Scheme of

UNDERGRADUATE DEGREE COURSE

in

Electronics & Communication Engineering

University Departments,

Rajasthan Technical University, Kota

Effective from session: 2018 – 2019

(For students admitted in session 2017-18 onwards)

2nd Year: Electronics & Communication Engineering
III Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	3ECU1	ICC	Advanced Engineering Mathematics-I	4	3	1	0	50	100	150
2	3ECU2	DCC	Electronics Devices	4	3	1	0	50	100	150
3	3ECU3	DCC	Digital System Design	3	3	0	0	50	100	150
4	3ECU4	DCC	Signal & Systems	3	3	0	0	50	100	150
5	3ECU5	DCC	Network Theory	3	3	0	0	50	100	150
6	3ECU6	DCC/IEC	Technical Communication	2	2	0	0	50	100	150
7	3ECU11	DCC	Electronics Devices Lab	2	0	0	3	50	25	75
8	3ECU12	DCC	Digital System Design Lab	1	0	0	2	50	25	75
9	3ECU13	DCC/IEC	Signal Processing Lab	1	0	0	2	50	25	75
10	3ECU14	DCC/IEC	Computer Programming Lab-I	1	0	0	2	50	25	75
11	3ECU20		Extra Curricular& Discipline	1				50		50
			TOTAL	**25**	**17**	**2**	09	**550**	**750**	**1250**

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2nd Year: Electronics & Communication Engineering
IV Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	4ECU1	ICC	Advanced Engineering Mathematics-II	4	3	1	0	50	100	150
2	4ECU2	DCC	Analog Circuits	4	3	1	0	50	100	150
3	4ECU3	DCC	Microcontrollers	3	3	0	0	50	100	150
4	4ECU4	DCC	Electronics Measurement & Instrumentation	3	3	0	0	50	100	150
5	4ECU5	DCC	Analog and Digital Communication	3	3	0	0	50	100	150
6	4ECU6	DCC/IEC	Managerial Economics and Financial Accounting	2	2	0	0	50	100	150
7	4ECU11	DCC	Analog and Digital Communication Lab	2	0	0	3	50	25	75
8	4ECU12	DCC	Analog Circuits Lab	2	0	0	3	50	25	75
9	4ECU13	DCC/IEC	Microcontrollers Lab	1	0	0	2	50	25	75
10	4ECU14	DCC/IEC	Electronics Measurement & Instrumentation Lab	1	0	0	2	50	25	75
11	4ECU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**26**	**17**	**2**	**10**	**550**	**750**	**1250**

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3rd Year: Electronics & Communication Engineering
V Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	5ECU1	DCC	Electromagnetics Waves	4	3	1	0	50	100	150
2	5ECU2	DCC	Control system	4	3	1	0	50	100	150
3	5ECU3	DCC	Digital Signal Processing	3	3	0	0	50	100	150
4	5ECU4	DCC	Microwave Theory & Techniques	3	3	0	0	50	100	150
5	5ECU5.1	DEC	Probability Theory & Stochastic Process	3	3	0	0	50	100	150
	5ECU5.2		Embedded Systems							
6	5ECU6.1	DEC	Bio-Medical Electronics	2	2	0	0	50	100	150
	5ECU6.2		Satellite Communication							
7	5ECU11	DCC	RF Simulation Lab	2	0	0	3	50	25	75
8	5ECU12	DCC	Digital Signal Processing Lab	1	0	0	2	50	25	75
9	5ECU13	DCC	Microwave Lab	1	0	0	2	50	25	75
10	5ECU14	DCC/IEC	PCB Design lab/EC workshop	1	0	0	2	50	25	75
11	5ECU20		Extra Curricular& Discipline	1				50		50
			TOTAL	**25**	**17**	**2**	**09**	**550**	**750**	**1250**

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3rd Year: Electronics & Communication Engineering
VI Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week L	T	P	Marks IA	ETE	Total
1	6ECU1	DCC	Computer Network	4	3	1	0	50	100	150
2	6ECU2	DCC	Fiber Optics Communications	4	3	1	0	50	100	150
3	6ECU3	DCC	Antennas and Propagation	3	3	0	0	50	100	150
4	6ECU4	DCC	Information theory and coding	3	3	0	0	50	100	150
5	6ECU5.1 6ECU5.2	DEC	Introduction to MEMS Nano Electronics	3	3	0	0	50	100	150
6	6ECU6.1 6ECU6.2	DEC	Power Electronics High Speed Electronics	2	2	0	0	50	100	150
7	6ECU11	DCC	Computer Network Lab	2	0	0	3	50	25	75
8	6ECU12	DCC	Antenna and wave propagation Lab	2	0	0	3	50	25	75
9	6ECU13	DCC	Electronics Design Lab	1	0	0	2	50	25	75
10	6ECU14	DCC/IEC	Power Electronics Lab	1	0	0	2	50	25	75
11	6ECU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**26**	**17**	**2**	**10**	**550**	**750**	**1250**

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4th Year: Electronics & Communication Engineering
VII Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	7ECU1	DCC	CMOS Design	4	3	1	0	50	100	150
2	7ECU2	DCC	Digital Image and Video Processing	4	3	1	0	50	100	150
3	7ECU3	DCC	Mobile Communication and Network	3	3	0	0	50	100	150
4	7ECU4	DCC	Mixed Signal Design	3	3	0	0	50	100	150
5	7ECU5.1	DEC	Error Correcting Codes	3	3	0	0	50	100	150
	7ECU5.2		Neural Network And Fuzzy Logic Controller							
6	7ECU11	DCC	VLSI Design Lab	2	0	0	3	50	25	75
7	7ECU12	DCC	Optical fibre lab	1	0	0	2	50	25	75
8	7ECU13	DCC	Minor project	1	0	0	2	50	25	75
9	7ECU14	DCC	Practical Training	4	0	0	4	150	75	225
10	7ECU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**26**	**15**	**2**	**11**	**600**	**650**	**1250**

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4th Year: Electronics & Communication Engineering
VIII Semester Option-A

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	8ECU1.1	DEC	Speech and audio processing	3	3	0	0	50	100	150
	8ECU1.2		Artificial intelligence							
2	8ECU2.1	DEC	Adaptive Signal Processing	3	3	0	0	50	100	150
	8ECU2.1		Wavelets							
3	8ECU3.1	DEC	Wireless Sensor Network	3	3	0	0	50	100	150
	8ECU3.2		Scientific Computing							
4	8ECU13	DCC	Seminar	4	0	0	4	150	75	225
5	8ECU14	DCC	Project	12	0	0	18	350	175	525
6	8ECU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**26**	**9**	**0**	**22**	**700**	**550**	**1250**

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4th Year: Electronics & Communication Engineering
VIII Semester Option-B*

1	8ECU13	DCC	Seminar	4			4	150	75	225
2	8ECU14	DCC	Project Cum Internship	21			36 hours per week	500	475	975
3	8ECU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**26**	**0**	**0**	**40**	**700**	**550**	**1250**

***In VIII semester, option-B be given (on Choice) to the student having CGPA ≥ 8.0 calculated up to the VI semester B.Tech. results.**

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3ECU1	ICC	Advance Engineering Mathematics-I	MM:150	3L:1T:0P	4 credits

Numerical Methods – 1: (10 lectures)
Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Gauss's forward and backward interpolation formulae. Stirling's Formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.
Numerical Methods – 2: (8 lectures)
Numerical solution of ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge- Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. Solution of polynomial and transcendental equations-Bisection method, Newton-Raphson method and Regula-Falsi method.
Laplace Transform: (10 lectures)
Definition and existence of Laplace transform, Properties of Laplace Transform and formulae, Unit Step function, Dirac Delta function, Heaviside function, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs by Laplace transforms method.
Fourier Transform: (7 lectures)
Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations only).
Z-Transform: (5 lectures)
Definition,properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.

Suggested Text/Reference Books
1. FranscisScheid, Theory and Problems of Numerical Analysis, Schaum Outline's series. 2. S. S. Sastry; Introductory Methods of Numerical Analysis; Prentice Hall India Learning Private Limited. 3. M. K. Jain, S. R. K. Iyengar and R. K. Jain; Numerical Methods for Scientific and Engineering Computation; New Age International

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Publishers.

4. Spiegel; Laplace Transforms; Schaum's outline series.
5. Erwin kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
6. R.K. Jain and S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publications.
7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.
8. Dennis G. Zill and Warren S. Wright; Advanced Engineering Mathematics; Jones & Bartlett Learning.
9. Pal and Bhunia, Engineering Mathematics, Oxford, India.
10. C.B. Gupta, Engineering Mathematics for semesters III and IV, McGraw Hill Education, India.

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3ECU2	DCC	Electronic Devices	MM:150	3L:1T:0P	4 credits

Introduction to Semiconductor Physics: Introduction, Energy band gap structures of semiconductors, 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.
Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance, design of resistors.
Generation and recombination of carriers; Poisson and continuity equation P-N junction characteristics, I-V characteristics, and small signal switching models; Avalanche breakdown, Zener diode, Schottky diode.
Bipolar Junction Transistor, I-V characteristics, Ebers-Moll Model, MOS capacitor, C-V characteristics, MOSFET, I-V characteristics, and small signal models of MOS transistor, LED, photodiode and solar cell.
Integrated circuit fabrication process: oxidation, diffusion, ion implantation, Photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process.

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.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU2	Electronic Devices	CO 1	Understanding the semiconductor physics of the intrinsic, P and N materials.
		CO 2	Understanding the characteristics of current flow in a bipolar junction transistor and MOSFET.
		CO 3	Understand and utilize the mathematical models of semiconductor junctions and MOS transistors for circuits and systems.
		CO 4	Analyze the characteristics of different electronic devices such as Amplifiers, LEDs, Solar cells, etc.
		CO 5	Theoretical as well as experimental understanding of Integrated circuit fabrication.

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
3ECU2 Electronic Devices	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	Introduction to Semiconductor Physics
Lecture 3	Introduction to Semiconductor Physics

Lecture 4	Introduction to Semiconductor Physics
Lecture 5	Review of Quantum Mechanics
Lecture 6	Electrons in periodic Lattices
Lecture 7	E-k diagrams
Lecture 8	Energy bands in intrinsic and extrinsic silicon
Lecture 9	Carrier transport: diffusion current, drift current, mobility and resistivity
Lecture 10	Sheet resistance and design of resistors
Lecture 11	Generation and recombination of carriers
Lecture 12	Poisson and continuity equation
Lecture 13	P-N junction characteristics and their I-V characteristics
Lecture 14	P-N junction characteristics and their I-V characteristics
Lecture 15	P-N junction small signal switching models
Lecture 16	P-N junction small signal switching models
Lecture 17	Avalanche breakdown
Lecture 18	Zener diode and Schottky diode
Lecture 19	Basics of Bipolar Junction Transistor
Lecture 20	I-V characteristics of BJT
Lecture 21	Ebers-Moll Model
Lecture 22	MOS capacitor
Lecture 23	MOS capacitor
Lecture 24	C-V characteristics
Lecture 25	Basics of MOSFET
Lecture 26	Basics of MOSFET
Lecture 27	I-V characteristics of MOSFET
Lecture 28	Small signal models of MOS transistor
Lecture 29	Small signal models of MOS transistor
Lecture 30	Light Emitting Diode
Lecture 31	Photodiode and solar cell
Lecture 32	Basics of Integrated Circuits
Lecture 33	Advancement in Integrated Circuits
Lecture 34	Oxidation, diffusion and ion implantation
Lecture 35	Photolithography and etching
Lecture 36	Chemical vapor deposition
Lecture 37	Sputtering
Lecture 38	Twin-tub CMOS process
Lecture 39	Spill over class
Lecture 40	Spill over class

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 applications of Ebers-Moll Model.
	Q2.	Discuss different types of fabrication techniques.
	Q3.	Discuss various characteristics of CMOS transistor.

3ECU3	DCC	Digital System Design	MM:150	3L:0T:0P	3 credits

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion.
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
Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of Synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation.
Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using programmable devices.
VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modeling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits.

Text/Reference Books:

1.	R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.
2.	Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.
3.	W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd edition ,2006.
4.	D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
5.	Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd edition 2012.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU3	Digital System Design	CO 1	Develop the understanding of number system and its application in digital electronics.
		CO 2	Development and analysis of K-map to solve the Boolean function to the simplest form for the implementation of compact digital circuits.
		CO 3	Design various combinational and sequential circuits using various metrics: switching speed, throughput/latency, gate count and area, energy dissipation and power.
		CO 4	Understanding Interfacing between digital circuits and analog component using Analog to Digital Converter (ADC), Digital to Analog Converter (DAC) etc.
		CO 5	Design and implement semiconductor memories, programmable logic devices (PLDs) and field programmable gate arrays (FPGA) in digital electronics.

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
3ECU3 Digital System Design	CO 1	3	2	2	1		1						
	CO 2	3	2	3	2								
	CO 3	2	2	3	1	1							
	CO 4	3	2	1	1	1							
	CO 5	2	1	3	1	1							

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

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Review of Boolean Algebra
Lecture 3	DeMorgan's Theorem, SOP & POS forms,
Lecture 4	Problem of SOP and POS forms of boolean functions.
Lecture 5	Simplification of karnaugh map up to 6 variables
Lecture 6	Simplification of karnaugh map up to 6 variables
Lecture 7	Simplification of karnaugh map up to 6 variables
Lecture 8	Binary codes and code conversion
Lecture 9	Binary codes and code conversion
Lecture 10	Encoder, Decoder
Lecture 11	Half and Full Adders, Subtractors, Serial and Parallel Adders
Lecture 12	BCD Adder, Barrel shifter
Lecture 13	S-R FF, edge triggered and level triggered
Lecture 14	D and J-K FF
Lecture 15	Master-Slave JK FF and T FF
Lecture 16	Ripple and Synchronous counters
Lecture 17	Other type of counters
Lecture 18	Shift registers, Finite state machines, Asynchronous FSM
Lecture 19	Design of synchronous FSM
Lecture 20	Design of synchronous FSM
Lecture 21	Design of synchronous FSM
Lecture 22	Designing synchronous circuits (pulse train generator, pseudo random binary sequence generator, clock generation)
Lecture 23	TTL NAND gate, specifications, noise margin, propagation delay, fan-in, fan-out
Lecture 24	TTL NAND gate
Lecture 25	Tristate TTL, ECL
Lecture 26	CMOS families and their interfacing
Lecture 27	CMOS families and their interfacing
Lecture 28	Read-Only Memory, Random Access Memory
Lecture 29	Programmable Logic Arrays (PLA)
Lecture 30	Programmable Array Logic (PAL),
Lecture 31	Field Programmable Gate Array (FPGA)
Lecture 32	Combinational PLD-Based State Machines,
Lecture 33	State Machines on a Chip
Lecture 34	Schematic, FSM & HDL
Lecture 35	Different modeling styles in VHDL
Lecture 36	Data types and objects, Data flow
Lecture 37	Behavioral and Structural Modeling

Lecture 38	Behavioral and Structural Modeling
Lecture 39	Simulation VHDL constructs and codes for combinational and sequential circuits
Lecture 40	Simulation VHDL constructs and codes for combinational and sequential circuits

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 $\oplus$ 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.

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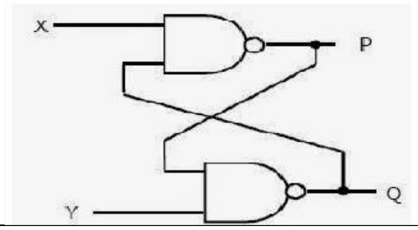
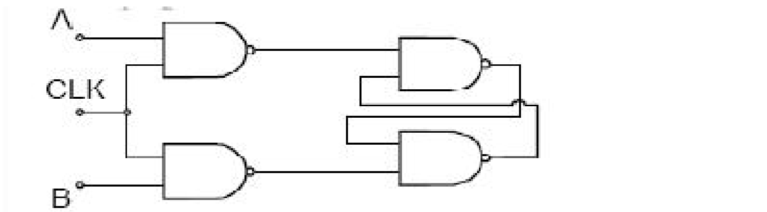
	
	Q3. When the race around condition will occur in the circuit given Below: 

3ECU4	DCC	Signals & Systems	MM:150	3L:0T:0P	3 credits

Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.
Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input output behavior with aperiodic convergent inputs. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations
Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and orthogonal bases
The Laplace Transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to differential equations and system behavior.
The z-Transform for discrete time signals and systems- eigen functions, region of convergence, z-domain analysis.
State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

Text/Reference Books:

1.	A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2.	R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
3.	Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
4.	B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
5.	Douglas K. Lindner, "Introduction to Signals and Systems", McGraw

	Hill International Edition: c1999.
6.	Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.
7	Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons, 1995.
8.	M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", TMH, 2003.
9.	J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, "Signals and Systems", TMH New Delhi, 2001.
10.	Ashok Ambardar,"Analog and Digital Signal Processing", 2nd Edition, Brooks/ Cole Publishing Company (An international Thomson Publishing Company), 1999.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU4	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
3ECU4 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

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	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	Energy signals power signals
Lecture 3	Continuous and discrete time signals
Lecture 4	Continuous amplitude signals
Lecture 5	and discrete amplitude signals
Lecture 6	System properties: linearity: additivity and homogeneity
Lecture 7	shift-invariance, causality
Lecture 8	stability, realizability.
Lecture 9	Linear shift-invariant (LSI) systems
Lecture 10	impulse response
Lecture 11	Step response
Lecture 12	Convolution.
Lecture 13	Input output behavior with aperiodic convergent inputs
Lecture 14	Characterization of causality and stability of linear shift-invariant systems.
Lecture 15	System representation through differential equations and difference equations.
Lecture 16	Characterization of causality and stability of linear shift-invariant systems.
Lecture 17	System representation through differential equations and difference equations.
Lecture 18	Periodic and semi-periodic inputs to an LSI system
Lecture 19	The notion of a frequency response.
Lecture 20	Its relation to the impulse response
Lecture 21	Fourier series representation
Lecture 22	Fourier Transform
Lecture 23	Convolution/multiplication and their effect in the frequency domain
Lecture 24	Magnitude and phase response
Lecture 25	Fourier domain duality.
Lecture 26	The Discrete-Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT).
Lecture 27	Parseval's Theorem. The idea of signal space and orthogonal bases

Lecture 28	The Laplace Transform
Lecture 29	Notion of eigen functions of LSI systems
Lecture 30	A basis of eigen functions, region of convergence
Lecture 31	Poles and zeros of system, Laplace domain analysis,
Lecture 32	Solution to differential equations and system behavior.
Lecture 33	The z-Transform for discrete time signals and systems- eigen functions,
Lecture 34	Region of convergence, z-domain analysis.
Lecture 35	State-space analysis and multi-input, multi-output representation.
Lecture 36	The state-transition matrix and its role.
Lecture 37	The Sampling Theorem and its implications- Spectra of sampled signals.
Lecture 38	Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on
Lecture 39	Aliasing and its effects.
Lecture 40	Relation between continuous and discrete time systems.

