Lecture 4	Noise in PCM systems,
Lecture 5	Noise in PCM systems,
Lecture 6	matched filter, rate due to noise
Lecture 7	Time division multiplexing, differential Pulse code multiplexing (DPCM
Lecture 8	Delta modulation,
Lecture 9	adaptive delta modulation(ADM),
Lecture 10	Introduction to Base Band Pulse Transmission
Lecture 11	Line codes uni-polar, Bipolar, AMI, Manchester
Lecture 12	Line codes uni-polar, Bipolar, AMI, Manchester
Lecture 13	Inter symbol interference(ISI)
Lecture 14	Pulse shaping
Lecture 15	Nyquist's criterion,
Lecture 16	Ideal Nyquist channel Raised cosine spectrum
Lecture 17	**I**ntroduction to Pass band Digital Transmission
Lecture 18	signal space analysis: Geometric representation of signals
Lecture 19	signal space analysis: Geometric representation of signals
Lecture 20	likelihood function
Lecture 21	correlation receiver, probability of error
Lecture 22	coherent binary amplitude,
Lecture 23	phase and frequency shift keying
Lecture 24	QPSK.
Lecture 25	MSK
Lecture 26	Hybrid amplitude/phase modulation schemes: M-ary QAM
Lecture 27	Basic **Information Theory**

Lecture 28	Information& Entropy coding theorem ,
Lecture 29	Shannon-fano Theorem
Lecture 30	Huffman coding,
Lecture 31	Discrete memory less channels,
Lecture 32	mutual information, channel capacity
Lecture 33	Differential entropy and mutual information for continuous ensembles
Lecture 34	information capacity theorem
Lecture 35	Linear Block code: minimum distance and syndrome decoding,
Lecture 36	Cyclic code: generator and parity check polynomial ,encoder for cyclic codes and calculation of syndrome
Lecture 37	Cyclic code: generator and parity check polynomial ,encoder for cyclic codes and calculation of syndrome
Lecture 38	Convolution code: code tree, trellis and state diagram, maximum likelihood decoding,.
Lecture 39	Convolution code: code tree, trellis and state diagram, maximum likelihood decoding,.
Lecture 40	viterbi algorithm

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignment1	Q1.What are drawback of delta modulation and how its remove by adaptive delta modulation?
	Q2.Expalin the inter-symbol interference in detail?
	Q3.Explian the following with equation(assume suitable data for the diagram) a) Unipolar RZ and NRZ b) Manchester format c) Bipolar RZ and NRZ d) polar Quaternary NRZ format
Assignment2	Q1. Explain the channel capacity and prove $C= B \log_2(1+S/N)$
	Q2.write a short note on T1 carrier system?
	Q3.A television picture is composed of approximately 300,000 basic pixels. Each of these elements can assume 10 distinguisable brightness level with equal probability.

	Find the information content of a television picture frame?

6ECU05	CONTROL SYSTEM	3L:0T:0P	3 credit

Syllabus:

CONTROL SYSTEM AND THEIR REPRESENTATION:

Terminology and basic structure of control system, Open loop and Closed loop systems, servomechanism, regulatory system, analogous systems. Physical Systems and their models, Electromechanical systems, electrical analogy of physicalsystems. Transfer function, Block diagram representation of physical systems, Blockdiagram algebra, Signal Flow graph and Mason's formula.

TIME RESPONSE: Types of test inputs, Response of first and second order system, Time domain specifications, Error coefficients, generalized error series.

STABILITY: Concepts of stability, location of roots in s-plane for stability,asymptotic stability and relative stability, Routh-Hurwitz stability criterion

ROOT LOCUS: Root locus plot, Properties of Root loci and applications, Stability range from the loci. Determination of roots of the closed loop system, Effect of pole zero addition.

NYQUIST PLOTS: Polar plots, Nyquist plots and Nyquist stability Criterion
BODE PLOTS: Concepts of Gain margin and phase margin, Bode plots Frequency-domain specifications, M and N loci, N**ichols chart,**

CONTROLLERS: Introduction to PID and Lag-lead type Controller

STATE VARIABLE ANALYSIS: Concepts of state, state variable and state model. State variable models for LTI systems. Canonical representations, Transfer function to state-space and vice-versa. Solution to state equations. Concepts of controllability & observability.

Text/Reference Books:

1.	Modern control Engineering, Ogata, Pearson,2009
2.	Nise's Control System Engineering, Rajeev Gupta, Wiley.2011
3	Control Systems: Principles & Design, M. Gopal, TMH 2002
4.	Control Systems: Principles & Design, M. Gopal, TMH 2009
5.	Singh & Janardhanan - Modern control engineering, Cengage learning,2010

6.	Manik – Control systems, Cengage learning ,2012
7.	Control Systems: Theory And Applications,Ghosh,Pearson,2004
8.	Control Systems, Srivastava, TMH ,2009
9.	Control Systems,Srivastava,TMH ,2009
	Systems and Control - Stanislawhizak, Oxford ,2002

Course outcome:

Course Code	Course Name	Course Outcome	Details
6ECU05	**Control Systems**	**CO1**	**Formulate** transfer function for given control system problem (k5).
		CO2	**Find** time response of given control system model.(k1)
		CO3	**Plot** Root Locus and Bode plots for given control system model.(k1)
		CO4	**Design** Lead, Lag, Lead-Lag systems in control systems(k5).
		CO5	**Apply** the concept on various engineering projects.(k3

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6ECU05 Control system	**CO 1**	2	3										
	CO 2	2	3	1									
	CO 3	3	2	1									
	CO 4	2	1	3	1								
	CO 5	3	2	1	1								

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Terminology and basic structure of control system,
Lecture 2	Open loop and Closed loop systems,
Lecture 3	servomechanism, regulatory system, analogous systems
Lecture 4	analogous systems
Lecture 5	Physical Systems and their models,
Lecture 6	Electromechanical systems, electrical analogy of physical systems
Lecture 7	Transfer function, Block diagram representation of physical systems,
Lecture 8	Block Concepts of state diagram algebra,
Lecture 9	Signal Flow graph and Mason's formula.
Lecture 10	Signal Flow graph and Mason's formula.
Lecture 11	Types of test inputs, Response of first and second order system,
Lecture 12	Types of test inputs, Response of first and second order system,
Lecture 13	Time domain specifications
Lecture 14	Error coefficients,
Lecture 15	Generalized error series
Lecture 16	Concepts of stability, location of roots in s-plane for stability,
Lecture 17	stability and relative stability
Lecture 18	Routh-Hurwitz stability criterion
Lecture 19	Routh-Hurwitz stability criterion
Lecture 20	Root locus plot, Properties of Root loci and applications
Lecture 21	Root locus plot, Properties of Root loci and applications
Lecture 22	Stability range from the loci.
Lecture 23	Determination of roots of the closed loop system,
Lecture 24	Effect of pole zero addition.
Lecture 25	Polar plots

Lecture 26	Nyquist plots and Nyquist stability Criterion
Lecture 27	Nyquist plots and Nyquist stability Criterion
Lecture 28	Concepts of Gain margin and phase margin,
Lecture 29	Bode plots . Frequency-domain specifications
Lecture 30	Bode plots . Frequency-domain specifications
Lecture 31	M and N loci, Nichols chart,
Lecture 32	Introduction to PID Controller
Lecture 33	Lag-lead type Controller
Lecture 34	Lag-lead type Controller
Lecture 35	Concepts of state, state variable
Lecture 36	state model. State variable models for LTI systems
Lecture 37	Canonical representations, Transfer function to state-space and vice-versa.
Lecture 38	Solution to state equations. Concepts of controllability & observability.
Lecture 39	Introduction to compensation design
Lecture 40	compensation design using frequency domain techniques

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignments 1.	Q1.Define the following in relation to control system a) Servomechanism c) regulatory system b) Electromechanical system d) transfer function
	Q2.Explain the following terminology in relation in control system i) Open loop control system c) Controller ii) Feedback control system d) Disturbance
	Q3. Drive any two frequency domain specification?
Assignments 2.	Q1. What is closed loop transfer function of a system with positive feedback? Explain, what is the effect of stability?
	Q2.Determine the stability of system? $S^6+ S^5+ 5S^4+3S^3+2S^2-4S- 8=0$

	Q3. Consider the system having open loop control function G(s) =1/ s(s+1). Calculate the rise time, peak time, peak overshoot and settling time?

6ECU06	Neural Network	3L:0T:0P	3 credit

Syllabus:

Overview Of Parallel Processing: Constraints of conventional architecture,Parallelism in uni-processor system, Architectural Classification. Application of parallel processing ,sorting networks ,
PRAM models, interconnection network memory ,consistency model, shared memory multiprocessor. Hardware taxonomy: Flynn's classification, Handler's classification, Software taxonomy, Kung's taxonomy, SPMD, Basic Algorithms – Fast Fourier Transform, Linear System Solution etc. Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture, Principles of scalable performance: Performance Metrics and Measures, Speedup Performance Laws efficiency utilization, overheads
Vector and Array Processor Basic vector architecture, Issues in Vector Processing, Vector performance modeling, SIMD Computer Organization Masking and Data network mechanism Inter PE Communication, Interconnection networks of SIMD, Static V s Dynamic network, cube hyper cube and Mesh Interconnection network, Parallel Algorithms For Array Processors. Multiprocessor Architecture Loosely and Tightly coupled multiprocessors, Processor characteristics of multiprocessors, Inter Processor communication network, Time shared bus, Crossbar switch.

Text/Reference Books:

1.	V.Rajaraman, L Sivaram Murthy, "Parallel Computers", PID, 2004
2.	William Stallings, "Computer Organization and Architecture, Designing for performancePrentice, 2007
3	Kai Hwang, Scalable Parallel Computing. 1998
4.	Harrold Stone, High performance computer Architectures.1992
5.	Richard Y. Kain , Advanced Computer Architecture.2000
6.	Parallel Computing in C and OpenMPI , M. J. Quinn, McGraw-Hill,2004
7.	Assembly Language and Computer Architure Using C++ and JAVA w/CD, Reis, Cengage Learning.2011

Course outcomes:

Course Code	Course Name	Course Outcome	Details
6ECU06	Neural network	CO1	**Describe** Biological neurons and memory as cells, artifi cial neuron the properties of nerve cells. and desiged to accurately describe and predict biological processes.(k2)
		CO2	**Discuss**supervised learning, Learning Methods such As boosting, random forests, bagging, and SVMs achieve excellent performance.(k2)
		CO3	**Learn** basic learning algorithms(k1)
		CO4	**Explain**the associated modals like Boltzmann machine Hopfield networks.(k6)
		CO5	**Apply**the genetic algorithm optimization technique and simulated annealing technique that how to minimization the gain of controller.(k3)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6ECU06 Neural network	**CO1**	3	1										
	CO2	3	1	1									
	CO3	3	2	1									
	CO4	3	1	1									
	CO5	3	1	2	1	3							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Constraints of conventional architecture,

Lecture 2	Parallelism in uni-processor system
Lecture 3	Architectural Classification.
Lecture 4	Application of parallel processing ,sorting
Lecture 5	PRAM models
Lecture 6	interconnection network memory
Lecture 7	consistency model
Lecture 8	shared memory multiprocessor
Lecture 9	Flynn's classification,
Lecture 10	Handler's classification
Lecture 11	Software taxonomy,
Lecture 12	Kung's taxonomy
Lecture 13	SPMD,
Lecture 14	Basic Algorithms
Lecture 15	Fast Fourier Transform,
Lecture 16	Linear System Solution etc
Lecture 17	Instruction level Parallelism
Lecture 18	Thread Level Parallelism
Lecture 19	Explicitly Parallel Instruction Computing (EPIC) Architecture
Lecture 20	Principles of scalable performance:
Lecture 21	Performance Metrics and Measures,
Lecture 22	Speedup Performance Laws efficiency utilization,
Lecture 23	Speedup Performance Laws efficiency utilization,
Lecture 24	Overheads
Lecture 25	Vector and Array Processor Basic vector architecture
Lecture 26	Vector and Array Processor Basic vector architecture
Lecture 27	Issues in Vector Processing,
Lecture 28	Vector performance modeling
Lecture 29	SIMD Computer Organization Masking
Lecture 30	Data network mechanism Inter PE Communication

Lecture 31	Interconnection networks of SIMD, Static V s Dynamic network,
Lecture 32	Interconnection networks of SIMD, Static V s Dynamic network,
Lecture 33	cube hyper cube and Mesh Interconnection network
Lecture 34	Parallel Algorithms For Array Processors
Lecture 35	Multiprocessor Architecture Loosely
Lecture 36	Tightly coupled multiprocessors
Lecture 37	Processor characteristics of multiprocessors.
Lecture 38	Inter Processor-communication network
Lecture 39	Time shared bus,.
Lecture 40	Crossbar switch

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignments 1.	Q1.Explain different network architecture with examples?
	Q2. Explain the hebbian learning rule with example.
	Q3.Explain the back propagation rule and architecture of it and training algorithm.
Assignments 2.	Q1. Explain the different types of learning and compare them?
	Q2 Explain reduce the basic number function use non data center in radial basic function network.
	Q3. Explain kohonen's self organizing feature map (SOM) and architecture and training algorithm.

