Curriculum for UG & PG Programmes

(2024-25 Onwards)

असतो मा सद्गमय

Swami Keshvanand Institute of Technology, Management & Gramothan

(An Autonomous Institute, Affiliated to Rajasthan Technical University, Kota)
(Accredited by NAAC with A ++ Grade)
Approved by AICTE, Ministry of Education, Government of India
Recognized by UGC under Section 2(f) of the UGC Act, 1956

M.Tech. in Digital Communication

Teaching and Examination Scheme

I Year I Semester: M.Tech. (DC)

S. No.	Course Code	Course Name	Category	Teaching Scheme			Exam Hrs	Marks			Credit
				L	T	P		CIE	SEE	Total	
1	ECPL101	**Advanced Digital Communication system**	PCC	3	0	0	3	40	60	100	**3**
2	ECPL102	**Advanced Digital Signal Processing**	PCC	3	0	0	3	40	60	100	**3**
3	ECPL111	**RF and Microwave Circuit Design**	PEC-I	3	0	0	3	40	60	100	**3**
4	ECPL112	**MIMO systems**		3	0	0	3	40	60	100	
5	ECPL113	**Information Theory and Coding**		3	0	0	3	40	60	100	
6	ECPL114	**Modern Satellite Communication**	PEC-II	3	0	0	3	40	60	100	**3**
7	ECPL115	**Terahertz Devices and Applications**		3	0	0	3	40	60	100	
8	ECPL116	**Design of MIC's and MMIC's**		3	0	0	3	40	60	100	
9	NP40.01	**Optimization Techniques**	MCC	3	0	0	3	40	60	100	**3**
10	NP99.XX	**Audit Course**	MCC	-	-	-	3	40	60	100	**0**
11	ECPP130	**Advance Digital Communication Lab**	PCC	0	0	4	2	60	40	100	**2**
12	ECPP131	**Advance Digital Signal Processing Lab**	PCC	0	0	4	2	60	40	100	**2**
13	ECPA100	**Social Outreach , Discipline & Extra Curricular Activities (SODECA)**	SODECA	0	0	0	0	0	0	100	**1**
										Total Credit	**20**

Syllabus

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **Advanced Digital Communication System**	Course Code**: ECPL101**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Unit 1: Review of Signal And Systems :** Signals and Systems with focus on Random Signals, Sampling Theorem, Signal Space and Constellation Diagrams and Orthogonal Signal Sets. Base band modulation and Demodulation: Detection of binary signals in Gaussian Noise, optimum receivers for channels with ISI , AWGN, Equalization, Carrier and symbol synchronization, and Signal Design for band limited channels.	12
3	**Unit 2: Band pass Modulation and Demodulation:** All Modulation Techniques, Coherent and Non Coherent Detection, Error performance for binary system, and Symbol error performance for M-ray systems.	11
4	**Unit 3: Communication Link Analysis:** Link budget analysis, Simple link analysis, system trade-offs, and Modulation coding trade-offs.	11
5	**Unit 4: Spread Spectrum:** signal PN sequences, direct sequence spread spectrum, DS-CDMA, frequency-hopped spread spectrum, FH-CDMA, and Jamming consideration. Communication through Fading Channels.	10
	Total	**45**

Text Books:

1.Simon Haykin, "Digital Communication Systems", 2nd Edition, Wiley, 2006.
2.B. P. Lathi, "Modern Digital and Analog Communication Systems", 4th Edition, Oxford, 2011.
3.Taub and Schilling, "Principles of Communication Systems", 4th Edition, TMH,
2013.

Reference Books:

1.Sklar and Ray, "Digital Communications", 2nd Edition, Pearson, 2008.
2.Glover and Grant, "Digital Communications", 3rd Edition, Pearson, 2010.
3.John G. Proakis and MasoudSalehi, "Digital Communications", 5th Edition, Mc-Graw Hill Education, 2007.

Prerequisite:

1. Electronics Devices and Circuits

Course Outcomes:After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL101.1	Discuss different modulation schemes in terms of error performance and bandwidth requirement.	L2
ECPL101.2	Apply mathematics in the analysis and design of a digital communication system.	L3
ECPL101.3	Use advanced communication techniques to improve the performance of a system.	L3
ECPL101.4	Analyze mathematically the effects of noise in a system	L4
ECPL101.5	Analyze mathematically the effects of the communication link	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL101.1	2	-	1	3	3
ECPL101.2	3	-	1	3	3
ECPL101.3	3	-	1	3	3
ECPL101.4	3	-	1	3	3
ECPL101.5	3	-	1	3	3
ECPL101	**3**	**-**	**1**	**3**	**3**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **Advanced Digital Signal Processing**	Course Code**: ECPL102**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT-1Multirate Sampling:** Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion, Multistage Implementation of Sampling Rate Conversion, Applications of Multirate Signal Processing, Sampling Rate Conversion of Band pass Signals	8
3	**UNIT 2 Frequency Domain Analysis:** Discrete Fourier transform (DFT), Inverse DFT, Inter relationship with z-transform and Hilbert-transforms, Discrete Hilbert transform, FFT algorithms- Decimation in time and decimation in frequency. Spectral analysis using DFT, Short term DFT.	8
4	**UNIT 3 Linear Prediction And Optimum Linear Filters:** Innovations Representation of a Stationary Random Process, Forward and Backward linear prediction, Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters.	8
5	**UNIT 4 Power Spectral Estimation:** Estimation of Spectra from Finite Duration Observations of a signal, the Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods	10
6	**UNIT 5 Parametric Method of Power Spectrum Estimation:** Parametric Methods for power spectrum estimation, Relationship between Auto-Correlation and Model Parameters, AR (Auto-Regressive) Process and Linear Prediction, Yule-Walker, Burg and Unconstrained Least Squares Methods .	10
	Total	45

Text Books:

1. J.G. Proakis & D.G. Manolokis, “Digital Signal Processing – Principles, Algorithms Applications' ', PHI.
2. Alan V Oppenheim & Ronald W Schaffer, “Discrete Time signal processing”, PHI.

Reference Books:

1. S. M .Kay, “Modern spectral Estimation techniques' ', PHI, 1997.Emmanuel C. Ifeacher Barrie. W. Jervis, “DSP – A Practical Approach”, Pearson Education.
2. Sanjit K Mitra “Digital Signal Processing” TMH

Prerequisite:

1. Signals and Systems
2. Digital Signal Processing

Course Outcomes:After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL102.1	Explain discrete signals, systems and their significance	L2
ECPL102.2	Apply interpolation and decimation for multi rate sampling based problems	L3
ECPL102.3	Compute sampling frequency for multi-rate Signal Processing	L3
ECPL102.4	Apply the optimization in filter designing	L3
ECPL102.5	Apply power spectral estimation methods	L3

Mapping of COs with POs-PSOs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
ECPL102.1	2	-	2	3	2
ECPL-102.2	2	-	2	3	2
ECPL102.3	2	-	2	3	2
ECPL102.4	3	-	2	3	2
ECPL102.5	3	-	2	3	2
ECPL102	**3**	**-**	**2**	**3**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **RF and Microwave Circuit Design**	Course Code**: ECPL111**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Review** of basics of Passive and Active Circuits.	2
3	**UNIT 2 Microwave Amplifier Design:** Comparison of active devices such as BJT, MOSFET, MESFET, HEMT, and HBT; Circuit models for FETs and BJTs; Two- port power gains; Stability of transistor amplifier circuits; Amplifier design using S-parameters: Design for maximum gain, maximum stable gain, design for specified gain.	8
4	**UNIT 3 RF power amplifiers:** Introduction, class A, AB, B, and C power amplifiers, class D amplifiers, class E amplifiers, Class F amplifiers, summary of PA characteristics, RF PA design examples LNA design: Introduction, LNA topologies- power match vs. noise match, Power constrained noise optimization, Design examples, Linearity and large-signal performance, Spurious free dynamic range	10
5	**UNIT 4 Mixers:** Mixer characteristics: Image frequency, conversion loss, noise figure; Devices for mixers: p-n junctions, Schottky barrier diode, FETs; Diode mixers: Small-signal characteristics of diode, single-ended mixer, large-signal model, switching model; FET Mixers: Single-ended mixer, other FET mixers; Balanced mixers; Image reject mixers, Analysis of microwave mixers.	10
6	**UNIT 5 Oscillators and Frequency Synthesizers:** General analysis of RF oscillators, transistor oscillators, voltage-controlled oscillators, dielectric resonator oscillators, frequency synthesis methods, analysis of first and second order phase-locked loop, oscillator noise and its effect on receiver performance	8
7	**UNIT 6 Switches:** Devices for microwave switches: PIN diode, BJT, FET; Device models; Types of switches; Switch configurations; Basic theory of switches; Multi-port, broad-band and isolation switches.	6
	Total	**45**

Text Books:

1. Pozar, D.M. "Microwave and RF Design of Wireless Systems", John Wiley & Sons. 2001
2. Gonzalez, G., "Microwave Transistor Amplifiers: Analysis and Design", 2nd Ed., Prentice-Hall. 1997
3 .Bahl, I. and Bhartia, P., "Microwave Solid State Circuit Design", 2nd Ed., John Wiley & Sons. 2003
4. Chang, K., Bahl, I. and Nair, V., "RF and Microwave Circuit and Component Design for Wireless Systems", Wiley Interscience. 2002

Reference Books:

1. Rohde, U.L. and Newkirk, D.P., "RF/Microwave Circuit Design for Wireless Applications", John Wiley & Sons. 2000
2. Larson, L.E., "RF and Microwave Circuit Design for Wireless Applications", Artech House. 1996
3. Egan, W. F., "Practical RF Circuit Design", John Wiley & Sons. 1998

Prerequisite:

1. Basic circuit theory.
2. Understanding of semiconductor device principles.
3. Familiarity with electromagnetic theory and transmission line concepts.

