Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

Curriculum Structure and Syllabus

Master of Engineering (2025 Pattern) in

ME - Electronics & Telecommunication (Signal Processing)

(With effect from Academic Year 2025-26)

Contents:

Abbreviations:

SGP : Signal Processing
PCC : Program Core Course
PEC : Program Elective Course
SEM : Seminar
RM : Research Methodology
OJT On Job Training
RPR : Research Project
PEO : Programme Educational Objectives
PO : Programme Outcomes
WK : Knowledge and Attitude Profile

Master of Engineering in Electronics & Telecommunication (Signal Processing) - 2025 Pattern

Preface by Board of Studies

Dear Students and Faculty Members,

We, the members of the Board of Studies of Electronics & Telecommunication engineering, are happy to present the syllabus for the Master of Engineering in **Signal Processing program**, effective from the Academic Year 2025–26 (2025 Pattern).

Signal Processing is a fundamental and dynamic domain that plays a crucial role in almost every modern technology. It deals with the representation, analysis, transformation, and interpretation of signals ranging from audio, speech, and images to biomedical and sensor data forming the foundation of communication, multimedia, healthcare, and intelligent systems.

This curriculum has been thoughtfully designed to provide students with a strong grasp of theoretical principles, advanced algorithms, and practical tools essential for processing and analysing signals in both time and frequency domains. It emphasizes mathematical rigor as well as hands-on exposure to modern platforms and software, enabling students to model, analyse, and implement efficient signal processing solutions. The syllabus of program prepares students for impactful careers in fields such as wireless communications, image and video processing, speech technology, biomedical signal analysis, machine learning, and artificial intelligence.

The curriculum revision is mainly focused on knowledge component, skill-based activities, experiential learning and project-based activities. The revised syllabus falls in line with the objectives of Savitribai Phule Pune University, AICTE New Delhi, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets. We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Dr. Suresh Shirbahadurkar
Chairman
Board of Studies - Electronics & Telecommunication Engineering

Members of Board of Studies, Electronics & Telecommunication Engineering, Savitribai Phule Pune University, Pune	
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Programme Educational Objectives (PEO)

Program education objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

PEO	PEO Focus	PEO Statements
PEO1	Core competence	To prepare globally competent post graduates with enhanced domain knowledge and skills attaining professional excellence and updated with modern technology to provide effective solutions for engineering and research problems.
PEO2	Breadth	To prepare the post graduates to work as a committed professionals with strong professional ethics and values, sense of responsibilities, understanding of legal, safety, health, societal, cultural and environmental issues.
PEO3	Professionalism	To prepare motivated post graduates with research attitude, lifelong learning, investigative approach, and multidisciplinary thinking to succeed in the career in industry/academia/research
PEO4	Team Building	To prepare post graduates with strong managerial and communication skills to work effectively as an individual as well as in teams.

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Knowledge and Attitude Profile (WK)

A Knowledge and Attitude Profile (KAP), often represented as WK (Knowledge and Attitude Profile) in some contexts, is a framework or assessment tool used to evaluate an individual's knowledge and attitudes related to a specific area, topic, or domain.

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

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Programme Outcomes (PO)

Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. On successful completion of M.E. in Electronics and Telecommunication (Signal Processing), graduating students/graduates will be able to:

PO1	Engineering knowledge	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2	Problem analysis	Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6	The Engineer and the World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Team Work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

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Curriculum Structure Semester I

M.E (Electronics & Telecommunication – Signal Processing)

2025 Pattern

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	End Sem	Term work	Oral	Total	Theory	Practical	Total
PCC-501-SGP	Program Core Course	Advanced Digital Signal Processing	4	-	50	50	-	-	100	4	-	4
PCC-502-SGP	Program Core Course	Digital Image and Video Processing	4	-	50	50	-	-	100	4	-	4
PCC-503-SGP	Program Core Course	Linear Algebra Statistics and Probability	4	-	50	50	-	-	100	4	-	4
PCC-504-SGP	Program Core Course	VLSI Chip Design and Fabrication	4	-	50	50	-	-	100	4	-	4
PCC-505-SGP	Program Core Course – Lab	Signal Processing Laboratory-I	-	4	-	-	25	25	50	-	2	2
PEC-521-SGP	Program Elective Course	Elective I	3	-	50	50	-	-	100	3	-	3
PEC-522-SGP	Program Elective Course	Skill Based Laboratory - I	-	2	-	-	25	25	50	-	1	1
Total			**19**	**6**	**250**	**250**	**50**	**50**	**600**	**19**	**3**	**22**

List of Elective I Courses:

PEC-521A-SGP	Mixed Signal Processing
PEC-521B-SGP	Blockchain
PEC-521C-SGP	Business Intelligence
PEC-521D-SGP	Estimation and Detection Theory

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Curriculum Structure Semester II

M.E (Electronics & Telecommunication – Signal Processing)

2025 Pattern

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	End Sem	Term work	Oral	Total	Theory	Practical	Total
PCC-551-SGP	Program Core Course	Biomedical and Speech Signal Processing	4	-	50	50	-	-	100	4	-	4
PCC-552-SGP	Program Core Course	Embedded Technologies and IoT	4	-	50	50	-	-	100	4	-	4
PCC-553-SGP	Program Core Course	Statistical Signal Processing	4	-	50	50	-	-	100	4	-	4
PCC-554-SGP	Program Core Course - Lab	Signal Processing Lab II	-	4	-	-	25	25	50	-	2	2
PEC-571-SGP	Program Elective Course	Elective – II	3	-	50	50	-	-	100	3	-	3
PEC-572-SGP	Program Elective Course	Elective – III	3	-	50	50	-	-	100	3	-	3
SEM-581- SGP	Seminar	Seminar – I	-	4	-	-	25	25	50	-	2	2
Total			**18**	**8**	**250**	**250**	**50**	**50**	**600**	**18**	**4**	**22**

List of Elective II Courses:

PEC-571A-SGP	Computational Intelligence
PEC-571B-SGP	Biometrics
PEC-571C-SGP	Machine Learning
PEC-571D-SGP	Optimization Techniques

List of Elective III Courses:

PEC-572A-SGP	Generative Artificial Intelligence and Agentic Artificial Intelligence
PEC-572B-SGP	Design and Analysis of Algorithm
PEC-572C-SGP	Cloud Architecture Protocols
PEC-572D-SGP	Artificial Intelligence for Industrial and Telecommunication Data

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Curriculum Structure Semester III

M.E (Electronics & Telecommunication – Signal Processing)

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Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	End Sem	Term work	Oral	Total	Theory	Practical	Total
RM-601-SGP	Research Methodology	Research Methodology	5	-	50	50	-	-	100	5	-	5
OJT-602-SGP	OJT / Internship	On Job Training / Internship	-	10	-	-	100	-	100	-	5	5
SEM-603-SGP	Seminar	Seminar – II	-	6	-	-	25	25	50	-	3	3
RPR-604-SGP	Research Project	Research Project - I	-	18	-	-	25	25	50	-	9	9
Total			**5**	**34**	**50**	**50**	**150**	**50**	**300**	**5**	**17**	**22**

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Curriculum Structure Semester IV

M.E (Electronics & Telecommunication – Signal Processing)

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Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	End Sem	Term work	Oral	Total	Theory	Oral	Total
SEM-651-SGP	Seminar	Seminar – III	-	8	-	-	50	50	100	-	4	4
RPR-652-SGP	Research Project	Research Project-II	-	36	-	-	150	50	200	-	18	18
Total			**-**	**44**	**-**	**-**	**200**	**100**	**300**	**-**	**22**	**22**

Savitribai Phule Pune University, Pune

Maharashtra, India

ME (2025 Course)
Electronics & Telecommunication Engineering
(Signal Processing)

Semester I

Savitribai Phule Pune University

Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering

(Signal Processing)

PCC-501-SGP – Advanced Digital Signal Processing

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Engineering Mathematics, Basic DSP, Probability and Random Processes and Signals and System

Course Objectives: The course aims to:

1. To build an understanding of designing FIR and IIR filters
2. To introduce the concept of Adaptive filters
3. To learn the delay models
4. To build an understanding of various processor architectures and implementation of DSP algorithms

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Analyze discrete time signals and LTI-DT systems using discrete Fourier transform

CO2: Explain various techniques to design FIR and IIR filters

CO3: Illustrate multi rate DSP and its applications

CO4: Describe the need of adaptive filters and various adaptive algorithms

CO5: Compare various DSP processor architectures, algorithms with their applications

Course Contents

Unit I	Discrete Fourier Transform	08 Hours

DFT, Properties of DFT, circular convolution, linear convolution, Computation of linear convolution using circular convolution, FFT, decimation in time and decimation in frequency using Radix-2 FFT algorithm, Introduction to Discrete Cosine Transform.

Unit II	FIR and IIR Filters	08 Hours

Ideal filter requirements, Gibbs phenomenon, FIR filters using windowing techniques, characteristics and comparison of different window functions, design techniques of linear phase FIR filters using frequency sampling method, IIR filters by IIR filter design by impulse invariance method, bilinear transformation

Unit III	Multi Rate DSP	08 Hours

Decimation, Interpolation, Sampling rate conversion by a non-integer factor, Multistage decimator, polyphase structure, applications of Multirate DSP

Unit IV	Adaptive Filters	08 Hours
Need of adaptive filters, adaptive filters as system identification, Wiener Hopf Equation, LMS adaptive algorithms, configuration of adaptive filters, recursive least square algorithms, adaptive telephone echo cancellation, Adaptive filtering of ocular artifacts from the human EEG.		
Unit V	**Unit V- DSP Processors**	**08 Hours**
DSP Architectures: Von Neumann Architecture, Harvard Architecture, Super Harvard Architecture, VLIW Architecture, Fixed and Floating point DSPs, Multiple access memory, multiport memory, circular buffering, MC unit, Barrel shifter, Parallel processing and pipelining, Application of DSP in Medical Imaging MRI and CT scan, interference cancellation in ECG, Speech coding and compression, Vibration signature analysis for defective gear teeth.		

Learning Resources

Text Books:

1. John G. Proakis, Oimitris G. Manolakis-Digital Signal Processing-Principles, algorithms & applications, PHI, 1997.
2. E. C. Ifleachor and B. W. Jervis, —Digital Signal Processing- A Practical Approach||, 2nd Edition, Pearson education
3. Proakis-Advanced Digital Signal Processing Macmillan publishing company, 1992

Reference Books:

1. Avtar Singh, S. Srinivasan, —Digital Signal Processing Implementation using DSP, Microprocessors with examples from TMS 320C54XX||, Thomas Publication.
2. S.K. Mitra - Digital Signal Processing- TMH, 1998.

MOOC Courses (Web Links):

1. NPTEL Course on " Real-Time Digital Signal Processing", By Prof. Rathna G N , IISC Bangalore. https://onlinecourses.nptel.ac.in/noc24_ee136/preview
2. NPTEL Course on " Introduction to Adaptive Signal Processing", By Prof. Mrityunjoy Chakraborty, IIT Kharagpur. https://onlinecourses.nptel.ac.in/noc24_ee149/preview

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Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering (Signal Processing)

PCC-502- SGP – Digital Image and Video Processing

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Pattern Recognition , Introduction to Computer Vision, Probability & Random and Processes, and Digital Signal Processing (basic)

Course Objectives: The course aims to:

1. To explain the fundamentals of DIP from human visual perception to image formation model.
2. To introduce fundamental concepts of low level image processing.
3. To explain object segmentation algorithms.
4. To introduce basic concepts of video processing

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Describe the fundamentals of DIP from human visual perception to image formation model.
CO2: Demonstrate image enhancement techniques in spatial and frequency domain
CO3: Make use of restoration techniques in spatial and frequency domain to improve the image quality.
CO4: Apply image processing techniques for object segmentation
CO5: Describe video signal representation and different algorithm for video processing.

Course Contents

Unit I	Image Representation and Transform	08 Hours

Gray scale and color images, image sampling and quantization, Fundamentals of color image processing. Color models - RGB, CMY, YIQ, HIS, Pseudo – coloring, Two dimensional orthogonal transforms: DFT, Haar transform, DCT and Wavelet Transform.

Unit II	Image Enhancement	08 Hours

Point and Mask processing of images, filters in spatial and frequency domains, histogram-based processing, homomorphic filtering. Edge detection , LOG filters. Pseudo coloring

Unit III	Image Restoration	08 Hours

A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the Fourier transform and the frequency domain, estimating the degradation function

Unit IV	Image Segmentation	08 Hours
Image Segmentation: Pixel classification, Bi-level thresholding, Multi-level thresholding, P-tile method, Adaptive thresholding, Spectral & spatial classification, Edge detection, Hough transform, Region growing and region merging. Morphological operators. Boundary Extraction, Boundary representation, Region representation, Moment representation, Structure, Shape features, Texture feature		
Unit V	**Video Processing**	**08 Hours**
Fundamental Concepts in Video –Types of video signals, Analog video, Digital video, Color models in video, Motion Estimation; Video Filtering; Video Compression, Video coding standards		

Learning Resources

Text Books:

1. Gonzalez and Woods, "Digital Image Processing", Pearson Education,
2. Bovik, Handbook of Image & VideoProcessing,AcademicPress,2000
3. K. Jain, Fundamentals of digital image processing, Prentice Hall of India,1989.
4. M. Tekalp, Digital Video Processing, Prentice-Hall, 1995

Reference Books:

1. William Pratt, “Digital Image Processing”, John Wiley & sons
2. S. Jayaraman, “Digital Image Processing”, McGraw Hill

MOOC Courses (Web Links):

1. https://onlinecourses.nptel.ac.in/noc19_ee55/preview
2. https://archive.nptel.ac.in/courses/117/104/117104020/

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Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering (Signal Processing)

PCC-503-SGP – Linear Algebra Statistics and Probability

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Discrete Mathematics **,** Algebraic manipulations, Functions and graphs, Probability Theory

Course Objectives: The course aims to:

1. To introduce the fundamental properties and theorems of probability theory, sample spaces, events and random variables for modeling real-life phenomena and computation and interpretation of probabilities of events.
2. To explain statistical methods for estimating parameters of numerical data from a representative sample of a population and interpretation of the results.
3. To illustrate matrix computations and use of eigenvalues and Eigen vectors for analyzing the structure of a matrix

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Apply matrices, Vectors for solving Linear systems.

CO2: Solve examples using Inner product and dot product.

CO3: Demonstrate various PDFs with a suitable example.

CO4: Create Contingency Tables using Statistics.

Course Contents

Unit I	Linear Algebra	08 Hours

Matrices, Vectors: Addition and Scalar Multiplication, Matrix Multiplication, Linear Systems of Equations. Gauss Elimination, Linear Independence. Rank of a Matrix. Vector Space, Solutions of Linear Systems: Existence, Uniqueness, Inverse of a Matrix. Gauss–Jordan Elimination, Vector Spaces, Inner Product Spaces. Linear Transformations.

