Department of Electronics & Communication Engineering
School of Studies of Engineering and Technology
Guru Ghasidas Vishwavidyalaya (Central University), Bilaspur, C.G.

Minutes of meeting

Regarding the updation of the scheme and syllabus of BTech 4th year, MTech 1st and 2nd year and Pre-phd course work to be started from academic session 2023-24, Department of Electronics & Communication Engineering conducted an online meeting of its BOS members due to the urgencies and non-availability of its external member and industrial expert through the medium of email on 28-06-2023 at 10.33 am and following members were available online:

1. Dr. Soma Das, Chairman & Member, BOS, Department of Electronics & Communication Engineering, GGV;
2. Dr. Anita Khanna, Member, BOS, Department of Electronics & Communication Engineering, GGV;
3. Prof. Kavita Thakur, Professor, Pt. Ravi Shankar Shukla University, Raipur & External expert Member of BOS.

The members approved the following documents after received the same online as listed below:

1. The vision and Mission of the department in line with the vision and Mission of the School of Studies of Engineering & Technology;
2. The scheme and syllabus of BTech 4th year to be started from academic session 2023-24;
3. The scheme and syllabus of MTech 1st and 2nd year to be started from academic session 2023-24;
4. The scheme and syllabus of Pre-phd course work to be started from academic session 2023-24

The Chairman BOS sent her heartful thanks to all BOS members available online for this work.

Dr. Soma Das
Chairman & Member, BOS
Head, Dept. of Elec & Comm. Engg, GGV

Dr. Anita Khanna
Member, BOS
Dept. of Elec & Comm. Engg, GGV Professor

consent taken online

Prof. Kavita Thakur
External expert Member of BOS
Pt. Ravi Shankar Shukla University, Raipur

Gmail

Soma Das <soma.iitkharagpur@gmail.com>

Regarding BOS, ECE, GGV: For your approval

4 messages

Soma Das <soma.iitkharagpur@gmail.com> Wed, Jun 28, 2023 at 10:33 AM
To: Kavita Thakur <kavithakur67@gmail.com>, anita dhawan <anitadhawan0308@gmail.com>, deepak_sanwal@rediffmail.com
Cc: Soma Das <soma.iitkharagpur@gmail.com>
Bcc: Bhawna Shukla <bha_vivek69@rediffmail.com>, sudakarggv@gmail.com

Dear Members, Board of Studies,
Department of Electronics & Communication Engg., GGV

Greetings from Guru Ghasidas Vishwavidyalaya, Central University, Bilaspur!

This is to submit you the syllabus of BTech 4th year, MTech 1st and 2nd year, and PrePhd course work to be started from academic session 2023-24. We are also submitting herewith the vision and mission of the Department along with the vision and mission of the School of studies of Engineering & Technology.

The academic session 2023-24 will be starting from July 3rd, 2023 for your information.
Submitted for your kind perusal and approval please.

4 attachments

- **Final-Vision-Mission-ECE+School of Engg.pdf** 16K
- **Final-1-Pre-phd course 2023-24.pdf** 943K
- **Final-Scheme + syllabus-B.Tech. 4th year 2023-24.pdf** 1446K
- **Final-Scheme + syllabus-MTech 1st and 2nd 2023-24.pdf** 1448K

Dr. Anita Khanna <anitadhawan0308@gmail.com> Wed, Jun 28, 2023 at 2:33 PM
To: Soma Das <soma.iitkharagpur@gmail.com>

Everything seema ok, I give my consent
[Quoted text hidden]

Kavita Thakur <kavithakur67@gmail.com> Wed, Jun 28, 2023 at 10:11 PM
To: Soma Das <soma.iitkharagpur@gmail.com>

Approved from my side.
All the best.
Thanks and Regards
[Quoted text hidden]

Soma Das <soma.iitkharagpur@gmail.com> Mon, Jul 3, 2023 at 4:30 PM
To: Kavita Thakur <kavithakur67@gmail.com>, anita dhawan <anitadhawan0308@gmail.com>, deepak_sanwal@rediffmail.com

Approved from my side

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING
SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A CENTRAL UNIVERSITY)

OUTCOME BASED EDUCATION
WITH
CHOICE BASED CREDIT SYSTEM (CBCS)

MASTER OF TECHNOLOGY

COURSE STRUCTURE AND SYLLABI
(Effective from the academic year 2023-24)

SCHEME OF EXAMINATION & EVALUATION

SEMESTER- I

SN	COURSE No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	TOTAL	
1.	ECPATT1	Linear Algebra	3	-	-	40	60	100	3
2.	**Elective-1**		3	-	-	40	60	100	3
	ECPATP1	Wireless Communication & Network							
	ECPATP2	Introduction to Embedded System & IoT							
	ECPATP3	Microstrip Antenna							
3.	**Elective-2**		3	-	-	40	60	100	3
	ECPATP4	Optoelectronic Devices							
	ECPATP5	Solid State Devices							
	ECPATP6	Antenna for Modern Wireless Communication							
4.	**Elective-3**		3	-	-	40	60	100	3
	ECPATP7	Analog CMOS VLSI Design							
	ECPATP8	Digital Image Processing							
	ECPATP9	Modern Digital Communication							
5.	**Elective-4**		3	-	-	40	60	100	3
	ECPATP10	Network Security & Cryptography							
	ECPATP11	Introduction to Signal Processing							
	ECPATP12	Satellite Communication							
6.	ECPATC1	Research Methodology & IPR	2	-	-	-	50	50	2
7.	ECPALT1	Adv Simulation Lab	-	-	4	30	20	50	2
		TOTAL	**17**	**0**	**4**	**230**	**370**	**600**	**19**

SEMESTER- II

SN	COURSE No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	TOTAL	
1.	ECPBTT1	Estimation and Detection Theory	3	-	-	40	60	100	3
2.	**Elective-5**		3	-	-	40	60	100	3
	ECPBTP1	Low Power VLSI Design							
	ECPBTP2	Adv Digital Signal Processing							
	ECPBTP3	Optical Instrumentation							
3.	**Elective-6**		3	-	-	40	60	100	3
	ECPBTP4	Pattern Recognition & Machine Learning							
	ECPBTP5	Optical Communication System							
	ECPBTP6	Next Gen. Comm. Technology							
4.	**Elective-7**		3	-	-	40	60	100	3
	ECPBTP7	Computer Vision							
	ECPBTP8	Digital Communication Receiver							
	ECPBTP9	Millimeter Wave Technology							
5.	**Open Elective**		3	-	-	40	60	100	3
6.	**Audit Course/Value Added Course**		2	-	-	40	60	100	2
7.	ECPBLT1	Semiconductor Device Design and Simulation Lab	-	-	4	30	20	50	2
8.	ECPBLT2	RF & Microwave Component Design Lab	-	-	4	30	20	50	2
		TOTAL	**17**	**0**	**08**	**300**	**400**	**700**	**21**

SEMESTER- III									
S.No.	COURSE No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	TOTAL	
1.	ECPCPT1	Dissertation Stage-I	-	-	28	100	100	200	14
		TOTAL	-	-	28	100	100	200	14
SEMESTER- IV									
S.No.	COURSE No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	TOTAL	
1.	ECPDPT1	Dissertation Stage-II	-	-	32	100	200	300	16
		TOTAL	-	-	32	100	200	300	16

Total Credits for the Program= 19+21+14+16=70

Open Elective	
MSPBTO1	Business Analysis
IPPBTO2	Industrial Safety
IPPBTO3	Operations Research
CEPBTO4	Cost Management of Engineering Projects
MEPBTO5	Composite Materials
CHPBTO6	Waste to Energy
ECPBTO7	Internet of Things
ITPBTO9	Software Engineering Techniques
MCPBTO8	MOOCs
Audit Course/Value Added Course	
ELPBTX1	English for Research Paper Writing
PEPBTX2	Stress Management by Yoga
CEPBTX3	Disaster Management
LAPBTX4	Constitution of India

Note: Under MOOCs, the students have to opt any subject other than Electronics & Communication Engg. From NPTEL/UGC SWAYAM.

Programme Outcomes:

Graduates will be able to:

PO1: Fundamentals: Apply knowledge of mathematics, science and engineering.
PO2: Problem analysis: Identify, formulate and solve real time engineering problems using first principles.
PO3: Design: Design engineering systems complying with public health, safety, cultural, societal and environmental considerations
PO4: Investigation: Investigate complex problems by analysis and interpreting the data to synthesize valid solution.
PO5: Tools: Predict and model by using creative techniques, skills and IT tools necessary for modern engineering practice.
PO6: Society: Apply the knowledge to assess societal, health, safety, legal and cultural issues for practicing engineering profession.
PO7: Environment: Understand the importance of the environment for sustainable development.
PO8: Ethics: Apply ethical principles and commit to professional ethics, and responsibilities and norms of the engineering practice.
PO9: Teamwork: Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary settings.
PO10: Communication: Communicate effectively by presentations and writing reports.
PO11: Management: Manage projects in multidisciplinary environments as member or a team leader.
PO12: Life-long learning: Engage in independent lifelong learning in the broadest context of technological change.

Programme Specific Outcomes:

PSO1: Identify, formulate and apply concepts acquired through Electronics & Communication Engineering courses to the real-world applications.
PSO2: Design and implement products using the cutting-edge software and hardware tools to attain skills for analyzing and developing subsystem/processes.
PSO3: Ability to adapt and comprehend the technology advancement in research and contemporary industry demands with demonstration of leadership qualities and betterment of organization, environment and society.

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATT1	3	-	-	40	60	100	3

LINEAR ALGEBRA

Course Objectives:

The objective of the course are to make the students:

1. Formulate, solve, apply, and interpret systems of linear equations in several variables.
2. Compute with and classify matrices. Master the fundamental concepts of abstract vector spaces.
3. Decompose linear transformations and analyze their spectra (eigenvectors and eigenvalues).
4. Utilize length and orthogonality in each of the above contexts.
5. Apply orthogonal projection to optimization (least-squares) problems.

UNIT-I:

Introduction to Vectors: Vectors and Linear Combinations, Lengths and Dot Products.

Solving linear Equations: Matrices and Linear Equations, Gaussian Elimination, Rules for Matrix Operations, Row-Reduced Echelon Form (RREF), Rank of a Matrix, Solution set of a Linear System, Inverse Matrices, Factorization: A=LUs.

UNIT-II:

Vector Spaces and Subspaces: Properties, Rank, Nullspace, The Complete Solution $Ax = b$, Independence, Basis of a Vector Space, Dimension, Linear Span and Linear Independence, Dimensions of the Four Subspaces, Sums and Direct Sums.

