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

SCHEME
Pre-PhD Course Work
(W.E.F. SESSION 2022-23)

S.N.	SUBJECT CODE	SUBJECT NAME	PERIODS /WEEK			ESE DURATION	ESE MARKS		CREDIT
			L	T	P		MAX	MIN	
1.	ECDATT1	Research Methodology in Engineering	3	1	0	3Hrs	100	40	4
2.		Elective-I	3	1	0	3Hrs	100	40	4
3.		Elective-II	3	1	0	3Hrs	100	40	4

S.N.	SUBJECT CODE	SUBJECT NAME	S.N.	SUBJECT CODE	SUBJECT NAME
1.	ECDATP1	Vacuum Technology	8.	ECDATP11	Machine Learning
2.	ECDATP2	Antenna For Modern Wireless Communication	9.	ECDATP13	Introduction to IoT
3.	ECDATP3	Microstrip Antenna	10.	ECDATP14	Satellite Communication
4.	ECDATP4	Wireless Communication & Network	11.	ECDATP23	Digital Image Processing
5.	ECDATP8	Tunnel Field Effect Transistor	12.	ECDATP24	Medical Image Processing
6.	ECDATP9	MIMO Communication System	13.	ECDATP25	Convex Optimization
7.	ECDATP10	Deep Learning	14.	ECDATP26	Introduction to Signal Processing

ESE: End Semester Examination, **L**: Lecture, **T**: Theory, **P**: Practical
Max: Maximum Marks in ESE
Min: Minimum Pass Marks in each subject as 40%

- Duration of the semester will be 6 months.
- Candidate has to score minimum 55% of aggregate marks to qualify in ESE.
- Two subjects as Electives (4 credits each) can be taken from the list of Electives

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.

RESEARCH METHODOLOGY IN ENGINEERING

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATT1	03	01	0	4 HRS	100	4

Unit 1: Philosophy and Ethics

Introduction to philosophy: nature and scope, concept, branches. Ethics: Definition, moral philosophy, nature of moral judgments and reactions.

Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP).Redundant publication duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data.

Unit 2: Errors in Measurements

Types of Errors, Mean Deviation, Standard Deviation and Probable Errors, Propagation of Errors with Summation, Difference, Product and Quotient.

Curve fitting, Method of least square fit, least square fit (straight line) to linear equations and equation reducible to linear equations. Least square fit (parabola) to quadratic equations and equations reducible to quadratic equations.

Unit 3: Data Processing & Analysis

Literature Survey, Defining the equation and formulating hypothesis/hypotheses. Collection of research data, tabulating and cataloging, Sampling and methods of data analysis. Laboratory Safety Measures, Maintenance of equipment's and proper storage and disposal of materials.

Unit 4: Scientific Presentation and Writing Skills

Survey of literature and presentation of data, one seminar paper-preparation in PowerPoint (which include texts, graphs, pictures, tables, references etc.)-Oral in PowerPoint/poster, development of communication skills in presentation of scientific seminars- eye to eye contact, facing the audience, question & answer sessions etc.

Steps to better writing, flow method, organization of material and style, drawing figures, graphs, tables, footnotes, references etc in research paper.

Unit 5: Publication Ethics.

1. Publication ethics: definition, introduction and importance.2. Best practice/standards setting initiatives and guidelines: COPE, WAME, etc. 3. Conflicts of interests 4. Publications misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types 5. Violation of publication ethics, authorship and contributor ship6. Identification of publication misconduct complains and appeals 7. Predatory publishers and journals.

Reference Books

1. D B Resnik, The Ethics of Science: An Introduction, Routledge Publisher, USA (1998).
2. Callahand D & Bok S, Ethics Teaching in Higher Education, Plenum Press, New York, USA (1996).
3. Kanpur J N, Ethical values for excellence in Education and Science, VishwaPrakashan, New Delhi (1996).
4. A. N Tripathi, Human Values, New Age International Publication, New Delhi (2008).
5. A Wilson: Handbook of Science Communication, Institute of Physics publishing, Bristol Philadelphia (1998).
6. Science Communication: Theory and practice; Stocklmayer, Gore MM, Bryant C (Eds), Springer (2002).
7. Laszios P., Communicating Science: A Practical Guide, Springer (2006).
8. C R Kothari, Research Methodology: Methods and Technology, 2nd revised edition, New Age International Publication 2004.
9. K. N. Krishanaswamy, A I Sivakumar, M Mathiranjan, Management Research Methodology: Integration Principles, Methods and Techniques, Pearson Education, New Delhi 2006.
10. C K Sharma, M K Jain; Research Methodology, Shree Publications, New Delhi.