6ECU07	**Communication Lab**	**0L:0T:2P**	**1 credit**

List of Experiments

Sr. No.	Name of Experiment
1.	To identify & solve the aliasing problem and verify the Nyquist criteria through the experimental setup.
2.	To perform the experiment of observe the transmission of four signals over a single channel using TDM-PAM method.
3.	To study the channel PCM multiplexing & de-multiplexing in telephony system an calculate line speed and baud rate through the experimental setup.
4.	To study the PCM, DPCM modulation & demodulation and study the effect of channel like as attenuation, noise in between modulator & demodulator through the experimental setup.
5.	To study the Delta, Adaptive delta & sigma delta modulation & demodulation and also study the effect of channel like as attenuation, noise in between modulator & demodulator through the experimental setup.
6.	To perform the experiment of generation and study the various data formatting schemes Uni-polar, Bi-polar, Manchester, AMI etc.)
7.	To perform the experiment of generation and detection of ASK, FSK, BPSK, DBPSK signals with variable length data pattern
8.	To perform the experiment of generation and detection of QPSK, OQPSK, DQPSK signals with variable length data pattern.
9.	To study the working of MSK modulation and its demodulation through the experimental setup.
10.	To study the working of cyclic code, block code error check methods in communication system through the experimental setup.
11.	Plot input-output characteristics of field effect transistor and measure I_{dss} and V_p.
12.	Plot frequency response curve for FET amplifier and calculate its gain bandwidth product.

Simulation using any virtual Instrumentation Software:

1. To carry out convolution in both continuous time and discrete time systems.
2. Commanding and multiplexing of PCM signals.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU07	Communication Lab	CO 1	**Explain** the basic theories of digital communication in practical.(k6)
		CO2	**Design** and **implement** different modulation and demodulation technique(k5).
		CO3	**Analyze** different modulation technique using MATLAB tools.(k4)
		CO4	**Understand** basic transmission concepts and to develop strong concepts in fundamentals.(k1)
		CO5	**Recognize** the importance of synchronization in communication systems.(k1)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6ECU07 Communication Lab	CO 1	3	1	1									
	CO 2	2	1	3									
	CO 3	2	3	1	1								
	CO 4	3	1										
	CO 5	3	2	1									

3: Strongly **2: Moderate** **1: Weak**

6EC08	MICROPROCESSOR LAB	0L:0T:2P	1 credit

List of Experiments

S. No.	Name of Experiment
1.	Arranging a set of data in Ascending order.
2.	Arranging a set of data in Descending order
3.	Finding out number of Positive, Negative and Zeros from a Data Set.
4.	Searching the Existence of a certain data in a given data.
5.	BCD to Binary conversion.
6.	Binary to BCD conversion.
7.	Design a Up/Down Counter.
8.	Multiply Two 8 Bit Numbers using Successive Addition and Shifting method
9.	Find Factorial of a number
10	Solve the given Algebraic Equation
11	Generate a Software Delay.
12	Division of 8 bit Unsigned Numbers.
13	A program to display real time clock. Assume a periodic signal is interrupting RST 7.5af ter every 0.5 seconds.
14	Generate a square wave and rectangular wave of given frequency at the Output pin of 8255 c hip.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6E C U0 9	**O C ES SO**	**CO 1**	**Understand and apply** the fundamentals of assembly level programming of microprocessor.(k1)

		CO 2	**Solve problem** related to **(trouble shooting)** interactions between hardware and software.(k3)
		CO 3	**Apply** a combination of hardware and software to address the problem(k3)
		CO 4	**Analyze** their different operation under different cases. (k4)
		CO 5	**Develop** testing and experimental procedure on microprocessor.(k3)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EC08 Microprocessor Lab	**CO 1**	2	2	1	1	3							
	CO 2	2	3	1									
	CO 3	2	3	1	1								
	CO 4	2	2	1		3							
	CO 5	3	2	1	1								

3: Strongly **2: Moderate** **1: Weak**

6EC09	RF SIMULATION LAB	0L:0T:2P	1 credit

List of Experiments

Sr.	Name of Experiment

No.	
1.	Study of field pattern of various modes inside a rectangular waveguide.
2.	Study of field pattern of various modes inside a rectangular waveguide cavity
3.	Observe the transient phenomenon of terminated coaxial transmission lines in order to study their time domain behavior
4.	Study the behavior of terminated coaxial transmission lines in frequency domain.
5.	Introduction to smith chart and its application on for unknown impendence measurement
6.	Study the behavior of impedance matching for passive networks (RL, RC, RLC, T- and Π-network) using Smith chart.
7.	Find the change in characteristics impedance and reflection coefficients of the transmission line by changing the dielectric properties of materials embedded between two conductors.
8.	Design and simulate the following *Planar Transmission Lines:* 1. Stripline and microstrip lines 2. Parallel coupled striplines and microstrip lines 3. Slot lines and Coplanar line 4. Determine their Field patterns and Characteristic impedance
9.	Design and simulate the following; 1. 3-dB branchline coupler, 2. backward wave coupler, 3. Wilkinson power dividers 4. rat- race hybrid ring. 5. Low pass filters 6. band pass filters.
10	Design RF amplifier using microwave BJT

Course Outcome:

Course Code	Course Name	Course Outcome	Details

6EC09	**RF SIMULATION LAB**	**CO 1**	**Design** different coupler(k5)
		CO 2	**Evaluate** various parameter in microwave engineering(k6)
		CO 3	**Design** different field pattern .(k5)
		CO 4	**Calculate** the various parameter using smith chart.(k4)
		CO 5	**Solve** real world problem.(k2)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EC09 RF simulation Lab	**CO 1**	2	2	3	1								
	CO 2	1	3	2									
	CO 3	2	1	3									
	CO 4	2	1										
	CO 5	2	2	1									

3: Strongly **2: Moderate** **1: Weak**

6EC10	**INDUSTRIAL ELECTRONICS LAB**	**0L:0T:2P**	**2 credit**

List of Experiments:

1.	1. Study the characteristics of SCR. (i) Observe the terminal configuration (ii) Measure the breakdown voltage. (iii)Measure latching and holding current (iv) V-I characteristics.
2.	Perform experiment on triggering circuits for SCR. (i) R-triggering circuit (ii)R-C triggering circuit. (iii) UJT triggering circuit.
3.	Study and obtain the characteristics of Diac
4.	Study and obtain the waveforms for single-phase half-wave controlled converter.
5.	Study and obtain the waveforms for single-phase half controlled symmetrical and asymmetrical bridge converters .
6.	Study and obtain the waveforms for single-phase fully controlled bridge converter
7.	Study and obtain the waveforms for voltage-commutated chopper.
8.	Study and obtain the waveforms for current-commutated chopper.
9.	Perform experiment on single phase PWM inverter
10.	Perform experiment on buck, boost and buck-boost regulators.
11.	Perform experiment on Motor control – open loop & closed loop**.**

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EC10	**Industrial Electronics Lab**	CO1	**Design** different inverters and converters using advanced techniques.(k5)
		CO2	Emloy the use of SCR and DIAC industries and related area(k3).
		CO3	**Design** the various components used in electronics area u sing power devices.(k5)
		CO4	**Calculate** the various parameter.(k3)
		CO5	**Analyze** the waveform of the devices(k4)

CO-PO mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EC10 Industrial electronics lab	CO1	2	1	3									
	CO2	2	1										
	CO3	2	1	3	1								
	CO4	3	2	1	1								
	CO5	2	3	1									

3: Strongly **2: Moderate** **1: Weak**

7ECU01	Antennas and Wave Propagation	3L:0T:0P	3 credits

Syllabus

ANTENNA FUNDAMENTALS – Review of Electromagnetic theory. Short elementary dipole and its fields. Basic antenna parameters - Radiation pattern, beamwidth, beam solid angle, directivity, efficiency, gain, radiation intensity, radiation resistance, input impedance and polarization. Receiving antenna- Reciprocity, effective length and aperture, antenna temperature.
ANTENNA ARRAYS – Point source, Array of two isotropic point sources. Uniform array of N point sources and array factor –Examples of 4 element broadside and endfire arrays. N-element linear array of elementary dipoles and principle of pattern multiplication. Two element array of elementary dipoles - Excitation with different relative phase shift and for different spacing.
DIFFERENT TYPES OF ANTENNAS – Thin linear antenna and thin half- wave dipole. V- and Rhombic antennas. Monopole antenna, Small loop antenna, Folded dipole and Yagi-Uda antenna. Broadband antennas – Broadband basics, log-periodic dipole array. Reflector antennas –Flat sheet, corner and parabolic reflector antennas. Slot, Horn and Lens antennas, Helical antennas. Microstrip patch antennas- Rectangular patch antenna, Two- element microstrip patch. Antenna Measurements - Antenna radiation pattern, gain, directivity and polarization.
GROUND WAVE PROPAGATION - Mechanism of radio wave propagation. Theory of ground reflection- Plane earth reflection, reflection factors for horizontal and vertical polarizations. Refraction and diffraction of radio waves. Space and surface waves. Tropospheric propagation, duct propagation and tropospheric scattering. .
IONOSPHERIC PROPAGATION: Various ionospheric layers, Electrical properties of the ionosphere and their effects on wave propagation. Critical frequency, virtual height, skip distance, maximum usable frequency. Multiple hop transmission. Effect of earth's magnetic field and Faraday rotation. Solar activity and meteorological conditions on wave propagation

Text/ Reference Books:

1	Sisir. Das and A. Das, Antenna and wave propagation, Tata McGraw-Hill Education Pvt. Ltd, (2013).
2	A.R. Harish and M. Sachidananda, Antennas and Wave Propagation, Oxford Univ. Press, Edition (2011).
3	J.D. Kraus, Antennas, Tata McGraw-Hill, 2nd Edition, 1999
4	E.C. Jordan and K.G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice- Hall of India, 2nd Edition, 1986
5	T. Milligan, Microstrip Antenna Design, Wiley, 2005
6	J.D. Kraus and R.J. Marhefka, Antennas for All Applications, Tata McGraw-Hill, Edition 2004
7	R. Chatterjee, Antenna Theory and Practice,Wiley Eastern Ltd., 1988
8	Balanis Constantine A, Antenna theory, Analysis and design, 3rd edition, A John Wiley & Sons Inc. Publication 2005
9	Collin R. E. And F. J. Zucker, Antenna Theory: Part I, McGraw-Hill, New York 1969

10	Collin R. E. And F. J. Zucker, Antenna Theory: Part II, McGraw-Hill, New York 1969
11	Ramesh Garg, P. Bhartia, Inder Bahl, and A Ittipiboon, Microstrip Antenna Design Hand, Artech House, Inc. 2001

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU01	Antennas and Wave Propagation	CO 1	Understand various types of antennas and antenna properties
		CO 2	Analyze the properties of different types of antennas and their design
		CO 3	Solve complex problems related to antennas
		CO 4	Conduct experiments with various antennas and arrays
		CO 5	Designing different antennas to meet different specifications

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU01 Antennas and Wave Propagation	CO 1	3	2	1	1	2							
	CO 2	2	3	3	2	2							
	CO 3	3	3	3	3	3							
	CO 4	2	3	3	3	3							
	CO 5	2	3	3	3	3							

3: Strong **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Review of Electromagnetic theory
Lecture 2	Short elementary dipole and its fields
Lecture 3	Basic antenna parameters - Radiation pattern, beamwidth
Lecture 4	Basic antenna parameters beam solid angle, directivity, efficiency, gain
Lecture 5	Basic antenna parameters radiation intensity, radiation resistance
Lecture 6	input impedance and polarization

