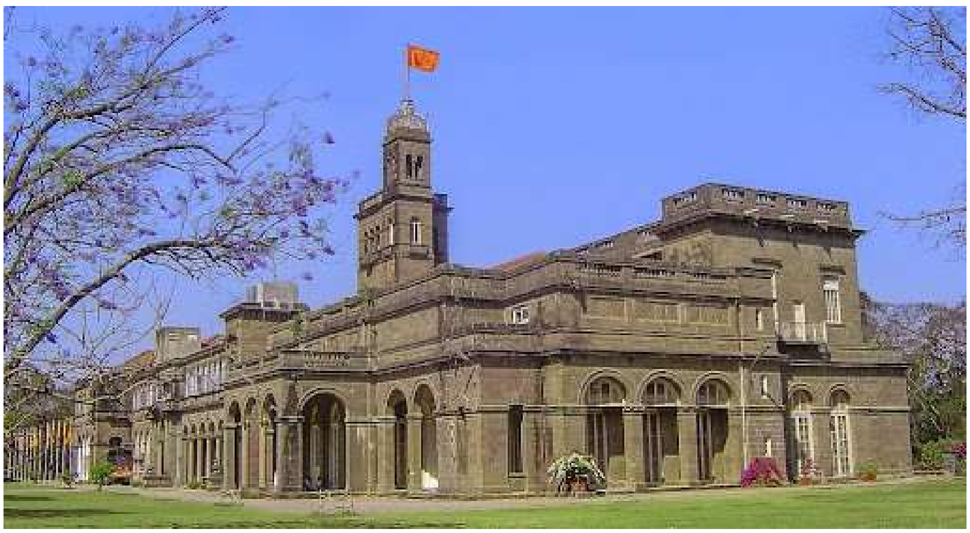
Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology



Curriculum Structure and Syllabus

Master of Engineering (2025 Pattern) in

ME - Electronics & Communication (VLSI & Embedded Systems)

(With effect from Academic Year 2025-26)

Contents

Abbreviations

PEO Programme Educational Objectives

PO Programme Outcomes

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

VLSI (Very-Large-Scale Integration) and Embedded Systems represent a crucial and rapidly advancing domain at the heart of modern electronics and computing. This discipline bridges the gap between hardware design and software integration, enabling the creation of compact, efficient, and intelligent systems that power everything from consumer electronics to industrial automation and automotive technologies.

The curriculum is meticulously designed to provide students with a strong foundation in the principles, methodologies, and tools essential for the design and development of VLSI circuits and embedded applications. It also aims to prepare students to meet the demands of a constantly evolving technological ecosystem through a balance of theoretical knowledge and hands-on experience.

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

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

Members of Board of Studies, Electronics & Telecommunication Engineering, Savitribai Phule Pune University, Pune	
Dr. Aaditya Abhyankar	Department of Technology, SPPU, Pune
Dr. Prachi Mukherji	MKSSS Cummins College of Engineering, Pune
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Dr. Urmila Patil	Dr. D. Y. Patil Institute of Technology, Pimpri, Pune

Savitribai Phule Pune University

Curriculum Structure Semester I

M.E (Electronics & Communication – VLSI & Embedded Systems)

2025 Pattern

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	End Sem	Term work	Oral	Total	Theory	Practical	Total
PCC-501-VLC	Program Core Course	Digital VLSI Design	4	-	50	50	-	-	100	4	-	4
PCC-502-VLC	Program Core Course	Reconfigurable Computing	4	-	50	50	-	-	100	4	-	4
PCC-503- VLC	Program Core Course	Embedded System Design	4	-	50	50	-	-	100	4	-	4
PCC-504- VLC	Program Core Course	VLSI Chip Design and Fabrication	4	-	50	50	-	-	100	4	-	4
PCC-505- VLC	Program Core Course - Lab	VLSI Embedded Laboratory-I	-	4	-	-	25	25	50	-	2	2
PEC-521- VLC	Program Elective Course	Elective I	3	-	50	50	-	-	100	3	-	3
PEC-522- VLC	Program Elective Course	Skill Based Laboratory - I	-	2	-	-	25	25	50	-	1	1
Total			**19**	**6**	**250**	**250**	**50**	**50**	**600**	**19**	**3**	**22**
Examinations & Syllabus of above subjects are common with M.E -Electronics & Telecommunication -VLSI & Embedded Systems												

List of Elective I Courses:

PEC-521A-VLC	Embedded Signal Processing Architectures
PEC-521B-VLC	Blockchain
PEC-521C-VLC	CMOS Device Modelling
PEC-521D-VLC	Nanotechnology

Savitribai Phule Pune University

Curriculum Structure Semester II

M.E (Electronics & Communication – VLSI & Embedded Systems)

