Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

Curriculum Structure and Syllabus

Master of Engineering (2025 Pattern) in

ME - Electronics (Digital Systems)

(With effect from Academic Year 2025-26)

Contents

Nomenclature

PEO Programme Educational Objectives

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WK Knowledge and Attitude Profile

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 Digital Systems program**, effective from the Academic Year 2025–26 (2025 Pattern).

Digital Systems is a vital and ever-evolving domain that underpins the operation of nearly all modern electronic systems. It focuses on the design, modelling, analysis, and implementation of digital circuits and systems, forming the backbone of computing, communication, control, and consumer electronics.

This curriculum has been carefully structured to provide students with a deep understanding of the theoretical foundations, design methodologies, and practical tools used in the development of digital systems. It emphasizes both hardware and system-level design, fostering the skills needed to build efficient, reliable, and scalable digital solutions.

By aligning with current industry trends and technological advancements, the program aims to prepare students for successful careers in areas such as FPGA/ASIC design, embedded systems, digital signal processing, and more.

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

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Savitribai Phule Pune University

Curriculum Structure Semester I

Master of Engineering (2025 Pattern)

Electronics Engineering – (Digital Systems)

Course Code	Course Type	Course Name	Teaching Scheme			Examination Scheme				Credits			
			Theory	Practical	CCE	End Sem	Term work	Practical	Oral	Total	Theory	Practical	Total
PCC-501-DIS	Programme Core Course	Analog and Digital CMOS Design	4	-	50	50	-	-	-	100	4	-	4
PCC-502-DIS	Programme Core Course	Advanced Multirate Signal Processing	4	-	50	50	-	-	-	100	4	-	4
PCC-503-DIS	Programme Core Course	Image Processing and Computer Vision	4	-	50	50	-	-	-	100	4	-	4
PCC-504-DIS	Programme Core Course	VLSI Chip Design & Fabrication	4	-	50	50	-	-	-	100	4	-	4
PCC-505-DIS	Programme Core Course	Digital Systems Lab Practice - I	-	4	-	-	25	-	25	50	-	2	2
PEC-521-DIS	Programme Elective Course	Elective I	3	-	50	50	-	-		100	3	-	3
PEC-522-DIS	Programme Elective Course	Skill Based Laboratory – I	-	2	-	-	25	-	25	50	-	1	1
Total			**19**	**6**	**250**	**250**	**50**	**-**	**50**	**600**	**19**	**3**	**22**

Elective I – Courses	
PEC-521A-DIS	Block chain
PEC-521B-DIS	Reconfigurable Computing
PEC-521C-DIS	Artificial Neural Network and Application
PEC-521D-DIS	Semiconductor Device Modeling

Savitribai Phule Pune University

Curriculum Structure Semester II

Master of Engineering (2025 Pattern)

Electronics Engineering – (Digital Systems)

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	End Sem	Term work	Practical	Oral	Total	Theory	Practical	Total
PCC-551-DIS	Programme Core Course	Advanced DSP Processors	4	-	50	50	-	-	-	100	4	-	4
PCC-552-DIS	Programme Core Course	Embedded Technology & IOT	4	-	50	50	-	-	-	100	4	-	4
PCC-553-DIS	Programme Core Course	PLD's and ASIC Design	4	-	50	50	-	-	-	100	4	-	4
PCC-554-DIS	Programme Core Course	Digital Systems Lab Practice – II	-	4	-	-	25	-	25	50		2	2
PEC-571-DIS	Programme Elective Course	Elective –II	3	-	50	50	-	-	-	100	3	-	3
PEC-572-DIS	Programme Elective Course	Elective –III	3	-	50	50	-	-	-	100	3		3
SEM-581-DIS	Seminar	Seminar 1	-	4	-	-	25	-	25	50	_	2	2
Total			**18**	**8**	**250**	**250**	**50**	**-**	**50**	**600**	**18**	**4**	**22**

Elective II – Courses		Elective III – Courses	
PEC-571A-DIS	Machine Learning	PEC-572A-DIS	Cloud Architecture Protocols
PEC-571B-DIS	Wireless Sensor Network for IOT	PEC-572B-DIS	Robotics and Automation
PEC-571C-DIS	Wireless Mobile Technologies	PEC-572C-DIS	Deep Learning and Applications
PEC-571D-DIS	RF Communication	PEC-572D-DIS	Cyber Security

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Curriculum Structure Semester III

Master of Engineering (2025 Pattern)

Electronics Engineering – (Digital Systems)

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	End Sem	Term Work	Practical	Oral/ Presentation	Total	Theory	Practical	Total
RM-601-DIS	Research Methodology	Research Methodology	5	-	50	50	-	-	-	100	5	-	5
OJT-602-DIS	On Job Training/ Internship	On Job Training/ Internship	-	10	-	-	100	-	-	100	-	5	5
SEM-603-DIS	Seminar	Seminar II	-	6	-	-	25	-	25	50	-	3	3
RPR-604-DIS	Research Project	Research Project Stage –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

Master of Engineering (2025 Pattern)

Electronics Engineering – (Digital Systems)

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

Savitribai Phule Pune University, Pune

Maharashtra, India

M.E (2025 Course) – Electronics Engineering (Digital Systems)

Semester I

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PCC-501-DIS - Analog and Digital CMOS Design		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE:** 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Electronic Devices and Circuits, VLSI Design

Course Objectives: The course aims to:

- Provide detailed understanding of MOSFET Models and layout.
- Understand the performance parameters of digital CMOS Design.
- Analyze digital circuit design.
- Understand techniques of CMOS Amplifiers.
- Provide brief knowledge of analog CMOS sub circuits

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

CO1: Describe and analyze CMOS and its characteristics.

CO2: Analyze CMOS Performance Parameters

CO3: Understand CMOS Combinational Circuits

CO4: Evaluate CMOS single stage amplifier

CO5: Understand CMOS Op Amp

Course Contents

Unit I	**MOS Basics and Layout** (9 Hours)
	MOS Structure and I/V Characteristic, MOS Capacitance models, MOS Small-Signal Model, MOS SPICE models, Non ideal I-V Effects, MOSFET equivalent circuits and analysis, Parasitic, CMOS layout techniques, CMOS Fabrication and Layout: Inverter Cross-section, Fabrication Process, Stick Diagrams
Unit II	**MOS Performance parameters** (9 Hours)
	Static, dynamic and short circuit power dissipations; Propagation delay; Power delay product; Fan in, fan out, Delay Estimation: RC Delay Models, Linear Delay Model, Logical efforts of paths
Unit III	**Logic design** (9 Hours)
	CMOS Logic: Inverter, NAND gate, Combinational Logic, NOR gate, Compound gates, Pass Transistors and Transmission Gates, Tristaes, Multiplexers, Latches and Flip-Flops, Design calculations for combinational logic and active area on chip, Introduction to logic families: Static CMOS, Ratioed circuits, Cascode voltage switch logic, Dynamic circuits, Pass transistor circuits
Unit IV	**Single Stage Amplifiers** (9 Hours)
	Basic Concept, Common Source Stage: Common-Source Stage with Resistive Load, CS Stage with Diode-Connected Load, CS Stage with Current-Source Load, CS Stage with Active Load, CS Stage with Triode Load, CS Stage with Source Degeneration , Source follower, Common gate stage, Cascade stage : Folded Cascode.
Unit V	**Analog CMOS Sub circuits** (9 Hours)
	CMOS Inverter as an Amplifier, MOS Switch, MOS Diode, Current Sinks and Sources,

	Current mirrors. CMOS Op Amp: Differential Amplifiers, Operational amplifier: General considerations, Two stage Op Amps

Learning Resources

Text Books:

1. Neil Weste and Kamaran, "Principles of CMOS VLSI Design", Education Asia.
2. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill

Reference Books:

1. J. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson (Low Price Edition)
2. S-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, Third Edition, McGraw-Hill
3. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, Second Edition, Oxford University Press
4. P. Gray, P. J. Hurst, S. H. Lewis and R. Meyer, Analysis and Design of Analog Integrated Circuits, Fourth Edition, Wiley, 2001. (Low Price Edition)

e-Resources:

1. http://cmosedu.com/cmos1/book.html
2. https://nptel.ac.in/courses/108/107/108107129/

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PCC-502-DIS - Advanced Multirate Signal Processing		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE:** 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Digital Signal Processing

Course Objectives: The course aims to:

- Understand the principles of multirate digital signal processing.
- Evaluate adaptive filter.
- Analyze design for subband coding and compression.
- Explore real-world and tools for multirate systems
- Apply applications of multirate signal processing.