Lecture 7	Receiving antenna- Reciprocity
Lecture 8	effective length and aperture, antenna temperature
Lecture 9	Point source, Array of two isotropic point sources
Lecture 10	Uniform array of N point sources and array factor
Lecture 11	4 element broadside and endfire arrays
Lecture 12	N-element linear array of elementary dipoles
Lecture 13	principle of pattern multiplication
Lecture 14	Two element array of elementary dipoles
Lecture 15	Excitation with different relative phase shift and for different spacing
Lecture 16	Thin linear antenna and thin half- wave dipole
Lecture 17	V- and Rhombic antennas. Monopole antenna
Lecture 18	Small loop antenna, Folded dipole and Yagi-Uda antenna
Lecture 19	Broadband antennas – Broadband basics, log-periodic dipole array
Lecture 20	Reflector antennas –Flat sheet, corner
Lecture 21	parabolic reflector antennas. Slot, Horn
Lecture 22	Lens antennas, Helical antennas
Lecture 23	Microstrip patch antennas- Rectangular patch antenna
Lecture 24	Two- element microstrip patch
Lecture 25	Antenna Measurements - Antenna radiation pattern, gain, directivity and polarization
Lecture 26	Mechanism of radio wave propagation
Lecture 27	Theory of ground reflection- Plane earth reflection
Lecture 28	reflection factors for horizontal and vertical polarizations
Lecture 29	Refraction and diffraction of radio waves
Lecture 30	Space and surface waves
Lecture 31	Tropospheric propagation
Lecture 32	duct propagation and tropospheric scattering
Lecture 33	Various ionospheric layers, Electrical properties of the ionosphere
Lecture 34	Electrical properties of the ionosphere effects on wave propagation.
Lecture 35	Critical frequency, virtual height, skip distance, maximum usable frequency.
Lecture 36	Critical frequency, virtual height, skip distance, maximum usable frequency.
Lecture 37	Multiple hop transmission
Lecture 38	Multiple hop transmission
Lecture 39	Effect of earth's magnetic field and Faraday rotation
Lecture 40	Solar activity and meteorological conditions on wave propagation

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Assignments:

Assignment 1	**Q1.** The radial component of the radiated power density of an

		infinitesimal linear dipole of length $l << \lambda$ is given by $\mathbf{W}_{av} = \hat{a}_r W_r = \hat{a}_r A_0 \frac{\sin^2\theta}{r^2}$ where A_0 is the peak value of the power density, θ is the usual spherical coordinate, and $\hat{a}_r$ is the radial unit vector. Determine the maximum directivity of the antenna and express the directivity as a function of the directional angles θ and ϕ.
	Q2.	A resonant half-wavelength dipole is made out of copper ($\sigma = 5.7 \times 10^7$ S/m) wire. Determine the conduction-dielectric (radiation) efficiency of the dipole antenna at *f* = 100 MHz if the radius of the wire *b* is 3 × 10−4 λ, and the radiation resistance of the $\lambda/2$ dipole is73 ohms.
	Q3.	Find the radiation resistance of a single-turn and an eight-turn small circular loop. The radiusof the loop is $\lambda/25$ and the medium is free-space.
Assignment 2	**Q1.**	Write short notes on Yagi Uda antennas, and log periodic antennas.
	Q2.	Design a rectangular microstrip antenna using a substrate(RT/Duroid 5880) with dielectricconstant of 2.2, *h* = 0.1588 cm (0.0625 inches) so as to resonate at 10 GHz.
	Q3.	What are the needs of smart antennas? What are the difficulties with smart array systems? What are the differences between adaptive and switched beamforming techniques?

7ECU02	**Digital Signal Processing**	**3L:1T:0P**	**4 credits**

Syllabus

SAMPLING - Discrete time processing of Continuous-time signals, continuous time processing of

discrete-time signals, Changing the sampling rate using discrete-time processing.
TRANSFORM ANALYSIS OF LTI SYSTEMS - Introduction, The frequency response of LTI systems, System functions for systems characterized by LCCD (Linear Constant Coefficient Difference) equations, All-pass system, Minimum-Phase systems, Linear systems with linear phase.
STRUCTURES FOR DISCRETE-TIME SYSTEMS- Block diagram and signal flow graph representation of LCCD equations,Basic structures for IIR and FIR systems, Transposed forms.
FILTER DESIGN TECHNIQUES - Introduction, Analog filter Design: Butterworth & Chebyshev, IIR filter design by impulse invariance & Bilinear transformation, Design of FIR filters by Windowing: Rectangular, Hanning, Hamming & Kaiser.
DFT, FFT- The Discrete Fourier transform (DFT), Properties of the DFT, Linear Convolution using DFT, Efficient computation of the DFT: Decimation–in-Time and Decimation in frequency FFT Algorithms.

TEXT / REFERENCE BOOKs:

S.No.	Name of Authors/Book/Publisher
1.	Proakis, Manolakis, "Digital Signal Processing: Principals, Algorithms And Applications", 4th ed., Pearson Education. 2006
2.	Oppenheim, Schafer, "Discrete Time Signal Processing", 3rd ed. , PHI 2010
3.	Digital Signal Processing: A Modern Introduction, Ambardar, cengage learning 2011
4.	Introduction to Digital Signal Processing using MATLAB, Schilling 2011
5	Sanjit K Mitra, "Digital Signal Processing", 4th ed., TMH 2013
6.	Tan, Jiang, "Digital Signal Processing: Fundamentals and Applications",2nd ed., Elsevier 2008
7.	Ifeachor, Jervis, "Digital Signal Processing", 2nd ed., Pearson Education 2009

Course Outcome

Course Code	Course Name	Course Outcome	Details
ECDSPL		**CO1**	To provide fundamental knowledge about various signal

			processing techniques
		CO2	Develop the governing equations for LCCD, LTI systems, All-pass system, Minimum-Phase systems, Linear systems with linear phase
		CO3	Understanding of the fundamentals and applications of discrete-time signals and systems, including sampling, convolution, filtering, and discrete Fourier transforms
		CO4	Solve problems for sampling, convolution, filtering, and discrete Fourier transforms
		CO5	Explain Efficient computation of the DFT

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU02 Digital Signal Processing	**CO 1**	3	1	1									
	CO 2	2	2	1									
	CO 3	3	2		1								
	CO 4	2	2										
	CO 5	1				2							

3: Strong **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Discrete time processing of Continuous-time signals
Lecture 2	Discrete time processing of Continuous-time signals
Lecture 3	continuous time processing of discrete-time signals
Lecture 4	continuous time processing of discrete-time signals
Lecture 5	continuous time processing of discrete-time signals
Lecture 6	Changing the sampling rate using discrete-time processing.
Lecture 7	Changing the sampling rate using discrete-time processing.
Lecture 8	Introduction of LTI system
Lecture 9	frequency response of LTI systems
Lecture 10	System functions for systems characterized by LCCD (Linear Constant Coefficient Difference) equations
Lecture 11	System functions for systems characterized by LCCD (Linear Constant

	Coefficient Difference) equations
Lecture 12	All-pass system
Lecture 13	Minimum-Phase systems
Lecture 14	Linear systems with linear phase.
Lecture 15	Block diagram representation of LCCD equations
Lecture 16	signal flow graph representation of LCCD equations
Lecture 17	Basic structures for IIR systems
Lecture 18	Basic structures for IIR systems
Lecture 19	Basic structures for FIR systems
Lecture 20	Basic structures for FIR systems
Lecture 21	Transposed forms.
Lecture 22	Introduction of Analog filter Design
Lecture 23	Butterworth filter Design
Lecture 24	Chebyshev filter Design
Lecture 25	IIR filter design by impulse invariance
Lecture 26	IIR filter design by Bilinear transformation
Lecture 27	Introduction of Windowing:
Lecture 28	Design of FIR filters by Windowing: Rectangular
Lecture 29	Design of FIR filters by Windowing: Hanning
Lecture 30	Design of FIR filters by Windowing: Hamming
Lecture 31	Design of FIR filters by Windowing: Kaiser.
Lecture 32	Discrete Fourier transform (DFT)
Lecture 33	Discrete Fourier transform (DFT)
Lecture 34	Properties of the DFT
Lecture 35	Properties of the DFT
Lecture 36	Linear Convolution using DFT
Lecture 37	Efficient computation of the DFT: Decimation–in-Time
Lecture 38	Efficient computation of the DFT: Decimation–in-Time and Decimation- in frequency
Lecture 39	Efficient computation of the DFT: Decimation- in frequency
Lecture 40	FFT Algorithms.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Assignments:

Assignment 1	**Q1.** Find a function f(t) = a + bt that is perpendicular to another function

	$g(t) = 1 - t$ in the interval [0, 1].
	Q2. Comment on the linearity, time-invariant and invertibility property of Up-sampler and Down-sampler
	Q3. Why is a filter with a zerophase response necessarily causal?
Assignment 2	**Q1.** Prove that if the length of wavelet filter is L then the support of scaling function $\varphi(t)$is $L - 1$?
	Q2. What is the effect of cascading a $(1- z^{-1})$ term in the high pass analysis filter?
	Q3. Interpret the following equation in the wake of perfect reconstruction: $\tau_0(Z) = 1\ 2\ \{H_1(-Z)\ H_0(Z) + (-H_0(-Z))\ H_1(Z)\}$

7ECU03	**Digital Image Processing**	**3L:1T:0P**	**4 credits**

Syllabus

DIGITAL IMAGE FUNDAMENTALS: Image sensing and acquisition, Image sampling and quantization, Representing digital images, Spatial and gray-level resolution, Spatial operations, Vector & matrix operations, Zooming and Shrinking of digital images. RGB and HSI Color models
BASIC IMAGE OPERATIONS: Intensity transformation functions, Histogram equalization, Spatial filtering for image smoothing, Image sharpening by first and second order derivatives, Image smoothing and sharpening using frequency domain filters
IMAGE RESTORATION: Image restoration model, Noise Models, Spatial and frequency properties of noise, noise probability density functions, Noise only- spatial filter, Mean, order Statistic and adaptive filters, Concepts of inverse and Wiener filtering
MORPHOLOGICAL IMAGE PROCESSING: Erosion and Dilation, Opening and closing, morphological algorithms for Boundary extraction, thinning, pruning, smoothing and thickening
IMAGE SEGMENTATION AND COMPRESSION: Edge based segmentation, Edge detection masks, Gradient operators, Thresholding, Region growing, Watershed transform, Fundamentals of image compression; Loss-less compression techniques; Lossy compression techniques, compression standards

TEXT / REFERENCE BOOKs:

1.	Gonzalez, Woods and Eddins, "Digital Image Processing", 3rd ed. , Pearson Education 2010
2.	Anil K Jain, "Fundamentals of Digital Image Processing", 4th ed., Prentice Hall 2010
3.	Tamal Bose, "Digital Signal and Image Processing", ", 3rd ed. , John Wiley 2005
4.	Sonaka,Hlavac and Boyle, "Image Processing, Analysis and Machine Vision", 3rd ed. , Cengage Learning 2013
5.	Pratt, "Digital Image Processing", 4th ed. , John Wiley 2001
6.	Image Processing, Analysis, and Machine Vision, Sonka, cengage Learning 2006

Course Outcome:

Course	Course	Course	Details

Code	Name	Outcome	
7ECU03	Digital Image Processing	**CO 1**	Able to represent the images mathematically and analyse them.
		CO 2	Understand the Fundamental technologies for digital image compression, analysis, and processing.
		CO 3	Able to enhance required properties of images as per application.
		CO 4	Develop algorithms for image compression and coding.
		CO 5	Acquire an appreciation for the image processing techniques and their application to real world problems.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU03 Digital Image Processing	**CO 1**	3	2										
	CO 2	3	1	2									
	CO 3		2	2	1								
	CO 4	1	2	3		1							
	CO 5		2	3	1								

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Image sensing and acquisition, Image sampling and quantization
Lecture 2	Representing digital images
Lecture 3	Spatial and gray-level resolution
Lecture 4	Spatial operations
Lecture 5	Vector & matrix operations
Lecture 6	Zooming and Shrinking of digital images. RGB and HSI Color models
Lecture 7	Intensity transformation functions

Lecture 8	Histogram equalization
Lecture 9	Spatial filtering for image smoothing
Lecture 10	Image sharpening by first order derivatives
Lecture 11	Image sharpening by second order derivatives
Lecture 12	Image sharpening by second order derivatives
Lecture 13	Image smoothing and sharpening using frequency domain filter
Lecture 14	Image smoothing and sharpening using frequency domain filter
Lecture 15	Image restoration model, Noise Models
Lecture 16	Spatial and frequency properties of noise
Lecture 17	noise probability density functions
Lecture 18	Noise only- spatial filter
Lecture 19	Mean, order Statistic
Lecture 20	adaptive filters
Lecture 21	Concepts of inverse and Wiener filtering
Lecture 22	Concepts of inverse and Wiener filtering
Lecture 23	Erosion
Lecture 24	Dilation
Lecture 25	Opening and closing
Lecture 26	morphological algorithms for Boundary extraction
Lecture 27	morphological algorithms for thinning
Lecture 28	morphological algorithms for pruning
Lecture 29	morphological algorithms for smoothing
Lecture 30	morphological algorithms for thickening
Lecture 31	Edge based segmentation
Lecture 32	Edge detection masks
Lecture 33	Gradient operators
Lecture 34	Thresholding
Lecture 35	Region growing
Lecture 36	Watershed transform

Lecture 37	Fundamentals of image compression
Lecture 38	Loss-less compression techniques
Lecture 39	Lossy compression techniques
Lecture 40	compression standards

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Assignments:

Assignment 1	**Q1.** Write a function flip-image which takes an image and reflects it in both the horizontal and vertical dimensions.
	Q2. Implement code for histogram equalization submit your code and the output images?
	Q3. Implement code to add and remove the salt-and-pepper noise submit your code and the output image?
Assignment 2	**Q1.** Write a function color-image-crop which acts like image-crop but works for color-images
	Q2. Write a function Gaussian-low pass which takes an integer n and a float variance as arguments and returns the frequency domain representation of a Gaussian low pass filter of size n×n. Your filter should be a Gaussian of variance cantered on the zero spatial frequency?
	Q3. Implement wiener filter apply it to different test images and display the images before and after Wiener filtering.