2025 Pattern

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	End Sem	Term work	Oral	Total	Theory	Practical	Total
PCC-551-VLC	Program Core Course	Analog VLSI Design	4	-	50	50	-	-	100	4	-	4
PCC-552-VLC	Program Core Course	Embedded Technologies and IOT	4	-	50	50	-	-	100	4	-	4
PCC-553-VLC	Program Core Course	Automotive Embedded Systems	4	-	50	50	-	-	100	4	-	4
PCC-554-VLC	Program Core Course - Lab	VLSI Embedded Laboratory-II	-	4	-	-	25	25	50	-	2	2
PEC-571-VLC	Program Elective Course	Elective – II	3	-	50	50	-	-	100	3	-	3
PEC-572-VLC	Program Elective Course	Elective – III	3	-	50	50	-	-	100	3	-	3
SEM-581-VLC	Seminar	Seminar - I	-	4	-	-	25	25	50	-	2	2
Total			**18**	**8**	**250**	**250**	**50**	**50**	**600**	**18**	**4**	**22**
Examinations & Syllabus of above subjects are common with M.E -Electronics & Telecommunication -VLSI & Embedded Systems												

List of Elective II Courses: **List of Elective III Courses:**

PEC-571A-VLC	Real Time Operating System	PEC-572A-VLC	Testing and Verification of VLSI Circuits
PEC-571B-VLC	Mixed Signal IC Design	PEC-572B-VLC	ASIC Design
PEC-571C-VLC	Machine Learning	PEC-572C-VLC	Cloud Architecture Protocols
PEC-571D-VLC	Robotics and Automation	PEC-572D-VLC	Wireless Sensor Network

Savitribai Phule Pune University

Curriculum Structure Semester III

M.E (Electronics & Communication – VLSI & Embedded Systems)

2025 Pattern

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	End Sem	Termwork	Oral	Total	Theory	Practical	Total
RM-601-VLC	Research Methodology	Research Methodology	5	-	50	50	-	-	100	5	-	5
OJT-602-VLC	OJT / Internship	On Job Training / Internship	-	10	-	-	100	-	100	-	5	5
SEM-603-VLC	Seminar	Seminar - II	-	6	-	-	25	25	50	-	3	3
RPR-604-VLC	Research Project	Research Project - I	-	18	-	-	25	25	50	-	9	9
Total			**5**	**34**	**50**	**50**	**150**	**50**	**300**	**5**	**17**	**22**
Examinations & Syllabus of above subjects are common with M.E -Electronics & Telecommunication -VLSI & Embedded Systems												

Savitribai Phule Pune University

Curriculum Structure Semester IV

M.E (Electronics & Communication – VLSI & Embedded Systems)

2025 Pattern

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	End Sem	Termwork	Oral	Total	Theory	Oral	Total
SEM-651-VLE	Seminar	Seminar - III	-	8	-	-	50	50	100	-	4	4
RPR-652-VLE	Research Project	Research Project-II	-	36	-	-	150	50	200	-	18	18
Total			**-**	**44**	**-**	**-**	**200**	**100**	**300**	**-**	**22**	**22**
Examinations & Syllabus of above subjects are common with M.E -Electronics & Telecommunication -VLSI & Embedded Systems												

Savitribai Phule Pune University, Pune

Maharashtra, India

ME (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)

Semester I

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PCC-501-VLC - Digital VLSI Design		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses : Digital Electronics, VLSI Design

Course Objectives: The course aims to:

1. To learn MOSFET Models and layout fundamentals
2. To nurture students understanding in performance parameters of digital CMOS Design
3. To learn the delay models
4. To understand the advanced trends in CMOS design

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

- CO1: Understand the fundamentals of CMOS Technology in fabrication domain
- CO2: Explore the skills of designing digital VLSI
- CO3: Demonstrate the ability of digital design
- CO4: Design the logic using various logic families.
- CO5: Create the logic circuits for specific design metrics.

Course Contents

Unit I - MOSFET Models and Layout - (9 Hours)

MOS Capacitance models, MOS Gate Capacitance Model, MOS Diffusion Capacitance Model. Non ideal I-V Effects, MOSFET equivalent circuits and analysis, Parasitic; Technology scaling; Lambda parameter; wiring parasitic; SPICE Models, CMOS layout techniques; Transient response. CMOS Technologies: Layout Design Rules CMOS Process Enhancements: Transistors, Interconnect, Circuit Elements, Beyond Conventional CMOS. CMOS Fabrication and Layout: Inverter Cross-section, Fabrication Process, Stick Diagrams.