Orthogonality: Orthogonality of the Four Subspaces, Projections and Least Square, Orthogonal Bases and Gram-SchmidtOrthonormalization Process, QR Decomposition, The Fast Fourier Transform.

UNIT-III:

Eigenvalues and Eigenvectors: Introduction to Eigenvalues, The Characteristic Polynomial**,** Eigenvalues of Square Matrices, Invariant Subspaces, Diagonalizing a Matrix, Applications to Differential Equations, Upper-Triangular Matrices, Diagonal Matrices, Invariant Subspaces on Real Vector Space Symmetric Matrices,Spectrum of a Matrix.

Positive Definite Matrices: Tests for Positive Definiteness**,**Similar Matrices, Singular Value Decomposition (SVD).

Operators on Complex Vector Spaces: Complex Numbers, Complex Vectors and Matrices: Hermitian and Unitary Matrices, Generalized Eigenvectors, The Characteristic Polynomial, Decomposition of an Operator, Square Roots, The Minimal Polynomial, Jordan Form**.**

UNIT-IV:

Linear Transformations: The Idea of a Linear Transformation, The Matrix of a Linear Transfonnation/Linear Maps: Definitions and Examples, Null Spaces and Ranges, Rank-Nullity Theorem, The Matrix of a Linear Map, Invertibility, Ordered Bases, Change of Basis, Diagonalization and the Pseudoinverse.

Trace and Determinant: Change of Basis, Trace, Determinant of a Matrix ,The Properties of Determinants, Permutations and Cofactors, Cramer's Rule. Inverses, and Volumes.

UNIT-V:

Inner-Product Spaces: Inner Products, Norms, Orthonormal Bases, Orthogonal Projections, Linear Functionals and Adjoints, The Intersection of Two Vector Spaces, The Sum of Two Vector Spaces, Cauchy-Schwartz Inequality, The Kronecker Product$A \otimes B$of Two Matrices.

Operators on Inner-Product Spaces: Self-Adjoint and Normal Operators, The Spectral Theorem, Normal Operators on Real Inner-Product Spaces, Positive Operators, Isometries.

Applications: Matrices in Engineering, Graphs and Networks, Markov Matrices, Linear Programming, Fourier Series: Linear Algebra for Functions, Computer Graphics.

Numerical linear Algebra: Gaussian Elimination in Practice, Norms and Condition Numbers, Iterative Methods for Linear Algebra.

Text/Reference Books:

1. Strang, Gilbert,"Introduction to Linear Algebra",4th/5th Edition,Wellesley-Cambridge Press.
2. Axler, Sheldon, "Linear Algebra Done Right", 2nd/3rd edition, Springer.
3. K.Hoffman and R.Kunze, "Linear Algebra", 2nd Edition, Prentice- Hall of India, 2005.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

CO1: Solve a system of linear equations required for analysing different systems. And apply the different matrix operations.

CO2: Evalute the a linear independence, vector space, subspace, null space and the dimension of a different vector spaces.

CO3: Define norm and orthogonality. And find the orthogonal bases and orthogonal projections; and QR decomposition.

CO4: Apply matrix diagonalization and determine its eigenvalues and eigenvectors, find Singular Value Decomposition and its application in wirless communication.

CO5: Apply linear mapping and least-squares solutions to solve the different engineering problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1						2	2	3	2	1
CO2	3	3	2	2	1						2	2	3	2	1
CO3	3	3	2	3	1						2	2	3	3	1
CO4	3	3	2	3	1						2	2	3	3	1
CO5	3	3	2	3	1						2	2	3	3	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP1	3	-	-	40	60	100	3

WIRELESS COMMUNICATION & NETWORK

Course Objectives:

1. To describe the concepts of wireless Communication and its different types.
2. To Identify recent wireless technologies for wireless communication.
3. To identify different contention free and contention based multiple access techniques.
4. To describe different wireless personal area network , standard and protocols.
5. To describe comprehensive understanding of ad-hoc wireless network.

UNIT-I:

Overview of wireless communication, cellular communication, different generations of Cellular communication system, satellite communication including , wireless local loop ,cordless phone.

UNIT-II:

Recent wireless technologies; multicarrier modulation, OFDM, MIMO system , diversity-multiplexing trade off; MIMO OFDM system; smart antenna; beamforming and MIMO, cognitive radio.

UNIT-III:

Multiple access techniques in wireless communication : contention free multiple access Schemes {FDMA TDMA, CDMA, SDMA and Hybrid}, contention-based multiple access schemes (ALOHA and CSMA).

UNIT-IV:

Wireless personal local area networks{Bluetooth, UWB and ZigBee), wireless local area network,{IEEE 802.11, network architecture, medium access methods, WLAN standards.

UNIT-V:

Ad-Hoc wireless network: Design Challenges in Ad-hoc wireless networks, concept of cross layer design, security in wireless networks MANET and WSN, Wireless system protocols.

Text/Reference Books:

1 Andrea Goldsmith, "Wireless Communications Cambridge University press, 2005.
2. Sanjay Kumar, "wireless communication the fundamental and advanced concepts, River publisher, Denmark ,2015 {Indian reprint}
3. Vijay K Garg , " Wireless communication and Network, Pearson education ,2012
4. Iti Saha Misra," Wireless Communication ,2/e ,MGH,2013.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Visualize the architecture of different types of wireless systems as a means of high speed, high range communication system.
2. Analyze various aspects related to recent wireless technologies.
3. Apply the Multiple access techniques in wireless technologies
4. Analyze various aspects related to wireless personal local area network.
5. Apply various aspects of Ad -hoc wireless network.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3				2			3	3	2	2
CO2	3	3	2	2	3				2			3	3	2	2
CO3	3	3	2	2	3				2			3	3	2	2
CO4	3	3	2	2	3				2			3	3	2	2
CO5	3	3	2	2	3				2			3	2	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP2	3	-	-	40	60	100	3

INTRODUCTION TO EMBEDDED SYSTEM & IoT

Course Objectives:

1. To introduce the Building Blocks of Embedded System
2. To understand the life cycle and applications of embedded system.
3. To understand the fundamentals about IoT, IoT Access technologies and IoT case studies.
4. To understand the design methodology and different IoT hardware platforms.
5. To study the basics of IoT Data Analytics and supporting services.

UNIT-I: Introduction and functioning: Review of Microcontroller concept. Functional block diagram of 8051 microcontroller. Introduction to Embedded system, characteristic of Embedded system. Functional building blocks of embedded systems, processor and controller.

UNIT-II: Life cycles and Applications: Interfacing of memory between analog and digital blocks, interfacing with external systems, Temperature control, stepper motor and keyboard interface. user interfacing, Embedded Life cycle, Water Fall Model , Spiral Model, RAD Model.

UNIT-III: Introduction to IOT: Definition and characteristics of IoT, Physical design of IoT, Logical design of IoT, IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabling technologies: Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels and Templates, Domain Specific IoTs – Home, City, Environment, Energy, Agriculture,Industry, and health and life style.

UNIT-IV: IoT and M2M- Software defined networks, network function virtualization, difference between SDNand NFV for IoT, Basics of IoT System Management with NETCOZF, YANG-NETCONF, YANG, SNMP NETOPEER. Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks IoT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, Arduino Board details.

UNIT-V: Data Analytics and Supporting Services: Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M, Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models.

Text/Reference Books:

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton,Jerome Henry,Cisco Press, 2017
2. Internet of Things–A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Univ Press, 2015
3. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education.
4.Internet of Things–Key applications and Protocols,O Hersent,D Boswarthick,O Elloumi, Wiley,12

Course Outcome: At the end of the course, students will demonstrate the ability to:

1. Comprehend the basics of Embedded System.
2. Implement the state of the Architecture of an Embedded system.
3. Explain the basics of IoT and Implement the state of the Architecture of an IoT.
4. Analyze the design methodology and hardware platforms involved in IoT.
5. Analyze the acquired data and supporting services related to IoT.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1							3	3		2
CO2	3	2	1	1	2							3	3		2
CO3	3	2	2	1	2							3	3		2
CO4	3	3	2	1	3							3	3		2
CO5	3	3	2	1	3							3	3		2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP3	3	-	-	40	60	100	3

MICROSTRIP ANTENNA

Course Objectives:

This course will enable student to

1. To introduce the basic concept of Microstrip Antenna
2. To introduce different Microstrip Antenna feeding techniques
3. To learn different parameters of Rectangular Microstrip Antenna
4. To learn the effect of various parameters on performance of Rectangular Microstrip Antenna
5. To develop the concept of antenna design to control different Antenna characteristics

UNIT-I:

Microstrip Antenna- Concept, Various Designs, Advantages, Problems, Applications.

UNIT-II:

Microstrip Antenna feeding techniques- Coaxial feed, Microstrip Line feed, EM Coupled feed, Aperture coupled feed.

UNIT-III:

Rectangular Microstrip Antenna- Resonance Frequency, Characterization, Design Equations, Design Examples.

UNIT-IV:

Effect of various parameters on performance of Rectangular Microstrip Antenna – Feed point location, Effect of width, Effect of thickness, Effect of probe diameter, Effect of Loss tangent, Effect of Dielectric constant.

UNIT-V:

Rectangular Microstrip Antenna : radiation patterns, Dual and circular Polarization, Effect of finite ground plane, Square and Circular Microstrip Antenna characteristics.

Text/Reference Books:

1. Microstrip Antenna Design Handbook, Ramesh Garg, Prakash Bhartia, Inder J. Bahl, A. Ittipiboon
2. Broadband Microstrip Antennas, Girish Kumar, K.P. Ray
3. Microstrip and Printed Antennas: NEW TRENDS, TECHNIQUES AND APPLICATIONS by Debatosh Guha, Yahia M. M. Antar

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Outline the basic concept of Microstrip Antenna
2. Outline the different Microstrip Antenna feeding techniques
3. Apply the Concept of different parameters of Rectangular Microstrip Antenna for its design
4. Apply the Concept of effect of various parameters on performance of Rectangular Microstrip Antenna
5. Apply the Concept of antenna design to control different Antenna characteristics

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1		3								3		2
CO2	3	1	2	2	3								3		2
CO3	3	2	2	1	3								3	2	2
CO4	3	1	1	1	3								3	2	2
CO5	3	1	2	2									3		2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP4	3	-	-	40	60	100	3

OPTOELECTRONIC DEVICES

Course Objectives:

1. To develop the basic concept of solid state physics and characteristics of light.
2. To develop the concept of luminescence, display devices, laser and their applications.
3. To learn the principle of optical detection mechanism in detection devices.
4. To learn different light modulation techniques and applications of optical switching.
5. To develop the concept of opto electronic integrated circuits in transmitters and receivers.

UNIT-I: WAVE NATURE OF LIGHT AND SOLID STATE PHYSICS:

Wave nature of light, Polarization, Interference, Diffraction, Light Source, Review of Solid State Physics, Review of Semiconductor Physics and Semiconductor Junction Device.