Unit II	Linear Algebra: Matrix Eigenvalue Problems	08 Hours

The Matrix Eigenvalue Problem, Determining Eigenvalues and Eigenvectors, Some Applications of Eigenvalue Problems, Symmetric, Skew-Symmetric, and Orthogonal Matrices, Eigenbases. Diagonalization. Quadratic Forms

Unit III	Vector Space and Vector Calculus	08 Hours

Vectors in 2-Space and 3-Space, Inner Product (Dot Product), Vector Product (Cross Product), Vector and Scalar Functions and Their Fields. Vector Calculus: Derivatives, Curves. Arc Length. Curvature. Torsion, Functions of Several Variables. Optional, Gradient of a Scalar Field. Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field

Unit IV	Probability Theory	08 Hours
Data Representation. Average. Spread, Experiments, Outcomes, Events, Probability, Permutations and Combinations, Random Variables. Probability Distributions, Mean and Variance of a Distribution, Binomial, Poisson, and Hypergeometric Distributions, Normal Distribution, Distributions of Several Random Variables		
Unit V	**Mathematical Statistics**	**08 Hours**
Statistics: Introduction to Statistical Inference Problems; Point Estimation; Interval Estimation; Testing of Hypotheses; Two Sample Problems Involving Normal Populations, Tests for Proportions, Chi-Square Goodness of Fit Test, Contingency Tables		

Learning Resources

Text Books:

1. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra: Vectors, Matrices and Least Squares, Cambridge University Press, 2018, ISBN 978-1-316-51896-0,
2. Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, Inc, 2011, ISBN 978-0-470-45836-5

Reference Books:

1. T.T. Soong, Fundamentals of Probability and Statistics for Engineers, John Wiley & Sons Ltd, 2004, ISBN 0-470-86814-7S.
2. Glyn James & Phil Dyke, Advanced Modern Engineering Mathematics, Fifth Edition, Pearson Education Limited, 2018, ISBN: 978-1-292-17434-1

MOOC Courses (Web Links):

1. Course on Linear Algebra, https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/
2. Courses on Statistics, https://www.mooc-list.com/tags/statistics
3. AdvancedProbability theory, https://onlinecourses.nptel.ac.in/noc20_ma18/preview

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PCC-504-SGP - VLSI Chip Design and Fabrication

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Digital Electronics, VLSI Design

Course Objectives: The course aims to:

1. To understand Verilog and its use to the design various applications.
2. To analyze HDL design flow and EDA tools.
3. To analyze different aspects of testing and fault models.
4. To understand the insights of chip design such as epitaxy and lithography.
5. To understand the insights of chip design such as ion implantation and metallization.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Analyze and implement basic Verilog coding.

CO2: Understand the IC design flow and EDA tools

CO3: Understand the AISC timing analysis and different fault models.

CO4: Understand the major steps in the fabrication process of VLSI circuits

CO5: Apply implantation process for VLSI devices and discuss the metallization.

Course Contents

Unit I	Design with HDL	09 Hours

Basics of Verilog: Typical HDL-flow, why Verilog HDL, trends in HDLs. Gate-Level Modelling: Modelling using basic Verilog gate primitives, description of and/or and buffer/not type gates, rise, fall and turn-off delays, min, max, and typical delays. Behavioral Modelling: Structured procedures, initial and always, blocking and non- blocking statements, delay control, generate statement, event control, conditional statements, Multiway branching, loops, sequential and parallel blocks

Unit II	ASIC Design Part I	09 Hours

Types of ASIC and Comparisons, ASIC Design Flow, Logic Synthesis, Simulation, EDA Tools, ASIC Physical Design : Architecture Design, Physical Design, CAD Tools, System partitioning, Partitioning Strategies, Floor planning, Placement, Routing

Unit III	ASIC Design Part II	09 Hours
ASIC Timing Analysis: Static timing analysis, Timing constraints, Delay estimation, ASIC Verification and Testing: Different Chip Test Methods, Fault Models, Scan Test, Partial Test, Digital scan standards, BIST architecture, BILBO, Boundary Scan, Self-Test, JTAG, ATPG		
Unit IV	**Chip Design**	**09 Hours**
Crystal Growth and Wafer Preparation: Introduction, Electronic-Grade Silicon, Czochralski Crystal Growing. Epitaxy: Introduction, Vapour-Phase Epitaxy. Lithography: Introduction, Optical Lithography, Electron Lithography, X-ray Lithography, Ion Lithography. Reactive Plasma, Etching: Introduction, Plasma Properties, Feature-Size Control and Anisotropic Etch Mechanisms, Reactive Plasma-Etching Techniques and Equipment.		
Unit V	**Chip Fabrication**	**09 Hours**
Ion Implantation: Introduction, Range Theory, Implantation Equipment, Annealing, Shallow Junctions, High-Energy Implantation. Metallization: Introduction, Metallization Applications, Metallization Choices, Physical Vapor Deposition, Patterning, Metallization problems.		

Learning Resources

Text Books:

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
2. S.M. Sze, VLSI Technology, McGraw-Hill, 2017, 2nd Edition (Indian).
3. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
4. S.M. Sze, VLSI Technology, McGraw-Hill, 2017, 2nd Edition (Indian).

Reference Books:

1. Smith Michael, “Application Specific Integrated Circuits” Pearson Education
2. S.K. Gandhi, “VLSI Fabrication Principles”, John Willey &Sons

MOOC Courses (Web Links):

https:// onlinecourses.nptel.ac.in/noc24_ee43/preview

NPTEL : Fabrication of Silicon VLSI Circuits using the MOS technology (Electrical Engineering)

Laboratory Experiments:

1. Write Verilog code and test bench to simulate, synthesis for the 4-bit counter [Synchronous & Asynchronous counter].
2. Write Verilog code and test bench to simulate, synthesis for 4/8-bit Magnitude Comparator
3. Write Verilog code and test bench to simulate, synthesis for counter with given input clock and check whether it works as clock divider performing division of clock by 2, 4, 8 and 16.
4. Write Verilog code and test bench to simulate, synthesis Mealy and Moore Sequence Detector to detect Sequence. ------11101-----.
5. Verify the functionality of the code Model in Verilog for a full adder and add functionality to perform logical operations of XOR, XNOR, AND, OR gates. Write test bench with appropriate input patterns to verify the modelled behaviour.

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PCC-505-SGP - Signal Processing Laboratory I

Teaching Scheme	Credits	Examination Scheme
Practical : 04 Hours/Week	02	**Term work**: 25 Marks **Oral**: 25 Marks

Prerequisite Courses: Digital Electronics, VLSI Design, MATLAB/Python/DSP kits, DSP processor coding

Course Objectives: The course aims to:

1. To introduce software based simulation and design tools necessary for practical image processing applications
2. To demonstrate adaptive filter for a particular application
3. To demonstrate implementation of DSP algorithms on digital signal processor

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Demonstrate low level to mid-level image processing

CO2: Explore video signal representation and different algorithms for video processing.

CO3: Use Adaptive filtering for real life applications.

CO4: Illustrate various DSP algorithms for digital signal processing.

Lab Practical	List of Experiments (Any 8 Experiment)

1. Implementation of filters: The case study consisting of application of nearly all kind of filters for enhancing of the image.
2. Implementation of Encoding and decoding scheme in JPEG image compression standard. The entropy coding step can be excluded. The performance of the JPEG with different quality factors should be analyzed.
3. Implement and study the effect of Different Mask (Sobel, Prewitt and Roberts).
4. Extraction of frames from video, improve the quality and convert them back to compressed video.
5. Any Miniproject based on image processing
6. Write a program to study & verify the DFT properties. (Minimum two)
7. To study the effect of different windows on FIR filter response.
8. To decimate/interpolate a signal.
9. To implement an LMS algorithm for adaptive filtering.
10. To convert Direct form to Lattice Coefficients

MOOC Courses (Web Links):

1. Fundamentals of Digital Image and Video Processing, https://www.coursera.org/learn/digital
2. NPTEL Course on " Real-Time Digital Signal Processing", By Prof. Rathna G N , IISC Bangalore, https://onlinecourses.nptel.ac.in/noc24_ee136/preview
3. NPTEL Course on " Introduction to Adaptive Signal Processing", By Prof. Mrityunjoy Chakraborty , IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc24_ee149/preview

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-521A-SGP - Mixed Signal Processing

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Analog Electronics, Digital Electronics, Microprocessors / Embedded Systems

Course Objectives: The course aims to:

1. To elaborate how to design CMOS digital to analog and analog to digital converters.
2. To explain the effect of noise and optimization of it in data converters.
3. To describe working and applications of PLLs for frequency synthesis.
4. To design switched-capacitor circuits.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Design Digital to Analog Converter.
CO2: Design Analog to Digital Converter.
CO3: Design PLLs and data conversion circuits to minimize switching and phase noise, and jitter.
CO4: Design switched capacitor circuits like amplifiers and integrators.

Course Contents

Unit I	**D/A Converter Architectures**	**08 Hours**

Digital to analog converter specifications, DAC architectures: Cyclic DAC, Pipeline DAC, R-2R ladder DAC, Charge-scaling DAC.

Unit II	**A/D Converter Architectures**	**08 Hours**

Analog to digital converter specifications, Sample-and-Hold (S/H) Characteristics, ADC architectures: Flash ADC, Pipeline ADC, Integrating ADCs, Successive Approximation ADC, Oversampling ADC.

Unit III	**Data Converter SNR**	**08 Hours**

Data Converter SNR: An Overview, Improving SNR using Averaging, Decimating Filters for ADCs, Interpolating Filters for DACs, Using Feedback to Improve SNR.

Unit IV	**Phase-Locked Loops(PLL)**	**08 Hours**

Simple Phase-Locked Loops(PLL), Charge-pump PLLs, Nonideal effects in PLL, Delay-locked loops, Applications of PLL.

Unit V	Switched-Capacitor Circuits	08 Hours

Switched capacitor amplifiers, Switched capacitor integrators, First and second order switched capacitor Circuits

Learning Resources

Text Books:

1. R. Jacob Baker, —CMOS: Circuit Design, Layout, and Simulation, 3rd Edition, Wiley- IEEE press.
2. R. Jacob Baker, —CMOS: Mixed-Signal Circuit Design, 2nd Edition, Wiley-IEEE press.
3. P. E. Allen and D. R. Holberg, —CMOS Analog Circuit Design, International student Edition / Indian edition, Oxford University press.

Reference Books:

1. BehzadRazavi, —Design of Analog CMOS Integrated Circuits, TMH edition.
2. BehzadRazavi, —Principles of data conversion system design, Wiley IEEE Press.
3. Tony Carusone, David Johns, and Kenneth Martin, —Analog Integrated Circuit Design, Wiley

MOOC Courses (Web Links):

https://home.iitk.ac.in/~ashwinrs/2023_EE698I.html

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-521B-SGP – Blockchain

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Computer Networks, Data Structures and Algorithms, Distributed Systems

Course Objectives: The course aims to:

1. Understand the fundamental concepts, architecture and cryptographic principles underlying blockchain and distributed ledger technologies.
2. Explore various consensus mechanisms to achieve secure and reliable agreement in decentralized systems.
3. Design and develop smart contracts, decentralized applications (DApps)
4. Evaluate the application of blockchain frameworks in enterprise environments, decentralized finance (DeFi) .
5. Explore advanced trends and research directions for integrating blockchain with IoT, AI and Cloud technologies.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Analyze the evolution, architecture, and cryptographic foundations of blockchain systems.
CO2: Design and evaluate smart contracts and decentralized applications (DApps),
CO3: Apply enterprise blockchain frameworks to evaluate cross-chain interoperability solutions.
CO4: Assess decentralized finance (DeFi) applications and challenges in blockchain adoption.
CO5: Investigate emerging blockchain research trends , integration with IoT, AI, and Cloud technologies.

Course Contents

Unit I	Blockchain Foundations & Cryptography	09 Hours

Evolution of blockchain: Bitcoin to Web3, Blockchain architecture: Blocks, chains, nodes, P2P network, Permissioned vs. permissionless blockchains, Distributed Ledger Technologies (DLT), Cryptographic principles:Hashing, Merkle Trees, Digital Signatures, Zero-Knowledge Proofs (zkSNARKs, zkSTARKs), Consensus mechanisms:Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Practical Byzantine Fault Tolerance (PBFT), Directed Acyclic Graphs (DAG)

Unit II	Smart Contracts & Decentralized Applications (DApps)	07 Hours

Smart contract fundamentals and design principles, Economic and legal aspects of smart contracts, Oracles and hybrid contracts: Conceptual overview, Security considerations: Common

vulnerabilities, Mitigation strategies, Gas costs and optimization concepts.

Unit III	Enterprise Blockchain Frameworks & Cross-Chain Interoperability	08 Hours

Hyperledger Fabric, Corda, Quorum — architecture and use-cases, Cross-chain interoperability: Polkadot, Cosmos — concepts and industry relevance, Case studies and real-world examples.

Unit IV	Decentralized Finance (DeFi), NFTs & Regulations	07 Hours

DeFi ecosystem, NFTs, DAOs, CBDCs — trends and conceptual frameworks, Regulatory frameworks: GDPR, KYC and AML, compliance challenges, Sustainability and green blockchain initiatives.

Unit V	Advanced Trends-IoT, AI, Cloud Integration	07 Hours

Blockchain for IoT: Secure device identity, data integrity, Blockchain for AI: Data provenance, AI model trustworthiness, Blockchain for Cloud: case study of Decentralized storage, edge computing integration, Privacy-enhancing techniques: Mixers, ring signatures, confidential transactions.

Learning Resources

Text Books:

1. Imran Bashir, Mastering Blockchain, 4th Edition, Packt Publishing, 2023.
2. Daniel Drescher, Blockchain Basics*:* A Non-Technical Introduction in 25 Steps, 1st Edition, Apress, 2017.
3. Andreas M. Antonopoulos, Gavin Wood, Mastering Ethereum: Building Smart Contracts and DApps*,* 1st Edition, O'Reilly Media, 2018.
4. Ritesh Modi, Solidity Programming Essentials*,* 2nd Edition, Packt Publishing, 2022.
5. Nitin Gaur, Luc Desrosiers, Venkatraman Ramakrishna, Petr Novotny, Anthony O'Dowd, *Hands-On* Blockchain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer*,* 1st Edition, Packt Publishing, *2018.*
6. Nakul Shah, Blockchain for Business with Hyperledger Fabric*,* 1st Edition, Packt Publishing, 2018.
7. Arshdeep Bahga, Vijay Madisetti, Blockchain Applications: A Hands-On Approach, 1st Edition, VPT, 2017.