Unit II - Performance parameters - (9 Hours)

Static, dynamic and short circuit power dissipations, Propagation delay, Power delay product, Fan in, fan out and dependencies. Delay Estimation: RC Delay Models, Linear Delay Model, Logical Effort, Parasitic Delay. Logical Effort and Transistor Sizing: Delay in a Logic Gate, Delay in Multistage Logic Networks, Interconnect: Resistance, Capacitance, Delay, Crosstalk. Design Margin.

Unit III - Logic design - (9 Hours)

Static CMOS Logic : Inverter, NAND Gate, Combinational Logic, NOR Gate, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers, Latches and Flip- Flops, Design calculations for combinational logic and active area on chip.

Unit IV- Logic Families - (9 Hours)

Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Domino logic, NORA logic, Differential Circuits, Sense Amplifier Circuits, BiCMOS Circuits, Comparison of Circuit Families.

Unit V- Design Trends - (9 Hours)

Hazards, sources and mitigation techniques, case study; HDL codes for FSM, Meta-stability and solutions; Transmission gate, utility and limitations. Low Power Logic Design, Materials for performance improvement, Techniques for Low power, High speed designs.

Learning Resources

Text Books:

1. Neil Weste and Kamaran, "Principles of CMOS VLSI Design", Education Asia.
2. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson (Low Price Edition)

Reference Books:

1. Charls Roth, "Digital System Design using VHDL", Tata McGrawHill.
2. S-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, Third Edition, McGraw-Hill
3. Samir Palnitkar, "Verilog HDL – A Guide to Digital Design and Synthesis", PHI

Laboratory Experiments:

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 logic for ATM machine password and access functionality. Assume suitable I/Os such as card sense, 4 digit PIN number, type of account, amount, other facilities needed etc.
3. To design CMOS logic for F=A+B(C+D)+EFG and prepare layout. Assume suitable capacitive load & foundry. Measure TR, TF& TPD.
4. To draw FSM diagram, write HDL code, synthesis, simulate, place & route for Tea/Coffee vending machine. Generalized I/Os of the machine are coin sense, cup sense, option sense, pour valve, timer count, alarm etc. You may assume additional I/Os too.
5. To design and simulate combinational logic to demonstrate hazards. Also, simulate the same logic redesigned for removal of hazards.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PCC-502- VLC – Reconfigurable Computing		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

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

Course Objectives: The course aims to:

1. Understand various computing architectures
2. Analyse the reconfigurable architecture.
3. Evaluate of FPGA design in view of reconfiguration
4. 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 (9 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 (9 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 (9 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 - (9 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.

Laboratory Experiments:

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)
4. SoPC based Hw-SW design (Soft/Hard Processor + FPGA HW)

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 & Communication Engineering (VLSI & Embedded Systems)		
PCC-503-VLC – Embedded System Design		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses : Basics of Microprocessors & Microcontrollers

Course Objectives: The course aims to:

1. Understand the advanced concepts of embedded systems and design methodologies.
2. Equip students with expertise in ARM, development platforms, and system-on-chip (SoC) designs
3. Provide comprehensive knowledge of an embedded Linux and real-time operating systems (RTOS).
4. Develop competence in embedded system development processes and tools
5. Enable critical analysis of embedded system case studies relevant to modern applications

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

CO1: Explain the fundamentals of embedded systems, their architecture, design methodology, and lifecycle with emphasis on modern platforms

CO2: Analyse ARM Cortex microcontroller architectures and evaluate suitable communication interfaces

CO3: Configure and customize Embedded Linux using build systems, and apply RTOS concepts

CO4: Apply embedded software development processes and tools, including hardware–software co-design and source code engineering practices, for system implementation.

CO5: Evaluate real-world embedded system case studies (digital camera, smart card, access control, mobile systems) with emphasis on product design, certification, testing, and documentation standards.

Course Contents

Unit I - Introduction to Embedded Systems and Modern Platforms - (9 Hours)

Embedded systems: Definitions, Desirable features and characteristics of Embedded Systems, classifications, Embedded system architecture, Design challenges in Embedded System Design, design metrics (real-time performance, reliability, power, cost), Embedded System on Chip (SoC) and embedded product lifecycle. Introduction to modern platforms: Arduino, Raspberry Pi, Beagle Bone, IDEs and development tools: Arduino IDE etc.

Unit II - ARM Cortex Microcontrollers and Communication Interfaces - (9 Hours)

ARM CORTEX series features, Improvement over classical series, CORTEX ARM processors series, Features and applications, Survey of CORTEX based controllers from various manufacturers, ARM-M3 Based Microcontroller LPC1768: Features, Architecture block diagram & its description, System Control, Clock & Power Control, Pin Connect Block. CMSIS Standard, Bus Protocols Ethernet, CAN, USB, Bluetooth.

