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
EC301		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
		Theory	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes, if any.	EC202: Electronic Devices MA203: Probability and Stochastic Processes EC207: 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***

EC301.1	Describe various entities of analog, pulse, and digital communication system.
EC301.2	Apply concepts of signals and systems to analyze behavior of modulated signals in time domain, frequency domain and signal space.
EC301.3	Analyze and compute system performance measures such as efficiency, bit rate and bandwidth of various analog, pulsed and digital modulation methods.
EC301.4	Analyze the behavior of a various analog, pulse, and digital modulation schemes in presence of noise.
EC301.5	Compare various modulation and demodulation techniques.
EC301.6	Examine various wired and wireless applications and further infer health, safety, and 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
EC301.1	3				-				-	-		1
EC301.2	2	2			3				3	3		
EC301.3	2	2			3				3	3		1

EC301.4	3	3			3				3	3		1
EC301.5	2	2			3				3	3		
EC301.6	1	1				1	1	1	3	3		3

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

	PEO1	**PEO2**	**PEO3**	**PSO1**	**PSO2**	**PSO3**
EC301.1	2	2				
EC301.2	2	2		2	1	
EC301.3	2	2		2	1	
EC301.4	2	2		2	1	
EC301.5	2	2				
EC301.6	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**
	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**

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	Fourth	Haykin S	John Wiley and Sons	2001
2	Principles of Communication Systems	Second	Taub H. and Schilling D. L	Tata McGraw Hill	2001

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Communication.	Third	Haykin S	John Wiley and Sons	2001
2.	Communication Systems Engineering	Fourth	Proakis J. G. and Salehi M.	Pearson Education	2002
3.	Digital and Analog Communication	Fourth	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
EC302		Examination Scheme								
		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)

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	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	

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**		10
	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	
	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 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.	10 CO4
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 Analysis and Design: Conventional and Modern	First	Constantine H. Houpis and John J. D'Azzo	Mcgraw-Hill	1975

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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	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	

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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	**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

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		

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								

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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**
	1.1	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

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
EC306		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			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	

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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 (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	Computer Communication Networks	3	-	2	5	10	3	-	1	4
EC307		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		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

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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				

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-1	Mobile and Wireless Communication	2	-	2	2	6	2	-	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC311 (IT11)		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC307: Computer Communication Network
Course Objective: The objective of the course is to provide a fundamental understanding of Mobile and Wireless Communication.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC311.1	Demonstrate the ability to discuss wireless communication concepts, system capacity and service provided.
EC311.2	Evaluate various path loss and fading effects.
EC311.3	Analyze losses, multipath effects, architecture, and protocols of 3G,4G and 5G systems.
EC311.4	Compare various operational aspects of Wireless Personal Area Networks.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC311.1	2		2									
EC311.2			2	2	2				2	2		
EC311.3	3				2				2	2		2
EC311.4	2	2										

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

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC311.1		2				
EC311.2		2	2			
EC311.3		2	2			
EC311.4		2				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand√	Apply √	Analyze√	Evaluate	Create

Theory Component

Module	Unit No.	Topics	Ref.	Hrs
1	**Title**	**Introduction to mobile communication**	1	5
	1.1	Frequency Division Multiple access, Time Division Multiple access, Spread Spectrum Multiple access, Space Division Multiple access, and OFDM.		
	1.2	Frequency reuse, channel assignment strategies, handoff strategies, interference and system capacity, trunking and grade of service, improving the capacity of cellular systems and related design problems		
2	**Title**	**Mobile Radio Propagation**	2,3	10
	2.1	Introduction to radio wave propagation, reflection, diffraction, scattering. Indoor and Outdoor propagation Models. Practical Link Budget Design using path loss models.		
	2.2	Small-Scale Multipath propagation, small scale multipath measurements, types of small-scale fading, fading effects due to Doppler spread. Statistical models for multipath fading		

		channels-Clarks model,2-day Rayleigh fading model, Saleh and Valenzuela indoor model.		
3	**Title**	**3G UMTS Network, 4G LTE and 5G Technologies**	4	8
	3.1	UMTS network architecture, Protocol Structure, Channel Structure, Frame slots and symbols, modulation, coding, multiple antenna techniques, WCDMA, Modulation, Handoff and Power Control.		
	3.2	4G LTE network Architecture, LTE Radio Access, Radio-Interface Architecture, Physical Transmission Resources, Downlink and Uplink Physical-Layer Processing, Scheduling and Rate Adaptation.5G Concepts and Architectures, Network Slicing Architecture, mm Wave communication, multiple Cell Types.		
4	**Title**	**Personal Area Network Technologies**	3	5
	4.1	**Bluetooth:** concepts of Piconet , scatternet etc., protocol stack, link types, security, network connection establishments, usage models, etc.		
	4.2	**Wifi and ZigBee:** components, architecture, network topologies, protocol stack etc.		
5	**Self-Study**	Rayleigh fading model, Saleh and Valenzuela indoor model**.** UWB and RFID: technical requirements, components and characteristics, applications.	2,3	4*
			Total (* Not Included)	28