UNIT-II: DISPLAY DEVICES AND LASERS:

Introduction, Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence, LED, Plasma Display, Liquid Crystal Displays, Numeric Displays, Laser Emission, Absorption, Radiation, Population Inversion, Optical Feedback, Threshold condition, Laser Modes, Classes of Lasers, Mode Locking, laser applications.

UNIT-III: OPTICAL DETECTION DEVICES:

Optoelectronic detectors: thermal detectors, Photon devices Photo emissive detectors, Photo conductive detectors, Photomultipliers (PMT), Photo diodes PIN & APD, photo transistors, Design of detector arrays, CCD, Solar cells.

UNIT-IV: OPTOELECTRONICS MODULATOR:

Opto Electronic Modulators: Basic principles, Polarization, birefringence. Electro optic effect, EO materials. Kerr modulators, scanning and switching, Magneto Optic Modulators Faraday effect, Accusto Optic Modulators.

UNIT-V: OPTOELECTRONICS INTEGRATED CIRCUITS:

Introduction, hybrid and Monolithic Integration, Application of Opto Electronic Integrated Circuits, Integrated transmitters and Receivers, Guided wave devices.

Text/Reference Books:

1. Opto electronics An introduction J Wilson and J F B Hawkes. (PHI, 1989)
2. Optical fiber communication J M Senior (Pearson, 2nd Ed)
3. Fiber Optics and Optoelectronics – R P Khare, (Oxford University Press, 4th Ed)

REFERENCES:

1. Optical Electronics – Ghattak & Thyagarajan, (Cambridge University Press,1984)
2. Essentials of OptoElectronics – A Rogers, CRC Press, 1st ed,1997
3. Optical fibre communication systems J Gowar (Prentice Hall, 2nd 1995).
4. Semiconductor Optoelectronics – Physics and Technology Jasprit Singh(McGraw Hill, 1995)

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Comprehend the concept of light and solid state physics
2. Analyze the Mechanism of various Display devices and light sources.
3. Distinguish between different detection methods.
4. Analyze various modulators and mechanism.
5. Analyze various type of integrated circuits.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	1			2			3	3	1	2
CO2	3	3	2	3	3	1			2			3	3	1	2
CO3	3	3	2	3	3	1			2			3	3	1	2
CO4	3	3	2	3	3	1			2			3	3	1	2
CO5	3	3	2	3	3	1			2			3	3	1	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP5	3	-	-	40	60	100	3

SOLID STATE DEVICES

Course Objectives:

The objectives of the course are to make the students:

- To develop strong background in semiconductor physics.
- To understand the importance of electrons and holes in semiconductors, the charge density and distribution, the charge transport mechanisms.
- To expose the physics of a p-n junction and semiconductor-metal junctions.
- To identify the internal workings of the most basic solid state electronic devices.

UNIT-I: Introduction: Review of electrons and energy band structures in crystals, density of states, effective density of states**,** Fermi function, Law of Mass action, Elemental and compound semiconductor, Electron & hole concentration in semiconductor, Temperature dependence of carrier concentration.

UNIT-II: Carrier Transport in Semiconductor: Drift and diffusion currents, Excess carriers in semiconductors-Generation & recombination, Basic equation for semiconductor device operation.

UNIT-III: PN Junctions: Abrupt & linearly graded junctions, V-I characteristics of an ideal diode, a real diode, C-V characteristics of reverse biased p-n junction, Electrical breakdown of a p-n junction in reverse bias- Zener & Avalanche Breakdown, Solar cell.

UNIT-IV: Bipolar Junction Transistor: Structure, Principle of operation, Ideal & real transistor, I-V characteristics, Small signal equivalent circuits, High frequency & switching transistors.

UNIT-V: MOSFETs: Basic operation & fabrication, Ideal MOS capacitor, Threshold voltage, C-V characteristics, I-V characteristics, Short channel MOSFET, Body effect, Subthreshold characteristics, Equivalent circuits, Short Channel effects, GIDL, DIBL.

Text/Reference Books:

1. M. S. Tyagi, Introduction to "Semiconductor Materials and Devices", John Wiley, 2004.
2. B. G. Streetman and S. K. Banerjee, "Solid State Electronic Devices", Prentice Hall India, 2014.
3. D. Neamen, "Semiconductors Physics and Devices", Tata Mc Graw Hill, 2003.
4. N. D. Gupta and A. D. Gupta, "Semiconductor Devices: Modeling and Technology", Prentice Hall, 2007.
5. R. Pierret, "Semiconductor Device Fundamentals", Pearson Education, 2006

Course Outcome:

At the end of the course, students will demonstrate the ability to:

CO1: Illustrate energy band structure of crystal and evaluate density of states.

CO2: Analyze carrier transport in semiconductor and basic equation for semiconductor.

CO3: Analyze ideal & real diode and establish I-V & C-V distribution of junction diode.

CO4: Describe the principle and analyze the operation of ideal & real bipolar junction transistor and their characteristics.

CO5: Analyze the operation of MOSFET and evaluate MOSFET performance at scaled gate lengths.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	2				3			3	3		2
CO2	3	3	1	1	2				3			3	3		2
CO3	3	3	1	1	2	1			3		1	3	3		3
CO4	3	3	1	1	2	1			3		1	3	3		3
CO5	3	3	1	1	2	1			3		1	3	3		3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP6	3	-	-	40	60	100	3

ANTENNA FOR MODERN WIRELESS COMMUNICATION

Course Objectives:

1. To understand the concept of radiation and characterizing parameters of Antenna
2. To get the knowledge of working principles of modern Antennas
3. Design the array of Antenna for modern communication
4. To perform analysis of MIMO key technology of 4G/5G System
5. To get the knowledge and design of Antennas for modern wireless system.

UNIT-I:

Concepts of Radiation and Antenna Fundamentals: Fundamental parameters of antennas, Near and Far Field regions, S Parameters, Antenna Measurements: Radiation pattern, Gain, directivity and polarization measurement.

UNIT-II:

Printed Antenna: Microstrip Antennas & Dielectric Resonator Antenna: Radiation mechanism - parameters and applications - feeding methods.

UNIT-III:

Array of Antennas: Linear and planar array fundamentals, Mutual Coupling in Arrays, Multidimensional Arrays, Phased Arrays, Array Feeding Techniques, Array optimization techniques.

UNIT-IV:

MIIMO System: Concept of Diversity, Introduction of MIMO, Types of MIMO Systems, Design parameters of MIMO system.

UNIT-V:

Antennas for Modern Wireless System: Antennas for space applications, Antennas for 5G System, Reconfigurable Antenna:Reconfigurable methodologies, Design Considerations for Reconfigurable systems, Concept of Smart Antenna.

Text/Reference Books:

1. Jordan E C and Balmain K G, "Electromagnetic Waves and Radiating Systems", 2nd Edition, Pearson Education, 2015.
2. Balanis C A, "Antenna Theory: Analysis and Design", 4th Edition, John Wiley and Sons, NewJersey, 2016.
3. Kraus J D and Marhefka R J, "Antennas for All Applications", 3rd. Edition, Tata McGraw Hill, 2002.
4. Girish Kumar and Ray K P, "Broadband Microstrip Antennas", Artech House, 2003

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Measurement of Antenna's parameters
2. Analyze the suitable antennas for Modern Wireless Communication
3. Evaluate array of Antenna to meet the requirement of Modern Wireless Communication
4. Apply analysis of key technology of 4G/5G wireless system
5. Evaluate antennas for various applications of modern wireless communication

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		3							2	3	2	2
CO2	3	2	2	2	3							2	3	2	2
CO3	3	3	2	1	3							2	3	2	2
CO4	3	2	3	3	3							2	3	2	3
CO5	3	1	2	3								2	3		3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP7	3	-	-	40	60	100	3

ANALOG CMOS VLSI DESIGN

Course Objectives:

- To demonstrate the ability to analyze and design the basic & advance analog integrated circuit.
- To gain knowledge of strengths and weaknesses of basic CMOS circuit building blocks and feedback concepts
- To develop skills in designing CMOS operational amplifier and reference circuits.
- To study the frequency response of the amplifier.
- To design analog IC circuits for a given specification.

UNIT-I: Basic MOSFET Physics: General consideration, MOS I/V characteristics, second order effects and MOS small & large signal models.

UNIT-II: CMOS Amplifier and Current Sources: Single Stage Amplifier: CS stage with resistance load, Diode connected load, Current source load, Triode load, CS stage with source degeneration, Source follower, Common-gate stage, Cascade stage, current sources, Basic current mirrors, Cascode current Mirrors, Active current Mirrors.

UNIT-III: Operational Amplifiers Design: Basic difference pair, Common mode response, Differential pair with MOS loads, Gilbert cell, Performance parameters, Design of 2-stage MOS operational amplifier, Gain boosting, Slew rate, Offset effects, PSRR, Stability and Frequency compensation.

UNIT-IV: Frequency Response and Feedback Amplifiers: Miller effect, Frequency response of all single stage amplifiers and Cascade stage, General consideration of feedback circuits, Feedback topologies, Effect of loading.

UNIT-V: Voltage References and Noise: Different configurations of voltage references, Major issues, Supply independent biasing, Temperature independent references, Types of noise, Analysis and representation of noise in single stage amplifiers, cascode stage and Noise in differential pairs.

Text/Reference Books:

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata Mc Graw-Hill,2001.
2. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", 5th Edition, Wiley, 2009
3. Phillip Allen and Douglas R. Holberg, "CMOS analog Circuit Design", 3rd Edition, Oxford University Press, USA, 2011.
4. T. Carusone, D. Johns, K. Martin, Analog Integrated Circuit Design, 2nd Edition, Wiley, 2011.

Course Outcome: At the end of the course, students will demonstrate the ability to:

CO1. Realize the concepts of analog IC design including small & large signal models.
CO2. Design different configuration of amplifiers for a given specification & current sources.
CO3. Illustrate the concept of op-amp and its design parameters and application.
CO4. Analyze the characteristics of frequency response of the amplifier and comprehend the feedback topologies.
CO5: Design band gap reference circuits providing constant dc voltage and immune to temperature variations and noise.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1			1			2	3	1	1
CO2	3	3	2	1	1	1			1			2	3	2	2
CO3	3	3	2	1	1	1			1			2	3	1	1
CO4	3	3	2	1	1	1			1			2	3	1	1
CO5	3	3	2	1	1	1			1			2	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP8	3	-	-	40	60	100	3

DIGITAL IMAGE PROCESSING

Course Objectives:

- To provide fundamental knowledge on digital image processing.
- To develop the ability to understand and implement various digital image processing algorithms.
- To facilitate the students for analyze and implementing various real-time digital image processing applications.