Course Outcome:

Course Outcomes:

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

CO1: Comprehend the ethical basis of the research and intellectual honesty.
CO2: Analyze the different types of errors related to measurement techniques.
CO3: Illustrate the data processing techniques.
CO4: Demonstrate the writing skills and scientific presentations.
CO5: Comprehend the ethics for research publication.

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	1		3	1	2		3	3	2	3
CO2	3	1	1		3	1		3	1	2		3	3	2	3
CO3	3	1	2		3	1		3	1	2		3	3	2	3
CO4	3	1	2		3	1		3	1	2		3	3	2	3
CO5	3	1	1		1	1		3	1	2		3	3	2	3

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

VACUUM TECHNOLOGY

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP1	03	01	0	4 HRS	100	4

Unit-1: Fundamentals of Vacuum Technology: vacuum nomenclature and definitions, Gas properties, Molecular process and Kinetic theory, Throughput, Pumping speed, Evacuation rate, Out gassing rate, Leak rate, Gas How, Conductance, Flow calculations.

Unit-2: Vacuum generation: Diaphragm pump, Rotary pump, Diffusion pump, Cryogenic pump, Turbo -molecular pump, Sputter-ion pump and Getter pumps.

Unit-3: Vacuum Measurement scale, Gauges and Leak detection: U.H.V. techniques, Mass Spectrometer.

Unit-4: Surface Physics and its Relation to Vacuum Science: Adsorptions, Chemisorptions, Isotherms, Desorption's and Photo-activation.

Unit-5: Materials for Vacuum tubes, Chemical and Thermal Cleaning, Sputtering Techniques, Brazing, Spot, Arc, Electron beam and Laser welding, Vacuum and Protected Atmosphere Furnaces, Jigs and Tools Processing of Electron-Beam Devices.

References Books:

1. Vacuum Science and Technology, V V Rao, T B Ghosh, K L Chopra
2. Vacuum Journal, Science direct, Elsevier Publication
3. Journal of Vacuum Science and Technology A, IEEE Transaction
4. Journal of Vacuum Science and Technology B, IEEE Transaction

Course Outcomes:

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

CO1: Comprehend the basic concepts of the vacuum, its properties and calculations.

CO2: Analyze the vacuum pump principles and architectures.

CO3: Analyze different measurement techniques and its utility in different vacuum levels.

CO4: Comprehend the surface physics and its relation in creating and maintaining the vacuum in a closed chamber.

CO5: Illustrate the effects of the materials used for fabrication, cleaning and maintaining the vacuum.

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	2				2			3	3	1	1
CO2	3	2	2	2	2				2			3	3	2	2
CO3	3	2	2	2	2				2			3	3	2	2
CO4	3	2	2	3	2				2			3	3	2	2
CO5	3	2	2	2	2				2			3	3	2	2

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

ANTENNA FOR MODERN WIRELESS COMMUNICATION

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP2	03	01	0	4 HRS	100	4

Unit 1: Concepts of Radiation and Antenna Fundamentals

Fundamental parameters of antennas, Near and Far Field regions, S Parameters, Antenna Measurements: Radiation pattern, gain, directivity, phase and polarization measurement

Unit 2: Printed Antenna

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

UNIT 3: Reconfigurable Antenna

Reconfigurable methodologies, Design Considerations for Reconfigurable systems, Reconfigurable Planar/printed antenna configurations, Active reconfigurable systems, Concept of Smart Antenna

Unit 4: Array of Antennas

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

Unit 5: MIMO System

Concept of MIMO: Types of MIMO Systems, Design Parameters of MIMO system.