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL111.1	Design oscillators, frequency synthesizers and switches.	L3
ECPL111.2	Analyze the fundamental principles of passive and active circuits.	L4
ECPL111.3	Design and analyze RF power amplifiers by selecting appropriate amplifier classes and topologies to meet specified requirements, considering factors such as efficiency, linearity and spurious-free dynamic range.	L4
ECPL111.4	Examine the operation and characteristics of mixers, employing knowledge of device types and mixer configurations to analyze their performance parameters such as conversion loss, noise figure, and image rejection, with an emphasis on practical design considerations.	L4
ECPL111.5	Evaluate the performance characteristics of various microwave amplifier designs, including BJT, MOSFET, MESFET, HEMT, and HBT, utilizing circuit models and two-port power gains to optimize amplifier design for specific criteria.	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL111.1	3	-	3	1	1
ECPL111.2	3	-	3	1	2
ECPL111.3	3	-	3	2	2
ECPL111.4	3	-	3	2	2
ECPL111.5	3	-	3	2	2
ECPL111	**3**	**-**	**3**	**2**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **MIMO systems**	Course Code**: ECPL112**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Introduction to Multi-antenna Systems:** Types of multi-antenna systems, MIMO vs. multi-antenna systems, Diversity-multiplexing trade-off, transmit diversity schemes, Delay diversity, Cyclic delay diversity, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation, advantages and applications of MIMO systems	8
3	**UNIT 2 Analytical MIMO Channel Models:** Uncorrelated, fully correlated, separately correlated and keyhole MIMO fading models, parallel decomposition of MIMO channel. Power allocation in MIMO systems: Uniform, adaptive and near optimal power allocation. Channel state information, Beam forming, Beam forming principles, Increased spectrum efficiency, Interference cancellation	6
4	**UNIT 3 Space-Time Codes:** Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space-time codes over separately correlated MIMO channel, Space-time turbo codes. MIMO detection: ML, ZF, MMSE, ZF-SIC, MMSE-SIC, LR based detection	12
5	**UNIT 4 Channel Estimation:** Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.	12
6	**UNIT 5 Advances in MIMO Wireless Communications:** Spatial modulation, MIMO based cooperative communication and cognitive radio, multi-user MIMO, cognitive-photocells and large MIMO systems for 5G wireless.	6
	Total	45

Text Books:

1. B. Clerckx and C. Oestges, MIMO wireless networks, Elsevier Academic Press, 2nd ed., 2013.
2. N. Costa and S. Haykin, Multiple-input multiple-output channel models, John Wiley & Sons, 2010.
3. A. Chokhalingam and B. S. Rajan, Large MIMO systems, Cambridge University Press, 2014.

Reference Books:

1. T. M. Duman and A. Ghrayeb, "Coding for MIMO communication systems", John Wiley and Sons, 2007.
2. J. Choi, "Optimal Combining & Detection", Cambridge University Press, 2010.
3. Hamid Jafarkhani, "Space Time coding-Theory and Practice",Cambridge University Press, First Edition, 2005.
4. David Tse, PramodViswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
5. M. Janakiraman, "Space-time codes and MIMO systems", Artech House, 2004.
6. Upena Dalal, "Wireless Communication", Oxford University Press, 2009

Prerequisite:

1. Mathematical analysis of various modulation schemes.
2. Knowledge of antenna design and its parameters.
3. Basic Knowledge of wireless and digital communication.

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL112.1	Describe the new technical advances in MIMO wireless communications	L1
ECPL112.2	Explain Multi antenna MIMO system along with its applications	L2
ECPL112.3	Implement a MIMO system	L3
ECPL112.4	Analyze space time codes for MIMO systems	L4
ECPL112.5	Investigate channel estimation for MIMO systems	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL112.1	2	-	1	3	1
ECPL112.2	2	-	1	3	1
ECPL112.3	2	-	1	3	1
ECPL112.4	2	-	1	3	1
ECPL112.5	2	-	1	3	1
ECPL112	**2**	**-**	**1**	**3**	**1**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **Information Theory and Coding**	Course Code**: ECPL113**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Introduction to Information Theory and Coding:** Definition of Information Measure and Entropy, Relative Entropy, Extension of an Information Source and Markov Source, Adjoint of An Information Source, joint and Conditional Information Measure, Properties of Joint and Conditional Information Measures and a Markov Source, Asymptotic Properties of Entropy and Problem Solving in Entropy, Estimation of Probability Density and Probability Mass functions, Expectation-Maximization algorithm, Maximum Entropy Principle Jensen's Inequality- Fano's Inequality	8
3	**UNIT 2 Introduction to lossless Coding:**Block Code and its Properties, Instantaneous Code and Its Properties, Kraft-McMillan Equality and Compact Codes, Shannon's Source Coding Theorem, Prefix Coding, Huffman Coding and Proof of Its Optamality, Competitive Optamality of the Shannon Code, Adaptive Huffman Coding, Shannon-fano Coding, Arithmetic Coding, Lempel-ziv Algorithm	8
4	**UNIT 3 Channel Capacity and Coding :**Introduction to Discrete information Channels, Equivocation and mutual information, Properties of Different information Channels, Reduction of information Channels, Noiseless Channel, Properties of Mutual information and introduction to Channel Capacity, Calculation of Channel Capacity for Different information Channels, Shannon's Channel Coding Theorem, Bandwidth S/N Trade-off, Channel Capacity Theorem, Discussion an Error free Communication over Noisy Channel, Error free Communication over a binary Symmetric Channel and introduction to Continuous Sources and Channels, Differential Entropy and Evaluation of Mutual information for Continuous Sources and Channels, Channel Capacity of A band-limited Continuous Channel.	9
5	**UNIT 4 Linear Block and Cyclic Error:**Correction Coding, Definition of Terms - Redundancy, Code Efficiency, Systematic Codes, Hamming Distance, Hamming weight, Hamming bound- Types of Codes - Parity Check Codes, Hamming Codes, BCH Codes, Reed-Solomon Codes, Concatenated Codes- linear block Codes, generator and Parity Check Matrix, Syndrome Decoding- Cyclic Codes, generation and Detection- Coding for Reliable Communication, Coding gain, bandwidth Expansion Ratio- Comparison of Coded and Uncoded systems.	8

6	**UNIT 5 Convolution Codes:** Burst Error Detecting and Correcting Codes- Convolutional Codes- Time Domain and frequency Domain Approaches- Code Tree, Trellis and State Diagram- Decoding of Convolutional Codes, Viterbi's Algorithm, Sequential Decoding- Transfer function and Distance Properties of Convolutional Codes- bound on the bit Error Rate- Coding gain.	6
7	**UNIT 6 Coded Modulation:** Coding for bandwidth Constrained Channels - Combined Coding and Modulation, Trellis Coded Modulation (TCM), Set-partitioning, Encoder and Decoder Design for TCM, Decoding of TCM Codes using the Viterbi Algorithm.	5
	Total	**45**

Text Books:

1. Ranjan Bose, "Information Theory, Coding and Cryptography", Tata McGraw Hill, 2nd edition.
2. P.S. Satyanarayana, "Concepts of Information Theory and Coding", Dynaram Publication, 2005
3. Simon Haykin, "Digital communication," , John Wiley, 2003

Reference Books:

1. Shu Lin and Daniel Castello, "Error Control Coding – Fundamentals and Applications", second edition 2004
2. Thomas M Cover, Joy Thomas, "Elements of Information Theory", 2nd Edition, 2013.
3. HariBhat ,"Information Theory and Coding", Ganesh Rao, Cengage, 2017.