Laboratory Components:

Sr. No	Title of the experiment
1	Study of GSM modem: i] Install and configure minicom, wvdial & AT Commands ii] Python scripting.

2	Channel Allocation Techniques
3	Modulation Techniques using GNU Radio.
4	Spread Spectrum Modulation, OFDM Modulation.
5	Wireless Path Loss Computations: i] Free-space Propagation Path Loss Modelii] Indoor Propagation Model - Okumura Model etc
6	Wireless Path Loss Computations: iii] Outdoor Propagation Model - Hata Model etc
7	Open-Source LTE/EPC Network Simulation using NS-3, Omnet++
8	Open-Source Personal Area Network simulation using NS-3, Omnet++
9	Millimeter Wave (5G) Network, WiFi Network simulation usingNS-3, Omnet++
10	Virtual Lab.

Text Books

Sr. No	**Title**	**Edition**	**Authors**	**Publisher**	**Year**
1	Wireless Communications	Third	Theodore S. Rappaport	Prentice Hall of India, PTR publication	-
2	Wireless Communications	Second	Andreas Molisch	Wiley	-
3	Wireless Network Evolution 2G-3G	Third	Vijay Garg	Pearson Education	
4	4 G Roadmap and Emerging Communication Technologies	Second	Young Kyun Kim and Ramjee Prasad	Artech house	

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Wireless Communication	Second	Singhal	TMH	
2	Mobile Communication	Second	C.Y Lee	Wiley	

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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	Microwave Communication	2	0	2	6	11	2	0	1	3
EC312 (IT12)		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC304: Electromagnetic Waves
Course Objective: The objective of the course is to provide a fundamental understanding of Microwave Communication	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC312.1	Apply EM Wave theory to understand nature of Microwave Signal and their corresponding guiding structures.
EC312.2	Identify Passive Waveguide Components, Sources and Detectors
EC312.3	Analyze Passive Waveguide Components, Sources and Detectors
EC312.4	Compute amplifier and filter design parameters on the basis of application/requirement.
EC312.5	Justify choice of amplifier and filter design parameter.
EC312.6	Design Microwave System components.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC312.1	3	3	3	1	3					3		
EC312.2	2	2	2	2	3					3		
EC312.3	2	2	2	2	3					3		
EC312.4	2	2	2	2	3					3		
EC312.5	2	2	2	2	3					3		
EC312.6	3	3	3		3					3		

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

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC312.1		2			-	
EC312.2		2			-	
EC312.3		2			2	
EC312.4		2			2	
EC312.5		2			2	
EC312.6		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		**Introduction to Microwave Engineering**	1	10
	1.1	Lumped and Distributed Elements, Frequency Bands, Characteristics, Application, Advantages and disadvantages		
	1.2	Rectangular and circular waveguides: TE, TM modes, dominant mode		
	1.3	Microwave Components: Resonators, re-entrant cavities, scattering parameters, tees, hybrid ring, directional couplers, phase shifters, terminations, attenuators, ferrite devices such as isolators, gyrators, and circulators.		
2		**Microwave Tubes and semiconductor devices**	1	10
	2.1	Two Cavity Klystron and Reflex Klystron, Helix Travelling Wave Tube, Cross Field Amplifier, Cylindrical Magnetron.		
	2.2	PIN Diode, Varactor Diode, Schottky Diode, Gunn Diode, Tunnel Diode, IMPATT Diodes.		
3		**Microwave Amplifiers and Filters**	1	08
	3.1	Two port power gain and stability		
	3.2	Microwave Low pass Filter design		
4(Self Study)		**Microwave Frequency Applications:** Radars, Biomedical Devices, Drying materials, Microwave Tomography, Satellite Communication		06
			Total	**28**

Laboratory Component, if any. (Minimum 10 Laboratory experiments using both hardware and software are expected)