Course Outcomes: Upon successful completion of this course, students will be able to:
CO1: Analyze the effects of up sampling, down sampling, and aliasing in multirate systems.
CO2. Use concept of multirate processing for design of QMFs and sub band coding for solving real time problems in the field of signal processing.
CO3. Evaluate adaptive filter for equalizer or echo canceller.
CO4. Implement discrete wavelet transforms
CO5: Design of multirate systems using software tools

Course Contents

Unit I	**Fundamentals of Multirate Systems** (9 Hours)
	Need for multirate DSP, Decimation and interpolation, Sampling rate conversion by (I/D), spectral diagrams, design of filters, efficient implementation of decimator and interpolator, Poly phase interpolator, time variant filter structures, multistage filter design
Unit II	**Paraunitary Perfect Reconstruction (PR) Filter Banks** (9 Hours)
	Paraunitary Perfect Reconstruction Filter Banks, Paraunitary Property, Perfect reconstruction and alias cancelation conditions, design of QMFs, sub band coding of speech. Cosine Modulated Filter Banks: Introduction, Pseudo QMF bank, Design of pseudo QMFbank, Efficient polyphase structures, Cosine modulated perfect reconstruction systems
Unit III	**Adaptive filtering** (9 Hours)
	Adaptive FIR filtering, Newton steepest descent algorithm, Least Mean Square algorithm, applications of adaptive filters such as adaptive noise cancellation, adaptive echo cancellers, Adaptive IIR filters, Pade approximation technique and least squares techniques, Prony‟s method and Shank‟s method.
Unit IV	**The Wavelet Transform and its Relation to Multirate Filter Bank** (9 Hours)
	DCT, Short-time Fourier transform, Multi-resolution analysis, Haar wavelet, Wavelet basis, Mother wavelet, Standard wavelets, Non-decimated frames and wavelet transform, Multidimensional wavelet transform, Adaptive wavelet transform, Applications of wavelet transform and DCT for speech and image processing like coding, compression, filtering etc., wavelet filter bank.

Unit V	**Applications of Advanced Multirate Signal Processing** (9 Hours)
	Applications of multirate Signal Processing: Audio signal processing; Image signal processing; Video signal processing; Base-band signal processing; Multirate systems in a CD player; Delta Sigma A/D conversion; digital system interfacing, trans multiplexing.

Learning Resources

Text Books:

1. J G Proakis, D G Manolokis, "Digital Signal Processing Principles, Algorithms, Applications", PHI.
2. K.P.Soman, K.I.Ramchandran, N.G. Resmi, "Insight into Wavelets from theory to practice", Third edition PHI
3. Openheim AV & Schafer RW, Discrete Time Signal Processing PHI.

Reference Books:

1. P.P. Vaidyanathan, "Multirate System and Filter Banks", Pearson.
2. Shaila D Apte, "Advanced Digital Signal Processing", 2nd Edition, Wiley India
3. Emmanuel C Ifeacher, Barrie. W. Jervis, "DSP- A Practical Approach", Pearson Education

e-Resources:

1) 1. https://onlinecourses.nptel.ac.in/noc20_ee21/preview
2) https://onlinecourses.nptel.ac.in/noc23_ee32/preview
3) https://nptel.ac.in/courses/117101123

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PCC-503-DIS - Image Processing and Computer Vision		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Signals and systems

Course Objectives: The course aims to:

1. To impart advanced theoretical knowledge of image formation, perception, and digital image processing techniques and analyze interpret complex image data.
2. To develop proficiency in applying advanced algorithms for image enhancement, restoration, segmentation, and morphological processing
3. To solve real-world engineering and research problems.
4. To enable the design and implementation of computer vision systems using modern tools and libraries (e.g., Open CV, TensorFlow, MATLAB)
5. To analyze applications such as object detection, tracking, and scene understanding.

Course Outcomes (COs): After completion of course students will be able to
CO1: To apply different techniques used for enhancement and segmentation
CO2: Evaluate color images in different color spaces
CO3: Understand different image registration techniques
CO4: Understand basic of stenography
CO5: Implement 3D reconstruction

Course Contents

Unit I	**Basic of image processing** (9 Hours)
	Formation of image model, histogram equalization, application of spatial filters for enhancement and segmentation– average, weighted average, first order and second order, Hough transform, Thresholding. Binary image processing: Erosion, Dilation, Opening and closing, Hit or miss transform Image transforms- DCT, Haar, Hadamard, PCA
Unit II	**Colour Image processing** (9 Hours)
	Color Models, Pseudo-color Image Processing, Basics of Full-Color Image Processing, Color Transformations, Formulation, Color Complements, Color Slicing, Tone and Color Corrections, Histogram Processing, Smoothing and Sharpening, Color Image Smoothing, Color Image Sharpening, Image Segmentation Based on Color, Segmentation in HSI Color Space, Segmentation in RGB Vector Space, Color Edge Detection, Noise in Color Images, Color Image Compression
Unit III	**Image registration** (9 Hours)
	Operational goal of registration, Classification of registration methods - Geometrical transformations, Rigid transformations, Nonrigid transformations, Rectification, Point-based methods, Points in rigid transformations, Points in scaling transformations, Points in perspective projections, Points in curved transformations, Surface-based methods, Disparity functions, Head and hat algorithm, Distance definitions, Distance transform approach, Iterative closest point algorithm, Weighted geometrical feature algorithm, Intensity-based

	methods, Similarity measures
Unit IV	**Stereo correspondence** (9 Hours)
	Epipolar geometry --Rectification, Plane sweep, Sparse correspondence, 3D curves and profiles, Dense correspondence, Similarity measures, Local methods, Sub-pixel estimation and uncertainty, Application: Stereo-based head tracking , Multi-view stereo, Volumetric and 3D surface reconstruction
Unit V	**3D reconstruction** (9 Hours)
	Shape from X, Shape from shading and photometric stereo, Shape from texture, Shape from focus, Active range finding, Range data merging, Application: Digital heritage Surface representations, Surface interpolation, Surface simplification, Geometry images, Point-based representations, Volumetric representations, Model-based reconstruction , Application: Facial animation, Recovering texture maps and albedos , Application: 3D photography

Learning Resources

Text Books:

1. Digital Image processing by Gonzalez
2. Computer Vision: A Modern Approach" by David Forsyth and Jean Ponce

Reference Books:

1. Computer Vision: Algorithms and Applications" by Richard Szeliski, published by Springer
2. Computer and Robot Vision" by Haralick & Shapiro

e-Resources:

Nptel Courses:

1. Computer Vision By Prof. Jayanta Mukhopadhyay | IIT Kharagpur
   Course Link https://onlinecourses.nptel.ac.in/noc19_cs58/preview
2. Computer Vision and Image Processing - Fundamentals and Applications By Prof. M. K. Bhuyan | IIT Guwahati
   Course Link : https://onlinecourses.nptel.ac.in/noc23_ee39/preview

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PCC-504-DIS - VLSI Chip design & 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:

- To understand Verilog and its use to the design various applications.
- To analyze HDL design flow and EDA tools.
- To analyze different aspects of testing and fault models.
- To understand the insights of chip design such as epitaxy and lithography.
- 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** (9 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** (9 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** (9 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** (9 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** (9 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).

Reference Books:

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

Savitribai Phule Pune University

Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)

PCC-505-DIS – Digital Systems Lab Practice - I

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

Course Objectives: The course aims to:

1. Provide hands-on training in the CMOS design domain.
2. To explore real-world and tools for multirate systems
3. Understand the concept of computer vision systems using modern tools and libraries
4. Learn chip design flow.

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

CO1: Design & simulate CMOS design for given application.

CO2: Design & analyze systems for real-time applications.

CO3: Design & implement real-world embedded applications.

CO4: Design chip & simulate using EDA tools for specific applications.

Lab Practical

Guidelines:

1. Digital Systems Laboratory-I Experiments based on programme core courses.
2. Use available software/hardware.

Part A: Analog and Digital CMOS Design (Any 2)

1 To design, prepare layout and simulate CMOS Inverter for the given specifications of load capacitance, propagation delay, power dissipation, foundry etc.
2. To design CMOS logic for F = A + B (C + D) + EFG and prepare layout. Assume suitable capacitive load & foundry. Measure TR, TF & TPD.
3. Design and Implement Differential amplifier by using AIMSPICE. Analyse the circuit using DC Analysis and Transient analysis.
4. To design current mirror for output current of 100μA. Prepare layout and simulate. Comment on output resistance.
5. To design, prepare layout and simulate CMOS differential amplifier for CMRR of 40 dBs

Part B: Advanced Multirate Signal Processing (Any 2)

1. Plot time and frequency domain representations of a test signal (sine wave) by applying downsampling and upsampling by 2 or 3. Also observe aliasing and imaging effects.
2. Record a speech file in your own voice with a sampling frequency of 8 KHzApply filter banks to compress audio signals. Split audio into subbands using a 2-channel filter bank. Retain only low-frequency subbands. Reconstruct and compare quality with respect to SNR.
3. Explore wavelet-based image compression techniques by applying 2D DWT on a grayscale image using Haar/Daubechies wavelets. Threshold detail coefficients to remove noise. Reconstruct the image and evaluate PSNR and compression ratio.

