Sardar Patel Institute of Technology
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Sem-V

Sardar Patel Institute of Technology

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Analog and Digital Communication	3	0	2	5	10	3	0	1	4
		Examination Scheme								
EC301		Component	ISE (%)		MSE (%)		ESE (%)			Total
		Theory	20		20		60			100
		Laboratory	70		--		30			100

Pre-requisite Course Codes, if any.	Electronic devices, Probability and random process and Signals and Systems

Course Objective: The objective is to equip the students with basic knowledge for analyzing analog and digital communication systems ranging from data networks and internet to mobile data communication systems such as cellular and WiFi systems. Specifically, the students will learn how to manage communication system resources including bandwidth and power by selecting a proper signaling and/or analog/pulse/digital modulation scheme

Course Outcomes (CO): ***At the End of the course students will be able to***

CO.1	Describe various entities of analog/pulse/ digital communication system
CO.2	Apply mathematical concepts and compute performance parameters of various analog/pulse/digital modulation schemes
CO.3	Analyze system performance of various analog/pulsed/digital modulation methods in time domain/ frequency domain/ signal space
CO.4	Analyze the behavior of a various analog/pulse/digital modulation schemes with and without noise
CO.5	Compare various modulation/demodulation techniques
CO.6	Examine various wired and wireless applications and further infer health/ safety/environment aspects of wired and wireless systems

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	**3**				-				-	-		
CO.2	**2**	**2**			3				3	3		
CO.3	**2**	**2**			3				3	3		1
CO.4	**3**	**3**			**3**				**3**	**3**		**1**
CO.5	**2**	**2**			**3**				**3**	**3**		
CO.6	**1**	**1**				**1**	**1**	**1**	**3**	**3**		**3**
overall strength	**3**	**3**			**3**	**1**	**1**	**1**	**2**	**2**		**2**

Mapping of CO with PO:(correlation/ strength matrix)

Correlation Levels : 1(weak) 2(medium) 3(strong)

It is decided on based on depth of the teaching -learning required and questions he/she plans to ask in exams in the various assessment modes during a semester.

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
CO.1	**2**	**2**				
CO.2	**2**	**2**		**2**	**1**	
CO.3	**2**	**2**		**2**	**1**	
CO.4	**2**	**2**		**2**	**1**	
CO.5	**2**	**2**				
CO.6	**1**	**1**				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Continuous-Wave Modulation**	1	**08**
2	**1.1**	Review of signals and systems, Frequency domain representation of signals,classification of Frequency spectrum,Need for modulation,Block diagram of an analog and digital communication system.		
	1.2	Amplitude modulation,Linear modulation schemes, Frequency translation,FDM		
	1.3	Frequency modulation,Spectral characteristics of angle modulated signals,Generation of FM signals:Indirect method, FM demodulation: Frequency discriminator		
	1.4	Super heterodyne receiver		
2	**Title**	**Pulse Modulation**	1	**06**

	2.1	Sampling process. Pulse Amplitude modulation,SNR, Noise BW trade off		
	2.2	Pulse code modulation (PCM),Differential pulse code modulation.		
	2.2	Delta modulation, Noise considerations in PCM,Time Division multiplexing, Digital Multiplexers		
3		**Source Coding and Error correction coding**	1	**08**
	3.1	Uncertainty, Information, Entropy, Source coding theorem, Huffmann encoding, Shannon Fano coding		
	3.2	Discrete memory less channels, Channel capacity Theorem, Linear block codes , Convolutional codes (Shift Register approach and Code tree)		
4	**Title**	**Baseband Pulse Transmission**	1,2	**8**
	4.1	Based band receiver, Probability of error of integrate and dump receiver, Matched filter , optimum filter		
	4.2	Line coding and Power spectral density (PSD) of line codes, Inter symbol Interference and Nyquist criterion, Raised cosine filter,		
	4.3	Duobinary encoding, Introduction to linear and adaptive equalization		
5	**Title**	**Pass band Digital Modulation schemes**	1,2	**12**
	5.1	BPSK,DPSK,QPSK,M-aryPSK,QAM,BFSK,M-ary FSK,MSK-Principle of working, PSD and Signal space analysis		
	5.2	Digital Modulation tradeoffs, Probability of Error evaluations of various modulations.(derivation not expected)		
	5.3	Synchronization and Carrier Recovery for Digital modulation.		
6	**Self Study**	**a.Case study (any one)** **b. Research article (any one)**		**06**
			Total	**42+06**

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Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Simulation and implementation of double sideband full carrier for various modulation index
2	Implement the frequency modulation circuit to obtain FM waveforms and calculate modulation index
3	Analyze effect of pre-emphasis and de-emphasis on FM waveforms
4	Implementation of natural sampling and reconstruction of waveforms
5	Implementation and detection of pulse amplitude modulation.
6	Implementation of Binary Phase Shift Keying
7	Implementation of Binary Frequency shift keying
8	Duo binary Encoder
9	Simulation of digital modulation scheme and analysis of Power spectral density
10	Simulation and analysis of signal space of various modulations in presence of noise
11	Signal transmission through Raised cosine filter and eye pattern analysis
12	Simulation of OFDM
13	Mini project in analog/pulse/digital modulation methods

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Communications Systems	**4th**	Haykin S	John Wiley and Sons	**2001**
2	Principles of Communication Systems	**2nd**	Taub H. and Schilling D.L	Tata McGraw Hill	2001

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Communication.	**3rd**	Haykin S	John Wiley and Sons	2001
2.	Communication Systems Engineering	**4th**	Proakis J. G. and Salehi M.	Pearson Education	2002.
3.	Digital and Analog Communication	**4th**	B.P.Lathi	Oxford	2017

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Control Systems	3	0	2	6	11	3	0	1	4
		Examination Scheme								
EC302		Component	ISE (%)		MSE (%)		ESE (%)			Total
		Theory	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes, if any.	MA101: Engineering Calculus MA102: Differential Equations and Complex Analysis EC 101: Digital Systems and Microprocessors EC 203: Probability and Stochastic Processes EC 204: Electronic Instruments and Measurement Lab
Course Objectives: To develop a system for real life application by applying the concepts of control system theory and allied techniques for system performance evaluation.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC302.1	Classify different types of control systems, component of control system and formulate mathematical modeling of the given system.
EC302.2	Apply various methods for representation of the given control system.
EC302.3	Analyze the transient and steady state behavior of given system for standard test inputs.
EC302.4	Analyze the stability of systems in time domain and frequency domain.
EC302.5	Discuss the concept of controllability and observability using state variable model.
EC302.6	Evaluate the system performance with the use of compensators & controllers.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC302.1	3				2			3	3	2	2	2
EC302.2		3			2			3	3	2	2	2
EC302.3		3			2			3	3	2	2	2
EC302.4		3			2			3	3	2	2	2
EC302.5		3			2			3	3	2	2	2
EC302.6	3				2	2		3	3	2	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC302.1	1	1	2		-	
EC302.2	1	1	2		-	
EC302.3	1	1	2		2	
EC302.4	1	1	2		2	
EC302.5	1	1	2		2	
EC302.6	1	1	2		2	

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate✓	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to control system and system Modeling**		
	1.1	**Introduction to control system:** Definition of system, Notion of feedback, Open loop and closed loop systems; feedback and feed forward control structure; Examples of control systems.	1,2	10
	1.2	**Dynamic Response:** Standard test signals; Transient and steady state behavior of first and second order systems; Generalized error coefficients, steady state errors in feedback control systems and their types.	1,2	
	1.3	**Control System Modeling:** Types of model's Impulse response model, State variable model, Transfer function model, Modeling of electrical systems and translational mechanical systems.	1,2	
2	Title	**Representation of Control System and State Space Analysis**		10
	2.1	Block diagram representation of systems, Block diagram reduction methods, closed loop transfer function, signal flow graph. Mason's gain rule	1,2	
	2.2	**State Space Analysis:** Concepts of state space, State equations, State transition matrix, properties of state transition matrix, Solution of homogeneous systems.	1,2	
	2.3	**Controllability and Observability:** Concept of controllability, Controllability analysis of LTI systems, Concept of observability, Observability analysis of LTI systems using Kalman approach.	3,4	
3	Title	**Time Domain System Stability Analysis**		8
	3.1	Concepts of Stability Concept of absolute, relative and robust stability	1,2	
	3.2	Routh-Hurwitz stability criteria	1,2	
	3.3	**Root Locus Analysis:** Root-locus concepts; General rules for constructing root-locus, Root-locus analysis of control systems.	1,2	
4	Title	**Frequency Domain System Stability Analysis**		8
	4.1	Relation between time and frequency response	1,2	
	4.2	**Bode Plot:** Magnitude and phase plot, Method of plotting Bode plot; Stability analysis by using Gain and phase margins on the Bode plots	1,2	
	4.3	Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	1,2	
5	Title	**Compensators & Controllers**		6

	5.1	Types of compensators, Realization of basic compensators – cascade compensation in time domain and frequency domain.	1,2	
	5.2	**Controllers**: Concept of ON/OFF controllers; Concept of P, PI, PD and PID Controllers.	1,2	
	5.3	**Advanced Control Systems:** Introduction to Robust Control, Adaptive control and Model predictive control, Neuro- fuzzy controllers.	3,4	
6	**Self-Study**	Examples on open loop and closed loop control system, Modeling of rotational mechanical systems, Pole placement using state feedback Popov–Belevitch–Hautus (PBH) test in state space, Design of lag, lead and lag-lead compensator using Bode plot and Root locus techniques, Design of real-life applications of control system.	1,2,3, 4,5	
			Total	**42**

Laboratory Component:

Exp. No.	**Experiment Details**	**Marks CO**
1	To obtain the characteristics of control system components: i. To plot the Synchro transmitter characteristics and Synchro transmitter and receiver as an error detector. ii. To plot characteristics of Potentiometer and its loading effect for different conditions of load.	05 CO1
2	To demonstrate the working of real-life feedback control system and obtain their characteristics: i. To plot Speed torque characteristic of DC servo motor. ii. To determine the line and load regulation characteristics of AC servo voltage stabilizer at different line and load conditions and observe the mechanism of AC voltage stabilization as an example of closed control system.	05 CO1
3	To develop a program in Matlab/Scilab/LabVIEW: i. To define the given closed loop transfer function of system and plot their poles & zeros on s-plane. ii. To reduce the given control system block diagram or signal flow graph.	05 CO2
4	To develop a program in Matlab/Scilab/LabVIEW: i. To obtain the step response of a given first/second order control system and obtain its time domain parameters from this step response. Compare these results with mathematical calculations. ii. To determine step response for a Type 0, Type 1, Type 2 systems and find error coefficients. iii. To find solution for a given control system described by its state space equation in terms of state transition matrix, zero input response, zero state response, complete response.	10 CO3
5	Develop a program in Matlab/Scilab/LabVIEW: i. To obtain the root locus of a system described by its Transfer Function with	10 CO4

	unity feedback, Comment on the stability of this given control system. Compare these results with mathematical calculations. ii. To find gain margin and phase margin of the system described by its Transfer Function with unity feedback using Bode/Nyquist plot. Comment on the stability of this given control system. Compare these results with mathematical calculations.	
6	Develop a program in Matlab/Scilab/LabVIEW: i. To find whether a given control system described by its state space equation is controllable or not, observable or not, to find rank of matrix and using rank comment on system controllability and observability. ii. To design a controller and observer via state space.	10 CO5
7	Evaluate the effect of Compensator/PID controller on performance of the control system.	5 CO6

ISE Evaluation: CO1-CO6

Mini-Project: Identify the model of control system for real life application and demonstrate controlling action for the same.