UNIT-I: Image Representation and Image Processing Paradigm: Image, Elements of Image perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels

Image Enhancements: Point operations, Arithmetic operations, Logical operation, Gray level transformations, histogram equalization, histogram specifications, pixel-domain smoothing filters, pixel-domain sharpening filters, two-dimensional DFT and its inverse, and Cosine transform.

UNIT-II: Image Filtering and Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering.

UNIT-III: Color Image Processing: Color models, Color transformations, Color image smoothing and sharpening; Color Segmentation. **Wavelets and Multi-resolution image processing**- Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub-band filter banks, wavelet packets.

UNIT-IV: Image Compression: Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding; Still image compression standards – JPEG and JPEG-2000.

UNIT-V: Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding, region-based segmentation, Segmentation Using Morphological Watersheds.

Text/Reference Books:

1. Rafael C. Gonzalez, R E. Woods, Digital Image Processing, 3rd Edition, Pearson Ed 2010
2. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall,2nd ed 2011
3. William K. Pratt, Digital Image Processing, 4th edition, John Wiley, 2007.
4. John C. Russ, The Image Processing Handbook, 6th edition, CRC Press,2011
5. Maria M. P. Petrou, C Petrou, Image Processing: The Fundamentals, 2nd Ed, Wiley 2010

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Acquire the knowledge of basic image processing concepts and image enhancement techniques involved.
2. Demonstrate the image restoration process and its respective filters required.
3. Illustrate the color image processing and various multi-resolution techniques
4. Interpret the various image compression techniques and their applications.
5. Design the various image segmentation operations for a meaningful partition of objects.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	1			1		2	1	1	1
CO2	3	3	3	3	3	1	1			1		2	2	2	2
CO3	3	3	3	3	3	1	1			1		2	3	2	2
CO4	3	3	3	3	3	1	1			1		2	3	2	2
CO5	3	3	3	3	3	1	1			1		2	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP9	3	-	-	40	60	100	3

MODERN DIGITAL COMMUNICATION

Course Objectives:

1. Understand and appreciate the need of various modulation and spread spectrum techniques.
2. To introduce the properties of basic Modulation techniques and apply them to Digital Communication
3. To understand coding techniques to design the optimum receiver for channels with ISI and AWGN.
4. To introduce the different types of modulation techniques, equalizer to improve the performance under fading channels for various applications.
5. To introduce Spread Spectrum Signals for Digital Communication.

UNIT-I:

Baseband Modulation and Transmission: Line coding - types, criterions for choosing a line code, power spectra. Matched filter – maximization of output SNR, properties, RF and baseband design, integrate and dump filter. Signal space representation, Gram-Schmidt orthogonalization, correlation receiver, equivalence of matched filter and correlation receiver. Baseband transmission of digital signal, eye pattern, intersymbol interference, Nyquist criterion for zero ISI. Pulse Shaping - raised cosine filtering. Correlative coding – duobinary coding, modified duobinary coding, generalized partial response signalling.

UNIT-II:

Passband Transmission: Signal space and mathematical representation, transmitter, receiver (coherent and non coherent detection), Carrier modulation – Linear modulation schemes: M-ary ASK, PSK, QAM, FSK etc. Nonlinear Modulation schemes: CPFSK, MSK, GMSK . Non coherent modulations schemes: DPSK Spectral properties of various modulation schemes and their comparison. probability of error for various modulation schemes in AWGN channel. Clock and carrier recovery, synchronization issues.

UNIT-III:

Optimum receivers: channels with ISI and AWGN, linear equalization and decision feed back equalization, adaptive linear and adaptive decision feed back equalizer.

UNIT-IV:

Error Control Codes: Examples of the use of error control codes, basic notions, Characterization of Error control codes performance of error control codes, comparison of uncoded and coded systems.Linear Block Codes,Cyclic Codes. Convolution Coding, Representation, properties of convolution codes, Reed Solomon coding, Interleaving and concatenated codes, Turbo Codes.

UNIT-V:

Spread Spectrum Signals for Digital Communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS, Synchronization of SS systems.

Text/Reference Books:

1.Bernard Sklar, "Digital Communication, Fundamentals and Application", Pearson Education Asia, 2nd Edition, 2001.

2. Simon, Hinedi, Lindsey, "Digital Communication Techniques, Signal Design and Detection", Prentice Hall of India Private Limited, New Delhi - 11, 1999.

3. John .G.Proakis, "Digital Communication", McGraw Hill Inc 2001.

4. Simon Haykin, "Digital Communications", John Wiley and Sons, 1998.

5. B.P.Lathi, "Modern Digital and Analog and communication systems", 3rd Edition Oxford university press 1998.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Represent Line coding and baseband data transmission over AWGN and band-limited channels

2. Apply and explain different digital modulation schemes and Passband data transmission
3. Analyze the performance of optimum receivers for different modulation schemes for AWGN channels
4. Apply different error control coding for secure and error-free communication.
5. Explain the concepts of spread spectrum for digital communication system.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	1							2	3	2	2
CO2	3	3	1	2	3							2	3	2	2
CO3	3	3	1	2	3							2	3	2	2
CO4	3	3	1	2	3							2	3	2	2
CO5	3	2	1	1	1							2	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP10	3	-	-	40	60	100	3

NETWORK SECURITY & CRYPTOGRAPHY

Course Objectives:

- To provide deeper understanding into cryptography, its application to network security, threats/vulnerabilities to networks and countermeasures.
- To explain various approaches to Encryption techniques, strengths of Traffic Confidentiality, Message Authentication Codes.
- To familiarize Digital Signature Standard and provide solutions for their issues.
- To familiarize with cryptographic techniques for secure communication of two parties over a public channel; verification of the authenticity of the source of a message.
- Understand Intrusions and intrusion detection.
- Generate and distribute a PGP key pair and use the PGP package to send an encrypted email message.
- Discuss Web security and Firewalls

UNIT-I:

INTRODUCTION:

Security trends, The OSI Security Architecture, Security Attacks, Security Services and Security Mechanisms, A model for Network security. CLASSICAL ENCRYPTION TECHNIQUES: Symmetric Cipher Modes, Substitute Techniques, Transposition Techniques, Rotor Machines, Stenography**.** key range and key size, possible types of attacks.

UNIT-II:

BLOCK CIPHER AND DATA ENCRYPTION STANDARDS: Block Cipher Principles, Data Encryption Standards, the Strength of DES, Differential and Linear Crypt Analysis, Block Cipher Design Principles.

Analysis, Block Cipher Design Principles.

ADVANCED ENCRYPTION STANDARDS: Evaluation Criteria for AES, the AES Cipher. MORE ON SYMMETRIC CIPHERS: Multiple Encryption, Triple DES, Block Cipher Modes of Operation, Stream Cipher and RC4

UNIT-III:

Introduction to Number Theory Principles of public key cryptosystems, RSA Algorithm, Key management, Diffie-Hellman key exchange algorithm, Elliptic Curve Cryptography (ECC).

AUTHENTICATION AND HASH FUNCTION: Authentication requirements – Authentication functions Message Authentication Codes – Hash Functions – Security of Hash Functions and MACs, MD5 message Digest algorithm, Secure Hash Algorithm, RIPEMD, HMAC Digital Signatures, Authentication Protocols – Digital Signature Standard.

UNIT-IV:

NETWORK AND SYSTEM LEVEL SECURITY:

Authentication Applications: Kerberos – X.509, Authentication Service, Electronic Mail Security – PGP – S/MIME - IP Security – Web Security, Intrusion detection – password management – Viruses and related Threats – Virus Counter measures – Firewall Design Principles – Trusted Systems, Hardware trojan.

UNIT-V:

WEB SECURITY: Requirements, Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET), Intruders, Viruses and related threats.

FIREWALL: Firewall Design principles, Trusted Systems.

Text/Reference Books:

1. Cryptography and Network Security: Principles and Practice by William Stallings, Pearson Education.
2. Cryptography: Theory and Practice by D Stinson, Chapman & Hall.
3. Network Security by C. Kaufman, R. Perlman and M. Spenser, Prentice Hall of India.
4. Internet Security and Firewalls by S. Bellovin and W. Chesvick, Addison-Wesley, Reading.
5. Introduction to Cryptography with Coding Theory by Wade Trappe and Lawrence C.

Washington, Prentice-Hall.
6. Cryptography & Network Security by Behrouz A. Forouzan, McGraw Hill Education

Course Outcome:

At the end of the course, students will demonstrate the ability to:
CO1: Apply block cipher and stream cipher algorithms.
CO2: Employ Public key cryptographic techniques .
CO3: Explain the authentication and hash algorithms .
CO4: Analyze the digital signature concepts and applications .
CO5: Apply the Network and System level security measures

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			1	2						3	3	1	1
CO2	3	2			1	2						3	3	2	2
CO3	3	2										3	3	2	2
CO4	3	2	2	2	1							3	3	2	2
CO5	3	2			1	2						3	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP11	3	-	-	40	60	100	3

INTRODUCTION TO SIGNAL PROCESSING

Course Objectives:

The objectives of the course are to make the students:

1. Review of signal and system, Fourier transforms, the Z-transform
2. To impart knowledge of mathematical concept involved in signal processing.
3. To introduce mathematical modeling for Statistical Signals processing.
4. To apply optimization techniques for signal processing applications.

UNIT-I: Discrete and Continuous time signals and systems, LTI systems, Convolution, z-transforms, Fourier transform and its properties.

UNIT-II: Sampling and reconstruction, Review of vector spaces, Eigenvectors and Eigen-values. Hilbert transforms, matched filtering, equalization. Coherent and Non-coherent detection.

UNIT-III: Probability theory review, Random variables, statistical averages, Random processes, Transmission of random process through an LTI system.

UNIT-IV: Statistical Signal Processing: Power Spectrum Estimation Parametric and Maximum Entropy Methods, Wiener, Kalman Filtering, and the Poisson process, Levinson Durbin Algorithms Least Square Method.

UNIT-V: Optimization techniques for linear and nonlinear problems, Applications in various areas of signal processing.