Part C: Image Processing and Computer Vision(Any 2)
1. Design a system for edge detection using Sobel and Prewitt edge operator. 2. Write a generalized program to take the 3*3 mask from the user and convolve the given image with the mask. 3. Write a program to implement any 3 Gray scale transformations on the image. 4. Use any image of size 512*512 and high pass filter it in WT domain. 5. Write as code for finding disparity for stereo images using SSD algorithm
Part D: VLSI Chip design and fabrication (Any 2)
1. Write Verilog code and testbench to simulate, synthesis for the 4-bit counter [Synchronous & Asynchronous counter]. 2. Write Verilog code and testbench to simulate, synthesis for 4/8-bit Magnitude Comparator 3. Write Verilog code and testbench 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 testbench 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.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-521A-DIS - Block Chain (Elective-I)		
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:

- Understand the fundamental concepts, architecture and cryptographic principles underlying blockchain and distributed ledger technologies.
- Explore various consensus mechanisms to achieve secure and reliable agreement in decentralized systems.
- Design and develop smart contracts, decentralized applications (DApps).
- Evaluate the application of blockchain frameworks in enterprise environments, decentralized finance (DeFi).
- 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** (9 Hours)
	Evolution of blockchain: Bitcoin to Web3, Blockchain architecture: Blocks, chains, nodes, P2P network, Permissioned vs. permission less 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)-** (7 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** (8 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** (7 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** (7 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 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.

e-Resources:

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 Engineering (Digital Systems)		
PEC-521B-DIS - Reconfigurable Computing (Elective-I)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE:** 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Digital Logic, Design Computer architecture and Hardware description language

Course Objectives: The course aims to:

- Understand various computing architectures
- Analyse the reconfigurable architecture.
- Evaluate of FPGA design in view of reconfiguration
- Examine various applications for reconfigurable computing

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

CO1: Understand the differentiation between traditional and reconfigurable computing.

CO2: Summarize the reconfigurable device characteristics and performance parameter metrics.

CO3: Interpret early systems for reconfigurable computing

CO4: Illustrate Reconfigurable Design approaches

CO5: Analyze Applications of Reconfigurable Computing

Course Contents

Unit I	Traditional Computing and Reconfigurable Computing (9 Hours)
	Traditional computing paradigms (ASIP, GPP, Domain Specific Processor) and RC. General-Purpose Computing, General-Purpose Computing Issues; Motivation and need for reconfigurable computing and field of application
Unit II	Reconfigurable Device Architectures and Performance Metrics (7 Hours)
	Reconfigurable Device Characteristics, Configurable, Programmable, and Fixed-Function Devices, Interconnect Requirements. Reconfigurable Processing Fabric Architectures: Fine-grained & Coarse- grained structures, Metrics: Density, Diversity, and Capacity
Unit III	Systems for Reconfigurable Computing (8 Hours)
	Early systems of Reconfigurable computing: PAM, VCC, Splash, PRISM, Teramac, Cray, SRC, non-FPGA research, other issues; Reconfiguration Management: Reconfiguration, Configuration architectures, managing reconfiguration process, reducing reconfiguration time, configuration security.
Unit IV	Design Flow with Reconfigurable Design Approach (7 Hours)

	Implementation: Integration, FPGA Design Flow, System On A Programmable Chip; Introduction to SoPC, Adaptive Multiprocessing on Chip. Reconfiguration Project Design Approaches: J-Bit, Modular, Early Access, Vivado.
Unit V	**Application of Reconfigurable Computing** (7 Hours)
	Reconfigurable devices for Rapid prototyping, non-frequently reconfigurable systems, frequently reconfigurable systems; Compile-time reconfiguration, Run-time reconfiguration; RC Applications: Implementing applications with FPGAs, various applications and use of reconfiguration; Video Streaming, Distributed arithmetic, Adaptive Controller, Adaptive cryptographic systems, Software Defined Radio, High-Performance Computing, Automatic target recognition systems.

Learning Resources

Text Books:

1. Bobda Christophe, "Introduction to Reconfigurable Computing: Architectures, Algorithms, and Applications", Springer.
2. Hauck Scott, Dehon A, "Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation", Elsevier.

Reference Books:

1. Maya Gokhale, Paul Ghaham, "Reconfigurable Computing", Springer Publication
2. Andre Dehon, "Reconfigurable Architectures for General Purpose Computing" PhD thesis.

SWAYAM/ MOOC / eBOOKS

1. Coursera: FPGA computing systems: Partial Dynamic Reconfiguration. Instructor: Marco Domenico Santambrogio
2. Coursera: FPGA computing systems: Partial Dynamic Reconfiguration. Instructor: Marco Domenico Santambrogio

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-521C-DIS - Artificial Neural Network and Application (Elective-I)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE:** 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Mathematics for Neural Networks, Fundamentals of Programming, Basic Machine Learning Concepts, Basic Data Handling Skills, Exposure to Computational Tools.

Course Objectives: The course aims to:

- Provide a comprehensive understanding of artificial neural networks, their mathematical foundations, and computational models.
- Equip learners with the skills to design and develop neural network architectures for classification, prediction, and clustering tasks.
- Introduce supervised, unsupervised, and reinforcement learning methods for training ANNs effectively.
- Explore advanced neural network models such as RBF, SOM, and SVM for solving real-world problems.
- Enable students to apply ANN techniques in diverse application domains like healthcare, finance, speech, image processing, and engineering systems.

Course Outcomes: Upon successful completion of this course, students will be able to:
CO1: Understand fundamentals of neural networks, architectures, learning paradigms, and training processes.
CO2: Design and implement multilayer feed forward networks and apply back propagation for supervised learning
CO3: Analyze and compare RBF, SOM, and SVM models for classification, clustering, and regression tasks.
CO4: Apply suitable ANN algorithms to solve real-world problems in healthcare, finance, speech, and image processing.
CO5: Evaluate and optimize ANN models using performance metrics, optimization techniques, and parameter tuning.

Course Contents

Unit I	**Fundamentals of Artificial Neural Networks** (9 Hours)
	Introduction to Neural Networks, Human Brain vs. Biological Neuron, Models of a Neuron, Directed Graph Representation, Network Architectures, Artificial Intelligence and Neural Networks, Learning Processes in ANN, Simple Neuron Networks for Pattern Classification: Hebb Network, Perceptron & its learning rule, Learning Paradigms: Supervised, Unsupervised, Reinforcement, Training vs Testing phases, Epochs, Convergence, Perceptron Convergence Theorem
Unit II	**Multilayer Neural Networks and Training** - (7 Hours)
	Single-layer and Multilayer Perceptrons, Backpropagation Algorithm, Hessian matrix, Generalization, Cross Validation, Virtues and Limitations of Backpropagation, Performance Optimization: Steepest Descent, Newton's Method,

	Conjugate Gradient, Cover's Theorem on Separability, Interpolation problem, Activation Functions: Sigmoid, tanh and their impact on learning
Unit III	**Radial Basis Functions and Unsupervised Learning** (8 Hours)
	Generalized Radial Basis Function (RBF) Networks,Estimation of Regularization Parameter, Approximation Properties of RBF Networks, Comparison: RBF vs Multilayer Perceptron, Kernel Regression and relation to RBF,Competitive Learning, Self-Organizing Feature Maps, Kohonen's Map,Support Vector Machine basics, Clustering using RBF Networks, Comparison with K-means
Unit IV	**Applications of ANN-1** (7 Hours)
	ANN vs. Traditional Computing Approaches, Key advantages in application domains, Healthcare Applications: Disease Prediction, Medical Image Analysis, EEG/Seizure Detection, Finance & Business: Stock Market Prediction, Customer Behavior Modeling, Churn Prediction
Unit V	**Application of Artificial Neural Network-2** (7 Hours)
	ANN in Speech and Image Processing: Voice Recognition, Speaker Identification, Speech-to-Text, Object Recognition, Image Classification, ANN in Industrial & Engineering Applications: Predictive Maintenance, Process Control, Fault Diagnosis, Robotics & Automation

Learning Resources

Text Books:

1. Simon Haykin, "Neural networks A comprehensive foundation "2nd edition, Pearson publication**.**
2. Mohamad H. Hassoun, "Fundamentals of Artificial Neural Networks", MIT Press

Reference Books:

1.Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Laurene Fausett, Pearson Education.
2. Neuro- Fuzzy and Soft Computing, J.S. Jang, C.T. Sun, E. Mizutani, PHI Learning Private Limited.
3. Soft Computing Using MATLAB, Sivanndam, Deepa, TMH publication.
4. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House.
5. Fuzzy Logic with Engineering Applications, Thomas, Timothy Ross, John Wiley & Sons
6. Machine learning in action, Peter Harrington, Manning Publications
7. Introduction to Fuzzy Logic using MATLAB: Sivanandam, S.N.Deepa, Sumathi

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-521D-DIS - Semiconductor Device Modeling (Elective-I)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE:** 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Electronics circuit, Digital Electronics and VLSI

Course Objectives: The course aims to:

1. To acquire the fundamental knowledge and to expose to the field of semiconductor theory and devices and their applications.
2. To gain adequate understanding of semiconductor device modelling aspects, designing devices for electronic applications
3. To acquire the fundamental knowledge of different semiconductor device modelling aspects
4. To analyze the various characteristics of MOSFET devices
5. To understand the concept of Device Modeling

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

CO 1 Demonstrate the development of semiconductor devices
CO 2 Understand the device physics of the devices used in foundry.
CO 3 Discuss the device level characteristics of BJT transistors
CO 4 Analyze the various characteristics of MOSFET devices
CO 5 Understand the modeling of semiconductor devices