Prerequisite:

1.Random Variables and Probabilities
2. Probability Density Functions (PDFs) and Cumulative Distribution Functions (CDFs)

Course Outcomes:After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL113.1	Explain various methods of generating and detecting different types of error correcting codes	L2
ECPL113.2	Implement the various types of source coding algorithms and analyze their performance.	L3
ECPL113.3	Derive equations for entropy, mutual information and channel capacity for all kinds of channels.	L3
ECPL113.4	Design linear block codes and cyclic codes (encoding and decoding).	L3
ECPL113.5	Implement and decode a sequence at the receiver using Trellis decoder and Viterbi decoder.	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL113.1	2	-	1	1	1
ECPL113.2	2	-	1	1	1
ECPL113.3	2	-	1	1	1
ECPL113.4	2	-	1	1	1
ECPL113.5	2	-	1	1	1
ECPL113	**2**	**-**	**1**	**1**	**1**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **Modern Satellite Communication**	Course Code**: ECPL114**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Architecture of Satellite Communication:** Origin and History of Satellite Communication, Current State of Satellite Communication, Orbital Aspect of Satellite Communication , Orbital Mechanism , Equation of Orbit, Locating Satellite in Orbit , Orbital Elements , Orbital Perturbation.	10
3	**UNIT 2 Orbital Analysis:** Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day.	8
4	**UNIT 3 Satellite Subsystems:** Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power subsystems, antenna sub-system.	8
5	**UNIT 4 Indian Satellite Launch Vehicle:** SLV (Satellite Launch Vehicle), ASLV (Augmented Satellite Launch Vehicle), PSLV (Polar Satellite Launch Vehicle), GSLV (Geosynchronous Satellite Launch Vehicle), GSLV Mk III, Sounding Rockets.	6
6	**UNIT 5 Satellite Link Design:** Satellite Link Design, System Noise Temperature and G/T Ratio, Downlink Design, Domestic Satellite System, Uplink Design	6
7	**UNIT 6 Indian Regional Navigation Satellite System:** IRNSS System Overview, IRNSS Signal Characteristics, IRNSS Data Structure, Sub Frame Structure.	6
	Total	**45**

Text Books:

1. T. Pratt & C.W. Bostain, Satellite Communication, Wiley 2000
2. M. Richharia , "Satellite Communication Systems Design Principles", Pearson Publications 2nd edition,1999.
3. Wilbur, L. Pritchand, Robert A. Nelson and Heuri G. Suyderhoud, "Satellite Communications Engineering – 2ndEd., Pearson Publications.

Reference Books:

1. D C Agarwal, Satellite Communication, Khanna Publication,5TH Edition.
2. D. Roddy, Satellite Communication (4/e), McGraw- Hill, 2009.
3. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.

Prerequisite:

1.Introduction to Communication Systems
2. Need of Satellite Communication
3. Electromagnetic Waves and Antennas
4. Basics of Digital Communication

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL114.1	Recall the basic concepts and terminologies of Satellite Communication	**L1**
ECPL114.2	Explain the Fundamentals of Orbital Mechanics & Indian Satellite Launchers.	**L2**
ECPL114.3	Make use of satellite systems and calculate orbital equations of transmitted and received signals through satellite.	**L3**
ECPL114.4	Solve Link power budget including Propagation effects in Satellite	**L3**
ECPL114.5	Examine the Indian Regional Navigation Satellite System.	**L4**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL114.1	2	-	1	1	1
ECPL114.2	2	-	1	1	1
ECPL114.3	2	-	1	1	1
ECPL114.4	2	-	1	1	1
ECPL114.5	2	-	1	1	1
ECPL114	**2**	**-**	**1**	**1**	**1**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **Terahertz Devices and Applications**	Course Code**: ECPL115**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Terahertz Overview and Principles:** Electromagnetic Radiation and Propagation Fundamentals, Terahertz Principles, Towards Terahertz communication systems, Key technological issues for Terahertz technology	7
3	**UNIT 2 Terahertz Sources :** The development of Terahertz sources, Terahertz sources based on Schottky diode frequency multipliers, Free Electron based Terahertz sources, Compact Tunable Terahertz Sources very short wave length Vacuum Electronic devices, Photo mixing Tunable Terahertz sources, Terahertz magnetic response from artificial material, Continuous wave THz radiation generation through nonlinear processes.	10
4	**UNIT 3 THz Detectors:** Pyroelectric detectors, gallium doped Germanium photoconductive detector, Bolometer detectors, composite Germanium Bolometer, unturned Indium Antimode, Go lay Cell detectors, Terahertz Electronic components, Travelling Wave Terahertz detector, Tunable Plasma Wave-HEMT THz Detector, Terahertz detector on a single chip, Quantum dot Photodetector, Multiband Terahertz detection and imaging devices, Integrated Terahertz Imager based on quantum dots, CNT based QD frequency tunable THz detector.	10
5	**UNIT 4 Low coherence THz signal sources and applications and THz chemical spectroscopy:** Introduction, Schemes for Noise generation, Characterization of noise signals, Imaging,2D imaging, Tomographic imaging, spectroscopy, amplifier characterization, Application: Terahertz spectroscopic imaging, chemical mapping of pharmaceuticals in medicine	9
6	**UNIT 5 Industrial and Wireless communications Applications of Terahertz waves :** Different kinds of Terahertz systems, Polymer Industry, Polymeric compounds, Paper Industry, Food Industry, Pharmaceuticals Industry, crops Industry, why the terahertz waves for communication, current technologies, frequency dispersion, Ray shadowing by moving persons.	8
	Total	**45**

Text Books:

1. Dimitris Pavlidis, "Fundamentals of Terahertz Devices and Applications", Wiley,August 2021 ISBN: 978-1-119-46071-8
2. Ali Rostami, Hassan Rasooli, Hamed Baghban, "Terahertz Technology: Fundamentals and applications," New York, Springer, 2011.

Reference Books:

1. RE Miles,P Harisson, D Lippens "Terahertz Sources and Systems ",Springer Science+Business media, BV 2000, ISBN 978-94-010-0824-2.
2. Kiyomi Sakai, "Terahertz Optoelectronics", Springer, 2004, ISBN 978-3-540-20013-0.
3. Ho-Jin Song,Tadao Nagatsuma, "Handbook of Terahertz Technologies, Devices and applications", Pan Stanford Publishing Pte. Ltd. 2015, ISBN: 9789814613088.

Prerequisite:

1. Semiconductor Physics
2. Wireless and Optical Communications

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL115.1	Identify THz principles and components.	L1
ECPL115.2	Understand technological issues and limitations of terahertz	L2
ECPL115.3	Select THz sources and detectors for a given application.	L2
ECPL115.4	Apply THZ systems knowledge for different Industrial and communication applications.	L3
ECPL115.5	Analyze suitability of THz imaging and spectroscopy systems for different applications.	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL115.1	2	-	1	3	2
ECPL115.2	2	-	1	3	2
ECPL115.3	2	-	1	3	2
ECPL115.4	2	-	1	3	2
ECPL115.5	2	-	1	3	2
ECPL115	**2**	**-**	**1**	**3**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year: I	Semester: I
Course Name: **Design of MIC's and MMIC's**	Course Code: ECPL116	Credit: 3
Max Marks: 100	CIE: 40	SEE: 60
End Term Exam Time: 3 Hrs	Teaching Scheme: 3L+0T+0P	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Introduction to Microwave Integrated Circuits (MIC)** and Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, Thick and Thin film technologies and materials, encapsulation and mounting of active devices in MIC and MMIC.	8
3	**UNIT 2 Hybrid MIC:** Definition, characteristics, comparison with conventional circuits, fields of application and limitations and criteria for the choice of substrate material; thin film hybrid circuits, thick film hybrid circuits, artwork, mask making, photolithography, resistor stabilization, sawing, brazing process, wire bonding.	8
4	**UNIT 3 Different Types of MMIC:** Advantages, disadvantages and application of MMICs, MMIC fabrication techniques, Thick and Thin film technologies and materials, Encapsulation and mounting of active devices, Introduction to MM-Wave Integrated Circuits, GaAs Fabrication Technology and various processes, Materials used for MM-wave Integrated Guides	10
5	**UNIT 4 Passive Circuit Elements:** Transmission lines for Microwave Integrated Circuits, Discontinuities, Lumped elements Passive Components: Introduction, Power transfer in parallel-coupled guides, Parallel Guide Directional Couplers, Other Directional Couplers, Ring Resonator Filters.	8
6	**UNIT 5 Active Semiconductor Circuit Elements:** Schottky-barrier diodes, Varactor diodes, p-i-n diodes, MESFETs, HEMTs Active Components: Introduction, Image Guide Detector Circuits, Electronic Phase Shifters, Balanced Mixers, High Frequency Devices, Low Noise MM-wave Amplifiers, Monolithic Mixers..	10
	Total	**45**

Text Book:

1. David H. Schrader, "Microstrip Circuit Analysis" Prentice Hall PTR, New Jersey
2. KC. Gupta, R. Gargand I.J. Bahl , "Microstrip lines and Slot lines"- Artech House.
3. I. D. Robertson, "MMIC Design" The Institution of Electrical Engineers, U.K., 1995

Reference Books:

1. B. Bhat, S. K. Koul, "Stripline-like Transmission lines for Microwave Integrated circuits", Wiley Eastern Ltd., New Delhi.
2. T.C.Edwards, "Foundations for Microstrip Circuit Design (2/e)", Wiley, 1992.
3. Ravender Goyal, "Monolithic MIC; Technology & Design", Artech House, 1989.