7ECU04	**Wireless Communication**	**3L:0T:0P**	**3 credits**

Syllabus

Spread Spectrum Modulation Techniques – Concept of spread spectrum, system processing gain, Spread Spectrum signals: Direct-sequence spread spectrum signals, Frequency-hopped spread spectrum signals, Code-division multiplexing, Spreading codes
Wireless Microwave Communication- Link Engineering, Frequency planning, Free space loss, Fresnel zone clearance, bending of radio beam, Effective earth radius, Fundamentals of fading, types and effects, Multipath channels; parameters, measurements, Building blocks of Transmitter & Receiver.
Multiple Access Techniques and Networks - FDMA, TDMA and CDMA with reference to mobile radio and satellite systems. TDMA based networks, OFDM and its characteristics, Packet radio multiple access techniques. CDMA based networks: Architecture, Air interface, Call processing, power control, Rake receiver concept and performance of CDMA system.
Cellular Wireless Networks-, GSM: Introduction, overview of the GSM systems, GSM codec, channel coding and interleaving, radio like control. Cordless systems and WLL, Mobile IP, Wireless access protocol. Wireless LAN's: Technology, IEEE 1002.11 standards, Broadband Wireless 1002.16, Blue tooth, Wi-Fi, Wi- Max, Zigbee & RFID technology.
Satellite Communication - Elements of satellite communication: Frequency bands, Transmission and Multiple access. Satellite orbit and description- orbital period and velocity, effects of orbital inclination, Azimuth and elevation, Coverage angle and slant range, Satellite Link: basic link design and analysis, Geostationary orbit, Satellite subsystems. Earth Station antenna, high-power amplifier, low-noise amplifier, up converter, down converter, monitoring and control, reliability

TEXT Books:

1.	William Stallings, Wireless Communication and Networks, Pearson Education (2013)
2.	Rappaport, T.S., Wireless Communications, Pearson Education (2013)
3.	Gottapu Sasibhushana Rao, Mobile Cellular Communications, Pearson Education 2013
4.	Singal, T.L, Wireless Communication, Tata McGraw Hill 2011
5.	Vijay Kr. Garg, Wireless Communications and Networking, Morgan Kaufmann, Elsevier 2013
6.	Blake, Wireless Communication Technology, Cengage Learning 2013
7.	W.C.Y. Lee , Mobile Cellular Telecommunications , Tata McGraw Hill 2011
8.	Wireless Communications and Networking, Price, TMH 2014
9.	Pratt, Bostain, Satellite Communications, Wiley India 2011
10.	Mark Zhuang, Wireless Communications and Networking, Prentice Hall of India 2003
11.	Simon Haykin, Modern Wireless Communications, Pearson Education 2005
12.	Price, Fundamentals of Wireless Networking, Tata McGraw Hill 2012

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU04	Wireless Communication	CO 1	Understand the working principle and able to model, and design wireless communication systems
		CO 2	Understand existing wireless networks and future system standards.
		CO 3	Apply multiple access techniques and diversity reception techniques in mobile arena
		CO 4	Analyze wireless communication systems for improved performance
		CO 5	Achieve output performance measures of different wireless systems.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU04 Wireless Communication	CO 1	3	2	3	3	2							2
	CO 2	3	1		1	2		1		1		2	2
	CO 3	3	3	1	2		1	2	1			1	1
	CO 4	2	3	2	3	2					1		1
	CO 5	2	2	3	3	2			1			2	2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught

Lecture 1	Introduction
Lecture 2	Concept of spread spectrum
Lecture 3	system processing gain
Lecture 4	Spread Spectrum signals
Lecture 5	Direct-sequence spread spectrum signals
Lecture 6	Frequency-hopped spread spectrum signals
Lecture 7	Code-division multiplexing
Lecture 8	Spreading codes
Lecture 9	Link Engineering
Lecture 10	Frequency planning, Free space loss
Lecture 11	Fresnel zone clearance
Lecture 12	bending of radio beam, Effective earth radius
Lecture 13	Fundamentals of fading
Lecture 14	types of fading and effects
Lecture 15	Multipath channels; parameters, measurements
Lecture 16	Building blocks of Transmitter & Receiver
Lecture 17	FDMA, TDMA and CDMA with reference to mobile radio and satellite systems
Lecture 18	FDMA, TDMA and CDMA with reference to mobile radio and satellite systems
Lecture 19	TDMA based networks, OFDM and its characteristics,
Lecture 20	Packet radio multiple access techniques.
Lecture 21	CDMA based networks: Architecture, Air interface
Lecture 22	CDMA based networks: Call processing, power control
Lecture 23	Rake receiver concept
Lecture 24	performance of CDMA system.
Lecture 25	GSM: Introduction, overview of the GSM systems, GSM codec
Lecture 26	Channel coding and interleaving
Lecture 27	Radio like control
Lecture 28	Cordless systems and WLL, Mobile IP
Lecture 29	Wireless access protocol. Wireless LAN’s: Technology

Lecture 30	IEEE 1002.11 standards, Broadband Wireless 1002.16
Lecture 31	Blue tooth, Wi-Fi, Wi- Max
Lecture 32	Zigbee & RFID technology.
Lecture 33	Elements of satellite communication: Frequency bands, Transmission and Multiple access
Lecture 34	Satellite orbit and description- orbital period and velocity
Lecture 35	Effects of orbital inclination, Azimuth and elevation, Coverage angle and slant range
Lecture 36	Satellite Link: basic link design and analysis
Lecture 37	Geostationary orbit, Satellite subsystems
Lecture 38	Earth Station antenna, high-power amplifier
Lecture 39	low-noise amplifier, up converter, down converter
Lecture 40	Monitoring and control, reliability

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Assignment 1	Q1. Give the difference between multiplexing and multiple access and discuss multiple access techniques.
	Q2. A satellite is in an elliptical orbit with a perigee of 2000 km and an apogee of 8000 km. using a mean earth radius of 6378.14 km, find the period of the orbit in hours, minutes and seconds, and the eccentricity of the orbit.
	Q3. What is transponder and explain single conversion transponder (bent pipe) for 6/4 GHz band.
Assignment 2	Q1. Explain architecture of CDMA based networks
	Q2. Explain Concept of spread spectrum.
	Q3. Explain transmission losses in satellite communication.

7ECU05	**VLSI Design**	**3L:0T:0P**	**3 credits**

Syllabus

INTRODUCTION TO MOSFET: - Basic MOS transistors, Enhancement Mode transistor action, Depletion Mode transistor action, NMOS and CMOS fabrication. Aspects of threshold voltage, threshold voltage with body effect. Ids versus Vds relationship, channel length modulation. Transistor Trans-conductance gm. MOS transistor circuit Model, Model parameter (oxide and junction capacitor, channel resistance) variation with scaling and biasing. High order effects (i.e. subthreshold conduction, hot electron effect, narrow channel effect and punch through effect.
CMOS LOGIC CIRCUITS- nMOS inverter (resistive and active load), Pull up to Pull-down ratio for a NMOS Inverter and CMOS Inverter (Bn/Bp), , determination of inverter parameter (VIL, VIH VOL VOH) and Noise Margin. Speed and power dissipation analysis of CMOS inverter. Combinational Logic, NAND Gate, NOR gate, XOR gate, Compound Gates, 2 input CMOS Multiplexer, Memory latches and registers, Transmission Gate, estimation of Gate delays, Power dissipation and Transistor sizing.
Basic physical design of simple Gates and Layout issues. Layout issues for CMOS inverter, Layout for NAND, NOR and Complex Logic gates, Layout of TG, Layout optimization using Eular path. DRC rules for layout and issues of interconnects, Latch up problem.
Dynamic CMOS circuits: Clocked CMOS (C2MOS) logic, DOMINO logic, NORA logic, NP(ZIPPER) logic, PE(pre-charge and Evaluation) Logic. Basic Memory circuits, SRAM and DRAM**.**
Physical Design: Introduction to ECAD tools for first and back end design of VLSI circuits. Custom /ASIC design, Design using FPGA and VHDL. VHDL Code for simple Logic gates, flip-flops, shift registers.

Text / Reference Books:

1.	CMO S DIGITAL INTEGRATED CIRCUITS Analysis and Design. SUNG-MO (STEVE) ANG, YUSUF LEBLEBIGI, McGraw Hill (2008)
2.	N.Weste and K. Eshraghian, Principles of CMOS VLSI, 2e, Pearson Education.2011
3.	VLSI Design , P P Sahu , , McGraw.2013
4.	VLSI Design, D.P. Das, Oxford.2011
5.	Chip Design for Submicron VLSI: CMOS Layout & Simulation, Uyemura, cengage learning 2009

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU05	VLSI Design	CO 1	Introduce the technology, design concepts, electrical properties and modeling of Very Large Scale Integrated circuits.
		CO 2	Basics of MOS Circuit Design & Models
		CO 3	Basics of MOS process technology
		CO 4	Understand the concepts of modeling a digital system using Hardware Description Language
		CO 5	Introduction of ECAD tools for designing of VLSI circuits.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU05 VLSI Design	CO 1	3	2	1	1	2							
	CO 2	2	3	3	2	2							
	CO 3	3	3	3	3	3							
	CO 4	2	3	3	3	3							
	CO 5	2	3	3	3	3							

3: Strong **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Basic MOS transistors,
Lecture 2	Enhancement Mode transistor action, Depletion Mode transistor action
Lecture 3	NMOS and CMOS fabrication. Aspects of threshold voltage
Lecture 4	threshold voltage with body effect
Lecture 5	Ids versus Vds relationship, channel length modulation
Lecture 6	Transistor Trans-conductance gm

Lecture 7	MOS transistor circuit Model
Lecture 8	Model parameter (oxide and junction capacitor, channel resistance) variation with scaling and biasing
Lecture 9	High order effects (i.e. subthreshold conduction, hot electron effect
Lecture 10	narrow channel effect and punch through effect
Lecture 11	nMOS inverter (resistive and active load)
Lecture 12	Pull up to Pull-down ratio for a NMOS Inverter and CMOS Inverter (Bn/Bp)
Lecture 13	determination of inverter parameter (VIL, VIH VOL VOH) and Noise Margin
Lecture 14	Speed and power dissipation analysis of CMOS inverter
Lecture 15	Combinational Logic, NAND Gate, NOR gate, XOR gate
Lecture 16	Compound Gates, 2 input CMOS Multiplexer
Lecture 17	Memory latches and registers, Transmission Gate
Lecture 18	estimation of Gate delays, Power dissipation and Transistor sizing
Lecture 19	Basic physical design of simple Gates and Layout issues
Lecture 20	Layout issues for CMOS inverter
Lecture 21	Layout for NAND, NOR
Lecture 22	Complex Logic gates
Lecture 23	Layout of TG
Lecture 24	Layout optimization using Eular path
Lecture 25	DRC rules for layout and issues of interconnects
Lecture 26	Latch up problem
Lecture 27	Clocked CMOS (C2MOS) logic
Lecture 28	DOMINO logic
Lecture 29	NORA logic
Lecture 30	NP(ZIPPER) logic
Lecture 31	PE(pre-charge and Evaluation) Logic
Lecture 32	Basic Memory circuits
Lecture 33	SRAM
Lecture 34	DRAM