Unit III - Embedded Linux and RTOS - (9 Hours)

Embedded Linux overview, Boot process: BIOS, Bootloader, Kernel initialization, Space initialization, Storage considerations, Kernel configuration and cross-compilation, Kernel Build systems. RTOS architecture: RTOS, basic OS functions, Concepts of tasking, scheduling, synchronization., prioritization, inter-task communications, interrupts, semaphores.

Unit IV- Embedded Software Development Process and Tools - (9 Hours)

Introduction to Embedded system development process &Tools, Host and Target Machines, Linking and Locating Software, Getting Embedded Software into The Target System, Issues in Hardware–software Design & Co-Design.

Unit V- Case Studies of an Embedded Systems - (9 Hours)

Case Study: Case study of Digital Camera, smart card, access control system, mobile phone software for key inputs. Certification and documentation: Mechanical Packaging, Testing, reliability and failure analysis, Certification (EMI / RFI) and Documentation.

Learning Resources

Text Books:

1. Rajkamal, Embedded Systems: Architecture, Programming and Design, McGraw Hill
2. System Design: A Unified Hardware/Software Introduction – by- Frank Vahid, Tony Givergis (John Wiley & Sons)
3. An Embedded Software Primer – by - David Simon (Pearson)
4. L. B. Das, Embedded Systems*:* An Integrated Approach. Pearson Education, 2012

Reference Books:

1. James K. (Jim) Peckol , Embedded Systems: A Contemporary Design Tool Frank Vasquez & Chris Simmonds
2. Tammy Noergaard, Mastering Embedded Linux Programming,
3. Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers, Newnes/Elsevier

Laboratory Experiments:

1. Write a program to generate square wave by using External Interrupt
2. Write a program for LCD Interface.
3. Write a program to control speed of AC/DC motor by using ARM cortex
4. To develop character device driver for GPIO
5. Interfacing USB & CAN of LPC 1768.
6. One experiment based on any one of development Platform: Arduino, Beaglebon, Rasberry Pi

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PCC-504-VLC - VLSI Chip Design and Fabrication		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses : Digital Electronics, VLSI Design

Course Objectives: The course aims to:

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

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

- CO1: Analyze and implement basic Verilog coding.
- CO2: Understand the IC design flow and EDA tools
- CO3: Understand the AISC timing analysis and different fault models.
- CO4: Understand the major steps in the fabrication process of VLSI circuits
- CO5: Apply implantation process for VLSI devices and discuss the metallization.

Course Contents

Unit I - Design with HDL - (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).

ReferenceBooks:

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

Laboratory Experiments:

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 & Communication Engineering (VLSI & Embedded Systems)		
PCC-505-VLC–VLSI Embedded Laboratory - I		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	02	**Term work**: 25 Marks **Oral**: 25 Marks

Course Objectives: The course aims to:

1. Provide hands-on training in the chip design domain.
2. Understand various computing architectures and their limitations.
3. Understand the concept of real-time embedded systems with the recent microcontrollers.
4. Learn chip design flow.

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

CO1: Design & simulate digital logic circuit 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. VLSI Embedded Laboratory-I Experiments based on programme core courses.
2. Use available software/hardware.

Part A: Digital VLSI 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 logic for ATM machine password and access functionality. Assume suitable I/Os such as card sense, 4-digit PIN number, type of account, amount, other facilities needed etc.
3	To design CMOS logic for F=A+B(C+D)+EFG and prepare layout. Assume suitable capacitive load & foundry. Measure TR, TF & TPD.
4	To draw FSM diagram, write HDL code, synthesis, simulate, place & route for Tea/Coffee vending machine. Generalized I/Os of the machine are coin sense, cup sense, option sense, pour valve, timer count, alarm etc. You may assume additional I/Os too
5	To design and simulate combinational logic to demonstrate hazards. Also, simulate the same logic redesigned for removal of hazards

Part B: Reconfigurable Computing (Any 2)

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)
4	SoPC based Hw-SW design (Soft/Hard Processor + FPGA HW)

Part C: Embedded Systems Design(Any 2)

1	Write a program to generate square wave by using External Interrupt
2	Write a program for LCD Interface.
3	Write a program to control speed of AC/DC motor by using ARM cortex
4	To develop character device driver for GPIO
5	Interfacing USB & CAN of LPC 1768.
6	One experiment based on any one of development Platform: Arduino, Beaglebon, Rasberry Pi

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 & Communication Engineering (VLSI & Embedded Systems)		
PEC-521A- VLC - Embedded Signal Processing Architectures		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Digital Signal Processing, Embedded systems.