Content delivery method:

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

Assignments:

Assignm

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

(a)

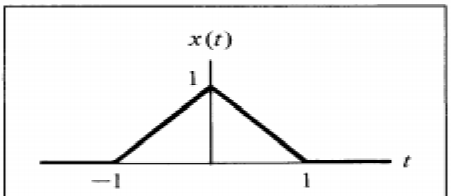

Figure P2.4-1

(b)

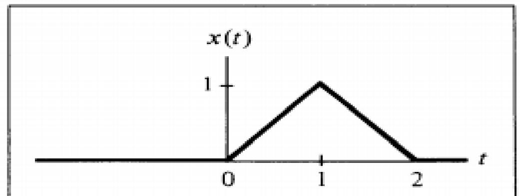

Figure P2.4-2

(c)

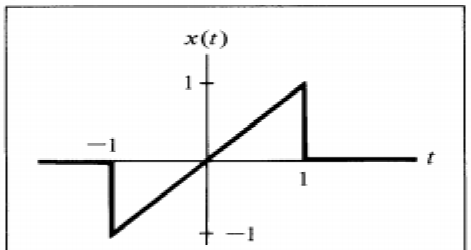

Figure P2.4-3

(d)

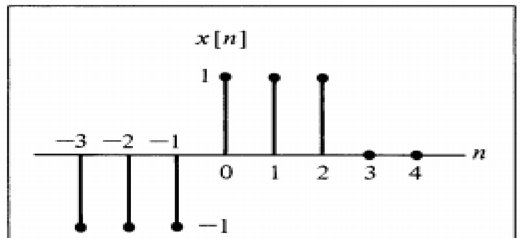

Figure P2.4-4

Q1.

Evaluate the following sums:

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

(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

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

and use the formulas

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

Q2.

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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 $|a| > 1$?

Q3.

Assignm

Consider a discrete-time system with impulse response

$$h[n] = (\tfrac{1}{2})^n u[n]$$

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

Q1.

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.

Q2.

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.,

$$\cos(\omega_0 nT) = (-1)^n, \qquad T = 10^{-3}\text{ s}$$

Determine three *distinct* possible values of ω_0.

Q3.

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3ECU5	DCC	Network Theory	MM:150	3L:0T:0P	3 credits

Node and Mesh Analysis, matrix approach of network containing voltage and current sources, and reactances, source transformation and duality.
Network theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits.
Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation.
Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions..
Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and Two four port network and interconnections, Behaviors of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

Text / Reference Books:

	Van, Valkenburg.; "Network analysis" ; Prentice hall of India, 2000
	Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata McGraw-Hill New Delhi, 1994
	A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU5	Network Theory	CO 1	Apply the basic circuital law and simplify the network using network theorems
		CO 2	Appreciate the frequency domain techniques in different applications.
		CO 3	Apply Laplace Transform for steady state and transient analysis

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		CO 4	Evaluate transient response and two-port network parameters
		CO 5	Analyze the series resonant and parallel resonant circuit and design filters

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
3ECU5 Network Theory	CO 1	3	2		3	2							
	CO 2	3	3	1	2	2							1
	CO 3	3	2	2		2							1
	CO 4	2	3	2	2	1							
	CO 5	2	3	3	2	1							

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Overview of Network Theory and its significance
Lecture 2	Node and Mesh Analysis
Lecture 3	matrix approach of network containing voltage and current sources and reactances
Lecture 4	source transformation and duality
Lecture 5	Network theorems: Superposition and reciprocity
Lecture 6	Thevenin’s and Norton’s theorem
Lecture 7	Maximum power Transfer theorem
Lecture 8	compensation and Tallegen's theorem as applied to AC. Circuits
Lecture 9	Trigonometric and exponential Fourier series
Lecture 10	Fourier series: Discrete spectra and symmetry of waveform
Lecture 11	Steady state response of a network to non-sinusoidal periodic inputs
Lecture 12	power factor and effective values
Lecture 13	Fourier transform and continuous spectra
Lecture 14	three phase unbalanced circuit and power calculation
Lecture 15	three phase unbalanced circuit and power calculation
Lecture 16	Laplace transforms

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Lecture 17	Laplace transforms
Lecture 18	Laplace transforms properties: Partial fractions
Lecture 19	singularity functions and waveform synthesis
Lecture 20	analysis of RC networks
Lecture 21	analysis of RL networks
Lecture 22	analysis of RLC networks
Lecture 23	Analysis of networks with and without initial conditions
Lecture 24	Analysis of networks with and without initial conditions
Lecture 25	Analysis of networks with and without initial conditions with lapalace transforms evaluation
Lecture 26	Analysis of networks with and without initial conditions with lapalace transforms evaluation of initial condition
Lecture 27	Transient behavior
Lecture 28	concept of complex frequency
Lecture 29	Driving points and transfer functions poles and zeros of immittance function
Lecture 30	Driving points and transfer functions poles and zeros of immittance function: their properties
Lecture 31	sinusoidal response from pole-zero locations
Lecture 32	sinusoidal response from pole-zero locations
Lecture 33	convolution theorem
Lecture 34	sinusoidal response from pole-zero locations
Lecture 35	Two four port network and interconnections
Lecture 36	Two four port network and interconnections
Lecture 37	Behaviors of series and parallel resonant circuits
Lecture 38	Introduction to band pass and low pass
Lecture 39	Introduction to high pass and reject filters
Lecture 40	Spill over class

Content delivery method:

1. Chalk and Duster
2. PPT
3. 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

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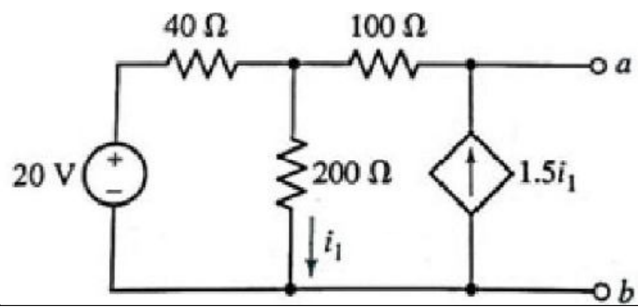
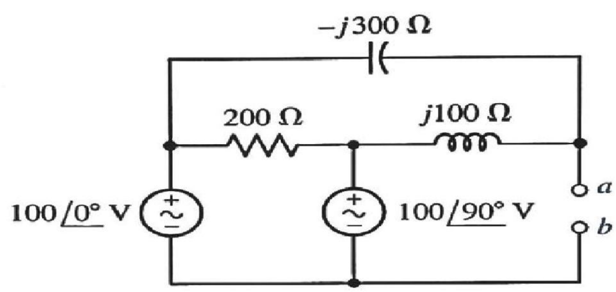
	Q3. Find the Thevenin equivalent of the network shown in figure. What power would be delivered to a load of 100 ohms at *a*and*b*? 
Assignment 2	**Q4.** Calculate Thevenin equivalent circuit with respect to terminals *a* and *b* 
	Q5. Derive transient current and voltage responses of sinusoidal driven RL and RC circuits.
	Q6. Specify the restrictions on pole and zero locations for transfer functions and driving-point functions.

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3ECU6	DCC/IEC	Technical Communication	MM:150	2L:0T:0P	2 credit

SN		Hours
1	**Introduction to Technical Communication-** Definition of technical communication, Aspects of technical communication, forms of technical communication, importance of technical communication, technical communication skills (Listening, speaking, writing, reading writing), linguistic ability, style in technical communication.	4
2	**Comprehension of Technical Materials/Texts and Information Design & development**- Reading of technical texts, Reading and comprehending instructions and technical manuals, Interpreting and summarizing technical texts, Note-making. Introduction of different kinds of technical documents, Information collection, factors affecting information and document design, Strategies for organization, Information design and writing for print and online media.	6
3	**Technical Writing, Grammar and Editing-**Technical writing process, forms of technical discourse, Writing, drafts and revising, Basics of grammar, common error in writing and speaking, Study of advanced grammar, Editing strategies to achieve appropriate technical style, Introduction to advanced technical communication. Planning, drafting and writing Official Notes, Letters, E-mail, Resume, Job Application, Minutes of Meetings.	8
4	**Advanced Technical Writing-**Technical Reports, types of technical reports, Characteristics and formats and structure of technical reports. Technical Project Proposals, types of technical proposals, Characteristics and formats and structure of technical proposals. Technical Articles, types of technical articles, Writing strategies, structure and formats of technical articles.	8
	Total	**26**

Suggested Text/Reference Books

1. "Technical Communication", 2018, Rajesh K. Lidiya, Oxford University Press, India.
2. Communication Skills, Pushplata& Sanjay Kumar, Oxford University Press, India.
3. The Written Word, Vandana Singh, Oxford University Press, India.
4. Current English Grammar and Usage with Composition, R. P. Sinha, Oxford University Press, India.

5. Rodriques M. V., ‘Effective Business Communication’, Concept Publishing Company, New Delhi, 1992 reprint (2000).
6. Bansal, R K and Harrison J B, ‘Spoken English’ Orient Longman, Hyderabad.
7. Binod Mishra &Sangeeta Sharma, ‘Communication Skills for Engineers and Scientists, PHI Learning Private Ltd, New Delhi, 2011.
8. Gartside L. ‘Modern Business Correspondence, Pitman Publishing, London.

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3ECU11	DCC	Electronics Devices Lab	MM:75	0L:0T:3P	2 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 the output waveform of half wave rectifier and effect of filters on waveform. Also calculate its ripple factor.
4.	Study bridge rectifier and measure the effect of filter network on D.C. voltage output & ripple factor.
5.	Plot and verify output waveforms of different clipper and clamper.
6.	Plot V-I characteristic of Zener diode
7.	Study of Zener diode as voltage regulator. Observe the effect of load changes and determine load limits of the voltage regulator
8.	Plot input-output characteristics of BJT in CB, CC and CE configurations. Find their h-parameters.
9.	Study of different biasing circuits of BJT amplifier and calculate its Q-point.
10.	Plot frequency response of two stage RC coupled amplifier & calculate its bandwidth .
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.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU11	Electronic Devices Lab	CO 1	Understand the characteristics of different Electronic Devices.
		CO 2	Verify the rectifier circuits using diodes and implement them using hardware.
		CO 3	Design various amplifiers like CE, CC, common source amplifiers and implement them using hardware and also observe their frequency responses
		CO 4	Understand the construction, operation and characteristics of JFET and MOSFET, which can be used in the design of amplifiers.
		CO 5	Understand the need and requirements to obtain frequency response from a transistor so that Design of RF amplifiers and other high frequency amplifiers is feasible

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 Electronic Devices Lab	CO 1	3	2	3	2	1							1
	CO 2	2	3	1	3	3							2
	CO 3	2	1	2	3	3							
	CO 4	3	2	3	2	2							1
	CO 5	3	2	1	2	2							

3: Strongly 2: Moderate 1: Weak

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3ECU12	DCC	Digital System Design Lab	MM:75	0L:0T:3P	1 credit

List of Experiments

S. No.	Name of Experiment
Part A: Combinational Circuits	
1.	To verify the truth tables of logic gates: AND, OR, NOR, NAND, NOR, Ex-OR and Ex-NOR
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 design 4-to-1 multiplexer using basic gates and verify the truth table. Also verify the truth table of 8-to-1 multiplexer using IC
7.	To design 1-to-4 demultiplexer using basic gates and verify the truth table. Also to construct 1-to-8 demultiplexer using blocks of 1-to-4 demultiplexer
8.	To design 2x4 decoder using basic gates and verify the truth table. Also verify the truth table of 3x8 decoder using IC
9.	Design & Realize a combinational circuit that will accept a 2421 BCD code and drive a TIL -312 seven-segment display
Part B: Sequential Circuits	
10.	Using basic logic gates, realize the R-S, J-K and D-flip flops with and without clock signal and verify their truth table.
11.	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.
12.	Design and construct unidirectional shift register and verify the
13.	Design and construct BCD ripple counter and verify the function.
14.	Design and construct a 4 Bit Ring counter and verify the function
15.	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: Minimum 6 experiments to be conducted from **Part-A**& 4 experiments to be conducted from **Part-B.**

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3ECU12	DCC	Digital System Design Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

S. No.	Name of Experiment
Part A: Combinational Circuits	
1.	To verify the truth tables of logic gates: AND, OR, NOR, NAND, NOR, Ex-OR and Ex-NOR
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 design 4-to-1 multiplexer using basic gates and verify the truth table. Also verify the truth table of 8-to-1 multiplexer using IC
7.	To design 1-to-4 demultiplexer using basic gates and verify the truth table. Also to construct 1-to-8 demultiplexer using blocks of 1-to-4 demultiplexer
8.	To design 2x4 decoder using basic gates and verify the truth table. Also verify the truth table of 3x8 decoder using IC
9.	Design & Realize a combinational circuit that will accept a 2421 BCD code and drive a TIL -312 seven-segment display
Part B: Sequential Circuits	
10.	Using basic logic gates, realize the R-S, J-K and D-flip flops with and without clock signal and verify their truth table.
11.	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.
12.	Design and construct unidirectional shift register and verify the
13.	Design and construct BCD ripple counter and verify the function.
14.	Design and construct a 4 Bit Ring counter and verify the function
15.	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: Minimum 6 experiments to be conducted from **Part-A**& 4 experiments to be conducted from **Part-B.**

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3ECU13	DCC/IEC	Signal Processing Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment (Simulate using MATLAB environment)
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 and verify random sequences with arbitrary distributions, means and variances for following: (a) Rayleigh distribution (b) Normal distributions: N(0,1). (c) Gaussion distributions: N (m, x)
9.	To plot the probability density functions. Find mean and variance for the above distributions

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3ECU13	Signal Processing Lab	CO 1	Able to generate different Continuous and Discrete time signals.
		CO 2	Understand the basics of signals and different operations on signals.
		CO 3	Develop simple algorithms for signal processing and test them using MATLAB
		CO 4	Able to generate the random signals having different distributions, mean and variance.
		CO 5	Design and conduct experiments, interpret and analyse data and report results.

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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
3ECU13 Signal Processing Lab	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

3ECU14	**DCC/IEC**	**Computer Programming Lab-I**	**MM:75**	**0L:0T:2P**	**1 credit**

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.

3ECU20		**DECA**	**MM:50**	**0L:0T:0P**	**1 credit**

4ECU1	ICC	Advance Engineering Mathematics-II	MM:150	3L:1T:0P	4 credit

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Complex Variable – Differentiation:** Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	7
3	**Complex Variable - Integration:** Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof).	8
4	**Applications of complex integration by residues:** Evaluation of definite integral involving sine and cosine. Evaluation of certain improper integrals.	4
5	**Special Functions:** Legendre's function, Rodrigues formula, generating function, Simple recurrence relations, orthogonal property. Bessel's functions of first and second kind, generating function, simple recurrence relations, orthogonal property.	10
6	**Linear Algebra:** Vector Spaces, subspaces, Linear independence, basis and dimension, Inner product spaces, Orthogonality, Gram Schmidt orthogonalization, characteristic polynomial, minimal polynomial, positive definite matrices and canonical forms, QR decomposition.	10
	Total	**40**

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4ECU2	DCC	Analog Circuits	MM:150	3L:1T:0P	4 Credit

Diode Circuits, Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.
High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.
Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators. Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP-AMP design: design of differential amplifier for a given specification, design of gain stages and output stages, compensation.
OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines.
Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog to digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.

Text/Reference Books:

1.	J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.
2.	J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill, 1988.
3.	P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
4.	A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College11 Publishing, Edition IV.
5.	Paul R. Gray and Robert G.Meyer, Analysis and Design of Analog

	Integrated Circuits, John Wiley, 3rd Edition.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU2	Analog Circuits	CO 1	Understand the characteristics of diodes and transistors
		CO 2	Design and analyze various rectifier and amplifier circuits
		CO 3	Design sinusoidal and non-sinusoidal oscillators
		CO 4	Understand the functioning of OP-AMP and design OP-AMP based circuits
		CO 5	Understanding the designing of ADCs and DACs

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
4ECU2 Analog Circuits	CO 1	3		1	1	2							
	CO 2	1	1	2		1							
	CO 3	3	1		1								
	CO 4	2				2							
	CO 5	2	3		2								

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Diode Circuits and Amplifier models

Lecture 3	Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier
Lecture 4	Biasing schemes for BJT and FET amplifiers
Lecture 5	Bias stability in various configurations such as CE/CS, CB/CG, CC/CD
Lecture 6	Small signal analysis of BJT and FET
Lecture 7	low frequency transistor models
Lecture 8	Estimation of voltage gain, input resistance, output resistance etc.
Lecture 9	Design procedure for particular specifications, low frequency analysis of multistage amplifiers.
Lecture 10	High frequency transistor models
Lecture 11	frequency response of single stage and multistage amplifiers
Lecture 12	Cascode Amplifier
Lecture 13	Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues
Lecture 14	Feedback topologies: Voltage series, current series, voltage shunt, current shunt
Lecture 15	Effect of feedback on gain, bandwidth etc.,
Lecture 16	Calculation with practical circuits
Lecture 17	Concept of stability, gain margin and phase margin.
Lecture 18	Basics of oscillator
Lecture 19	Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.)
Lecture 20	LC oscillators (Hartley, Colpitt, Clapp etc.)
Lecture 21	Non-sinusoidal oscillators. Current mirror: Basic topology and its variants,
Lecture 22	V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load.
Lecture 23	Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR.
Lecture 24	OP-AMP design: design of differential amplifier for a given specification
Lecture 25	Design of gain stages and output stages, compensation
Lecture 26	OP-AMP applications: review of inverting and non-inverting amplifiers
Lecture 27	Integrator and differentiator, summing amplifier
Lecture 28	Precision rectifier, Schmitt trigger and its applications
Lecture 29	Active filters: Low pass, high pass
Lecture 30	Band pass and band stop Filters
Lecture 31	Filter Design guidelines
Lecture 32	Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc
Lecture 33	Analog to digital converters (ADC): Single slope, dual slope
Lecture 34	successive approximation, flash TYPE ADC

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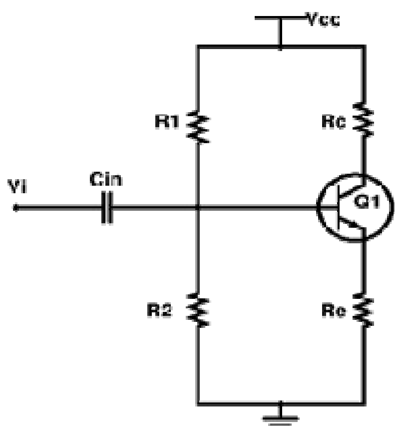
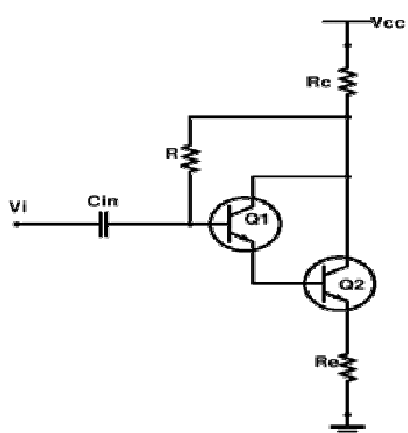
Lecture 35	Switched capacitor circuits: Basic concept
Lecture 36	Switched capacitor circuits: practical configurations
Lecture 37	Switched capacitor circuits: applications
Lecture 38	Spill over classes
Lecture 39	Spill over classes
Lecture 40	Spill over classes

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. 