Text/Reference Books:

1. Proakis, John G. - Digital signal processing: principles algorithms and applications, PHI.
2. Oppenheim, Alan V - Discrete-time signal processing, Pearson Education India.
3. Vaidyanathan, Parishwad P - Multirate systems and filter banks, Pearson Education India.
4. Monson H. Hayes, "Statistical Digital Signal Processing And Modeling", 1st Edition, Wiley India Pvt Ltd, 2008.
5. Vaidyanathan, Palghat P- The theory of linear prediction, Morgan and Claypool Publishers.
6. Haykin, Simon S. - Adaptive filter theory, Pearson Education India.
7. Henry Stark and John W. Woods, "Probability and Random Processes with Applications to Signal Processing", Prentice Hall, 3rd Edition 2001
8. Sanjit K. Mitra. " Digital Signal Processing: A computer based approach." McGraw Hill. 1998.
9. Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory", Prentice Hall, 1993

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Apply the basic concept of frequency domain analysis for signal processing.
2. Utilize the linear analysis concept for signal processing.
3. Describe and apply probability theory concept for random signals.
4. Apply basic statistical signal processing filtering techniques.
5. Design and Demonstrate basic optimization techniques for the applications based on signal processing.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1						3	3	1	2
CO2	3	3	3	2	1	1						3	3	1	2
CO3	3	3	3	2	1	1						3	3	2	2
CO4	3	3	3	2	1	1						3	3	2	2
CO5	3	3	3	2	1	1						3	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATP12	3	-	-	40	60	100	3

SATELLITE COMMUNICATION

Course Objectives:

1. recall the basic concepts, frequency allocations and applications of satellite communication system
2. To know the role of different factors affecting satellite and link budget equation.
3. explain satellite sub system .
4. compare various multiple access schemes used in satellite communications.
5. To know the basics and details of Earth station

UNIT-I:

An overview of satellite communication, Satellite orbits, Kepler's law, Orbital Elements, Eclipse effect, Sun transit outage, Placement of a satellite in a geostationary orbit, Station keeping and Stabilization.

UNIT-II:

Satellite Link Design: Basic transmission theory, Friss transmission equation, EIRP, Completion Link design, System noise temperature G/T ratio, Noise figure and Noise temperature.

UNIT-III:

Communication Satellite Subsystems: Space Platform (Bus) and Communication Subsystem (Payload), Satellite Antennas, Frequency reuse Antennas.

UNIT-IV:

Earth Stations: Earth station antennas, Tracking, Equipment for earth stations, Equipment Reliability and Space qualification.

UNIT-V:

Analogue Satellite Communication Vs Digital Satellite Communication, Multiple Access Techniques : FDMA Concept, MCPC & SCPC, TDMA frame efficiency and super frame structure, Frame Acquisition and Synchronisation, CDMA concept, PN system, Spread spectrum, DSSS, DS CDMA, FHSS, FH CDMA.

Text/Reference Books:

"1. "Satellite Communication", T. Pratt & C. W. Bostian.
2. "Digital Satellite communication", Tri T. Ha, McGraw Hill.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Visualize the architecture of satellite systems as a means of high speed, high range communication system.
2. State various aspects related to satellite systems such as orbital equations, sub-systems in a satellite, link budget.
3. Solve numerical problems related to orbital motion and design of link budget for the given parameters and conditions.
4. Explain how satellite is controlled to become stationary w.r.t a point on the earth.
5. Explain how a single satellite is shared by large number of earth stations on the earth by using multiple access schemes

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1									2	3		1
CO2	3	3	1									2	3		1
CO3	3	3	2	2								2	3		1
CO4	3	2	1									2	3		3
CO5	3	2	1									2	2		1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPATC1	2	-	-	-	50	50	2

RESEARCH METHODOLOGY & IPR

Course Objectives:

1. To understand the objectives, motivation, and significance of research.
2. To enable the students to prepare report writing and framing Research proposals.
3. To understand the concept and importance of IPR.

UNIT-I:

Research Methodology: Meaning, objectives, and Motivation of research, types of research, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, identification and definition of the research problem, Research Process, Criteria of Good Research, Research Ethics, Problems Encountered by Researchers in India.

UNIT-II:

Literature Survey and Data Collection: literature survey and its necessity, Sources of information, Effective literature studies approach, Data collection: primary and secondary data, sources of data, collection of primary data through observation, interview, questionnaire, and schedule methods, and Collection of secondary data.

UNIT-III:

Interpretation and Report Writing: Meaning, techniques, and precautions of interpretation, Significance of Report writing, different steps in writing report, the layout of the research report, types of report, mechanics of writing a research report, Precautions for writing research,

UNIT-IV:

Intellectual Property Rights: Introduction to IPRs, Basic concepts and need for Intellectual Property, Patents, Trademarks, and Copyright, Nature of Intellectual Property**,** technological research, innovation, Important examples of IPR**,** International Scenario: International cooperation on Intellectual Property, Role of WIPO and WTO in IPR establishments

UNIT-V:

Patents: objectives and benefits of patent, Benchmarks for patentability of inventions, Process of Patenting and Development: technological research, innovation, patenting, development, procedure for grants of patents, Patenting under PCT.

Text/Reference Books:

1. Research Methodology – Methods and Techniques, C K Kothari, New Age International.
2. Research in education, By J W Best and J V Kahn, Pearson/ Allyn and Bacon.
3. Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education.
4. Fundamentals of IP for Engineers, K.Bansal & P.Bansal.
5. Intellectual property right- The Law of Trademarks, Copyrights, Patents and Trade Secrets, Deborah, E. BoDcboux, Cengage learning.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Comprehend the basics of research methodology.
2. Prepare a literature review and collect the data for research.
3. prepare report writing and framing Research proposals
4. Identify the need of IPR for economic growth and social benefits
5. Identify the significance of practice and procedure of Patents

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1		2						1		2	3	2	2
CO2	3							3	2	3		2	2		2
CO3	3							3	2	3		2	2		2
CO4	3	2	1									2	2		2
CO5	3	2	1					1	1	2		2	2		2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPALT1	-	-	4	30	20	50	2

ADV SIMULATION LAB

Course Objectives:

1. Apply different parameters to solve for channel capacity.
2. Understand and compare different multiple access techniques.
3. Analyse and plot the results.

List of experiments:

1. Programme to calculate SNR using channel capacity theorem.
2. Programme to calculate Channel capacity for variable SINR and its plot using channel capacity theorem.
3. Programme to show relationship between E_b/N_0 and SINR and its plot.
4. Programme to calculate channel capacity of FDMA system and its plot.
5. Programme to calculate channel capacity of TDMA system and its plot.
6. Programme to calculate channel capacity of CDMA system and its plot.
7. Programme for comparison of channel capacity of FDMA,TDMA and CDMA systems and its plot.
8. Programme to calculate channel capacity of latest mobile communication system and its plot.
9. Programme to calculate spectral efficiency of latest mobile communication system and its plot.
10. Programme to calculate energy efficiency of latest mobile communication system and its plot.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Demonstrate the concept of channel capacity of wireless system.
2. Analyze SINR and other parameters for channel capacity of wireless communication system.
3. Analyze the different multiple access techniques for wireless system.
4. Analyze the spectral efficiency for latest cellular network
5. Analyze the energy efficiency for latest cellular network

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1							3	3	1	3
CO2	3	3	1	1	1							3	3	1	3
CO3	3	3	1	1	1							3	3	1	3
CO4	3	3	1	1	1							3	3	1	3
CO5	3	3	1	1	1							3	3	1	3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTT1	3	-	-	40	60	100	3

ESTIMATION AND DETECTION THEORY

Course Objectives:

- To teach students the basics of estimation and detection theory.
- To introduce the students to estimation bounds.
- To introduce classical and Bayesian estimators like ML, LS, and MMSE to students.
- To teach hypothesis testing and a number of detectors of signals in noise. And to introduce the likelihood ratio test and GLRT.
- Exposing the students to applications of estimation and detection is another important goal.

UNIT-I: Introduction: Recap of probability and linear algebra, Introduction of estimation in signal processing, Minimum variance unbiased estimation, Unbiased estimators, Minimum variance criterion, Existence of minimum variance unbiased estimator, Cramer-Rao lower bound (CRLB), scalar parameters, Signal in white Gaussian noise.

UNIT-II: Linear model and Estimation: Linear models, General minimum variance unbiased estimation, Sufficient statistic, finding minimum variance unbiased estimators, Best linear unbiased estimators (BLUE), Finding the BLUE, Signal processing example.

UNIT-III: Likelihood Estimation: Maximum Likelihood estimators (MLE), finding the MLE, Properties of the MLE, MLE for transformed parameters, Extension to a vector parameter, Introduction to Least Square (LS) Approach, Linear least square estimation, Geometrical interpretations of LS estimation, Some examples.

UNIT-IV: Bayesian Estimation: Bayesian estimators, Priors and Posteriors probabilities, Choosing a Prior PDF, General Bayesian estimators, Minimum mean square estimators (MMSE), Maximum A Posteriori (MAP) Estimators, Linear MMSE Estimation.

UNIT-V: Detection and Decision: Basics of statistical decision theory, Simple hypothesis testing, Likelihood ratio testing, Neyman-Pearson detectors, Detection of known signals in noise, Composite hypothesis testing, Generalized likelihood ratio tests (GLRTs), Deterministic signals with unknown parameters.

Text/Reference Books:

1. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory, vol. I" Prentice-Hall, 1993 & "vol. II" Prentice-Hall, 1998.
2. H. Vincent Poor, "An Introduction to Signal Detection and Estimation" Springer, 2nd Ed, 1998
3. H. L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley, 1968

Course Outcome: At the end of the course, students will demonstrate the ability to:

CO1: Explain the principle of estimation and detection.
CO2: Learn different estimation and detection techniques like ML, LS, MMSE.
CO3: Solve problems that involve estimation of the signal parameters or detection of the presence of a signals.
CO4: Evaluate the performance of different estimation technique in different setups.
CO5: Apply these skills to solve problems with practical context.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2							3	3	2	2
CO2	3	3	3	3	3							3	3	2	2
CO3	3	3	3	3	3							3	3	2	2
CO4	3	3	3	3	3							3	3	2	2
CO5	3	3	3	3	3							3	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP1	3	-	-	40	60	100	3

LOW POWER VLSI DESIGN

Course Objectives:

- To understand the low power low voltage VLSI design.
- To understand the impact of power on system performances.
- To realize different design approaches.
- To identify suitable techniques to reduce power dissipation in the circuits.

UNIT-I:

Introduction: Need for Low Power VLSI chips, Low power application, Low power design methodology, Basic principal of low power design, Low power figure of merits, Sources of Power dissipation: Dynamic, Short-circuit, Glitching and Leakage power dissipation, The load capacitance.

UNIT-II:

Supply Voltage Scaling for Low Power: Introduction, Device feature size scaling, Architectural-level approaches, Multilevel voltage scaling and challenges, Dynamic voltage and frequency scaling.

UNIT-III:

Switching Capacitance Minimization: Dynamic voltage and frequency scaling, Bus encoding, clock gating, Gated-clock FSM, Glitching power minimization, Logic style for low power, some related techniques for dynamic power reduction.