Course Objectives: The course aims to:

1. Impart knowledge on the theoretical aspects of signal analysis and processing
2. Explore DSP Processor architectures.
3. Understand DSP algorithms
4. Understand Adaptive filters
5. Elaborate real world DSP applications

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

CO1: Design system with linear filters using DFT

CO2: Develop technical abilities of designing applications with FIR and IIR filters

CO3: Port algorithms on DSP Processor Platforms.

CO4: Design Adaptive filters

CO5: Analyze filter structures

Course Contents

Unit I - Signal Analysis and Processing - (8Hours)

Discrete Fourier Transform, Fast Fourier Transform, Design of FIR Filters using windowing technique, Design and Applications of Adaptive Filters. Understanding the unique architectural features of DSPs, such as Harvard architecture (separate instruction and data memories), specialized addressing modes, and dedicated hardware for common DSP operations like MAC (multiply-accumulate).

Unit II - DSP processor architectures - (8 Hours)

Digital Signal Processor Architectures, hardware units as MAC unit, Barrel shifter, Address generators, pipelining, circular buffering, memory configurations, peripherals and input/output, Fixed point and floating-point formats. TMS 320C54XX, TMS 320C67XX, Blackfin processor: Architecture overview, memory management, Real time implementation Considerations.

Unit III - DSP algorithms - (8 Hours)

Learning to design and implement algorithms that meet strict timing constraints, often involving techniques like pipelining, parallel processing, and efficient memory management, Representations of the DSP algorithms, Block diagrams, Signal flow graph, Data-flow graph, Dependence graph. Iteration bounds: Critical Path, Loop Bound, Algorithm to compute iteration bound, Longest Path Matrix (LPM).

Unit IV- Performance Optimization - (7 Hours)

TMS 320C54XX, TMS 320C67XX, Blackfin processor: Memory System and Data Transfer, Code Optimization. Learning to program DSPs using assembly language and high-level languages (like C/C++) with a focus on performance optimization

Unit V- Practical Applications - (7Hours)

Studying practical examples of how DSPs are used in various embedded systems, such as audio processing, image processing, and control systems. Practical DSP Applications: Digital Image Processing. Two- Dimensional Filtering. Image Enhancement, DTMF generation and detection, FFT algorithms, Wavelet algorithms. Adaptive algorithms: system identification, inverse modeling, noise cancellation, prediction.

Learning Resources

Text Books:

1. Woon-SengGan, Sen M. Kuo, "Embedded Signal Processing with the Micro Signal Architecture", Wiley-IEEE Press,
2. KunSen M, Woon-SengGan," Digital Signal Processors Architectures, Implementations and Applications", Prentice-Hall.
3. Proakis J G, Manolakis D G. "Digital Signal Processing Principles. Algorithms and Applications", Prentice-Hall.
4. Lawrence R R, Bernard Gold, "Theory and Application of Digital signal Processing", Prentice-Hall.
5. ParhiKeshab, "VLSI Digital Signal Processing System", Wiley Publication.

Reference Books:

1. Embedded Signal Processing with the Micro Signal Architecture, by Woon-Seng Gan and Sen M. Kuo:
2. DSP for Embedded and Real-Time Systems, by Robert Oshana:
3. Signal Processing in Radar Systems, by Vyacheslav Tuzlukov: This book focuses on the signal processing aspects of radar systems, which often involve embedded architectures.
4. Practical Applications in Digital Signal Processing, by Richard Newbold

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PEC-521B - VLC - Blockchain		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory :03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

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

Course Objectives: The course aims to:

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

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

- **CO1: A**nalyze 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. permissionless blockchains, Distributed Ledger Technologies (DLT), Cryptographic principles:Hashing, Merkle Trees, Digital Signatures, Zero-Knowledge Proofs (zkSNARKs, zkSTARKs), Consensus mechanisms:Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Practical Byzantine Fault Tolerance (PBFT), Directed Acyclic Graphs (DAG)

Unit II - Smart Contracts & Decentralized Applications (DApps)- (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 - (7Hours)

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.

SWAYAM/ MOOC / eBOOKS

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 & Communication Engineering (VLSI & Embedded Systems)		
PEC-521C- VLC - CMOS Device Modelling		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Digital CMOS Design

Course Objectives: The course aims to:

1. Provide detailed understanding of MOS Device's Structure and operations.
2. Understand the effect of various materials on the characteristics of MOSFET.
3. Analyze three and four terminal MOS Device's Structure and operations.
4. Acquaint the students with SPICE tool for modelling transistor behavior.
5. Provide brief knowledge of advanced MOSFET models.