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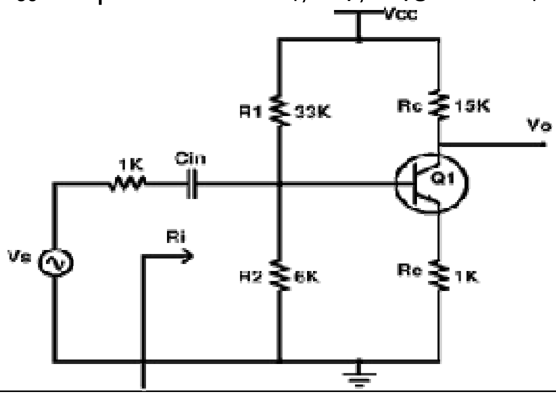
	Q3.	For the amplifier shown in Fig.3 using a transistor whose parameters are h_{ie}=1100,h_{re}=2.5×10^{-4},h_{fe}=50,h_{oe}=24µA/V.Find A_I, A_V, A_{VS} and R_i. 
Assignment 2	**Q1.**	Discuss the applications of operational amplifier.
	Q2.	Discuss different types of filters.
	Q3.	Discuss Dual counter type DAC and its applications

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4ECU3	DCC	Microcontrollers	MM:150	3L:0T:0P	3 Credit

Overview of microcomputer systems and their building blocks, memory interfacing, concepts of interrupts and Direct Memory Access, instruction sets of microprocessors (with examples of 8085 and 8086);
Interfacing with peripherals - timer, serial I/O, parallel I/O, A/D and D/A converters; Arithmetic Coprocessors; System level interfacing design;
Concepts of virtual memory, Cache memory, Advanced coprocessor Architectures- 286, 486, Pentium; Microcontrollers: 8051 systems,
Introduction to RISC processors; ARM microcontrollers interface designs.

Text/Reference Books:

1.	R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with the 8085/8080A, Penram International Publishing, 1996
2.	D A Patterson and J H Hennessy, "Computer Organization and Design The hardware and software interface. Morgan Kaufman Publishers.
3.	Douglas Hall, Microprocessors Interfacing, Tata McGraw Hill, 1991.
4.	Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU3	Microcontrollers	CO 1	Develop assembly language programming skills.
		CO 2	Able to build interfacing of peripherals like, I/O, A/D, D/A, timer etc.
		CO 3	Develop systems using different microcontrollers.
		CO 4	Explain the concept of memory organization.
		CO 5	Understand RSIC processors and design ARM

			microcontroller based 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
4ECU3 Microcontrollers	CO 1			3	1								
	CO 2			3		1							
	CO 3	1	2	3									
	CO 4	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	Overview of microcomputer systems and their building blocks
Lecture 3	Overview of microcomputer systems and their building blocks
Lecture 4	Memory interfacing
Lecture 5	Memory interfacing
Lecture 6	Concepts of interrupts
Lecture 7	Direct Memory Access
Lecture 8	Direct Memory Access
Lecture 9	Instruction sets of microprocessors (with examples of 8085 and 8086)
Lecture 10	Instruction sets of microprocessors (with examples of 8085 and 8086)
Lecture 11	Instruction sets of microprocessors (with examples of 8085 and 8086)
Lecture 12	Instruction sets of microprocessors (with examples of 8085 and 8086)
Lecture 13	Interfacing with peripherals
Lecture 14	Timer
Lecture 15	Serial I/O
Lecture 16	Parallel I/O

Lecture 17	A/D and D/A converters;
Lecture 18	A/D and D/A converters
Lecture 19	Arithmetic Coprocessors
Lecture 20	System level interfacing design
Lecture 21	Concepts of virtual memory, Cache memory
Lecture 22	Concepts of virtual memory, Cache memory
Lecture 23	Advanced coprocessor Architectures- 286, 486, Pentium
Lecture 24	Advanced coprocessor Architectures- 286, 486, Pentium
Lecture 25	Advanced coprocessor Architectures- 286, 486, Pentium
Lecture 26	Microcontrollers: 8051 systems,
Lecture 27	Microcontrollers: 8051 systems,
Lecture 28	Microcontrollers: 8051 systems,
Lecture 29	Microcontrollers: 8051 systems,
Lecture 30	Microcontrollers: 8051 systems,
Lecture 31	Introduction to RISC processors
Lecture 32	Introduction to RISC processors
Lecture 33	Introduction to RISC processors
Lecture 34	ARM microcontrollers interface designs
Lecture 35	ARM microcontrollers interface designs
Lecture 36	ARM microcontrollers interface designs
Lecture 37	ARM microcontrollers interface designs
Lecture 38	ARM microcontrollers interface designs
Lecture 39	Spill Over Classes
Lecture 40	Spill Over Classes

Content delivery method:

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

Assignments:

Assignment 1	**Q1.** Compare between microprocessor & microcontroller based on no. of instructions used, registers, memory and applications.
	Q2. Interface external program memory with 8051 & explain how the data is transfer.
	Q3. List the I/O ports of microcontroller 8051. Explain their alternative function?
Assignment 2	**Q1.** Explain RISC and CISC?
	Q2. Without using MUL instruction, perform multiplication operation on any two operands, with both of them being: a. Positive numbers

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	b. One positive and other negative number c. Both negative numbers Verify the values computed.
	Q3. Can you brief up the evolution of ARM architecture?

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4ECU4	DCC	Electronics Measurement & Instrumentation	MM:150	3L:0T:0P	3 Credit

THEORY OF ERRORS - Accuracy & precision, Repeatability, Limits of errors, Systematic & 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. 1971
3.	Electronic Instrumentation, H S Kalsi, TMH 2012
4.	Instrumentation Measurement & Analysis, B.C.Nakra,K.K. Chaudhry, TMH 2004
5.	Electronic Measurements and Instrumentation, Gupta &Soni, Genius pub. 2014.
6.	Electronic Measurements & Instrumentation, Bernard Oliver, John Cage, TMH 1971
7.	Electronic Measurements and Instrumentation, Lal Kishore, Pearson 2010

8.	Elements of Electronic Instrumentation And Measurement, Carr, Pearson 1996
9.	Instrumentation for Engineering Measurements, 2ed, Dally, Wiley 1993
10.	Introduction To Measurements and Instrumetation, Arun K. Ghosh, PHI 2012

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4ECU5	**DCC**	**Analog and Digital Communication**	**MM:150**	**3L:0T:0P**	**3 credit**

Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.
Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.
Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.
Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.
Digital Modulation tradeoffs. Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation.

Text / Reference Books:

1.	Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2.	Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
3.	Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
4.	Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering'',John Wiley, 1965.
5.	Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication'', Kluwer Academic Publishers, 2004.
6.	Proakis J.G., ``Digital Communications'', 4th Edition, McGraw Hill, 2000.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU5	Analog and Digital Communication	CO 1	Analyze and compare different analog modulation schemes for their efficiency and bandwidth
		CO 2	Analyze the behavior of a communication system in presence of noise
		CO 3	Investigate pulsed modulation system and analyze their system performance
		CO 4	Analyze different digital modulation schemes and can compute the bit error performance
		CO 5	Design a communication system comprised of both analog and digital modulation 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
4EC4-02 Analog & Digital Communication	CO 1	3	3		3		1				1		
	CO 2	3	2		3		1						
	CO 3	3	2		3		2						
	CO 4	3	3		3		2				1		
	CO 5	3	2	3	3		3			2	2		

3: Strongly 2: Moderate 1: Weak

Content delivery method:

1. Chalk and Duster
2. PPT

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Introduction to the COURSE
Lecture 2	Review of signals and systems, Frequency domain representation of signals
Lecture 3	Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations
Lecture 4	Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations
Lecture 5	Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations
Lecture 6	Angle Modulation, Representation of FM and PM signals
Lecture 7	Angle Modulation, Representation of FM and PM signals
Lecture 8	Spectral characteristics of angle modulated signals.
Lecture 9	Review of probability and random process
Lecture 10	Review of probability and random process
Lecture 11	Noise in amplitude modulation systems
Lecture 12	Noise in amplitude modulation systems
Lecture 13	Noise in Frequency modulation systems
Lecture 14	Pre-emphasis and Deemphasis
Lecture 15	Threshold effect in angle modulation
Lecture 16	Pulse modulation. Sampling
Lecture 17	Pulse Amplitude and Pulse code modulation (PCM)
Lecture 18	Pulse Amplitude and Pulse code modulation (PCM)
Lecture 19	Differential pulse code modulation
Lecture 20	Delta modulation
Lecture 21	Noise considerations in PCM
Lecture 22	Time Division multiplexing, Digital Multiplexers
Lecture 23	Elements of Detection Theory
Lecture 24	Optimum detection of signals in noise
Lecture 25	Coherent communication with waveforms- Probability of Error evaluations
Lecture 26	Coherent communication with waveforms- Probability of Error evaluations
Lecture 27	BasebandPulse Transmission- Inter symbol Interference and Nyquist criterion
Lecture 28	BasebandPulse Transmission- Inter symbol Interference and Nyquist criterion
Lecture 29	Pass band Digital Modulation schemes
Lecture 30	Phase Shift Keying
Lecture 31	Frequency Shift Keying
Lecture 32	Quadrature Amplitude Modulation
Lecture 33	Continuous Phase Modulation and Minimum Shift Keying.

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Lecture 34	Digital Modulation tradeoffs
Lecture 35	Optimum demodulation of digital signals over band-limited channels
Lecture 36	Optimum demodulation of digital signals over band-limited channels
Lecture 37	Maximum likelihood sequence detection (Viterbi receiver)
Lecture 38	Equalization Techniques
Lecture 39	Synchronization and Carrier Recovery for Digital modulation
Lecture 40	Synchronization and Carrier Recovery for Digital modulation

Assignments:

Assignment 1	**Q1.** Design Modulator and Demodulator of SSB-SC Modulation based on its mathematical expression.
	Q2. Derive the figure of merit in a) FM Receiver b) PM Receiver
	Q3. A Carrier signal c(t) = 20 cos ($2\pi 10^6 t$) is modulated by a message signal having three frequencies 5 KHz, 10 KHz & 20 KHz. The corresponding modulation indexes are 0.4, 0.5 & 0.6. Sketch the spectrum. Calculate bandwidth, power and efficiency.
Assignment 2	**Q1.** Derive the expression for probability of error in ASK, FSK and PSK systems and compare them.
	Q2. With block diagrams explain about DPCM & DM. also compare them.
	Q3. A message signal m(t) = 4 cos ($2\pi 10^3 t$) is sampled at nyquist rate and transmitted through a channel using 3-bit PCM system. i. Calculate all the parameters of the PCM. ii. If the sampled values are 3.8, 2.1, 0.5, -1.7, -3.2 & -4 then determine the quantizer output, encoder output and quantization error per each sample. iii. Sketch the transfer characteristics of the quantizer.

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4ECU6	DCC/IEC	Managerial Economics And Financial Accounting	MM:150	2L:0T:0P	2 Credit

SN	Contents	Hours
1	**Basic economic concepts-** Meaning, nature and scope of economics, deductive vs inductive methods, static and dynamics, Economic problems: scarcity and choice, circular flow of economic activity, national income-concepts and measurement.	4
2	**Demand and Supply analysis-Demand-** types of demand, determinants of demand, demand function, elasticity of demand, demand forecasting–purpose, determinants and methods, Supply-determinants of supply, supply function, elasticity of supply.	5
3	**Production and Cost analysis-Theory of production-** production function, law of variable proportions, laws of returns to scale, production optimization, least cost combination of inputs, isoquants. Cost concepts-explicit and implicit cost, fixed and variable cost, opportunity cost, sunk costs, cost function, cost curves, cost and output decisions, cost estimation.	5
4	**Market structure and pricing theory-**Perfect competition, Monopoly, Monopolistic competition, Oligopoly.	4
5	**Financial statement analysis-**Balance sheet and related concepts, profit and loss statement and related concepts, financial ratio analysis, cash-flow analysis, funds-flow analysis, comparative financial statement, analysis and interpretation of financial statements, capital budgeting techniques.	8
	Total	**26**

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4ECU11	DCC	Analog and Digital Communication Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Observe the Amplitude modulated wave form & measure modulation index and demodulation of AM signal.
2.	Harmonic analysis of Amplitude Modulated wave form.
3.	Generation & Demodulation of DSB – SC signal.
4.	Modulate a sinusoidal signal with high frequency carrier to obtain FM signal and demodulation of the FM signal.
5.	Verification of Sampling Theorem.
6.	To study & observe the operation of a super heterodyne receiver.
7.	PAM, PWM & PPM: Modulation and demodulation.
8.	To observe the transmission of four signals over a single channel using TDM-PAM method.
9.	To study the PCM modulation & demodulation and study the effect of channel like attenuation, noise in between modulator & demodulator through the experimental setup.
10.	To study the 4 channel PCM multiplexing & de-multiplexing in telephony system.
11.	To study the Delta & Adaptive delta modulation & demodulation and also study the effect of channel like attenuation, noise in between modulator & demodulator through the experimental setup.
12.	To perform the experiment of generation and study the various data formatting schemes (Unipolar, Bipolar, Manchester, AMI etc.)
13.	To perform the experiment of generation and detection of ASK, FSK, BPSK, DBPSK signals with variable length data pattern.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU11	Analog and Digital Communication Lab	CO 1	Understand different analog modulation schemes and evaluate modulation index
		CO 2	Able to understand the principle of superhetrodyne receiver
		CO 3	Develop time division multiplexing concepts in real time applications
		CO 4	Develop and able to comprehend different data formatting schemes
		CO 5	Comprehend and analyze the concepts of different digital modulation techniques in communication.

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
4EC4-21 Analog and Digital Communication Lab	CO 1	3	2		1								
	CO 2	3	2	1									
	CO 3	3	3	2	2	1							
	CO 4	3	3	2	2	1							
	CO 5	3	3	2	2	1							

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

4ECU12	DCC	Analog Circuits Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Study and implementation of Voltage Series and Current Series Negative Feedback Amplifier.
2.	Study and implementation of Voltage Shunt and Current Shunt Negative Feedback Amplifier.
3.	Plot frequency response of BJT amplifier with and without feedback in the emitter circuit and calculate bandwidth, gain bandwidth product with and without negative feedback.
4.	Study and implementation of series and shunt voltage regulators and calculate line regulation and ripple factor.
5.	Plot and study the characteristics of small signal amplifier using FET.
6.	Study and implementation of push pull amplifier. Measure variation of output power & distortion with load and calculate the efficiency.
7.	Study and implementation of Wein bridge oscillator and observe the effect of variation in oscillator frequency.
8.	Study and implementation of transistor phase shift oscillator and observe the effect of variation in R & C on oscillator frequency and compare with theoretical value.
9.	Study and implementation of the following oscillators and observe the effect of variation of capacitance on oscillator frequency: (a) Hartley (b) Colpitts.
10.	Study and implementation of the Inverting And Non-Inverting Operational Amplifier.
11.	Study and implementation of Summing, Scaling And Averaging of Operational Amplifier
12.	Implementation of active filters using OPAMP.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU12	Analog Circuits Lab	CO 1	Discuss and observe the operation of a bipolar junction transistor and field-effect transistor in different region of operations.
		CO 2	Analyze and design of transistor Amplifier and Oscillators. Importance of negative feedback.
		CO 3	Analyze the frequency response of amplifiers and operational amplifier circuits. Develop an intuition for analog circuit behavior in both linear and nonlinear operation.
		CO 4	Design op-amps for specific gain, speed, or switching performance. Compensate operational amplifiers for stability.
		CO 5	Design and conduct experiments, interpret and analyze data, and report results.

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
4ECU12 Analog Circuits 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

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4ECU13	DCC / IEC	Microcontrollers Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
Following exercises has to be Performed on 8085	
1.	Write a program for 1.1 Multiplication of two 8 bit numbers 1.2 Division of two 8 bit numbers
2.	Write a program to arrange a set of data in Ascending and Descending order.
3.	Write a program to find Factorial of a given number.
4.	Write a program to generate a Software Delay. 4.1 Using a Register 4.2 Using a Register Pair
8085 Interfacing Programs	
5.	5.1 Write a program to Interface ADC with 8085.
	5.2 Write a program to interface Temperature measurement module with 8085.
6.	Write a program to interface Keyboard with 8085.
7.	Write a program to interface DC Motor and stepper motor with 8085.
Following exercises has to be Performed on 8051	
8.	Write a program to convert a given Hex number to Decimal.
9.	Write a program to find numbers of even numbers and odd numbers among 10 Numbers.
10.	Write a program to find Largest and Smallest Numbers among 10 Numbers.
11.	11.1 To study how to generate delay with timer and loop.
	11.2 Write a program to generate a signal on output pin using timer.
8051 Interfacing Programs	
12	12.1 Write a program to interface Seven Segment Display with 8051.
	12.2 Write a program to interface LCD with 8051.
13	Write a program for Traffic light Control using 8051.
14	Write a program for Elevator Control using 8051.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
4ECU13	Microcontrollers Lab	CO 1	Develop skills related to assembly level programming of microprocessors and microcontroller.
		CO 2	Interpret the basic knowledge of microprocessor and microcontroller interfacing, delay generation, waveform generation and Interrupts.
		CO 3	Interfacing the external devices to the microcontroller and microprocessor to solve real time problems.
		CO 4	Illustrate functions of various general purpose interfacing devices.
		CO 5	Develop a simple microcontroller and microprocessor based 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
4ECU13 Microcontrollers Lab	CO 1	2	1	2	1	3							
	CO 2	3	2	1	2	1							
	CO 3	1	1	3	1	3							
	CO 4	2	2	1									
	CO 5	1	1	3	2	2		2					

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

4ECU14	DCC/IEC	Electronic Measurement and Instrumentation Lab	MM:75	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
4ECU14	Electronic Measurement and 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
4ECU14 Electronic Measurement and 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**

4ECU20		**DECA**	**MM:50**	**0L:0T:0P**	**1 credit**

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5ECU1	**DCC**	**Electromagnetics Waves**	**MM:150**	**3L:1T:0P**	**4 credit**

Transmission Lines-Equations of Voltage and Current on TX line, Propagation constant and characteristic impedance, and reflection coefficient and VSWR, Impedance Transformation on Loss-less and Low loss Transmission line, Power transfer on TX line, Smith Chart, Admittance Smith Chart, Applications of transmission lines: Impedance Matching, use transmission line sections as circuit elements.
Maxwell's Equations-Basics of Vectors, Vector calculus, Basic laws of Electromagnetics, Maxwell's Equations, Boundary conditions at Media Interface.
Uniform Plane Wave-Uniform plane wave, Propagation of wave, Wave polarization, Poincare's Sphere, Wave propagation in conducting medium, phase and group velocity, Power flow and Poynting vector, Surface current and power loss in a conductor.
Plane Waves at a Media Interface-Plane wave in arbitrary direction, Reflection and refraction at dielectric interface, Total internal reflection, wave polarization at media interface, Reflection from a conducting boundary.
Waveguides- Wave propagation in parallel plate waveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation in waveguide.
Radiation-Solution for potential function, Radiation from the Hertz dipole, Power radiated by hertz dipole, Radiation Parameters of antenna, receiving antenna, Monopole and Dipole antenna

Text / Reference Books:

1.	W. Hayt, Engineering Electromagnetics, MGH, India
2.	E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, Prentice Hall, India
3.	David Cheng, Electromagnetics, Prentice Hall
4.	Matthew N O Sadiku, S V Kulkarni, Principle of Electromagnetics, 6th edition, Oxford higher education

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU1	Electromagnetic Waves	CO 1	Understand the fundamentals of Electromagnetic waves and develop the basics of vector operations
		CO 2	Use boundary conditions for Maxwell's equations for analyzing EM waves
		CO 3	Understand characteristics and wave propagation on high frequency transmission lines, Use sections of transmission line sections for constructing circuit elements
		CO 4	Characterize uniform plane wave, analyze wave propagation on metallic waveguides in modal form
		CO 5	Understand principle of radiation and radiation characteristics of an antenna