Prerequisite:

1. Microwave Theory & Technique
2. IC technology
3.EMFT

Course Outcomes:After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL116.1	Understand the concept of hybrid and monolithic MIC technology..	**L2**
ECPL116.2	Interpret conformal transformation method and its application in characterization and design of microstrip integrated circuits	**L2**
ECPL116.3	Realize microwave distributed circuit elements.	**L3**
ECPL116.4	Examine different measurement techniques for microwave and MM-wave technology	**L3**
ECPL116.5	Analyze the active elements for microwave and MM-wave technology.	**L4**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL116.1	3	-	1	2	2
ECPL116.2	3	-	1	2	2
ECPL116.3	3	-	1	3	2
ECPL116.4	3	-	1	3	2
ECPL116.5	3	-	1	3	2
ECPL116	**3**	**-**	**1**	**3**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name:**Optimization Techniques**	Course Code**: NP40.01**	Credit**:** 3
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme:3L**+0T+0P**	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction to optimization:** Engineering applications of optimization, Mathematical Modeling and simulation, Formulation of structural optimization problems as programming problems. Graphical method.	7
3	**Linear Programming:** Theory of Simplex Method, Standard form of LPP, feasible solution and basic feasible solution, Improving BFS, Optimality condition, Unbounded solution, Alternative optimal solution, Simplex method, Big M Method, Two phase method.	9
4	**Metaheuristics in Optimization:** Genetic algorithms, Tabu search, particle swarm intelligence and their applications in Engineering	8
5	**PERT & CPM:** Objective of CPM & PERT, elements of network, network rules, constraints, error in network, Critical Path Analysis, Activity time and floats, optimization through CPM techniques, PERT and three estimates, critical path analysis of a PERT network, probability of completion of project, controlling and monitoring.	9
6	**Non-linear Programming:** Local and global minima of one and two variables, constraints optimization, Lagrange's Method, K-T conditions, Steepest descent method, Conjugate gradient method.	11
	Total	**45**

Text Books:

1. S. S. Rao, Engineering Optimization: Theory and Practice , Wiley, 2008.
2. K. Deb, Optimization for Engineering design algorithms and Examples , Prentice Hall, 2 nd edition 2012.

Reference Books:

1. Operations Research, Hira & Gupta,
2. C.J. Ray, Optimum Design of Mechanical Elements , Wiley, 2007.
3. R. Saravanan, Manufacturing Optimization through Intelligent Techniques , Taylor & Francis Publications, 2006.
4. D. E. Goldberg, Genetic algorithms in Search, Optimization, and Machine Learning , Addison-Wesley Longman Publishing, 1989.

Prerequisite:

1. Basic concepts of matrix operations, graph study, differentiation

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
NP40.1.1	**Determine** Mathematical formulation of given design problem and achieve optimal solution using Graphical method, Cutting plane method.	**L3**
NP40.1.2	**Solve** Linear programming problems using Simplex method, Two Phase method, Big-M method	**L3**
NP40.1.3	**Calculate** nonlinear programming problems using Lagrange's method, K-T conditions and numerical methods like Steepest descent method, Conjugate gradient method.	**L3**
NP40.1.4	**Use** PERT and CPM to control and monitor projects effectively.	**L3**
NP40.1.5	**Analyze** Metaheuristics based optimization and its applications to solve complex optimization problems using genetic algorithms, tabu search and particle swarm intelligence.	**L4**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
NP40.1.1	2	2	-	2	1
NP40.1.2	2	2	-	2	1
NP40.1.3	2	2	-	2	1
NP40.1.4	2	2	-	2	1
NP40.1.5	2	2	-	2	1
NP40.1	**2**	**2**	**-**	**2**	**1**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **Advance Digital Communication Lab**	Course Code**: ECPP130**	Credit**: 2**
Max Marks: **100**	CIE: **60**	SEE: **40**
End Term Exam Time: **2 Hrs**	Teaching Scheme: **0L+0T+4P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	2
2	PCM Encoding and Decoding Use MATLAB • To simulate PCM encoding and decoding processes for an analog signal. • Observe how an analog signal is sampled, quantize, and encoded into a digital form. • To simulate PCM encoding with different quantization levels and observe the resulting quantization error.	16
3	Signal Modulation and Demodulation: • Understand different digital modulation schemes (e.g., BASK, BFSK, BPSK and QPSK). Use MATLAB • simulate and visualize the modulation and demodulation process. • Analyze the effect of noise on different modulation schemes	16
4	Digital Filters Design: Use MATLAB • Design digital filters (e.g., FIR, IIR) . • Apply the designed filters to process digital signals. • Evaluate the performance of different filter designs in terms of frequency response and filter order.	16
5	OFDM System Design: Use MATLAB • To design and simulate an OFDM system. • Analyze the performance of the OFDM system under different channel conditions.	10
	Total	**60**

Text Books:

1."Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris G. Manolakis

2."Discrete-Time Signal Processing" by Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck

3. Digital Signal Processing: A Practical Approach" by Emmanuel Ifeachor and Barrie Jervis

Reference Books:

1. "Digital Signal Processing Using MATLAB" by Vinay K. Ingle and John G. Proakis
2. "Digital Signal Processing Laboratory Using MATLAB" by E. S. Gopi

Prerequisite:

1. Understanding of Digital Modulation techniques
2. Basics of MATLAB Programming
3. Knowledge of Probability and Random Processes
4. DSP concepts such as signal sampling, quantization, Fourier analysis, and digital filtering

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPP130.1	Utilize MATLAB simulations to investigate the performance of different modulation schemes	**L3**
ECPP130.2	Develop a MATLAB script to simulate the performance of an OFDM system and optimize its parameters for a given channel condition	**L3**
ECPP130.3	Utilize MATLAB to simulate PCM encoding and decoding for various analog signal waveforms, adjusting sampling rates and quantization levels to observe their effects on signal fidelity:	**L3**
ECPP130.4	Analyze the impact of filter design parameters on the frequency response of a digital filter	**L4**
ECPP130.5	Evaluate the trade-offs between different modulation schemes in terms of bandwidth efficiency and susceptibility to channel noise	**L4**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPP130.1	3	3	3	3	2
ECPP130.2	3	3	3	3	2
ECPP130.3	3	3	3	3	2
ECPP130.4	3	3	3	3	2
ECPP130.5	3	3	3	3	2
ECPP130	**3**	**3**	**3**	**3**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I**
Course Name: **Advance Digital Signal Processing Lab**	Course Code**: ECPP131**	Credit**: 2**
Max Marks: **100**	CIE: **60**	SEE: **40**
End Term Exam Time: **2 Hrs**	Teaching Scheme: **0L+0T+4P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	2
2	**(Use Matlab for this Lab)** Introduction to Advanced DSP ● Review of basic DSP concepts ● Complex signals and systems	4
3	Spectral Analysis ● Fourier Transform and Fourier Series ● Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)	6
4	Advanced Filtering Techniques ● FIR filter design techniques (Windowing methods) IIR filter design techniques (Butterworth, Chebyshev, Elliptic filters) ● Design of Multirate systems (Decimation and Interpolation)	12
5	Statistical Signal Processing ● Random signals and stochastic processes ● Estimation theory (Parameter estimation, Least Squares estimation) ● Detection theory (Hypothesis testing, Signal detection)	12
6	Adaptive Signal Processing ● Adaptive filtering fundamentals ● LMS algorithm and its variants ● Applications of adaptive filters (Noise cancellation, Echo cancellation)	12
8	Advanced DSP Applications ● Image and video processing ● Biomedical signal processing	12
	Total	**60**

Text Books:

1."Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris G. Manolakis
2."Discrete-Time Signal Processing" by Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck
3."Digital Signal Processing: A Practical Approach" by Emmanuel Ifeachor and Barrie Jervis

Reference Books:

1. "Digital Signal Processing Using MATLAB" by Vinay K. Ingle and John G. Proakis
2. "Digital Signal Processing Laboratory Using MATLAB" by E. S. Gopi

Prerequisite:

1.A solid understanding of mathematical concepts relevant to signal processing is essential
2.Proficiency in programming languages commonly used in DSP, such as MATLAB, Python, or C/C++, is important
3.Understanding of advanced signal processing theory beyond the basics is necessary.
4.Since DSP often intersects with digital communications, familiarity with digital modulation techniques, channel coding, and communication systems is advantageous.