UNIT-IV:

Leakage Power Minimization: Fabrication of multiple threshold voltages, VTCMOS approach, Transistor stacking, MTCMOS approach, Power gating, DTCMOS, Dynamic V_{th} scaling.

UNIT-V:

Special Techniques: Low power clock distribution, Single driver Vs distributed buffers, Various clock distribution networks, Power reduction in clock networks, Low power bus, CMOS floating nodes, and Adiabatic logic.

Text/Reference Books:

1. Ajit Paul, "Low Power VLSI Circuits & Systems", Springer, 2015.
2. Kaushik Roy, Sharat Prasad, "Low power CMOS VLSI circuit design", John Wiley sons Inc.,2000.
3. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998.
4. J. B. Kulo and J. H. Lou, "Low voltage CMOS VLSI Circuits", Wiley, 1999.
5. A. P. Chandrasekaran and R. W. Broadersen, "Low power digital CMOS design", Kluwer, 1995.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

CO1: Identify sources of power dissipation in VLSI systems.

CO2: Understand how to apply techniques at the device, circuit and architectural level to reduce power dissipation in an electronic design.

CO3: Illustrate and design switching capacitance & leakage power minimization techniques low voltage low power applications.

CO4: Learn and design special techniques for various low voltage low power applications.

CO5: Design and implementation of various structures for low power applications.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1			1	1		2	3	1	2
CO2	3	3	2	1	1	1			1	1		2	3	1	2
CO3	3	3	3	1	1	1			1	1		2	3	3	2
CO4	3	3	3	1	1	1			1	1		2	3	3	2
CO5	3	3	1	1	1	1			1	1		2	3	1	1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP2	3	-	-	40	60	100	3

ADV DIGITAL SIGNAL PROCESSING

Course Objectives:

The objectives of the course are to make the students:

1. To impart knowledge about the sampling/reconstruction of signals and their analysis in the frequency domain
2. To introduce the fundamental concepts for filter designs, and multi-rate processing.
3. To enable the students to understand the efficient algorithms and their use in real-time implementation

UNIT-I:

Multirate Digital Signal Processing: Decimation and Interpolation, Applications of multirate signal processing, Digital filter banks, two-channel quadrature mirror filter banks.

UNIT-II:

Linear prediction and Optimum Linear Filters: Random signals, Stationary Random Process. Forward and Backward Linear Prediction, The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters.

UNIT-III:

Adaptive filters: Applications of Adaptive Filters-Adaptive Channel Equalization, Adaptive noise cancellation, Linear Predictive coding of Speech Signals, Adaptive direct form filters.

UNIT-IV:

Power Spectrum Estimation:

Parametric and Non parametric Methods for Power Spectrum Estimation, Methods for the AR Model Parameters, ARMA Model for Power Spectrum Estimation.

UNIT-V:

Wavelet Transform: Origin of Wavelets, Wavelets and other reality transforms History and future of wavelets, Short Time Fourier Transform, Continuous Wavelet, and Discrete Wavelet Transform.

Text/Reference Books:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Pearson, Fourth edition, 2007.
2. S. Haykin, "Adaptive Filter Theory" Prentice Hall, Englewood Cliffs, NJ, 1991.
3. K P Soman, Ramachandran, Resmi, "Insight into Wavelets- from Theory to Practice", PHI, Third Edition, 2010.
4. P.P.Vaidyanathan, "Multi rate systems and filter banks", Prentice Hall, 1993.
5. Mallet,"A Wavelet tour of Signal Processing", Academic Press, 1998

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Apply knowledge of Multi-rate signal processing and the concept of decimators and interpolators.
2. Analyze the signals using prediction-based filtering
3. Design adaptive filters for a given application
4. Implement various estimation algorithms for signal analysis
5. Understand advanced signal processing techniques, including wavelet transform

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1						3	3	2	2
CO2	3	3	3	2	1	1						3	3	2	2
CO3	3	3	3	2	1	1						3	3	2	2
CO4	3	3	3	2	1	1						3	3	2	2
CO5	3	3	3	2	1	1						3	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP3	3	-	-	40	60	100	3

OPTICAL INSTRUMENTATION

Course Objectives:

- To understand the measuring methods and instruments of electrical quantities.
- To understand the concept of optical instrumentation.
- To get the concept of optical switching and various instruments.
- To get the concept of optical fiber sensors.
- To get the measurement concept of optical instrumentation.

UNIT-I:

Performance characteristics of instruments: Static characteristics, accuracy, resolution, precision, expected value, error and sensitivity. Errors in measurement and dynamic characteristics: speed of response, fidelity, lag and dynamic error.

UNIT-II:

Optical Instruments: basic principles, interferometric configurations, MachZender, Michelson and FabriPerot configurations components and construction, OTDR and applications.

UNIT-III:

Fiber optic components and devices : Direction couplers, beam splitters, switches modulations, connectors, couplers, polarizer, polarization controllers, amplifiers, wavelength filters, polarizing beam splitters, wavelength division multiplexers, fiber optic isolators.

UNIT-IV:

Fibre optic sensors : general features, types of OFS, intrinsic and extrinsic sensors, intensity sensors, shutter based multimode OFS, simple fibre based sensors for displacement, temperature and pressure. Fibre Bragg grating based sensors.

UNIT-V:

Measurements methods in optical fiber : General experimental consideration, measurement of refractive index profile, numerical aperture, attenuation, pulse dispersion and bandwidth, Cut off wavelength, mode field diameter and birefringence of single mode fiber.

Text/Reference Books:

1. B. P. Pal : Fundamentals of Fibre Optics in Telecommunication and Sensor Systems, New Age, New Delhi.
2. A. K. Ghatak and K. Thyagarajan, Introduction to Fiber Optics, Cambridge.
3. S.M. Senior : Optical Fibre Communication: Principles and Practice, PHI, New Delhi.
4. A.K.Ghatak, M.R. Shenoy : Fibre Optics Measurements, Viva, New Delhi.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

- Explain the measuring methods and instruments of electrical quantities.
- Apply the concept of optical instrumentation.
- Analyze the concept of optical switching and various instruments.
- Explain the concept of optical fiber sensors.
- Demonstrate the measurement concept of optical instrumentation.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	3	1							3	2	2	
CO2	2	2	1	3	2							3	2	2	
CO3	3	2	3	3	2							3	2		3
CO4	3	2	1	2	3							3	2		2
CO5	3	2	1	2	3							3	2	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP4	3	-	-	40	60	100	3

PATTERN RECOGNITION & MACHINE LEARNING

Course Objectives:

1- To study the fundamentals of pattern recognition.
2- To study the various parameter based estimation methods.
3- To study some dimensionality reduction methods.
4- To study the fundamentals of artificial neural networks.
5- To be able to choose and apply algorithms for pattern recognition.

UNIT-I:

Introduction to statistical pattern recognition, Bayes Decision Theory: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Discrete features.

UNIT-II:

Parameter Estimation Methods: Maximum-Likelihood estimation, Bayesian estimation, Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation.

UNIT-III:

Gaussian mixture models, Expectation-Maximization method for parameter estimation. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs.

UNIT-IV:

Dimensionality reduction: Principal component analysis - relationship to eigen analysis. Fisher discriminant analysis - Generalised eigen analysis.

UNIT-V:

Artificial neural networks: Multilayer perceptron - feedforward neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks.

Text Books:

1. J.I. Tou & R C Gonzalez, Pattern Recognition Principles, Addition-Wesley.
2. R Schalkoff, Pattern Recognition- Statistical, Structural and Neural Approaches, John Wiley, 1992.

Reference Books

1. P A Devijer & J Kittler, Pattern Recognition – A statistical Approach, Prentice Hall
2. R O Duda, P E Hart, D G Stork, Pattern Classification, Wiley Publication 2001.
3. D Mckay, Information Theory, Inference and Learning Algorithms, Cambridge University Press 2003.
4. C M Bishop, Pattern Recognition and Machine Learning, Springer, 2006
5. Christopher M Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Course Outcome:

At the end of the course, students will demonstrate the ability to:

CO1: Summarize the various techniques involved in pattern recognition
CO2: Ability to analyse the various parameter based estimation methods.
CO3: Illustrate the artificial neural network based pattern recognition
CO4: Discuss the applications of pattern recognition in various applications
CO5: Apply to choose and evaluate suitable algorithm given the application.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	-	-	-	-	-	-	2	3	1	2
CO2	3	3	3	2	1	2	-	-	-	-	-	2	3	2	2
CO3	3	2	2	1	2	2	-	-	-	-	-	2	3	2	2
CO4	3	3	3	2	3	2	-	-	-	-	-	2	3	1	3
CO5	3	2	3	1	2	2	-	-	-	-	-	2	3	1	3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP5	3	-	-	40	60	100	3

OPTICAL COMMUNICATION SYSTEM

Course Objectives:

- To understand the transmission mechanism of optical fiber communication system .
- To understand the working of light source.
- To introduce the concept of optical detector and various parameter associated with it.
- To get the concept of design of system link and its characteristics.
- To introduce the concept of optical fiber cable and working principle of amplifier

UNIT-I: Introduction to Guided optical communication system : Review of Unguided optical communication system, Guided optical communication, Elements of an Optical Fiber Transmission System. Optical Fibres Types, Materials, Fabrication techniques. Signal degradation Attenuation, Signal Distortion.

UNIT-II: Sources for communication: Review of LED – modulation circuits: analog & digital. Laser Diode – Structure, modulation analog & digital circuits. Opto mechanical switches, Photonic & digital switches.

UNIT-III: Detectors for communication: Noise in PIN diode, Noise Sources, Principal Noises thermal noise, dark current noise, quantum noise, receiver noise, noise in APD receiver. Receiver configurations: Receiver noises preamplifiers, Low impedance, High impedance, Trans impedance amplifiers.

UNIT-IV: System design considerations: multiplexing, OTDM, WDM. Digital systems: regenerative repeaters, Point to point Link s Link Power Budget Analysis, Rise Time Budget Analysis. Line coding: NRZ codes, RZ codes, block codes. Analog Systems: Sub carrier multiplexing. Coherent systems homodyne and heterodyne detection.

UNIT-V: Optical fiber cable componenets and amplifier. Optical Fiber Cables, Fiber Connectors, Joints, Splicers, Couplers, , Fiber amplifiers : Types, Semiconductor Laser Amplifier, Erbium doped fiber amplifier, Raman Fiber Amplifier, Brillowin fiber Amplifier, Solitons Communication.