Lecture 35	Introduction to ECAD tools for first and back end design of VLSI circuits
Lecture 36	Custom /ASIC design
Lecture 37	Design using FPGA and VHDL
Lecture 38	VHDL Code for simple Logic gates
Lecture 39	VHDL Code for flip-flops
Lecture 40	VHDL Code for shift registers

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Assignment 1	Q1. what are different techniques of VLSI fabrication? Explain in detail
	Q2. What are different techniques of CMOS fabrication? Explain in detail. Comparison between CMOS and bipolar Technology
	Q3. Explain CMOS inverter power dissipation i) Static power dissipation ii) short circuit power dissipation iii) dynamic power Dissipation
Assignment 2	Q1. Describe the structure of a CMOS transmission gate. Explain why such a gate is desirable to control transmission of a signal rather than just a single transistor.
	Q2. What is FPGA?What is the advantage of FPGA in VLSI technology.
	Q3. Design the following CMOS logic and draw the stick diagram (i) $y=A\overline{B}+\overline{A}B$ (ii) $y = A + \overline{B}$ (iii) $y = ABC + \overline{ABC}$ (iv) $y = AB\overline{C} + \overline{A}BC$

7ECU06.1	**Advanced Microprocessors**	**3L:0T:0P**	**3 credits**

Syllabus

The 8086 Microprocessor Family: 8086 ARCHITECTURE- Hardware specifications, Pins and signals, Internal data operations and Registers, Minimum and maximum mode, System Bus Timing, Linking and execution of Programs
Software & Instruction Set: Assembly language programming: addressing mode and instructions of 8086, Strings, Procedures and Macros, 8086 interrupts. Assembler Directives and operators.
Analog Interfacing: A/D and D/A converter interfacing, keyboard and display interfacing, RS 232 & IEEE 488 communication standards. An 8086 based Process Control Systems
Digital Interfacing: Programmable parallel ports, Interfacing microprocessor to keyboard and alphanumeric displays, Memory interfacing and Decoding , DMA controller.
Multiprocessor Configurations: - Multiuser / Multi tasking operating system concepts, 8086 based Multiprocessor systems. Introduction and basic features of 286, 386, 486 & Pentium processors.

TEXT / REFERENCE BOOKS

1.	A Nagoor Kani "Microprocessors and Microcontrollers" Mc Graw Hill Education 2ed. (2012)
2.	Douglas V. Hall "Microprocessors and Interfacing Programming and Hardware" Tata Mc Graw Hill.(2000)
3.	A. Ray & K. Bhurchandi. "Advanced Microprocessors and Peripherals. Tata Mc Graw Hill, 2012
4.	A Nagoor Kani "Microprocessors and Microcontrollers" Mc Graw Hill Education 2ed.2012
5.	Introduction to Microprocessors, A. P. Mathur Mc Graw Hill 2011
6.	The Intel Family of Microprocessors: Hardware and Software Principles and Applications, Antonakos, cengage learning 2012
7.	The 8086 Microprocessor: Programming & Interfacing the PC, Ayala, cengage Learning 2007

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU06.1	**Advanced Microprocessors**	**CO 1**	Introduction of 8086 Microprocessor Family
		CO 2	Design system using memory chips and peripheral chips for 16 bit 8086 microprocessor.
		CO 3	Understand and devise techniques for faster execution of instructions, improve speed of operations and enhance performance of microprocessors.
		CO 4	Explain Digital Interfacing: Memory interfacing, interfacing with microprocessor.
		CO 5	Understand multi core processor and its advantages

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU06.2 Advanced Microprocessors	CO 1	3	1										
	CO 2	2	2	3									
	CO 3		1	3									
	CO 4	1	2	3									
	CO 5	2		1									

3: Strong **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	8086 ARCHITECTURE- Hardware specifications
Lecture 2	Pins and signals
Lecture 3	Pins and signals
Lecture 4	Internal data operations and Registers
Lecture 5	Internal data operations and Registers
Lecture 6	Minimum and maximum mode
Lecture 7	System Bus Timing
Lecture 8	Linking and execution of Programs
Lecture 9	Assembly language programming: addressing mode
Lecture 10	instructions of 8086
Lecture 11	instructions of 8086
Lecture 12	Strings
Lecture 13	Procedures and Macros

Lecture 14	8086 interrupts.
Lecture 15	Assembler Directives and operators.
Lecture 16	Assembler Directives and operators.
Lecture 17	A/D converter interfacing
Lecture 18	D/A converter interfacing
Lecture 19	keyboard and display interfacing
Lecture 20	keyboard and display interfacing
Lecture 21	RS 232 & IEEE 488 communication standards.
Lecture 22	RS 232 & IEEE 488 communication standards.
Lecture 23	An 8086 based Process Control Systems
Lecture 24	An 8086 based Process Control Systems
Lecture 25	Programmable parallel ports
Lecture 26	Programmable parallel ports
Lecture 27	Interfacing microprocessor to keyboard and alphanumeric displays
Lecture 28	Interfacing microprocessor to keyboard and alphanumeric displays
Lecture 29	Memory interfacing and Decoding
Lecture 30	Memory interfacing and Decoding
Lecture 31	DMA controller.
Lecture 32	DMA controller.
Lecture 33	Multiuser / Multi tasking operating system concepts,
Lecture 34	8086 based Multiprocessor systems.
Lecture 35	8086 based Multiprocessor systems.
Lecture 36	Introduction and basic features of 286
Lecture 37	Introduction and basic features of 386
Lecture 38	Introduction and basic features of 486
Lecture 39	Pentium processors.
Lecture 40	Pentium processors.

Content delivery method:

1. Chalk and Duster

2. PPT
3. Hand-out

Assignment 1	Q1. Draw and explain the architecture diagram of 8086 Microprocessors.
	Q2. Write a program to find out the largest and smallest number from a given unordered array of 8 bit numbers, stored in the locations starting from a known address.
	Q3. What are the basic modes of operation of 8086?
Assignment 2	Q1. What do you mean by microprocessor and microcontroller? Give the applications of microprocessor in brief.
	Q2. Give the classification of 8086 interrupts. Explain in detail.
	Q3. Draw the block diagram of 8257 DMA controller and explain its features.

7ECU06.2	**ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS**	**3L:0T:0P**	**3 credits**

Syllabus

Introduction to Artificial Intelligence: Intelligent Agents, State Space Search, Uninformed Search,

Informed Search, Two Players Games, Constraint Satisfaction Problems.
Knowledge Representation: Knowledge Representation And Logic, Interface in Propositional Logic, First Order Logic, Reasoning Using First Order Logic, Resolution in FOPL
KNOWLEDGE ORGANIZATION: Rule based System, Semantic Net, Reasoning in Semantic Net Frames, Planning
KNOWLEDGE SYSTEMS: Rule Based Expert System, Reasoning with Uncertainty, Fuzzy Reasoning
KNOWLEDGE ACQUISITION: Introduction to Learning, Rule Induction and Decision Trees, Learning Using neural Networks, Probabilistic Learning Natural Language Processing

TEXT / REFERENCE BOOKS:

1.	Elaine Rich and Kevin Knight, Artificial Intelligence 3/e, TMH (1991)
2.	Padhy: Artificial Intelligence & Intelligent Systems, Oxford(2005)
3.	James A Anderson, An introduction to Neural Networks. Bradford Books 1995
4.	Dan. W Patterson, Artificial Intelligence and Expert Systems,PHI 1990
5.	Kumar Satish, "Neural Networks" Tata Mc Graw Hill 2004
6.	S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications" Prentice Hall of India. 2006
7.	Siman Haykin,"Neural Netowrks"Prentice Hall of India 1990
8.	Artificial Intelligence, Kaushik, cengage learning 1997

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU06.1	**Artificial Intelligence And Expert Systems**	**CO 1**	Describe the modern view of AI as the study of agents that receive percepts from the Environment and perform actions.
		CO 2	Demonstrate awareness of informed search and exploration methods.
		CO 3	Explain about AI techniques for knowledge representation, planning and uncertainty Management.
		CO 4	Develop knowledge of decision making and learning methods.
		CO 5	Explain the concept of Knowledge Representation

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU06.2 Artificial Intelligence And Expert Systems	**CO 1**	3	2	3	3	2							2
	CO 2	3	1		1	2		1		1		2	2
	CO 3	3	3	1	2		1	2	1			1	1
	CO 4	2	3	2	3	2					1		1
	CO 5	2	2	3	3	2			1			2	2

3: Strong **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Introduction to Artificial Intelligence
Lecture 2	Intelligent Agents
Lecture 3	State Space Search
Lecture 4	Uninformed Search
Lecture 5	Informed Search
Lecture 6	Informed Search
Lecture 7	Two Players Games
Lecture 8	Two Players Games
Lecture 9	Satisfaction Problems
Lecture 10	Knowledge Representation And Logic
Lecture 11	Interface in Propositional Logic
Lecture 12	First Order Logic
Lecture 13	Reasoning Using First Order Logic
Lecture 14	Resolution in FOPL
Lecture 15	Introduction to Knowledge Organization
Lecture 16	Introduction to Knowledge Organization
Lecture 17	Rule based System

Lecture 18	Rule based System
Lecture 19	Semantic Net
Lecture 20	Semantic Net
Lecture 21	Reasoning in Semantic Net Frames
Lecture 22	Reasoning in Semantic Net Frames
Lecture 23	Planning
Lecture 24	Planning
Lecture 25	Rule Based Expert System
Lecture 26	Rule Based Expert System
Lecture 27	Rule Based Expert System
Lecture 28	Reasoning with Uncertainty
Lecture 29	Reasoning with Uncertainty
Lecture 30	Fuzzy Reasoning
Lecture 31	Fuzzy Reasoning
Lecture 32	Introduction to Learning
Lecture 33	Knowledge Acquisition
Lecture 34	Rule Induction and Decision Trees
Lecture 35	Rule Induction and Decision Trees
Lecture 36	Rule Induction and Decision Trees
Lecture 37	Learning Using neural Networks
Lecture 38	Learning Using neural Networks
Lecture 39	Probabilistic Learning
Lecture 40	Natural Language Processing

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Assignment 1	Q1. What is an expert system? Q2. Explain Rule Induction and Decision Trees.

	Q3. Explain Rule Based Expert System
Assignment 2	Q1. Explain Interface in Propositional Logic
	Q2. Explain Natural Language Processing
	Q3. Explain Reasoning Using First Order Logic

7ECU06.3	**VHDL**	**3L:0T:0P**	**3 credits**

Syllabus

INTRODUCTION:VHDL/PLD Design Methodology, Advantages, Requirement Analysis and specification, VHDL description, Verification Using simulations, Functional Simulation, Logic Synthesis, Place and route and timing Simulation Fundamental & history of various hardware description language, VHDL for Synthesis V/s Simulation, Design flow of ASICs and standard logic circuits. Implementation Details for SPLDs, CPLDs and FPGAs
LANGUAGE FUNDAMENTALS: Entities, Architectures and coding Styles, Signals and Data types, Packages, Dataflow, Structural, Behavioral and RTL Style of Combinational design, Event- Driven Simulation: Simulation Approaches, Elaboration Signal Drivers Simulator Kernel process, Signals verses Variables.
COMBINATIONAL and SEQUENCIAL CIRCUITS BUILDING BLOCKS: Multiplexer, Synthesis using Shannon's expansions, Decoders, encoders, Code Converters, VHDL Code for Combinational Circuits. VHDL code for Flip-Flops, shift registers, Counters.
SYNCHRONOUS/ ASYNCHRONOUS SEQUENCIAL CIRCUITS: Mealy & Moore type FSMs, VHDL Code for Mealy & Moore Machines, VHDL Codes for Serial Adder, Vending Machine.
DIGITAL SYSTEM DESIGN: Building Block circuits, Memory organization, SRAM, Design examples of divider, Multiplier, Shifting & Sorting Operations, Clock Synchronization, CPU organization and design concepts.