Course Outcomes:After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPP131.1	Understand advanced concepts in digital signal processing and their applications.	L2
ECPP131.2	Apply spectral analysis techniques to analyze signals in both time and frequency domains.	L3
ECPP131.3	Implement adaptive and advanced digital signal processing for real-world applications.	L3
ECPP131.4	Apply statistical signal processing for random signals using estimation and detection theory	L3
ECPP131.5	Analyze and design advanced digital filters for various signal processing tasks.	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPP131.1	3	3	3	3	2
ECPP131.2	3	3	3	3	2
ECPP131.3	3	3	3	3	2
ECPP131.4	3	3	3	3	2
ECPP131.5	3	3	3	3	2
ECPP131	**3**	**3**	**3**	**3**	**2**

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Teaching and Examination Scheme

I Year II Semester: M.Tech. (DC)

S. No.	Course Code	Course Name	Category	Teaching Scheme			Exam Hrs	Marks			Credit
				L	T	P		CIE	SEE	Total	
1	ECPL201	**Fiber Optic Communications and Optical Networks**	PCC	3	0	0	3	40	60	100	**3**
2	ECPL202	**Smart Antennas**	PCC	3	0	0	3	40	60	100	**3**
3	ECPL211	**Automation using IOT and AI**	PEC-III	3	0	0	3	40	60	100	**3**
4	ECPL212	**Advanced Photonics devices and components**		3	0	0	3	40	60	100	
5	ECPL213	**Applied Machine Learning**		3	0	0	3	40	60	100	
6	ECPL214	**Neural Network and Fuzzy Logic**	PEC-IV	3	0	0	3	40	60	100	**3**
7	ECPL215	**Cryptography and Network security**		3	0	0	3	40	60	100	
8	ECPL216	**Adaptive Digital Image Processing**		3	0	0	3	40	60	100	
9	NP99.XX	**Audit Course**	MCC	-	-	-	3	40	60	100	**0**
10	ECPP230	**Antenna & Radiating System Lab**	PCC	0	0	4	2	60	40	100	**2**
11	ECPP231	**Wireless and Fiber Optical Communication Lab**	PCC	0	0	4	2	60	40	100	**2**
12	ECPD250	**Mini Project & Seminar**	REW	0	0	4	2	60	40	100	**2**
13	ECPA200	**Social Outreach , Discipline & Extra Curricular Activities (SODECA)**	SODECA	0	0	0	0	0	0	100	**1**
										Total Credit	**19**

Syllabus

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Fiber Optic Communications and Optical Networks**	Course Code**: ECPL201**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Introduction to Optical fiber:** LEDs for Optical Communication:Quantum dot LEDs (QLEDs): Emission characteristics, color-tunable LEDs, and applications, Plasmonic LEDs, Nanophotonic LEDs: Photonic crystal LEDs, nanowire LEDs, and metal-insulator-metal (MIM) LEDs for improved light extraction and efficiency, Organic light-emitting diodes (OLEDs): Electroluminescent materials, device architectures, and applications in displays.	8
3	**UNIT 2 Optical sources LASER:** Quantum well lasers: Design, fabrication, and operation principles.Quantum cascade lasers (QCLs): Band structure engineering, mid-infrared (mid-IR) emission, and applications in spectroscopy and sensing. Vertical-cavity surface-emitting lasers (VCSELs): Fabrication techniques, mode control, and high-speed modulation. Widely tunable lasers, High-power diode lasers. Industrial and medical applications.	9
3	**UNIT 3 Photo Detectors and Optical Components:** PIN photodiodes, Avalanche photodiodes Optical Amplifiers: Raman amplifiers, EDFAs and semiconductor optical amplifiers (SOAs) for WDM signal amplification. Optical Modulators: Electro-optic modulators, Mach-Zehnder modulators (MZMs), Semiconductor optical modulators, Semiconductor Optical Switches. Electro-Optic Semiconductor Optical Switches, (MZI) Semiconductor Optical Switches.	9
4	**UNIT 4 Optical Networks: Optical Network Evolution and Concepts:** Optical networking terminology, Optical network node and switching elements, Wavelength division multiplexed networks, Optical network transmission modes, layers and protocols: Synchronous networks, Asynchronous transfer mode, Optical switching networks, Optical network deployment: Long-haul networks, Metropolitan area networks, Access networks, Local area networks.	9
5	**UNIT 5 Applications and Future Trends Optical Communication:** in data centers, optical networks with 5G and beyond, Deployment of dense fiber networks, fiber-to-the-antenna (FTTA) solutions, Optical communication for IoT applications, optical sensors and instrumentation in industrial applications, need for scalability, cost-effectiveness, and energy efficiency in optical networks.	9
	Total	**45**

Text Books:

1.Ghatak A and Tyagarajan K, "Introduction to Fiber optics", Cambridge University Press, 1998
2.Thyagarajan K and Ghatak A., " Fiber Optic Essentials", Wiley Interscience, 2007

Reference Books:

1.Rajiv Ramaswami: "Optical Networks: A Practical Perspective" (3rd edition, 2010); Morgan Kaufman/Elsevier
2.Keiser, Gerd: Optical Fiber Communications, 4th Ed., McGraw Hill (2009).

Prerequisite:

1. Working principle and Types of Fiber
2. Propagation losses and dispersion in optical fiber Commnuication
3.Basics of networking

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL201.1	Describe the different types of LEDs and LASER for optical fiber communication and compare their advantages and limitations.	**L2**
ECPL201.2	Understand the operating principles, characteristics, and performance metrics of photo detectors and optical components used in optical communication and sensing systems.	**L2**
ECPL201.3	Apply principles and techniques in optical networking to optimize high-performance optical communication systems for diverse real-world applications.	**L3**
ECPL201.4	Apply Optical Networking Concepts to enhance the capacity of channel.	**L3**
ECPL201.5	Ensure scalability, cost-effectiveness, and energy efficiency in optical networks.	**L3**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL201.1	3	-	3	3	1
ECPL201.2	3	-	3	3	1
ECPL201.3	3	-	3	3	1
ECP L201.4	3	-	3	3	1
ECPL201.5	3	-	3	3	1
ECPL201	**3**	**-**	**3**	**3**	**1**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Smart Antennas**	Course Code**: ECPL202**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT I : Smart Antennas:** Introduction, Need for Smart Antennas, Overview, Smart Antenna Configurations, Switched-Beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits and Drawbacks, Basic Principles, Mutual Coupling Effects.	10
3	**UNIT 2 : DOA Estimation Fundamentals:** Introduction, Array Response Vector, Received Signal Model, Subspace-Based Data Model, Signal Auto covariance, Conventional DOA Estimation Methods, Conventional Beam forming Method, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation, , ESPRIT Algorithm, Uniqueness of DOA Estimates	9
4	**UNIT 3 : Beam Forming Fundamentals:** Classical Beam former, Statistically Optimum Beam forming Weight Vectors, Maximum SNR Beam former, Multiple Sidelobe Canceller and Maximum, SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beamforming.	9
5	**UNIT 4 : Integration and Simulation of Smart Antennas:** , Antenna Design, Mutual Coupling, Adaptive Signal Processing Algorithms, DOA, Adaptive Beam forming, Beam forming and Diversity Combining for Rayleigh-Fading, Channel, Trellis-Coded Modulation (TCM) for Adaptive Arrays, Smart Antenna Systems for Mobile Adhoc Networks (MANETs), Protocol, Simulations, Discussion.	9
6	**UNIT 5 : Space–Time Processing:** Introduction, Discrete Space–Time Channel and Signal Models, Space– Time Beam forming, Inter symbol and Co-Channel Suppression, Space–Time Processing for DSCDMA, Capacity, and Data Rates in MIMO Systems, Discussion.	8
	Total	**45**

Text Books:

1. Constantine A. Balanis & Panayiotis I. Ioannides, “Introduction to Smart Antennas”, Morgan & Claypool Publishers’ series-2007
2. Joseph C. Liberti Jr., Theodore S Rappaport, “Smart Antennas for Wireless CommunicationsIS-95 and Third Generation CDMA Applications”, PTR – PH publishers, 1st Edition, 1989.

Reference Books:

1.T.S Rappaport, “Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location”, IEEE press 1998, PTR – PH publishers 1999.
2.Lal Chand Godara, “Smart Antennas”, CRC Press, LLC-20

Prerequisite:

1. Basic understanding of electro-magnetics and antenna theory.
2. Proficiency in signal processing concepts.
3. Familiarity with wireless communication principles.