Text/Reference Books:

1. Optical Fiber Communication G Keiser (4th Ed, TMH)
2. Optical Fiber Communications J M Senior (Pearson Publication)
3. Introduction to Optical Fibre Communication Suematsu and Iga, (John Wiley)
4. Fiber Optic Communication – Joseph C Palais, (PHI)
5. Optical Communication Components and Systems – J H Franz, V K Jain (Narosa Pub House)
6. Optical Fiber Communication Systems J Gowar (Prentice Hall India,)
7. Fiber Optic Communication Systems D C Agarwal (S Chand).
8. An Introduction to Fiber Optic Systems – John Powers(McGraw Hill Irwin)
9. Fiber optic Communications Technology – D K Mynbaev & L L Scheiner, (Pearson Edu)

Course Outcome: At the end of the course, students will demonstrate the ability to:

1. Analyze the performance of OFC system.
2. Distinguish between various emission approaches and also light source based on it.
3. Analyze the noise performance of optical detector.
4. Demonstrate the design of system link and performance of the OFC system.
5. Distinguish between the working of electrical and optical amplifier and analyze the performance of optical amplifiers

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2								3	2	2	2
CO2	3	2	1	2								3	2	2	2
CO3	3	2	1	1								3	3	3	3
CO4	3	2	1	1								3	2	2	2
CO5	3	2	2	2								3	2	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP6	3	-	-	40	60	100	3

NEXT GEN. COMM. TECHNOLOGY

Course Objectives:

1. To learn the new communication technologies such as OFDM and MIMO used in Next Generation communication systems.
2. To understand and apply the fundamental concept of Coherence Time, Coherence Bandwidth.
3. To learn the different fading model and evaluate the SNR.
4. To learn and analyse the performance of a massive MIMO system.
5. To analysis the performance such as capacity/spectral efficiency and energy efficiency of the MIMO and massive MIMO system.

UNIT – I

Introduction and Preliminaries: Introduction to point-to-point Multi-input Multi-output (MIMO), multiuser MIMO, massive MIMO, Coherence Time, Coherence Bandwidth, Coherence Interval. TDD Coherence Interval structure, Coherence Interval in the context of OFDM modulation, Small-scale and Large-scale fading, Normalized signal model, and SNR.

UNIT –II

OFDM: Principle of Orthogonal Frequency Division Multiplexing (OFDM), Multiple access – OFDMA, Implementation of transceivers, Frequency-selective channels, Cyclic Prefix (CP), Performance in the frequency-selective channel, Pilot based channel estimation, Peak-to-average power ratio, Inter-carrier-interference, Parameter adaptation.

UNIT –III

MIMO Systems: Introduction to MIMO systems, Diversity in wireless channel, Introduction to fading distributions, Analytical MIMO channel models, Independent and identically distributed (uncorrelated) MIMO fading model, Fully correlated MIMO channel model, MIMO channel parallel decomposition.

UNIT –IV

MIMO Channel Capacity and Power Allocation: Power allocation in MIMO systems, Uniform power allocation, Adaptive power allocation, MIMO channel capacity, Capacity of i.i.d. Rayleigh fading MIMO channels, Capacity of separately correlated Rayleigh fading MIMO channel.

UNIT –V

Massive MIMO Systems: Definition of Massive MIMO, Correlated Rayleigh fading, Uplink, and downlink system model, Impact of Spatial channel correlation, Channel hardening and favorable propagation, Pilot transmission and channel estimation, Spectral Efficiency (SE), Transmit precoding and Receive decoding, Single-cell uplink and downlink SE expressions, Asymptotic analysis, Energy efficiency.

Suggested Books & References: -

1. D. Tse and P. Vishwanath, "Fundamentals of Wireless Communications," Cambridge Univ. Press, 2005.
2. A. J. Goldsmith, "Wireless Communications," Cambridge Univ. Press, 2005.
3. R. S. Kshetrimayum, "Fundamentals of MIMO Wireless Communications," Cambridge University Press, 2017.
4. T. L. Marzetta, E. G. Larsson, H. Yang, and H. Q. Ngo, "Fundamentals of Massive MIMO," Cambridge Univ. Press, 2016.
5. Emil Björnson, Jakob Hoydis, and Luca Sanguinetti, "Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency," Foundations and Trends® in Signal Processing: Vol. 11: No. 3-4, pp 154-655 (2017).

Course Outcome:

At the end of the course, students will demonstrate the ability to:

CO1: Explain the different physical layer wireless communication technologies used in 4G and 5G communication systems.

CO2: Apply the concept of Coherence Bandwidth, Coherence Time, Coherence Interval, Small-scale and Large-scale fading to analyze the physical layer performance of 4G and 5G

communication systems.
CO3: Evaluate the channel capacity of the MIMO and massive MIMO Systems.
CO4: Analyze the communication system performance under OFDMA.
CO5: Evaluate the spectral efficiency and energy efficiency of massive MIMO technology used in 5G.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1							2	3	3	3
CO2	3	3	2	2	2							2	3	3	2
CO3	3	3	2	3	2							2	3	3	1
CO4	3	3	2	3	2							2	3	3	1
CO5	3	3	2	3	2							2	3	3	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP7	3	-	-	40	60	100	3

COMPUTER VISION

Course Objectives:

1) To provide the fundamental concept of Computer Vision.
2) To Comprehend the working of stereo vision.
3) To identify and analyze various features with extraction in an image and video signal.
4) To study basic motion detection and object tracking.
5) To facilitate the ability to develop basic vision based applications.

UNIT-I:

Image Formation Models: Introduction and Goals of Computer Vision, Image Formation and Radiometry, Introduction to Computer Vision and Basic Concepts of Image Formation: Geometric Transformation, Geometric Camera Models, Image Reconstruction from a Series of Projections.

UNIT-II:

Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; basic introduction to Auto-calibration in stereo vision.

UNIT-III:

Image Descriptors and Features: Texture Descriptors, Colour Features, Edge Detection, Object Boundary and Shape Representations, Binary shape analysis, Interest or Corner Point Detectors, Histogram of Oriented Gradients(HOG), Scale Invariant Feature Transform (SIFT), Speeded up Robust Features (SURF).

UNIT-IV:

Motion Detection and Estimation : Regularization theory , Optical computation , Motion estimation, Background Subtraction and Modelling, Optical Flow, Kanade–Lucas–Tomasi (KLT), SpatioTemporal Analysis, Motion Tracking in Video.Mean Shift and Cam shift object Tracking.

UNIT-V:

Introduction to basic Pattern Recognition Concepts: Linear Regression, Basic Concepts of Decision Functions, Gaussian Classifier, Parameter Estimation,Template Matching, Clustering for Knowledge Representation, Dimension Reduction.

Applications of Computer Vision: Machine Learning Algorithms and their Applications in Medical Images, Motion Estimation and Object Tracking,Biometrics, Image Fusion,Document Image Processing.

Text/Reference Books:

1) D. Forsyth and J. Ponce,"Computer Vision - A modern approach", 2nd Edition, Pearson Prentice Hall, 2012

2) Szeliski, Richard, "Computer Vision: Algorithms and Applications", 1st Edition, SpringerVerlag London Limited, 2011.

3) Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", 2nd Edition, Cambridge University Press, 2004.

4) K. ,Ll the concept of calibration and stereo vision.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

CO1: Explain Image formation and mathematically analyze the camera model.

CO2: Explain working concept of stereo vision.

CO3: Identify and detect standard features in the image or video frame.

CO4: Apply techniques for motion detection and estimation in video frames.

CO5: identify challenges and develop basic computer vision based application in medical , security and document Image processing

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1						1	3	3	2
CO2	3	3	3	2	3	2						1	3	3	2
CO3	3	3	3	2	3	2						1	3	3	2

CO4	**3**	**3**	**3**	**2**	**3**	1						**1**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	2						**2**	**3**	**3**	**2**

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP8	3	-	-	40	60	100	3

DIGITAL COMMUNICATION RECEIVER

Course Objectives:

1. To gain knowledge about basic principles of digital communication techniques and Detection of Binary Signals in Gaussian Noise.
2. To gain knowledge about Coherent and Noncoherent Detection
3. To gain knowledge about receivers for AWGN channel and Fading channels.
4. To gain knowledge about concepts of synchronization and
5. To gain knowledge about concepts of adaptive equalization techniques.

UNIT-I:

Review of Digital Communication Techniques: Base band communication; signal space representation, linear and nonlinear modulation techniques, Error tracking and Spectral characteristics of digital modulation.

Detection of Binary Signal in Gaussian Noise: Detection of Binary signal in Gaussian Noise: Maximum Likelihood Receiver Structure, The Matched Filter, Correlation Realization of Matched Filter, Optimum error performance, Error performance of Binary Signalling.

UNIT-II:

Coherent and Noncoherent Detection: Coherent Detection: Coherent Detection of PSK, Sampled Matched Filter, Coherent Detection of Multiphase Shift Keying, Coherent Detection of FSK. Noncoherent Detection: Detection of Differential PSK, Binary Differential PSK example, Noncoherent Detection of FSK, Required Tone Spacing for Noncoherent Orthogonal FSK.

UNIT-III:

Optimum Receivers for AWGN Channel: Correlation demodulator, matched filter, maximum likelihood sequence detector, optimum receiver for CPM signals, M-ary orthogonal signals, envelope detectors for M-ary and correlated binary signals.

Receivers for Fading Channels: Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, Optimal receivers for data detection, coded waveform for fading channel.

UNIT-IV:

Synchronization Techniques: Carrier and signal synchronization, carrier phase estimation-PLL, Decision directed loops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation.

UNIT-V:

Adaptive Equalization: Zero forcing algorithm, LMS algorithm, adaptive decision-feedback equalizer and Equalization of Trellis-coded signals. Kalman algorithm, blind equalizers and stochastic gradient algorithm.

Text/Reference Books:

1. Digital Communications, 2ndEd, Bernard Sklar, Pearson Education, 2001.
2. Digital Communication Microwave Applications By Kamilo Feher, PHI, 1987.
3. Heinrich Meyer, Mare Moeneclacy, Stefan.A.Fechtel, " Digital communication receivers ", Vol I & Vol II, John Wiley, New York, 1997.
4. H.Meyr & G.Ascheid, Synchronization in Digital Communications, John Wiley, 1990
5. Simon Marvin, "Digital communication over fading channel; An unified approach to performance Analysis ", John Wiley, New York, 2000.
6. U. Mengali & A.N.D"Andrea, Synchronization Techniques for Digital Receivers, Kluwer, 1997

Reference Books:

1. Digital Communication, Prokis, John G. Tata McGraw Hill.
2. Digital Communication Technique, Signal Design & Detection By Simon, Marvin K, Hinedi,Sami M & Lindsey, William C, PHI.
3. Heinrich Meyer, Mare Moeneclacy, Stefan.A.Fechtel, " Digital communication receivers ", Vol I & Vol II, John Wiley, New York, 1997.