This is group activity. Students will form a group of minimum 3 students. Students will develop the block diagram of the system first, then design each block using appropriate components. Simulate the complete block diagram using any tool like Matlab, Scilab or LabVIEW. The duration of this activity is a complete semester, but evaluation will be done in phases and rubrics designed. In the first phase students will develop the block diagram for the given problem statement. In the second phase students will develop the block diagram and simulate each of the block diagrams and test it for input-output relationship. In the third phase students will interface all the designed blocks to obtain final input-output relationship of the system. Hardware implementation is optional.

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Control Systems Engineering	Fifth	I. J. Nagrath, M. Gopal	New Age International	2012
2	Modern Control Engineering	Fifth	Ogata. K	Prentice Hall of India	2010

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Control Systems: Principle and design	First	M. Gopal	Tata McGraw Hill	1998
2	Modern Control System	Eleventh	Richard C. Dorf and Robert H. Bishop	Pearson	2013
3	Control Systems Engineering	Sixth	Norman Nise	John Wiley & Sons	2011
4	Linear Control System	First	Constantine H.	Mcgraw-Hill	1975

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	Analysis and Design: Conventional and Modern		Houpis and John J. D'Azzo		

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Digital Signal Processing	3	0	2	5	10	3	0	1	4
EC303		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
		Theory	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes, if any.	EC207: Signals and Systems
Course Objective: To develop mathematical foundation of system and design digital filters	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC303.1	Classify and perform various operations on signals and systems.
EC303.2	Apply DFT properties and illustrate FFT algorithms.
EC303.3	Apply Z Transform on discrete time signals.
EC303.4	Analyze LTI System using Z Transform.
EC303.5	Design and Realize Digital filters.
EC303.6	Analyze Multirate Signal Processing.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC303.1	3	1	2		2							
EC303.2	1	1	2		2							
EC303.3	1	1	2		2							
EC303.4	1	1	2		2							
EC303.5	1	1	2		2							
EC303.6	1	1	2		2							**2**

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC303.1		2				2	
EC303.2		2				2	
EC303.3		2				2	
EC303.4		2				2	
EC303.5		2				2	
EC303.6		1				2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

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Remember	Understand	✓ Apply	✓ Analyze	✓ Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Overview of Discrete Time Signals**	6,7,8	**08**
	1.1	Sampling of Continuous Time Signal, Standard Discrete Time Signals: Impulse Signal, Unit Step, Unit Ramp, Sinusoidal, Exponential.		
	1.2	**Classification of Signals:** Deterministic and non-deterministic, Periodic and a periodic, Symmetric (even) and Asymmetric (odd), Energy and Power, Causal and Anti-causal signals.		
	1.3	**Operations of Signals:** Shifting, Scaling, Time Reversal, Addition and Multiplication, Convolution (Linear and Circular), Correlation		
2	Title	**Discrete Fourier Transform (DFT)**	1, 3	**12**
	2.1	Discrete Time Fourier transform (DTFT), Discrete Fourier Transform (DFT), Properties of DFT, Inverse DFT.		
	2.2	**Fast Fourier Transform:** Radix-2 Decimation in Time Fast Fourier Transform (DIT-FFT) and Decimation in Frequency Fast Fourier Transform (DIF-FFT) algorithms, Real and Complex Calculations using FFT, Linear and Circular Convolution using FFT,		
	2.3	Filtering of long data sequence, Overlap Add Method, Overlap Save Method		
3	Title	**Z-Transform**	6,7	**04**
	3.1	Z-Transform of discrete time signals, Properties of Z-Transform, Relation between Z-Transform and DTFT,		
	3.2	Inverse Z-Transform, Long division Method, Partial Fraction Expansion Method		
4	Title	**Linear Time Invariant (LTI) Systems**	1,4	**08**
	4.1	**Classification of systems:** Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non-causal, stable and unstable systems.		
	4.2	Impulse Response, Transfer Function, Differential Equation, Stability of Systems, Frequency Response, Solution of Differential Equation using Z-Transform		
	4.3	LTI systems as frequency-selective filters like; Low pass, High pass, Band pass, Invertibility of LTI systems, Minimum-phase, Maximum-phase, Mixed-phase systems		
5	Title	**Design of Digital filters and Implementation**	1,2	**10**
	5.1	Design of Infinite Impulse Response (IIR) filters using Impulse Invariant Method and Bilinear Transformation Method, Butterworth and Chebyshev Type I filter design.		

	5.2	Concepts of Finite Impulse Response (FIR) filter, symmetric and anti-symmetric FIR filter, FIR filter design using Window method and Frequency sampling method.		
	5.3	Realization structures for IIR and FIR filters using direct Form Realization, cascade, parallel structures; Linear Phase Realization, Frequency Sampling Realization.		
6	**Self-Study**	**1.Multirate Signal Processing:** Down-sampling and Up-sampling by integer factors; Decimator and Interpolator, Sampling rate conversion by non-integer factor. 2. **Application of Filter**: Sub-band filters.	1,5	***5**
			Total	**42+*5**

Laboratory Component

Sr. No	Title of the Experiment
1	Discrete Convolution and Correlation
2	Discrete Fourier Transform
3	Fast Fourier Transform
4	Linear Filtering using Overlap Add Method/ Overlap Save Method.
5	Design of Butterworth IIR Filter using Impulse invariant method
6	Design of Butterworth IIR Filter using Bilinear Transformation method
7	Linear phase FIR Filter design using Windowing method
8	Linear phase FIR Filter design using Frequency sampling method
9	Multirate Signal Processing
10	Mini Project on real Time DTSP application

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processing: Principles, Algorithms and Applications	Fourth	J. Proakis, D. G. Manolakis, and D. Sharma	Pearson Education	**2014**
2	Digital Signal Processing	Fourth	Ramesh Babu	Scitech	2014
3	Digital Signal Processing	-	S.Salivahanan, A Vallavaraj, C Gnanapriya	Tata McGraw Hill	2010

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Signals and Systems	Second	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab	Pearson	2002
2	Signals and Systems	Third	Simon Haykin and Barry Van Veen	John Wiley & Sons	2002
3	Theory and Applications of Digital Signal Processing	Second	L. R. Rabiner and B. Gold	Prentice-Hall	2006
4	Multirate Systems and Filter Banks	First	P.P. Vaidyanathan,	Pearson	1992

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Electromagnetic Engineering	3	0	2	6	11	3	0	1	4
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
EC304		Theory	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes, if any.	MA101: Engineering Calculus MA102: Differential Equations and Complex Analysis MA201: Linear Algebra
Course Objective: To teach fundamentals of Electromagnetic Waves	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC304.1	Apply basic laws of electromagnetic and Maxwell's equations.
EC304.2	Illustrate the behavior of EM waves and travelling of waves in free space as well as media.
EC304.3	Solve problems related to the propagation of electromagnetic waves.
EC304.4	Discuss the types of antennas and their parameters.
EC304.5	Discuss types of radio wave propagation.
EC304.6	Design applications using Electromagnetic Waves theory.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC304.1	1	1	2		2					3		
EC304.2	1	1	2		2							
EC304.3	1	1	2		2					3		
EC304.4	1	1	3		2					1		
EC304.5	1	1	2		2							
EC304.6	1	1	3		2					2		3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC304.1		2			2	
EC304.2		2			2	
EC304.3		2			2	
EC304.4		2			2	
EC304.5		2			2	
EC304.6		1			1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Coordinate system transformation and vector calculus**		3
	1.1	Cartesian, cylindrical and spherical coordinate, Differential length, area and volume, line surface and volume integrals.	2	
	1.2	Del Operator, Gradient of scalar, Divergence of a vector and Divergence Theorem, Curl of a Vector and Stoke's Theorem, Laplacian Theorem, Classification of a Vector Field.		
2	Title	**Basic Laws of Electromagnetic and Maxwells Equations**	1	9
	2.1	Coulombs law, Electric fields due to continuous charge distributions, Gauss law and its applications, Electric potential (Magnetic vector potential and Electrical Scalar Potential), relationship between E and V, Poisson and Laplace equations, Bio-Savarts law, Amperes law.		
	2.2	Boundary conditions for static electric and magnetic fields		
	2.3	Faradays Law, Displacement current, Maxwells Equations: Integral and differential form for static and time varying fields and its interpretation		
3	Title	**Electromagnetic Wave Propagation**	1,2	9
	3.1	Wave equation: Derivation and its solution in Cartesian co-ordinates.		
	3.2	Solution of wave equations: Partially conducting media, perfect dielectrics and good conductors, Concept of Skin Depth.		
	3.3	Electromagnetic Power: Poynting Vector and power flow in free space and in dielectric, conducting media.		
	3.4	Polarization of wave: Linear, Circular and Elliptical.		
	3.5	Propagation in different media: Behavior of waves for normal and oblique incidence in dielectrics and conducting media.		
4	Title	**Waveguide**	1,2	6
	4.1	Wave propagation in parallel plane waveguide (No derivation expected), Analysis of waveguide general approach (No derivation expected), in waveguide.		
	4.2	Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation.		
5	Title	**Transmission Lines**	1,2	9
	5.1	Power frequency lines: Representation, losses and efficiency in power lines, effect of length, calculation of inductance and capacitance.		
		Radio frequency lines: Representation, propagation constant, attenuation constant, phase constant, group velocity, input impedance, characteristic impedance, trade-off between attenuation and power transfer, reflection coefficient, standing wave ratio, VSWR, ISWR, ABCD parameters of transmission line.		