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
5ECU1 Electromagnetic Waves	CO 1	3	3	2	3	1							3
	CO 2	3	3	3	3	2							2
	CO 3	3	3	3	3	3							2
	CO 4	3	3	3	3	3							
	CO 5	3	3	3	3	3							

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

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Basics of Vectors, Vector calculus and Co-ordinate systems
Lecture 2	Implications of vector calculus in electromagnetic fields and Basic laws of electromagnetic
Lecture 3	Numerical examples including applications of vector operations
Lecture 4	Equations of Voltage and Current on TX line

Lecture 5	Propagation constant and characteristic impedance, and reflection coefficient and VSWR
Lecture 6	Numerical examples
Lecture 7	Impedance Transformation on Loss-less and Low loss Transmission line, Power transfer on TX line
Lecture 8	Numerical examples
Lecture 9	Smith Chart, Admittance Smith Chart
Lecture 10	Applications of transmission lines: Impedance Matching
Lecture 11	Use transmission line sections as circuit elements
Lecture 12	Numerical examples
Lecture 13	Divergence theorem, stokes theorem and Maxwell's Equations
Lecture 14	Boundary conditions at Media Interface
Lecture 15	Uniform plane wave and Propagation of wave
Lecture 16	Wave polarization and Poincare's Sphere
Lecture 17	Wave propagation in conducting medium, phase and group velocity
Lecture 18	Numerical examples
Lecture 19	Power flow and Poynting vector and numerical examples
Lecture 20	Surface current and power loss in a conductor
Lecture 21	Plane Waves at a Media Interface-Plane wave in normal and arbitrary direction
Lecture 22	Reflection and refraction at dielectric interface and review of boundary conditions
Lecture 23	Review of Reflection coefficients and VSWR from propagating wave point of view
Lecture 24	Total internal reflection, wave polarization at media interface, Reflection from a conducting boundary
Lecture 25	Boundary conditions and Wave propagation in parallel plate waveguide
Lecture 26	Analysis of waveguide general approach
Lecture 27	Analysis of Rectangular waveguide
Lecture 28	Modal propagation in rectangular waveguide
Lecture 29	Surface currents on the waveguide walls, Field visualization
Lecture 30	Attenuation in waveguide
Lecture 31	Numerical examples
Lecture 32	Review of co-ordinate systems
Lecture 33	Solution for potential function
Lecture 34	Solution for potential function
Lecture 35	Radiation mechanism and Radiation from the Hertz dipole
Lecture 36	Power radiated by hertz dipole
Lecture 37	Radiation Parameters of antenna
Lecture 38	Numerical examples
Lecture 39	Receiving antenna
Lecture 40	Monopole and Dipole antennas

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Content delivery method:

1. Chalk and Duster
2. Animation

Assignments:

Assignment 1	**Q1.** A charge $Q_A = -20\mu C$ is located at $A(-6,4,7)$, and a charge $Q_B = 50\mu C$ is at $B(5,8,-2)$ in free space $\epsilon_0 = 8.854\times10^{-12} F/m$. Find the force exerted by Q_A by Q_B.
	Q2. Calculate the total charge within the universe. Consider the following expression for field distribution: $\rho_v = e^{-2r}/r^2$, $0 \le \theta \le \pi$, $0 \le \phi \le 2\pi$.
	Q3. A lossless transmission line is 80 cm long and operates at a frequency of 600 MHz. The line parameters are $L = 0.25$\mu H/m and $C = 100 pF/m$. Find the characteristics impedance, the phase constant, and phase velocity.
Assignment 2	**Q1.** Standing wave measurements on a lossless 75Ω line show maxima of 18V and minima of 5V. One minimum is located at a scale reading of 30 cm. With the load replaced by a short circuit, two adjacent minima are found at the scale readings of 17 cm and 37 cm. Find VSWR, λ, *f*, Z_L and Γ_L.
	Q2. Consider a material for which $\mu_r = 1, \epsilon_r' = 2.5$ and the loss tangent is 0.12. If these values are constant with frequency in the range $0.5\text{MHz} \le f \le 100\text{MHz}$, calculate $\sigma, \lambda, v_p, \eta$ at 75MHz.
	Q3. A parallel plate waveguide has plate spacing of 5mm and is filled with glass $(n = 1.45)$. What is the maximum frequency at which the guide will operate in the TEM mode only?

5ECU2	DCC	Control System	MM:150	3L:1T:0P	4 credit

Introduction to control problem- Industrial Control examples. Transfer function. System with dead-time. System response. Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis.
Feedback control systems- Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. Feed forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion.
Time response of second-order systems- steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.
Frequency-response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers. State variable formulation and solution.
State variable Analysis- Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.
Introduction to Optimal control & Nonlinear control, Optimal Control problem, Regulator problem, Output regulator, treking problem. Nonlinear system – Basic concept & analysis.

Text/Reference Books:

1.	Gopal. M., “Control Systems: Principles and Design”, Tata McGraw-Hill, 1997.
2.	Kuo, B.C., “Automatic Control System”, Prentice Hall, sixth edition, 1993.
3.	Ogata, K., “Modern Control Engineering”, Prentice Hall, second edition, 1991
4.	Nagrath&Gopal, “Modern Control Engineering”, New Age International, New Delhi

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU2	Control Systems	CO 1	Characterize a system mathematically and find its steady state behaviour
		CO 2	Analyze stability of a system using different tests
		CO 3	Design various controllers
		CO 4	Solve linear, non-linear and optimal complex control problems
		CO 5	Designing state model for a given system of equations

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
5ECU2 Control Systems	CO 1	3	2	2	2	2			1				1
	CO 2	3	2	2	3	1							
	CO 3	2	2	3	3	2							
	CO 4	3	3	2	3	2			1				2
	CO 5	3	3	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	Industrial Control examples. Transfer function. System with dead-time
Lecture 3	System response. Control hardware and their models: potentiometers
Lecture 4	Synchros, LVDT,
Lecture 5	Dc and ac servomotors, tacho-generators,
Lecture 6	Electro hydraulic valves, hydraulic servomotors, electro pneumatic valves,
Lecture 7	Pneumatic actuators
Lecture 8	Close loop systems

Lecture 9	Block diagram and signal flow graph analysis.
Lecture 10	Disturbance rejection, insensitivity and robustness. proportional
Lecture 11	Integral and derivative systems.
Lecture 12	Feed forward and multi-loop control configurations,
Lecture 13	stability concept, relative stability
Lecture 14	Routh stability criterion.
Lecture 15	Time response of second-order systems
Lecture 16	Steady-state errors and error constants.
Lecture 17	Performance specifications in time-domain.
Lecture 18	Root locus method of design
Lecture 19	Lead and lag compensation.
Lecture 20	Polar plots
Lecture 21	Bode plot, stability in frequency domain,
Lecture 22	Nyquist plots.
Lecture 23	Nyquist stability criterion.
Lecture 24	Performance specifications in frequency-domain.
Lecture 25	Frequency domain methods of design,
Lecture 26	Compensation & their realization in time & frequency domain
Lecture 27	Lead and Lag compensation.
Lecture 28	Op-amp based and digital implementation of compensators.
Lecture 29	Tuning of process controllers.
Lecture 30	State variable formulation and solution.
Lecture 31	Concepts of state, state variable, state model
Lecture 32	State models for linear continuous time functions
Lecture 33	Diagonalization of transfer function
Lecture 34	Solution of state equations,.
Lecture 35	Concept of controllability &observability.
Lecture 36	Introduction to Optimal control & Nonlinear control
Lecture 37	Optimal Control problem
Lecture 38	Regulator problem
Lecture 39	Output regulator, treking problem
Lecture 40	Nonlinear system – Basic concept & analysis..

Content delivery method:

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

Assignments:

Assignment 1	**Q1.** Find is the convolution of e $^{-t}$ with sin(t) applying the convolution theorem.

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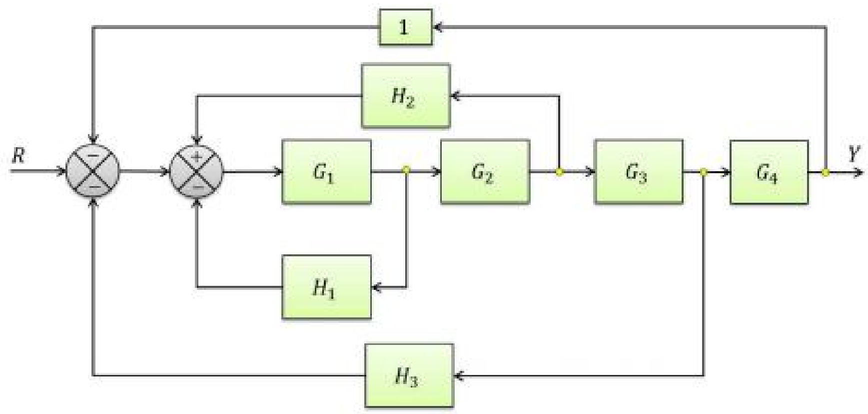
	Q2. Find the transfer function Y (s) R(s) for the system with the following block diagram: 
	Q3. The forward transfer function of a unity feedback system is G(s) = K(s 2 + 1) (s + 1)(s + 2) The system is stable for (a) K < −1 (b) K > −1 (c) K < −2 (d) K > −2
	Q1. The root locus having the open loop transfer function G(s)H(s) = K s(s + 4)(s 2 + 4s + 5) has (a) 3 breakaway point (b) 3 breakin point (c) 2 breakin point and 1 breakaway point (d) 2 breakaway point and 1 breakin point
	Q2. The phase margin of a system with open loop transfer function G(s)H(s) = 1 − s (s + 1)(s + 3), is (a) 68.3 ^{o} (b) 90^{o} (c) 0^{o} (d) ∞

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	Q3. Given the plant transfer function of a servomechanism to be G(s) = 10 s(s+2)(s+8) Design a lead-lag compensator Gc(s) in unity feedback configuration to meet the following specification for step response: (a) Mp = 16.3% (b) The rise time tr = 0.6046 sec (c) The steady state error to a unit ramp input must be equal 0.0125. What is the real part of the dominant poles of the compensated system?

5ECU3	DCC	Digital Signal Processing	MM:150	3L:0T:0P	3 credit

Discrete time signals: Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals; Discrete systems attributes, Z-Transform, Analysis of LSI systems, frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform Algorithm, Implementation of Discrete Time Systems
Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.
Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to mult-irate signal processing. Application of DSP.

Text/Reference Books:

1.	S.K. Mitra, Digital Signal Processing: A computer based approach. TMH
2.	A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3.	John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And Applications, Prentice Hall, 1997
4.	L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.
5.	J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6.	D.J. De Fatta, J. G. Lucas and W. S. Hodgkiss, Digital Signal Processing, John Wiley& Sons, 1988.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU3	Digital Signals Processing	CO 1	Represent signals mathematically in continuous and discrete time and frequency domain
		CO 2	Get the response of an LSI system to different signals
		CO 3	Design of different types of digital filters for various applications
		CO 4	Estimation of spectral parameters
		CO 5	Application of Digital Signal Processing

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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
5ECU3 Digital Signals Processing	CO 1	3	3	3	2	1							1
	CO 2	3	2	2	2	1							
	CO 3	2	3	3	2	3	2	1					
	CO 4	3	3	2	3	3							
	CO 5	2	2	2	2	2	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	Sequences; representation of signals on orthogonal basis
Lecture 3	Sequences; representation of signals on orthogonal basis
Lecture 4	Sequences; representation of signals on orthogonal basis
Lecture 5	Sampling and reconstruction of signals;
Lecture 6	Sampling and reconstruction of signals;
Lecture 7	Sampling and reconstruction of signals;
Lecture 8	Discrete systems attributes
Lecture 9	Discrete systems attributes
Lecture 10	Z-Transform
Lecture 11	Z-Transform
Lecture 12	Z-Transform
Lecture 13	Z-Transform
Lecture 14	Analysis of LSI systems
Lecture 15	Analysis of LSI systems
Lecture 16	frequency Analysis
Lecture 17	frequency Analysis
Lecture 18	Inverse Systems
Lecture 19	Inverse Systems
Lecture 20	Discrete Fourier Transform (DFT
Lecture 21	Fast Fourier Transform Algorithm
Lecture 22	Fast Fourier Transform Algorithm
Lecture 23	Implementation of Discrete Time Systems
Lecture 24	Design of FIR Digital filters

Lecture 25	Window method
Lecture 26	Park-McClellan's method
Lecture 27	Design of IIR Digital Filters
Lecture 28	Butterworth, Chebyshev filter
Lecture 29	Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.
Lecture 30	Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.
Lecture 31	Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.
Lecture 32	Effect of finite register length in FIR filter design
Lecture 33	Effect of finite register length in FIR filter design
Lecture 34	Parametric and non-parametric spectral estimation
Lecture 35	Parametric and non-parametric spectral estimation
Lecture 36	Introduction to mult-irate signal processing.
Lecture 37	Introduction to mult-irate signal processing.
Lecture 38	Application of DSP
Lecture 39	Application of DSP
Lecture 40	Spill-over Classes

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. 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 zero phase 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: $\tau_0(Z) = 1\ 2\ \{H_1(-Z)\ H_0(Z) + (-H_0(-Z))\ H_1(Z)\}$

5ECU4	DCC	Microwave Theory and Techniques	MM:150	3L:0T:0P	3 credit

Introduction to Microwaves-History of Microwaves, Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC.
Mathematical Model of Microwave Transmission-Concept of Mode, Features of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission.
Analysis of RF and Microwave Transmission Lines-Coaxial line, Rectangular waveguide, Circular waveguide, Strip line, Micro strip line.
Microwave Network Analysis-Equivalent voltages and currents for non-TEM lines, Network parameters for microwave circuits, Scattering Parameters.
Passive and Active Microwave Devices-Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. **Microwave active components:** Diodes, Transistors, Oscillators, Mixers. **Microwave Semiconductor Devices:** Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. **Microwave Tubes:** Klystron, TWT, Magnetron.
Microwave Design Principles-Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power Amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design. **Microwave Antennas**- Antenna parameters, Antenna for ground based systems, Antennas for airborne and satellite borne systems, Planar Antennas.
Microwave Measurements- Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal, Noise at microwave frequency and measurement of noise figure. Measurement of Microwave antenna parameters.
Microwave Systems-Radar, Terrestrial and Satellite Communication, Radio Aidsto Navigation, RFID, GPS. Modern Trends in Microwaves Engineering-Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC), Monolithic Microwave ICs, RFMEMS for microwave components, Microwave Imaging.

Text/Reference Books:

1.	S. Y. Liao, Microwave Devices and Circuits, Prentice Hall
2.	D. M. Pozar, Microwave Engineering, John Wiley, India
3.	R.E. Collins, Microwave Circuits, McGraw Hill
4	Annapurna Das and Sisir K Das, Microwave Engineering, McGraw Hill

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU4	Microwave Theory and Techniques	CO 1	Understand various microwave system components their properties
		CO 2	Identify different mathematical treatment needed to analyze different microwave circuits and systems
		CO 3	Solve complex problems of microwave signals and systems
		CO 4	Characterize different microwave components
		CO 5	Design microwave systems for different practical 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
5ECU4 Microwave Theory and Techniques	CO 1	3	2	2	2	2							3
	CO 2	3	3	3	3	2							
	CO 3	3	3	3	3	3							
	CO 4	3	2	3	1	2							
	CO 5	3	2	3	3	3							2

3: Strong 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	History of Microwaves, Microwave Frequency bands
Lecture 2	Applications of Microwaves: Civil and Military, Medical, EMI/ EMC
Lecture 3	Review of Maxwells equations, Uniform plane wave, Boundary conditions in media interface and wave propagation
Lecture 4	Review concepts of Mode, Features of TEM, TE and TM Modes
Lecture 5	Losses associated with microwave transmission, Concept of Impedance in Microwave transmission
Lecture 6	Numerical examples

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Lecture 7	Transmission line and Coaxial line, Modes and Rectangular waveguide
Lecture 8	Analysis of Stripline and Microstrip line
Lecture 9	Analysis of Circular waveguide, Numerical examples
Lecture 10	Transmission lines and Microwave Network Analysis
Lecture 11	Equivalent voltages and currents for non-TEM lines
Lecture 12	Microwave Network Parameters and Scattering parameters, Inter-relations of the Network parameters
Lecture 13	Numerical examples
Lecture 14	Microwave passive components: Directional Coupler
Lecture 15	Power divider and Magic Tee
Lecture 16	Microwave resonator
Lecture 17	Attenuator, Numerical examples
Lecture 18	Passive and active components, Microwave Diodes, Transistors
Lecture 19	Microwave oscillators
Lecture 20	Microwave Mixers, Numerical examples
Lecture 21	Semiconductor Microwave devices: Gunn diodes
Lecture 22	IMPATT Diodes, BARITT Diodes
Lecture 23	Schottkey Barrier Diodes, PIN Diodes
Lecture 24	Microwave tubes: Klystron
Lecture 25	Travelling Wave Tubes
Lecture 26	Magnetron, Numerical examples
Lecture 27	Impedance transformation and matching, Smith chart review
Lecture 28	Microwave filter designing, Numerical example
Lecture 29	RF and Microwave amplifier design, Power amplifier design
Lecture 30	Low noise amplifier design, numerical examples
Lecture 31	Microwave mixer design, numerical examples
Lecture 32	Microwave oscillator design, numerical examples
Lecture 33	Antennas and Antenna parameters, numerical examples
Lecture 34	Antenna for ground based systems, Airborne and satellite borne systems
Lecture 35	Planar Antennas
Lecture 36	Radar, Terrestrial and Satellite Communication, Radio Aidsto Navigation
Lecture 37	RFID and GPS
Lecture 38	Effect of Microwaves on human body, Medical and Civil applications of microwaves
Lecture 39	Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC)
Lecture 40	Monolithic Microwave ICs, RFMEMS for microwave components, Microwave Imaging.