Course Contents

Unit I	**Solid State Devices** (9 Hours)
	Solid State Device Physics, Material Properties, Crystal structure, Energy band model, Equilibrium carrier concentrations, Drift and Diffusion mechanism, Recombination and generation of carriers, continuity equations, minority carrier diffusion equations, diffusion length quasi Fermi level concepts
Unit II	**Multilayer Neural Networks and Training** - (7 Hours)
	Single-layer and Multilayer Perceptrons, Backpropagation Algorithm, Hessian matrix, Generalization, Cross Validation, Virtues and Limitations of Backpropagation, Performance Optimization: Steepest Descent, Newton's Method, Conjugate Gradient, Cover's Theorem on Separability, Interpolation problem, Activation Functions: Sigmoid, tanh and their impact on learning
Unit III	**Radial Basis Functions and Unsupervised Learning** (8 Hours)
	Generalized Radial Basis Function (RBF) Networks,Estimation of Regularization Parameter, Approximation Properties of RBF Networks, Comparison: RBF vs Multilayer Perceptron, Kernel Regression and relation to RBF,Competitive Learning, Self-Organizing Feature Maps, Kohonen's Map,Support Vector Machine basics, Clustering using RBF Networks, Comparison with K-means
Unit IV	**Applications of ANN-1** (7 Hours)
	ANN vs. Traditional Computing Approaches, Key advantages in application domains, Healthcare Applications: Disease Prediction, Medical Image Analysis,

	EEG/Seizure Detection, Finance & Business: Stock Market Prediction, Customer Behavior Modeling, Churn Prediction
Unit V	**Application of Artificial Neural Network-2** (7 Hours)
	ANN in Speech and Image Processing: Voice Recognition, Speaker Identification, Speech-to-Text, Object Recognition, Image Classification, ANN in Industrial & Engineering Applications: Predictive Maintenance, Process Control, Fault Diagnosis, Robotics & Automation

Learning Resources

Text Books:

1. Simon Haykin, "Neural networks A comprehensive foundation "2nd edition, Pearson publication**.**

2. Mohamad H. Hassoun, "Fundamentals of Artificial Neural Networks", MIT Press

Reference Books:

1.Fundamentals of Neural Networks: Architectures, Algorithms And Applications, LaureneFausett, Pearson Education.
2. Neuro- Fuzzy and Soft Computing, J.S. Jang, C.T. Sun, E. Mizutani, PHI Learning Private Limited.
3. Soft Computing Using MATLAB, Sivanndam, Deepa, TMH publication.
4. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House.
5. Fuzzy Logic with Engineering Applications, Thomas, Timothy Ross, John Wiley & Sons
6. Machine learning in action, Peter Harrington, Manning Publications
7. Introduction to Fuzzy Logic using MATLAB: Sivanandam, S.N.Deepa, Sumathi

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Telecommunication Engineering (VLSI & Embedded Systems)		
PEC-522-DIS- 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:

- Skill Based Laboratory is based on the electives chosen by the students.

List of Assignments

Select practical experiments from Part A (any 3) and Mini- Project from Part B

Part A	**Practical experiments of 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	**Practical experiments of Reconfigurable Computing**
1	To design and implement a Multi Context (4) 4-LUT and implement using HDL and download on FPGA.
2	Top level modular and hierarchical designs of Adder and Subtractor such that they can be replaced.
3	An adaptive design of LED shifter (Right & Left shift)
Part A	**Practical experiments of Artificial Neural Network and Application**
1	Study and Implementation of Various Activation Functions
2	Simulation of Multilayer Feedforward Network Using Backpropagation Algorithm.
3	Disease Prediction Using ANN with UCI Dataset.
Part A	**Practical experiments of Semiconductor Device Modeling**
1	Develop a MOSFET model and write a MATLAB code for verifying the I-V Characteristics of this device.
2	Develop a MOS capacitance model and write a MATLAB code for verifying the C-V Characteristics of this junction.
3	Develop a pn junction model and write a MATLAB code for verifying the I-V

	Characteristics of this junction
Part B	**Mini project of Blockchain**
	To design and implement a blockchain-based voting system where votes are securely stored, tamper-proof, and transparently counted using Ethereum smart contracts
Part B	**Mini project of Reconfigurable Computing**
	SoPC based Hw-SW design (Soft/Hard Processor + FPGA HW)
Part B	**Mini project of Artificial Neural Network and Application**
	To design Customer Churn Prediction Using ANN **or** Feature Selection and Model Optimization in Neural Networks.
Part B	**Mini project of Semiconductor Device Modeling**
	Design and simulate MOSFET behavior using circuit simulation software like PSpice, MATLAB/Simulink

Savitribai Phule Pune University, Pune

Maharashtra, India

M.E (2025 Course) – Electronics Engineering (Digital Systems)

Semester II

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PCC-551-DIS - Advanced DSP Processors		
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 (DSP), Linear Algebra & Probability Theory, Calculus, Basic Communication System

Course Objectives: The course aims to:

1. To understand the architectural details and hardware features of advanced digital signal processors.
2. To compare fixed-point and floating-point DSPs and evaluate their performance in real-time systems.
3. To explore embedded DSP processors such as Blackfin and Micro Signal Architecture.
4. To gain hands-on experience in DSP development tools and environment.
5. To apply DSP techniques in real time processing and embedded applications

Course Outcomes (COs): After completion of course students will be able to

CO1: Explain the architecture and core components of advanced DSPs.

CO2: Analyze and compare the TMS320C54XX and TMS320C6713 DSP processors.

CO3: Understand Embedded DSP platforms.

CO4: Develop and debug real-time DSP applications using integrated development environments.

CO5: Select appropriate DSP processors for implementation of real-time applications.

Course Contents

Unit I	**DSP Architectures and Core Concepts (9 Hours)**
	Overview of DSP systems and processors, Memory architectures: Harvard, modified Harvard, Core hardware units: MAC unit, barrel shifter, address generators, Pipelining and circular buffering, DSP peripherals and I/O interfacing, Data formats: fixed-point and floating-point, Concept and Challenges of real-time signal processing.
Unit II	**Architecture of DSPs (9 Hours)**
	DSPs: TMS320C54XX and TMS320C6713: Architecture and functional blocks**,** Instruction sets and programming models**,** Data types, addressing modes**,** Memory mapping and peripheral interface**.** **ADSP-21XX and ADSP-210XX:** Architecture, Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation Real-time signal processing applications: speech, audio, radar**,** Comparison of fixed vs floating-point DSPs.
Unit III	**Embedded DSP Platforms (9 Hours)**
	Embbeded processor: Embedded processors for signal processing, Micro Signal Architecture (MSA), Features and Real time embedded signal processing, Overview of Blackfin Processor architecture**,** Register files, ALU, and DMA controllers**,** Bus architecture and memory system**,** On-chip peripherals (UART, SPI, I2C, timers,

	GPIO).
Unit IV	**DSP Development Environments and Tools (9 Hours)**
	VisualDSP++ IDE: Introduction and setup**,** Software development flow: writing, compiling, linking, debugging**.** **DSP development tools:** C compiler, Assembler, Linker, Simulator and emulator, Code Composer Studio (CCS): Project creation, building, memory views, breakpoints, graphics visualization
Unit V	**Real Time Processing and Applications (9 Hours)**
	Processor selection criteria for real-time applications, Sampling, Quantization, A/D, D/A interfacing. **DSP applications** in: Audio filtering, Image processing, Introduction to real-time DSP on embedded systems.

Learning Resources:
Text Books:

1. "Digital Signal Processors: Architecture, Programming and Applications", B. Venkataramani & M. Bhaskar, McGraw Hill, 2nd Edition.
2. "Digital Signal Processor", SenM.Kuo, Woon-SengS.Gan, Pearson Publication.
3. "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Rulph Chassaing, , Wiley Publication, 2005.

Reference Books:

1. "Embedded Signal Processing with the Micro Signal Architecture", Woon-Seng Gan & Sen M. Kuo, Wiley-IEEE Press, 2007.
2. "Digital Signal Processing: A Computer-Based Approach", S. K. Mitra, McGraw-Hill, 4th Edition.

MOOC / NPTEL/YouTube Links:
https://onlinecourses.nptel.ac.in/noc22_ee99/preview
https://archive.nptel.ac.in/courses/108/108/108108185/

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PCC-552-DIS - 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 give insight to various platforms needed for Embedded Technologies and IoT.
- To expose students to the usage of protocol standardization in Embedded Technologies and It's selection to various applications.
- To Understand the fundamental of sensors and actuators along with the basic concepts of an IoT and how to design IoT based applications.

Course Outcomes: On completion of the course, the learner 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 its analyze concepts.

CO4: Develop design skills in industrial IoT.

CO5: Provide suitable solution for specific application and illustrate the technologies of IoT using suitable case studies.