TEXT / REFERENCE BOOKS:

1.	Digital Logic with VHDL Design, Brown, TMH.(2007)
2.	VHDL for Engineers, Short, Pearson. (2011)
3.	VHDL (Text BOOK Binding), Douglas L. Perry, TMH 2002
4.	VHDL , A design oriented Approach, S S Limaye, TMH 2008
5.	VHDL: Programming By Example, Douglas Perry, Oxford 2002
6.	The Designer's Guide To VHDL, Peter J. Ashenden, Oxford 2010
7.	Circuit Design With VHDL , By Volnei A Pedroni, PHI 2004
8.	VHDL Bascis to programming, Gaganpreet Kaurt, Pearson 2013
9.	Digital System Design Using VHDL, cengage learning 2008
10.	HDL Programming Fundamentals VHDL & VERILOG. Botros. cengage learning 2002

Course Outcome:

Course Code	Course Name	Course Outcome	Details

7ECU06.3	**VHDL**	**CO 1**	Design and implement semiconductor memories, programmable logic devices (PLDs) and field programmable gate arrays (FPGA) in digital electronics.
		CO 2	Introduction of hardware description language (HDL) for the specification, simulation, synthesis and implementation of digital logic systems.
		CO 3	Describe language fundamentals
		CO 4	Develop VHDL Code for Combinational Circuits and sequential circuits
		CO 5	Explain Digital system design.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU06.3 VHDL	**CO 1**	3	2	1	1	2							
	CO 2	2	3	3	2	2							
	CO 3	3	3	3	3	3							
	CO 4	2	3	3	3	3							
	CO 5	2	3	3	3	3							

3: Strong **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	VHDL/PLD Design Methodology, Advantages, Requirement Analysis and specification
Lecture 2	VHDL description, Verification Using simulations
Lecture 3	Functional Simulation, Logic Synthesis
Lecture 4	Place and route and timing Simulation Fundamental & history of various hardware description language
Lecture 5	VHDL for Synthesis V/s Simulation, Design flow of ASICs and standard logic circuits
Lecture 6	Implementation Details for SPLDs, CPLDs and FPGAs
Lecture 7	Language Fundamentals: Entities, Architectures

Lecture 8	coding Styles, Signals and Data types
Lecture 9	Packages, Dataflow, Structural
Lecture 10	Behavioral and RTL Style of Combinational design
Lecture 11	Event- Driven Simulation: Simulation Approaches
Lecture 12	Elaboration Signal Drivers Simulator Kernel process
Lecture 13	Signals verses Variables.
Lecture 14	Combinational And Sequencial Circuits Building Blocks
Lecture 15	Multiplexer
Lecture 16	Synthesis using Shannon's expansions
Lecture 17	Decoders, encoders
Lecture 18	Code Converters
Lecture 19	VHDL Code for Combinational Circuits
Lecture 20	VHDL code for Flip-Flops
Lecture 21	VHDL code for shift registers
Lecture 22	VHDL code for Counters
Lecture 23	Synchronous/ Asynchronous Sequential Circuits
Lecture 24	Mealy & Moore type FSMs
Lecture 25	Mealy & Moore type FSMs
Lecture 26	VHDL Code for Mealy & Moore Machines,
Lecture 27	VHDL Code for Mealy & Moore Machines,
Lecture 28	VHDL Code for Mealy & Moore Machines,
Lecture 29	VHDL Codes for Serial Adder
Lecture 30	Vending Machine
Lecture 31	Vending Machine
Lecture 32	Digital System Design: Building Block circuits
Lecture 33	Memory organization
Lecture 34	SRAM
Lecture 35	Design examples of divider
Lecture 36	Multiplier
Lecture 37	Shifting Operations
Lecture 38	Sorting Operations
Lecture 39	Clock Synchronization
Lecture 40	CPU organization and design concepts

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Assignments:

Assignment 1	Q1. Write in VHDL a dataflow description of a negative edge triggered D flip-flop which has generic parameters to specify the setup time and hold time. The

	two times are to be defaulted to 8 and 5 ns. If either the setup or hold times are violated, the flip-flop state should not be changed.
	Q2. What are the main differences between HDLs and software languages?
	Q3. What do you mean by subprogram? Also explain operator overloading?
Assignment 2	Q1. What are concurrent statements? Which architectural model use concurrent statements? Explain conditional and selected signal assignment statements. Discuss the concept of delta delay in dataflow modelling.
	Q2. Write down the VHDL code of following: (a)D-flip flop (b) T-flip flop
	Q3. Write VHDL code for 8:1 MUX using process statement.

7ECU07	**SIGNAL AND IMAGE PROCESSING LAB**	**0L:0T:3P**	**2 credits**

List of Experiments

S.No.	Name of Experiment
1	To simulate the transmitter and receiver for BPSK
2	To design and simulate FIR digital filter (LP/HP).
3	To design and simulate IIR digital filter (LP/HP).
4	Reading and displaying Gray/ Colour images of different formats

5	RGB/HSI conversions in an image, Image arithmetic operations.
6	Image Histogram and histogram equalization
7	Image filtering in Spatial and frequency domain
8	Morphological operations in analyzing image structures
9	Thresholding-based image segmentation
10	Study of image compression

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU07	SIGNAL AND IMAGE PROCESSING Lab	CO 1	Able to generate Discrete time signals and systems, FIR and IIR filters.
		CO 2	Understand the different formats for images
		CO 3	Analyzing image structures and Image filtering
		CO 4	Able to Learn practical knowledge image processing
		CO 5	Analyzing image structures and Image filtering

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU07 SIGNAL AND IMAGE PROCESSING Lab	CO 1	3				3	2						3
	CO 2	2	3	1			1						
	CO 3	2	3	3	1								
	CO 4	2				3	2						3
	CO 5	2	3	3	2	2	2			2			3

3: Strongly **2: Moderate** **1: Weak**

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

7ECU08A	Wireless Communication Lab	0L:0T:3P	2 credit

List of Experiments

Sr. No.	Name of Experiment
1	Measurement of antenna input characteristics: Measure the input return loss versus frequency in the operating band for (i) Half wave dipole (printed dipole/strip dipole), (ii) Folded dipole and (ii) Log-periodic antenna.
2	Measurement of radiation characteristics of a (i) Half wave dipole (printed dipole/strip dipole), and (ii) Printed Yagi antenna -. Measure radiation patterns in the two principal planes and plot on polar chart. Determine beam width, directivity and antenna efficiency.
3	Measurement of antenna gain using absolute gain and relative gain measurements: a) Measure gain of Bi-quad antenna using absolute gain measurements. b) Measure gain of log-periodic antenna and printed slot antenna using relative gain measurements.
4	Circular polarization measurements on helical antenna.
5	Antenna array theory demonstration using single EM coupled rectangular patch, 2x1 EM coupled and 2x2 EM coupled rectangular patch antennas.
6	Communication link budget calculations- Friis formula and demonstration with transmit and receive antenna setup.
7	Radar Trainer: Working of Doppler radar, velocity of moving object, time and frequency measurement and other applications.
8	To perform Modulation, Demodulation and BER measurement using CDMA – DSSS Trainer.
9	To establish analog/digital communication link and transmit & receive three signals (audio, video, tone) simultaneously using Satellite Communication Trainer.
10	To study GPS Receiver, establishing link between GPS satellite & GPS trainer and measure of latitude & longitude

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU08A	Wireless Communication Lab	CO 1	Develop the understanding of basic antenna characteristics, classification parameters, antenna array fundamentals and the antenna design/ synthesis method.
		CO 2	Identify, analyze different principles and performance parameters of various types of antennas in practice
		CO 3	Analyze and design the antenna system for optimum

			minimization of the interference from ground.
		CO 4	Understand the antenna designing in CST Microwave Studio.
		CO 5	Development and implementation of different real time antenna system applications for the growth of society.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7ECU08A Wireless Communication Lab	**CO 1**	3				3	2						3
	CO 2	2	3	1			1						
	CO 3	2	3	3	1								
	CO 4	2				3	2						3
	CO 5	2	3	3	2	2	2			2			3

3: Strongly **2: Moderate** **1: Weak**

8ECU01	IC TECHNOLOGY	3L:0T:0P	3 credits

Syllabus

INTRODUCTION TO IC TECHNOLOGY- Semiconductor SubstrateCrystal defects, Electronic Grade Silicon, Czochralski Growth, Float Zone Growth, Characterization & evaluation of Crystals; Wafer Preparation- Silicon Shaping, Etching and Polishing, Chemical cleaning.
DIFFUSION & OXIDATION - Ficks diffusion Equation in One Dimension, Atomic model, Analytic Solution of Ficks Law, correction to simple theory, Diffusion in SiO2. Ion Implantation and Ion Implantation Systems. Oxidation Growth mechanism and Deal-Grove Model of oxidation, Linear and

Parabolic Rate co-efficient, Structure of SiO2, Oxidation techniques and system, Oxide properties.
CHEMICAL VAPOUR DEPOSITION AND EPITAXIAL LAYER GROWTH- CVD for deposition of dielectric and polysilicon thick Layer – a simple CVD system, Chemical equilibrium and the law of mass action, Introduction to atmospheric CVD of dielectric, low pressure CVD of dielectric and semiconductor. Epitaxy-Vapour Phase Expitaxy, Defects in Epitaxial growth, Metal Organic Chemical Vapor Deposition, Molecular beam epitaxy.
PATTERN TRANSFER & ETCHING - Introduction to photo/optical lithography, Contact/ proximity printers Projection printers, Mask generation, photo resists. Dry & Wet etching, methods for anisotropic etching, Plasma etching, Reaction ion etching (RIE).
VLSI PROCESS INTEGRATION- Junction and Oxide Isolation, LOCOS methods, Trench Isolation, SOI; Metallization, Planarization. Fundamental consideration for IC Processing, NMOS IC Technology, CMOS IC Technology, Bipolar IC Technology. Fault diagnosis and characterization techniques.

Text/Reference Books:

1.	S.M. Sze (Ed), VLSI Technology, 2nd Edition, McGraw Hill, 1988
2.	S.K. Ghandhi, VLSI Fabrication Principles, John Wiley Inc., New York,
3.	IC Technology, Gouranga Bose, McGraw Hill
4.	C.Y. Chang and S.M.Sze (Ed),ULSI Technology, McGraw Hill Companies Inc

Course Outcome:

Course Code	Course Name	Course Outcome	Details
8ECU 01	**IC TECHNOLOGY**	**CO 1**	Describe different processes involved in wafer preparation along with the methods which makes wafer suitable for fabrication purpose.

		CO 2	Analyse kinetics involved in oxidation of SiO2 and diffusion of various dopants needed in fabrication.
		CO 3	Explain the deposition of dielectric and polysilicon thick layer using chemical vapour deposition. Further, the epitaxial growth process for deposition of thin film is studie
		CO 4	Classify To provide the knowledge of photo/optical lithography and dry & wet etching.
		CO 5	Examine VLSI process integration using contact and interconnect metallization. Further, different IC Technology is introduced along with their comparison.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
8ECU01 IC TECHNOLOGY	**CO 1**	3	1										
	CO 2	3	2	2	1								
	CO 3	2	2	2	1	1							
	CO 4	3	1	2	1	1							
	CO 5	2	1	2	1								2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Semiconductor Substrate -Crystal defects,

Lecture 3	Electronic Grade Silicon, Czochralski Growth
Lecture 4	Float Zone Growth
Lecture 5	Characterization & Evaluation of Crystals,
Lecture 6	Wafer Preparation - Silicon Shaping,
Lecture 7	Etching and Polishing
Lecture 8	Chemical cleaning
Lecture 9	Ficks diffusion Equation in One Dimension, , Diffusion in SiO_2
Lecture 10	Atomic model, Analytic Solution of Ficks Law,
Lecture 11	Correction to simple theory
Lecture 12	Ion Implantation and Ion Implantation Systems
Lecture 13	Oxidation Growth mechanism and Deal-Grove Model of oxidation
Lecture 14	Linear and Parabolic Rate co-efficient
Lecture 15	Structure of SiO_2
Lecture 16	Oxidation techniques and system
Lecture 17	Oxide properties.
Lecture 18	CHEMICAL VAPOUR DEPOSITION AND EPITAXIAL LAYER GROWTH: CVD for deposition of dielectric
Lecture 19	polysilicon thick Layer – a simple CVD system
Lecture 20	Chemical equilibrium and the law of mass action
Lecture 21	Introduction to atmospheric CVD of dielectric,
Lecture 22	low pressure CVD of dielectric and semiconductor
Lecture 23	Epitaxy-Vapour Phase Expitaxy
Lecture 24	Defects in Epitaxial growth
Lecture 25	Metal Organic Chemical Vapor Deposition,
Lecture 26	Molecular beam epitaxy
Lecture 27	PATTERN TRANSFER & ETCHING: Introduction to optical lithography
Lecture 28	Introduction to photo lithography
Lecture 29	Contact/ proximity printers Projection printers
Lecture 30	Mask generation, photo resists

Lecture 31	Dry & Wet etching, Methods for anisotropic etching,
Lecture 32	Plasma etching, Reaction ion etching (RIE).
Lecture 33	VLSI PROCESS INTEGRATION: Junction and Oxide Isolation, LOCOS methods,
Lecture 34	Trench Isolation, SOI,
Lecture 35	Metallization, Planarization,
Lecture 36	Fundamental consideration for IC Processing,
Lecture 37	NMOS IC Technology,.
Lecture 38	CMOS IC Technology, Bipolar IC Technology
Lecture 39	Fault diagnosis and characterization techniques.
Lecture 40	Spill over class

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.**	Discuss different types of Growth.
	Q2.	Discuss Ion Implantation in detail.
	Q3.	Discuss two types of deposition techniques
Assignment 2	**Q1.**	Discuss fundamentals of photo lithography.
	Q2.	Discuss difference between Dry & Wet etching.
	Q3.	Discuss Trench Isolation in detail.