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL202.1	Apply different DOA estimation algorithms to emphasize the desired signal and minimize the interference.	L3
ECPL202.2	Analyze Smart Antenna configurations for modern communication systems.	L4
ECPL202.3	Analyze MIMO system capacity and data rates using Space-Time Processing.	L4
ECPL202.4	Evaluate Beam forming techniques for signal optimization.	L4
ECP L202.5	Design Smart Antenna systems considering mutual coupling and channel fading	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL202.1	3	1	3	3	3
ECPL202.2	3	1	3	3	3
ECPL202.3	3	1	3	3	3
ECP L202.4	3	1	3	3	3
ECPL202.5	3	1	3	3	3
ECPL202	**3**	**1**	**3**	**3**	**3**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Automation using IOT and AI**	Course Code**: ECPL211**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Internet of Things (IoT):** Definition, Conceptual Framework, Architectural view, technology behind IoT, Sources of the IoT, M2M Communication, IoT Examples. Design Principles for Connected Devices: IoT/M2M systems layers and design standardization, communication technologies, data enrichment and consolidation, ease of designing and affordability	7
3	**UNIT 2 AI problems, Foundation of AI and History of AI Intelligent Agents:** Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.	7
4	**UNIT 4 Introduction to Automation :** Automated manufacturing systems. Sensors and Actuators in Automation, Digital and analog sensors; Fluid power actuators; Control valves; Electrical system elements; Motors drives; Mechanical devices. Pneumatic and Hydraulic Systems position and pressure sensing	10
5	**UNIT 5 Industrial Robotics -Robot Anatomy:** Work volume – Drive systems – Sensors in robotics – Robot reference frames and coordinates and robot kinematics. End effectors: Mechanical and other types of grippers – Tools as end effectors – Robot end effectors interface. Robot kinematics. Typical applications of robots: material transfer, machine loading/unloading; processing operations; assembly and inspection.	10
6	**UNIT 6 Industry 4.0 & IoT:** Introduction. Digitization, Drivers of Industry 4.0, End-to-end digital integration within a smart factory, IOT Swarm Sensors, RF and wireless sensors module, power management module; Challenges. Cyber-Physical Systems Applications: Smart cities & smart homes, connected vehicles, Healthcare, Machine condition monitoring, Process monitoring and control.	10
	Total	45

Text Books:

1. Kamal, R.,"Internet of Things – Architecture and Design Principles," 1st Edition, Mcgraw Hill,2017.
2. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", SecondEdition, Pearson Education
3. Robert J. Schilling, "Fundamentals of Robotics, Analysis & Control", Prentice Hall, 2009.
4. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Third Edition, Pearson Education, 2009.

Reference Books:

1. David Poole, Alan Mackworth, Randy Goebel, "Computational Intelligence : a logical approach", Oxford University Press.
2. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem solving", Fourth Edition, Pearson Education.
3. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.
4. Raj, Pethuru, and Anupama C. Raman.The Internet of things: Enabling technologies, platforms, and use cases. Auerbach Publications, 2017.
5. Buyya, Rajkumar, and Amir VahidDastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.
6. Antony Espossito, "Fluid power with Applications ", Pearson, Sixth Edition., 2003.
7. Nanua Singh, Tatla Dar Singh., "Systems Approach to Computer-Integrated Design and Manufacturing", John Wiley & Sons, 1995.
8. Bahga, Arshdeep, and Vijay Madisetti.Internet of Things: A hands-on approach. Vpt, 2014.

Prerequisite:

1. Basics of IoT
2. Basics of AI/ML
3. Basics of Mechanics and Kinematics

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL211.1	Explain the conceptual framework and architectural view of the Internet of Things (IoT)	**L2**
ECPL211.2	Explain the nature of environments in AI contexts	**L2**
ECPL211.3	select and integrate the sensors and actuators in automated manufacturing systems	**L3**
ECPL211.4	Assess the design and functionality of industrial robotics systems	**L3**
ECPL211.5	Analyze the concepts and components of Industry 4.0 and IoT	**L4**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL211.1	3	-	3	3	3
ECPL211.2	3	-	3	3	3
ECPL211.3	3	-	3	3	3
ECP L211.4	3	-	3	3	3
ECPL211.5	3	-	3	3	3
ECPL211	**3**	**-**	**3**	**3**	**3**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Advanced Photonics devices and components**	Course Code**: ECPL212**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	U**NIT 1 Optical Network Components:** Components of Fiber Optic Networks, Couplers/ Splitters, Semiconductor Optical Amplifier, EDFA, Wavelength Division Multiplexers/ Demultiplexers, isolators, Circulators, switches, grating, tunable filters.	7
3	**UNIT 2 Optical Instruments for Test Purpose:** BR Meter, Optical Spectrum Analyzer, Optical power meters, OTDR, Fiber optic Sources- Fiber joints-connectors, splices, Fusion splicers-Fiber polishing-Fiber cable design and structures- Photonic Packaging-Passive and active component packaging	9
4	**UNIT 3 Photonic Crystals:** Photonic band structures-rotational symmetry and irreducible Brillouin zone-time reversal invariance- Bloch wave propagation velocity, Photonic crystals- multilayer film- physical origin of photonic band gaps- the size of the bandgap- evanescent modes in PBG Two dimensional Photonic crystals-localization of light by point defects-linear defects and waveguides, Photonic Crystals: Basics concepts, Bandgap and band structures in two and three dimensional lattices. Photonic crystal fibers (PCF).	10
5	**UNIT 4 Plasmonics:** Drude theory, Surface Plasmons, Localized Surface Plasmons, Enhancement of emission and scattering of light, Local density of states in plasmonic nanostructures, Hot-spots in plasmonic nanostructures, Raman scattering enhancement in metal–dielectric nanostructures	10
6	**UNIT 5 Optical Biosensors:** Fluorescence and energy transfer sensing, molecular beacons and optical geometries of bio-sensing, Laser activated therapy; Photodynamic therapy, photo-sensitizers for photodynamic therapy.	9
	Total	**45**

Text Books:

1. Chuang, Shun Lien, "Physics of photonic devices". John Wiley & Sons, 2012.
2. Saleh, Bahaa EA, and Malvin Carl Teich. "Fundamentals of photonics" John Wiley & sons, 2019

Reference Books:

1. Maier, Stefan A. Plasmonics: fundamentals and applications. Vol. 1. New York: springer, 2007.
2. S O Kasap, Optoelectronics and Photonics: Principles and Practices, International Edition, Pearson Prentice Hall, 2013.

Prerequisite:

1. Optical Engineering
2. Fiber Optics Communication

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL212.1	Explain the concepts of optical components and photonic devices.	**L2**
ECPL212.2	Classify different optical instruments used for testing purposes.	**L2**
ECPL212.3	Describe the underlying concepts of photonic band structures	**L2**
ECPL212.4	Illustrate Plasmonics effects in nano-metallic structures	**L2**
ECPL212.5	Describe the optical phenomenon for bio-sensing principal	**L2**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL212.1	3	-	-	3	-
ECPL212.2	3	-	3	3	-
ECPL212.3	3	-	-	3	-
ECPL212.4	3	-	3	3	-
ECPL212.5	3	-	3	3	-
ECPL212	3	-	2	3	-

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Applied Machine Learning**	Course Code**: ECPL213**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Introduction: Introduction to Machine Learning:** Different types of learning, Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance. Linear Regression: Introduction, Linear regression, Simple and Multiple Linear regression, Polynomial regression, evaluating regression fit.	8
3	**UNIT 2 Decision Tree Learning:** Decision tree representation, appropriate problems for decision tree learning, the basic decision tree algorithm, hypothesis space search in decision tree learning, inductive bias in decision tree learning, issues in decision tree learning, Python exercise on Decision Tree. Instance based Learning: K nearest neighbour, the Curse of Dimensionality, Feature Selection: forward search, backward search, univariate, multivariate feature selection approach, Feature reduction (Principal Component Analysis), Python exercise on KNN and PCA. Recommender System: Content based system, Collaborative filtering based.	10
4	**UNIT 3 Probability and Bayes Learning:** Bayesian Learning, Naïve Bayes, Python exercise on Naïve Bayes, Logistic Regression. Support Vector Machine: Introduction, the Dual formulation, Maximum margin with noise, nonlinear SVM and Kernel function, solution to dual problem.	9
5	**UNIT 4 Artificial Neural Networks:** Biological motivation, ANN representation, appropriate problem for ANN learning, Perceptron, multilayer networks and the back propagation algorithm	9
6	**UNIT 5 Ensembles:** Introduction, Bagging and boosting, Random forest, Discussion on some research papers. Clustering: Introduction, K-mean clustering, agglomerative hierarchical clustering, Python exercise on k-mean clustering.	8
	Total	**45**

Text Books:

1. Tom Mitchell , “Machine Learning”. . First Edition, McGraw- Hill, 1997.
2. Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.
3. M.Gopal , “Applied Machine Learning”, 1st Edition, McGraw- Hill.