Course Contents

Unit I	**ARM, Raspberry Pi Microcontroller (9 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 (9 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 (9 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 (9 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 (9 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.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics (Digital Systems)		
PCC- 553-DIS– PLD's & ASIC Design		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE:** 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Introduction to Digital systems, Logic gates, VHDL programming

Course Objectives: The course aims to:

1) To understand the programmable logic & systems.
2) To explore the architecture of FPGA & CPLD.
3) To overview the advance FPGAs & CPLD & understand their basic features.
4) To interface real world with FPGAs using VHDL
5) To learn basics of ASICs

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

CO1: To understand the features and applications of programmable logic.
CO2: To analyze FPGAs & CPLDs
CO3: To compare & analyze the FPGAs & CPLDs for applications.
CO4: To design & implement the FPGA based system.
CO5: To understand the features and applications of ASICs

Course Contents

Unit I	**Introduction to Programmable Logics (9 Hours)**
	History of Digital Logic, Programmable Logic versus Discrete Logic, Programmable Logic versus Processors, Types of Programmable Logic, PLD Configuration Technologies, Programmable Logic Design Methods and Tools, Technology Trends
Unit II	**FPGAs & CPLDs Architecture (9 Hours)**
	Introduction to FPGAs & CPLDs, CPLD architecture, Function Blocks, I/O Blocks, Clock Drivers, Interconnect, FPGA Architectures, Configurable Logic Blocks, Configurable I/O Blocks, Programmable Interconnect, Clock Circuitry, Simulation Software, Testbench Generators, Automatic Test Pattern Generation (ATPG), Built-In Self-Test (BIST) Generators
Unit III	**Advanced FPGAs/CPLDs Designs (9 Hours)**
	High Throughput, Low latency, Timing, Rolling Up the Pipeline, Control-Based Logic Reuse, Resource Sharing, Impact of Reset on Area, Clock Control, Input Control, Reducing the Voltage Supply, Overview and comparison of Spartan 7, Artix – 7, Kintex – 7 FPGAs, Features of 7-series FPGAs, Overview of Cool Runner-II CPLD family & their comparison
Unit IV	**VHDL with real world interfacing (9 Hours)**
	Filp – Flops & their conversion, Data shift registers, multifrequency generator, seven – segment interfacing using VHDL, counter design & interfacing digital clock design and interfacing, PWM signal generation, Optical display interfacing, Buzzer control, LCD interfacing and programming, General purpose switch interfacing, infrared and proximity sensor interfacing using VHDL
Unit V	**ASICs (9 Hours)**

	Types of ASICs, Custom IC Design Flow, ASIC Cell Libraries, ASIC Library Design, Programming Technologies, RTL to GDS-II flow, Introduction to ASIC design EDA Tools: Cadence, Mentor and Synopsis. Design and development of serial/ parallel converter, Introduction to IP cores.

Learning Resources

Text Books

1) Ian Grout, Digital Systems Design with FPGAs and CPLDs, Elsevier
2) Douglas L. Perry, VHDL Programming by Examples, McGraw Hill
3) Michael John Sebastian Smith, Application-Specific Integrated Circuits, Addison Wesley

Reference Books

1) Jon F Wakerly, Digital Design: Principles and Practices, Prentice Hall.
2) Web resource for FPGA & CPLD Data sheets

SWAYAM/ MOOC / eBOOKS

1) https://archive.nptel.ac.in/courses/117/108/117108040/

Savitribai Phule Pune University

Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)

PCC-554-DIS – Digital Systems Lab Practice - II

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

Course Objectives: The course aims to:

- Understand advanced DSP processors & its usefulness in various applications.
- Know sensors, actuators & standardization in IoT design.
- Explore PLD and ASIC Design.

Course Outcomes: Upon successful completion of this course, students will be able to:
CO1: Explore the architecture and core components of advanced DSPs..
CO2: Design & implement IoT system for specific applications.
CO3: Design and implement VHDL code for sensor interface with FPGA/CPLD

Lab Practical

Guidelines:

1. Digital Systems Laboratory-II Experiments based on programme core courses.
2. Use available software/hardware.

Part A: Advanced DSP Processors (Any 2)

1. Write a program in C for Finite impulse response LPF or HPF or BPF filter and 25 implement on TMS 320CXXX processor.
2. Write a program in C for infinite impulse response LPF or HPF or BPF filter and implement on TMS 320CXXX processor.
3. Write a program in C for Adaptive filter and implement on TMS 320CXXX processor.
4. To implement coder-decoder using MATLAB Simulink.

Part B: Embedded Technologies and IoT (Any 2)

1. IoT based stepper motor/ DC motor control using Raspberry-Pi
2. To interface sensors and actuators with Arduino/Raspberry-pi
3. To use MQTT/ CoAP protocol and send sensor data to cloud using Raspberry-Pi/ ESP8266.
4. To prepare IoT based small project implementation on the topics based on small problem statements of the fields like smart home (Home Automation) etc. This project can be built on any IoT simulation platform like Tinkercad, Cooja etc.

Part C: PLD's & ASIC Design (Any 2)

1) To study FPGA/CPLD development board and implement D flip-flop using VHDL
2) To write & implement a VHDL code to interface LCD with FPGA/CPLD and display text on LCD.
3) To write & implement a VHDL code to interface servo motor/ DC motor with FPGA/CPLD
4) To write & implement VHDL code for sensor interface with FPGA/CPLD

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-571 A- DIS Machine Learning (Elective II)		
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:

- Introduce fundamental Machine Learning concepts and their applications in real-world problems.
- Implement regression and classification models to solve engineering problems
- Apply clustering and dimensionality reduction techniques to unlabeled data.
- Optimize datasets through preprocessing and feature selection for Machine Learning pipelines.
- 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 (7 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 (7 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 (7 Hours)**
	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), Apriori
Unit IV	**Feature Engineering (7 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 (7 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, Hyper parameter 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

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 Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-571 B- DIS Wireless Sensor Networks for IOT (Elective II)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Networking Principles, Communication Protocols and Embedded Systems

Course Objectives: The course aims to:

- Understand basic WSN Technology and its supporting Protocols.
- Learn routing protocols and their design issues in WSN.
- Understand sensor- management, sensor- network middle ware and operating systems.
- Understand WSN layers' issues and their protocols.
- Analyze Wireless Sensor Network for IOT applications

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

CO1: Gain knowledge of Architecture of WSN network.

CO2: Understand Physical, Data link and Network layer aspects with their protocols.

CO3: Learn different techniques of power management and security.

CO4: Exhibit knowledge of operating systems in WSN systems.

CO5: Design Wireless Sensor Network for IOT based Applications.

Course Contents

Unit I	**Overview of Wireless Sensor Networks - (8 Hours)**
	Sensor Networks, Classification of Wireless sensor network ARCHITECTURES : Single-Node Architecture - Hardware Components, Energy Consumption of Sensor, Nodes, Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts
Unit II	**Wireless Sensor Network Protocol Stack - (8 Hours)**
	WSN Protocol stack, overview of different layers of protocol stack, Physical Layer-Basic Components, Source Encoding, Channel Encoding, Modulation, Signal Propagation. Medium Access Control –types, protocols, standards and characteristics, challenges Network Layer -Routing Metrics, different routing techniques, QoS and Energy Management: Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.
Unit III	**INTRODUCTION TO THE INTERNET OF THINGS - (8 Hours)**
	Introduction to IoT and its importance, Elements of an IoT ecosystem, Technology drivers, Business drivers, M2M vs IOT, IPv6 vs. IPv4 , 6LoWPAN IP for Smart

	Objects: motivation and main challenges, Definition of Low Power and Lossy Networks (LLN); survey of current link-layer technologies for the IoT, Big Data and IOT Analytics
Unit IV	**IOT ARCHITECTURE AND PROTOCOLS - (8 Hours)**
	IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views IOT Protocols: Identification: EPC, UCODE,IPV6,URI; Data Protocols : HTTP, MQTT,REST, COAP,AMQP, Web-socket, SOAP IoT Ethics, Privacy, Security, Security Protocols : Open Trust Protocol (OTrP), X.509
Unit V	**Applications of WSN for IOT - (8 Hours)**
	Real-World Design Constraints, Real Time Applications of IOT, Home Automation, Health care, Infrastructure, IoT in Energy and Environment, Building Automation.

Learning Resource

Text Books

1. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless SensorNetworks" , John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An InformationProcessing Approach", Elsevier, 2007.
3. KazemSohraby, Daniel Minoli, &TaiebZnati, “Wireless Sensor Networks-Technology, Protocols, And Applications”, John Wiley, 2007.
4. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

Reference Books

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-571 C- DIS Wireless and Mobile Communications (Elective II)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Analog and Digital Communication Engineering

Course Objectives: The course is taught with the objectives of enabling the student to:

- Understand concept of fading in wireless communication.
- Learn different multiple access techniques used in communication systems.
- Apply the Transmission Control Protocol (TCP).
- Analyze the Medium Access Control (MAC) protocol
- Understand the Domain Name System (DNS).

Course Outcomes: On completion of this course, the student will be able to:

CO-1 Understand wireless communication system.
CO -2 understand the different multiple access techniques.
CO-3 Analyze the working of the TCP protocol
CO-4 Understand the functioning of the MAC protocol.
CO-5 Apply DNS in networking.