Reference Books:

1. Roberto Infante, Building Ethereum DApps, 1st Edition, Packt Publishing, 2019.
2. Kevin Solorio, Randall Kanna, David H. Hoover, Hands-On Smart Contract Development Kevin with Solidity and Ethereum: From Fundamentals to Deployment, 1st Edition, O'Reilly Media, 2019.
3. Debajani Mohanty, Corda in Action, 1st Edition, Manning Publications, 2021

MOOC Courses (Web Links) :

1. https://onlinecourses.nptel.ac.in/noc22_cs44/preview
2. https://onlinecourses.nptel.ac.in/noc19_cs63/preview
3. https://onlinecourses.nptel.ac.in/noc20_cs01/preview
4. https://onlinecourses.swayam2.ac.in/aic21_ge01/preview

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-521C-SGP – Business Intelligence

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Database Management Systems**,** Data Mining, Programming / Software Skills

Course Objectives: The course aims to:

1. To introduce the role of Business Intelligence in transforming data into actionable insights for strategic decision-making and organizational success.
2. To describe information flow and data systems like data warehouses, OLAP, and metadata for business decision-making..
3. To explore business rules, data profiling, and data quality techniques for ensuring accurate and compliant information management.
4. To demonstrate information integration, parallel processing, and alternate data contexts for enhanced business intelligence.
5. To explain data enhancement, data mining, and the use of public and semi-structured data for knowledge discovery and business insights.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Summarize fundamentals of Business Intelligence, its processes, infrastructure, and the role of actionable information in achieving business success.

CO2: Analyze business models, information flow, and apply concepts of data warehousing, OLAP, and metadata for effective information management.

CO3: Apply business rules, perform data profiling, and implement data quality and compliance techniques for reliable information management.

CO4: Show data integration, parallel processing, and alternate data contexts for effective business intelligence.

CO5: Apply data enhancement and data mining techniques, utilize public and semi-structured data sources, and address management and privacy issues to support knowledge discovery and business decision-making.

Course Contents

Unit I	Business Intelligence and Information Exploitation	08 Hours

Why Business Intelligence? The Information Asset, Exploiting Information, Business Intelligence and Program Success, what is Business Intelligence? Actionable Knowledge Business Case, Business Intelligence Process, System Infrastructure, Information Access, Delivery, and Analysis Services, Management Issues

Unit II	Business Models	07 Hours
Smart contract fundamentals and design principles, Economic and legal aspects of smart contracts, Oracles and hybrid contracts: Conceptual overview, Security considerations: Common vulnerabilities, Mitigation strategies, Gas costs and optimization concepts. Business Models and Information Flow: The Business Case, Information Processing and Information Flow, the Information Flow Model Usage in Practice Modeling Frameworks Manageme Data Warehouses, Online Analytical Processing, and Metadata: The Business Case, Data Models, The Data Warehouse, The Data Mart, Online Analytical Processing, Metadata, Management Issuesnt Issues		
Unit III	**Data Quality and Information Compliance**	**08 Hours**
Business Rules: Business Case, Business Rules Approach, What Is a Business Rule? What Is a Business Rule System? Sources of Business Rules, Management Issues Data Profiling: The Business Case, Data Profiling Activities, Data Model Inference, Attribute Analysis, Relationship Analysis, Management , Issues Data Quality and Information Compliance: Business Case, More Than Just Names and Addresses, Types of Errors, Data Cleansing, Business Rule-Based Information Compliance, Management Issues.		
Unit IV	**Information Integration**	**08 Hours**
Information Integration: The Business Case, ETL: Extract, Transform, Load, Enterprise Application Integration and Web Services, Record Linkage and Consolidation, Management Issues,The Value of Parallelism: Business Case, Parallelism and Granularity, Parallel Processing Systems, Dependence, Parallelism and Business Intelligence, Management Issues Alternate Information Contexts: Business Case, Psychographics and Demographics, Geographic Data , Web Behavior Intelligence, Management Issue.		
Unit V	**Data Enhancement, Knowledge Discovery and Data Mining**	**08 Hours**
Data Enhancement: The Business Case, Types of Data Enhancement, Incremental Enhancements, Batch Enhancements, Standardization Example: Address Standardization, Enhancement Methodologies Management Issues Knowledge Discovery and Data Mining: The Business Case, Data Mining and the Data Warehouse, The Virtuous Cycle, Directed versus Undirected Knowledge Discovery, Six Basic Tasks of Data Mining, Data Mining Techniques, Management Issues Using Publicly Available Data: Business Case, Management Issues, Public Data, Data Resources Semi Structured Data, The Myth of Privacy		

Learning Resources

Text Books:

1. C. R. Kothari and Gaurav Garg, "Research Methodology Methods and Techniques", 4th Edition, New Age International Publishers, 2019
2. Ranjit Kumar, "Research Methodology": A Step by Step Guide for Beginners, 3rd Edition, Sage Publications, 2011
3. T. Ramappa, "Intellectual Property Rights under WTO: Tasks before India", Wheeler Publications, 2010
4. Debora J. Halbert, "Resisting Intellectual Property", Routledge, Taylor & Francis Group, 2005

Reference Books:

1. William G. Zikmund, Barry J. Babin, John C. Carr, and Mitch Griffin, "Business Research Methods", Cengage Learning, 2013
2. Royce Singleton and Bruce C. Straits, "Approaches to Social Research", Oxford University Press, 2017

MOOC Courses (Web Links) :

1. https:// onlinecourses.nptel.ac.in/noc21_ge03/preview

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-521D-SGP – Estimation and Detection Theory

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Engineering Mathematics**,** Digital Communication and Signals and Systems

Course Objectives: The course aims to:

1. To introduce the principles of hypothesis testing and various decision rules used in signal detection.
2. To develop analytical skills for detecting deterministic and random signals under uncertain parameters.
3. To explore non-parametric and robust detection techniques in the absence of complete statistical information.
4. To explain classical and Bayesian estimation frameworks including optimal filtering.
5. To enable students to model, analyze, and implement signal detection and estimation techniques in practical systems.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Apply decision rules for signal detection and evaluating detector performance using ROC and asymptotic relative efficiency.

CO2: Design matched and generalized filters for detecting deterministic signals.

CO3: Analyze detection methods for random signals using statistical models.

CO4: Evaluate non-parametric detection strategies and robust detectors under quantized or incomplete data scenarios.

CO5: Estimate unknown parameters using classical and Bayesian approaches.

Course Contents

Unit I	Statistical Decision Theory	08 Hours

Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, receiver operating characteristics, generalized LRT, composite hypothesis testing, locally optimum tests, detector comparison techniques, asymptotic relative efficiency.

Unit II	Detection of Deterministic Signals	07 Hours

Detection of deterministic Signals: Deterministic Signals, Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, Detection in linear signal models.

Unit III	Detection of Random Signals	08 Hours
Estimator-correlator structure, Linear model for random signals, General Gaussian detection, Gaussian random signals with unknown parameters, Detection of weak signals.		
Unit IV	**Nonparametric Detection**	**08 Hours**
Detection in the absence of complete statistical description of observations, Non-parametric detectors: sign detector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.		
Unit V	**Estimation of Signal Parameters**	**08 Hours**
Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, minimum statistics, complete statistics, linear models; best linear unbiased estimation, maximum likelihood estimation, invariance principle; estimation efficiency, Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation Linear Bayesian estimation, Weiner filtering, dynamical signal model, discrete Kalman filtering.		

Learning Resources

Text Books:

1. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall PTR, 1993.
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", Prentice Hall PTR, 1998.
3. H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II, and III", John Wiley, NY, 1968.
4. Signal Detection and Estimation Second Edition by Mourad Barkat, Pearson education

Reference Books:

1. D. L. Melsa and J. L. Cohn, “Detection and Estimation Theory”, First edition, McGraw Hill, 1978.
2. L. L. Scharf, “Statistical Signal Processing: Detection, Estimation, and Time Series Analysis”, First edition, Addison-Wesley, 1991.

MOOC Courses (Web Links) :

1. https:// nptel.ac.in/courses/117103018

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-522-SGP- Skill Based Laboratory – I

Teaching Scheme	Credits	Examination Scheme
Practical : 02 Hours/Week	01	**Term Work:** 25 Marks **Oral:** 25 Marks

Prerequisite Courses: Program Elective Course

Guidelines for Skill Based Laboratory:

1. Skill Based Laboratory is based on the electives chosen by the students.
2. Respective course faculty assigned will frame course objectives, course outcomes, list of assignments, mini projects and references
3. The list of assignments/ practical should be prepared and approved by the respective heads of Department before conduction of laboratory
4. Select practical assignments from Part A **(Any 3)** and Mini- Project from Part B.

Part A : List of Assignments

Part A- Mixed Signal Processing : Using suitable simulation software (MATLAB, Simulink, Cadence, OrCAD, PSpice)

1. R-2R Ladder DAC Implementation: Design and construct an R-2R ladder DAC using resistors and op-amps. Analyze its linearity and resolution, using suitable simulation software
2. Cyclic and Pipeline DACs: Simulate cyclic and pipeline DAC architectures using software tools like MATLAB or SPICE. Evaluate their performance metrics such as speed and accuracy.
3. Flash ADC Design: Build a 3-bit flash ADC using comparators and a resistor ladder. Test its conversion speed and accuracy. Simulate a consensus mechanism using Python or an online tool and demonstrate how nodes agree on the next block even in the presence of faulty nodes.

Part A –Blockchain

1. Write a program to simulate a blockchain with multiple blocks using hashing and a simple Proof-of-Work mechanism.
2. Design and deploy a simple smart contract using Solidity on Remix IDE and test it on an Ethereum test network.
3. Simulate a consensus mechanism using Python or an online tool and demonstrate how nodes agree on the next block even in the presence of faulty nodes.

Part A – Business Intelligence: Using suitable software (PowerBI, Panda, Python, MySQL, Lucidchart)

1. Analyze a real-world business problem and propose a BI solution. You can use Microsoft Power BI or Tableau for implementation
2. Create a basic data warehouse schema. Use MySQL / PostgreSQL / Snowflake (free trial) for implementation.
3. Simulate Extract, Transform, Load (ETL) on multi-source data. Use Apache Nifi / Talend Open Studio / Python (Pandas) for implementation
4. Link records from two datasets with inconsistent naming. Use Python (FuzzyWuzzy or RecordLinkage libraries) for implementation.
5. Apply a supervised machine learning model for knowledge discovery. Use Python (Scikit-learn) / RapidMiner.

Part A – Estimation and Detection Theory: Using suitable simulation software (MATLAB, Scilab, Simulink)

1. Implement and analyze the performance of the matched filter for detecting deterministic signals in noise.
2. Detect a deterministic signal embedded in Gaussian noise and estimate the signal parameters (amplitude, frequency, phase) using Bayesian methods.
3. Implement FIR Wiener filter to predict transmitted signals in a noisy communication channel.

Part B :List of Mini Project

1. **Mixed Signal Processing**
   - To design and implement a Mixed-Signal Battery Management System (BMS) / Audio Noise Cancelling Headphones / Smart ECG Monitoring System using suitable simulation software.

Text Books:

- R. Jacob Baker, —CMOS: Circuit Design, Layout, and Simulation, 3rd Edition, Wiley- IEEE press.
- R. Jacob Baker, —CMOS: Mixed-Signal Circuit Design, 2nd Edition, Wiley-IEEE press.

2. **Blockchain** –
   - To design and implement a blockchain-based voting system where votes are securely stored, tamper-proof, and transparently counted using Ethereum smart contracts

3. **Business Intelligence:**
   - Design and implement a Customer Intelligence and Sales Optimization System for a retail/e-commerce company to better understand its customers, improve data quality, integrate multiple sales channels, and discover insights for decision-making.

Text Books:

1. Ramesh Sharda, Dursun Delen, Efraim Turban, “Business Intelligence: A Managerial Perspective on Analytics”, 4th Edition,Perason Publishers,
2. Sam Anahory and Dennis Murray, “Data Warehousing in the Real World”, Addison-Wesley Publisher

4. **Estimation and Detection Theory:**
   - To design and implement a system for detecting the speech in a noisy signal and estimate key parameters of the speech signal using estimation and detection theory.

Text Books:

1. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall PTR, 1993.
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", Prentice Hall PTR, 1998.
3. H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II, and III", John Wiley, NY, 1968.

Savitribai Phule Pune University, Pune

Maharashtra, India

ME (2025 Course)
Electronics & Telecommunication Engineering
(Signal Processing)

Semester II

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PCC-551-SGP – Biomedical and Speech Signal Processing

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Signals and Systems, Digital Signal Processing, and Speech Recognition

Course Objectives: The course aims to:

1. Introduce acquisition, characteristics and instrumentation of common biomedical signals (ECG, EEG, EMG).
2. Develop advanced signal processing methods for noise reduction, feature extraction and analysis.
3. Explain speech production models and algorithms for speech analysis, coding and recognition.
4. Link theoretical methods to applications in telemedicine, diagnostics and assistive technologies

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Characterize biomedical signals and design appropriate acquisition chains.
CO2: Identify noise sources in biomedical signals and apply appropriate grounding, shielding, and filtering techniques to improve signal quality in medical devices.
CO3: Apply time-frequency and wavelet methods to denoise and analyze biomedical signals.
CO4: Implement speech processing pipelines (feature extraction, coding, recognition).
CO5: Use adaptive filtering and statistical methods for artifact removal and parameter estimation.

Course Contents

Unit I	Biomedical Signals and Acquisition	08 Hours

Overview of ECG, EEG, EMG signals and physiological origins.
Electrode types, instrumentation amplifiers, front-end design and requirements, CMRR and its importance, Sampling theory for biomedical signals,anti-aliasing filtering and quantization issues for biomedical signals.

Unit II	Time & Frequency Domain Methods, Wavelets and Denoising	07 Hours

Noise sources in biomedical recordings: powerline interference, motion artifacts, electrode noise, Grounding, shielding and isolation techniques, Signal preprocessing workflows in medical devices, Motion artifact suppression techniques,Powerline interference removal methods (notch filters, adaptive approaches),Baseline wander correction methods.

Unit III	Biomedical Signal Feature Extraction & Adaptive Processing	08 Hours
STFT and spectrogram interpretation for non-stationary signals. DWT based denoising, thresholding and mother wavelet selection. Adaptive filtering (LMS) for artifact removal and baseline wander correction. Feature extraction: QRS detection, HRV metrics and EEG band-power computation.		
Unit IV	**Speech Production, Short-Time Analysis and Coding**	**08 Hours**
Source-filter model, vocal tract representation and formants. LPC analysis, Levinson-Durbin algorithm and pitch detection methods. Speech coding basics (LPC vocoder, ADPCM) and perceptual considerations. Evaluation metrics for speech quality (PESQ, segmental SNR).		
Unit V	**Speech Applications and ML Integration**	**08 Hours**
MFCC pipeline, delta features and feature normalization. ASR overview: HMM-GMM to DNN transitions and basic decoding (Viterbi). Speaker recognition & verification techniques, and clinical speech analysis. Telemedicine and assistive speech tech applications.		