	5.2	Smith Chart: Impedance locus diagram, impedance matching.		
6	**Title**	**Applications of Electromagnetics**	2,3	6
	Self-Study	Xerography. Laser printer, Faraday's cage, lightning, RF MEMS, Magnetic levitation, Metamaterials, RFID, Stealth aircraft, remote sensing, radio astronomy, EMI and Electromagnetic Compatibility, Different types of antennas.	1,2,6	06
Total				**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	**Basic operations on scalar and vectors** Working with Numbers: Scalars and Vectors using any simulation platform or Python. Working with Complex Numbers using any simulation platform or Python. Working with Matrices using any simulation platform or Python.
2	**Curl and Divergence** Numerical Computation of Divergence and Curl. Numerical Computation of Divergence and Curl for a Current Carrying Wire.
3	Write a program that displays the distribution of the electric potential due to an electric dipole with a moment located at the origin of a spherical coordinate system.
4	Numerical Integration and Calculating the Electric Field from a Ring of Charge.
5	3-D and 2-D radiation patterns of a Hertzian dipole using MATLAB/Python.
6	**Antenna parameters** Visualization of a wireless system with two antennas. Radiation patterns of a small loop antenna. Radiation patterns of a quarter-wave monopole.
7	**Waveguide:** Verify the relationship between wavelength of an EM wave in air and inside a rectangular waveguide.
8	Simulating the Two-ray Propagation Model in any simulation platform or Python.
9	**Using Virtual Lab: Introduction** to Smith chart and its application for the unknown impedance measurement using virtual lab IIT K
10	Measurement of Frequency and wavelength of a waveguide using Microwave bench setup.
11	**Using Virtual Lab: Study** of field pattern of various modes inside a rectangular waveguide using virtual lab IIT K
12	**Case Study-** The student is required to develop a simple tool to carry out unit conversions that are associated with EM-related calculations.

Text Books :

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Electromagnetic Waves	Third	R.K. Shevgaonkar	Tata McGraw Hill	2009
2	Principles of Electromagnetics	Sixth	Matthew N.O. Sadiku	Oxford International Student	2015

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Engineering Electromagnetics	Third	W.H. Hayt, and J.A. Buck	McGrawHill	2006
2	Electromagnetic Waves and Radiating Systems	Second	Edward C. Jordan and Keth G. Balmin	Pearson Publications	2006
3	Engineering Electromagnetics	Third	Nathan Ida	Springer Publications	2015
4	Antennas & Wave Propagation	Fourth	J.D. Kraus, R.J. Marhefka, and A.S. Khan	McGrawHill	2011

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SBC)	Java Programming Lab	0	1	2	1	4	0	1	1	2
		Examination Scheme								
		Component		ISE (%)		MSE (%)		ESE (%)		Total
EC305A		Theory		--		--		--		--
		Laboratory		50		--		50		100

Pre-requisite Course Codes, if any.	CS101: Problem Solving using Imperative Programming CS102: Problem Solving using OOPs
Course Objective: To learn Object-Oriented programming paradigm using Java programming language**.**	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC305.1	Demonstrate programming using basic constructs of JAVA.
EC305.2	Apply Inheritance and polymorphism for a given scenario.
EC305.3	Apply abstraction and exception handling to create an efficient program.
EC305.4	Use Generic classes and collection for solving problem.
EC305.5	Develop a mini project based on the real-world problem.

Note:

*= Tutorial-50 marks and Mini Project-50 marks (Preferably based on real-world problem statement from Industry/Academia/Research)

#= oral exam-20 marks and Lab experiment-30 marks

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC305.1	3				2							2
EC305.2	2				2							2
EC305.3	2				2							2
EC305.4	2				2							2
EC305.5	2	1	1	1	2	1			2	2		2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC305.1		2		2		
EC305.2		2		2		
EC305.3		2		2		
EC305.4		2		2		
EC305.5		2		2		

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create✓

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to JAVA**	1,2,3	3
	1.1	Fundamentals of Java Programming: Classes, JDK, JRE, JVM, Unicode system, I/O using Scanner class and Buffered Reader class.		
	1.2	Instance variables, Methods, Constructors.		
	1.3	Object class, Nested class, Access Specifiers, Abstract Classes and Wrapper Classes.		
2	Title	**OOP Concepts Mapping to JAVA**	1,2,3	4
	2.1	Inheritance (IS – A), Aggregation & Composition (Has – A) Method overloading & overriding, this, super, final keyword, Static.		
	2.2	Autoboxing and Unboxing, Polymorphism.		
	2.3	Packages and Interfaces: Package concept, creating user defined package, Access control protection, Interface.		
3	Title	**Exception Handling and Multithreading**	1,2,3	4
	3.1	Try and catch block, Multiple catch block, Nested try, finally block, Throw, Throws keywords, Exception propagation, Custom exception.		
	3.2	Create thread using Thread and Runnable class. Thread methods, schedule, sleep, join, Thread priority, Thread group, perform multiple tasks using multiple thread Thread synchronization.		
4	Title	**Generics and Collection**	1,2,3	3
	4.1	Creating Generic Classes, Generic Methods, Bounded Type		
	4.2	Collection's framework, methods of collection interface (Array list, Linked list, Queue etc.)		
			Total	**14**

Laboratory Component, if any.

Sr. No	Title of the Experiment
1	Program on I/O using command line arguments, scanner class, Buffered Reader etc.
2	Program on Constructor, types of constructors and constructor overloading.
3	Program on Polymorphism, Runtime polymorphism.
4	Program on Inheritance, Abstract Class, Interface.
5	Program on Nested Class, Aggregation, Composition.

6	Program on Multithreading.
7	Program on Exception Handling. (built in and User defined)
8	Program on Package and access modifiers.
9	Program on Generics
10	Program on Collection

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Java Programming From the Group Up	First	Ralph Bravaco, Shai Simoson	Tata McGraw-Hill	2009
2	Java The Complete Reference	Eleventh	Herbert Schildt	Tata McGraw-Hill	2019

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	An introduction to Programming and Object Oriented Design using Java	Third	Jaime Nino, Frederick A. Hosch	Wiley Student Edition	2008
2	Java Programming A Practical Approach	First	C Xavier	Tata McGraw-Hill	2011
3	Java™ Programming Language	Fourth	Ken Arnold, James Gosling, David Holmes	The (Java Series) by Sun	2005

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SBC	Internet of Things Laboratory	--	1	2	2	5	--	1	1	2
		Examination Scheme								
		Component	ISE%		MSE%		ESE%		Total	
EC305B		Theory	--		--		--		--	
		Laboratory	75		--		25		100	

Pre-requisite Course Codes, if any.	EC101: Digital Systems and Microprocessors EC201: Computer Architecture and Organization EC206: Microcontrollers
Course Objective: This course provides an introduction to the fundamental concepts, technologies, data communication protocols, data analytics, security and applications of the Internet of Things (IoT).	
Course Outcomes (CO): After successful completion of the course, student will be able to	
EC305B.1	Identify the key challenges and opportunities in IoT development and deployment.
EC305B.2	Acquire real world signals and perform remote process monitoring utilizing the concept of IoT
EC305B.3	Apply appropriate communication protocols for IoT devices.
EC305B.4	Evaluate security risks and apply relevant measures to protect IoT systems

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC305B.1	2	2	2									
EC305B.2	2	2	2	2								
EC305B.3	2	2	2	2								
EC305B.4	2	2	2	2								

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PSO1	PSO2
EC305B.1	1	1	1		

EC305B.2	**1**	**1**	**1**		
EC305B.3	**1**	**1**	**1**		
EC305B.4	**1**	**1**	**1**		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✔	**Understand** ✔	**Apply** ✔	**Analyze** ✔	**Evaluate**	**Create**

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	**Title**	**Fundamentals of IOT Systems:**		**04**
	1.3	Evolution of Internet of Things, Enabling Technologies, IoT Architectures: M2M, IoT configurations, IoT architecture and components, Gateways, Fog computing, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects	1,2	
2		**Functionality based IoT Protocol Organization:**		**07**
	2.1	Connectivity (6LoWPAN), Communication/ Transport: WiFi, Bluetooth, Zigbee, Z-wave, Data Protocols: MQTT, CoAP, Websocket, Node. Device Management: JSON-LD, Web Thing Model, Multilayer Framework.	3	
3	**Title**	**Security, trust, and privacy issues in IoT**		**03**
	3.1	IoT security challenges and vulnerabilities, Authentication and access control in IoT, Distributed Denial of service (DDoS), Privacy considerations and regulation	3	
		Self study on Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries,IOT application in Home automation, Agriculture, Healthcare.	1,2	
			Total	**14**

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year

1	Internet of Things: Architecture and Design Principles	First edition	Raj Kamal	McGraw Hill Education	2017
2	Internet of Things, "A Hands on Approach		Vijay Madisetti, ArshdeepBahga	UniversityPress	,2015.
3	The Internet of Things : Enabling Technologies, Platforms and Use Cases	-	Pethuru Raj and Anupama C. Raman	CRC Press	2017

Suggested List of Laboratory Experiments:

1. Getting started with IoT development board in the IDE and GPIO Interfacing and programming
2. IoT Sensor Integration: Design and implement a small-scale IoT system that includes sensors such as temperature, humidity, and light sensors. Collect data from these sensors and transmit it wirelessly to a central hub or cloud platform for analysis and visualization.
3. Communication Protocols:
   - Implement a simple IoT system using different communication protocols (e.g., MQTT, CoAP).
   - Set up a broker or server to handle the communication between IoT devices.
   - Develop programs on IoT devices to publish and subscribe to sensor data using the chosen protocol.
4. Controlling devices remotely using Bluetooth link, WiFi link
5. IoT Data Analytics:
   - Collect real-time sensor data from IoT devices or use publicly available IoT datasets.
   - Perform data preprocessing, cleaning, and transformation.
   - Apply data analytics techniques such as clustering or regression to extract insights from the IoT data.
6. IoT Security and Privacy:
   - Explore security vulnerabilities in an IoT system.
   - Implement security measures such as encryption, authentication, and access control.
   - Conduct penetration testing to identify and address potential security risks.
7. IoT Application Development:
   - Choose an IoT application domain (e.g., smart home, healthcare, agriculture).
   - Develop a prototype application using appropriate hardware components, sensors, and actuators.
   - Integrate the application with cloud services or a mobile app for remote monitoring and control.
8. Development of Android applications suitable for IoT
9. Implementing certificate keys to make your application secure on the cloud
10. Developing Voice App for IoT device

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Sem-VI

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Fundamentals of Antenna	3	0	2	6	11	3	0	1	4
		Examination Scheme								
EC306A		Component	ISE (%)		MSE (%)		ESE(%)			Total
		Theory	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes, if any.	EC304: Electromagnetic Waves
Course Objective: The objective of the course is to provide a fundamental understanding of Antennas	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC306.1	Calculate the fundamental parameters of Antenna.
EC306.2	Describe fundamental theory of antennas.
EC306.3	Select antenna based on applications.
EC306.4	Evaluate antenna based on applications.
EC306.5	Design Antenna Arrays.
EC306.6	Design antenna based on given requirements.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC306.1	2	3						2	2	2		
EC306.2	2	3						2	2	2		
EC306.3		2						2	2	2		
EC306.4		2		2				2	2	2		
EC306.5		2		2				2	2	2		
EC306.6	2	1						2	2	2		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC306.1		2				-	
EC306.2		2				2	
EC306.3		2				2	
EC306.4		2				2	
EC306.5		2				2	
EC306.6		1				1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

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Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1 (CO1)		**Fundamental Concepts:**	1	08
	1.1	Introduction, types of Antennas, Radiation mechanism, Poynting vector, Steradian concept, Power intensity		
	1.2	Antenna Parameter: Radiation pattern, Radiation power density, Radiation Intensity, Gain, Directivity, HPBW, FNBW, Beam efficiency, Bandwidth, Polarization, Input Impedance, Reflection coefficient, Return loss, VSWR, Antenna Efficiency, Effective Aperture, Communication link and Friis transmission equation.		
2 (CO2, CO3)		**Radiation from wires and loops**	1	10
	2.1	Introduction, Infinitesimal dipole: Radiation zones, Total radiated power, Radiation resistance, Directivity, Effective area, Short dipole, Finite-length dipole: Radiated power, Radiation resistance, Directivity, Effective area, Half-wave dipole and its properties, Loop antenna.		
3 (CO3, CO4)		**Aperture Antennas**	1	06
	3.1	Introduction, Field equivalence principle, Love's equivalence principle, Electrical and magnetic conductor equivalence principle, Computation of field quantities of aperture antenna, Relation between wire and aperture antennas, Horn antenna design principle.		
4 (CO5)		**Antenna Arrays**	1	10
	4.1	Introduction, Two-element array, Example problems, Pattern multiplication concept, N-element array, Uniform array, Array factor, Broad-side and end-fire arrays, Phased array, Directivity and pattern characteristic of linear uniform array, non-uniform array, Binomial array, Dolph-Chebyshev array concept, Design principle of Chebyshev array and examples, Planar arrays		
5 (CO6)		**Microstrip Antennas**		
	3.1	Introduction: Rectangular Patch, Circular Patch, Parametric study, Circularly polarized antennas, Axial Ratio, MSA suspended Configuration.	1,4	08
	3.2	MSA Arrays and Feed Networks, Corporate and Series Feeds		
6 (Self Study)		**Advanced Antennas:** Reflector antenna, Dielectric Resonator antenna, Metamaterial based antennas, Wearable antenna, Reconfigurable antennas, Ultra-wideband antennas, Smart Antennas		06
			Total	**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Design a Dipole Antenna using HFSS
2	Design a monopole Antenna using HFSS
3	Design a Horn Antenna using HFSS
4	Design a Helical Antenna using HFSS
5	Design a Microstrip Patch Antenna
6	To calculate and infer various fundamental parameters of antenna like Radiation pattern, Radiation power density, Radiation Intensity, Gain, Directivity, HPBW and FNBW using Scilab.
7	To calculate the power delivered to the Receiver Antenna.
8	To design a Pyramidal Horn Antenna in E-plane and H-plane
9	To show Pattern Multiplication phenomena in an Antenna using two infinitesimal dipoles.
10	To design Array factor pattern of N-element of uniform amplitude of Broadside Array.
11	To design Array factor pattern of N-element of uniform amplitude of End-fire Array
12	To design Array factor pattern of N-element of non-uniform amplitude of Broadside / End-fire Array using Binomial Array method.
13	To design Array factor pattern of N-element of non-uniform amplitude of Broadside /End-fire Array using DolphTschebyscheff Array method.

Text Books:

S. N.	Title	Authors	Edition	Publisher	Year
1	Antenna Theory: Analysis and Design	Constantine A. Balanis	Fourth	Wiley	1982

Reference Books:

S. N.	Title	Authors	Edition	Publisher	Year
1	Antennas & Wave Propagation	J.D. Kraus, R.J. Marhefka, and A.S. Khan	Fourth	McGraw Hill	2011
2	Handbook of Microstrip Antennas	R. James and P.S. Hall	Third	Peter Peregrinus	1989
3	Antennas and Radio Wave Propagation	R. E. Collin	Fourth	McGraw-Hill	1985
4	Broadband Microstrip antennas	Girish Kumar and K.P. Ray	First	Artech House	2003

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Fundamentals of Power Electronics	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component			ISE (%)		MSE (%)		ESE(%)	Total
ET306B		Theory			20		20		60	100
		Laboratory			50		--		50	100

Pre-requisite Course Codes, if any.	Basic Electrical Engineering
Course Objective: To impart knowledge on the basic topology, operation and analysis using performance parameters of power electronic converters.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
ET306.1	Interpret tradeoffs in power semiconductor switches.
ET306.2	Analyze various single/ three phase AC-DC power converter circuits
ET306.3	Illustrate the operating principle and construct a various type of DC-DC converters.
ET306.4	Analyze various single/ three phase DC-AC power converter circuits and understand their typical applications.
ET306.5	Understand the operation of AC voltage converters/ cyclo-converter by means of circuit topology and waveforms.
ET-306-6	To learn using circuit simulation software for analysis and design of PE Converters

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET306.1	2											
ET306.2	2	3										
ET306.3		2.5										
ET306.4		3	2.5									
ET306.5	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PEO/PSO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
ET306.1	2	1					
ET306.2	2				3		
ET306.3	2				2		
ET306.4	2				2		
ET306.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

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Remember	Understand √	Apply √	Analyze √	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Power Semiconductor Devices**		10
	1.1	Principle of operation, constructional features, characteristics, specification and applications of: MOSFET and IGBT, Wide Band-gap devices such as Ga-As and Silicon Carbide devices, traditional devices such as Power Diodes and Thyristor Family		
	1.2	Loss Computation in Power Devices, Design of Heatsinks and other thermal issues, reliability and Life of Power Devices		
	1.3	Gate Driver Circuits for Controllable and Latching Power devices		
2	Title	**AC to DC Converters**		10
	2.1	Designing Power Diode based Rectifier Circuits with Capacitive Filter Circuits		
	2.2	Understanding Working principles, topologies and applications of different Phase controlled rectifier circuits using Silicon Controlled Rectifier		
	2.3	Understanding input side Harmonic issues in AC-DC Converters with the exposure to IEEE Std. 519, IEC-61000		
3	Title	**DC to DC Converters**		12
	3.1	Principles of PWM based Power Control of switches for DC-DC Conversion, Buck, Boost and Buck-Boost Operation and topologies of non-isolated Primary Converters		
	3.2	Design of Primary non-isolated DC-DC Converters using controllable switches with inductor and capacitor-based filter components		
	3.3	Isolated DC-DC Converters such as Flyback, Forward and Push-pull Converter		
4	Title	**DC to AC Converters**		07
	4.1	Voltage source inverters: Principle of operation and analysis of: Single phase Half bridge, full bridge inverters with R and R-L Load		
	4.2	Operation of Three Phase Inverters with 120 degree and 180-degree conduction mode		
	4.3	Single Phase PWM Inverter		
5	Title	**AC–AC converters**		06
	5.1	Principle of on-off and phase control – single-phase half and full wave AC voltage controller, three phase AC voltage controller.		
	5.2	Buck, Boost and Buck-Boost Operation of Solid-state AC-AC Converters with Bidirectional Switches		
6	*Self-Study	Design of Magnetic Components for High Frequency Switched Mode Power Converters: Design of Transformer; Design of inductors and Design of Current Transformers		05
			Total Hours (*excluded)	45

Laboratory Component (Indicative): To be completed minimum of 8 to 10 experiments with Computer Simulation and Laboratory Experimentation

Sr. No	Title of the Experiment
1	Operation and characteristics of an SCR/ IGBT
2-a	Demonstration of SCR firing circuits
2-b	Demonstration of MOSFET/IGBT Gate Driver Circuits
3	Single phase Line Commuted Semi-converter
4	Design and Verification of Diode Rectifier Circuits and its output side performance indices
5	To study Single phase Line Commutated Semi-converter and Fully controlled Converter with Thyristors
6	Boost Converter based Power Factor Correction in Single Phase PWM Inverter
7	Evaluation of Course Project-1 through Presentation and Report
8	Design and Demonstration of a Buck-Converter and Boost Converter in CCM and for CV and CC Mode Operation
9	Demonstration of PWM three Phase bridge Voltage Source inverter with R Load, 120 degree and 180-degree conduction mode (Part-1)
10	Demonstration of PWM three phase bridge Voltage Source inverter with Sinusoidal Pulse width Modulation (Part-2)
11	AC-AC Buck-Boost PWM Voltage Controller with bidirectional switches
12	To measure Harmonics and Power Quality Indices at the SPIT Electrical feeder for 24-hours using Fluke/Hioki/Yokogawa Power Quality Analyzer and to make a consolidated report on the same.
13	Presentation of LAB-Course Project