Reference Books:

1.Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
2. Yegnanarayana, B. “Artificial Neural Networks”, PHI Learning

Prerequisite:

1.Statistics, Linear Algebra,Calculus
2.Probability
3.Programming Languages

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL213.1	Understand the appropriate machine learning algorithms and techniques for different problem domains.	L2
ECPL213.2	Discuss the ANN representation, appropriate problem for ANN learning	L2
ECPL213.3	Apply analytical thinking skills to comprehend the principles of probability and Bayesian learning.	L3
ECPL213.4	Apply critical analysis skills to evaluate the basic decision tree algorithm and its implementation	L3
ECPL213.5	Implement clustering algorithms, including K-means and agglomerative hierarchical clustering, to group data effectively and derive meaningful insights.	L3

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL213.1	2	-	1	1	2
ECPL213.2	2	-	1	1	2
ECPL213.3	2	-	1	1	2
ECPL213.4	2	-	1	1	2
ECPL213.5	2	-	1	1	2
ECPL213	**2**	**-**	**1**	**1**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Neural Network and Fuzzy Logic**	Course Code**: ECPL214**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 FUNDAMENTALS OF NEURAL NETWORKS:** Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN-single layer net for pattern classification-Biases and thresholds, linear separability - Hebb's Rule- algorithm -perceptron - Convergence theorem-Delta rule	9
3	**UNIT 2 BASIC NEURAL NETWORK TECHNIQUES:** Back propagation neural net:standard back propagation-architecture algorithm- derivation of learning rules number of hidden layers--associative and other neural networks- hetero associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine	9
4	**UNIT 3 COMPETITIVE NEURAL NETWORKS:** Neural network based on competition: fixed weight competitive nets- Kohonen Self organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2	9
5	**UNIT 4 FUNDAMENTALS OF FUZZY LOGIC:** Basic concepts: fuzzy set theory-basic concept of crisp sets and fuzzy sets- complement- union intersection- combination of operation- general aggregation operations- fuzzy relations-compatibility relations-orderings- morphisms- fuzzy relational equations-fuzzy set and systems	8
6	**UNIT 5 SPECIAL NEURAL NETWORKS:** Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.	9
	Total	**45**

Text Books:

1. Rajasekharan, Pai , "Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications", PHI Publications.
2. Rajesh Kumar, "Fundamental of Artificial Neural Network and Fuzzy Logic" Lakshmi publications
3. Simon Haykin , "Neural Networks and Learning Machines" Mac Millen College Pub co., New York, 2011.
4. Klier Van, "Fuzzy System & Fuzzy logic" Prentice Hall of India, First Edition.
5. Lawrence Fussett, "Fundamental of Neural network" Prentice Hall , First Edition.

Reference Books:

1. Bart Kosko, "Neural network and Fuzzy System" Prentice Hall-1994.
2. J.Klin and T.A.Folger, "Fuzzy sets - Uncertainty and information" Prentice Hall -1996.
3. Introduction to artificial neural systems by J.M.Zurada-Jaico Publication house,Delhi 1994.
4. Neural Networks by James A Freeman and Davis Skapura, Pearson Education.
5. Neural Networks: A Comprehensive Foundation by S. Haykin-Prentice- Hall India, 2nd Edition, 1999.

Prerequisite:

1. knowledge of fundamentals of set theory, control systems and networks.
2. Microcontroller based system design

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL114.1	Understand training algorithms and are able to provide adequate knowledge about feed forward and feedback neural networks.	L2
ECPL214.2	Differentiate Biological system, intelligent systems and the concepts of crisp and fuzzy set theory	L2
ECPL214.3	Demonstrate knowledge and understanding of fuzzy system as they apply in real time systems	L3
ECPL214.4	Implement training algorithms for associative memory network for pattern recognition problems	L3
ECPL214.5	Analyze the learning strategies of Artificial Neural networks and learning rules	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL214.1	2	-	1	1	2
ECPL214.2	2	-	1	1	2
ECPL214.3	2	-	1	1	2
ECPL214.4	2	-	1	1	2
ECPL214.5	2	-	1	1	2
ECPL214	**2**	**-**	**1**	**1**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year: I	Semester: II
Course Name: **Cryptography and Network Security**	Course Code: **ECPL215**	Credit: 3
Max Marks: 100	CIE: 40	SEE: 60
End Term Exam Time: 3 Hrs	Teaching Scheme: 3L+0T+0P	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1 Introduction to Network Security:** Introduction - Need for Security, Security Approaches, Principles of Security, Security services, Types of Attacks – General View - Technical View, Programs that Attack, Specific Attacks.	7
3	**UNIT 2 Basics of Cryptography and Encryption:** Introduction to Cryptography, Plain Text and Cipher Text, Symmetric Cipher Model, Cryptography, Cryptanalysis, Brute Force Attacks, Substitution Techniques - Caesar Cipher and Modified Caesar Cipher, Mono Alphabetic cipher, Poly-Alphabetic Cipher, Playfair Cipher, Transposition Techniques- Rail Fence technique, Simple Columnar transposition Technique, Encryption and Decryption-Symmetric and Asymmetric key cryptography, Steganography.	8
4	**UNIT 3 Block ciphers and Data Encryption Standards:** Stream ciphers Block ciphers, Data Encryption Standard, a DES example, AES- structure, AES transformation functions.Public key cryptography and RSA: Principles of public key cryptosystems - public key cryptosystems - applications for public key cryptosystems, RSA algorithm - algorithm and example, Deffie Hellman key exchange algorithm and example.	10
5	**UNIT 4 Cryptographic Data Integrity Algorithms** - Cryptographic Hash functions - applications, Message Authentication – Requirements and Functions. Digital signatures – Introduction, Properties, attacks and forgeries, digital signature requirements. User Authentication mechanisms- Authentication basics, Passwords- Introduction- clear text passwords, Password encryption- Problems with passwords, Authentication tokens- introduction and types, use of smart cards, biometric authentication, Kerberos- introduction and working, Remote user authentication principles, personal identity verification.	11
6	**UNIT 5 Applications of Network Security, Ethical and legal Issues:** Network and internet security -Cloud computing- Data protection on the cloud, cloud security as a service, Web/Internet security protocols- HTTPS, SSL, SSH, Wireless network security, Mobile device security, Email security -Pretty good privacy, S/MIME .Legal and Ethical issues- Introduction to Cybercrime & computer crime, Intellectual property, Privacy, Ethical issues.	8
	Total	**45**

Text Books:

1. William Stallings, "Crpyptography and Network security Principles and Practices", Pearson.
2. Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with coding theory", Pearson
3. William Stallings, Network Security Essentials (Applications and Standards), PearsonEducation, India.

Reference Books:

1. W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education.
2. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India.
3. Robert Bragg, Mark Rhodes, Network Security: The complete reference, Tata McGrawhill, India.

Prerequisite:

1. Digital Electronics
2. Computer Networks
3. Embedded System

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL215.1	Discuss cryptography and network security concepts and applications.	**L2**
ECPL215.2	Identify security attacks and services.	**L2**
ECPL215.3	Use symmetric and asymmetric key algorithms for cryptography.	**L3**
ECPL215.4	Examine the issues and structure of Authentication Service and Electronic Mail Security.	**L3**
ECPL215.5	Apply security principles to System design	**L3**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL215.1	2	-	3	1	1
ECPL215.2	2	-	3	1	2
ECPL215.3	3	-	3	2	2
ECPL215.4	3	-	3	2	2
ECPL215.5	3	-	3	2	2
ECPL215	**3**	**-**	**3**	**2**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Adaptive Digital Image Processing**	Course Code**: ECPL216**	Credit**: 3**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **3L+0T+0P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**UNIT 1: Fundamental of Image Processing and Image Transformation :** Fundamental steps in DIP – Image Sampling and Quantization - Basic relationship between pixels. Image enhancement - Spatial Domain: Basic Grey level Transformations – Histogram Processing – Smoothing spatial filters- Sharpening spatial filters. Color image Processing:Models, Transformation. Image Transforms: Two dimensional Fourier Transform- Discrete cosine transform – Multi resolution analysis – Haar Transform- Discrete Wavelet Transform. Karhunen-Loeve transforms. SVD.	12
3	**UNIT-2: Image Compression, Segmentation & Restoration :I**mage Compression Techniques- Encoding- JPEG and MPEG, TIFF, GIF, PNG WebP standards. Detection of discontinuities – point, corner, edge detection- Thresholding -edge based segmentation-region based segmentation- morphological segmentation - watershed algorithm Descriptors: Boundary descriptors-Region descriptors- Texture descriptors, RANSAC. Image Restoration: Image deformation and geometric transformations, Restoration techniques, Noise characterization, Linear, Position invariant degradations	12
4	**UNIT 3: Recognition and Classification :** Patterns and pattern classes – Introduction to classification – Decision theoretic methods –structural and syntactic classifiers – Clustering techniques – similarity measures – hierarchical methods – K-Means algorithm – Cluster evaluation methods. Convolution neural networks,Region-based CNN, fully convolution networks, Multi-modal networks, Hybrid learning methods.	12
5	**UNIT 4 :Computer Vision Applications :**Face recognition application: personal photo collections – Instance recognition application :Location recognition – Machine learning applications: Deep voting, transfer learning and structured regression for image analysis and categorization.	8
	Total	**45**

Text Books:

1.Rafael C. Gonzalez & Richard E. Woods, “Digital Image Processing”, 4th Edition, 2018, Pearson, USA.

2.David A. Forsyth and Jean Ponce, “Computer Vision: A Modern Approach”, 2nd Edition, 2012, Prentice Hall, Pearson Education

Reference Books:

1.Richard Szeliski, “Computer vision: Algorithm and Applications”, Springer- Verlag, London,2010.