Learning Resources

1. Rangayyan, R. M.,Biomedical Signal Analysis: Wiley-IEEE Press, 2nd Edition, 2015
2. Tompkins – Biomedical Digital Signal Processing (Prentice Hall, 1993)
3. D. C. Reddy ,. Biomedical Signal Processing Principles and Techniques||, Tata McGraw- Hill,2005.
4. Rabiner, Lawrence R., and Schafer, Ronald W. Theory and Applications of Digital Speech Processing Pearson, 2010.
5. Proakis, John G., and Manolakis, Dimitris K. Digital Signal Processing: Principles, Algorithms, and Applications Pearson, 4th Edition, 2007

1. Widrow, Bernard, and Stearns, Samuel D Adaptive Signal Processing, Prentice Hall, 1985.
2. Poon , C. C. Y., and Addison, Paul S. Biomedical Signal Processing and Modeling, IEEE/Wiley, 2005.
3. O'Shaughnessy, Douglas, Speech Communications: Human and Machine, IEEE Press, 2nd Edition, 2000

MOOC Courses (Web Links)

1. https:// nptel.ac.in/courses/117/104/117104020/
2. https://nptel.ac.in/courses/117/101/117101076/

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PCC-552-SGP - Embedded Technologies and IoT

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Embedded System and Analog Circuits

Course Objectives: The course aims to:

1. To give insight to various platforms needed for Embedded Technologies and IoT.
2. To expose students to the usage of protocol standardization in Embedded Technologies and
3. It's selection to various applications .
4. To Understand the fundamentals of sensors and actuators along with the basic concepts of an IoT and how to design IoT based applications .

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Understand various Embedded platforms and IoT platforms.
CO2: Comprehend the operation of different buses and protocols.
CO3: Interpret IoT architecture design aspects and analyze concepts.
CO4: Develop design skills in industrial IoT.
CO5: Provide suitable solutions for specific applications and illustrate the technologies of IoT using suitable case studies.

Course Contents

Unit I	ARM, Raspberry Pi Microcontroller	09 Hours

Basics of Raspberry Pi (RPi) board, Features and architecture, pin configurations, Installing OS on RPi, connecting to network, Programming languages with examples, Various interfaces e.g. I2C, UART, SPI, CAN. Node MCU ESP8266 Pin configuration, Station, AP, ST-AP modes, NodeMCU as web server, posting sensor data to gateway

Unit II	Buses and Protocols	09 Hours

CAN Bus: Features and applications, CAN Frame, sequence of transmitting and receiving data on CAN Bus. Ethernet and USB Bus: Features and applications.Protocols: PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Bluetooth Low Energy, Zigbee Smart Energy, Network Layer-IPv4, IPv6, 6LoWPAN, Transport Layer (TCP, MPTCP, UDP) Session Layer HTTP, CoAP, XMPP, AMQP, MQTT

Unit III	IoT Fundamentals	08 Hours
IoT Architecture and Design Concepts: IoT – An architectural overview, Design Principles and capabilities, M2M & IOT Technology Fundamentals- End Devices and gateways, Local and wide area networking, Challenges Associated with IoT, Cloud Platforms for IoT. Sensors: Different types of sensors and Actuators, Working, Networking Basics, RFID Principals and components, Wireless Sensor Networks, Physical Design of an IoT, Logical design of IoT Communication Models, Communication API's, Concept of IoE, Difference between IoT and IoE.		
Unit IV	**Industrial IoT**	**09 Hours**
Introduction, Key Industrial IOT (IIoT) technologies, Catalysts, and precursors of IIoT, Innovation and the IIoT, Applications of IIoT Examples: Healthcare, Oil and Gas Industry, Logistics and the Industrial Internet, Retail applications, IoT innovations and design methodologies		
Unit V	**IoT Applications**	**09 Hours**
Applications: Smart Environment: Forest Fire Detection, Air Pollution, Smart Cities: Parking, Structural Health, Noise Urban maps, Smart Metering: Smart Grid, Tank level, Photovoltaic Installations, Health: Fall Detection, Medical Fridges, Sportsmen Care, Patients Surveillance		

Learning Resources

Text Books:

1. Olivier Hersent, David Boswarthick, and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2 nd Edition, Wiley Publications.
2. Arshdeep Bahga and Vijay Madisetti , "Internet of Things: A Hands-On Approach", Orient Blackswan Private Limited - New Delhi; First Edition (1 January 2015).
3. Simon Monk , "Programming Raspberry Pi", McGraw Hill TAB; 2nd edition (16 November 2015).

Reference Books:

1. Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", ELSEVIER
2. Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series
3. Rajesh Singh, "Internet of Things with Raspberry Pi and Arduino", CRC Press 2020.

MOOC Courses (Web Links)

https://www.coursera.org/learn/industrial-internet-of-things

https://www.coursera.org/learn/raspberry-pi-platform

https://onlinecourses.nptel.ac.in/noc19_cs65/preview

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PCC-553-SGP - Statistical Signal Processing

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Digital Signal Processing, Probability, and Engineering Statistics,

Course Objectives: The course aims to:

1. To build an understanding of signal modelling using different methods
2. To introduce Lattice structures and Linear Prediction.
3. To implement Wiener FIR filter for noise cancellation.
4. To understand the basics of the adaptive system
5. To equip students with the knowledge and skills to estimate unknown parameters within mathematical models using empirical data.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Use appropriate methods for signal modelling.

CO2: Compute linear prediction coefficients in an efficient manner.

CO3: Apply Wiener filter for noise cancellation.

CO4: Understand the theory of different filters and algorithms.

CO5: Develop the ability to interpret parameter estimates, assess their reliability, and understand potential limitations.

Course Contents		
Unit I	**Discrete Time Random Processes**	**08 Hours**
Filtering of Random Processes, Spectral Factorization, Innovations representation of Random Process, AR, MA and ARMA processes		
Unit II	**Signal Modeling**	**08 Hours**
Least Square methods for signal modeling and its disadvantages, PadeApproximation, Prony‘s and Shank‘s Methods for signal Modeling.		

Unit III	Linear Prediction	10 Hours

Forward and Backward linear prediction, Yule-Walker equation, Reflection coefficients, Lattice structures, Relationship of AR process to linear prediction, Solution of Normal equations, Levinson-Durbin algorithm, selection of order of LPC filter, Schur algorithm, Wiener filter, noise cancellation using FIR wiener filter

Unit IV	Adaptive Filters	09 Hours

Need of adaptive filters, steepest descent method, LMS algorithm, convergence, application using LMS algorithms, Normalize LMS. Echo cancellation in telephone circuits, and adaptive beamforming.

Unit V	Parameter Estimation	09 Hours

Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Maximum likelihood estimation. Spectral estimation, method of periodogram, Bartlett method, Welch method, Blackman-Tukey method, Power spectrum estimation using AR model.

Learning Resources

Text Books:

1. Sophocles, J. Orphanidies, "Optimum signal processing an introduction", McMillan,1985
2. Simon Haykins, "Adaptive signal processing", PHI, 1986

Reference Books:

1. M. H. Hayes, _Statistical Digital Signal Processing and Modelling', Wiley, (1996)
2. S. M. Kay,—Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall, 1993.
3. John G. Proakis, Dimitris G. Manolakis-Digital Signal Processing-Principles, algorithms & applications, PHI, 1997.

MOOC Courses (Web Links)

https:// onlinecourses.nptel.ac.in/noc20_ee53/preview

https:// online.stanford.edu/courses/ee278-introduction-statistical-signal-processing

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PCC-554-SGP–- Signal Processing Lab II

Teaching Scheme	Credits	Examination Scheme
Practical : 04 Hours/Week	02	**Term work**: 25 Marks **Oral**: 25 Marks

Prerequisite Tools:

MATLAB, Python (Google Colab / Jupyter / Kaggle), Open-source DSP libraries, Arduino, ESP32, Raspberry Pi

Course Objectives: The course aims to:

1. To provide practical exposure to biomedical, speech, and statistical signal processing techniques.
2. To develop skills in implementing IoT-based embedded solutions using signal processing.
3. To enable students to apply MATLAB, Python, and Azure for signal modeling, analysis, and deployment.
4. To explore machine learning, deep learning, and optimization techniques in signal processing applications.
5. To enhance problem-solving abilities through advanced experiments and real-time datasets.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Apply modern tools such as MATLAB, Python, and open-source IoT platforms to analyze, design, and implement solutions for biomedical, speech, and statistical signal processing problems.

CO2: Develop and integrate signal modeling, IoT-based monitoring, machine learning, and optimization techniques to solve real-time engineering problems using open-source hardware and software platforms.

CO3: Demonstrate the ability to design, simulate, and validate advanced signal processing models by employing techniques such as AR/MA/ARMA modeling, PCA, GANs, GNNs, and Bayesian optimization for practical applications.

List of Experiments

Part A: Biomedical & Speech Processing (Any 2 Lab Assignments)

1. Design a bandpass filter to extract heart-rate components from noisy ECG signals. *(MATLAB)*
2. Speech feature extraction and classification using MFCC + SVM. *(Python)*
3. Develop a real-time speech-to-text system and evaluate accuracy using Vosk / Coqui STT *(Open-Source Speech APIs)*

Part B: Embedded Technologies & IoT (Any 2 Lab Assignments)

1. Implement AR, MA, and ARMA models for speech signal prediction. *(MATLAB / Python — statsmodels)*
2. Perform statistical analysis & hypothesis testing on biomedical datasets (EEG / ECG) using NumPy / SciPy / Pandas.
3. Apply Principal Component Analysis (PCA) for dimensionality reduction in multi-sensor biomedical datasets. *(Python / Scikit-learn)*

Part C: Programme Elective II: *EII* : (Any 1 Lab Assignments)

EII : (A) Computational Intelligence OR Biometrics OR Optimization Techniques OR Machine Learning

1: Design a fuzzy inference system for ECG classification. (MATLAB / Scikit-fuzzy)

2: Implement face recognition using Eigenfaces + PCA. (Python / OpenCV)

3: Optimize hyperparameters for a deep CNN using Bayesian Optimization. (Python / Optuna)

4: Implement SVM-based biometric authentication using fingerprint / iris datasets. (Python / Scikit-learn)

Part D: Programme Elective III (Any 1 Lab Assignments)

EIII: (A) Generative AI OR Design & Analysis of Algorithms OR AI for Industrial IoT OR Cloud Protocols

1: Build a speech signal enhancement model using a Generative Adversarial Network (GAN). *(Python / TensorFlow)*

2: Implement Dijkstra's Algorithm for shortest-path routing on a network graph. *(Python / NetworkX)*

3: Apply Graph Neural Networks (GNN) for industrial IoT anomaly detection using PyTorch Geometric.

4: Deploy an edge-based signal processing model using MQTT on Raspberry Pi / NodeMCU. (Mosquitto Broker + Python)

Learning Resources: MOOC Courses

1	https://in.mathworks.com/matlabcentral/fileexchange/128844-ecg-signal-simulation-and-analysis
2	https://in.mathworks.com/matlabcentral/fileexchange/73049-calculate-heart-rate-from-electrocardiogram-data/
3	https://github.com/electronjia/MATLAB-ECG_Digital_Signal_Processing
4	https://iotvirtuallab.github.io/vlab/Experiments/index.html
5	https://python-speech-features.readthedocs.io/en/latest/
6	https://github.com/sarthak268/Audio-Classification-using-MFCC-and-Spectrogram
7	https://github.com/Nilotlawl/Graph-based-Neural-Network-for-Anomaly-Detection
8	https://iotdunia.com/best-iot-simulation-tools-online/
9	https://sl-coep.vlabs.ac.in/
10	https://bmi-iitr.vlabs.ac.in/
11	https://vlab.amrita.edu/?brch=78&sub=3&
12	https://docs.google.com/document/d/1yxQIxZIf5689J9Sd-_I-GpzMHh--raUq/edit
13	https://pyimagesearch.com/2021/05/10/opencv-eigenfaces-for-face-recognition/
14	https://www.geeksforgeeks.org/deep-learning/hyperparameter-tuning-with-optuna-in-pytorch/
15	https://thinkrobotics.com/blogs/learn/complete-guide-to-mqtt-broker-setup-on-raspberry-pi-in-2025

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-571A-SGP – Computational Intelligence

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Introduction to Artificial Intelligence , Deep Learning**,** and Engineering Mathematics

Course Objectives: The course aims to:

1. To introduce fundamental concepts of neural networks, optimization algorithms, and regularization techniques for efficient learning.
2. To develop understanding of Convolutional Neural Networks (CNNs) and advanced vision models for image analysis and recognition tasks.
3. To explore sequence models such as RNN, LSTM, and attention mechanisms for processing sequential and time-series data.
4. To familiarize students with state-of-the-art deep learning architectures like Transformers, model compression, and deployment strategies for Edge AI.
5. To provide knowledge of fuzzy logic and neuro-fuzzy systems for handling uncertainty and hybrid intelligent systems in real-world applications.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Apply optimization algorithms and regularization techniques to train deep neural networks effectively.
CO2: Design and analyze CNN-based architectures for object detection, segmentation, and vision applications.
CO3: Implement sequence models (RNN, LSTM, GRU) and attention mechanisms for NLP and time-series tasks.
CO4: Evaluate advanced architectures such as Transformers, and demonstrate model compression and deployment on Edge AI platforms.
CO5: Integrate fuzzy logic and neuro-fuzzy approaches to solve complex decision-making and pattern recognition problems.

Course Contents		
Unit I	**Foundations & Optimization Algorithms**	**08 Hours**
Multi-Layer Perceptron (MLP) and Universal Approximation Theorem. Backpropagation – derivation and implementation. Optimization algorithms – SGD, Adam. Regularization techniques – L1/L2, dropout, batch normalization, early stopping.		

Unit II	CNNs and Vision Models	08 Hours
Basics of Convolutional Neural Networks – convolution, pooling, activation, normalization. Classic Architectures – AlexNet, VGG, ResNet. Vision tasks – object detection (R-CNN, YOLO) and segmentation (U-Net, DeepLab). Applications in medical imaging, autonomous vehicles, and industrial inspection.		
Unit III	**Sequence Models: RNN, LSTM, and Attention Mechanisms**	**08 Hours**
Recurrent Neural Networks (RNNs) – architecture and challenges. Long Short-Term Memory (LSTM) and GRU for sequential data. Attention mechanisms and encoder–decoder frameworks. Applications in NLP, speech recognition, and time-series forecasting.		
Unit IV	**Advanced Topics & Deployment**	**08 Hours**
Transformer basics and self-attention; Transformer models – BERT, GPT, and Vision Transformers. Model compression – pruning, quantization, distillation. Edge AI – model conversion, optimization, and deployment on embedded devices. Ethical aspects – fairness, bias, and privacy in intelligent systems.		
Unit V	**Fuzzy Logic & Neuro-Fuzzy Systems**	**08 Hours**
Fuzzy sets, fuzzy numbers, and membership functions. Fuzzy relations, rule base, and inference systems. Adaptive Neuro-Fuzzy Inference System (ANFIS) – architecture and learning. Applications in control, decision-making, and pattern recognition.		

Learning Resources

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press, 2016.
2. Charu C. Aggarwal, *Neural Networks and Deep Learning: A Textbook*, Springer, 2018.
3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly, 2022.

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. François Chollet, Deep Learning with Python, Manning, 2021.
3. Dan Jurafsky, James H. Martin, Speech and Language Processing, Pearson, 3rd Edition (Draft), 2023.
4. J.-S. R. Jang, C.-T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Prentice Hall, 1997.