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Power Electronics: converters, Application and design	Third	Ned Mohan, Undeland and Robbin	John Wiley and sons	2003
2	Power Electronics Circuits, Devices and Applications	Fourth	Rashid M.H.	Pearson Education	2004
3	Power Electronics	Second	M D Singh and K.B Khanchandani	Tata McGraw Hill	2006

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Modern Power Electronics and AC Drives	First	Bimal K Bose	Pearson Education Asia	2002
2	Modern Power Electronics	Second	P.C Sen	S.chand	2005
3	Power Electronics	Eleventh	P.S.Bimbra,	Khanna Publishers	2003
4	Power Electronics	First	S. K. Mandal	McGraw Hill Education (India)	2014

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Computer Communication Networks	3	-	2	5	10	3	-	1	4
EC307		Examination Scheme								
		Component		ISE (%)		MSE (%)		ESE(%)		Total
		Theory		20		20		60		100
		Laboratory		50		--		50		100

Pre-requisite Course Codes, if any.	EC301: Analog and Digital Communication
Course Objective: The objective of the course is to provide a fundamental understanding of ComputerCommunication networks.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC307.1	Apply Conceptual understanding and functional aspects of computer communication and telecom networks.
EC307.2	Analyze design and configure small and medium sized computer network that meets a specific need for communications.
EC307.3	Simulate computer networks and analyze the simulation results including troubleshoot connectivity problem occurring at layers of TCP/IP model.
EC307.4	Apply the principles behind the Modern Network approaches such as SDN NFV and IoT and security issues.

CO-PO Correlation Matrix: (1-Weak, 2-Medium, 3-Strong)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC307.1	3	3										
EC307.2			3	2	3							2
EC307.3			3		3	2						
EC307.4	2	2							3	3		3

CO-PEO/PSO Correlation Matrix : **(1-Weak, 2-Medium 3-Strong)**

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC307.1		2				
EC307.2		2		3		
EC307.3		2			3	
EC307.4		2				

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Fundamental of Computer Networks**	1	08
	1.1	Basic definitions. Networking devices. Layering architecture: The OSI model. Description of layers.		
	1.2	The Internet protocols TCP/IP protocol suit, IP Protocol and address. What is the Internet? Delay in the Internet (trace route and ping). History of the Internet. Security in the Internet.		
2	**Title**	**Enterprise Network Design**	2	06
	2.1	Network requirements, Planning and Design, Structured Wiring and Structured Network Design consist of Core Layer, Distribution Layer, and Access.		
	2.2	Network Design methodology &Network Design considerations Core La yer Technologies. Investigating Server Farms and Security Integrating, Remote Sites into the Network Design.		
3	**Title**	**Transport and Application Layer**	1,3	06
	3.1	Transport Protocols introduction. Reliable data transfer - Stop-and-wait and Go-back-N design and evaluation. TCP and UDP semantics and syntax. TCP RTT estimation. Principles of congestion control - efficiency and fairness, reactive and proactive. Socket's programming A simple client-server implementation.		
	3.2	Application layer: Application layer protocols, Client-server as a key model. Web, HTTP, FTP, SMTP, POP3, and DNS. Peer-to-peer file sharing networks.		
4	**Title**	**Software Defined Network and Network Function Visualization**	5	10
	4.1	Network Requirements - The SDN Approach - SDN- and NFV-Related Standards - SDN Data Plane - OpenFlow Logical Network Device - OpenFlow Protocol - SDN Control Plane Architecture - REST API - SDN Application Plane Architecture.		
	4.2	NFV Concepts - NFV Reference Architecture - NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration - NFV Use Cases - SDN and NFV		
5	**Title**	**Internet of Things (IoT) SECURITY**	1,3	10
	5.1	Threats and attacks. Symmetric and public key cryptography. IPsec-Authentication Header-Encapsulating security payload,		
	5.2	Secure sockets-Secure Socket Layer (SSL) - Firewalls and Internet access- Packet filter firewall- Proxy firewall- VPNs – Mobile IP –		

		Header Compression – Voice over IP –		
	Title	**Networks**		5
6	Self-Study	Types of Networks, Transmission media, Network Topologies		
Total				**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Network Lab set up
2	IP Networking & Network Commands: ifconfig, ping, traceroute, netstat, arp ,nslookup dig & route etc.
3	Network Protocol Analyzers: TCPDUMP & Wireshark
4	Installation & Configuration of Web Server (at least four) using open-source tool
5	Network Socket Programming
6	Installation and configuration of open-source Network simulator software
7	Firewall Implementation (IPTABLES)
8	Implementation of SDN
9	Implementation of VPN
10	Cryptography using open source tools/Crypt tools and open SSL

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	TCP/IP protocol suit	Fourth	Behrouz A. Forouzan (Author)	McGraw Hill Education	2009
2	Introducing Network Design Concepts	-	CCNA Discovery Learning Guide	-	-
3	Computer Networking: A Top-Down Approach	Fifth	J. F. Kurose and K. W. Ross	Prentice Hall	2009
4	Data Communication and Networking	Fourth	B.A.Forouzan	McGraw Hill	2017
5	Information Security: Principles and Practice	First	Deven Shah	Wiley	2007

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud	--	William Stallings	Addison-Wesley ISBN: 9780134175393	2015
2	Computer Networks	Fifth	A.Tanenbaum	Pearson Education	2013
3	Data and Computer Communications	Tenth	William Stallings	Pearson Education	2013

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Course (Category) Code	Course Name	Teaching Scheme (Hrs./week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-I	Information Theory & Coding	2	0	2	6	11	2	0	1	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
EC311 (IT11)		Theory	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes		Computer Communication Networks, Analog and digital communication
Course Outcomes	3T11.1	Interpret information theory concepts and compute the capacity of various typesof channels
	3T11.2	Analyze encoding and decoding of various source codes and error correction codes
	3T11.4	Estimate various performance parameters of errorcorrection coding algorithms
	3T11.5	Understand basics of cryptography algorithms

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
3T11.1	3											
3T11.2	3		2		2							
3T11.3	3		2	2	2				2	2		
3T11.4	3	3			1							
3T11.5	3	1			1				1	1		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
3T11.1		2					

3T11.2		2	2				
3T11.3		2	2		3		
3T11.4		1					
3T11.5		1					

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
	✓	✓	✓		

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Information theory and source coding** Introduction to Information Theory, Uncertainty and Information, Average Mutual Information and Entropy, Information Measures for Continuous, Random Variables, Source Coding Theorem, Huffman Source coding: second and thirdorder, extensions, Lempel Zivcoding, Arithmetic coding Run length coding, Introduction to Image Compression The JPEG Standard for Lossless Compression, The JPEG Standard for Lossy Compression, Video Compression Standards, Review of Shannon's Channel capacity, Discrete memoryless channels and capacity, Examples of channel capacity, symmetric channels, AWGN channel, fading channels, Channel coding theorem	1,2	06

2		**Linear Block Codes** Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Errorcorrecting capabilities. Standard array and Syndrome decoding. Error Probability after Coding (Probability of Error Correction) Perfect Codes, Hamming Codes,Low Density Parity Check (LDPC) Codes, Optimal Linear Codes Maximum Distance Separable (MDS) Codes.	1,2	06
3		**Cyclic Codes** Introduction, Generator and Parity check· Polynomials, Systematic Cyclic codes – Encoding and decoding using Feedback shift register circuitsand polynomial method. Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder. Cyclic Hamming codes, Golay code, Shortened cyclic codes, Cyclic Redundancy Check (CRC) Codes. BCH codes	1,2	06
4		**Convolution Codes** Graphical representation for encoding and decoding using code tree, trellis, state diagram,polynomial and time domain method, Viterbi decoding. Introduction to Turbo coding	1,2	06
5		**Introduction to cryptography** Introduction, overview of various techniques Symmetric (Secret Key) Cryptography Asymmetric (Public-Key) Cryptography	1,2	04
6(Self Study)		**Cryptography Algorithms**	1,2	06
			Total	**28**

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Laboratory Components:

Sr. No	Title of the experiment
1	Write a simulation program to test shannon's source coding ,channel coding and channel capacity theorem.
2	Write a program to encode and decode a text file and determine thecode efficiency using Shannon – Fano coding and Huffman Coding
3	Write a program to construct Lempel Ziv Coding and decoding andexamine its code efficiency
4	Write a program to examine BER performance of linear block code fora a coded and uncoded BPSK communication system in AWGN channel
5	Write a program to examine BER performance of cyclic codes for acoded and uncoded BPSK and QPSK communication system in AWGN channel
6	Write a program to examine BER performance of BPSK modulatedlinear block coded communication system in AWGN channel and fading channel
7	Write a program to examine BER performance of convolutional encoder in a coded and uncoded communication system based on802.11a standard with and without AWGN channel
8	Write a program to examine BER performance of convolutional encoder in a coded and uncoded OFDM system with and withoutAWGN channel
9	Write a program to examine BER performance of convolutional encoder in a coded and uncoded OFDM system with and withoutfading channels
10	Simulation either turbo codes/RS codes/ LDPC codes/BCH codes andtest their error correction capability.