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

- CO1: Describe and analyze MOSFET model.
- CO2: Analyze three and four terminal MOS Device's Structure and operations
- CO3: Evaluate MOSFET characterization using SPICE simulation
- CO4: Understand advanced MOSFET models
- CO5: Understand non-classical MOS structures

Course Contents

Unit I - Overview of the MOS Transistor- (8 Hours)

A qualitative Description of MOS Transistor operation, MOS Transistor Characteristics, contact potentials, two terminal MOS structure: Flat band voltage, Potential balance and charge balance, Effect of Gate-Substrate voltage on Surface Condition, Accumulation and Depletion, Inversion, Small signal capacitance.

Unit II –Three and Four Terminal MOS Structures - (8 Hours)

The Three-Terminal MOS Structure - Introduction, Contacting the Inversion Layer, The Body Effect, Strong Inversion, Weak Inversion, Moderate Inversion Four-Terminal MOS Transistor - Introduction, Transistor Regions of Operation, Complete All-Region Model, Effective Mobility Effect of Extrinsic Source and Drain Series Resistances, Temperature Effects

Unit III - Small-Dimension Effects - (8 Hours)

Short channel MOSFET, Small Dimension Effects, Carrier Velocity Saturation Channel Length Modulation, Charge Sharing, Barrier lowing two-dimensional charge sharing and threshold voltage, Punch through, Hot Carrier Effects; Impact Ionization Scaling, Velocity Overshoot and Ballistic Operation, Effects due to thin oxides and high doping, mobility degradation. Classical Scaling, Modern Scaling

Unit IV - Transistor: Spice Modelling- (7 Hours)

Modeling of Transistor using SPICE: Basic concepts, The level 1 Equations, The Level 2 Equations, The Level 3 Equations, Comparison of SPICE Models[2,4]Capacitance Models, Basic MOSFET models, DC Model, Transient and AC Models, Temperature Model, Noise Model Comparison of MOSFET Models., DC Analysis, AC Analysis, TIME-DOMAIN Analysis

Unit V- Advanced MOSFETs- (7 Hours)

Advanced MOSFET models for circuit simulators, Surface potential models, inversion charge based models, Compact MOSFET models, threshold voltage-based model models, advanced MOSFET structures such as FINFET, tunnel field-effect transistor (TFET), Double-Gate (DG) MOSFET, Surrounding-Gate MOSFET, Cylindrical Surrounding Double-Gate (CSDG) MOSFET

Learning Resources

Text Books:

1. Yannis Tsividis, "Operation and modeling of the MOS transistor", Oxford University Press.
2. Kang S. M , "CMOS Digital Integrated Circuits", Tata Mc-Graw Hill.
3. Carlos Galup &Montoro, "MOSFET Modeling for Circuit Analysis and Design", World Scientific.

Reference Books:

1. Donald Neamen, "Semiconductors Physics and Devices", Tata Mc-Graw Hill.
2. Sze S. M, "Physics of Semiconductor Devices, Second Edition, Wiley Publications.
3. THE SPICE BOOK - Andrei Vladimirescu , John Wiley & Sons, Inc.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PEC-521D- VLC - Nanotechnology		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE**: 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Science and Engineering

Course Objectives: The course aims to:

1. Get familiar with fundamental science behind Nano technology and systems
2. Get acquainted with concepts of nano systems
3. Acquire basic understanding of material science for designing NEMS based systems
4. Understand the principles of biomaterial
5. Study the applications of bio medical systems

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

- CO1: Choose suitable material based on the properties for Nanotechnology
- CO2: Identify various nanostructures and materials for different applications
- CO3: Learn techniques of nano-structures and fabrication
- CO4: Understand nanolithography
- CO5: Gain knowledge of designing and developing NEMS based systems

Course Contents

Unit I – Fundamentals of Nanotechnology (8 Hours)

The fundamental science behind nanotechnology, bio systems, molecular recognition, quantum mechanics & quantum ideas, optics. Smart materials & Sensors, self-healing structures, heterogeneous nano-structures & composites, encapsulations.

Unit II – Nanostructures and Nanomaterials- (8 Hours)

Nanostructures, Micro/Nano-devices, nano-materials Synthesis and Applications, Molecule Based Devices- Introduction to Carbon nano-tubes- nano-wires- Introduction to Micro/Nanofabrication- Stamping Techniques. Methods and Applications

Unit III – Nanostructure Devices- (8 Hours)

Materials Aspects of Micro and Nanoelectromechanical Systems, Nanostructure devices –Resonant tunneling diodes, Single-electrode transfer devices. Scanning Probe Microscopy, Noncontact Atomic Force Microscopy

Unit IV- Nanolithography- (7 Hours)

Low Temperature Scanning Probe Microscopy, Dynamic Force Microscopy - Nanolithography, Lithography using photons, electron beams soft lithography.