Reference Books:

1. Jordan E C and Bahl-lain K G, "Electromagnetic Waves and Radiating Systems", 2nd Edition, PL.:arson Education.
2. BaIanis C A, "Antenna Theory: Analysis and Design". 4th Edition, John Wiley and Sons, New Jersey, 2016.
3. Kraus J D and Viarhefka R J, "Antennas for All Applications", 3rd Edition, Tata McGraw Hill, 2001.
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**

MICROSTRIP ANTENNA

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP3	03	01	0	4 HRS	100	4

Course Objective:

This course will enable student to

1. To introduce the basic concept of Rectangular 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-1:

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

Unit-2:

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

Unit-3:

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

Unit-4:

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-5:

Rectangular Microstrip Antenna patterns for different Dielectric constant, Dual 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 semester, the students will be able to

1. Outline the different Microstrip Antenna feeding techniques
2. Outline the basic concept of Smart Antenna
3. Apply the Conceptof different parameters of Rectangular Microstrip Antenna for its design
4. Apply the Conceptof effect of various parameters on performance of Rectangular Microstrip Antenna
5. Apply the Conceptof 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**

WIRELESS COMMUNICATION & NETWORK

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP4	03	01	0	4 HRS	100	4

Unit 1: Overview of wireless communication, cellular communication, different generations of cellular communication system, satellite Communication including, wireless local loop, cordless phone,

Unit 2: Recent wireless technologies: multicarrier modulation, OFDM, MIMO system, diversity-multiplexing trade-off, MIMO-OPOM system, smart-antenna; beamforming and MIMO, cognitive radio,

Unit 3: 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 4: Wireless personal area networks (Bluetooth, UWB and Zig-Bee), wireless local area networks (IEEE 802.11, network architecture, medium access methods, WLAN standards

Unit 5: Ad-hoc wireless networks: Design Challenges in Ad-hoc wireless networks, concept of cross layer design, security in wireless networks MANET and WS.N. Wireless system protocols.

Reference Books:

Textbooks:

1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
2. Sanjay Kumar, "Wireless Communication the Fundamental and Advanced Concepts" River Publishers, Denmark, 2015 (Indian reprint).

Reference books:

1. Vijay K Garg, "Wireless Communications and Networks'', Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint)
2. J. Schiller, "Mobile Communication" 2/e, Pearson Education, 2012.
3. Iti Saha vilisra, "Wireless Communication and Networks: 3G and Beyond", 2/e, McGraw Hill (India) Private Ltd, New Delhi, 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**

TUNNEL FIELD EFFECT TRANSISTOR

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP8	03	01	0	4 HRS	100	4

Course objective:

- To introduce CMOS scaling and its limitations.
- To demonstrate the fundamental aspect of quantum tunneling.
- To gain the knowledge of principle working , characteristics and current improving techniques of TFET.
- To cognize the role of TFET in low power application.

UNIT-I:

CMOS Scaling: Introduction, Basics of MOSFET and CMOS, MOSFET structure and operation, Operation of MOSFET as a switch, Short-channel effects in a MOSFET, CMOS inverter, Power dissipation in a CMOS circuit, CMOS scaling, Types of CMOS scaling-Constant-field scaling, Constant-voltage scaling, Current trends in CMOS scaling, Challenges in continued CMOS scaling, Emerging research devices.

UNIT-II:

Quantum Tunneling: Quantum mechanics, Quantum mechanical tunneling, Solving the tunneling problems-Analytic Approximation methods, Numerical methods, Junction breakdown due to tunneling, Tunnel diode.

UNIT-III:

Basics of Tunnel Field Effect Transistors: Introduction, Device structure, Operation, Transfer characteristics-OFF state, Subthreshold region, Super-threshold region, Subthreshold swing, Tunneling current, Output characteristics, Threshold voltage, Impact of device parameters, Ambipolar current.

UNIT-IV:

Boosting ON-Current in Tunnel Field Effect Transistor: Introduction, Types of techniques to boost ON current, Gate Engineering, Tunneling junction engineering, Material engineering.

UNIT-V:

Application of Tunnel Field Effect Transistor: Introduction, Electrical characteristics of TFETs, Digital Circuits, Application in memories, Analog circuits, Future perspective of TFETs in circuits.