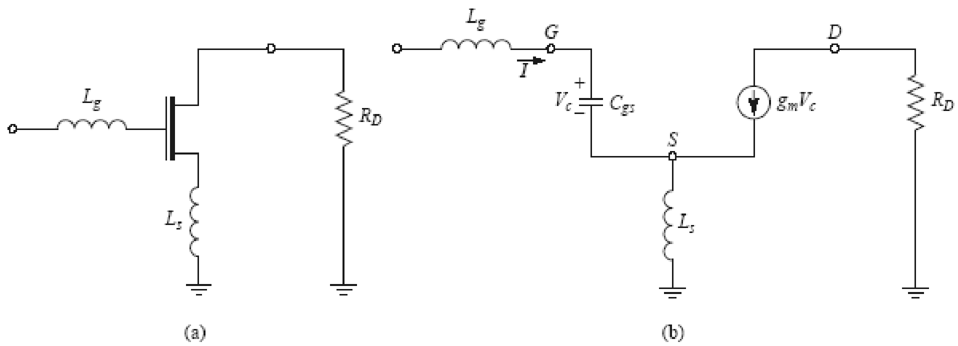
Content delivery method:

1. Chalk and Duster

2. Animation

Assignments:

Assignme	**Q1.** Consider a length of Teflon filled, copper K-band rectangular waveguide having dimensions $a = 1.07cm, b = 0.43cm$. Find the cutoff frequencies of the first two propagating modes. If the operating frequency is 15 GHz, find the attenuation due to dielectric and conductor losses.
	Q2. A Design a microstrip line on a 0.5 mm alumina substrate ($\epsilon_r = 9.9$, tan δ = 0.001) for a 50 Ω characteristic impedance. Find the length of this line required to produce a phase delay of 270° at 10 GHz, and compute the total loss on this line, assuming copper conductors.
	Q3. A two-port network is known to have the following scattering matrix: $$S = \begin{bmatrix} 0.15\angle 0^{\circ} & 0.85\angle -45^{\circ} \\ 0.85\angle 45^{\circ} & 0.2\angle 0^{\circ} \end{bmatrix}$$ Determine if the network is reciprocal and lossless. If port 2 is terminated with a matched load, what is the return loss seen at port 1? If port 2 is terminated with a short circuit, what is the return loss seen at port 1?
Assignme	**Q4.** Consider a microstrip resonator constructed from a $\lambda/2$ length of 50 Ωopen circuited microstrip line. The substrate is Teflon ($\epsilon_r = 2.08$, tan δ = 0.0004), with a thickness of 0.159 cm, and the conductors are copper. Compute the required length of the line for resonance at 5 GHz, and the unloaded *Q* of the resonator. Ignore fringing fields at the end of the line.
	Q5. Write short notes on a) PIN Diode and b) Schottkey Diode, c) IMPATT Diode.
	Q6. An Infineon BF1005 *n*-channel MOSFET transistor having C_{gs}= 2.1 pF and g_m= 24 mS is used in a 900 MHz low-noise amplifier with inductive source degeneration, as shown in figure below.

	 Figure: Low-noise MOSFET amplifier. (a) Basic AC circuit. (b) Equivalent circuit using a simplified unilateral FET model. Determine the source and gate inductors, and estimate the bandwidth of the amplifier. Assume a source impedance of $Z0 = 50\ \Omega$.

5ECU5.1	DEC	Probability Theory and Stochastic Processes	MM:150	3L:0T:0P	3 credit

Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.
Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions;
Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds;
Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.
Random process. Stationary processes. Mean and covariance functions. Ergodicity. Transmission of random process through LTI.Power spectral density.

Text / Reference Books:

1.	H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing,'' Third Edition, Pearson Education
2.	A.Papoulis and S. UnnikrishnanPillai, ``Probability, Random Variables and Stochastic Processes,'' Fourth Edition, McGraw Hill.
3.	K. L. Chung, Introduction to Probability Theory with Stochastic Processes, Springer International
4.	P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability, UBS Publishers,
5.	P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Stochastic Processes, UBS Publishers
6.	S. Ross, Introduction to Stochastic Models, Harcourt Asia, Academic Press.

5ECU5.2	DEC	Embedded System	MM:150	3L:0T:0P	3 credit

The concept of embedded systems design, Embedded microcontroller cores, embedded memories. Examples of embedded systems, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing. Sub system interfacing, interfacing with external systems, user interfacing. Design tradeoffs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

Text/Reference Books:

1.	J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2.	Raj Kamal, Embedded System, McGraw Hill
3.	Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
4.	V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
5.	David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
6.	K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.

5ECU6.1	DEC	Bio-Medical Electronics	MM:150	2L:0T:0P	2 credit

Brief introduction to human physiology. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases. Bio-electrodes and bio potential amplifiers for ECG, EMG, EEG, etc.
Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrasonic, X-ray and nuclear imaging. Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.

Text / Reference Books:

1.	W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
2.	J.G. Websster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
3.	A.M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.
4.	R.S.Khandpur, Handbook of Biomedical Instrumentation, McGraw Hill

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5ECU6.2	DEC	Satellite Communication	MM:150	2L:0T:0P	2 credit

Introduction to Satellite Communication: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications and frequency bands used for satellite communication.
Orbital Mechanics: Orbital equations, Kepler's laws, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day.
Satellite sub-systems: Study of Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems etc.
Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift. Satellite link budget
Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions.
Modulation and Multiple Access Schemes: Various modulation schemes used in satellite communication, Meaning of Multiple Access, Multiple access schemes based on time, frequency, and code sharing namely TDMA, FDMA and CDMA.

Text/Reference Books:

1.	Timothy Pratt Charles W. Bostian, Jeremy E. Allnutt: Satellite Communications: Wiley India. 2nd edition 2002.
2.	Tri T. Ha: Digital Satellite Communications: Tata McGraw Hill, 2009
3.	Dennis Roddy: Satellite Communication: 4th Edition, McGraw Hill,2009.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5ECU6.2	Satellite Communication	CO 1	Able to understand the dynamics and architecture of the satellite
		CO 2	Solve numerical problems related to orbital

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			motion
		CO 3	Examine the design of Earth station and tracking of the satellites
		CO 4	Evaluate and design link power budget for the satellites.
		CO 5	Analyze the analog and digital technologies used for satellite communication.

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
5ECU6.2 Satellite Communication	CO 1	2	2		1	1		1					
	CO 2	3	3		2	1	1						
	CO 3	2	3	2	3	2		2		1		2	2
	CO 4	3	3	3	2	2				1		1	1
	CO 5	1	3	2	3	2			1		2		

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Introduction to Satellite Communication
Lecture 2	Introduction to Satellite Communication
Lecture 3	Principles and architecture of satellite Communication
Lecture 4	Brief history of Satellite systems, advantages, disadvantages
Lecture 5	applications and frequency bands used for satellite communication.
Lecture 6	Orbital Mechanics: Orbital equations
Lecture 7	Orbital Mechanics: Orbital equations
Lecture 8	Kepler's laws, Apogee and Perigee for an elliptical orbit
Lecture 9	Kepler's laws, Apogee and Perigee for an elliptical orbit
Lecture 10	evaluation of velocity, orbital period, angular velocity etc. of a satellite
Lecture 11	concepts of Solar day and Sidereal day
Lecture 12	Satellite sub-systems
Lecture 13	Study of Architecture and Roles of various sub-systems of a

	satellite
Lecture 14	Study of Architecture and Roles of various sub-systems of a satellite
Lecture 15	Telemetry, tracking, command and monitoring (TTC & M)
Lecture 16	Telemetry, tracking, command and monitoring (TTC & M)
Lecture 17	Attitude and orbit control system (AOCS)
Lecture 18	Communication sub-system and power sub-systems etc.
Lecture 19	Typical Phenomena in Satellite Communication
Lecture 20	Solar Eclipse on satellite, its effects, remedies for Eclipse
Lecture 21	Sun Transit Outage phenomena, its effects and remedies
Lecture 22	Doppler frequency shift phenomena and expression for Doppler shift
Lecture 23	Doppler frequency shift phenomena and expression for Doppler shift
Lecture 24	Satellite link budget
Lecture 25	Satellite link budget
Lecture 26	Flux density and received signal power equations
Lecture 27	Calculation of System noise temperature for satellite receiver
Lecture 28	noise power calculation
Lecture 29	Drafting of satellite link budget and C/N ratio
Lecture 30	Drafting of satellite link budget and C/N ratio
Lecture 31	Calculations in clear air and rainy conditions.
Lecture 32	Modulation and Multiple Access Schemes
Lecture 33	Various modulation schemes used in satellite communication
Lecture 34	Meaning of Multiple Access, Multiple access schemes based on time
Lecture 35	Multiple access schemes based on frequency
Lecture 36	TDMA
Lecture 37	FDMA and CDMA
Lecture 38	FDMA and CDMA
Lecture 39	Spill over class
Lecture 40	Spill over class

Content delivery method:

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

Sample assignments:

Assignment 1	**Q1.** A Satellite is orbiting in an elliptical orbit with apogee height at 20000 Km and perigee height at 400 Km. Calculate the ratio of velocity at perigee to that at apogee.

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	Q2. A satellite is orbiting in a circular orbit which is 1000 Km away from the surface of the earth. Estimate number of times in a day, the satellite will be overhead from a particular location on the earth.
	Q3. Telemetry system of the satellite samples in sequence 40 sensors each producing 20 bits, adds 240 bits overhead to form a frame and transmits the data at 1 Kbps to Control Earth Station 42,000 km away. How long does it take to receive a complete telemetry data frame at control earth station after the last bit of the frame is transmitted by the telemetry?
Assignment 2	**Q1.** The difference between the farthest and the closest point in a satellite's elliptical orbit from the surface of the earth is 30000 Km, and the sum of the distances is 50000 Km, if the mean radius of the earth is considered to be 6400 Km, determine the eccentricity and length of semi-major axis of the orbit.
	Q2. A 36 MHZ bandwidth limited transponder is allotted with voice only carrier in FDMA mode with 45 KHz separation between centre frequency of carriers. Assuming 40% voice activity, what will be the number of carriers?
	Q3. A receiver at 290K is having noise figure of 4 dB. Calculate the noise power density of the receiver.

5ECU11	DCC	RF Simulation Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Study of field pattern of various modes inside a rectangular and circular waveguide.
2.	Study of field pattern of various modes inside a rectangular cavity resonator.
3.	Find the change in characteristics impedance and reflection coefficients of the transmission line by changing the dielectric properties of materials embedded between two conductors.
4.	Design and simulate the following Planar Transmission Lines: (a) Strip and micro-strip lines (b) Parallel coupled strip line (c) Coplanar and Slot lines (d) Determine their field patterns and characteristic impedance.
5.	Design and simulate the following: (a) 3-dB branch line coupler (b) Wilkinson power divider (c) Hybrid ring (d) Backward wave coupler (e) Low pass filters (f) Band pass filters
6.	Design RF amplifier using microwave BJT.
7.	Design RF amplifier using microwave FET.

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5ECU12	DCC	Digital Signal Processing Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment (Simulate using MATLAB environment)
1.	Generation of continuous and discrete elementary signals (impulse, unit-step, ramp) using mathematical expression.
2.	Perform basic operations on signals like adding, subtracting, shifting and scaling.
3.	Perform continuous and discrete time Convolution (using basic definition).
4.	Checking Linearity and Time variance property of a system using convolution, shifting.
5.	To generate and verify random sequences with arbitrary distributions, means and variances for following: (a) Rayleigh distribution (b) Normal distributions: N(0,1). (c) Gaussion distributions: N (m, x) (d) Random binary wave.
6.	To find DFT / IDFT of given DT signal.
7.	N-point FFT algorithm.
8.	To implement Circular convolution.
9.	MATLAB code for implementing z-transform and inverse z-transform.
10.	Perform inverse z-transform using residue z MATLAB function.
11.	MATLAB program to find frequency response of analog LP/HP filters.
12.	To design FIR filter (LP/HP) using windowing (rectangular, triangular, Kaiser) technique using simulink.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EC4-22	Digital Signal Processing Lab	CO 1	Simulate, synthesize and process communication signals using software tools such as MATLAB.
		CO 2	To understand the difference between analog, discrete & digital signals & their processing.
		CO 3	Analyse & process signals in communication systems to meet a particular requirement.
		CO 4	Apply z-transform, DFT, FFT to analyse and design DSP systems.
		CO 5	Design of various basic digital filters.

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
5ECU12 Digital Signal Processing Lab	CO 1	3	2			3							2
	CO 2	3	2	1									
	CO 3	3	3	2	1	1	2						1
	CO 4	3	3	3	2	3							1
	CO 5	3	3	3	2	3	1						1

3: Strongly 2: Moderate 1: Weak

5ECU13	DCC	Microwave Lab	MM:75	0L:0T:3P	1 credit

List of Experiments

Sr. 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 micro-strip 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.

5ECU13	DCC	Microwave Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. 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 micro-strip 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.

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5ECU14	DCC/IEC	PCB Design lab/EC Workshop	MM:75	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.	Soldering & desoldering practice.
4	Step down transformer winding of less than 5VA.
5.	Fabrication of a PCB for a DC regulated power supply.
6.	Identification of various types of Printed Circuit Boards (PCB) and soldering Techniques.
7.	Introduction to PCB And OrCAD Design software
8.	(a). Artwork & printing of a simple PCB. (b). Etching & drilling of PCB.
9.	Wiring & fitting shop: Fitting of power supply along with a meter in cabinet.
10.	To study the specifications and working of a Transistor radio kit and perform measurements on it.

5ECU20		DECA	MM:50	0L:0T:0P	1 credit

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6ECU1	DCC	Computer Network	MM:150	3L:1T:0P	4 credit

Introduction to computer networks and the Internet: Application layer: Principles of network applications, The Web and Hyper Text Transfer Protocol, File transfer, Electronic ail, Domain name system, Peer-to-Peer file sharing, Socket programming, Layering concepts.
Switching in networks: Classification and requirements of switches, a generic switch, Circuit Switching, Time-division switching, Space-division switching, Crossbar switch and evaluation of blocking probability, 2-stage, 3-stage and n-stage networks, Packet switching, Blocking in packet switches, Three generations of packet switches, switch fabric, Buffering, Multicasting, Statistical Multiplexing.
Transport layer: Connectionless transport - User Datagram Protocol, Connection oriented transport – Transmission Control Protocol, Remote Procedure Call. Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines, TCP congestion Control, Congestion Avoidance Mechanisms and Quality of Service.
Network layer: Virtual circuit and Datagram networks, Router, Internet Protocol, Routing algorithms, Broadcast and Multicast routing
Link layer: ALOHA, Multiple access protocols, IEEE 802 standards, Local Area Networks, addressing, Ethernet, Hubs, Switches.

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 McGrawHill,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
6ECU1	Computer Networks	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
6ECU1 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	Application layer, Principles of network applications
Lecture 4	Detail explanation of web and Hyper Text Transfer Protocol
Lecture 5	File transfer, Electronic mail services
Lecture 6	Domain name system, Peer-to-Peer file sharing

Lecture 7	Socket programming
Lecture 8	Layering concepts of networks
Lecture 9	Introduction of Switching in networks: Classification and requirements of switches
Lecture 10	A generic switch, Circuit Switching,
Lecture 11	Time-division switching, Space-division switching
Lecture 12	Crossbar switch and evaluation of blocking probability
Lecture 13	2-stage, 3-stage and n-stage networks
Lecture 14	2-stage, 3-stage and n-stage networks continued.
Lecture 15	Packet switching, Blocking in packet switches, Three generations of packet switches
Lecture 16	Switch fabric, Buffering, Multicasting
Lecture 17	Statistical Multiplexing, summary of switching networks.
Lecture 18	Introduction of Transport layer: Connectionless transport - User Datagram Protocol
Lecture 19	Connection-oriented transport – Transmission Control Protocol
Lecture 20	Remote Procedure Call
Lecture 21	Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines
Lecture 22	Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines Continued
Lecture 23	TCP congestion Control
Lecture 24	Congestion Avoidance Mechanisms and Quality of Service
Lecture 25	Congestion Avoidance Mechanisms and Quality of Service continued.
Lecture 26	Summary of transport layer and congestion control
Lecture 27	Introduction to network layer, Virtual circuit and datagram network,
Lecture 28	Routers, Internet Protocol
Lecture 29	Internet Protocol
Lecture 30	Routing Algorithms
Lecture 31	Broadcast and multicast routing
Lecture 32	Broadcast and multicast routing continued and review of network layer
Lecture 33	Introduction to data link layer and ALOHA
Lecture 34	Detail explanation of Multiple access protocols
Lecture 35	IEEE 802 standards
Lecture 36	Local area Networks
Lecture 37	Data link layer addressing
Lecture 38	Ethernet, Hub
Lecture 39	Switches
Lecture 40	Summary of data link layer and Review of whole syllabus

Content delivery method:

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

Assignments:

Assignment 1	**Q1. (a)**Consider an FTP session in which the user three separate *get* commands. How many TCP connections are created during this session? Explain. **(b)** An IMAP server keeps track of which email messages have been read by a user and which have not. POP allows you to download an email message from the server while leaving it stored on the server, but does not remember which ones you've read. What are the pros and cons of these two approaches?
	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. (a) How many bytes are there in the UDP packet header? How many in the TCP header? **(b)**Give two reasons you might prefer to implement an application using UDP, rather than TCP.
(b)	**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, 13. How many distinct packets were sent by the original host?
	Q2. Consider a router with 10 Gb/s links and designed for use in wide area networks with typical round-trip times of 200 ms. If the router has 16 links, how much memory is required for packet buffers, assuming each buffer is dimensioned according to the standard rule-of-thumb.

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	Q3. (a) Consider a 100 Mb/s version of Ethernet using CSMA/CD. If the maximum separation between two nodes is 5 km, how efficient is the network if all packets have the minimum length? What if they have the maximum length? **(b)** How long is the payload of an Ethernet frame carrying an IPv4 packet that contains a minimum size UDP packet. How long is the frame if the IPv4 packet is a TCP packet with 40 bytes of user data? **(c)** How many distinct IP multicast addresses are there? How many distinct Ethernet multicast addresses are available for use with IP? Discuss how the difference in these two numbers might affect the operation of IP multicast, in the context of Ethernet LANs.

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6ECU2	DCC	Fiber Optic Communications	MM:150	3L:1T:0P	4 credit

Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod, Ray model, wave model. Different types of optical fibers, Modal analysis of a step index fiber.
Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR
Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detector responsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.
Optical switches - coupled mode analysis of directional couplers, electro-optic switches. Optical amplifiers - EDFA, Raman amplifier.
WDM and DWDM systems. Principles of WDM networks. Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion and solition based communication.

Text/Reference Books:

1.	J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2.	T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
3.	J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4.	S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
5.	G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.
6.	G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1997
7.	F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” 7th edition, Pearson,2014.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU2	Fiber Optic Communication	CO 1	Understand the basics of fiber-optic communication system, components and significance
		CO 2	Analysis of different types of Optical fiber

			based on ray and wave model
		CO 3	Able to understand channel impairments like losses and dispersion
		CO 4	Assess and compare optical sources, detectors and their application
		CO 5	Design optical networks and understand non-linear effects in optical fibers

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
6ECU2 Fiber Optic Communication	CO 1	3	2		1								1
	CO 2	3	3	2	2	1							
	CO 3	3	2	1	1	2	1						
	CO 4	3	3	3	3	2	2	1	2				1
	CO 5	2	2	3	2	1					1	2	2

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

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Introduction
Lecture 2	Introduction to vector nature of light, propagation of light
Lecture 3	propagation of light in a cylindrical dielectric rod
Lecture 4	Ray model
Lecture 5	Wave model
Lecture 6	Different types of optical fibers, Modal analysis of a step index fiber.
Lecture 7	Modal analysis of a step index fiber.
Lecture 8	Modal analysis of a step index fiber.
Lecture 9	Signal degradation on optical fiber
Lecture 10	Signal degradation on optical fiber
Lecture 11	Signal degradation on optical fiber
Lecture 12	Dispersion
Lecture 13	Attenuation
Lecture 14	Fabrication of fibers

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Lecture 15	measurement techniques
Lecture 16	measurement techniques
Lecture 17	OTDR
Lecture 18	Optical sources
Lecture 19	LEDs
Lecture 20	Lasers
Lecture 21	Photo-detectors
Lecture 22	pin-diodes
Lecture 23	APDs
Lecture 24	detector responsivity characteristics
Lecture 25	Noise and optical receivers
Lecture 26	Optical link design
Lecture 27	BER calculation
Lecture 28	quantum limit and power penalties
Lecture 29	Optical switches - coupled mode analysis of directional couplers,.
Lecture 30	electro-optic switches
Lecture 31	Optical amplifiers - EDFA
Lecture 32	Raman amplifier
Lecture 33	WDM and DWDM systems
Lecture 34	Principles of WDM networks
Lecture 35	Nonlinear effects in fiber optic links
Lecture 36	Concept of self-phase modulation
Lecture 37	Group velocity dispersion
Lecture 38	solition based communication
Lecture 39	Spill over class
Lecture 40	Spill over class

Content delivery method:

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

Sample assignments:

Assignment 1	**Q1.**	Consider a planar mirror waveguide with n = 1.45, d = 1 µm at λ_0= 0.85 µm. Estimate the propagation constant and effective index of the first mode.
	Q2.	A step index multimode fiber with NA = 0.2 supports approximately 1000 modes at 850 nm wavelength. What is core diameter?
	Q3.	Find the value of normalized frequency (V) for given fiber with n_1 = 1.45, Δ = 0.003, a = 4µm for wavelength λ_0 = 1300nm.
Assignment 2	**Q1.**	Calculate the pulse broadening in a multimode

		step index fiber with n_1= 1.47, n_2= 1.465 and fiber length of 2 km.
	Q2.	Consider an LED source at λ_0 = 880 nm with a spectral width of 40 nm. Calculate the material dispersion coefficient in ps/km-nm in fused silica glass with $d^2n/d\lambda^2_0 = 0.03\ \mu m^{-2}$.
	Q3.	Consider a step- index optical fiber with n_1= 1.472, n_2= 1.431 and a= 2 µm. Calculate the approximate group velocity at wavelength 1550 nm.