8EC2A	**RADAR AND TV ENGINERING**	**3L:0T:0P**	**3 credits**

Syllabus

RADAR: Radar Block diagram, frequencies and applications, Radar range equation. Continuous wave (CW) & FM radar Moving target indicator (MTI): Delay line cancellers, blind velocity Pulse Doppler Radar. Tracking radar sequential lobbing, Conical scan and mono-pulse radar Types of display, Radar receivers, Noise figure. NAVIGATIONAL AIDS - Principle of operation of Radar direction finder & range system LORAN system, DME, TACAN, Aircraft landing systems.
T.V. Systems : Block diagram of T.V. transmitters, Principles of Monochrome and colour T.V.system (PAL, SECAM, NTSC). Theory of scanning standards, Composite video signal analysis. T.V Cameras Image orthicon, plumbicon, vidicon and CCD camera tubes Analog Monochrome and colour picture tubes,
Processing and transmission of TV signals. Modulation of video and sound signals, Vestigial side band transmission, Compatibility of colour and monochrome frequency interleaving & transmission of colour signals, Picture, sound and colour sub carriers Encoding picture information. Generation of colour, colour difference and Chrominance signal modulation. TV transmission & reception antennas.
Basic circuits of TV Receiver: Functional block diagram of T.V. receiver, R.F. Tuner, I.F. amplifier, Video detector, video amplifier, AGC, Synch. Separation, Sync. Processing and AFC Deflection oscillators, vertical & horizontal deflection and sound system circuits EHT generation. Common faults and their diagnosis Basic idea of HDTV, DBS-TV and 3D-TV.
Modern TV System: Digital transmission and reception of TV signals, DISHTV, DTH and cable TV, transmission of TV signals through, Satellite and Transponders Working principles of HDTV, DBS-TV, IPTV and 3D-TV. Modern TV receiver with LCD, LED and Plasma displays.

Text/Reference Books:

1.	Monochrome and colour Television , R R Gulathi, Wiley Eastern Ltd.2007
2.	Introduction to Radar System, 3rd, M I Skolink, MGH, 2003
3.	Television Engineering and Video System, R G Gupta, MGH, 2005
4.	Television and Video Engineering , A M Dhake, MGH,1995
5.	Nathanson, F.E., "*Radar Design Principles*", McGraw-Hill Inc.1991
6.	Principles, Technology, Applications, Prentice Hall,1993
7.	D.K.Barton, Modern radar systems analysis, Artech House,1988
8.	Microwave and radar engineering, G.S.B. Rao, Pearson P.2013

Course Outcome:

Course Code	Course Name	Course Outcome	Details
8E CU 02	**AR AND TV ENG INE RIN**	**CO 1**	**Explain** Understand the working of Radar. The terminology used in Radar engineering. (K2)

		CO 2	**Describe** Understand the working of Black & white as well as color TV (K2).
		CO 3	**Define** The terminology used in TV engineering (K1).
		CO 4	**Construct** different TV circuits. (K3
		CO 5	**Identify** Able to diagnose different Faults in TV receiver (K4).

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
8ECU02 RADAR AND TV ENGINERING	**CO 1**	3	1										
	CO 2	2	2	2	1								
	CO 3	2	1										
	CO 4	3	1	3	1								
	CO 5	2	3	2	3	1							2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Radar Block diagram, frequencies and applications,
Lecture 3	Radar range equation. Continuous wave (CW) & FM radar
Lecture 4	Moving target indicator (MTI): Delay line cancellers,
Lecture 5	blind velocity Pulse Doppler Radar.
Lecture 6	Tracking radar sequential lobbing,
Lecture 7	Conical scan and mono-pulse radar
Lecture 8	Types of display, Radar receivers, Noise figure.
Lecture 9	NAVIGATIONAL AIDS - Principle of operation of Radar direction finder & range system
Lecture 10	LORAN system, DME,.
Lecture 11	TACAN, Aircraft landing systems

Lecture 12	T.V. Systems: Block diagram of T.V. transmitters, Principles of Monochrome and colour T.V.system PAL,
Lecture 13	Block diagram of T.V. transmitters, Principles of Monochrome and colour T.V.system SECAM
Lecture 14	Block diagram of T.V. transmitters, Principles of Monochrome and colour T.V.system NTSC
Lecture 15	Theory of scanning standards
Lecture 16	Composite video signal analysis. T.V Cameras
Lecture 17	Image orthicon, plumbicon,
Lecture 18	vidicon and CCD camera tubes
Lecture 19	Analog Monochrome and colour picture tubes,
Lecture 20	Processing and transmission of TV signals: Modulation of video and sound signals,
Lecture 21	Vestigial side band transmission,
Lecture 22	Compatibility of colour and monochrome frequency interleaving & transmission of colour signals,
Lecture 23	Picture, sound and colour sub carriers
Lecture 24	Encoding picture information. Generation of colour,
Lecture 25	colour difference and Chrominance signal modulation.
Lecture 26	TV transmission & reception antennas.
Lecture 27	Basic circuits of TV Receiver: Functional block diagram of T.V. receiver, R.F. Tuner,
Lecture 28	I.F. amplifier, Video detector,
Lecture 29	video amplifier, AGC,
Lecture 30	Synch. Separation, Sync. Processing and AFC
Lecture 31	Deflection oscillators, vertical & horizontal deflection and sound system circuits
Lecture 32	EHT generation. Common faults and their diagnosis
Lecture 33	Basic idea of HDTV, DBS-TV and 3D-TV.
Lecture 34	Modern TV System: Digital transmission and reception of TV signals, DISHTV, DTH and cable TV,
Lecture 35	transmission of TV signals through
Lecture 36	Satellite and Transponders
Lecture 37	Working principles of HDTV, DBS-TV,
Lecture 38	IPTV and 3D-TV.
Lecture 39	Modern TV receiver with LCD, LED and Plasma displays.
Lecture 40	Spill over class

Content delivery method:

4. Chalk and Duster
5. PPT
6. Hand-outs

Assignment 1	Q1. Explain the working LORAN?
	Q2. When CW transmitter has 10 GHz frequency, calculate Doppler frequency seen by stationary Radar. Target radial velocity is 250km/h?
	Q3.what is limitation of NTSC system and how it is overcome in PAL? Explain the PAL system?
Assignment 2	Q1. Draw the automatic direction finder for aircraft and explain its working?
	Q2. Describe the instument landing system?
	Q3. Explain the function of : a) Colour killer b) colour matrix

8ECU03	**MEMS AND NANOTECHNOLOGY**	**3L:0T:0P**	**3 credits**

Syllabus

Introduction to Nanoelectronics: Top Down and Bottom UP Approach, Nanotechnology Potentials, Idea of band structure – Metals, Insulators and Semiconductors. Effect of crystal size on density of states and band gap, Electronic structure of nanoparticles. Nanostructured crystals, Size and dimensionality effects – Single electron tunneling – Applications – Superconductivity, Graphenes and CNT.
Nano Fabrication and Patterning Techniques: Si processing methods, Cleaning/etching, Oxidation, Gettering, doping, Epitaxy. CVD & MOCVD, Physical Vapor Deposition (PVD), Liquid Phase Techniques, Self assembly and catalysis. Etching: Wet and Dry, Nanolithography, Nanoimprinting, XRay Lithography(XRL), Particle beam lithography(e-beam, FIB, shadow mask evaporation).
General Characterization Techniques: X- Ray Diffraction studies – Bragg's law – particle size – Scherrer's equation, Infrared Spectroscopy of Semiconductors, Raman Spectroscopy, Dynamic Light Scattering (DLS), NMR Spectroscopy, ESR Spectroscopy. photo electron spectroscopy(XPS)- SEM, TEM, STM, Atomic force microscopy(AFM).
Electrical, Magnetic, Mechanical and Optical Properties and Applications: Electronic and electrical properties -One dimensional systems-Metallic nanowires, Quantum dots -Two dimensional systems - Quantum wells. Magnetic properties -Transport in a magnetic field. Mechanical properties, Optical properties, Evolving interfaces of Nano in NanoBiology, Nano Sensors and Nanomedicines
MEMS and Microsystems: Evolution of Micro Fabrication – Micro Systems and Microelectronics. Application of MEMS in Various Fields. Introduction – Substrate and Wafer, Active Substrate Material. Silicon as a substrate material, MEMS packaging. Case study on pressure sensor with packaging.

Text/Reference Books:

1.	Nano Essentials, T Pradeep, Mc Graw Hill, (2008).
2.	Nanotechnology-Enabled Sensors, Kourosh Kalantar-zadehand Benjamin Fry, Springer, (2007).
3.	Fundamental of Nanoelectronics, George W. Hanson, Pearson 2009
4.	Principal of Nanotechnology, G. A. Mansoori, Wiley 2005
5.	Mems and Micro Systems, Mahalik, TMH 2007
6.	Gabriel, Wiley 2006 5 MEMS, A.R. Jha, CRC 2008
7.	Nano Fabrication, CRC 2012
8.	MEMS & Microsystems, Design and Manufacture, Tai-Ran HSU, TMH 2013

Course Outcome:

Course Code	Course Name	Course Outcome	Details
ECUDO	ANOT	CO1	**Outline** the fundamental concept of Nanoelectronics (K1).

		CO2	**Explain** the fabrication and the MEMS manufacturing technologies (K2).
		CO3	**Identify** general characterization techniques in nanotechnology (K4).
		CO4	**Interpret** the fundamental concepts of nanotechnology and its applications (K3).
		CO5	**Interpret** the fundamental concepts of nanotechnology and its applications (K3).

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
8EC3 MEMS AND NANOTECHNOGY	**CO1**	3	2	2									
	CO2	2	2	3									
	CO3	2	3	2	3								
	CO4	2	1										
	CO5	3	2	3	2	2							2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture: Overview of subject
Lecture 2	Introduction to Nanoelectronics
Lecture 3	Top Down and Bottom UP Approach
Lecture 4	Nanotechnology Potentials
Lecture 5	Idea of band structure – Metals, Insulators and Semiconductors
Lecture 6	Effect of crystal size on density of states and band gap
Lecture 7	Electronic structure of nanoparticles

Lecture 8	Nanostructured crystals, Size and dimensionality effects
Lecture 9	Single electron tunneling
Lecture 10	Applications – Superconductivity, Graphenes and CNT
Lecture 11	Nano Fabrication and Patterning Techniques
Lecture 12	Si processing methods, Cleaning/etching, Oxidation
Lecture 13	Gettering, doping, Epitaxy
Lecture 14	CVD & MOCVD, Physical Vapor Deposition (PVD),
Lecture 15	Liquid Phase Techniques, Self assembly and catalysis
Lecture 16	Etching: Wet and Dry
Lecture 17	Nanolithography, Nanoimprinting
Lecture 18	X- Ray Lithography(XRL)
Lecture 19	Particle beam lithography(e-beam, FIB, shadow mask evaporation),
Lecture 20	General Characterization Techniques
Lecture 21	X- Ray Diffraction studies – Bragg's law – particle size – Scherrer's equation
Lecture 22	Infrared Spectroscopy of Semiconductors, Raman Spectroscopy
Lecture 23	Dynamic Light Scattering (DLS), NMR Spectroscopy, ESR Spectroscopy
Lecture 24	Photo electron spectroscopy(XPS)
Lecture 25	SEM,TEM,STM, Atomic force microscopy(AFM).
Lecture 26	Electrical, Magnetic, Mechanical and Optical Properties and Applications
Lecture 27	Electronic and electrical properties -One dimensional systems-Metallic nanowires
Lecture 28	Quantum dots -Two dimensional systems - Quantum wells.
Lecture 29	Magnetic properties -Transport in a magnetic field
Lecture 30	Mechanical properties, Optical properties
Lecture 31	Evolving interfaces of Nano in NanoBiology
Lecture 32	Nano Sensors and Nanomedicines
Lecture 33	MEMS and Microsystems
Lecture 34	Evolution of Micro Fabrication
Lecture 35	Micro Systems and Microelectronics
Lecture 36	Application of MEMS in Various Fields

Lecture 37	Introduction – Substrate and Wafer
Lecture 38	Active Substrate Material. Silicon as a substrate material
Lecture 39	MEMS packaging
Lecture 40	Case study on pressure sensor with packaging.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignment 1	Q1. Discuss various wall structure of carbon nano tube with suitable diagram?
	Q2. Explain single electron tunneling and its current voltages characteristics.
	Q3. Write a note on lithography?
Assignment 2	Q1. Explain NPR Spectroscopy and ESR Spectroscopy in details?
	Q2 what do you means by MEMS packaging?
	Q3. Write an essay on application of MEMS in various fields?