Text/Reference Books:

1. S. Saurabh and M. J. Kumar, "Fundamentals of tunnel field effect transistors", CRC Press, Taylor & Francis, 2016.
2. M. J. Kumar, R. Vishnoi and P. Pandey, "Tunnel Field Effect Transistor-Modelling & Simulation" Wiley, 2016.
3. N. Gupta, A. Makosiej, A. Amara, A. Vladimirescu and C. Anghel, "TFET Integrated Circuits", Springer, 2021.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Develop an understanding for the scaling of CMOS and its future limitation.

CO2: Explore the fundamental aspect of quantum tunneling and the physical principle that forms the basis of TFET.

CO3: Comprehend the operating principle of TFET and analyze the characteristics of TFET.

CO4: Discuss & explore various techniques to improve the ON current of TFET device.

CO5: Apply TFET based device in various low power 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	2	2	2	1			2			3	3	1	2
CO2	3	3	2	2	2	1			2			3	3	2	2
CO3	3	3	3	2	2	1			2			3	3	2	2
CO4	3	3	3	2	2	1			2			3	3	2	2
CO5	3	3	3	2	2	1			2			3	3	2	2

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

MIMO COMMUNICATION SYSTEM

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP9	03	01	0	4 HRS	100	4

Course objective:

- To introduce the fundamentals need and limitations of MIMO communication systems.
- To demonstrate the different MIMO channel models.
- To identify the role of diversity and MIMO techniques in combating the effect of fading and maximizing the capacity.
- To cognize the most recent trends in the broad area of wireless communication.

Introduction: MIMO wireless communication, Need for MIMO systems, Multiple antennas in wireless communication systems, MIMO in wireless networks, Diversity-multiplexing trade-off, Transmit diversity schemes, advantages and applications of MIMO systems, MIMO channel and signal model, MIMO in wireless standards, Future challenges.

MIMO Channel Models: Analytical MIMO channel models: Uncorrelated, fully correlated, separately correlated and keyhole MIMO fading models, parallel decompositionof MIMO channel.

Capacity limits of MIMO systems, Introduction, Single-user MIMO, Multi-user MIMO, MIMO Channel models, Capacity and information rates in MIMO channels: Capacity and Information rates in AWGN and fading channels, Capacity of MIMO channels, Capacity for deterministic and random MIMO channels, Capacity of i.i.d., separately correlated and keyhole Rayleigh fading MIMO channels, Single user MIMO Capacity, Single user capacity metrics, Multi-user capacity metrics.

Precoding Design: Channel state information at the transmitter (CSIT), Information-theoretic foundation for exploiting CSIT, A transmitter structure, Precoding design criteria, Linear precoder designs, Precoder performance results and discussion, Applications in practical systems.

Space Time-Coding for Wireless Communications: Principles and applications, Introduction, Space time coding principles, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space-time codes over separately correlated MIMO channel.

Text/Reference Books:

1. E. G. Larsson, P. Stoica, "Space-Time Block Coding for Wireless Communications", Cambridge University Press, 2008.
2. E. Biglieri, R. Calderbank et al "MIMO Wireless Communications" Cambridge Univ Press, 2007.
3. D. Tse, P. Viswanath, "Fundamentals of Wireless Communication", Cambridge Univ Press, 2005.
4. H. Jafarkhani, "Space-Time Coding: Theory and Practice", Cambridge University Press 2005.
5. Paulraj, R. Nabar, and D. Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2003.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Understand the concept & working principle of MIMO communication systems.
CO2: Learn & design uncorrelated & correlated MIMO channel and its impact on system capacity.
CO3: Analyze the information theoretic capacity of MIMO system under different conditions.
CO4: Illustrate the concept of channel state information at the transmitter side and their impact on channel capacity.
CO5: Comprehend space time coding and design a suitable coding of structure for the improvement of bit error rate.