6ECU3	DCC	Antennas and Propagation	MM:150	3L:0T:0P	3 credit

Fundamental Concepts-Physical concept of radiation, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.
Radiation from Wires and Loops-Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.
Aperture and Reflector Antennas-Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas.
Broadband Antennas-Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas.
Micro strip Antennas-Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.
Antenna Arrays-Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method.
Basic Concepts of Smart Antennas- Concept and benefits of smart antennas, fixed weight beam forming basics, Adaptive beam forming.
Different modes of Radio Wave propagation used in current practice.

Text/Reference Books:

1.	J.D. Kraus, Antennas, McGraw Hill, 1988
2.	C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982
3.	R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985
4.	S. Silver, Microwave Antenna Theory and Design, McGrawHill, 1949
5.	I.J. Bahl and P. Bhartia, Micro Strip Antennas, Artech House, 1980

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU3	Antennas and 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
6ECU3 Antennas and 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	Introduction to Antennas and their applications, review of Maxwells equations
Lecture 2	Physical concept of radiation, Radiation pattern, near-and far-field regions
Lecture 3	Reciprocity, Input impedance, Polarization
Lecture 4	Directivity and Gain, Effective aperture, Efficiency and Numerical examples
Lecture 5	Friis transmission equation and numerical examples

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Lecture 6	Radiation integrals and Auxiliary potential functions
Lecture 7	Radiation integrals and Auxiliary potential functions (contd.)
Lecture 8	Radiation from Infinitesimal dipole
Lecture 9	The finite-length dipole
Lecture 10	Review of boundary conditions and Linear elements near conductors
Lecture 11	dipoles for mobile communication, small circular loop
Lecture 12	Numerical examples
Lecture 13	Huygens' principle and aperture antennas, radiation from rectangular aperture
Lecture 14	Radiations from circular apertures, Modes
Lecture 15	Design considerations
Lecture 16	Babinet’s Principle and Horn antennas, Radiation from Sectoral Horn
Lecture 17	Radiation from Pyramidal Horn antennas and design concepts
Lecture 18	Reflector antennas and feeds
Lecture 19	Prime-focus Parabolic reflector and Cassegrain antennas
Lecture 20	Numerical examples
Lecture 21	Impedance matching, resonance and Broadband antennas, Log-periodic antennas
Lecture 22	Yagi-Uda antennas, frequency independent antennas
Lecture 23	Boradcast antennas, numerical examples
Lecture 24	Basic characteristics of micro strip antennas, feeding methods
Lecture 25	Methods of analysis
Lecture 26	The rectangular microstrip antenna, its modes and radiation behavior
Lecture 27	The circular microstrip antenna, its modes and radiation behavior
Lecture 28	Designing rectangular and circular patch antennas
Lecture 29	Numerical examples
Lecture 30	Arrays, their basic properties and their applications
Lecture 31	Analysis of uniformly spaced arrays with uniform excitation
Lecture 32	Analysis of uniformly spaced arrays with non-uniform excitation amplitudes
Lecture 33	The Binomial array, The Tchebysheff array, Taylor array
Lecture 34	The planar arrays, rectangular arrays
Lecture 35	Circular array, Cheng-Sheng array, Numerical examples
Lecture 36	Synthesis of arrays, Schelkounff Polynomial method
Lecture 37	WoodyardLawsons method
Lecture 38	Antennas- Concept and benefits of smart antennas, fixed weight beam forming basics
Lecture 39	Adaptive beam forming
Lecture 40	Different modes of Radio Wave propagation used in current practice.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

Assignments:

Assignment 1	**Q1.**	The radial component of the radiated power density of an infinitesimal linear dipole of length $\ell << \lambda$ 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 (σ= 5.7×10^{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 × 10−4λ, and the radiation resistance of the $\lambda/2$ dipole is 73 ohms.
	Q3.	Find the radiation resistance of a single-turn and an eight-turn small circular loop. The radius of the loop is $\lambda/25$ and the medium is free-space.
Assignment 2	**Q1.**	Write short notes on YagiUda antennas, and log periodic antennas.
	Q2.	Design a rectangular microstrip antenna using a substrate (RT/Duroid 5880) with dielectric constant 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 beam forming techniques?

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6ECU4	DCC	Information Theory and coding	MM:150	3L:0T:0P	3 credit

Basics of information theory- entropy for discrete ensembles; Shannon's noiseless coding theorem; Encoding of discrete sources.
Markov sources- Shannon's noisy coding theorem and converse for discrete channels; Calculation of channel capacity and bounds for discrete channels; Application to continuous channels.
Techniques of coding and decoding; Huffman codes and uniquely detectable codes; Cyclic codes, convolutional arithmetic codes.

Text / Reference Books:

1. N. Abramson, Information and Coding, McGraw Hill, 1963.
2.RanjanBose,Information Theory Coding &Cryptography,McGraw Hill
3. M. Mansurpur, Introduction to Information Theory, McGraw Hill, 1987.
4. R.B. Ash, Information Theory, Prentice Hall, 1970.
5. Shu Lin and D.J. Costello Jr., Error Control Coding, Prentice Hall, 1983.

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6ECU5.1	DEC	Introduction to MEMS	MM:150	3L:0T:0P	3 credit

Introduction and Historical Background.
Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview: Case studies. **Review of Basic MEMS fabrication modules:** Oxidation, Deposition Techniques, Lithography (LIGA), and Etching. Micromachining: Surface Micromachining, sacrificial layer processes, Stiction; Bulk Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding.
Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law, Poisson effect, Linear Thermal Expansion, Bending; Energy methods, Overview of Finite Element Method, Modeling of Coupled Electromechanical Systems.

Text/Reference Books:

1.	G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.
2.	Tai-Ran Hsu,MEMS and Microsystems:Design and Manufacture,McGraw Hill
3.	S. E.Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and Microengineering (Vol. 8). CRC press, (2005).
4.	S. D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.
5.	M. Madou, Fundamentals of Microfabrication, CRC Press, 1997.
6.	G. Kovacs, Micromachined Transducers Sourcebook, McGraw-Hill, Boston, 1998.
7.	M.H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and Gyroscopes, Elsevier, New York, 2000.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU5.1	Introduction to MEMS	CO 1	Understanding of historical background of MEMS devices.
		CO 2	Appreciate the underlying working principles of MEMS and NEMS devices.

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		CO 3	Design and model MEM devices.
		CO 4	Understanding of core electronics fabrication techniques.
		CO 5	Understanding of underlying mathematics of MEMS 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
6ECU5.1 Introduction to MEMS	**CO 1**	3	3			2							
	CO 2	3											
	CO 3	2		1	3	1		3					
	CO 4	2	2			2		1					
	CO 5	1			2	3							2

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

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero lecture
Lecture 2	Introduction and Historical Background.
Lecture 3	Introduction and Historical Background.
Lecture 4	Introduction and Historical Background.
Lecture 5	Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview
Lecture 6	Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview
Lecture 7	Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview
Lecture 8	Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview
Lecture 9	Oxidation, Deposition Techniques
Lecture 10	Oxidation, Deposition Techniques
Lecture 11	Lithography
Lecture 12	Lithography
Lecture 13	Etching
Lecture 14	Micromachining: Surface Micromachining

Lecture 15	Micromachining: Surface Micromachining
Lecture 16	Sacrificial layer processes
Lecture 17	Stiction; Bulk Micromachining
Lecture 18	Stiction; Bulk Micromachining
Lecture 19	Isotropic Etching
Lecture 20	Anisotropic Etching
Lecture 21	Wafer Bonding
Lecture 22	Wafer Bonding
Lecture 23	Wafer Bonding
Lecture 24	Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law
Lecture 25	Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law
Lecture 26	Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law
Lecture 27	Poisson effect
Lecture 28	Linear Thermal Expansion
Lecture 29	Bending; Energy methods
Lecture 30	Bending; Energy methods
Lecture 31	Overview of Finite Element Method
Lecture 32	Overview of Finite Element Method
Lecture 33	Overview of Finite Element Method
Lecture 34	Modeling of Coupled Electromechanical Systems
Lecture 35	Modeling of Coupled Electromechanical Systems
Lecture 36	Modeling of Coupled Electromechanical Systems
Lecture 37	Modeling of Coupled Electromechanical Systems
Lecture 38	Spill over classes
Lecture 39	Spill over classes
Lecture 40	Spill over classes

Content delivery method:

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

Sample assignments:

Assignment 1	**Q1.**	Discuss three types of fabrication techniques.
	Q2.	Discuss Bulk micromachining in detail.
	Q3.	Discuss two types of deposition techniques
Assignment 2	**Q1.**	Discuss fundamentals of microengineering.
	Q2.	Discuss different types of transducers used in microfabrication.
	Q3.	Discuss actuators and sensor used in MEMS industry.

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6ECU5.2	DEC	Nano Electronics	MM:150	3L:0T:0P	3 credit

Introduction to nanotechnology, meso structures, Basics of Quantum Mechanics: Schrodinger equation, Density of States. Particle in a box Concepts, Degeneracy. Band Theory of Solids. Kronig-Penny Model. Brillouin Zones.
Shrink-down approaches: Introduction, CMOS Scaling, The nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.), Resonant Tunneling Diode, Coulomb dots, Quantum blockade, Single electron transistors, Carbon nanotube electronics, Band structure and transport, devices, applications, 2D semiconductors and electronic devices, Graphene, atomistic simulation.

Text/ Reference Books:

1.	G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2.	K.E. Drexler, Nanosystems, Wiley, 1992.
3.	W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Materialand Novel Devices), Wiley-VCH, 2003.
4.	J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
5.	C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003.
6.	T.Pradeep,Nano:TheEssentials,McGraw Hill

6ECU6.1	DEC	Power Electronics	MM:150	2L:0T:0P	2 credit

SEMICONDUCTOR POWER DEVICES: Introduction. Basic characteristics &working of Power Diodes, Diac, Triac, MOSFETs, IGBT, GTO, Power Transistor and SCR- Principle of operation, V-I Characteristics, Turn-On mechanism and its applications
CONVERTERS: Basic concept, Working Principles of Single phase half Wave bridge converter, Single Phase Full Bridge Converter, 3 Phase Bridge Converter.
INVERTERS: Voltage Source Inverter, Current Source Inverter, PWM Control of Voltage Source Converter and applications.
INDUSTRIAL POWER SUPPLIES: Principle of operation of choppers. Step up, Step down and reversible choppers. Chopper control techniques, 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: Principle of operation, Types of stepper motor: Variable reluctance, Permanent magnet and hybrid stepper motors. Brushless DC motor and its control. Induction and dielectric heating control.

Text/Reference Books:

1. Power Electronics Principles & Applications, Joseph Vithayathil, TMH, (2010).
2. Power Eletronics, M.D.Singh, TMH, (2012).
3. Industrial Electronics And Control, Ttti, TMH (2001)
4. Power Electronics: Converters Applications., Mohan, Robbins, Wiley (1995)
5. Power Electronics, Moorthi, Oxford (2005)
6. Elements Of Power Electronics, Krein, Oxford (1998)
7. Power Electronics, R.S.Murthy, Pearson (2012)
8. Power Electronics: Circuits, Devices And Applications (2004)

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9.	Industrial Electronics: Thomas E. Kissell, PHI (2004).
10.	Power Electronics: Sivanagaraju, Reddy Prasad PHI (2010)

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6ECU6.2	DEC	High Speed Electronics	MM:150	2L:0T:0P	2 credit

Transmission line theory (basics)- crosstalk and non ideal effects; signal integrity: impact of packages, vias, traces, connectors; non-ideal return current paths, high frequency power delivery, methodologies for design of high speed buses; radiated emissions and minimizing system noise; Noise Analysis: Sources, Noise Figure, Gain compression, Harmonic distortion, Inter modulation, Cross-modulation, Dynamic range
Devices: Passive and active, Lumped passive devices (models), Active (models, low vs High frequency)
RF Amplifier Design, Stability, Low Noise Amplifiers, Broadband Amplifiers (and Distributed) Power Amplifiers, Class A, B, AB and C, D E Integrated circuit realizations, Cross-over distortion Efficiency RF power output stages
Mixers –Up conversion Down conversion, Conversion gain and spurious response. Oscillators Principles. PLL Transceiver architectures
Printed Circuit Board Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.

Text/Reference Books:

1.	Stephen H. Hall, Garrett W. Hall, James A. McCall "High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", August 2000, Wiley-IEEE Press
2.	Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press, 2004, ISBN 0521835399.
3.	BehzadRazavi, "RF Microelectronics", Prentice-Hall 1998, ISBN 0-13-887571-5.
4.	Guillermo Gonzalez, "Microwave Transistor Amplifiers", 2nd Edition, Prentice Hall.
5.	Kai Chang, "RF and Microwave Wireless systems", Wiley.
6.	R.G. Kaduskar and V.B.Baru, Electronic Product design, Wiley India, 2011

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU6.2	High Speed Electronics	CO 1	Develop the understanding of transmission line and its application in high speed electronics.

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		CO 2	Designing of the RF and power amplifier for high speed electronics with low noise and stability.
		CO 3	Understand the properties and fundamental limitation with the signal conversion of high speed electronic system.
		CO 4	Design and implement printed circuit board using CAD simulation.
		CO 5	Design High-speed electronic system using appropriate components.

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
6ECU6.2 High Speed Electronics	CO 1	3	2	2	1	1		1					
	CO 2	2	2	3	1	1							1
	CO 3	3	2	1	1			1					
	CO 4	2	2	3	1	3	2	1					1
	CO 5	2	2	3	2	2							2

3: Strongly 2: Moderate 1: Wea

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction of Transmission line.
Lecture 3	Crosstalk in transmission line.
Lecture 4	Nonideal effects in transmission line.
Lecture 5	Analysis of signal integrity.
Lecture 6	Impact of packages and vias.
Lecture 7	Effect of traces and connectors.
Lecture 8	Non-ideal return current paths

Lecture 9	High frequency power delivery
Lecture 10	Methodologies for design of high speed buses
Lecture 11	Analysis of radiated emissions
Lecture 12	Minimizing system noise
Lecture 13	Noise Analysis
Lecture 14	Inter modulation
Lecture 15	Cross Modulation
Lecture 16	Passive and active devices
Lecture 17	Lumped passive and active device models
Lecture 18	RF Amplifier Design
Lecture 19	Stability of RF amplifier design
Lecture 20	Low Noise Amplifiers
Lecture 21	Broadband Amplifiers
Lecture 22	Power Amplifiers
Lecture 23	Class A, B power amplifier
Lecture 24	Class AB and C power amplifier
Lecture 25	D E Integrated circuit realizations
Lecture 26	Cross-over distortion Efficiency
Lecture 27	Up conversion mixer
Lecture 28	Down Conversion Mixer
Lecture 29	Conversion gain and spurious response
Lecture 30	Oscillators Principles
Lecture 31	PLL Transceiver architectures
Lecture 32	Introduction to Printed Circuit Board
Lecture 33	CAD tools for PCB design
Lecture 34	Standard fabrication, micro-via boards.
Lecture 35	Surface Mount Technology
Lecture 36	Through Hole Technology
Lecture 37	Process Control and Design challenges
Lecture 38	Spill-Over Class
Lecture 39	Spill-Over Class
Lecture 40	Spill-Over Class

Content delivery method:

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

Sample Assignments:

Assignment 1
Q1. The characteristic impedance of a 20 metre length of

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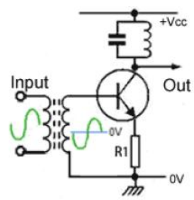
transmission line is 52 ohm. If 10 meters is cut off, find the impedance.
Q2. Calculate the attenuation due to ohmic losses at 20 GHz for a microstrip line constructed of copper conductor having a width of 2.5 mm on an alumina substrate. Take the characteristic impedance of the line as 50 Ω.
Q3. A 70-Q lossless line has s = 1.6 and 0r = 300°. If the line is 0.6X long, obtain (a) T,ZL,Zin (b) The distance of the first minimum voltage from the load.
Assignment 2
Q1. For the class B power amplifier shown in figure, find the voltage swing of the output signal. 
Q2. Which problem may occur as a result of pulse width modulation in audio amplifier and how to overcome it?
Q3. Which component is necessary to drive the loudspeaker in a class D amplifier?

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6ECU11	DCC	Computer Network Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

1.	**PRELIMINARIES:** Study and use of common TCP/IP protocols and term viz. telnet rlogin ftp, ping, finger, Socket, Port etc.
2.	**DATA STRUCTURES USED IN NETWORK PROGRAMMING:** Representation of unidirectional, Directional weighted and unweighted graphs.
3.	**ALGORITHMS IN NETWORKS:** computation of shortest path for one source-one destination and one source –all destination
4.	**SIMULATION OF NETWORK PROTOCOLS:** i. Simulation of M/M/1 and M/M/1/N queues. ii. Simulation of pure and slotted ALOHA. iii. Simulation of link state routing algorithm.
5.	**Case study : on LAN Training kit** i. Observe the behavior & measure the throughput of reliable data transfer protocols under various Bit error rates for following DLL layer protocols- a. Stop & Wait b. Sliding Window : Go-Back-N and Selective Repeat ii. Observe the behavior & measure the throughput under various network load conditions for following MAC layer Protocols a. Aloha b. CSMA, CSMA/CD & CSMA/CA c. Token Bus & Token Ring
6.	**Software and hardware realization of the following:** i. Encoding schemes: Manchester, NRZ. ii. Error control schemes: CRC, Hamming code.