MOOC Courses (Web Links)

1. Coursera – Andrew Ng, *Deep Learning Specialization* (2017, updated) https://www.coursera.org/specializations/deep-learning
2. Natural Language Processing with Attention Models: https://www.coursera.org/learn/attention-models-in-nlp
3. Neural Networks and Applications, IIT Kharagpur Prof. Somnath Sengupta https://nptel.ac.in/courses/117105084

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-571B-SGP – Biometric

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Digital Signal Processing**,** Pattern recognition, Statistics, and Programming.

Course Objectives: The course aims to:

1. To Understand the need of biometrics, its types and different performance measures
2. To Study physiological and behavioural biometrics, feature extraction and matching
3. To Study limitation of unibiometric system, need and importance of multibiometric system, types of fusion carried out at different levels
4. To Know the difference between physiological and behavioral biometrics
5. To Design and Implement Biometric Systems

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Analyze the characteristics of physiological and behavioural biometrics

CO2:. Integrating the different biometrics at different fusion level to form Multi-modal biometric system.

CO3: Design and analyze simple modules of biometric based systems.

CO4: Determine security mechanisms in Biometrics.

CO5: Students will learn how to design biometric systems, considering factors like accuracy, security, and user acceptance

Course Contents

Unit I	Biometric Fundamentals	08 Hours

Definition, Biometrics versus traditional techniques, Operation of Biometric system, Characteristics of biometrics, Key biometric processes: Verification - Identification-Biometric matching, performance measures in biometric systems, Assessing the privacy risks of biometrics, Different biometric standards, Application of Biometrics

Unit II	Physiological Biometrics	08 Hours

Least Square methods for signal modeling and its disadvantages, PadeApproximation, Prony‘s and Shank‘s Methods for signal Modeling. Introduction to various physiological biometrics like Facial scan, Ear scan, Retina scan, Iris scan, Finger scan, Automated fingerprint identification system in detail, Palm print, Hand geometry analysis, hand vascular pattern technology, dental identification

Unit III	Behavioural Biometrics	10 Hours

Signature scan, Keystroke scan, Voice scan, Gait recognition, Gesture recognition, Video face, Mapping the body technology.Biometric User Interface and Applications :
Biometric interfaces: Human machine interface Human side interface: Iris scanner interface, Hand geometry and fingerprint sensor, Machine side interface: Parallel port -Serial port-Network topologies, Case study: Palm Scanner interface. Categorizing biometric applications, Application areas: Criminal and citizen identification

Unit IV	Introduction to Multibiometrics	08 Hours

Introduction and need of multi-biometric system, levels of fusion – sensor level fusion, feature level fusion – feature normalization, score level fusion, Examples of multimodal biometric systems.

Unit V	Security of Biometric Systems	06Hours

Threat Model for Biometric Systems, Extrinsic Attacks, Presentation Attacks, Attacks on Biometric Processing, Attacks on the Template Database

Learning Resources

Text Books:

1. Anil K. Jain, Arun A. Ross, Karthik Nandakumar, Thomas Swearingen, Introduction to Biometrics, Springer Cham, 2nd Edition
2. Bodade, Rajesh M., and Sanjay N. Talbar. Iris Analysis for Biometric Recognition Systems. Springer India, 2014
3. Biometrics: Identity Verification in a Networked World : Samir Nanavati, Michael Thieme, Raj Nanavati

Reference Books:

1. Kenneth Revett, ―Behavioral Biometrics – A Remote Access Approach‖, Wiley, 2008S. M. Kay,―Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall, 1993.
2. Charles A. Shoniregun, Stephen Crosier, ―Securing Biometrics Applications‖, Springer 2006
3. Anil K Jain, Patrick Flynn and Arun A Ross, ―Handbook of Biometrics‖, Springer, USA, 2010

MOOC Courses (Web Links)

https://nptel.ac.in/courses/106104119

https://www.mooclab.club/resources/biometric-technologies-identification-for-the-future.323/

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-571C-SGP – Machine Learning

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Engineering Mathematics (Linear Algebra, Probability & Statistics, Calculus), Digital signal processing, Data Structures and Algorithms

Course Objectives: The course aims to:

1. Introduce fundamental Machine Learning concepts and their applications in real-world problems.
2. Implement regression and classification models to solve engineering problems
3. Apply clustering and dimensionality reduction techniques to unlabeled data.
4. Optimize datasets through preprocessing and feature selection for Machine Learning pipelines.
5. Combine models and validate performance for robust predictions.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Compare Machine Learning paradigms for real time applications
CO2: Design regression models for predictive tasks and classification models (SVM, decision trees) for signal/label prediction.
CO3: Develop clustering models (K-Means, DBSCAN) and PCA-based solutions for defect detection or customer segmentation.
CO4: Construct feature engineering pipelines (scaling, encoding, and selection) to improve model performance in VLSI/telecom datasets.
CO5: Implement ensemble techniques like Random Forest, XGBoost and statistical tests like t-test to enhance accuracy in IC testing or power grid stability.

Course Contents

Unit I	Introduction to Machine Learning	08 Hours

Introduction, Definition and motivation, History and evolution of Machine learning, types: Supervised, Unsupervised, Semi-supervised, Reinforcement, Machine Learning Models: Geometric, Probabilistic, Logical, and Parametric. Non-parametric, Applications of Machine Learning in Signal processing, speech recognition, image processing, Wireless communications,

Unit II	Supervised Machine Learning	08 Hours

Introduction to Supervised Learning, Types of Supervised Problems, Regression Models: Linear Regression, Types of Linear Regression, cost function, gradient descent of linear regression, Evaluation Metrics for Linear Regression, Classification Models: Logistic Naive Bayes algorithm

KNN algorithm Support Vector Machine (SVM).

Unit III	Unsupervised Machine Learning	08Hours

Introduction, Types of Unsupervised Learning: Clustering, Association Rule Learning, Dimensionality Reduction, K-means Clustering algorithm, Evaluation: Elbow method, Silhouette score, Density-Based Methods, Dimensionality Reduction Techniques, Principal Component Analysis (PCA).

Unit IV	Feature Engineering	07 Hours

Importance of feature engineering in Machine Learning pipeline, handling missing values, outliers, encoding: Label, One-Hot, Ordinal, Target Scaling: Min-Max, Standardization, Normalization, Feature selection: Filter (Chi-square), Wrapper (RFE), Embedded (Lasso)

Unit V	Ensemble Learning and Model Evaluation	07 Hours

Introduction to Ensembles, Need of Ensemble Learning, Basic Ensemble Learning Techniques: Voting (Hard/Soft), Advanced Ensemble Learning Techniques: Bagging (Random Forest), Boosting (AdaBoost, XGBoost), Stacking, Cross-validation: Hold-out, K-Fold, LOOCV, Model comparison using t-test, McNemar's test, Hyperparameter tuning (Grid Search, Random Search)

Learning Resources

Text Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", Publisher: The MIT Press,2014
2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, Edition 2012

Reference Books:

1. Ian H Witten, Eibe Frank, Mark A Hall, "Data Mining, Practical Machine Learning Tools and Techniques", Elsevier, 3rd Edition
2. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques", Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807
3. Shalev-Shwartz, Shai, and Shai Ben-David, "Understanding machine learning: From theory to algorithms", Cambridge university press, 2014
4. McKinney, "Python for Data Analysis O' Reilly media, ISBN : 978-1-449- 31979-3

MOOC Courses (Web Links)

1. Introduction to Machine Learning(IIT kharagpur) : https://nptel.ac.in/courses/106105152
2. Introduction to Machine Learning (IIT Madras): https://onlinecourses.nptel.ac.in/noc22_cs29/prevew
3. Machine Learning A-Z™: AI, Python & R + ChatGPT Bonus [2025] https://www.udemy.com/course/machinelearning/
4. Machine Learning and Deep Learning A-Z: Hands-On Python https://www.udemy.com/course/machine-learning-and-deep-learning-a-z-hands-on-python/

Savitribai Phule Pune University
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PEC-571D-SGP – Optimization Techniques

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Numerical Methods, Probability and Statistics, Computer Programming (C / Python / MATLAB)

Course Objectives: The course aims to:

1. To introduce various optimization techniques i.e, classical, linear programming, transportation problem, simplex algorithm, dynamic programming
2. Constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real-world situations
3. To explain the concept of Dynamic programming and its applications to project implementation

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Explain the need for optimization of engineering systems
CO2: Understand the optimization of electrical and electronics engineering problems
CO3: Apply classical optimization techniques, linear programming, simplex algorithm, transportation problem
CO4: Apply unconstrained optimization and constrained non-linear programming and dynamic programming
CO5: Formulate optimization problems.

Course Contents		
Unit I	**Introduction to optimization methods**	**08 Hours**
Use of optimization methods. Introduction to classical optimization techniques, motivation to the simplex method, simplex algorithm, sensitivity analysis.		
Unit II	**Techniques employed in optimization and problem-solving**	**08 Hours**
Search methods - Unrestricted search, exhaustive search, Fibonacci method, Golden section method, Direct search method, Random search methods, Univariate method, simplex method, Pattern search method.		
Unit III	**Numerical Optimization**	**08Hours**
Descent methods, Gradient of function, steepest descent method, conjugate gradient method. Characteristics of constrained problem, Direct methods, the complex method, cutting plane method.		

Unit IV	Global Optimization Techniques	09 Hours
Global optimization techniques such as Monte Carlo method, Simulated annealing and Tunneling algorithm, Probabilistic Methods, Deterministic Methods		
Unit V	**Genetic Algorithms**	**09 Hours**
Genetic algorithm-Selection process, Crossover, Mutation, Schema theorem, Comparison between binary and floating-point implementation.		

Learning Resources

Text Books:

1. Jorge Nocedal Stephen J. Wright, Numerical Optimization, Second Edition,Springer
2. Singiresu S.Rao, Engineering Optimization theory and practice,fifth edition, wiley

Reference Books:

1. J. Borwein and A. S. Lewis, Convex Analysis and Nonlinear Optimization:Theory and Examples, Springer.
2. Weldo D.J., "Optimum seeking method", PHI, 1964.
3. A. Ben-Tal, A. Nemirovski, Lectures on Modern Convex Optimization: Analysis,Algorithms, and Engineering Applications, SIAM.

MOOC Courses (Web Links)

https://onlinecourses.nptel.ac.in/noc21_me10/preview
https://nptel.ac.in/courses/111105039

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-572A-SGP - Generative AI & Agentic AI

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Programming & Data Structures, Deep Learning

Course Objectives: The course aims to:

1. Teach GANs/VAEs/diffusion models and agentic AI basics
2. Discuss safety and deployment of generative/agentic systems

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Implement generative models, design simple agents and discuss safety mitigations.
CO2: Analyze the mathematical formulation, training objectives, and applications of diffusion models, and compare them with GANs/VAEs and advanced scalable variants.
CO3: Evaluate transformer architectures and apply autoregressive and multimodal transformer models for generative tasks across text, image, and speech.
CO4: Apply reinforcement learning and planning techniques to formulate autonomous decision-making and multi-agent coordination problems.
CO5: Assess safety, robustness, ethical considerations, and evaluation strategies for the deployment of generative and agentic AI systems

Course Contents

Unit I	GANs & VAEs Basics	08 Hours

Introduction to generative modeling & applications, GAN architecture: generator, discriminator, minimax formulation, Training dynamics & stability issues in GANs, DCGAN: convolutional GAN architecture, WGAN: Wasserstein distance and improvements, Introduction to VAEs: latent variables and probabilistic modelling, ELBO derivation and VAE training process, training challenges.

Unit II	Diffusion Models & Transformers	08 Hours

Introduction to diffusion models & historical context, Forward noise process and mathematical formulation, Reverse denoising steps & training objective, Applications in image/audio generation, Comparison of diffusion models vs GANs/VAEs, Advancements: DDPM, DDIM, score-based models, Scaling diffusion for large datasets (e.g., Stable Diffusion)

Unit III	Transformers for Generation	08 Hours

Transformer architecture basics: attention, positional encoding, Encoder–decoder vs decoder-only models, Autoregressive transformers: GPT-style generation, Decoder-only models in large language

models (LLMs), Autoregressive vs decoder-only transformers, Transformer efficiency: scaling laws & optimization, Multimodal generation: text-to-image, text-to-speech, cross-modal tasks, Emerging transformer architectures: Vision Transformers, Speech Transformers

Unit IV	Agentic AI & RL Essentials	08 Hours

Introduction to Agentic AI and autonomous decision-making, MDP formulation: states, actions, rewards, transitions, Value-based methods: Q-learning, deep Q-networks, Policy-based methods: REINFORCE, actor-critic, Planning (A*, MPC) basics, Multi-agent coordination

Unit V	Safety, Evaluation & Deployment	09 Hours

Safety challenges in generative and agentic AI, Hallucination & calibration, Uncertainty estimation, Evaluation methods: BLEU, FID, human evaluation, Deployment trade-offs: on-device vs server/cloud deployment, Robustness and adversarial attacks in generative AI, Ethical considerations

Learning Resources

Text Books:

1. Goodfellow, Ian, Bengio, Yoshua, and Courville, Aaron. Deep Learning.MIT Press, 2016.
2. Sutton, Richard S., and Barto, Andrew G., *Reinforcement Learning: An Introduction.*2nd Edition, MIT Press, 2018
3. Russell, Stuart, and Norvig, Peter, *Artificial Intelligence: A Modern Approach (AIMA).*4th Edition, Pearson, 2020.

1. Meng, Chenlin; Song, Yang; Ermon, Stefano.Diffusion Models: A Comprehensive Foundation. Springer, 2023
2. Russell, Stuart.Human Compatible: AI and the Problem of Control.Viking/Penguin, 2019

MOOC Courses (Web Links)

https://nptel.ac.in/courses/106/106/106106126/
https://www.udemy.com/share/101Wpy/

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-572B-SGP – Design and Analysis of Algorithm

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Programming Fundamentals, Data Structures, Discrete Mathematics and Mathematics for Computer Science

Course Objectives: The course aims to:

1. Introduce algorithmic foundations
2. Develop problem-solving skills
3. Explore advanced data structures and graph algorithms
4. Understand computational complexity
5. Introduce parallel and CUDA-based algorithm design
6. Prepare for research and advanced applications

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Explain fundamental concepts of algorithms, asymptotic notations, and performance measures.
CO2: Apply greedy strategy to solve real-world optimization problems like activity selection, MST, and shortest path.
CO3: Analyze algorithms for shortest path and minimum spanning tree.
CO4: Apply backtracking techniques to solve combinatorial problems
CO5: Explain fundamentals of parallel algorithm design and GPU architecture.