TEXT BOOKS :

1. Ranjan Bose "Information theory coding and cryptography" 3rd edn, McGraw Hill Education India Private Limited
2. Haykin Simon, "Digital Communication Systems," John Wiley and Sons, NewDelhi,Fourth Edition, 2014.
3. Lathi B P, and Ding Z., "Modern Digital and Analog Communication Systems,"Oxford University Press, Fourth Edition, 2009

REFERENCE BOOKS:

1. R. G. Gallager, "Information Theory and Reliable Communication," Wiley, 1968,ISBN-13: 978-0471290483
2. Roman, Steven, "Introduction to Coding and Information Theory", Springer, ISBN978-0-387-94704-4
3. Shu Lin & Daniel J. Costello, Jr. "Error Control Coding" Prentice Hall, Second Edition, 2004.
4. S. B Wicker, Error Control Systems for Digital Communication and Storage,Prentice Hall International, 1995
5. Sklar B, and Ray P. K., "Digital Communication: Fundamentals and applications,"Pearson, India, Second Edition, 2009
6. .Ranjan Bose, "Information theory, Coding and Cryptography," TMH publication,ISBN: 978-0-07-0669017, 2008.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-I	Speech and Audio Processing	2	0	2	8	8	2	0	1	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
EC321 (2T21)		Theory	50		50		100			100
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC303: Digital Signal Processing
Course Objective: To familiarize the basic & advance mechanisms of speech and audio processing	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC321.1	Apply concepts of speech coding.
EC321.2	Analyze Audio Perception& psycho-acoustic model.
EC321.3	Demonstrate parametric representation, time domain & frequency domain representation of speech.
EC321.4	Analysis of predictive methods of speech.
EC321.5	Develop systems for various applications of speech & audio processing.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC321.1	2											
EC321.2		2										
EC321.3			2									
EC321.4			2		2							
EC321.5					2							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC321.1	2			2		
EC321.2	2			2		
EC321.3		2			2	
EC321.4		2			2	
EC321.5		2			2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze√	Evaluate√	Create

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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Mechanics of speech**		8
	1.1	Speech production: Mechanism of speech production, Acoustic phonetics – Digital models for speech signals -Sampling speech signals, basics of quantization, delta modulation, and Differential PCM	1,2	
	1.2	Signal Processing Models of Audio Perception: Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model.	1,2	
2	Title	**Time domain methods for speech processing**		8
	2.1	Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude, zero crossing Rate – Silence Discrimination using ZCR and energy	1,2	
	2.2	Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function.	4	
3	Title	**Frequency domain method for speech processing**	1,2	8
	3.1	Short Time Fourier analysis: Fourier transform and linear filtering interpretations.	4	
	3.2	Sampling rates - Spectrographic displays - Pitch and formant extraction - Analysis by Synthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder.	2,3	
	3.3	Homomorphic speech analysis: Cepstral analysis of Speech, Formant and Pitch Estimation, Homomorphic Vocoders, Speech coding, speech enhancement.	3,5	
4	Title	**Linear predictive analysis, synthesis of speech**	3,5	4
	4.1	Basic Principles of linear predictive analysis – Auto correlation method – Covariance method.		
	4.2	Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm.		
	4.3	Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP, Speech synthesis: basics of articulatory, source-filter, and concatenative synthesis – VOIP.		
5	Self Study	Audio compression methods, Audio quality analysis, Spatial Audio Perception and rendering, Speaker identification and verification		
			Total	**28**

Laboratory Component

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Sr No.	Experiment Title
1	Speech production
2	Analysis of speech signal
3	Short-time spectrum analysis of speech
4	Spectrographic analysis of speech
5	Linear prediction analysis of speech
6	Formant synthesis
7	Cepstral analysis of speech
8	Analysis by synthesis of speech
9	Manual speech signal-to-symbol transformation
10	Speaker Analysis /speaker recognition

Text Books :

Sr. No	Title	Edition	Authors	Publisher	Year
1	Speech Communications: Human & Machine	Second	Douglas O'Shaughnessy	IEEE Press, Hardcover 2/e, ISBN: 0780334493.	1999
2	Discrete-Time Speech Signal Processing	First	Thomas F, Quatieri,	Prentice Hall /Pearson Education	2004

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Speech Processing and Synthesis Toolboxes	First	Donald G. Childers	John Wiley &Sons,September ISBN:0471349593	1999
2	Fundamentals of Speech Recognition	First	L.R. Rabiner and B. H. Juang	Prentice Hall	2009
3	Speech and Audio Signal Processing	Second	Ben Gold and Nelson Morgan	John Wiley and Sons Inc., Singapore	2011
4	Discrete Time Processing of Speech Signals	First	J.R. Deller, J.H.L. Hansen and J.G. Proakis	John Wiley, IEEE Press	1999
5	Digital Processing of Speech Signals	First	L.R.Rabiner and R.W.Schaffer .	Prentice Hall	1979

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Course (Category) Code	Course Name	Teaching Scheme (Hrs./week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-II	Optical Fiber Communication	2	0	2	6	11	2	0	1	3
EC312 (1T12)		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			100
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	AS101: Engineering Physics EC304: Electromagnetic Waves
Course Objective: The objective of the course is to provide an understanding of usage of optical fiber for communication.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC322.1	Apply EM Wave theory to understand nature of Optical Signal and their corresponding guiding structures.
EC322.2	Identify Passive Optical Components, Sources and Detectors.
EC322.3	Analyze Passive Optical Components, Sources and Detectors.
EC322.4	Evaluate losses in the optical systems.
EC322.5	Compare different Optical Networks.
EC322.6	Design optical Link Budget system.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC322.1	3	3	3	1	3					3		
EC322.2	2	2	2	2	3					3		
EC322.3	2	2	2	2	3					3		
EC322.4	2	2	2	2	3					3		
EC322.5	2	2	2	2	3					3		
EC322.6	3	3	3		3					3		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC322.1		2			2	
EC322.2		2			2	
EC322.3		2			2	
EC322.4		2			2	
EC322.5		2			2	
EC322.6		2			1	

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Optical communication fundamentals**	1	10
	1.1	Block diagram of Optical Communication system, advantages, loss and bandwidth window, ray theory transmission, total internal reflection, acceptance angle, numerical aperture, skew rays and meridional rays		
	1.2	EM waves, modes in planar guide, phase and group velocities, types of fiber according to refractive index profile and mode transmission.		
	1.3	Couplers, Isolators, circulators, multiplexers, filters, fiber gratings, Fabry Perot filters, arrayed waveguide grating, switches and wavelength converters		
2		**Optical communication Components**	1	08
	2.1	Sources (LED, LASER), Detectors (PIN, APD) and Amplifiers		
3		**Optical Networks and losses in the system**	1	10
	3.1	Attenuation, absorption, linear and nonlinear scattering losses, bending losses, modal dispersion, waveguide dispersion, dispersion and pulse broadening, dispersion shifted, and dispersion flattened fibers, and nonlinear effects Measurements of attenuation, dispersion and OTDR		
	3.2	Optical Networks: Link budget, SONET, SDH, WDM, DWDM		
4(Self Study)		**Review of latest optical fiber application and research**		06
			Total	**28**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Setup of Optical fiber communication link and measurement of Bit Error Rate (BER) and Eye pattern analysis A) Setup of analog fiber optic communication link B) Setup of digital fiber optic communication link C)Measurement of Bit Error Rate D)Study and measurement of Eye pattern
2	Measurement of Numerical Aperture (NA) of optical fiber
3	Measurement of Losses in Optical Fiber
4	Study characteristic of LED and Photo detector in optical fiber communication link.
5	To verify the Brewster's law and to find the Brewster's angle
6	Michelson's Interferometer- Refractive index of glass plate: To determine the refractive

	index of a thin glass plate.
7	To Demonstrate the working of LASER using Phet virtual Lab
8	Measure propagation loss in plastic fiber and to measurethe bending loss.
9	Plotting optical link power budget.
10	Mini project on optical network.

Textbooks:

S. N.	**Title**	**Authors**	**Edition**	**Publisher**	**Year**
1	Optical Fiber Communication	John M. Senior	Fourth	Prentice Hall of India Publication	2013
2	Optical Fiber Communication	Gred Keiser	Third	Mc-Graw Hill Publication	2012
3	Optical Networks: A Practical Perspective	Rajiv Ramaswamy and Kumar N. Sivarajan	Third	Elsevier Publication	2010

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-II	Wavelet Transform and Applications	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
EC322 (2T22)		Theory		50		50		100		100
		Laboratory		50		--		50		100

Pre-requisite Course Codes, if any.	Foundation of Signal Processing OR Digital Signal Processing
Course Objective:	
Course Outcomes (CO): ***At the End of the course students will be able to***	
1	Analyze the terminology that are used in the wavelets literature
2	justify why wavelets provide the right tool
3	Apply wavelets, filter banks, and multiresolution techniques to signal processing problem justify why wavelets provide the right tool.
4	Develop wavelet based applications

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2		3							2
2	3	2	3		3							1
3	3	2	3	2	3							1
4	3	3	3	2	3				3	3	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
1							
2					3		
3							
4						3	

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Fundamentals of Wavelets and Short Time Fourier Transform**		06
	1.1	Introduction to Wavelets, The concept of scale and resolution, uncertainty, History of wavelet, Different types of wavelets (e.g., Haar, Daubechies, Morlet), Orthogonal and Biorthogonal wavelet bases, Multiresolution analysis and scaling functions .		
	1.2	**Short Time Fourier Transform (STFT),** Signal representation with continuous and discrete STFT, concept of time-frequency resolution, Resolution problem associated with STFT, Heisenberg's Uncertainty principle and time frequency tiling, lacunas of STFT and necessity of wavelet transform.		
2	Title	**Continuous Wavelet Transform**		04
	2.1	Wavelet transform-A first level introduction, Continuous time-frequency representation of signals, Definition and formulation of the continuous wavelet transform		
	2.2	Properties of wavelets used in continuous wavelet transform, Condition of admissibility and its implications. Discretization of scale - generalized filter bank. Discretization of translation - generalized output sampling. Discretization of time/ space (independent variable) - sampled inputs.		
3		**Discrete Wavelet Transform**		06
	3.1	Introduction to discrete wavelet transform, Haar scaling functions and function spaces, Translation and scaling of $\phi(t)$, Haar wavelet function, Scaled and translated Haar wavelet functions, Orthogonality of $\phi(t)$ and $\psi(t)$, Normalization of Haar bases at different scales, Daubechies wavelets		
	3.2	Construction and Computation of the discrete wavelet transform		