Sr. No	Title of the Experiment
1	Model and simulate rectangular waveguide in CAD to study EM wave propagation within it.
2	Model and simulate circular waveguide in CAD to study EM wave propagation within it.
3	Design of Waveguide H-plane TEE using CAD
4	Design of Directional Coupler Using CAD
5	Design of Low pass Filter using CAD
6	Implementation of a technical paper using CAD
7	Microwave bench setup (CO1) A) Introduction to the lab B) Identification of waveguide and its components. How to determine the parameters for each component by looking at the data

	sheet. C) Klystron setup and characterization plotting Vr vs Vo D) Frequency and wavelength measurement of the signal generated by klystron
8	Determination of parameters of passive components using Bench and VNA. Analysis of comparative study to be submitted.
9	Determine the frequency and wavelength in a rectangular waveguide using direct and indirect measurement.
10	Design of Planar Hybrid Ring using CAD

Textbooks:

S. N.	**Title**	**Authors**	**Edition**	**Publisher**	**Year**
1	Microwave Engineering	David M Pozar	Fourth	John Wiley & Sons	**2012**
2	Microwave Devices and Circuits	Samuel Y Liao	Third	Pearson Education	

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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
EC321 (1T21)		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		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	

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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	**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

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	DSP Processors	2	0	2	4	4	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC322 (1T22)		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC303: Digital Signal Processing
Course Objective: To develop implementation of DSP algorithms using DSP Processor	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC322.1	Evaluate different types of errors in DSP implementation.
EC322.2	Describe architectures of TMS320XX devices.
EC322.3	Explore various interfacing devices to DSP Processors.
EC322.4	Demonstrate Fast DSP algorithms using DSP processor
EC322.5	Develop DSP application using DSP hardware.

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	2											
EC322.2		2	1									
EC322.3		2	1									
EC322.4	2				1							
EC322.5			2					1	1	1		1

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		

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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	**Computational Accuracy in DSP Implementations**		04
	1.1	Number formats for signals and coefficients in DSP systems. Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.	1,2	
	1.2	Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors.	1,2	
2	Title	**Programmable DSP Hardware**		08
	2.1	Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT).	1,2	
	2.2	IEEE standard for Fixed- and Floating-Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.	1,2	
3	Title	**Structural and Architectural Considerations**		06
	3.1	Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point &floating-Point TI DSP Processors.	1,2	
	3.2	Data Addressing modes, Memory space of Processors, Program Control, instructions, and programming of TMS320XX Processors.	1,2	
	3.3	On-Chip Peripherals, Interrupts of TMS320XX processors, Pipeline operation of TMS320XX Processors.	1,2	
4	Title	**VLIW Architecture**		06
	4.1	Current DSP Architectures, GPUs as an alternative to DSP Processors.	1,2	
	4.2	Code Composer Studio, Mixed C and Assembly Language programming, on-chip peripherals, Simple applications developments as an embedded environment.	1,2	
	4.3	Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).	1,2	
5	Title	**Hardware implementation of DSP Algorithms**		04
	5.1	The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters	1,2	

	5.2	An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation	1,2	
6	**Self-Study**	A CODEC interface circuit, A CODEC-DSP interface example.		
			Total	**28**

Laboratory Component

Sr. No	Title of the Experiment
1	Harmonic Generation
2	FIR Filtering
3	IIR Filtering
4	Fast Fourier Transform Algorithm
5	Linear Filtering Algorithm
6	Sensor Interface
7	ADC-DAC Interface
8	Real Time Audio Signal Processing
9	Real time Biomedical Signal Processing
10	Real Time Power Signal Processing

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processors, Architecture, Programming and Applications.	First	B. Venkata Ramani and M. Bhaskar	Tata McGraw Hill (TMH) Publication 2004	2004
2	DSP Implementation using DSP microprocessor with Examples from TMS32C54XX	First	Avtar Singh, S.Srinivasan	Thomson Publication	2004

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	DSP Processor Fundamentals, Architectures & Features	First	Phil Lapsley, Jeff Bier, AmitShoham, Edward A. Lee	Wiley Publication	1997
2	Digital Signal Processors Architectures, Implementation and Application	First	Sen M. Kuo&WoonSergGan,	Pearson	2009

3	Architectures for Digital Signal Processing	First	Peter Pirsch,	Wiley Publication	1998
4	Digital Signal Processing	Second	S. Salivahanan A. Vallavaraj G. Gnanapriya	Tata McGraw Hill Publication	2001

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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 and coding	2	0	2	2	6	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC331 (1X)		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC301: Analog and digital communication EC307: Computer Communication Networks
Course Objective: To introduce the principles and applications of information theory. To teach study how information is measured in terms of probability and entropy. To teach coding schemes, including error correcting codes.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC331.1	Interpret information theory concepts and compute the capacity of various types of channels.
EC331.2	Construct various source codes and error correction codes.
EC331.3	Examine information theory and coding algorithms.
EC331.4	Estimate various performance parameters of information theory and error correction coding algorithms.
EC331.5	Survey various error correction codes used in wired and wireless applications.