6ECU12	DCC	Antenna and wave propagation Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Study the gain pattern, HPBW, FNBW and Directivity of a dipole antenna.
2.	Measurement of Radiation Pattern, Gain, HPBW of a folded dipole antenna.
3.	Measurement of Radiation Pattern, Gain, HPBW of a loop antenna
4.	Measurement of Radiation Pattern, Gain, VSWR, input impedance and reflection coefficient for given Monopole antenna
5.	Measurement of Radiation Pattern, Gain, VSWR, input impedance and reflection coefficient for given Yagi antennas
6.	Study of the Radiation Pattern, Gain, HPBW of a horn antenna
7.	Study of the Radiation Pattern, Gain, HPBW of a reflector antennas
8.	Study the radiation pattern, gain, VSWR, and input impedance of a rectangular micro-strip patch antenna
9.	Study the effect of inset feed on the input impedance of a rectangular patch antenna
10.	Study the effect of ground plane on the radiation pattern of an antenna
11.	Study antenna designing in CST Microwave Studio
12.	Design a rectangular microstrip patch antenna using CST MWS

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU12	Antenna and wave propagation 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
6ECU12 Antenna and wave propagation 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**

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6ECU13	DCC	Electronics Design Lab	MM:75	0L:0T:2P	1 credit

To design the following circuits, assemble these on bread board and test them.
Simulation of these circuits with the help of appropriate software.

1.	Op-Amp characteristics and get data for input bias current measure the output-offset voltage 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) Monostablemultivibrators using IC-555 timer
9.	Design Triangular & square wave generator using 555 timer.
10.	Design Amplifier (for given gain) using Bipolar Junction Transistor.
11.	Op-Amp characteristics and get data for input bias current measure the output-offsetvoltage and reduce it to zero and calculate slew rate.
12.	Op-Amp in inverting and non-inverting modes.
13.	Op-Amp as scalar, summer and voltage follower.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU13	Electronics Design Lab	CO 1	Designing of different forms of Electronic circuits.
		CO 2	Understanding the working of Op-amp and amplifier circuits
		CO 3	Design and understanding of different oscillators.
		CO 4	Understanding of different filters and multi-vibrators.
		CO 5	Designing of different Op-amp based 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
6ECU13 Electronics Design Lab	CO 1	3	2	2	2	3							
	CO 2	2	2	2	3	3							
	CO 3	2	2	1	3	1							
	CO 4	3	2	1	2	1							
	CO 5	3	3	2	2	2							

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

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6ECU14	DCC/IEC	Power Electronics Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Study the characteristics of SCR and observe the terminal configuration, measure the breakdown voltage, latching and holding current. Plot V-I characteristics.
2.	Perform experiment on triggering circuits for SCR. i.e. R triggering, R-C triggering and UJT triggering circuit.
3.	Study and test AC voltage regulators using triac, antiparallel thyristor sand triac & diac
4.	Study and obtain the waveforms for single-phase bridge converter.
5.	Perform experiment on single phase PWM inverter.
6.	Perform experiment on buck, boost and buck-boost regulators.
7.	Control speed of a dc motor using a chopper and plot armature voltage versus speed characteristic.
8.	Control speed of a single-phase induction motor using single phase AC voltage regulator.
9.	(i) Study single-phase dual converter (ii) Study speed control of dc motor using single-phase dual converter
10.	Study single-phase cyclo converter.
11.	Perform experiment on Motor control – open loop & closed loop.
12.	Design, observe and perform experiment on various type of pulse generation from DSP/ FPGA platform. Perform experiment for PWM inverters and choppers.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU14	Power Electronics Lab	CO 1	Explain characteristics of SCR and use various triggering circuits for it.
		CO 2	Describe single phase half bridge and full bridge rectifier with R and RL load.
		CO 3	Design and perform various pulse generations from DSP on PWM inverter and chopper.
		CO 4	Compare various configurations of DC regulators.
		CO 5	Explain speed control of dc motor using a chopper and single phase induction motor using AC voltage regulators.

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
6ECU14 Power Electronics Lab	CO 1	3	2	1	2	1							
	CO 2	3	2	1	1								
	CO 3	3	3	2	3	2							
	CO 4	3	1	1	2								
	CO 5	3	2	1	2	1							

6ECU20		**DECA**	**MM:50**	**0L:0T:0P**	**1 credit**

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7ECU1	DCC	CMOS Design	MM:150	3L:1T:0P	4 credit

Review of MOS transistor models, Non-ideal behavior of the MOS Transistor, Transistor as a switch, Inverter characteristics, Integrated **Circuit Layout:** Design Rules, Parasitic, Delay: RC Delay model, linear delay model, logical path efforts, Power, interconnect and Robustness in CMOS circuit layout,
Combinational Circuit Design: CMOS logic families including static, dynamic and dual rail logic. Sequential Circuit Design: Static circuits. Design of latches and Flip-flops.

Text/Reference Books:

1.	N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4thEdition, Pearson Education India, 2011..
2.	Sung-Mo-Kang and Yusuf Leblebici,CMOS Digital Integrated Circuits Analysis &Design,McGraw Hill
3.	C.Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley, 1979.
4.	J. Rabaey, Digital Integrated Circuits: A Design Perspective, Prentice Hall India, 1997.
5.	P. Douglas, VHDL: programming by example, McGraw Hill, 2013.
6.	L. Glaser and D. Dobberpuhl, The Design and Analysis of VLSI Circuits, Addison Wesley, 1985.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU1	CMOS Design	CO 1	The basic operation of MOS transistors, impact of scaling and parasitic.
		CO 2	Analysis of Inverter characteristics with required noise margin, propagation delay, power consumption of CMOS
		CO 3	Designing of the layout of complex logic gates by following the design rules.
		CO 4	Understand and calculate the logical effort of

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			any digital circuit.
		CO 5	Design and implement combinational CMOS circuit design including static, dynamic and dual rail logic.

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
7ECU1 CMOS Design	**CO 1**	3	2	1		1	1						
	CO 2	2	3	1									
	CO 3	2	1	3	1	3	1					1	1
	CO 4	3	2	1									
	CO 5	3	2	3	2								

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Review of MOSFET
Lecture 3	MOS Transistor Models, MOS Device Design Equation
Lecture 4	Non-ideal behavior of the MOS Transistor
Lecture 5	Long Channel I-V Characteristics, Non ideal I-V effects
Lecture 6	DC transfer characteristics
Lecture 7	CMOS technology
Lecture 8	Layout design rules
Lecture 9	CMOS process enhancement
Lecture 10	Manufacturing issues
Lecture 11	Process parameterization
Lecture 12	Introduction to delay and timing optimization
Lecture 13	Transient response
Lecture 14	RC delay model
Lecture 15	RC delay model
Lecture 16	Linear delay model

Lecture 17	Linear delay model
Lecture 18	Calculation of delay in logic gates
Lecture 19	Logical efforts of paths
Lecture 20	Iterative solution for sizing
Lecture 21	Timing analysis delay model
Lecture 22	Introduction to sources of power dissipation
Lecture 23	Dynamic Power Consumption
Lecture 24	Static Power consumption
Lecture 25	Energy Delay Optimization
Lecture 26	Low power architectures
Lecture 27	Introduction to wire geometry
Lecture 28	Interconnect modeling
Lecture 29	Interconnect impact
Lecture 30	Interconnect engineering, logical efforts with wire
Lecture 31	Robustness with circuit variability and scaling
Lecture 32	Combinational circuit design with different circuit families
Lecture 33	Combinational circuit design with different circuit families
Lecture 34	Circuits Pitfalls
Lecture 35	Silicon on insulator circuit design, sub-threshold circuit design
Lecture 36	Designing of sequential static circuits
Lecture 37	Designing of sequential static circuits
Lecture 38	Circuit design of latch
Lecture 39	Circuit design of Flip Flop
Lecture 40	SDFF, dual edge triggered, Differential, TSPC Flip Flop

Content delivery method:

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

Sample Assignments:

Assignment 1
Q1. Consider four designs of 6-inputs AND gate shown in figure. Develop an expression for the delay of each path if the path electrical effort is H. What design is fastest for A) H = 1 B) H = 5 C) H = 20 Explain your conclusion intuitively.

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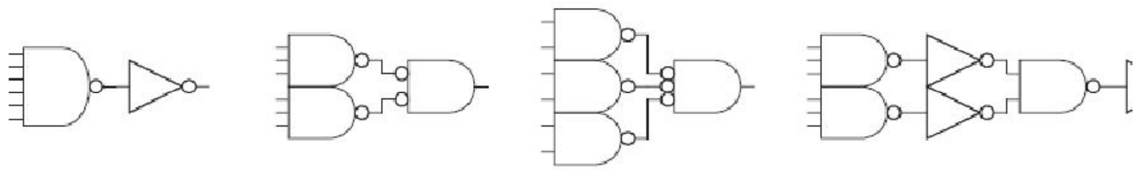

Q2.	Suppose a unit inverter with three units of input capacitance has unit drive. a) What is the drive of a 4x inverter? b) What is the drive of a 2-input NAND gate with three units of input capacitance?
Q3.	Find the worst-case Elmore parasitic delay of an *n*-input NOR gate.
Assignment 2	
Q4.	Design a static CMOS circuit to compute $F = (A + B)(C + D)$ with least delay. Each input can Present a maximum of 30 λ of transistor width. The output must drive a load equivalent to 500 λ of Transistor width. Choose transistor sizes to achieve least delay and estimate this delay in τ.
Q5.	Sketch a pseudo-NMOS gate that implements the function $F = A(B + C + D) + E \cdot F \cdot G$
Q6.	Sketch a 3-input symmetric NOR gate. Size the inverters so that the pull down is four times as strong as the net worst-case pull up. Label the transistor widths. Estimate the rising, falling and average logical efforts. How do they compare to a static CMOS 3-input NOR gate?

7ECU2	DCC	Digital Image & Video Processing	MM:150	3L:1T:0P	4 credit

Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.
Image Enhancements and Filtering-Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.
Color Image Processing-Color models–RGB, YUV, HSI; Color transformations-formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation.
Image Segmentation- Detection of discontinuities, edge linking and boundary detection, Thresholding – global and adaptive, region-based segmentation.
Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub-band filter banks, wavelet packets.
Image Compression-Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000.
Fundamentals of Video Coding- Inter-frame redundancy, motion estimation techniques – full search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X.
Video Segmentation- Temporal segmentation–shot boundary detection, hard-cutsand soft-cuts;spatial segmentation – motion-based; Video object detection and tracking.

Text/Reference Books:

1.	R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008

2	R.C. Gonzalez, R.E. Woods and S.L.Eddins,Digital Image Processing using Matlab, McGraw Hill,2nd Edition
3.	Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition 2004
4.	Murat Tekalp , Digital Video Processing" Prentice Hall, 2nd edition 2015

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU2	Digital Image & Video 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
7ECU2 Digital Image & Video 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	Content to be taught

No.	
Lecture 1	Zero Lecture
Lecture 2	Elements of visual perception, image sensing and acquisition
Lecture 3	Image sensing and acquisition, image sampling and quantization
Lecture 4	Basic relationships between pixels – neighbourhood, adjacency, connectivity, distance measures.
Lecture 5	Gray level transformations, histogram equalization and specifications
Lecture 6	Pixel-domain smoothing filters – linear and order-statistics
Lecture 7	Pixel-domain sharpening filters – first and second derivative,
Lecture 8	Two-dimensional DFT and its inverse
Lecture 9	Frequency domain filters – low-pass and high-pass.
Lecture 10	Color models–RGB, YUV, HSI;
Lecture 11	Color transformations– formulation, color complements
Lecture 12	Color slicing, tone and color corrections
Lecture 13	Color image smoothing and sharpening; Color Segmentation
Lecture 14	Image Segmentation- Detection of discontinuities,
Lecture 15	Edge linking and boundary detection
Lecture 16	Thresholding – global and adaptive, region-based segmentation.
Lecture 17	Thresholding – global and adaptive, region-based segmentation.
Lecture 18	Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time-frequency localization
Lecture 19	Continuous wavelet transforms
Lecture 20	Wavelet bases and multi-resolution analysis
Lecture 21	Wavelets and Sub band filter banks, wavelet packets.
Lecture 22	Image Compression-Redundancy–inter-pixel and psycho-visual
Lecture 23	Lossless compression – predictive, entropy
Lecture 24	Lossy compression- predictive and transform coding
Lecture 25	Discrete Cosine Transform
Lecture 26	Still image compression standards – JPEG and JPEG-2000
Lecture 27	Still image compression standards – JPEG and JPEG-2000
Lecture 28	Fundamentals of Video Coding- Inter-frame redundancy
Lecture 29	Motion estimation techniques – full search, fast search strategies
Lecture 30	Forward and backward motion prediction
Lecture 31	Frame classification – I, P and B
Lecture 32	Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks
Lecture 33	Elements of a video encoder and decoder
Lecture 34	Video coding standards – MPEG and H.26X.
Lecture 35	Video Segmentation
Lecture 36	Temporal segmentation–shot boundary detection, hard-cutsand soft-cuts
Lecture 37	Temporal segmentation–shot boundary detection, hard-cutsand soft-cuts

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Lecture 38	Spatial segmentation – motion-based;
Lecture 39	Video object detection and tracking.
Lecture 40	Video object detection and tracking.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

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.

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7ECU3	DCC	Mobile Communication and Network	MM:150	3L:0T:0P	3 credit

Cellular concepts- Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G and 3G cellular standards.
Signal propagation-Propagation mechanism- reflection, refraction, diffraction and scattering, large scale signal propagation and log normal shadowing. Fading channels-Multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate.
Capacity of flat and frequency selective channels. Antennas- Antennas for mobile terminal monopole antennas, PIFA, base station antennas and arrays.
Multiple access schemes-FDMA, TDMA, CDMA and SDMA. Modulation schemes- BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM.
Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity-Altamonte scheme.
MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff. Performance measures- Outage, average snr, average symbol/bit error rate. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA.

Text/Reference Books:

1.	WCY Lee, Mobile Cellular Telecommunications Systems, McGraw Hill, 1990.
2.	WCY Lee, Mobile Communications Design Fundamentals, Prentice Hall, 1993
3.	Raymond Steele, Mobile Radio Communications, IEEE Press, New York, 1992.
4.	AJ Viterbi, CDMA: Principles of Spread Spectrum Communications, Addison Wesley, 1995.
5.	VK Garg&JE Wilkes, Wireless & Personal Communication Systems, Prentice Hall, 1996.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU3	Mobile Communication and Networks	CO 1	Understand the working principle and able to model, and design mobile communication systems
		CO 2	Understand existing mobile networks and future system standards.
		CO 3	Apply multiple access techniques and diversity reception techniques in mobile arena
		CO 4	Analyze mobile communication systems for improved performance
		CO 5	Achieve output performance measures of different mobile 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
7ECU3 Mobile Communication and Networks	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	Introduction to Cellular concepts
Lecture 3	Cellular concepts
Lecture 4	Cell structure and frequency reuse
Lecture 5	Cell splitting and channel assignment
Lecture 6	Handoff, interference, capacity, power control

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Lecture 7	Wireless Standards: Overview of 2G and 3G cellular standards
Lecture 8	Signal propagation mechanism- reflection, refraction, diffraction and scattering,
Lecture 9	Signal propagation mechanism- reflection, refraction, diffraction and scattering
Lecture 10	large scale signal propagation and log normal shadowing
Lecture 11	Fading channels-Multipath and small scale fading
Lecture 12	Doppler shift, statistical multipath channel models,
Lecture 13	narrowband and wideband fading models
Lecture 14	power delay profile, average and rms delay spread
Lecture 15	coherence bandwidth and coherence time, flat and frequency selective fading
Lecture 16	slow and fast fading
Lecture 17	average fade duration and level crossing rate
Lecture 18	Capacity of flat and frequency selective channels.
Lecture 19	Capacity of flat and frequency selective channels.
Lecture 20	Antennas for mobile terminal monopole antennas
Lecture 21	PIFA, base station antennas and arrays.
Lecture 22	PIFA, base station antennas and arrays.
Lecture 23	Multiple access schemes-FDMA, TDMA, ,
Lecture 24	CDMA and SDMA
Lecture 25	CDMA and SDMA
Lecture 26	Modulation schemes- BPSK
Lecture 27	QPSK and variants
Lecture 28	QAM, MSK and GMSK
Lecture 29	multicarrier modulation and OFDM.
Lecture 30	Receiver structure- Diversity receivers
Lecture 31	MRC receivers, RAKE receiver
Lecture 32	Equalization: linear-ZFE
Lecture 33	Adaptive and DFE
Lecture 34	Transmit diversity-Altamonte scheme
Lecture 35	MIMO and space time signal processing
Lecture 36	spatial multiplexing, diversity/multiplexing tradeoff
Lecture 37	Performance measures- Outage, average SNR
Lecture 38	average symbol/bit error rate
Lecture 39	System examples- GSM, EDGE, GPRS, IS-95
Lecture 40	CDMA 2000 and WCDMA.

Content delivery method:

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

Sample assignments:

Assignment 1	**Q1.** Consider a N-cell reuse pattern (hexagonal geometry) with base stations at the centre of each cell with omni-directional antennas. What would be the D/R ratio required if a minimum value of C/I = 18dB must be ensured. Assume path loss exponent n = 3.1 and only tier 1 interferers
	Q2. Assuming Free space propagation model, If the transmit power is 1000 mW and the received power is 10-9 mW, what is the distance between the transmitter and the receiver. The carrier frequency is 1 GHz.
	Q3. Consider a cellular signal with carrier frequency fc = 900 MHz. Compute the maximum doppler frequency if the transmitter is moving at 60 kmph.
Assignment 2	**Q1.** Consider a transmitter antenna. The output power of the transmitter amplifier is 30 W and the transmit antenna gain is 15 dB. The feeder attenuation is 5 dB. What is the EIRP (Equivalent Isotropic Radiated Power)?
	Q2. A cellular system is designed for a receiver sensitivity of -102 dBm. Evaluate the transmitted power needed if the total path loss permitted is 112 dB, and a fading margin of 20 dB
	Q3. Consider a system that uses coherent QPSK modulation and detection scheme with 10 us symbol period for communication. The channel has a coherence time of 5 ms. If 50 symbols are being used for the purpose of channel estimation find the data rate ?

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7ECU4	DCC	Mixed Signal Design	MM:150	3L:0T:0P	3 credit

Analog and discrete-time signal processing, introduction to sampling theory; Analog continuous time filters: passive and active filters; Basics of analog discrete-time filters and Z-transform.
Switched-capacitor filters- Non-idealities in switched-capacitor filters; Switched-capacitor filter architectures; Switched-capacitor filter applications.
Basics of data converters; Successive approximation ADCs, Dual slope ADCs, Flash ADCs, Pipeline ADCs, Hybrid ADC structures, High-resolution ADCs, DACs.
Mixed-signal layout, Interconnects and data transmission; Voltage-mode signaling and data transmission; Current-mode signaling and data transmission.
Introduction to frequency synthesizers and synchronization; Basics of PLL, Analog PLLs; Digital PLLs; DLLs.

Text / Reference Books:

1.	R. Jacob Baker, CMOS mixed-signal circuit design, Wiley India, IEEE press, reprint 2008.
2.	Behzad Razavi , Design of analog CMOS integrated circuits, McGraw-Hill, 2003.
3.	R. Jacob Baker, CMOS circuit design, layout and simulation, Revised second edition, IEEE press, 2008.
4.	Rudy V. de Plassche, CMOS Integrated ADCs and DACs, Springer, Indian edition, 2005.
5.	Arthur B. Williams, Electronic Filter Design Handbook, McGraw-Hill, 1981.
6.	R. Schauman, Design of analog filters by, Prentice-Hall 1990 (or newer additions).
7.	M. Burns et al., An introduction to mixed-signal IC test and measurement by, Oxford university press, first Indian edition, 2008.