8EC4.1A	**Computer Networks**	**3L:0T:0P**	**3 credits**

Syllabus

Queuing Theory , Pure birth, Pure death & Birth-death processes, Mathematical models for M/M/1, M/M/∞, M/M/m, M/M/1/K and M/M/m/m queues. Little's formula.
Physical and Data link layer , OSI model & TCP/IP reference models ,Line coding schemes, Packet & Circuit switching, Virtual circuit network, Framing, Simplex protocol, Simplex stop & wait protocol, Sliding window protocol, Go back N protocol, selective repeat, HDLC ,PPP
MAC Sublayer ,Static & dynamic channel allocation, Multiple Access Protocols: ALOHA, slotted ALOHA, CSMA, Token Bus, Token Ring, FDDI ,IEEE standards 1002.3 & 1002.5, Virtual circuit network: frame relay & ATM frame and protocol architecture, Network connection devices: Hubs, Bridges, switches, Routers and Gateways
Network Layer ,IPv4 & IPv6 addressing and datagram, Internetworking Non-adaptive & Adaptive routing algorithms, Distance vector routing and Link state routing algorithms, OSPF and BGP
Transport and Application Layer ,Client server paradigm, TCP frame format, Data traffic descriptors ,Data traffic descriptors, QoS, Congestion and its control algorithms, Improving QoS by different queuing schemes, leaky bucket and token bucket implementation ,Domain name, DNS in the internet SMTP, FTP, WWW, HTTP

Text/Reference Books:

1.	J.F. Kurose and K. W. Ross, "Computer Networking – A top down approach featuring the Internet", Pearson Education, 5th Edition
2.	L. Peterson and B. Davie, "Computer Networks – A Systems Approach" Elsevier Morgan Kaufmann Publisher, 5th Edition.
3.	T. Viswanathan, "Telecommunication Switching System and Networks", Prentice Hall
4.	S. Keshav, "An Engineering Approach to Computer Networking" , Pearson Education
5.	B. A. Forouzan, "Data Communications and Networking", Tata McGraw Hill, 4th Edition
6.	Andrew Tanenbaum, "Computer networks", Prentice Hall
7.	D. Comer, "Computer Networks and Internet/TCP-IP", Prentice Hall
8.	William Stallings, "Data and computer communications", Prentice Hall

Course outcome

Course Code	Course Name	Course Outcome	Details
8EC4.1A	**mputer Net**	**CO 1**	Describe the significance and concepts of computer networks and services offered at each layer.

		CO 2	Analyse and appreciate the layered model for computer networking.
		CO 3	Identify basic protocols and design issues for layered model.
		CO 4	Design and implement protocols related to various networking layers.
		CO 5	Explain different switching in networks.

CO –PO Mapping

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
8EC4.1A Computer Networks	**CO 1**	3	2	1									
	CO 2	2	3	1	2								
	CO 3	1	3	2	3								
	CO 4	1	2	3	2								
	CO 5	3	1										

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture: Overview of subject
Lecture 2	Introduction to computer networks and the Internet
Lecture 3	Queuing Theory , Pure birth, Pure death & Birth-death processes,
Lecture 4	Mathematical models for M/M/1 queues
Lecture 5	Mathematical models for M/M/∞ queues
Lecture 6	Mathematical models for M/M/m queues
Lecture 7	Mathematical models for M/M/1/K and M/M/m/m queues
Lecture 8	Little's formula.

Lecture 9	Physical and Data link layer,
Lecture 10	OSI model & TCP/IP reference models
Lecture 11	Line coding schemes, Packet & Circuit switching,
Lecture 12	Virtual circuit network,
Lecture 13	Framing, Simplex protocol
Lecture 14	Simplex stop & wait protocol
Lecture 15	Sliding window protocol,
Lecture 16	Go back N protocol, selective repeat
Lecture 17	HDLC, PPP
Lecture 18	Static & dynamic channel allocation,
Lecture 19	Multiple Access Protocols: ALOHA, slotted ALOHA
Lecture 20	CSMA,
Lecture 21	Token Bus, Token Ring,
Lecture 22	FDDI
Lecture 23	IEEE standards 1002.3 & 1002.5,
Lecture 24	Virtual circuit network: frame relay & ATM frame
Lecture 25	protocol architecture,
Lecture 26	Network connection devices: Hubs, Bridges,
Lecture 27	Network connection devices: switches, Routers and Gateways
Lecture 28	IPv4 & IPv6 addressing and datagram,
Lecture 29	Internetworking
Lecture 30	Non-adaptive & Adaptive routing algorithms,
Lecture 31	Distance vector routing algorithms
Lecture 32	Link state routing algorithms
Lecture 33	OSPF and BGP
Lecture 34	Client server paradigm, TCP frame format,
Lecture 35	Data traffic descriptors , Data traffic descriptors,
Lecture 36	QoS, Congestion and its control algorithms,
Lecture 37	Improving QoS by different queuing schemes,

Lecture 38	leaky bucket and token bucket implementation
Lecture 39	Domain name, DNS in the internet
Lecture 40	SMTP, FTP, WWW, HTTP

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

Sample Assignments:

Assignment 1	**Q1.** Consider an FTP session in which the user three separate *get* commands. How many TCP connections are created during this session? Explain.
	Q2. Consider a 100 Mb/s link, preceded by a queue that can hold 1000 packets. Suppose packets with an average packet length of 125 bytes are arriving at the queue, at the rate of 85 thousand packets per second. What is the average number of packets in the queue? How long does it take to transmit a packet over the link? What is the average amount of time that a packet waits in the queue?
	Q3. Explain CSMA technique.
Assignment 2	**Q1.** Suppose a host receives 10 IP packets and the id field in these packets are: 3, 7, 8, 8, 8, 7, 9, 13, 3 and 13. How many distinct packets were sent by the original host?
	Q2. Define HTTP and WWW.
	Q3. Define these network connection devices: Hubs, Bridges, switches, Routers .

8ECU05	RF FABRICATION LAB	0L:0T:3P	2 credits

List of Experiments

Sr. No.	Name of Experiments
1	Design and fabricate the following *Planar Transmission Lines:* a) Stripline and microstrip lines b) Parallel coupled striplines and microstrip lines c) Slot lines and Coplanar lines Measure their S-parameters and Characteristic impedance.
2	Design and Fabricate the following; • 3-dB branchline coupler, • backward wave coupler, • Wilkinson power dividers • Low pass filters • band pass filters. Measure their S-parameters & frequency responses.
3	Design, fabrication, and measurement of RF amplifier using microwave BJT.

Course Outcomes

Course Code	Course Name	Course Outcome	Details
8ECU05	**RF Fabrication Lab**	**CO 1**	**Experiment** with design and fabrication of planar transmission lines, couplers, dividers and filters and RF amplifiers(K3).
		CO 2	**Examine** the back-end tool for fabrication and layout designing (K4).
		CO 3	**Describe** the fabrication process**.** (K2)
		CO 4	**Choose** appropriate fabrication technique and tools (K3)**.**

CO-PO Mapping :

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12

8ECU05 RF Fabrication Lab	**CO 1**	2	2	3	1	2							
	CO 2	1	1	1	2	3							
	CO 3	3	2										
	CO 4	1	1	2	3	3							

3: Strong **2: Moderate** **1: Weak**

8ECU06	**INDUSTRIAL ECONOMICS & MANAGEMENT**	**0L:0T:2P**	**1 credits**

Syllabus

S.No.	Contents
1	Framework of industrial economics – organizational forms and alternative motives of the firm, industrial efficiency, theory of profitability, market structure, principles of costing.
2	Approaches to industrial location analysis, Productivity analysis, Input-Output analysis, Concentration of economic power. New Industrial Policy – Critical analysis, Role of technology and entrepreneurship in industrial development.
3.	Industrial project appraisal- classification of industries, industrial legislations in India, recent trends in MNCs, LPG, FDI &joint ventures, methods of project evaluation-NPV, CBA, IRR, break-even analysis.
4	Management – Principles of management, functions of management- planning, organizing, staffing, directing, controlling, coordinating, decision making
5	Emerging issues – Total quality management, JIT, quality circle, KANBAN, benchmarking, six-sigma, quality management, ISO 9000, ISO 14000, Customer relationship management (CRM).

Course Outcomes:

Course Code	Course Name	Course Outcome	Details
E C U 0	**n o m ic s &**	**CO 1**	**Outline** framework of industrial economics and related policies. (K1).

		CO 2	**Demonstrate** differentiate classify industries in India and related legislations (K3).
		CO 3	**Illustrate** management principles and functions**.** (K2).
		CO 4	**Analyse** the contemporary emerging issues. (K4).

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
8ECU06 Industrial Economics & Management	**CO 1**	3	1	1									
	CO 2	2	3										
	CO 3	3	2	2									
	CO 4	2	2	1	3								

3: Strongly **2: Moderate** **1: Weak**

8ECU07	VLSI Design And Optical Fibre Lab	0L:0T:3P	2 credit

List of Experiments

Sr.No.	Name of Experiment

PART-I: Design and simulation of following VLSI circuits using EDA Tools (Software) Schematic design and make Device Level Layout of following circuits	
1	Design 2-input NAND, NOR and XOR using CMOS logic. Obtain its static and dynamic analysis for speed and power dissipation.
2	Design 2X1 and 4X1 Multiplexer using Transmission Gate (TG. Obtain its static and dynamic analysis for speed and power dissipation.
3	Design a SR-latch and D-latch using CMOS. Obtain its static and dynamic analysis for speed and power dissipation.
4	Design a SRAM and DRAM Memory Cell. Obtain its static and dynamic analysis for speed and power dissipation.
PART-II Design and simulation of following VLSI circuits using VHDL and then burn/implement the circuits on FPGA kit for real input.	
5	Design a 4- bit parallel Adder. Obtain its number of gates, area, and speed and power dissipation.
6	Design a 4- bit Serial in-serial out shift register. Obtain its number of gates, area, and speed and power dissipation.
7	Design a 4- bit binary synchronous counter. Obtain its number of gates, area, and speed and power dissipation.
PART-III. To perform following experiments based on Fibre Optic Trainer.	
8	To set up Fiber Optic Analog link.
9	To set up fiber Optic Digital link.
10	Measurement of Propagation loss and numerical aperture.
11	Characterization (VI Characteristics) of laser diode and light emitting diode.

Course Outcomes

Course Code	Course Name	Course Outcome	Details
8ECU07	**VLSI Design And Optical Fibre Lab**	**CO 1**	**Assess** and implement performance characterization and component level parameter optimization of digital IC basic building blocks(K3).
		CO 2	**Experiment** Layout designing and parasitic extraction and performance evaluation of layouts of digital logic circuits(K4).
		CO 3	**Apply** VHDL modelling and FPGA implementation of digital IC building blocks(K3).
		CO 4	**Identify** analog and digital link and performance evaluation of these links(K1).
		CO 5	**Illustrate** understanding of frontend and backend EDA design tools (K2).

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
8ECU07 VLSI Design And Optical Fibre Lab	**CO 1**	2	3	3	2	1							
	CO 2	1	1	3	1	2							
	CO 3	2	1	3									
	CO 4	2	2	1									
	CO 5	1	1	1	2	3							

3: Strongly **2: Moderate** **1: Weak**