2. Anil K. Jain, Fundamentals of Digital Image Processing, 2015, 3rd Edition, Pearson Education, USA.

3. K.P.Soman, K.I. Ramchandran, N.G.Resmi, Insights into Wavelets, From Theory to Practice, 2013, 3rd Edition, PHI Learning Private Limited, New Delhi, India.

4. Mark Nixon & Alberto Aguado, Feature Extraction, and Image Processing, 2013, 3rd Edition, Elsevier‟s Science & Technology Publications, USA

5. William K. Pratt, Digital Image Processing, 2013, John Wiley Sons, USA.

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test.

Prerequisite:

1. Signals and Systems
2. Digital Signal Processing
3.Filter Designing

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPL216.1	Recall the basic principles of digital image processing.	L1
ECPL216.2	Examine various types of images, intensity transformations and spatial filtering.	L3
ECPL216.3	Apply image processing algorithms in practical applications through computer vision methodology.	L3
ECPL216.4	Model various algorithms required for image recognition and classification.	L4
ECPL216.5	Evaluate methodologies for Image segmentation and restoration.	L4

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPL216.1	1	-	1	3	2
ECPL216.2	2	-	1	3	3
ECPL216.3	3	-	1	3	3
ECPL216.4	3	-	1	3	3
ECPL216.5	3	-	1	3	3
ECPL216	**3**	**-**	**1**	**3**	**3**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name:**Antenna & Radiating System Lab**	Course Code**: ECPP230**	Credit**: 2**
Max Marks: **100**	CIE: **60**	SEE: **40**
End Term Exam Time: **2 Hrs**	Teaching Scheme: **0L+0T+4P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	2
2	Study of antenna parameters i.e., S-parameters, VSWR, Gain, Directivity, Radiation Mechanism, Field Zones, Axial ratio, Polarization, HPBW, Impedance matching, antenna modeling	4
3	Design of half wave dipole antenna using HFSS software	6
4	Design of quarter wave, full wave antenna and comparison of their parameters using HFSS software	6
5	Design of half wave dipole antenna array (Broadside and End fire array) using HFSS software	6
6	Design of Pyramidal Horn antenna using HFSS software	6
7	Design of Parabolic reflector antenna using HFSS software	6
8	Design and Development of Rectangular Microstrip antenna with microstrip inset feed. Compare the simulated and measured parameters (Return loss, VSWR, E- and H-plane radiation Pattern, Directivity, Gain, HPBW, etc.).	6
9	Design and Development of Circular Microstrip antenna with probe feed. Compare the simulated and measured parameters (Return loss, VSWR, E- and H-plane radiation Pattern, Directivity, Gain, HPBW, etc.).	6
10	Design and Simulation of 4-element microstrip antenna array using power divider	6
11	Design a smart antenna as per latest trend and submit a report	6
	Total	**60**

Text Books:

1. J.D. Kraus, RJ. Marhefka and Ahmad S. Khan., "Antennas and Wave Propagation" TMH, New Delhi, 4th ed., (Special Indian Edition), 2010.
2. Harish AR and Sachidananda M, O, "Antenna and Wave Propagation"Oxford University Press, 2007
3. E.C. Jordan and K.G. Balmain., "Electromagnetic Waves and Radiating Systems" PHI, 2nd ed., 2000

Reference Books:

1.C.A.Balanis, Antenna Theory - Analysis and Design, John Wiley & Sons, 1998
2. J.D.Kraus and R.J.Marhefka, Antennas for all Applications, McGraw Hill, 2003
3. G.Kumar and K.P.Ray, Broadband Microstrip Antennas, Artech House, 2000

Prerequisite:

1. Basic Knowledge of Electromagnetics
2. Electronics & Electromagnetic Course
3. Experience with Simulation Tools
4. Mathematical skills

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPP230.1	Recall the concepts involved in propagation of EM waves in waveguide.	**L1**
ECPP230.2	Compare the array factor for an array of identical antennas	**L2**
ECPP230.3	Make use of tools for designing and testing antennas .These tools include HFSS etc.	**L3**
ECPP230.4	Evaluate the input Impedance, efficiency and ease of match for antennas.	**L5**
ECPP230.5	Design antennas and antenna arrays for various desired radiation pattern characteristics.	**L6**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPP230.1	3	3	2	3	2
ECPP230.2	3	3	2	3	2
ECPP230.3	3	3	2	3	2
ECPP230.4	3	3	2	3	2
ECPP230.5	3	3	2	3	2
ECPP230	**3**	**3**	**2**	**3**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Wireless and Fiber Optical Communication Lab**	Course Code**: ECPP231**	Credit**: 2**
Max Marks: **100**	CIE: **60**	SEE: **40**
End Term Exam Time: **2 Hrs**	Teaching Scheme: **0L+0T+4P**	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite	2
2	Design Free-Space Propagation-Path Loss model to determine the free space loss and power received.	4
3	. Realization of WLAN Multipath Channel to plot BER-SNR and Bit Rate -SNR graph for the fading environments of (i)No Fading (ii) Flat Fading	6
4	Realization of WLAN Multipath Channel to plot BER-SNR and Bit Rate -SNR graph for Dispersive Fading environment.	6
5	Implement Amplitude Modulation, Frequency Modulation and Pulse Modulation Techniques	6
6	Setting up of LTE 2x2 MIMO system for establishing two-way communication.	6
7	Observe the effect of noise and dispersion on eye pattern in a communication system .	6
8	Measure insertion loss, reflectance, total loss, attenuation coefficient and fiber break location using OTDR.	6
9	Observe the Four Wave Mixing and Nonlinear Effect in Optical Fiber	6
10	Simulate optical fibre modes with OptiSIM Software	6
11	Setup the WDM link with the given components and determine the total loss for each wavelength	6
	Total	**60**

Text Books:

1. Introduction to Fiber Optics, Ajoy Ghatak and K Thyagarajan, Cambridge University Press, 1998. Reprinted by Foundation Books, New Delhi.
2. Fundamentals of Optical Fiber Sensors, Z. Fang, K.K.Chin, R. Qu, H. Cai, Wiley,2012, New Jersy, USA
3. David Tse, PramodViswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.

Reference Books:

1. G P Agarwal, Academic Press, Boston, 2013
2. G. Keiser, McGraw Hill, 2000

Prerequisite:

1. Knowledge of Fiber Optics ,Optical Communication.
2. Knowledge of wireless communication

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPP231.1	Examine Path-Loss models	**L3**
ECPP231.2	Realize fading environments in wireless channels	**L3**
ECPP231.3	Realize various modulation techniques	**L3**
ECPP231.4	Apply the channel characteristics of Fiber optics	**L3**
ECPP231.5	Analyze Nonlinear Effect in Optical Fiber	**L4**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPP231.1	3	3	2	3	2
ECPP231.2	3	3	2	3	2
ECPP231.3	3	3	2	3	2
ECPP231.4	3	3	2	3	2
ECPP231.5	3	3	2	3	2
ECPP231	**3**	**3**	**2**	**3**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: II**
Course Name: **Mini Project & Seminar**	Course Code**: ECPD250**	Credit**: 2**
Max Marks:**100**	CIE:**60**	SEE:**40**
End Term Exam Time: **2 Hrs**	Teaching Scheme: **0L+0T+4P**	

Course Outcomes: After learning the course the students should be able to:

Course Code	Course Outcomes	Bloom's Level
ECPD250.1	Identify real-life problems and suggest possible solutions.	**L2**
ECPD250.2	Identify promising new directions of various cutting-edge technologies.	**L2**
ECPD250.3	Apply the technical knowledge gained from previous courses for project development.	**L3**
ECPD250.4	Demonstrate effective communication and presentation skills through oral presentations.	**L3**
ECPD250.5	Apply report writing skills for preparing detailed professional report on new technologies.	**L3**

Mapping of COs with POs-PSOs:

Course Code	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
ECPD250.1	2	1	1	3	1
ECPD250.2	3	1	3	3	1
ECPD250.3	3	1	3	3	1
ECPD250.4	3	1	3	3	3
ECPD250.5	3	3	-	1	3
ECPD250	**3**	**1**	**2**	**3**	**2**

Name of the Programme: M.Tech. in Digital Communication	Year**: I**	Semester**: I/II**
Course Name: **Audit Courses**	Course Code**: NP99.XX**	Credit**: 0**
Max Marks: **100**	CIE: **40**	SEE: **60**
End Term Exam Time: **3 Hrs**	Teaching Scheme: **0L+0T+0P**	

S. No.	Course Title	Course Code	Credits
1	English for Research Paper Writing	NP99.01	0
2	Disaster Management	NP99.02	0
3	Sanskrit for Technical Knowledge	NP99.03	0
4	Value Education	NP99.04	0
5	Constitution of India	NP99.05	0
6	Pedagogy Studies	NP99.06	0
7	Stress Management by Yoga	NP99.07	0
8	Personality Development through Life Enlightenment Skills	NP99.08	0
9	IoT and Machine Learning	NP99.09	0
10	Data Analytics using Python	NP99.10	0