Course Contents

Unit I	**Introduction Wireless and Mobile Communication (7 Hours)**
	Wireless Concept: Examples of Wireless Communication Systems, Overview of 1G,2G, 2.5G, 3G, 4G and 5G Cellular networks. Wireless Transmission, multipath propagation, two-day model, path loss, different path loss models, Doppler shift, frequency selective fading, flat fading, fast fading and slow fading, Rayleigh fading, diversity-space, time and frequency, etc. **The Cellular Concept**: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Improving Coverage and Capacity in cellular systems. cellular model, selection of energy threshold for hand offs, etc
Unit II	**Multiple Access Techniques (7 Hours)**
	Medium access control, hidden and exposed terminals, near and far terminals, fixed TDMA, Aloha, Slotted Aloha, CSMA, demand assigned multiple access, PRMA Packet Reservation Multiple Access, Reservation TDMA, Multiple access with collision avoidance, polling, inhibit sense multiple access, CDMA, Spread aloha multiple access
Unit III	**TCP Protocol (7 Hours)**
	Mobile Network Layer, Mobile IP – IP packet delivery, Agent advertisement and discovery, Registration, tunneling and encapsulation, optimizations, dynamic host configuration protocol, Ad- hoc networks – destination sequence distance vector,

	dynamic source routing, Hierarchical algorithms, etc. Mobile Transport Layer – traditional TCP, indirect TCP, snooping TCP, Mobile TCP, Fast transmit / fast recovery, selective retransmission, transmission oriented TCP
Unit IV	**MAC Protocol (7 Hours)**
	GSM Architecture, protocols, localization and calling, handover, security, IEEE 802.11 system, architecture, protocol, physical layer, MAC layer, MAC management, HIPERLAN protocol architecture, physical layer, channel access control and sub layer, MAC sub layer, Introduction to evolving standards
Unit V	**Domain Name System (DNS) (7 Hours)**
	Domain Name System (DNS): Name Space, Domain Name Space, Distribution of Name Space, and DNS in the internet. Remote Login TELNET: Concept, Network Virtual Terminal (NVT). File Transfer FTP and TFTP: File Transfer Protocol (FTP). Electronic Mail: SMTP and POP. Network Management-SNMP: Concept, Management Components, World Wide Web- HTTP Architecture

Learning Resources:

Text Books:

1.Schillar, "Mobile Communications" – Pearson Education
2. Kaveh pah Laven and P.Krishna Murthy, Principles of Wireless networks, 2002,PE.
3. Ashok Raj, Wireless Communication, First Edition, 2014, Khanna Publishers

Reference Books:

1. Lee, "Mobile Cellular Communication" McGraw Hill
2. Theodore, S.Rappaport , Wireless Communications, Principles and Practice, 2nd Ed.,2002,PHI.
3. Andrea Goldsmith, Wireless Communications, 2005, Cambridge University Press
4. P.Nicopolitidis, M.S.Obaidat, G.I.Papadimitriou, A.S.Pomportsis, Wireless Networks, 2003**,**John Wiley & Sons Pte Ltd.
5. The Internet and Its Protocols – Adrin Farrel, Elsevier, 2005.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-571 D-DIS RF Communication (Elective II)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory: 03 Hours/Week	03	**CCE**: 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Introduction to Digital systems, Logic gates

Course Objectives: The course aims to:

1) To understand characteristics of RF communication systems.
2) To explore RF circuits such as filters and amplifiers.
3) To study features and characteristics of RF oscillators and mixers.
4) To study the RF antennas.
5) Analyze the modern design techniques of RF antennas

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

CO1 – To understand and analyze the basic RF communication systems.
CO2 - To analyze and design RF filters and amplifiers.
CO3 – Evaluate the design of RF oscillators and mixers.
CO4 - To understand the characteristics of RF antennas.
CO5 – To analyze design of RF antennas.

Course Contents

Unit I	**Introduction to RF communication (7 Hours)**
	History of RF/microwave engineering, various RF frequency bands, Applications of RF/microwave engineering, Lumped circuit model for a transmission line, Smith chart Quarter-wave transformer, generator and load mismatches, Lossy transmission lines, Strip lines, Microstrip lines, The scattering Matrix, T-junction power divider, Wilkinson power divider
Unit II	**RF Filters and Amplifiers (7 Hours)**
	Types of filters, periodic structure, filter design by insertion loss method, stepped-impedance filter, coupled line filters, RF amplifier design – two-port power gain, stability, single stage amplifier design, balanced amplifier, power amplifiers.
Unit III	**RF Oscillators and Mixers (7 Hours)**
	General analysis, oscillators using BJT, oscillators using FET, practical consideration, crystal oscillators, Mixer characteristics, single ended diode mixer, single ended FET mixer, Balanced mixer, image rejection mixer.
Unit IV	**RF Antennas (7 Hours)**
	Types of antennas, antenna parameters such as return loss, VSWR, bandwidth, radiation pattern, gain and directivity, Microstrip antenna structure, characteristics, Advantages, disadvantages, feeding techniques, substrate materials, wearable antennas for body area network, fabric materials, specific absorption rate (SAR).

Unit V	**RF Antenna Design (7 Hours)**
	Design and analysis of rectangular shape, circular shape and triangular shape microstrip antennas, bandwidth enhancement techniques such as gap coupling, electromagnetic coupling, compact microstrip antenna.

Learning Resources

Text Books

1.David M. Pozer, Microwave Engineering, John Wiley & Sons, Inc
2.Protap Pramanick and Prakash Bhartia, Modern RF and Microwave Filter Design, Artech House.

Reference Books:

1.Girish Kumar and K. P. Ray, Broadband Microstrip Antennas, Artech House
2) Debatosh Guha and Yahia M.M. Antar, Microstrip and Printed Antennas New Trends Techniques and Applications, Artech House

SWAYAM/ MOOCS

1) https://archive.nptel.ac.in/courses/108/103/108103141/

2) https://archive.nptel.ac.in/courses/117/105/117105138/

3) https://archive.nptel.ac.in/courses/108/101/108101092/

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-572 A- DIS Cloud Architecture Protocols (Elective III)		
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:

- Define core cloud architecture principles using standardized models (NIST, SPI).
- Analyse network protocol mechanics, including encapsulation systems and data center topologies.
- Evaluate security frameworks using cryptographic protocols and identity management algebras.

Course Outcomes: Upon successful completion of this course, students will be able to:
CO-1 Classify cloud service/deployment models using NIST taxonomies and deconstruct virtualization architectures.
CO-2 Analyze encapsulation protocols and data center fabrics using routing algebras and congestion control formalisms.
CO-3 Analyze the components of a virtualised data centre and review the performance of Data archiving solutions.
CO-4 Implement /identity cryptographic protocols via state-machine models and Zero Trust policy algebras.
CO-5 Quantify system resilience using queueing theory, failure distributions and resource optimization heuristics.

Course Contents

Unit I	**Cloud Ontology & Architectural Frameworks (7 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 (7 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 (7 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 (7 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 (7 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. Azodolmolky, Cloud Networking: Understanding Cloud-Based Data Center Networks. Waltham, MA: Morgan Kaufmann, 2014.

SWAYAM/ MOOC / eBOOK

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 Engineering (Digital Systems)		
PEC-572B - DIS - Robotics and Automation		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE**: 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Microcontrollers, Control Systems, Embedded Systems

Course Objectives: The course aims to:

- Understand the concepts of robotics
- Analyze robot kinematics, dynamics, transformations, drives, and grippers.
- Explore sensors and actuators and integrate with robotic systems.
- Explore different industrial domains where robotics plays a crucial role

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

CO1: Understand the fundamental principles of robotics

CO2: Apply concepts of kinematics, dynamics, transformations, and gripper mechanisms to analyze and model robotic systems.

CO3: Demonstrate the working and integration of various sensors and actuators in robotic applications for perception and control.

CO4: Apply the knowledge of robot operating systems and programming to design and implement robotic systems.

CO5: Analyze and evaluate the implementation of robotic applications.

Course Contents

Unit I	**Principles of Robotics (7 Hours)**
	Introduction to Robotics: Definitions, history, and evolution of robots, Types of robots and classification, Robot anatomy: Links, joints, actuators, end-effectors, Basics of Automation, Automation principles and strategies, Introduction to Industrial Automation Systems, Overview of control systems in automation, Automation tools and hardware.
Unit II	**Robot Kinematics and Dynamics (8 Hours)**
	Kinematics: Forward and inverse kinematics, Denavit-Hartenberg (D-H) representation, Degrees of freedom, manipulability, Dynamics: Euler-Lagrange and Newton-Euler formulations, Lagrangian mechanics for manipulators, Manipulator dynamics in Cartesian space, Dynamic control and motion planning, robotic drives and their types. Grippers in Robotics and their types.
Unit III	**Sensors and Actuators in Robotics (7 Hours)**
	Sensor Basics and Classification: Position, velocity, proximity, force, torque, tactile, pressure, temperature sensors, Acoustic, optical, infrared, ultrasonic sensors, Vision and Imaging Sensors: Camera models, stereo vision, depth sensing, Machine vision and 3D sensing, Actuators: Electric, pneumatic, and hydraulic actuators, Servo motors, stepper motors, Actuator selection and integration
Unit IV	**Robot Operating Systems and Programming (7 Hours)**

	The ROS Equation, History, Distributions & difference from other meta-operating systems. ROS framework: Operating system and its various releases, Robotic Programming, On-line and off-line programming, programming examples. Introduction to VAL and RAPID robot languages.
Unit V	**Applications of Robotics (7 Hours)**
	Robotic Applications in Industries, Underwater robots, aerial robots (drones), mobile robots, Humanoid and legged robots, and Autonomous Guided Vehicles (AGVs). Case Studies and Emerging Trends: Robotics in warehouse automation, Human-robot collaboration (cobots), Industry 4.0 and smart manufacturing, Machine vision in inspection systems.