4. H.Meyr & G.Ascheid, Synchronization in Digital Communications, John Wiley, 1990
5. John.G.Proakis, "Digital communication "4th Edition, McGraw-Hill, New York, 2001.
6. R.G. Gallager, "Principles of Digital Communication", New York, Cambridge University Press, 2008

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Analyze the concept of basic modulation technique and detection technique of Binary Signal in Gaussian Noise.
2. Apply the concept of Coherent and Non-Coherent detection techniques.
3. Design the optimum receiver for AWGN channels and Analyse the concept of Receivers for Fading Channels
4. Apply Synchronization Techniques for Receivers and various estimation techniques
5. Design and develop the different types of equalizers

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1							3	3	2	2
CO2	3	3	2	2	2							3	3	2	2
CO3	3	3	2	3	3							3	3	2	2
CO4	3	3	2	3	3							3	3	2	2
CO5	3	3	2	3	3							3	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTP9	3	-	-	40	60	100	3

MILLIMETER WAVE TECHNOLOGY

Course Objectives:

1. To understand the Characteristics of Millimeter Wave Technology
2. To understand the concepts and working principles of various guiding Structures at Millimeter Wave Technology.
3. To design the Antenna for Millimeter Wave Applications.
4. To perform analysis of passive Components at Millimeter Wave
5. To understand the basic concept of Active Devices and Link Design at Millimeter Wave.

UNIT-I:

Introduction to Millimeter wave Technology: Advantages and Challenges of Millimeter Wave Technology, Millimeter Wave Applications, Sources of losses at Millimeter wave; Dielectric Loss, Conduction Loss, Radiation Surface wave losses, Wave propagation, Phase and Group Velocity, Slow and Fast waves.TEM, TE and TM modes.

UNIT-II:

Guiding Structure: Transmission Lines, Surface Wave in Grounded Dielectric Slab, Parallel Plate Guide, Rectangular Wave Guide, Circular Waveguides, Microstrip Lines, High Frequency Limitation of Microstrip Lines, Microstrip Coupled Lines, Conductor Backed CPW, Substrate Integrated Waveguide (SIW), SIW Losses, Design of SIW.

UNIT-III:

Antennas at Millimeter wave Frequency: Antennas Parameters, Printed Millimeter Wave Antennas, Dipole and Slot Antenna, Loop Antennas, Printed Millimeter Wave Array Antennas, Waveguide Slot Arrays, On Chip Antennas: Design and Challenges.

UNIT-IV:

Passive Components: Dielectric Resonators, Dielectric Resonators Antenna and its modes, filters, Different types of couplings, Power divider, Directional Coupler, Hybrid Coupler.

UNIT-V:

Active Components: PIN Diode, Gunn Diode, IMPATT Diode**,** FET, MOSFET, HEMT, Comparison of Solid State Devices **,** Noise and Link Budget, Friss Transmission Equation, Millimeter Wave Systems, Noise Figure for Cascaded System Elements.

Text/Reference Books:

1. S. Rappaport, R.W. Heath, R.C. Daniels and J.N. Murdock,Millimeter Wave Wireless Communication, Prentice Hall
2. NPTEL Lectures by Dr M K Mondal, IIT Kharagpur on Millimeter Wave Technology

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Explain the Need of Millimeter Wave Technology for Communication
2. Apply the suitable Guiding Structure at Millimeter Wave Technology
3. Design of Antenna for Millimeter wave Frequency
4. Analyze the various Passive Devices at MM Wave Systems
5. Explain the principle of Active Devices and Design of MM Wave System

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1								2	3		2
CO2	3	3	2	3								2	3		2
CO3	3	2	2	3	3							1	3	2	2
CO4	3	1	2	1	3							1	3	2	2
CO5	3	2	1	1	3							1	3		2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBLT1	-	-	4	30	20	50	2

SEMICONDUCTOR DEVICE DESIGN AND SIMULATION LAB

Course Objectives:

- To give the exposure of TCAD tools.
- To develop skills in designing diodes and transistors using TCAD.
- To efficiently understand the various device parameters, working and characteristics.
- To provides an opportunity to design feature low power devices.

List of Experiments:

1. Introduction of VLSI TCAD tools.
2. Design and Simulation of 2D/3D NMOS Channel Length 20nm or higher.
3. Design and Simulation of 2D/3D PMOS Channel Length 20nm or higher.
4. Design and Simulation of 2D/3D CMOS using NMOS and PMOS.
5. Design and Simulation of SOI/Bulk Dual Gate FET & Dual Gate Junction less FET.
6. Design and Simulation of SOI/Bulk FINFET device using GDS2MESH and GENIUS.
7. Design and Simulation of SOI/Bulk 2D/3D Nanowire FET.
8. Design and simulation of dopingless FET.
9. Design and implementation of SRAM using CMOS & FINFET Process.
10. Desgn and implemenation of Tunnel Field Effect Transistor.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

CO1. Familiar with sophisticated VLSI TCAD tools.

CO2. Design and implement any diode and transistor using TCAD tools.

CO3. Design and implement SOI based junction/junction less dual gate FET & FINFET using TCAD tools.

CO4. Understand the working of all devices and implement advanced device using TCAD tools.

CO5: Learn advanced features in device design & simulation.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3		1		3			3	3	3	3
CO2	3	3	2	3	3		1		3			3	3	3	3
CO3	3	3	2	3	3		1		3			3	3	3	3
CO4	3	3	2	3	3		1		3			3	3	3	3
CO5	3	3	2	3	3		1		3			3	3	3	3

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBLT2	-	-	4	30	20	50	2

RF & MICROWAVE COMPONENT DESIGN LAB

Course Objectives:

1. To understand the concepts and working principles of the feeding techniques used in RF and Microwave Communication
2. Hands on Experience of High frequency Software
3. To understand the concepts and working principles of the microwave filters
4. To understand the concepts and working principles of the microwave Antennas
5. To analyze the complex system of RF component like antenna

LIST OF EXPERIMENTS:

1. Design and Simulate Rectangular Waveguide at f = _____Ghz
2. Design and Simulate Microstrip feed
3. Design and Simulate CPW feed
4. Design and Simulate SIW feed
5. Design and Simulate power divider at f = _____GHz.
6. Design and Simulate planar band reject filter at frequency of f =_____GHz
7. Design and Simulate planar band pass filter at frequency of f =_____GHz
8. Design and Simulate microstrip patch antenna at resonating frequency of f = ____GHz.
9. Design and Simulate Dielectric Resonator Antenna at resonating frequency of f =GHz
10. Design and Simulate array of Antennas

Course Outcome:

At the end of the course, students will demonstrate the ability to:

1. Select the suitable feed at microwave component design
2. Design the microwave filter
3. Design the Microwave Antennas
4. Design the Arrays of Antennas
5. Operate high frequency design software tools

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		3								3		
CO2	3	2	2	2	3								3		
CO3	3	3	2	1	3								3		
CO4	3	2	3	3	3								3		
CO5	3	1	2	3									3		

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

OPEN ELECTIVES

Sub Code	L	T	P	IA	ESE	Total	Credits
ECPBTO7	3	-	-	40	60	100	3

INTERNET OF THINGS

Course Objectives:

1.To understand the definition and significance of the Internet of Things.
2. To learn the architecture, operation, and business benefits of an IoT solution.
3. To examine the potential Security issues in IoT and explore the relationship between IoT, cloud computing, and big data.
4. Design and program IoT devices, use real IoT protocols for communication, Secure the elements of an IoT device.

UNIT-I: Introduction to The Internet of Things

IoT Definition, Elements of an IoT ecosystem, IoT applications, trends and implications, sensing components and devices, Wearable sensors and their Applications, operating System for IoT, Industrial IoT: case study: Agriculture, Healthcare, Process Automation & monitoring etc.

UNIT-II: Internet of Things– Architecture and Communication Protocol

Layered Architecture for IoT, Protocol Architecture of IoT, Infrastructure Protocols: MAC protocols for sensor network, S-MAC, IEEE 802.15.4, Near Field Communication (NFC), RFID, ZigBee, Bluetooth Low Energy (BLE),IPv6 over LowPower Wireless Personal Area Networks (6LoWPAN), Long Term Evolution-Advanced, Z-Wave, Components of ZWave Network, Protocols for IoT Service Discovery: DNS service discovery, multicast domain name system.

UNIT-III: Internet of Things – Networking Protocol Constrained Application Protocol (CoAP), Message Queue Telemetry Transport (MQTT), Extensible Messaging and Presence Protocol (XMPP), Advanced Message Queuing Protocol (AMQP), Data Distribution Service (DDS), Service Discovery Protocols, Routing Protocol for Low Power and Lossy Networks (RPL), sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, sensor network architecture, data dissemination and gathering protocol.

UNIT-IV: Platforms for IOT Applications and Analytics

Role of the cloud and fog resources in the delivery of IoT services, The IoT Building Blocks, Connected Devices, IoT or Sensor Data Gateway, The IoT Data Analytics Platforms: IBM Watson IoT Platform, Splunk Software for IoT Data, Amazon Web Service IoT Platform, Azure IoT Hub, The IoT Data Virtualization Platforms, IoT Data Visualization Platform, Security and Privacy in IoT.

UNIT-V: Design and Development

IoT Platforms, Arduino, Raspberry Pi Board, Other IoT Platforms; Data Analytics for Design Methodology,Embedded computing logic, Microcontroller, System on Chips , IoT system building blocks Arduino, Board details, IDE programming ,Raspberry Pi , Interfaces and Raspberry Pi with Python Programming Case Studies: Agriculture, Healthcare, and Activity Monitoring. Sensor-Cloud, Smart Cities and Smart Homes.

Text/Reference Books:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.
2. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, "Internet of Things: Architectures, Protocols and Standards," Wiley, 2018.
3. Fei Hu, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations," CRC Press, 2016Fundamentals of Wireless Communications, D. Tse and P. Vishwanath, ,Cambridge Univ. Press, 2005.
4. R. Buyya and A.K. Dastjerdi (eds.), "Internet of Things: Principles and Paradigms," Cambridge, MA, USA: Morgan Kaufmann (Elsevier), 2016.
5. Modern Mobile Wireless Communication, Haykins S & Moher M, Pearson Ed.

Course Outcome:

At the end of the course, students will demonstrate the ability to:

CO1: Explain the concept of IoT.

CO2: Define and analyze the concept of data communications protocols and convergence of technologies.

CO3: Interpret protocols to track, monitor and manage IoT devices.

CO4: Apply data analytics and use cloud offerings related to IoT.

CO5: Understand the principles and various research issues related to Internet of Things.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1							3	3	2	2
CO2	3	2	1	1	1							3	3	2	2
CO3	3	2	2	1	1							3	3	2	2
CO4	3	3	2	1	1							3	3	2	2
CO5	3	3	2	1	1							3	3	2	2

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**