Unit V- Sensors and Applications of Nanotechnology- (7 Hours)

Natural nano-scale sensors, electromagnetic sensors, biosensors, electronic noses. Bio-medical applications, MEMS/NEMS, Devices and Applications

Learning Resources

Textbooks:

1. Kulkarni Sulbha K, "Nanotechnology: Principals & Practices", Capital Publications
2. Rattner Mark, Rattner Daniel, "Nanotechnology: A Gentle Introduction to the Next Big Idea"

Reference Books:

1. Springer Handbook of Nanotechnology
2. Vlaimir Mitin, "Introduction to Nano electronics science, Nanotechnology, Engineering and Applications", Cambridge University Press

<table>
<tr><td colspan="3">Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)</td></tr>
<tr><td colspan="3">PEC-522-VLC- Skill Based Laboratory - I</td></tr>
<tr><td>Teaching Scheme</td><td>Credits</td><td>Examination Scheme</td></tr>
<tr><td>Practical: 02 Hours/Week</td><td>01</td><td>Term Work: 25 Marks
Oral: 25 Marks</td></tr>
</table>

Prerequisite Courses: Program Elective Course

Guidelines for Skill Based Laboratory

- Skill Based Laboratory are 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- Embedded Signal Processing Architecture

1. Design and simulate N point FFT by targeting DSP processor platform.
2. Design and simulate N tap FIR filter by targeting suitable DSP processor platform.
3. Design and simulate LMS adaptive filter.
4. Design a system for DTMF signal detection. Write a program to detect the DTMF signal using Goertzel algorithm
5. Performance comparison of different filter structure

Part A –Blockchain

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

Part A - CMOS Device Modeling

1. Characterize n-MOSFET with the given model parameters, from the parameters students
2. will reproduce I-V characteristics. Replace the model with any other SPICE model. Compare both the I-V characteristics.
3. Characterize p-MOSFET with the given model parameters, from the parameters students
4. will reproduce I-V characteristics. Replace the model with any other SPICE model. Compare both the device I-V characteristics.
5. Characterize n-MOSFET and p-MOSFET to find out low frequency C-V characteristics behavior with the given model parameters.

6. Characterize n-MOSFET and p-MOSFET to find out high frequency C-V characteristics behavior with the given model parameters**.**
7. Characterize gm/ID of the MOS devices

Part A- Nanotechnology

1. Introduction of analysis and characterization of Nano structured materials, coating and thin film sensors.
2. Surface tension measurement of Nano fluids.
3. To observe size and slope of the Nano sized sample using scanning electron microscopy.

Part B: Mini project

1. **Embedded Signal Processing Architecture** - Design a system to filter a speech signal using DSP filter. Write a program FFT analysis of it.
2. **Blockchain** - To design and implement a blockchain-based voting system where votes are securely stored, tamper-proof, and transparently counted using Ethereum smart contracts
3. **CMOS Device Modeling -** MOS Device Modeling and Characterization: One compulsory mini project by using Spice simulation
4. **Nanotechnology** - Design, simulate and analysis Nano structures

Savitribai Phule Pune University, Pune

Maharashtra, India

ME (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)

Semester II

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PCC-551-VLC - Analog VLSI Design		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses : Electronics Circuits, VLSI Design

Course Objectives: The course aims to:

1. To understand theory of analog circuits using MOS small signal models
2. To understand design principles and techniques of CMOS Amplifiers
3. To gain design aspects of HF and Low Noise Amplifiers
4. To learn different methods of Stability and Frequency Compensation

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

- CO1: Understand design concepts and issues of CMOS analog circuit building blocks
- CO2: Design operational amplifier for specifications
- CO3: Acquire the knowledge of stability and frequency responses
- CO4: Design the HF amplifiers for given specifications
- CO5: 5.Explore the methodologies in LNA design

Course Contents

Unit I - Analog CMOS Building Blocks - (9 Hours)

Current sources and References: MOSFET as switch, diode and active resistor; MOS Small- signal Models, Common Source Amplifier, The CMOS Inverter as an Amplifier, Weak inversion; Short channel regime; Current sinks and sources; Current mirrors; Current and voltage references, band gap reference.

Unit II - CMOS Opamps - (9 Hours)

CMOS Amplifiers: Design of CMOS amplifiers, Inverting amplifiers, Cascode amplifiers, Differential amplifiers, Folded cascade; Current amplifiers, Output amplifier. Op Amps, high speed Op Amps, micro power Op Amps, low noise Op Amps.

Unit III - Frequency Responses - (9 Hours)

Comparators, Stability and Frequency Compensation: General considerations, Multi-pole systems, Phase Margin, Frequency Compensation, Compensation of two stage Op Amps, Slewing in two stage Op Amps and Other compensation techniques.