4	**Title**	**Discrete Wavelet Transform and Relation to Filter Banks**		**06**
	4.1	Signal decomposition (Analysis), Relation with filter banks, Frequency response, Signal reconstruction: Synthesis from coarse scale to fine scale, Upsampling and filtering, Perfect reconstruction filters, QMF conditions, Concepts of Multi-Resolution Analysis (MRA) and Multi-rate signal processing.		
	4.2	**Multiresolution Analysis:** Multi-resolution decomposition and reconstruction of 1-D and 2-D signals. The concept of Time-Frequency filtering.		
5	**Title**	**Applications of Wavelet Transform**		**06**
	5.1	One dimensional Signal Compression, Analysis and classification of audio signals, Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Digital Communication and Multicarrier Modulation .		
	5.2	Image Compression, image processing and Image fusion		
6	**Self Study**	**The wavepacket transform:** Nobel identities and wavelet packets, the basis used. Signal representation using Wavelet Packet Analysis, Selection of best basis		

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Short Time Fourier Transform
2	Time and Frequency domain Analysis of Different Wavelets
3	Image Compression: Investigating the use of DWT for image compression
4	Feature Extraction: Experimenting with DWT to extract relevant features from signals or images, such as edges, textures, or key points, for tasks like object recognition or pattern analysis.
5	Signal Analysis: Applying DWT to analyze signals in the time-frequency domain, examining the decomposition coefficients to identify significant frequency components or transient features.
6	Biomedical Applications: Using DWT for analyzing biomedical signals like electrocardiograms (ECG), electroencephalograms (EEG), or medical imaging, to detect abnormalities, perform signal classification, or extract diagnostic features.
7	Compression Performance Evaluation: Comparing different wavelet families,

	decomposition levels, and coding techniques to evaluate the compression performance of DWT-based compression algorithms in terms of rate-distortion trade-offs.
8	Watermarking: Experimenting with DWT for digital watermarking, embedding imperceptible information into signals or images to protect copyright or verify authenticity.
9	Image Fusion: Exploring DWT-based image fusion techniques to combine multiple images while preserving important information from each source, such as in multi-modal medical imaging or remote sensing applications.
10	Image Fusion: Exploring DWT-based image fusion techniques to combine multiple images while preserving important information from each source, Time-Frequency Analysis: Examining the time-frequency representation obtained by DWT to analyze non-stationary signals and capture localized frequency content over time.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Insight into Wavelets: From Theory to Practice,	Third Edition	K. P. Soman, K. I. Ramachandran, N. G. Resmi	PHI Learning Pvt. Ltd.	2010
2	Multiresolution signal Decomposition: Transforms, Subbands and Wavelets	--	A.N. Akansu and R.A. Haddad	Academic Press, Oranld, Florida	1992
3	Introduction to Wavelets and Wavelet Transforms: A Primer			**Prentice Hall Series**	**1997**

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Fundamentals of Wavelets: Theory, Algorithms, and Applications	Second Edition	J.C. Goswami and A.K. Chan,	Wiley	2011

2	Wavelets and their Applications	---	Michel Misiti, Yves Misiti, Georges Oppenheim, JeanMichel Poggi	John Wiley & Sons	2010
3	A friendly guide to Wavelets	--	Gerald Keiser	Springer	2011
4	Multirate Systems and Filter Banks	--	P. P. Vaidyanathan	Pearson Education,	2004
5	Wavelets and signal processing: An application based introduction	--	Hans-Georg Stark	Springer	2005

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-II	Digital CMOS VLSI Design	3	--	--	5	8	3	--	--	3
		Examination Scheme								
		Component	ISE(%)		MSE(%)		ESE(%)			Total
EC332 3T32		Theory	20		20		60			100
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	ET101: Basic Electrical Engineering EC101: Digital Systems and Microprocessors ET202: Electronic Devices ET205: Analog Circuits
Course Objective:	
Course Outcomes (CO): After successful completion of the course, student will be able to	
CO1	Explain scaling theory for MOSFET
CO2	Design MOSFET based inverter circuits with given constraints
CO3	Analyze MOSFET based combinational and sequential logic circuits
CO4	Realize MOSFET based logic circuits with different design styles
CO5	Explain principle of working of semiconductor memories

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	Title	**Review of MOSFET Physics**		08
	1.1	Threshold Voltage Equation, MOSFET Structure and Operation, Current-Voltage Characteristics and MOSFET Capacitances	1	
	1.2	MOSFET Scaling, Types of scaling and Small geometry effects	1	
2	Title	**MOSFET Inverters**		08
	2.1	Static Characteristics of resistive load and CMOS Inverter, comparison of all types of MOS inverters	1	
	2.2	Dynamic Characteristics of inverters, design of CMOS inverters with constraints	1	
3	Title	**Combinational MOS Logic Circuits**	1,2	08
	3.1	MOS Logic Circuits with Depletion NMOS Loads and CMOS Logic Circuits		

	3.2	Complex Logic Circuits and Concept of equivalent CMOS inverter		
4	**Title**	**Dynamic Logic Circuits**	1	**08**
	4.1	Static CMOS, pass transistor logic, transmission gate		
	4.2	Pseudo NMOS, Domino, NORA, Zipper, C^2MOS		
5	**Title**	**Sequential MOS Logic Circuits**	1,2	**06**
	5.1	Behavior of Bi-stable Elements		
	5.2	**Circuit Realization:** SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX, decoder		
6	**Title**	**Semiconductor Memories**	2,3	**06**
	6.1	ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits),		
	6.2	DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits),		
	6.3	Flash (mechanism, NOR flash, NAND flash)		
	6.4	**Peripheral Circuits:** Sense amplifier, decoder		
			Total	**42**

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	CMOS Digital Integrated Circuits Analysis and Design	Third Edition	Sung-Mo Kang, Yusuf Leblebici	Tata McGraw Hill	
2	Digital Integrated Circuits: A Design Perspective	Second Edition	Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic	Pearson Education	
3	Introduction to VLSI Circuits and Systems	Student Edition	John P. Uyemura	Wiley	2013

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-I	Control of Power Electronics Converters	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component			ISE (%)		MSE (%)		ESE(%)	Total
EC341 (4T41)		Theory			20		20		60	100
		Laboratory			50		--		50	100

Pre-requisite Course Codes, if any.	Basic Electrical Engineering
Course Objective: To study controlling aspects of major types of power electronic converters in analog and digital domain with appropriate signal conditioning and sensing circuits	
Course Outcomes (CO): ***At the End of the course students will be able to***	
ET306.1	To study design aspects of signal sensing and conditioning circuits in PE Converters
ET306.2	To get familiar with voltage mode and current mode controllers in PE
ET306.3	To study control strategies for stand-alone and grid connected converters used in PV and Power System applications
ET306.4	To study converter control in AC Drives system
ET306.5	To study analog and digital techniques for Battery Chargers and SMPS PE Converters

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET306.1	2											
ET306.2	2	3										
ET306.3		2.5										
ET306.4		3	2.5									
ET306.5	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PEO/PSO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
ET306.1	2	1					
ET306.2	2				3		
ET306.3	2				2		
ET306.4	2				2		
ET306.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create

Theory Component

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Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Fundamental Functional Blocks in Converter Control for Discrete-time implementations**		**06**
	1.1	Low Pass and High-pass filters, Proportional Integral and Derivative Controller, Harmonic Oscillators, Reference frame transformations, Phase-shift and quadrature filters, Phase lock-loop, higher order digital filters, etc.		
2	**Title**	**Modulation Techniques**		
	2.1	**Voltage Controllers** **Ramp based linear PWM, Sinusoidal PWM, Voltage Space Vector Modulation, Inverter Flux Vector based Modulation**		**06**
	2.2	**Current Controllers: Hysteresis Control, Linear Current Control, dead-beat current control, SOGI based Controller**		
3	**Title**	**Control of AC to DC Converters**		**09**
	2.1	Control of SCR based rectifier with Cosine-wave crossing techniques		
	2.2	PWM Rectifier Control, Control implementation of PFC		
	2.3	Three Phase PWM Rectifier and Active Power Filter control with rotating reference frame method and instantaneous p-q theory		
3	**Title**	**Control of DC-to-DC Converters**		**09**
	3.1	Modelling of DC-DC Buck and Bosot Converter		
	3.1	Conventional Constant Voltage Control with PI Controller		
	3.2	Conventional Constant Current Control with PI Controller		
	3.3	Implementation of CV-CC Mode of Control		
	3.4	Current Mode Control		
4	**Title**	**DC to AC Converters**		**09**
	4.1	Full Bridge/Half Bridge Sinusoidal Pulse Width Modulation with voltage mode Control		
	4.2	Space Vector Modulation		
	4.3	Inverter flux control method		
5	**Title**	**AC–AC converters**		**06**
	5.1	Principle of on-off and phase Control – single-phase half and full wave AC voltage controller, three phase AC voltage controller.		
	5.2	Buck, Boost and Buck-Boost Operation of Solid-state AC-AC Converters with Bidirectional Switches		
6	***Self-Study**	Laplace transformations, z-transformations, s-z transformations, discretization techniques, control system stability in continuous and discrete time mode. SOGI		**05**
			Total Hours (*excluded)	**45**

Laboratory Component (Indicative): To be completed minimum of 4 Lab Project Assignments with Computer Simulation (Mandatory) and Laboratory Experimentation (optional)

LAB Project-1
Static Var Compensator
Lab Project-2
Closed Loop Control of DC-DC Converter
Lab Project-3
Implementation of a Sine Wave Inverter with Inverter Flux Control
Lab Project-4
Implementation of a Buck-Boost AC-AC PWM Voltage Controller

Sr. No	Title	Edition	Authors	Publisher	Year
1	Power Electronics: converters, Application and design	Third	Ned Mohan, Undeland and Robbin	John Wiley and sons	2003
2	Power Electronics Circuits, Devices and Applications	Fourth	Rashid M.H.	Pearson Education	2004
3	Discrete Time Control Systems	second edition,	K. Ogata	Pearson International	