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	2	1			2			3	3	1	2
CO2	3	3	2	2	2	1			2			3	3	2	2
CO3	3	3	3	2	2	1			2			3	3	2	2
CO4	3	3	3	2	2	1			2			3	3	2	2
CO5	3	3	3	2	2	1			2			3	3	2	2

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

DEEP LEARNING

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP10	03	01	0	4 HRS	100	4

Course objectives:

1. To introduce the basic concept of artificial neural network for deep learning.
2. To introduce techniques used for training artificial neural networks.
3. To understand practical aspects of deep neural networks.
4. To understand the Convolutional neural network and optimization algorithms.
5. To carry out design and implementation of deep learning models on signals and images.

UNIT I: Introduction: Introduction to deep learning, Machine learning vs and Deep learning, review of gradient descent; logistic regression; cost function- maximum likelihood based cost, cross entropy, MSE; perceptron learning; activation functions – softmax, logistic sigmoid, tanh, ReLU; types of neural networks – feed forward neural network, recurrent neural network, symmetrically connected network.

UNIT II: Deep Feed Forward Neural Networks: Gradient based learning; hidden units; architecture design; back-propagation; hyperparameters. output units: linear, softmax; hidden units: tanh, RELU; GPU training etc.

UNIT III: Regularization and Practical Aspects of Deep Learning: Regularization and under-constrained problems, dataset augmentation, noise robustness, early stopping, bagging, dropout, normalizing inputs; vanishing/exploding gradients, weight initialization for deep networks; numerical approximation of gradients; gradient checking; hyperparameter tuning; batch normalization.

UNIT IV: Convolutional neural networks , Fundamentals, architectures, pooling, visualization, Deep learning for spatial localization, Convolution operation, Transposed convolution, efficient pooling, object detection, semantic segmentation, Optimization Algorithms: mini-batch gradient descent; gradient descent with momentum; rmsprop, ADAM optimization algorithm.

UNIT V: Recurrent neural networks (RNN), long-short term memory (LSTM), language models, machine translation, image captioning, video processing, visual question answering, video processing, and learning from descriptions. Deep Learning Tools: Use of deep learning tools such as tensor flow, Keras for deep learning applications.

Reference books:

1. Goodfellow, Ian, Yoshua Bengio, Aaron Courville, Deep Learning (Adaptive Computation and Machine Learning Series), MIT Press, 2016.
2. Nielsen, Michael A., Neural Networks and Deep Learning, 2015.
3. Gibson, Adam, and Josh Patterson, Deep Learning: a Practitioner's Approach, O'Reilly Media, Inc 2016.
4. Chollet, Franois. Deep Learning with Python, 2017.
5. Buduma, Nikhil, and Nicholas Locascio, Fundamentals of Deep Learning: Designing Next-generation Machine Intelligence Algorithms, O'Reilly Media, Inc., 2017.
6. Hope, Tom, Yehezkel S Resheff, Itay Lieder, Learning Tensorflow: A Guide to Building Deep Learning Systems, O'Reilly Media, Inc., 2017.
7. Nikhil Ketkar, "Deep Learning with Python: A Hands-on Introduction", Apress, 2017.
8. AurélienGéron, "Hands-On Machine Learning with Scikit- Learn and TensorFlow", O'Reilly, 2017.

Course Outcomes (COs): At the end of the course, the students will be able to:

1. Explain the mathematics behind functioning of artificial neural network for deep learning.
2. Illustrate the basic concepts of Neural Networks based on architectures and learning rules.
3. Comprehend the practical aspects of Deep Neural Networks (DNN) with parameter tuning.
4. Design and implementation of deep learning models for signal/image processing applications
5. Design and deploy simple TensorFlow-based deep learning solutions to classification/ segmentation 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	2				2			3	3	1	3
CO2	3	2	2	1	2				2			3	3	1	3
CO3	3	2	2	2	2				2			3	3	2	3

CO4	3	2	2	2	2				2			3	3	2	3
CO5	3	2	2	2	2				2			3	3	2	3

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

MACHINE LEARNING

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP11	03	01	0	4 HRS	100	4

Course Objectives:

1. To understand the basic theory underlying machine learning.
2. To understand a range of machine learning algorithms along with their strengths and weaknesses.
3. To understand the working of neural network.
4. To be able to formulate machine learning problems corresponding to different applications.
5. To be able to learn different metrics for error and anomasly detection.