Course Contents

Unit I	Introduction to Algorithm Design	08 Hours

Characteristics of Algorithms, Time and Space Complexity, Asymptotic Notations, Recurrence Relations and Solution Methods (Substitution, Recursion Tree, Master's Theorem),Performance analysis: Worst, Average, Best Case, Divide and Conquer Technique: Merge Sort, Quick Sort, Binary Search

Unit II	Greedy and Dynamic Programming Approaches	08 Hours

Greedy Strategy: Activity Selection, Huffman Coding, Minimum Spanning Tree (Prim's, Kruskal's), Dijkstra's Algorithm,Dynamic Programming (DP): Principle of Optimality,Examples: Matrix Chain Multiplication, Longest Common Subsequence (LCS), Knapsack Problem, Floyd-Warshall, Bellman-Ford,Comparison of Greedy and DP Approaches

Unit III	Advanced Data Structures and Graph Algorithms	08 Hours
Graph Representations: Adjacency Matrix, List Graph Traversals: BFS, DFS, Topological Sorting, Shortest Path Problems, Minimum Spanning Trees, Network Flow Algorithms: Ford-Fulkerson, Edmonds-Karp,Union-Find, Disjoint Set, Applications in Kruskal's Algorithm,Advanced Trees: AVL, Red-Black, B-Trees, Tries		
Unit IV	**Backtracking, Branch & Bound, and Complexity Classes**	**08 Hours**
Backtracking: N-Queens, Hamiltonian Cycle, Graph Coloring, Subset Sum,Branch and Bound: Knapsack, Traveling Salesman Problem (TSP),Complexity Theory: P, NP, NP-Complete, NP-Hard Problems, Cook's Theorem, Satisfiability Problem (SAT), Polynomial Reductions		
Unit V	**Parallel Algorithm Design and CUDA Perspective**	**08 Hours**
Introduction to Parallel Algorithms and GPU Computing,Basics of CUDA Programming (Threads, Blocks, Grids, Memory Hierarchy),Parallelizing Classical Algorithms using CUDA: Sorting, Matrix Multiplication, Graph Traversals, Complexity Analysis in Parallel Models (PRAM, Work-Time model),Applications in Engineering and Machine Learning		

Learning Resources

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran: Fundamentals of Computer Algorithms
2. Thomas H. Cormen, Charles E. Leiserson, Ronald Rivest, Clifford Stein : Introduction to Algorithms (CLRS), MIT Press.

Reference Books:

1. Jon Kleinberg, Éva Tardos: Algorithm Design
2. David A. Bader: Designing Parallel Algorithms (for CUDA/parallel part): Design and Analysis of Algorithms

MOOC Courses (Web Links)

https://nptel.ac.in/courses/106106131

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-572C-SGP – Cloud Architecture Protocols

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Computer Networks, Operating Systems

Course Objectives: The course aims to:

1. Define core cloud architecture principles using standardized models (NIST, SPI).
2. Analyze network protocol mechanics, including encapsulation systems and data centre topologies.
3. Evaluate security frameworks using cryptographic protocols and identity management algebras.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Classify cloud service/deployment models using NIST taxonomies and deconstruct virtualization architectures.
CO2: Analyze encapsulation protocols and data center fabrics using routing algebras and congestion control formalisms.
CO3: Analyze the components of a virtualised data centre and review the performance of Data archiving solutions.
CO4: Implement /identity cryptographic protocols via state-machine models and Zero Trust policy algebras.
CO5: Quantify system resilience using queueing theory, failure distributions and resource optimization heuristics.

Course Contents

Unit I	Cloud Ontology & Architectural Frameworks	08 Hours

Foundational Models: NIST essential characteristics, SPI service model taxonomy, resource abstraction layers. Deployment Topologies: Public, Private and Hybrid structural patterns, community cloud governance frameworks. Virtualization Theory: Hypervisor architectures (Bare-metal/Hosted), container isolation formalisms, docker basics and architecture.

Unit II	Network Virtualization & Protocol Architectures	08 Hours

Encapsulation Systems: VXLAN/Geneve header structures, NVGRE protocol mechanics, virtual switching paradigms. Data Center Fabrics: BGP-EVPN control plane theory, Clos topology mathematics, spine-leaf routing algebras. Transport Layer Theory: TCP congestion control formalisms, QoS traffic shaping models, packet scheduling algorithms.

Unit III	Storage Networks	08 Hours
Storage network design considerations: NAS and FC SANs, hybrid storage networking technologies (iSCSI, FCIP, FCoE), design for storage virtualization in cloud computing, host system design considerations. Replications in NAS and SAN environments. Data archiving solutions, analyzing compliance and archiving design considerations.		
Unit IV	**Security Protocols & Cryptographic Frameworks**	**07 Hours**
Identity Systems: SAML 2.0 assertion flows, OAuth 2.0 grant type formalisms, RBAC/ABAC policy algebras. Cryptographic Systems: TLS 1.3 handshake state machine, AES-GCM mode operations, PKI trust hierarchies. Network Security Models: Zero Trust formal architectures, IPsec/IKEv2 tunneling protocols, firewall policy verification.		
Unit V	**Scalability & Reliability Theory**	**07 Hours**
Elasticity Frameworks: Autoscaling hysteresis models, M/M/c queueing systems, horizontal scaling proofs. Failure Engineering: Weibull failure distributions, RTO/RPO calculus, chaos engineering principles. Cost Governance Ontologies: TCO analytical frameworks, bin packing optimization, cloud governance taxonomies.		

Learning Resources

Text Books:

1. T. Erl et al., Cloud Computing: Concepts, Technology & Architecture. Upper Saddle River, NJ: Prentice Hall, 2013.
2. D. Dutt, Cloud Native Data Center Networking. Sebastopol, CA: O'Reilly Media, 2019.
3. B. Beyer et al., Site Reliability Engineering: How Google Runs Production Systems. Sebastopol, CA: O'Reilly Media, 2016.
4. C. Wu and R. Buyya, Cloud Data Centers and Cost Modeling: A Complete Guide To Planning, Designing and Building a Cloud Data Center. Cambridge, MA: Morgan Kaufmann, 2015.

Reference Books:

1. R. Mather et al., Cloud Security: A Comprehensive Guide to Secure Cloud Computing. Hoboken, NJ: Wiley, 2010.
2. P. Mell and T. Grance, The NIST Definition of Cloud Computing, NIST SP 800-145. Gaithersburg, MD: National Institute of Standards and Technology, 2011.
3. A. Azodolmolky, Cloud Networking: Understanding Cloud-Based Data Center Networks. Waltham, MA: Morgan Kaufmann, 2014.

MOOC Courses (Web Links)

1. Cloud computing By Prof. Soumya Kanti Ghosh, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_cs14/preview
2. Advanced Computer Networks, By Prof. Neminath Hubballi, Prof. Sameer G Kulkarni IIT Indore, IIT Gandhi nagar https://onlinecourses.nptel.ac.in/noc25_cs02/preview
3. Cloud Computing and Distributed Systems By Prof. Rajiv Misra IIT Patna https://onlinecourses.nptel.ac.in/noc21_cs15/preview

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

PEC-572D-SGP – Artificial Intelligence for Industrial and Telecommunication Data

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Computer Networks & Telecommunication Basics, Communication Systems, Telecommunication Data Analytics

Course Objectives: The course aims to:

1. To understand SCADA, telemetry, IoT data, CDR processing, and time-series feature engineering.
2. To learn anomaly detection, fraud detection, predictive maintenance, and RUL estimation techniques.
3. To apply forecasting models and optimize network resources using advanced AI methods.
4. To gain hands-on experience through case studies and AI model deployment using MLOps.
5. To explore emerging AI techniques like XAI, federated learning, GNNs, and AI in 5G/6G.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Analyze industrial and telecom data systems, CDRs, and time-series features.

CO2: Implement anomaly detection and RUL estimation using ML/DL methods.

CO3: Design forecasting and resource optimization models using ARIMA, LSTM, and RL.

CO4: Develop AI solutions for predictive maintenance, fraud detection, and churn prediction.

CO5: Evaluate and apply emerging AI techniques for telecom and industrial applications.

Course Contents

Unit I	Foundations of Industrial & Telecom Data Systems	08 Hours

SCADA, telemetry, IoT data characteristics, CDR structure and processing,- Time synchronization and data labeling,- Time-series feature engineering (lags, frequency domain features)

Unit II	Anomaly Detection & RUL	08 Hours

Statistical approaches: Control charts (Shewhart, CUSUM, EWMA), trend analysis, Machine learning approaches: Autoencoders, Isolation Forest, One-Class SVM, Anomaly detection in telecom: fraud detection, intrusion detection, network fault diagnosis, Anomaly detection in industry: predictive maintenance, quality control, Basics of RUL estimation: degradation modeling, regression-based RUL,

survival analysis,Deep learning methods for RUL estimation (LSTM, CNN for sensor streams)

Unit III	Advanced Forecasting and Intelligent Resource Optimization	08 Hours

ARIMA/SARIMA, LSTM/GRU-based forecasting,- Network capacity planning and traffic prediction, Reinforcement Learning: Q-learning, DQN for resource/spectrum allocation

Unit IV	Case Studies & Deployment	08 Hours

Churn prediction in telecom: customer segmentation, supervised ML models, Predictive maintenance case study in industrial IoT,Fraud detection case study using CDRs and anomaly detection, Model deployment: edge vs cloud AI, containerization, MLOps lifecycle, Deployment challenges: latency, scalability, reliability, data privacy, Model monitoring and retraining: handling model drift, adaptive learning

Unit V	Emerging AI Techniques in Industry and Telecommunication	08 Hours

Explainable AI (XAI), Federated Learning, Graph Neural Networks,- Security-focused AI, AI in 5G/6G networks, digital twins, sustainable AI

Learning Resources

Text Books:

1. Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 4th Edition, 2021
2. Rajendra Prasad, Artificial Intelligence for Communication Networks and Services, Wiley, 2023.

Reference Books:

1. Kaushik Kumar, Divya Zindani, Artificial Intelligence for Industrial Applications, Springer, 2021.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2017.

MOOC Courses (Web Links)

https://www.coursera.org/learn/intro-to-predictive-analytics-using-python

https://www.coursera.org/learn/advanced-malware-and-network-anomaly-detection

https://www.edx.org/learn/engineering/mathworks-machine-learning-for-anomaly-detection

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

SEM-581-SGP - Seminar I

Teaching Scheme	Credits	Examination Scheme
Practical: 04 Hours/Week	02	**Term Work** : 25 Marks **Practical** : 25 Marks

Course Description:

The seminar aims to enhance students' research, presentation, and critical thinking skills, preparing them for advanced academic pursuits and professional careers. Seminars will provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.

Course Objectives: The course aims to:

1. **Deepen Technical Knowledge:** To enable students to explore a specialized topic within E&TC Engineering beyond the regular curriculum, fostering in-depth understanding.
2. **Develop Research Skills:** To provide practical experience in identifying, acquiring, evaluating, and synthesizing information from various technical sources (research papers, standards, technical reports).
3. **Enhance Communication Skills:** To cultivate effective oral and visual presentation skills, enabling students to articulate complex technical concepts clearly and concisely to a knowledgeable audience
4. **Foster Critical Thinking:** To encourage students to critically analyze existing research, identify challenges, propose solutions, and engage in constructive discussions.
5. **Promote Independent Learning:** To encourage self-directed learning and the ability to stay updated with emerging technologies and research trends.
6. **Prepare for Thesis/Dissertation:** To serve as a foundational step for the Master's thesis/dissertation, allowing students to explore potential research areas.

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1 : **Formulate** the goals and objectives of scientific research;
- CO2 : Search, evaluate and **analyze** information about the achievements of science and tech- nology in the target area and beyond;
- CO3 : **Interpret** data from different fields of science and technology;
- CO4 **: Build** the logic of reasoning and statements;
- CO5 **:Create**, design and edit text documents in accordance with the requirements of the organization or publisher;

Guidelines

1. **Responsibility of the Students:**

- The Seminar should be carried out individually by each student.
- A student should identify the area or topics in recent trends and developments in consul- tation with the guide
- A student should report to his/her respective guide regularly (at least once in a week) and report the progress of the seminar work.
- A student should follow the timelines and deadlines and inform the supervisor in case of any difficulty/delay.
- Students should maintain the record of all the meetings, remarks given by guide/reviewers and progress of the work in the project diary. The project diary must be presented during each review presentation to the reviewers.
- A student should conduct the research ethically, adhere to the academic integrity stan- dards, and cite sources whenever using any existing results
- A student should Incorporate constructive feedback to improve the quality and rigor of the research
- For final examination, students should complete the Seminar Report in all aspects includ- ing formatting and citation.
- Each student should prepare the report, get it approved by his/her guide and submit the duly signed copy within the deadline.
- A student should invest time and effort in preparing for seminar presentations and the oral defense of the seminar

2. **Topic Selection:**

- Relevance: Topics must be directly related to E&TC Engineering, encompassing current research trends, emerging technologies, advanced concepts, or interdisciplinary applications.
- Scope: The topic should be sufficiently focused to allow for in-depth exploration within the seminar timeframe, yet broad enough to demonstrate a comprehensive understanding. Avoid overly narrow or excessively broad topics.
- Novelty (Desired): While not strictly a research paper, students are encouraged to explore topics that have recent advancements, open problems, or areas where their unique insights can be presented. Avoid merely summarizing introductory textbook material.
- Guide / Supervisor Approval: Each student must select a seminar topic in consultation with and obtain approval from an assigned faculty supervisor. The supervisor will guide the student in refining the topic and identifying relevant resources.

- Examples of Broad Areas: Natural Language Processing, VLSI Design, Embedded Systems, Artificial Intelligence/ Machine Learning, Cloud Computing, Internet of Things (IoT), High-Performance Computing, Computer Vision, Blockchain, Quantum Computing, etc…

3. **Seminar Structure and Deliverable:**

- Topic Proposal (2-3 weeks after topic approval):
- A concise document (1-2 pages) outlining:
- Proposed Seminar Title
- Brief Description/Abstract of the Topic
- Motivation and Relevance to E&TC Engineering
- Preliminary List of Key References (at least 5-7 reputable sources)
- Tentative Scope and Outline of the Presentation
- Submission: To the faculty supervisor for approval.
- Literature Review and Research (Ongoing): Sources: Students must primarily rely on peer-reviewed academic sources (IEEE Xplore, ACM Digital Library, SpringerLink, arXiv, Google Scholar), reputable conference proceedings, and established industry standards. Wikipedia and unverified blogs are generally not acceptable as primary sources.
- Critical Analysis: Beyond mere summarization, students are expected to critically analyze the literature, identifying different approaches, their advantages/disadvantages, open issues, and potential future directions.
- Note-Taking & Organization: Maintain systematic notes and organize research material effectively.

4. **Seminar Report/Paper (Due 2-3 weeks before presentation):**

- A written report (typically 15-25 pages, excluding references and appendices) detailing the seminar content.
- Format: Follow a professional academic paper format (e.g., IEEE transaction style).
- Sections
    * Abstract: A concise summary of the seminar topic and key findings.
    * Introduction: Background, motivation, problem statement (if applicable), and outline of the report.
    * Literature Review/Background: Detailed discussion of relevant concepts, theories, and existing work.
    * Core Content: In-depth exploration of the chosen topic, presenting different

method- ologies, architectures, algorithms, or challenges as relevant.