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Simulation of Power Electronic Circuits	First	M. B. Patil, V. Ramanarayanan, V.T. Ranganathan	Narosa Publishing House	2013
2	The switching function analysis of Power Electronic Circuits	First	Christos Marouchos	IET, Devices and Circuits	2008
3	Digital Signal Processing in Power Electronics Control Circuits	Second	Krzysztof Sozański	Springer	2017
4	Control Circuits in Power Electronics Practical issues in design and implementation	First	Miguel Castilla	The Institution of Engineering and Technology	2016

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-II	Real-Time Embedded Systems	2	--	2	5	8	2	--	1	3
		Examination Scheme								
		Component		ISE(%)		MSE(%)		ESE(%)		Total
EC332 (3T32)		Theory		20		20		60		100
		Laboratory		80		--		20		100

Pre-requisite Course Codes, if any.	EC101: Digital Systems and Microprocessors EC201: Computer Architecture and Organization EC206: Microcontrollers EC305B: Internet of Things Laboratory
Course Objective: To impart students the fundamentals of Operating Systems, system design skills using modeling practices, learn key concepts in reliability, and implementation aspects of real time concepts with respect to Industrial standards.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
CO1	Get an insight of design metrics of Embedded systems to design real-time applications to match recent trends in technology
CO2	Compare and contrast various ARM architecture series
CO3	Demonstrate the basic concept of OS and configure the System
CO4	Apply kernel Services and Synchronization
CO5	Apply the industry standards for assessment of embedded product
CO6	Analyze the reliability of embedded system with respect to fault detection and fault tolerance

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2									
CO2	2	2	2									
CO3	2	2	2									
CO4	2	2	2									

CO5	2	2	2									
CO6	2	2	2	2	2							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
CO1		**1**				
CO2	**1**		**1**			
CO3	**1**		**1**			
CO4	**1**	**1**	**1**			
CO5		**1**	**1**			
CO6	**1**		**1**	**2**		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✔	Understand ✔	Apply ✔	Analyze ✔	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	**Title**	**Fundamentals of Embedded System:**		**06**
	1.1	Introduction to Embedded Systems, Characteristics of Embedded System, Design Process, Design Metrics, and optimization of various parameters of embedded system. Design trade-offs due to process compatibility. Real-time System's requirements, real-time issues.	1,2	
	1.2	Embedded Product development lifecycle. Program Modeling concepts with design examples: DFG, FSM, Petri-net and Use case.	1,2	
2	**Title**	**ARM Architecture:**	3,4	**04**
	2.1	Differences among ARM7, ARM9 and ARM11 architectures	3,4	
	2.2	Generic architecture concepts of ARM Cortex Series (A, R and	3,4	

		M)		
	2.3	ARM Cortex M3- Detailed Architecture	3,4	
3	**Title**	**Real-time Operating System concepts**		**08**
	3.1	Tasks, Task states, Message Queue, Mailbox, Pipe Function, Mutex, RPC Function, Shared Resources	2,5,6	
	3.2	Inter-process Communication, Semaphore, Spinlock Semaphore, round-robin scheduler, Blocking Semaphore, Mailbox, Pre-emptive scheduler, FCFS, EDF and RMA scheduler.	2,5,6	
4	**Title**	**Implementation of a Real-time kernel**	5,6	**06**
	4.1	Foreground Background System, Critical Section of codes, Task control Blocks, Task Scheduling, Creating a Task and Deleting a Task.	5,6	
	4.2	Creating and Deleting Semaphore, Creating and deleting Mutex, creating and Deleting Mailbox, Creating and deleting Message Queue.	5,6	
5	**Title**	**Industry Standards**		**04**
	5.1	Introduction to IEC 61508, IEC 60601 and IEC 26262 standards: Organizing and managing the life-cycle, Requirements involving the specification, Requirements for design and development, Integration and test, Operations and maintenance, Validation, Modifications, Acquired sub-systems, Organizing and managing the software engineering	7,8, 9, 10	
			Total	**28**

Laboratory Component

Sr. No.	Title of the Experiment
1	Implementing a basic program of "HelloWorld" in ARM Cortex M3 processor
2	Porting Operating System kernel on Cortex M3 architecture and understanding file hierarchy.
3	Initializing the Kernel, Create Task and Start the Task in OS
4	Implementing OS interrupt Handler
5	Performing OS Kernel Scheduling. (Pre-emptive Scheduler)

6	Implementing various Kernel Services in OS
7	Implementing Semaphore in OS
8	Performing Shared Resources Protection in OS
9	Implementing Mutexes in Micrium OS.
10	Implementing Message Queues in Message Queues

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	Embedded System: Architecture, Programming and Design	2nd edition	Rajkamal	Tata McGraw-Hill	2011
2	Introduction to Embedded Systems	2nd edition	Shibu K. V	Tata McGraw-Hill	2017
3	ARM System Developer"s Guide Designing and Optimizing System Software	First	Andrew N. Sloss, Dominic Sysmes and Chris Wright	Elsevier Inc Morgan Kaufmann	2004
4	Embedded System: Real time Operating Systems for the ARM Cortex^{TM}M3		Jonathan W. Valvano	Create Space Independent Publishing Platform	2012
5	MicroC/OS-II: The Real-Time Kernal		Jean J. Labrosse	CRC press	2002
6	Using the FreeRTOS Real Time Kernel -a Practical Guide- Cortex-M3	Third	Richard	McGraw-Hill	2010

	Edition		Barry		
7	Functional Safety, A Straightforward Guide to applying IEC 61508 and Related Standards	2nd edition	David Smith	Elsevier	2004
8	IEC 61508: IEC standard for the functional safety for electrical, electronics and programmable electronics equipment	-	-	https://www.iec.ch/safety	-
9	IEC 60601: IEC standard on Medical Electric Equipment	-	-	https://www.iec.ch/safety	-
10	IEC 26262: IEC standard on Road vehicles	-	-	https://www.iec.ch/safety	

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-II	Electric Motor Drive Systems	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component			ISE(%)		MSE(%)		ESE(%)	Total
EC342 (4T42)		Theory			20		20		60	100
		Laboratory			50		--		50	100

Pre-requisite Course Codes, if any.	Basic Electrical Engineering
Course Objective: To study controlling aspects of major types of power electronic converters in analog and digital domain with appropriate signal conditioning and sensing circuits	
Course Outcomes (CO): ***At the End of the course students will be able to***	
1	To grasp fundamental concepts of modern electric motors and load characterization
2	To study electric motor drive control system
3	To study different applications of electric motor drives

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2											
2	2	3										
3		2.5										
4		3	2.5									

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PEO/PSO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
1	2	1					
2	2				3		
3	2				2		
4	2				2		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.

1	**Title**	**Electric Motor Basics**		
	1.1	Induction Motors, Brushless DC Motors, Synchronous Reluctance Motor, Switched Reluctance Motors, Permanent Magnet Synchronous Motors, Stepper Motors, Linear Motors and Actuators, Electric and regenerative breaking, load characterization, field of applications of various motors		**12**
2	**Title**	**Electric Motor Drive Control Techniques for AC Motors**		
	Scalar and Vector Control of AC Electric Motors, Direct Torque control, field-oriented control, Sensor based and Sensor-less Control			**12**
3	**Title**	**Electric Motor Drive Control Techniques for BLDC Motors and Syn-RM Motors**		
	Practical implementation of sensor based and sensorless BLDC Motor Drive Systems, Practical implementation of Switched Reluctance Motors			**09**
4	**Title**	**Control of Linear Motors and Actuators**		
		Control of Linear Motors and Actuators		**09**
		Control of Stepper Motors		
			Total Hours	**40**

Laboratory Component (Indicative): To be completed minimum of 4 Lab Project Assignments with Practical Implementation on Digital Platforms

LAB Project-1
Closed loop control Induction Motor with V/F Control

Lab Project-2
Closed loop control

Lab Project-3
sensor/sensorless BLDC Motor Drive

Lab Project-4
Implementation of drive system for Linear Motors and Actuators

Lab Project-5
Implementation of drive system for stepper-motor

Reference Books:
Books:

1. Chang Liang Xia,"Permanent Magnet Brushless Dc Motor Drives and Controls" Wiley 2012.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2011.
3. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education, second Edition, 2003.
4. Dubey. G.K., "Thyristorised power controllers", New age International, New Delhi, 2002.
5. Bhimbhra P.S., "Power Electronics", Khanna Publishers, New Delhi, 2005
6. Miller. T. J. E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
7. Kenjo. T and Nagamori. S, "Permanent Magnet and Brushless DC Motors", Clarendon Press, Oxford, 1989.
8. Kenjo. T, "Stepping Motors and their Microprocessor Control", Clarendon Press, Oxford,

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PROGRAM ELECTIVE COURSES

- 4 Electives are sufficient to specialize in a particular vertical/thread/area.

TD/ PE	PE1	PE2	PE3	PE4	PE5	PE6
THREAD 1: **Communication**	**T11:** Information Theory & Coding	**T12:** Optical Fiber Communication	**T13:** Microwave Communication	**T14:** Space Communication on Technologies	T11, T12, T21, T22, T31, T32, T41, T42, X, Y P, Q	T11, T12, T21, T22, T31, T32, T41, T42, X, Y P, Q
THREAD 2: **Signal Processing**	**T21:** Speech and Audio Processing	**T22**: Wavelet Transform	**T23:** Image & Video Processing	**T24:** Principles Soft Computing		
THREAD 3: **VLSI & Embedded Systems**	**T31:** Digital CMOS VLSI Design	**T32:** Real Time Embedded Systems	**T33:** Semiconductor Technologies	**T34:** Mixed VLSI Design		
THREAD 4: **Power Electronics and Energy Systems**	**T41:** Control of Power Electronics Converters	**T42:** Electric Motor Drive Systems	**T43:** Embedded & Digital Control of PE Systems	**T44:** Selected topic in Power Electronics & Drives		
GENERAL	**X:** Computer Communication Network (Cat2) T11, T12, T21, T22, T31, T32, T41, T42	**Y:** Fundamentals of Antenna (Cat2) T11, T12, T21, T22, T31, T32, T41, T42	**P:** Artificial Intelligence & Machine Learning T13, T14 T23, T24 T33, T34 T43, T44	**Q:** Telecomm Network Operations & Management T13, T14 T23, T24 T33, T34 T43, T44		