UNIT I

Introduction To Machine Learning: Concept of Machine Learning, Applications of Machine Learning, Key elements of Machine Learning, Supervised vs. Unsupervised Learning, Statistical Learning: Bayesian Method, The Naive Bayes Classifier, Decision Trees.

UNIT II

Linear Regression: Prediction using Linear Regression, Gradient Descent, Linear Regression with one variable, Linear Regression with multiple variables, Polynomial Regression, Feature Scaling/Selection.

Logistic Regression: Classification using Logistic Regression, Logistic Regression vs. Linear Regression, Logistic Regression with one variable and with multiple variables, Optimization, Decision Trees vs Logistic Regression

UNIT III

Neural Networks: Introduction, Model Representation, Gradient Descent vs. Perceptron Training, Stochastic Gradient Descent, Multilayer Perceptrons, Multiclass Representation, Back-propagation Algorithm and related Issues.

UNIT IV

Support Vector Machines:Knowing SVMs, SVM as Large Margin Classifier, Kernels, Using SVMs in Learning complex non-liner functions, Constrained Optimization, SVM utilization.

Introduction to Clustering, K-Means Algorithm, Random Initialization, Choosing the number of Clusters, Mixture Models, Dimensionality Reduction and its application, Principal Component Analysis (PCA).

UNIT V

Error Analysis and Anomaly Detection: Utility of Error Analysis, Precision/Recall, Error Metrics for Skewed Classes, Introduction of Anomaly Detection, Gaussian Distribution, Anomaly Detection vs. Supervised Learning.

Reference books:

1. Ethem Alpaydin, "Introduction to Machine Learning", 3rd Edition, The MIT Press.
2. Simon O. Haykin, "Neural Networks and Learning Machines", Pearson Education, 2016.
3. C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2010.
4. Smola and Vishwanathan, "Introduction to Machine Learning", Cambridge University Press, 2010.
5. T.M. Mitchell, "Machine Learning", McGraw Hill Education, 2017.
6. Andrew NG, "Machine Learning Yearning", Amazon.com Services LLC, Kindle Edition, 2019.
7. V.N. Vapnik, “The Nature of Statistical Learning Theory”
8. Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Taylor & Francis

Course Outcomes:

At the end of the course, the students will be able to:

1. Comprehend the basic concept of machine learning with its working principle.
2. Comprehend a range of machine learning algorithms along with their strengths and weaknesses.
3. Illustrate the concept and working of neural network.
4. Design various machine learning algorithms for different applications.
5. Illustrate the error analysis and anomaly detection in machine learning algorithms.

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	3				2			3	3	1	2
CO2	3	2	2	1	3				2			3	3	1	2
CO3	3	2	2	2	3				2			3	3	2	3
CO4	3	2	2	2	3				2			3	3	2	3
CO5	3	2	2	2	3				2			3	3	2	3

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

INTRODUCTION TO IoT

Sub Code	L	T	P	Duration	ESE	Credits
ECDATP13	3	1	-	4 hours	100	4

Course Objectives:

1. To provide fundamental knowledge on the Internet of Things.
2. To develop the ability to explore the use of various hardware, Protocols, and communication technologies to build IoT devices.
3. To facilitate the students for analyzing and implementing various real time IOT applications.

Unit 1: Introduction to IOT: Definition, History and characteristics of IoT, IOT reference Architecture, Major component of IO, IOT enabling technologies: Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels, and Templates.

Unit 2 M2M & System Management with NETCONF-YANG: M2M, Difference between IOT and M2M, Software-defined networks, Network function virtualization, the difference between SDN and NFV for IoT, Need for IOT Systems Management, Simple Network Management Protocol, Limitations of SNMP, Network Operator Requirements, NETCONF, YANG, IOT Systems Management with NETCONF-YANG.

Unit 3: IOT protocols and Communication Technologies: MQTT, MQTT brokers, QoS levels in MQTT, HTTP, COAP, XMPP and gateway protocols, IOT Communication Pattern, IOT Protocol Architecture, Selection of Wireless technologies. Wireless technologies for IOT: WiFi, Bluetooth, BLE, Zigbee, NFC, 6LoWPAN, LORA.