* Analysis/Discussion: Critical evaluation of the presented material, comparing different approaches, discussing implications, and identifying gaps.
* Future Trends/Conclusion: Summarization of key takeaways, potential future direc- tions, and concluding remarks.
* References: A comprehensive list of all cited sources, properly formatted.
* Appendices (Optional): Supplementary material if necessary.

5. **Oral Presentation :**

- Duration: Typically 25-30 minutes for presentation, followed by 10-15 minutes for Q&A. (Specific timings will be announced)
- Audience: Faculty members, peers, and potentially other interested individuals.
- Content: The presentation should effectively convey the key aspects of the seminar topic. It should not simply be a reading of the report.
- Visual Aids: High-quality presentation slides (e.g., PowerPoint, Google Slides, LaTeX Beamer) are mandatory. Slides should be clear, concise, visually appealing, and support the oral de- livery. Avoid excessive text on slides.
- Delivery: Clear articulation, confident posture, good eye contact, and appropriate pace. Practice the presentation thoroughly.
- Q&A Session: Be prepared to answer questions from the audience on all aspects of the seminar topic. Demonstrate a strong understanding and ability to defend your perspectives.

6. **Evaluation Criteria:**

The seminar will be evaluated based on the following criteria:

- Topic Selection and Scope (10%): Relevance, timeliness, and appropriate depth of the chosen topic. Clarity and focus of the topic proposal.
- Literature Review and Research (25%): Breadth and depth of literature surveyed. Quality and credibility of sources used. Critical analysis and synthesis of information.
- Seminar Report/Paper (30%): Clarity, organization, and logical flow of content. Technical accuracy and depth of discussion. Adherence to academic writing standards (grammar, spelling, formatting, referencing). Originality in synthesis and critical insights. Absence of plagiarism.
- Oral Presentation (35%): Content: Clarity, completeness, and accuracy of the presented material. Organization: Logical flow, effective use of time. Visual Aids: Quality, clarity, and effectiveness of slides. Delivery: Confidence, clarity of speech, enthusiasm, engagement with the audience. Q&A: Ability to answer questions accurately, comprehensively, and confidently.

Learning Resources

Text Books:

1. "Engineering Communication" by Charles W. Knisely & Karin I. Knisely
2. "Technical Communication: Principles and Practice" by Meenakshi Raman & Sangeeta Sharma
3. "The Craft of Scientific Presentations" by Michael Alley

MOOC Courses (Web Links)

1. https://nptel.ac.in/courses/109/106/109106180/
2. https://www.udemy.com/course/technical-writing/
3. https://www.edx.org/course/writing-in-the-sciences

Savitribai Phule Pune University, Pune

Maharashtra, India

ME (2025 Course)
Electronics & Telecommunication Engineering
(Signal Processing)

Semester III

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

RM-601- SGP - Research Methodology

Teaching Scheme	Credits	Examination Scheme
Theory : 05 Hours/Week	05	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses:

1. Familiarity with project-based learning (e.g., mini projects, seminars, undergraduate theses)
2. Knowledge of basic statistics (mean, median, variance, standard deviation, probability concepts)
3. Basic skills in technical writing (reports, presentations, documentation).
4. Sound fundamentals of the core engineering/science domain

Course Objectives: The course aims to:

1. Understand the philosophy of research in general
2. Understand basic concepts of research and its methodologies
3. Learn the methodology to conduct the Literature Survey
4. Acquaint with the tools, techniques, and processes of doing research
5. Learn the effective report writing skills and allied documentations
6. Become aware of the ethics in research, academic integrity and plagiarism

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1 : **Define** research and **explain** its essential characteristics with examples from engineering and science fields.

CO2 : Identify and **apply** different types of research (basic, applied, qualitative, quantitative, exploratory, descriptive, etc.) to specific problems.

CO3 : **Analyze** the outcomes of research such as publications, patents, and technological contributions, and understand their societal and industrial impacts.

CO4 : **Apply** ANOVA and ANCOVA techniques for effective experimental data analysis and interpretation of results.

CO5 : **Understand** and **apply** the basics of Intellectual Property Rights (IPR) to safeguard innovative research and prevent unethical practices.

Course Contents		
Unit I	**Definition and Characteristics of Research**	**12 Hours**

Basic of Research : Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that de- scribe characteristics of research such as systematic, valid, verifiable, empirical and critical approach. Types - Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches.

Engineering Research : Why? Research Questions, Engineering Ethics, conclusive proof-what con- stitutes, A research project-Why take on?

Case Study : Code of Ethics, IEEE Code of Ethics, ACM Software Engineering Code of Ethics and Professional Practice, Code of Ethics especially covering Engineering discipline, various aspects-environment, sustainable outcomes, employer, general public, and Nation, Engineering Disasters.

Unit II	**Literature Search and Review**	**12 Hours**

Literature Review, Types of review , Developing the objectives, Preparing the research design including sample Design, Sample size. Archival Literature, Why should engineers be ethical? Types of publications- Journal papers, conference papers, books, standards, patents, theses, trade magazine, newspaper article, infomercials, advertisement, Wikipedia & websites, Measures of research impact, publication cost.

Case Study : Engineering dictionary, Shodhganga, The Library of Congress, Research gate, Google Scholar, Bibliometrics, Citations, Impact Factor, h-index, I-index, plagiarism, copyright infringement

Unit III	**Analysis of Variance and Covariance**	**12 Hours**

Basic principle of Analysis of Variance, ANOVA Technique, Setting up Analysis of Variance Table, short-cut method for oneway ANOVA, Coding method, Two-way ANOVA, ANOVA in Latin-square design, analysis of co-variance (ANCOVA), assumptions in ANCOVA. Academic Ethics: Plagiarism, exposure on anti-plagiarism tools.

Unit IV	**Technical Writing and IPR**	**12 Hours**

Academic writing, sources of information, assessment of quality of journals and articles, writing scientific report, structure and component of research report, types of report – technical reports and thesis, SCOPUS Index, citations, search engines beyond google, impact factor, H-Index. IPR: What is IPR?, importance of patents, types of IPR, process of patent.

Unit V	**Outcome of Research and Research Presentation**	**12 Hours**

Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation of analysis, Preparation of the Report on conclusions reached, Testing validity of research outcomes, Suggestions and recommendations, identifying future scope.

Research presentation: Introduction, Standard terms, Standard research methods and

experimental techniques, Paper title and keywords, Writing an abstract, Paper presentation and review, Conference presentations, Poster presentations, IPR, Copyright, Patents.

Case Study: Intellectual Property India- services, InPASS - Indian Patent Advanced Search System, US patent, IEEE / ACM Paper templates.

Learning Resources

Text Books:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers' Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed), Sin- gapore, Pearson Education.
4. Neeraj Pandey, Intellectual Property Rights ,1st Edition, PHI
5. Shrivastava, Shenoy& Sharma, Quantitative Techniques for Managerial Decisions, Wiley

Reference Books:

1. Goode W J &Hatt P K, Methods in Social Research, McGraw Hill
2. Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH)

MOOC Courses (Web Links)

1. https://www.youtube.com/playlist?list=PLm-zueI9b64QGMcfn5Ckv_8W5Z1d3vMBY
2. https://onlinecourses.swayam2.ac.in/cec20_hs17/preview
3. https://onlinecourses.nptel.ac.in/noc23_ge36/preview

Practical Assignments / Mini Project Problem Statements		
Sr.	**Title**	**Objectives**
1	Problem Identification Exercise	Identify and clearly define a real-world research problem in your engineering discipline.
2	Literature Review Report	Conduct a detailed literature survey (minimum 30 research papers) and summarize gaps in existing research.
3	Research Proposal Drafting	Prepare a structured research proposal including problem statement, objectives, scope, and methodology.
4	Hypothesis Formulation	Develop testable hypotheses based on selected research problems.
5	Design of Experiment	Design a detailed experimental plan or simulation for validating hypotheses.
6	Sampling Techniques	Select and justify a sampling method for data collection in your project.
7	Data Collection Tools Development	Design a survey questionnaire or sensor-based data collection method.
8	Statistical Data Analysis	Perform statistical analysis (ANOVA, regression, t-tests) on sample data.
9	Research Paper Writing	Draft a full research paper based on hypothetical or preliminary data.
10	Research Ethics and Plagiarism Check	Analyze ethical aspects and conduct a plagiarism check for your paper.

Mini Project statement list for Research Methodology (ANY ONE)		
Sr.	**Project Title**	**Description/Deliverable**
1	AI-based Systematic Literature Review Tool	Build a tool that automates screening and organizing research papers.
2	Comparison of Research Methodologies	Compare qualitative vs. quantitative methods through case studies.
3	Development of a Research Gap Identification Model	Create an algorithm that detects research gaps from published articles.
4	Design of a Predictive Analytics Model	Design a model that predicts the future trend of research in a selected field.
5	Big Data Analysis for Research Trends	Analyze publication data from Scopus/IEEE/Google Scholar to identify top emerging topics.
6	AI-based Systematic Literature Review Tool	Build a tool that automates screening and organizing research papers.

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

OJT-602- SGP - On Job Training / Internship

Teaching Scheme	Credits	Examination Scheme
Practical: 10 Hours/Week	05	Term Work : 100 Marks

Course Objectives: The course aims to:

1. To put theory into practice and expand thinking and broaden the knowledge and skills acquired through course work in the field.
2. To relate to, interact with, and learn from current professionals in the field.
3. To understand and adhere to professional standards in the field.
4. To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
5. To develop the initiative and motivation to be a self-starter and work independently.

Course Outcomes: Upon successful completion of this course, students will be able to:

- **Gain** practical experience within industry in which the internship is done.
- **Acquire** knowledge of the industry in which the internship is done.
- **Apply** knowledge and skills learned to classroom work.
- **Develop** and refine oral and written communication skills.
- **Acquire** the knowledge of administration, marketing, finance and economics.

Course Description:

1. Internship/On Job Training provide students the opportunity of hands-on experience that includes personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc.
2. An internship is the phase of time for students when they are trained for their skills, they are good at, and it gives them a chance to apply their knowledge practically in industries
3. The internship can be carried out in any industry/R&D Organization/Research Institute/Institute of national repute/R&D Centre of Parent Institute.
4. The Department/college shall nominate a faculty to facilitate, guide and supervise students under internship.

Guidelines:

- **Purpose:** Internships are designed to bridge the gap between academic learning and industry practice. They aim to provide hands-on experience, expose students to the industrial environment, develop technical and soft skills (communication, teamwork, problem-solving), and help in career exploration.

- **Internship Duration and Academic Credentials**

  1. Student can take internship work in the form of Online/Offline mode from any of the Industry / Government Organization Internship Programmes approved by SPPU/AICTE/UGC portals
  2. A intern is expected to spend 10 - 12 hours per week on Internship, Training will result in about 160-170 hours of total internship duration.
  3. The minimum requirement regarding Internship duration should not be below 8 weeks

- **Type of Internship**

  1. Industry/Government Organization Internship: Working directly with a company or government body.
  2. Research Internship: Focused on research projects, often in collaboration with academic institutions or R&D labs.
  3. Innovation/Entrepreneurship: Working on developing new products, processes, or even starting a venture.
  4. Social Internship: Engaging in community-based projects.

- **Assessment Details (TW and Practical)**

  1. Term work for 100 marks
  2. A daily log submitted by the student and a work log signed by the office HoDs where the student has interned will be considered towards the TW marking.

- **Indicative list of areas for OJT**

  1. Trade and Agriculture
  2. Economy & Banking Financial Services and Insurance
  3. Logistics, Automotive & Capital Goods
  4. Fast Moving Consumer Goods & Retail
  5. Information Technology/Information Technology Enabled Services & Electronics

6. Handcraft, Art, Design & Music
7. Healthcare & Life Science
8. Sports, Wellness and Physical Education
9. Tourism & Hospitality
10. Digitization & Emerging Technologies (Internet of Things / Artificial Intelligence / Machine
11. Learning / Deep Learning / Augmented Reality / Virtual Reality etc.)
12. Humanitarian, Public Policy and Legal Services
13. Communication
14. Education
15. Sustainable Development
16. Environment
17. Commerce, Medium and Small-Scale Industries

- **Faculty Supervision:** Students are usually assigned an internal faculty guide/mentor who supervises their internship activities. This faculty member acts as a teacher, mentor, and critic, and ensures the internship aligns with academic goals. External Supervision: In many cases, an external expert from the host organization also guides the student.
- **Documentation and Reporting:**
    1. Joining Report: To be submitted within a specified time frame (e.g., one week from joining).
    2. Daily/Periodical Diary: Students are often required to maintain a daily or weekly record of their observations, work, and learning.
    3. Internship Report: A comprehensive report detailing the work done, learning outcomes, and achievements during the internship. This report needs to be duly signed by the com- pany official and faculty mentor.
    4. Completion Certificate: Issued by the host organization upon successful completion.
- **Evaluation :**
    1. Evaluation is typically done by the institute, often within a short period after the internship ends.
    2. It may involve presentations, viva-voce examinations, and assessment of the internship report and daily diary.
    3. Performance-based feedback from the industry mentor is usually a key component.

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

SEM-603- SGP - Seminar – II

Teaching Scheme	Credits	Examination Scheme
Practical: 06 Hours/Week	03	**Term Work:25 Marks** **Practical: 25 Marks**

Course Description:

1. Research Project seminar is the first stage of work on a master's thesis. During this course, students gain experience in the field of intellectual property and research ethics. They conduct patent searches and analyze related works to study the current state of the target area.
2. Work on the "Research Project seminar" is carried out on the basis of the research and training laboratories of the Institute and the Scientific Library of the Institute/University and in close cooperation with the student's scientific supervisor.
3. The aim of the "Research Project Seminar " is to prepare for the implementation of the Final Project and for master's thesis defense. It includes finding or developing methods and tools to solve a stated problem, taking into account the latest research and trends; clarification of requirements for the object under development; planning experiments and tests to prove the effectiveness of the proposed solution

Course Objectives: Upon successful completion of this course, students will be able to:

1. To provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.
2. To raise student's awareness in advanced methods of research and mastering the skills to apply them.
3. Teach students to find and critically analyze sources of information.
4. Develop their ability to build logic of reasoning and statements based on the interpretation of data combined from various fields of science and technology, to make judgments based on incomplete data.
5. Improve the student's academic writing experience.