Learning Resources

Text Books:

1. Robert J Schilling, Fundamentals of Robotics, Prentice Hall India, 2003.
2. John J Craig, Introduction to Robotics, Prentice Hall International, 2005.
3. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.
4. Dr. Jisu Elsa Jacob, Manjunath N Robotics Simplified: An Illustrative Guide to Learn Fundamentals of Robotics, Including Kinematics, Motion Control, and Trajectory Planning Paperback - 2022.

Reference Books:

1. Deb S.R., "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2012.
2. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, "Technology Programming and Applications", McGraw Hill, 2012.
3. Online course on, "Robotics and Control: Theory and Practice Indian Institute of Technology Roorkee via Swayam.

SWAYAM/ MOOC / eBOOKS:

1. NPTEL Course on **"Robotics" -** https://nptel.ac.in/courses/112/105/112105249/
2. NPTEL Course on **"Introduction to Robotics" –** https://nptel.ac.in/courses/107/106/107106090/

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-572 C- DIS **Deep Learning and Application (Elective III)**		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE**: 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Artificial Neural Network, Fundamentals of Programming, Basic Machine Learning Concepts, Basic Data Handling Skills, Exposure to Computational Tools

Course Objectives:

- Understand the fundamental concepts, architectures, and mathematical foundations of deep learning.
- Develop and implement neural network models, including CNNs, RNNs, and transformers, using modern frameworks.
- Apply deep learning techniques to solve real-world problems in computer vision, natural language processing, and time-series forecasting.
- Evaluate, optimize, and deploy deep learning models while considering ethical and interpretability aspects.
- Explore advanced topics such as auto encoders, GANs, reinforcement learning, and attention mechanisms for innovative applications.

Course Outcomes: On completion of this course, student will be able to:
CO1: Explain and compare deep learning principles, architectures, and training processes.
CO2: Build and train CNN, RNN, and transformer-based models using Tensor Flow or PyTorch.
CO3: Apply deep learning models to practical applications in vision, NLP, and time-series domains.
CO4: Evaluate and improve model performance using advanced metrics, optimization strategies, and hyper parameter tuning.
CO5: Demonstrate proficiency in advanced deep learning methods (GANs, VAEs, reinforcement learning, attention) and discuss ethical issues such as fairness, bias, and interpretability.

Course Contents

Unit I	**Fundamentals of Deep Learning (7 Hours)**
	Overview of AI, ML, and DL – differences, overlaps, and applications, Biological vs. Artificial neurons, Mathematical foundations: Linear algebra, calculus, probability basics, Tensors and computational graphs Activation functions: Sigmoid, Tanh, ReLU, Leaky ReLU, Softmax, Overview of Deep Learning ecosystem: TensorFlow, PyTorch, hardware accelerators (GPU/TPU)
Unit II	**Neural Network Architectures and Training (7 Hours)**
	Perceptron and Multilayer Perceptrons (MLP),Forward and backward propagation,Loss functions: MSE, cross-entropy,Optimization: Gradient Descent, SGD, Momentum, Adam,Weight initialization, Batch Normalization, Dropout,Learning rate schedules,Model evaluation metrics: Accuracy, precision, recall, F1-score, confusion matrix
Unit III	**Convolutional Neural Networks (CNNs) (7 Hours)**
	CNN concepts: Convolution, pooling, padding, CNN architectures: LeNet, AlexNet, VGG, ResNet, Transfer learning basics, Applications in image classification
Unit IV	**Recurrent Networks and Transformers (7 Hours)**

	RNN basics, vanishing gradient problem, LSTM and GRU networks,Applications in NLP: Sentiment analysis, machine translation,Word embeddings: Word2Vec, GloVe, Transformer basics, BERT, Vision Transformers (ViT)
Unit V	**Advanced Deep Learning and Applications (7 Hours)**
	Autoencoders and Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs) and applications, Attention mechanisms in depth, Deep Reinforcement Learning basics, Model interpretability & Explain ability, Real-world applications: Healthcare, Finance, Autonomous Systems, AI ethics: Bias detection, fairness, responsible AI deployment

Learning Resources

Text Books:

1. Richard S. Sutton and Andrew G. Barto, ―Reinforcement Learning: An Introduction||

2. Seth Weidman, Deep Learning from Scratch: Building with Python from First Principles

O'Reily

3. Francois Duval, Deep Learning for Beginners, Practical Guide with Python and Tensorflow

Reference Books:

1. Fundamentals of Neural Networks: Architectures, Algorithms And Applications, LaureneFausett, Pearson Education.

2. Neuro- Fuzzy and Soft Computing, J.S. Jang, C.T. Sun, E. Mizutani, PHI Learning Private Limited.

3. Soft Computing Using MATLAB, Sivanndam, Deepa, TMH publication.

4. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House .

5. Fuzzy Logic With Engineering Applications, Thomas, Timothy Ross, John Wiley & Sons

6. Machine learning in action, Peter Harrington , Manning Publications

7. Introduction to Fuzzy Logic using MATLAB: Sivanandam, S.N.Deepa, Sumathi.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
PEC-572 D-DIS Cyber Security (Elective III)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory: 03 Hours/Week	03	**CCE**: 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to:

- To introduce foundational concepts of cyber security with emphasis on their application in communication and electronic systems.
- To develop the ability to analyze and secure communication protocols, embedded devices, and IoT platforms.
- To provide in-depth knowledge of cryptographic methods and secure system design for real-time digital networks.
- To expose students to cyber forensics, industry standards, ethical hacking, and compliance practices in critical infrastructure domains.

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

CO-1 Identify and evaluate cyber threats and vulnerabilities in communication, embedded, and IoT-based systems.
CO-2 Apply cryptographic and network security mechanisms in the design of secure communication and wireless systems.
CO-3 Design secure architectures for embedded systems and IoT platforms.
CO-4 Demonstrate awareness of legal, ethical, and forensic practices in handling cyber incidents across networked systems.
CO-5 Understand and apply cybersecurity principles, cryptographic techniques, forensic tools, and emerging technologies to secure modern communication and IoT systems.

Course Contents

Unit I	Fundamentals of Cyber Security in Communication Systems (7 Hours)
	Introduction to Cyber Security: Threats, Vulnerabilities, Attacks (specific to E&TC), Security in OSI & TCP/IP Models, Communication Channel Attacks: Signal jamming, Packet sniffing, Replay attacks, Role of Firewalls, VPNs, and IDS/IPS in telecom networks, Wireless Security Protocols: WEP, WPA2, WPA3, Zigbee, Bluetooth, LoRa WAN
Unit II	**Cryptography for Secure Transmission (7 Hours)**
	Symmetric & Asymmetric Cryptography (AES, RSA, ECC), Public Key Infrastructure (PKI), Digital Certificates, Secure Signal Modulation: CDMA security, spread spectrum, Secure Key Distribution in IoT & Sensor Networks, Digital Signatures, Hashing (SHA, MD5), and Message Integrity
Unit III	**Embedded & IoT System Security (7 Hours)**
	Embedded System Threats: Backdoors, JTAG exploitation, Firmware tampering, IoT Architecture & Protocols (MQTT, CoAP, 6LoWPAN), Secure Boot, TPM, Secure Firmware Updates, Wireless Sensor Networks (WSN) Security. Case Study: Smart Meter / Smart Camera Cybersecurity
Unit IV	**Cyber Forensics, Standards, and Telecom-Specific Regulations (7 Hours)**
	Basics of Cyber Forensics: Disk, Network, Mobile Forensics, Tools: Wireshark,

	Autopsy, Kali Linux, FTK, Telecom Regulatory Authority of India (TRAI) guidelines on data security, Cyber Law (IT Act 2000), GDPR, Privacy in Telecom Applications, Case Studies: SIM cloning, Base Station Spoofing, Satellite communication hacks
Unit V	**AI, ML & Quantum Impacts on Communication Security (7 Hours)**
	AI/ML in Cyber Security: Anomaly and intrusion detection, traffic classification, adversarial ML.Security in 5G & Beyond: 5G vulnerabilities, network slicing, SDN/NFV security, edge computing threats. Quantum-Safe Security: Quantum threats to cryptography, Post-Quantum Cryptography (PQC), Quantum Key Distribution (QKD). Future-Proofing: Zero Trust Architecture, Blockchain in telecom security, Case Study on AI-driven security solutions.