Unit 4: DATA ANALYTICS AND IOT PLATFORM: Introduction to Data Analytics for IOT, Structured Versus Unstructured Data, Data in Motion Versus Data at Rest, IoT Data Analytics Overview, IoT Data Analytics Challenges, IoT Platform overview: Overview of IoT supported Hardware platforms such as Raspberry pi, Arduino Board details

UNIT-V IoT PHYSICAL SERVERS AND CLOUD OFFERINGS: Introduction to cloud computing, Cloud Service and Deployment Models, Communication APIs, Cloud and WAMP for IOT, Case studies illustrating IoT design – home automation, smart cities, smart environment.

Text/Reference Books:

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017
2. Internet of Things – A hands-on approach, ArshdeepBahga, Vijay Madisetti, Universities Press,

2015
3. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education, 2022.
4. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012.

Course Outcome:

Upon successful completion of the course, students will be able to

1. Comprehend the concepts, components, enabling technologies, and reference architecture of IOT.
2. Evaluate the concept of M2M, SDN/NFV, and system management with NETCONF-YANG
3. Analyze IoT protocols and communication technologies
4. Elaborate the need for data analytics and hardware platforms in IOT.
5. Analyze potential applications of IoT and the cloud.

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	3				2			3	3	2	2
CO2	3	2	2	1	3				2			3	3	2	3
CO3	3	2	2	1	3				2			3	3	2	3
CO4	3	2	2	1	3				2			3	3	2	3
CO5	3	2	2	1	3				2			3	3	2	3

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

SATELLITE COMMUNICATION

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP14	03	01	0	4 HRS	100	4

Course Objective:

1.To know the evolution of Satellite communication and its concept
2. To know the orbital mechanism and different satellite subsystems.
3. To know the role of different factors affecting satellite and link budget equation.
4. To know the various types of multiple access techniques for satellite communication.
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 Outcomes:

At the end of this 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.
2. Explain how satellite is controlled to become stationary w.r.t a point on the earth.
3. 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**

DIGITAL IMAGE PROCESSING

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP23	03	01	0	4 HRS	100	4

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 Ed, 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**

MEDICAL IMAGE PROCESSING

Sub Code	L	T	P	Duration	ESE	Credits
ECDATP24	3	1	-	4 hours	100	4

Course Objectives:

4. To provide fundamental knowledge about images & their processing.
5. To understand & to know how an image model is developed and processed.
6. To develop a capacity to analyze the image through various segmentation techniques.
7. To develop a capacity to apply these processings in medical applications.

UNIT-1 Medical Imaging: fundamentals of medical imaging, Various Modalities of Medical Imaging: X-ray Imaging, Computed Tomography, magnetic resonance imaging, Ultrasound Imaging, Nuclear medicine imaging, Mammographic Imaging. Fundamental steps in Digital Image Processing, Components of Image processing system, Image Formation Model, Image Sampling and Quantization, Basic relationship between pixels, Image sensing, and acquisition.

UNIT-2: Medical Image Enhancement in spatial domain: Background, Point processing-Image negatives, Log transformation, Power law transformations, Contrast stretching, Intensity level slicing, Bit plane slicing, histogram processing-Histogram equalization, Histogram matching, Arithmetic/Logic operations-Image subtraction, Image averaging, Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters.

UNIT-3: Medical Image Enhancement in Frequency Domain: Background, 2D-Discrete Fourier Transform and its Inverse, Basic properties of the 2D-Discrete Fourier Transform, Basics of filtering in the frequency domain. Image smoothing using frequency domain filters-Ideal lowpass filters, Butterworth lowpass filters, Gaussian lowpass filters; Image sharpening using frequency domain filters- Ideal highpass filters, Butterworth highpass filters, Gaussian highpass filters, Homomorphic filtering.

UNIT-4: Medical Image restoration: Image degradation model, Image noise models, filtering techniques. Image Compression: Fundamentals, image compression models, basic compression methods- Huffman coding, Arithmetic coding, LZW coding, Run-length coding.

UNIT-5: Medical Image Segmentation: Fundamentals, Point detection, Line detection, Edge models, Edge detection, Canny edge detector, Thresholding, Region-based segmentation.