Course Outcomes: Upon successful completion of this course, students will be able to:

1. Fundamental concepts and categories in the field of scientific research- ways of organizing and planning research
2. Relevant information sources that allow him or her to acquire new knowledge and skills in various fields
3. Advanced information technologies allowing us to acquire new knowledge in various fields
4. Features of the technical and scientific style of writing texts
5. Basic concepts of the culture of thinking, logic, rules for constructing reasoning and statements
6. Formal apparatus of the logic of constructing reasoning and statements
7. Evaluation criteria and methods of handling incomplete data

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

- Formulate the goals and objectives of scientific research;
- Search, evaluate and analyze information about the achievements of science and technology in the target area and beyond;
- Interpret data from different fields of science and technology;
- To build the logic of reasoning and statements;
- Write a text in a scientific or scientific and technical style, use the appropriate vocabulary;
- Create, design and edit text documents in accordance with the requirements of the organization or publisher;
- Plan a pilot study
  - methods of planning scientific research, taking into account the peculiarities of the profes- sional area.
  - methods of collecting and analyzing information on the achievements of science and tech- nology in the target area and beyond.
  - proficiency in preparing publications on the topic of research
  - experience in data integration from different fields of science and technology and building evidence-based judgments.
  - methods of planning an experiment, taking into account the peculiarities of the field of professional activity.

Responsibility of the Students:

- The Seminar should be carried out individually by each student.
- A student should identify the area or topics in recent trends and developments in consultation with the guide
- A student should report to his/her respective guide regularly (at least once in a week) and report the progress of the seminar work.
- A student should follow the timelines and deadlines and inform the supervisor in case of any difficulty/delay.
- Students should maintain the record of all the meetings, remarks given by guide/reviewers and progress of the work in the project diary. The project diary must be presented during each review presentation to the reviewers.
- A student should conduct the research ethically, adhere to the academic integrity standards, and cite sources whenever using any existing results
- A student should Incorporate constructive feedback to improve the quality and rigor of the research
- For final examination, students should complete the Seminar Report in all aspects including formatting and citation.
- Each student should prepare the report, get it approved by his/her guide and submit the duly signed copy within the deadline.
- A student should invest time and effort in preparing for seminar presentations and the oral defense of the seminar

Course Contents

Seminars / Assignments

1. Introductory lesson: clarification of the project topic, analysis of the assignment.
2. The structure of scientific texts: abstract, article, presentation, research report, master's thesis.
3. An analytical review on the research topic, its goals and objectives. Related works. Sources of information: open sources, journals, databases and collections of publishers. Citation rules. Scientific ethics. Plagiarism. Presentation and discussion of an in-depth analytical review on the research topic.
4. Scientific novelty. Intellectual property. Patent search: goals and objectives, patent databases, rules for compiling a patent search report.

5. Critical analysis of the related works. Identification and evaluation of methods used by other researchers. Choosing or developing your own method its rational.
6. Research Design Stage: clarification of the requirements for the object being developed (soft- ware, hardware and software system, technical product).
7. Formulation of criteria for the project goal achieving. Determination of ways to confirm the achievement of the set goal. Experimental study of the object under development.
8. Experiment planning.
9. Preliminary report on the Research Project. Discussion of the preliminary results of the project. Recommendations for improvement and revision.
10. Final assessment: Project defense in the form of a presentation as seminar

Learning Resources:

Text Books:

1. Kennett, B. (2014). Planning and managing scientific research. ANU Press. https://www.jstor.org/ stable/(free access)
2. Sirotinina, N. (2012). History and methodology of computer science. Siberian Federal Univer- sity. Tomsk: TPU Publishing House.
3. Moore, N. (2006). How to do research: a practical guide to designing and managing research projects. Facet publishing.

Savitribai Phule Pune University

Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering (Signal Processing)

RPR-604- SGP - Research Project – I

Teaching Scheme	Credits	Examination Scheme
Practical: 18 Hours/Week	09	**Term Work :** 25 Marks **Oral :** 25 Marks

Course Description:

The master's degree culminates in a research project of the student's own design. This research project is documented by a final research report or dissertation. The student's work is guided by an academic supervisor. Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc.

Students are expected to construct a research project that includes original research, deliberate and well considered methodological choices, and shows relevance to significant conversations within the discipline. The dissertation should represent the very best research and analysis a student can produce.

Course Objectives: Upon successful completion of this course, students will be able to:

1. Demonstrate an ability to plan a research project, such as is required in a research proposal prior to the launch of their work
2. Demonstrate an ability to comply with ethical, safety, and documentation processes appropriate to their project
3. Demonstrate expert knowledge in the subject of their research project, such as through a inte- grated literature survey
4. Demonstrate expert knowledge in the research methods appropriate to generating reliable data for their research questions
5. Demonstrate the ability to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
6. Demonstrate an ability to relate their original data to existing literature, or to create an novel synthesis of existing materials
7. Demonstrate an ability to assemble their findings into a substantial piece of writing that presents a clear thesis and a cohesive, evidence-based argument
8. Demonstrate an ability to balance description, analysis, and synthesis within their project report
9. Demonstrate an ability to reflect on the strengths and weaknesses of their research and method- ology, with constructive advice on how they might improve their efforts in future work

Course Outcomes:

After successful completion of the course, learner will be able to:

- CO 1 : Demonstrate how to search the existing literature to gather information about a specific problem or domain.
- CO 2 : Identify the state-of-the-art technologies and research in the chosen domain, and high- light open problems that are relevant to societal or industrial needs.
- CO 3 : Evaluate various solution techniques to determine the most feasible solution within given constraints for the chosen dissertation problem.
- CO 4 : Apply E&TC engineering principles related to requirements gathering and design to produce relevant documentation.
- CO 5 : Write a dissertation report that details the research problem, objectives, literature review, and solution architecture.

Guidelines

1. **General Guidelines :**

   (a) The dissertation is a year-long project, conducted and evaluated in two phases. It can be carried out either in-house or within an industry as assigned by the department. The project topic and internal advisor (a faculty member from the department) are determined at the beginning of Phase I.

   (b) Student is expected to complete the following activities in Phase-I:

   i. Literature survey
   ii. Problem Definition
   iii. Motivation for study and Objectives
   iv. Preliminary design / feasibility / modular approaches
   v. Design of the research project

Phase 1: Informal Conversations :

Students are strongly encouraged to discuss possible research project ideas with the internal guide, fellow students, and other research professionals. All research projects begin with open- ended conversations and scoping exercises. These should be non-committal.

Phase 2: Identify Topic:

The first formal step in the module involves identifying a preliminary project title and writing an abstract of no more than 200 words. This requires submitting a completed registration form. Writing an abstract for a research proposal or for completed research work is an important transferable skill. Students who do not submit a completed registration form will be assigned a project. The project title is understood to be provisional. Supervisors will be assigned to

students after the project title/ abstract forms have been submitted. Supervision: A supervisor is required. The main responsibilities of the supervisor are to assist the student with project management and to advise the student on criteria for assessment. You can expect your supervisor to read and comment on a full draft of your research proposal and of your project.

It is a good idea to discuss a time line for your project with your supervisor, and to establish a definite timetable.

Some key points in our advice to students on compliance:

1. Allow at least two weeks between submitting an ethics application and the date of your first data collection
2. Your supervisor must approve (and sign!) your ethics application before you submit it at depart- mental level
3. After your protocols have been approved, append a copy of your ethical approval certificate to the dissertation and project proposal

Phase 3: Project Proposal:

The proposal should reflect a student's best effort. At the same time, we recognize research often raises new questions. Some redefinitions of topics and titles is common later in the research process. Students should keep their supervisors up to date on these developments, and they can expect a reasonable amount of adaptation.

Phase 4: Term-1 Research:

Students are expected to commit substantial time during the term to their research project. Supervisions The principal form of academic input for the research project normally comes through discussions with the designated supervisor. The majority of these meetings should be face-to-face, either in person or via video- or audio-conferencing technology.

Students are expected to respect these periods of absence and plan their needs accordingly. One distinction is crucial:

(1) When staff are on leave, they are off work (i.e., not expected to maintain contact with their supervisees or to undertake their duties); however,

(2) When staff are working remotely, they are at work (i.e., expected to maintain contact and to be available for normal duties).

A student's supervisor is not the only person who may advise on projects and writing. Others include peers and subject experts.

Phase 5: Submit project report:

The project report with the specific due date must be submitted to Department

Additional Information:

- **Research Notebook :** Students are strongly advised to maintain a research notebook, either digital or paper, and to keep this up to date. A research notebook can prove useful should examiners query research methods, research integrity, or research process.
- **Preventing Data Loss:** Protect yourself against loss of research material and writing by main-

taining a system for secure, redundant, up-to-date back-up of research material and writing. Loss cannot be accepted as a reason for failing to meet a deadline. A copy of written notebooks can be stored by supervisors for the duration of the project. Loss of project materials through accidents and theft have occurred in the past; these have had devastating effects on the un prepared. All students are warned to create redundancies to protect their project from similar calamities.

- **Extensions :** This is a long-term research project, and time management is a learning objective. Short-term extensions normally are not considered. Applications for extension must be made through the processes described in the STS Student Handbook. Personal Tutors are the first point of contact on extension requests.

- **Word Counts :** Words counted towards the total word count include the main body of the report and supporting footnotes or endnotes. The word count does not include: bibliography, front matter (title page, keywords, abstract, table of contents, acknowledgments), appendix material, supplemental data packages, table and figure legends, or documentation of ethics protocols or approvals. Otherwise, University standard policy on word counts will apply.

- **Re-using Coursework From Other Modules :** Text and ideas in the research proposal may reappear in the dissertation if significantly developed or further elaborated; however, Universities policy on self-plagiarism prevents the same work receiving credit twice. This means rote duplication is not allowed.

- **Citation Format :** The style must be clear, explicit, and meaningful. In every instance, it must allow an examiner to locate efficiently and specifically material referred to. As a recommendation, students should use a style frequently used in the literature relevant to their research project. Most journals have style guides in their notes to contributors. Students should discuss options with their supervisors, and they should keep in mind that efficient citation is one element in the criteria for assessment.

Savitribai Phule Pune University, Pune

Maharashtra, India

ME (2025 Course)
Electronics & Telecommunication Engineering
(Signal Processing)

Semester IV

Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering
(Signal Processing)

SEM-651- SGP - Seminar – III

Teaching Scheme	Credits	Examination Scheme
Practical: 08 Hours/Week	04	**Term Work:**50 Marks **Oral:** 50 Marks

Course Objectives: Upon successful completion of this course, students will be able to:

1. To provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.
2. To raise student's awareness in advanced methods of research and mastering the skills to apply them.
3. Teach students to find and critically analyze sources of information.
4. Develop their ability to build logic of reasoning and statements based on the interpretation of data combined from various fields of science and technology, to make judgments based on incomplete data.
5. Improve the student's academic writing experience.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Formulate the goals and objectives of scientific research.

CO2: Search, evaluate and analyze information about the achievements of science and technology in the target area and beyond.

CO3: Interpret data from different fields of science and technology.

CO4: To build the logic of reasoning and statements.

CO5: Write a text in a scientific or scientific and technical style, use the appropriate vocabulary

Responsibility of the Students:

- The Seminar should be carried out individually by each student based on their research project
- A student should identify the area or topics in from the topic selected for research project related recent trends and developments in consultation with the guide
- A student should report to his/her respective guide regularly (at least once in a week) and report the progress of the seminar work.

- A student should follow the timelines and deadlines and inform the supervisor in case of any difficulty/delay.
- Students should maintain the record of all the meetings, remarks given by guide/reviewers and progress of the work in the project diary. The project diary must be presented during each review presentation to the reviewers.
- A student should conduct the research ethically, adhere to the academic integrity standards, and cite sources whenever using any existing results
- A student should Incorporate constructive feedback to improve the quality and rigor of the research
- For final examination, students should complete the Seminar Report in all aspects including formatting and citation.
- Each student should prepare the report, get it approved by his/her guide and submit the duly signed copy within the deadline.
- A student should invest time and effort in preparing for seminar presentations and the oral defense of the seminar

Learning Resources:

Reference Books:

1. Kennett, B. (2014). Planning and managing scientific research. ANU Press. https://www.jstor.org/stable/(free access)
2. Moore, N. (2006). How to do research: a practical guide to designing and managing research projects. Facet publishing.

Savitribai Phule Pune University

Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering (Signal Processing)

RPR-652-- SGP - Research Project-II

Teaching Scheme	Credits	Examination Scheme
Practical: 36 Hours/Week	18	**Term Work:**100 Marks **Oral :** 50 Marks

Prerequisite : Research Project Stage-I

Course Objectives: Upon successful completion of this course, students will be able to:

1. **Demonstrate** an ability to plan a research project, such as is required in a research proposal prior to the launch of their work
2. **Ability** to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
3. **Ability** to relate their original data to existing literature, or to create an novel synthesis of existing materials
4. **Identify** and **formulate** a problem of research interest in the chosen area of E&TC.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: **Undertake** independent research that makes an original contribution to knowledge, or produces a novel synthesis of existing materials relevant to significant conversations in the discipline

CO2 : **Plan** their project in advance, using a proposal to describe their undertaking, describe how it will be managed, and reflect upon its value

CO3 : **Relate** their original research to existing literature on the subject and relate their work to general themes in their relevant scholarly literature

CO4 : **Assemble** their rationale, methods, findings, and analysis into a substantial piece of writing that presents a clear thesis and a cohesive evidence-based argument or analysis

CO5**: Reflect** on the strengths and weaknesses of their research and methodology, understanding how they might improve their efforts in future work

Guidelines for Research Project

- **General Guidelines**

1. The student shall consolidate and complete the remaining part of the research work started in Semester III. This will consist of Selection of Technology, Installations, implementations, testing, Results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions
2. The student shall prepare the duly certified final report of dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
3. The students are expected to validate their study undertaken by publishing it at standard platforms.
4. The investigations and findings need to be validated appropriately at standard platforms like conference and/or peer reviewed journal.
5. The student has to exhibit continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination/Head of the department. The continuous assessment of the progress needs to be documented unambiguously.
6. Supervisor Interaction: Minimum one meeting per week.
7. Logbook: Maintain a record of work progress and supervisor comments.
8. Ethics: No plagiarism, false results, or unethical practices allowed.
9. Backup: Keep source code, datasets, and reports backed up securely.
10. Submission Format: Soft copy (PDF) + Hard copy as per institute norms.

a. Key Components:

i. Implementation

1. Complete development/simulation/testing of the system or model.
2. Ensure correctness, efficiency, and validation of results.

ii. Results & Analysis

1. Include experimental setup, datasets used, performance metrics.
2. Graphs, tables, and comparison with existing techniques.
3. Highlight key findings and their significance.

iii. Conclusion and Future Work

1. Summarize outcomes, contributions, and applications.
2. Suggest extensions or improvements for future research.

iv. Paper Publication

1. At least one paper (optional/encouraged) in peer-reviewed conference/journal.
2. Attach publication/proof as appendix (if available).

v. Final Report Format

1. Revised version of Stage 1 report with added implementation, results, and conclusion chapters.
2. Maintain academic writing standards and include all necessary references.

vi. Plagiarism Report

1. Final version must again be checked and should not exceed 15% similarity.

vii. Evaluation Parameters

1. Completeness and quality of implementation
2. Analysis and originality of results
3. Quality of documentation and adherence to format
4. Viva-voce performance and clarity of understanding
5. Contribution to knowledge or innovation

Task Force for Curriculum Design and Development

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