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7ECU5.1	DEC	Error Correcting Codes	MM:150	3L:0T:0P	3 credit

Linear block codes: Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels; Hamming codes; Weight enumerators and the McWilliams identities; Perfect codes.
Introduction to finite fields and finite rings; factorization of (X^n-1) over a finite field; Cyclic Codes. BCH codes; Idempotents and Mattson-Solomon polynomials; Reed-Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes.
Decoding of BCH codes: Berlekamp's decoding algorithm, Massey's minimum shift register synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp - Massey algorithm. Convolution codes; Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm.

Text / Reference Books:

1.	F.J. McWilliams and N.J.A. Slone, The theory of error correcting codes, 1977.
2.	R.E. Balahut, Theory and practice of error control codes, Addison Wesley, 1983.

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7ECU5.2	DEC	Neural Network And Fuzzy Logic Control	MM:150	3L:0T:0P	3 credit

NEUROPHYSIOLOGY: Introduction: Elementary neurophysiology – From neurons to ANNs - Neuron model McCulloch-Pitts model, Hebbian Hypothesis; limitations of single-layered neural networks. Applications Of Neural Networks: Pattern classification, Associative memories, Optimization, Applications in Image Processing-Iris, finger print & face, Applications in decision making.
THE PERCEPTRON: The Perceptron and its learning law. Classification of linearly separable patterns. Linear Networks: Adaline - the adaptive linear element. Linear regression. The Wiener-Hopf equation. The Least-Mean-Square (Widrow-Hoff) learning algorithm. Method of steepest descent. Adaline as a linear adaptive filter. A sequential regression algorithm. Multi-Layer Feedforward Neural Networks: Multi-Layer Perceptrons. Supervised Learning. Approximation and interpolation of functions. Back-Propagation Learning law. Fast training algorithms. Applications of multilayer perceptrons: Image coding, Paint-quality inspection, Nettalk.
FUZZY LOGIC: Introduction -Uncertainty & precision, Statistics and random process, Uncertainty in information, Fuzzy sets and membership. Membership Functions: Features of membership function. Standard forms and boundaries, Fuzzification, Membership value assignment – Intuition, Inference, Neural networks. Fuzzy To Crisp Conversions: Maximum membership principle.
DEFUZZIFICATION METHODS- Centroid method, Weighted average method, Meanmax membership. Fuzzy Rule Based Systems: Natural language, linguistic hedges, Rule based system –Canonical rule forms, Decomposition of compound rules, Likelihood and truth qualification Aggregation of Fuzzy rules. Graphical techniques of reference.
FUZZY CONTROL SYSTEM- Simple Fuzzy Logic controller, General FLC, Control System Design Problem Control (Decision) Surface, Assumptions in a Fuzzy Control System Design, Special forms of FLC system models, Industrial application: Aircraft Landing Control Problem. Fuzzy Engineering Process Control: Classical Feedback Control, Classical PID Control, Multi-input, Multi-output (MIMO) Control Systems, Fuzzy Statistical Process Control

Text / Reference Books:

S.No.	Name of Book / publication / Authors
1.	S.N. Sivanandam, S. Sumathi and S.N. Deepa -Introduction to Neural Networks using MATLAB 6.0, Tata McGraw-Hill 2006.

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2.	Timothy J. Ross -Fuzzy Logic with Engineering Applications, Third Edition 1995.
3.	Artificial Neural Network,Robert Schalloff, TMH 1997
4.	Fundamental Of Neural Network Architecture And Application, Laurene V. Fausett, Pearson 1993
5.	Neural Network Algorithm And Programing Tech, James A Freeman, Pearson 1991
6.	Neural N/W For Pattern Recognition, Cristopher, M.Bhishop, Oxford 1995
7.	Fuzzy Neuro Approach To Agent Application, Lee ,Raymond S.T., New Age 2008
8.	Fuzzy Logic and Neural Networks: Basic Concept And Application, A Lavala, Chemakesava R.,New Age 2012

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6ECU5.2	**Neural Networks And Fuzzy Logic Control**	**CO 1**	**Discuss** the elementary neurophysiology with the study of Neurons and different models & applications for Neural Networks**.** (K2)
		CO 2	**Describe** the perceptron, the linear networks & the Multi-Layer Feed forward Neural Networks(K2).
		CO 3	**Explain** theFuzzy Logics, their uncertainty & precision & the Membership Function. (K6)
		CO 4	**Illustrate** the Defuzzification Methods & Fuzzy Rule based Systems (K4).
		CO 5	**Examine** Fuzzy Control Systems & Fuzzy Engineering Process Control & their 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
Neural Networks And Fuzzy Logic	**CO 1**	3		2		1							
	CO 2	3			2	1							
	CO 3	3			2	1							

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	CO 4	2	3		1								
	CO 5	3		2	1								

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

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Introduction: Elementary neurophysiology
Lecture 2	Neuron model McCulloch-Pitts model
Lecture 3	Hebbian Hypothesis; limitations of single-layered neural networks
Lecture 4	Application in Pattern classification, Associative memories, Optimization
Lecture 5	Applications in Image Processing-Iris, finger print & face
Lecture 6	Applications in decision making
Lecture 7	The Perceptron and its learning law
Lecture 8	Classification of linearly separable patterns
Lecture 9	Adaline - the adaptive linear element, Linear regression.
Lecture 10	The Wiener-Hopf equation. The Least-Mean-Square (Widrow-Hoff) learning algorithm.
Lecture 11	Method of steepest descent. Adaline as a linear adaptive filter. A sequential regression algorithm
Lecture 12	Multi-Layer Perceptrons
Lecture 13	Supervised Learning
Lecture 14	Approximation and interpolation of functions. Back-Propagation Learning law
Lecture 15	Fast training algorithms. Applications of multilayer perceptrons: Image coding,
Lecture 16	Paint-quality inspection, Nettalk.
Lecture 17	Introduction -Uncertainty & precision
Lecture 18	Statistics and random process, Uncertainty in information
Lecture 19	Fuzzy sets and membership
Lecture 20	Features of membership function
Lecture 21	Standard forms and boundaries
Lecture 22	Fuzzification, Membership value assignment – Intuition, Inference
Lecture 23	Neural networks & Maximum Membership Principle
Lecture 24	Neural networks & Maximum Membership Principle

Lecture 25	Centroid method
Lecture 26	Weighted average method
Lecture 27	Meanmax membership
Lecture 28	Natural language, linguistic hedges
Lecture 29	Rule based system –Canonical rule forms, Decomposition of compound rules
Lecture 30	Decomposition of compound rules
Lecture 31	Likelihood and truth qualification Aggregation of Fuzzy rules
Lecture 32	Graphical techniques of reference
Lecture 33	Simple Fuzzy Logic controller
Lecture 34	General FLC, Control System Design Problem Control (Decision) Surface
Lecture 35	General FLC, Control System Design Problem Control (Decision) Surface
Lecture 36	Assumptions in a Fuzzy Control System Design, Special forms of FLC system models
Lecture 37	Industrial application: Aircraft Landing Control Problem
Lecture 38	Classical Feedback Control
Lecture 39	Classical PID Control, Multi-input, Multi-output (MIMO) Control Systems
Lecture 40	Fuzzy Statistical Process Control

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

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7ECU11	DCC	VLSI Design Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Design and simulate all the logic gates with 2 inputs using VHDL/Verilog.
2.	Design and simulate 2-to-4 decoder using VHDL/Verilog.
3.	Design and simulate 3-to-8 encoder using VHDL/Verilog.
4.	Design and simulate 8X1 multiplexer using VHDL/Verilog.
5.	Design and simulate binary to gray converter using VHDL/Verilog.
6.	Design and simulate 4-bit comparator using VHDL/Verilog.
7.	Design and simulate half adder and full adder using VHDL (data flow method)/Verilog.
8.	Design and simulate full adder using VHDL (structural and behavioral method).
9.	Design and simulate D, T and J-K flip flop using VHDL/Verilog.
10.	Design a 4- bit parallel Adder using VHDL/Verilog. Obtain its number of gates, area, and speed and power dissipation.
11.	Design a 2- bit multiplier using VHDL/Verilog. Obtain its number of gates, area, and speed and power dissipation.
12.	Design a 4- bit Serial in-serial out shift register. Obtain its number of gates, area, and speed and power dissipation.
13.	Design a 4 bit binary Asynchronous and synchronous counter. Obtain its number of gates, area, and speed and power dissipation.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
7ECU11	VLSI Design Lab	CO 1	Develop the basic understanding of different HDL languages for the implementation of digital logics.
		CO 2	Understanding the synthesis and analysis of digital system designs using modern software platform.
		CO 3	Identify analysis and design of different combinational circuits using any HDL language.
		CO 4	Identify analysis and design of different sequential circuits using any HDL language.
		CO 5	Development and implementation of different real time digital 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
7ECU11 VLSI Design Lab	CO 1	3				3	2						3
	CO 2	3				3	2						3
	CO 3	2	3	3	1	2							
	CO 4	2	3	3	1	2							
	CO 5	2	3	3	2	2	2			2			3

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

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7ECU12	DCC	Optical Fiber Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	To set up Fiber Optic Analog link.
2.	To set up fiber Optic Digital link.
3.	Measurement of Propagation loss and numerical aperture.
4.	Measurement of optical power attenuation in a plastic optical fiber.
5.	Study and measurement of losses in optical fiber
6.	Study and measure characteristics of fiber optic LED’s and Laser diode
7.	Finding V-number for a glass fiber(Multimode / single mode fiber)
8.	Measurement of coupling and bending losses in Optical fiber
9.	Fiber Dispersion Measurement
10.	OTDR Measurement of Fiber Length, Attenuation and Splice Loss.
11.	Fiber Misalignment Loss Measurement.
12.	Study of Propagation of light and Refractive index profile in optical fibers.

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7ECU13	**DCC**	**Minor Project**	**MM:75**	**0L:0T:2P**	**1 credit**

7ECU14	**DCC**	**Practical Training**	**MM:225**	**0L:0T:4P**	**4 credit**

7ECU20		**DECA**	**MM:50**	**0L:0T:0P**	**1 credit**

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8ECU1.1	DEC	Speech and Audio Processing	MM:150	3L:0T:0P	3 credit

Introduction- Speech production and modeling - Human Auditory System; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid ; Requirements of speech codecs –quality, coding delays, robustness.
Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.
Linear Prediction of Speech- Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.
Speech Quantization- Scalar quantization–uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.
Scalar Quantization of LPC- Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF. Linear Prediction Coding-LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.
Code Excited Linear Prediction-CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zerostate method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP. Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards.

Text/Reference Books:

1.	"Digital Speech" by A.M.Kondoz, Second Edition (Wiley Students_ *Edition), 2004.*
2.	"Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", W.C. Chu, Wiley Inter science, 2003.

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8ECU1.2	DEC	Artificial intelligence	MM:150	3L:0T:0P	3 credit

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

Course Outcome:

Course Code	Course Name	Course Outcome	Details
8ECU1.2	**Artificial Intelligence**	**CO 1**	**Generalise** the basic introduction to Artificial Intelligence. (K5)
		CO 2	**Deduce** the knowledge representation & Logic. (K4)
		CO 3	**Interpret** the knowledge organization in

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			detail. (K3)
		CO 4	**Illustrate** the different knowledge systems of artificial intelligence. (K4)
		CO 5	**Investigate** the study of knowledge acquisition for Learning & processing. (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
8ECU1.2 Artificial Intelligence	**CO 1**	3	2		1								
	CO 2	1	3	2									
	CO 3	3	2	1									
	CO 4	2		3	1								
	CO 5	1			3	2							

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

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Intelligent Agents
Lecture 2	State Space Search
Lecture 3	Uninformed Search
Lecture 4	Informed Search
Lecture 5	Informed Search
Lecture 6	Two Players Games
Lecture 7	Two Players Games
Lecture 8	Constraint Satisfaction Problems
Lecture 9	Constraint 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	Rule based System
Lecture 15	Rule based System
Lecture 16	Semantic Net

Lecture 17	Semantic Net
Lecture 18	Reasoning in Semantic Net Frames
Lecture 19	Reasoning in Semantic Net Frames
Lecture 20	Reasoning in Semantic Net Frames
Lecture 21	Planning
Lecture 22	Planning
Lecture 23	Planning
Lecture 24	Programmable parallel ports.
Lecture 25	Programmable parallel ports.
Lecture 26	Interfacing microprocessor to keyboard and alphanumeric displays.
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	Introduction to Learning
Lecture 34	Introduction to Learning
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 Natural Language Processing
Lecture 40	Probabilistic Learning Natural Language Processing

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

8ECU2.1	DEC	Adaptive Signal Processing	MM:150	3L:0T:0P	3 credit

General concept of adaptive filtering and estimation, applications and motivation, Review of probability, random variables and stationary random processes, Correlation structures, properties of correlation matrices.
Optimal FIR (Wiener) filter, Method of steepest descent, extension to complex valued The LMS algorithm (real, complex), convergence analysis, weight error correlation matrix, excess mean square error and mis-adjustment Variants of the LMS algorithm: the sign LMS family, normalized LMS algorithm, block LMS and FFT based realization, frequency domain adaptive filters, Sub-band adaptive filtering.
Signal space concepts - introduction to finite dimensional vector space theory, subspace, basis, dimension, linear operators, rank and nullity, inner product space, orthogonality, Gram-Schmidt orthogonalization, concepts of orthogonal projection, orthogonal decomposition of vector spaces.
Vector space of random variables, correlation as inner product, forward and backward projections, Stochastic lattice filters, recursive updating of forward and backward prediction errors, relationship with AR modeling, joint process estimator, gradient adaptive lattice.
Introduction to recursive least squares (RLS), vector space formulation of RLS estimation, pseudo-inverse of a matrix, time updating of inner products, development of RLS lattice filters, RLS transversal adaptive filters. Advanced topics: affine projection and subspace based adaptive filters, partial update algorithms, QR decomposition and systolic array.

Text/Reference Books:

1.	S. Haykin, Adaptive filter theory, Prentice Hall, 1986.
2.	C.Widrow and S.D. Stearns, Adaptive signal processing, Prentice Hall, 1984.

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8ECU2.2	**DEC**	**Wavelets**	**MM:150**	**3L:0T:0P**	**3 credit**

Introduction to time frequency analysis; the how, what and why about wavelets, Short-time Fourier transform, Wigner-Ville transform.; Continuous time wavelet transform, Discrete wavelet transform, tiling of the time-frequency plane and wave packet analysis, Construction of wavelets.
Multiresolution analysis. Introduction to frames and biorthogonal wavelets, Multirate signal processing and filter bank theory, Application of wavelet theory to signal de-noising, image and video compression, multi-tone digital communication, transient detection.

Text / Reference Books:

1.	Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993.
2.	I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
3.	C. K. Chui, An Introduction to Wavelets, Academic Press Inc., New York, 1992.
4.	Gerald Kaiser, A Friendly Guide to Wavelets, Birkhauser, New York, 1995.
5.	P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, New Jersey, 1993.
6.	A.N. Akansu and R.A. Haddad, Multiresolutionsignal Decomposition: Transforms, Subbands and Wavelets, Academic Press, OranId, Florida, 1992.
7.	B. Boashash, Time-Frequency signal analysis, In S.Haykin, (editor), Advanced Spectral Analysis, pages 418--517. Prentice Hall, New Jersey, 1991.

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8ECU3.1	DEC	Wireless Sensor Networks	MM:150	3L:0T:0P	3 credit

Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks.
Issues and challenges in wireless sensor networks Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee, Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.
Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication.
Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC.

Text/Reference Books:

1.	Waltenegus Dargie , Christian Poellabauer, “Fundamentals Of Wireless Sensor Networks Theory And Practice”, By John Wiley & Sons Publications, 2011.
2.	Sabrie Soloman, “Sensors Handbook" by McGraw Hill publication. 2009.
3.	Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks”, Elsevier Publications,2004.
4.	Kazem Sohrby, Daniel Minoli, “Wireless Sensor Networks”: Technology, Protocols and Applications, Wiley-Inter science.
5.	Philip Levis, And David Gay "TinyOS Programming” by Cambridge University Press 2009.

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8ECU3.2	DEC	Scientific Computing	MM:150	3L:0T:0P	3 credit

Introduction: Sources of Approximations, Data Error and Computational, Truncation Error and Rounding Error, Absolute Error and Relative Error, Sensitivity and Conditioning, Backward Error Analysis, Stability and Accuracy.
Computer Arithmetic: Floating Point Numbers, Normalization, Properties of Floating Point System, Rounding, Machine Precision, Subnormal and Gradual Underflow, Exceptional Values, Floating-Point Arithmetic, Cancellation.
System of liner equations: Linear Systems, Solving Linear Systems, Gaussian elimination, Pivoting, Gauss-Jordan, Norms and Condition Numbers, Symmetric Positive Definite Systems and Indefinite System, Iterative Methods for Linear Systems Linear least squares: Data Fitting, Linear Least Squares, Normal Equations Method, Orthogonalization Methods, QR factorization, Gram-Schmidt Orthogonalization, Rank Deficiency, and Column Pivoting Eigenvalues and singular values: Eigen values and Eigenvectors, Methods for Computing All Eigen values, Jacobi Method, Methods for Computing Selected Eigen values, Singular Values Decomposition, Application of SVD
Nonlinear equations: Fixed Point Iteration, Newton's Method, Inverse Interpolation Method Optimization: One-Dimensional Optimization, Multidimensional Unconstrained Optimization, Nonlinear Least Squares Interpolation: Purpose for Interpolation, Choice of Interpolating, Function, Polynomial Interpolation, Piecewise Polynomial Interpolation Numerical Integration And Differentiation: Quadrature Rule, Newton-Cotes Rule, Gaussian Quadrature Rule, Finite Difference Approximation.
Initial Value Problems for ODES, Euler's Method, Taylor Series Method, Runga-Kutta Method, Extrapolation Methods, Boundary Value Problems For ODES, Finite Difference Methods, Finite Element Method, Eigen value Problems Partial Differential Equations, Time Dependent Problems, Time Independent Problems, Solution for Sparse Linear Systems, Iterative Methods, Fast Fourier Transform, FFT Algorithm, Limitations, DFT, Fast polynomial Multiplication, Wavelets, Random Numbers And Simulation, Stochastic Simulation, Random Number Generators, Quasi-Random Sequences.

Text/ Reference Books:

1.	Heath Michael T., "Scientific Computing: An Introductory Survey" , McGraw-Hill, 2nd Ed., 2002.
2.	Press William H., Saul A. Teukolsky, Vetterling William T and Brian P. Flannery, "Numerical Recipes: The Art of Scientific Computing",

	Cambridge University Press, 3rd Ed., 2007
3.	Xin-she Yang (Ed.)., “Introduction To Computational Mathematics”, World Scientific Publishing Co., 2nd Ed., 2008.
4.	Kiryanov D. and Kiryanova E., “Computational Science”, Infinity Science Press, 1st Ed., 2006
5.	Quarteroni, Alfio, Saleri, Fausto, Gervasio and Paola, “Scientific Computing With MATLAB And Octave”, Springer, 3rd Ed., 2010

8ECU13	**DCC**	**Seminar**	**MM:225**	**0L:0T:4P**	**4 credit**

8ECU14	**DCC**	**Project**	**MM:525**	**3L:0T:18P**	**12 credit**

8ECU20		**DECA**	**MM:50**	**0L:0T:0P**	**1 credit**

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