Learning Resources

Text Books:

1. *Cryptography and Network Security by William Stallings – Pearson Educatio*
2. *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives* by Nina Godbole and Sunit Belapure – *Wiley India*
3. *Network Security Essentials: Applications and Standards* by William Stallings Pearson Education
4. *Cryptography and Network Security* by Behrouz A. Forouzan and Debdeep Mukhopadhyay – McGraw Hill Education

Reference Books

1. Introduction to Cyber Security by Chwan-Hwa (John) Wu and J. David Irwin,CRC Press
2. Practical Internet of Things Security by Brian Russell and Drew Van Duren – Packt Publishing
3. Security in Computing by Charles P. Pfleeger and Shari Lawrence Pfleeger – Pearson Education

e LEARNING RESOURCES

1. Practical Cyber Security for Cyber Security Practitioners By Prof. Sandeep K. Shukla |IIT Kanpur
https://onlinecourses.nptel.ac.in/noc24_cs85/preview

2. Network Security By Prof. Gaurav S. Kasbekar | IIT Bombay
https://onlinecourses.nptel.ac.in/noc25_ee54/preview

3.Ethical Hacking By Prof. Indranil Sengupta | IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc22_cs13/preview

Savitribai Phule Pune University Master of Engineering (2025 Course) – E & TC (VLSI & Embedded Systems)		
SEM-581-DIS - Seminar I		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 04 Hours/Week	02	**Term Work** : 25 Marks **Oral** : 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: Upon successful completion of this course, students will be able to:

- Deepen Technical Knowledge: To enable students to explore a specialized topic within Electronics Engineering beyond the regular curriculum, fostering in-depth understanding.
- Develop Research Skills: To provide practical experience in identifying, acquiring, evaluating, and synthesizing information from various technical sources (research papers, standards, technical reports).
- 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.
- Foster Critical Thinking: To encourage students to critically analyze existing research, identify challenges, propose solutions, and engage in constructive discussions.
- Promote Independent Learning: To encourage self-directed learning and the ability to stay updated with emerging technologies and research trends.

Course Outcomes: After successful completion of the course, learner 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

- **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

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

- **Seminar Structure and Deliverable :** The technical seminar typically involves the following stages 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, Springer Link, 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.
  -

- **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.

- **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.

- **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" Meenakshi Raman & Sangeeta Sharma
3. "The Craft of Scientific Presentations" by Michael Alley

NPTEL Courses

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

M.E (2025 Course) – Electronics Engineering (Digital Systems)

Semester III

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
RM-601-DIS Research Methodology		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 05 Hours/Week	05	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses:

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

Course Objectives: The course aims to:

- Understand the philosophy of research in general
- Understand basic concepts of research and its methodologies
- Learn the methodology to conduct the Literature Survey
- Acquaint with the tools, techniques, and processes of doing research
- Learn the effective report writing skills and allied documentations
- 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 constitutes 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 Book

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)

SWAYAM / MOOC / YouTube Links

1. https://www.youtube.com/playlist?list=PLm-ueI9b64QGMcfn5Ckv_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 Engineering (Digital Systems)		
OJT-602-DIS - On Job Training / Internship (OJT / IN)		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 10 Hours/Week	05	Term Work : 100 Marks

Course objectives:

- To put theory into practice. And expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- 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, budget- ing, 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**
  - 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
  - An intern is expected to spend 10 - 12 hours per week on Internship, Training will result in about 160-170 hours of total internship duration.
  - The minimum requirement regarding Internship duration should not be below 8 weeks
- **Type of Internship**
  - Industry/Government Organization Internship: Working directly with a company or government body.
  - Research Internship: Focused on research projects, often in collaboration with academic institutions or R&D labs.
  - Innovation/Entrepreneurship: Working on developing new products, processes, or even starting a venture.
  - Social Internship: Engaging in community-based projects
- **Assessment Details (TW and Practical)**
  - Term work for 100 marks
  - 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**
  - Trade and Agriculture
  - Economy & Banking Financial Services and Insurance
  - Logistics, Automotive & Capital Goods
  - Fast Moving Consumer Goods & Retail
  - Information Technology/Information Technology Enabled Services & Electronics
  - Handcraft, Art, Design & Music
  - Healthcare & Life Science
  - Sports, Wellness and Physical Education
  - Tourism & Hospitality
  - Digitization & Emerging Technologies (Internet of Things / Artificial Intelligence / Machine
  - Learning / Deep Learning / Augmented Reality / Virtual Reality etc.)
  - Humanitarian, Public Policy and Legal Services
  - Communication
  - Education
  - Sustainable Development

- Environment
- 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:**
  - Joining Report: To be submitted within a specified time frame (e.g., one week from joining).
  - Daily/Periodical Diary: Students are often required to maintain a daily or weekly record of their observations, work, and learning.
  - 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.
  - Completion Certificate: Issued by the host organization upon successful completion.

- **Evaluation :**
  - Evaluation is typically done by the institute, often within a short period after the internship ends.
  - It may involve presentations, viva-voce examinations, and assessment of the internship report and daily diary.
  - Performance-based feedback from the industry mentor is usually a key component.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
SEM-603-DIS - Seminar - II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 06 Hours/Week	03	**Term Work: 25 Marks** **Oral: 25 Marks**

Course Description:

- 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.
- 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.
- 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:

- 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.
- To raise student's awareness in advanced methods of research and mastering the skills to apply them.
- Teach students to find and critically analyze sources of information.
- 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.
- Improve the student's academic writing experience.

Course Outcomes: After successful completion of the course, learner 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

Seminars/ Assignments

Course Contents

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 Resource

Text Books

1. Kennett, B. (2014). Planning and managing scientific research. ANU Press. https://www.jstor.org/stabl (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 Engineering (Digital Systems)		
RPR-604-DIS - Research Project Stage - I		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 18 Hours/Week	09	**Term Work :** 25 Marks **Oral/ Presentation :** 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:

- Demonstrate an ability to plan a research project, such as is required in a research proposal prior to the launch of their work
- Demonstrate an ability to comply with ethical, safety, and documentation processes appropriate to their project
- Demonstrate expert knowledge in the subject of their research project, such as through a integrated literature survey
- Demonstrate expert knowledge in the research methods appropriate to generating reliable data for their research questions
- Demonstrate the ability to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
- Demonstrate an ability to relate their original data to existing literature, or to create an novel synthesis of existing materials
- Demonstrate an ability to assemble their findings into a substantial piece of writing that presents a clear thesis and a cohesive, evidence-based argument
- Demonstrate an ability to balance description, analysis, and synthesis within their project report
- 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 software 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

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. Su- pervisions 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 maintaining 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 has occurred in the past these have had devastating effects on the unprepared. 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 dis- cuss 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 - Electronics Engineering (Digital Systems)

Semester IV

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics Engineering (Digital Systems)		
SEM-651-DIS- 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:

- 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.
- To raise student's awareness in advanced methods of research and mastering the skills to apply them.
- Teach students to find and critically analyze sources of information.
- 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.
- Improve the student's academic writing experience.

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

1. CO1: Formulate the goals and objectives of scientific research.
2. CO2: Search, evaluate and analyze information about the achievements of science and technology in the target area and beyond.
3. CO3: Interpret data from different fields of science and technology.
4. CO4: To build the logic of reasoning and statements.
5. CO5: Write a text in a scientific or scientific and technical style, use the appropriate vocabulry.

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

Kennett, B. (2014). Planning and managing scientific research. ANU Press. https://www.jstor.org/stabl (free access)

1. Sirotinina, N. (2012). History and methodology of computer science. Siberian Federal Univer- sity. Tomsk: TPU Publishing House.
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 Engineering (Digital Systems)		
RPR-652-DIS - Research Project Stage-II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 36 Hours/Week	18	**Term Work:**150 Marks **Oral/ Presentation : 5**0 Marks

Prerequisite: Research Project Stage-I

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

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

Course Outcomes: After successful completion of the course, learner 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**

  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 con- sidered for the improvement with existing/known algorithms/systems, comparative anal- ysis, validation of results and conclusions.

- 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.
- The students are expected to validate their study undertaken by publishing it at standard platforms.
- The investigations and findings need to be validated appropriately at standard platforms like conference and/or peer reviewed journal.
- 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.
- Supervisor Interaction: Minimum one meeting per week.
- Logbook: Maintain a record of work progress and supervisor comments.
- Ethics: No plagiarism, false results, or unethical practices allowed.
- Backup: Keep source code, datasets, and reports backed up securely.
- Submission Format: Soft copy (PDF) + Hard copy as per institute norms

- **Key Components:**
  - **Implementation**
    - Complete development/simulation/testing of the system or model.
    - Ensure correctness, efficiency, and validation of results.
  - **Results & Analysis**
    - Include experimental setup, datasets used, performance metrics.
    - Graphs, tables, and comparison with existing techniques.
    - Highlight key findings and their significance.
  - **Conclusion and Future Work**
    - Summarize outcomes, contributions, and applications.
    - Suggest extensions or improvements for future research.
  - **Paper Publication**
    - At least one paper (optional/encouraged) in peer-reviewed conference/journal.
    - Attach publication/proof as appendix (if available).
  - **Final Report Format**
    - Revised version of Stage 1 report with added implementation, results, and conclusion chapters.
    - Maintain academic writing standards and include all necessary references.
  - **Plagiarism Report**

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

– Evaluation Parameters

- Completeness and quality of implementation
- Analysis and originality of results
- Quality of documentation and adherence to format
- Viva-voce performance and clarity of understanding
- Contribution to knowledge or innovation

Task Force for Curriculum Design and Development

Programme Coordinator

Dr. Pratibha Chavan – PG Coordinator Electronics Engineering (Digital Systems)
Trinity College of Engineering and Research Pune

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Dean

Dr. Pramod Patil - Dean – Science and Technology
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