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

	PO 1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC331.1	3											
EC331.2	3		2		2							
EC331.3	3		2	2	2				2	2		
EC331.4	3	3			1							
EC331.5	1	1			1				1	1		

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

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC331.1		2				
EC331.2		2	2			
EC331.3		2	2	3		
EC331.4		1				
EC331.5		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**	1,2	8
	1.1	Block diagram and sub-system description of a digital communication system, measure of information and properties, entropy and its properties, differential entropy and mutual information kraft inequality, optimal codes, bounds on optimal code length, kraft inequality for uniquely decodable codes.		
	1.2	Source Coding, Shannon's Source Coding Theorem, Huffman Source Coding and its second and third order extensions, Shannon Fano coding, Lempel Ziv coding.		
	1.3	Shannon's Channel capacity: discrete memoryless channels and capacity, examples of channel capacity, symmetric channels, AWGN channel and, fading channels, properties of channel capacity, channel coding theorem.		
2		**Linear Block Codes**	1,2	6
	2.1	Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities.		
	2.2	Standard array and Syndrome decoding.		

	2.3	Hamming Codes, Reed – Muller codes, Golay code, Product codes and Interleaved codes.		
3		**Cyclic Codes**	1,2	6
	3.1	Introduction, Generator and Parity check· Polynomials, Systematic Cyclic codes – Encoding and decoding using Feedback shift register circuits and polynomial method.		
	3.2	Generator matrix for Cyclic codes, Syndrome computation and Error detection.		
	3.3	Meggitt decoder, Cyclic Hamming codes, Golay code, Shortened cyclic codes.		
4		**Convolutional Codes**	1,2	8
	4.1	Graphical representation for encoding and decoding using code tree, trellis, state diagram.		
	4.2	Polynomial and time domain method, Viterbi decoding		
	4.3	Introduction to Turbo coding and LDPC codes		
5(Self Study)		Case study (any one): Golay codes, turbo codes, LDPC codes, Reed Solomon codes, BCH codes		4
			Total	**28**

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 the code efficiency using Shannon – Fano coding and Huffman Coding
3	Write a program to construct Lempel Ziv Coding and decoding and examine its code efficiency
4	Write a program to examine BER performance of linear block code for a coded and uncoded BPSK communication system in AWGN channel
5	Write a program to examine BER performance of cyclic codes for a coded and uncoded BPSK and QPSK communication system in AWGN channel
6	Write a program to examine BER performance of BPSK modulated linear 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 on 802.11a 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 without AWGN channel
9	Write a program to examine BER performance of convolutional encoder in a coded and uncoded OFDM system with and without fading channels
10	Simulation either turbo codes/RS codes/ LDPC codes/BCH codes and test their error correction capability.

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Communication Systems	Fourth	Haykin Simon	John Wiley and Sons, New Delhi	2014
2	Modern Digital and Analog Communication Systems	Fourth	Lathi B Pand Ding Z	Oxford University Press	2009

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Information Theory and Reliable Communication		R. G. Gallager	Wiley, ISBN-13: 978-0471290483	1968
2	Introduction to Coding and Information Theory		Roman, Steven	Springer, ISBN 978-0-387-94704-4	
3	Error Control Coding	Second	Shu Lin & Daniel J. Costello	Prentice Hall	2004
4	Error Control Systems for Digital Communication and Storage		S. B Wicker	Prentice Hall International	1995
5	Digital Communication: Fundamentals and applications	Second	Sklar B, and Ray P. K	Pearson, India	2009
6	Information theory, Coding and Cryptography		Ranjan Bose	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-II	Optical Fiber Communication	2	0	2	6	11	2	0	1	3
EC332 (1Y)		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		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	

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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PROGRAM ELECTIVE COURSES

Assumptions

- Some Elective courses may be of interest to the students of both the branches.
- 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		