Text/Reference Books:

1. Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, 3rd Ed. Pearson Edu, 2012.
2. Medical Image Processing Concepts and Applications by G.R. Sinha, Bhagwati Charan Patel. PHI Learning, 2014
3. Handbook of Medical Image Processing and Analysis by Isaac Bankman, Academic Press
4. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd ed, 2011.
5. John C. Russ, The Image Processing Handbook, 6th edition, CRC Press,2011

Course Outcome:

Upon successful completion of the course, students will be able to

1. Acquire the knowledge of basic medical imaging and recognize the imaging modality from their visualization
2. Describe fundamental methods of medical image enhancement in the spatial domain.
3. Demonstrate the frequency domain image enhancement process and its respective filters required.
4. Interpret the various medical image restoration and compression techniques.
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	1	1	1	3				3			3	3	1	2
CO2	3	1	1	1	3				3			3	3	1	2
CO3	3	2	2	1	3				3			3	3	2	3
CO4	3	2	2	2	3				3			3	3	2	3
CO5	3	2	2	2	3				3			3	3	2	3

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

CONVEX OPTIMIZATION

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP25	03	01	0	4 HRS	100	4

Course Objective

1- To study the fundamentals of convex optimization.
2- To study the Unconstrained optimization methods.
3- To study Linear programming and its usability.
4- To study the fundamentals of Non-linear constrained optimization.
5- Learn to apply and convert real world problem in to convex optimization framework.

Prerequisites: Linear Algebra, Probability.

Unit I Background on linear algebra, Convex sets and Convex functions: examples of convex problems.

UNIT II Level sets and Gradients. Unconstrained Optimization: Search methods, Gradients Methods, Newton Method, Conjugate Direction Methods, Quasi-Newton Methods.

UNIT III Linear Programming: Standard Form Linear Programs, Simplex method, Duality and Non Simplex Methods, applicability in Communication domain.

UNIT IV Nonlinear Constrained Optimization: Problems with equality constraints, Problems with Inequality Constraints, Convex Optimization Problems.

UNIT V Algorithms for Constrained Optimization: Projected Gradient Methods and Penalty Methods.

References:

● Lieven Vandenberghe and Stephen P. Boyd, Convex Optimization, Cambridge University Press, 2004.

● Dimitris Bertsekas, John N. Tsitsiklis, Introduction to Linear Optimization, Athena Scientific Series, 1997.

● Aharon Ben-Tal and Arkadi Nemirovski, Lectures on Modern Convex Optimization: Analysis,
Algorithms, and Engineering Applications, SIAM, 2001.

● Stephen Boyd and Lieven Vandenberghe, Convex Optimization, Cambridge University Press.
[Online]. http://www.stanford.edu/~boyd/cvxbook/

● Convex Optimization in Signal Processing and Communications, D. P. Palomar, Y. C. Eldar. Cambridge Press, 2010.

●https://ocw.mit.edu/courses/6-079-introduction-to-convex-optimization-fall-2009/pages/readings/

● Dimitri P. Bertsekas, Convex Analysis and Optimization, Athena-Scientific, 2003.

Course Outcome

On the successful completion of this course Student are able to

CO1: Differentiate between non convex and convex functions and sets
CO2: Analyse the various algorithms and their convergence.
CO3: Formulate communication problems in convex optimization framework
CO4: Discuss the applications of convex optimization methods in various applications
CO5: Choose and apply 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	2	2	2	1	1			2			3	3	1	2
CO2	3	2	2	2	1	1			2			3	3	1	2
CO3	3	2	2	2	1	1			2			3	3	1	2
CO4	3	2	3	2	1	1			2			3	3	1	2
CO5	3	2	3	2	1	1			2			3	3	1	2

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

INTRODUCTION TO SIGNAL PROCESSING

SUB CODE	L	T	P	DURATION	ESE	CREDITS
ECDATP26	03	01	0	4 HRS	100	4

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 Ed India.
4. M H. Hayes, "Statistical Digital Signal Processing And Modeling", 1st Ed, Wiley, 2008.
5. Vaidyanathan, Palghat P- The theory of linear prediction, Morgan and Claypool Pub.
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**