Unit IV- HF Amplifiers - (9 Hours)

HF Amplifiers &Low Noise Amplifier: Open and Short circuit methods to estimate bandwidth, Rise time, Delay, Bandwidth, Zero as bandwidth enhancer, Tuned Amplifiers, Neutralization, Unilateralization, Cascaded amplifiers

Unit V- Low Noise Amplifiers - (9 Hours)

Types of noise. MOSFET two port noise parameters, Low Noise Amplifier (LNA) design, noise and power trade off, optimizations, Linearity, Spur free dynamic range, Design of mixer, Advanced trends in Radio Frequency (RF) chip design.

Learning Resources

Text Books:

1. Thomas Lee, “The Design of CMOS Radio – Frequency Integrated Circuits”, Second edition, Cambridge.
2. Razavi B, “Design of Analog CMOS Integrated Circuits”, McGraw-Hill.

Reference Books:

1. Allen P E and Holberg D R, CMOS Analog Circuit Design, Second Edition, Oxford University Press.
2. Gray P, Hurst P. J, Lewis S. H and Meyer R, “Analysis and Design of Analog Integrated Circuits”, Fourth edition, Wiley

Laboratory Experiments:

1. To design cascode current mirror for output current of 100 μA. Prepare layout and simulate. Comment on output resistance.
2. To design, prepare layout and simulate CMOS differential amplifier for CMRR of 40 dB. Comment on ICMR.
3. To design, prepare layout and simulate multistage CMOS RF amplifier in 90 nm technology for voltage gain of 60 dB, bandwidth of 100 MHz, and source impedance of 50Ω.
4. To design CMOS RF amplifier for voltage gain of 60 dB. Suggest and design suitable techniques to enhance bandwidth. Simulate each added technique step by step. Comment on the improvement resulted each time. Prepare layout of the final schematic and simulate.
5. List the sources of cross talk. Explore in detail the existence of cross talk in each case. Explain the mitigation techniques. Prepare case study for one of them. Verify the cross talk and its mitigation through simulation.

<table>
<tr><td colspan="3">Savitribai Phule Pune University
Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)</td></tr>
<tr><td colspan="3">PCC-552-VLC - Embedded Technologies and IoT</td></tr>
<tr><td>Teaching Scheme</td><td>Credits</td><td>Examination Scheme</td></tr>
<tr><td>Theory : 04 Hours/Week</td><td>04</td><td>CCE : 50 Marks
End-Semester: 50 Marks</td></tr>
</table>

Prerequisite Courses : Embedded System and analog circuits

Course Objectives: The course aims -

1. To give insight to various platforms needed for Embedded Technologies and IoT.
2. To expose students to the usage of protocol standardization in Embedded Technologies and It's selection to various applications.
3. 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.

Laboratory Experiments:

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.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PCC-553-VLC–Automative Embedded Systems		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory :04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Embedded system design, Analog circuits

Course Objectives: The course aims to:

1. Introduce the potential of automotive systems in industries.
2. Understand Automotive Sensory Systems.
3. Explain the importance of Automotive control in system design.
4. Make student aware of different Automotive protocols for internal communication.

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

- CO1: Understand the fundamentals of different Automotive Systems
- CO2: Learn utility of sensors and instrumentation in vehicle systems
- CO3: Design control system for various vehicular modules
- CO4: Acquire knowledge of various automotive protocols
- CO5: Provide technical embedded solutions for the development of automotive Systems

Course Contents

Unit I - Automotive Systems Overview (9 Hours)

Automotive Systems Overview: Automotive Vehicle Technology, Overview of Vehicle Categories, Various Vehicle Sub Systems like Chassis, Body, Driveline, Engine technology, Fuelling technology, vehicle Emission, Brakes, Suspension, Emission, Doors, Dashboard instruments, Wiring Harness, Safety & Security, Comfort & Infotainment, Communication & Lighting, Future Trends in Automotive Embedded Systems: Hybrid Vehicles, Electric Vehicles.

Unit II - Software-Defined Vehicles & Architectures (9 Hours)

Evolution from distributed ECUs to software-defined vehicles (SDVs) with centralized/zonal architectures. ECU consolidation, virtualization, and OTA software update frameworks. Embedded AI in vehicles for driver assistance, predictive maintenance, and vehicle health monitoring. Integration of infotainment, telematics, and safety-critical systems.

Unit III - Automotive Sensory System (9 Hours)

Automotive Sensors and Transducers: Temperature, Manifold and Barometric Pressures, Humidity, Carbon Dioxide (CO_2), Carbon Monoxide (CO), Oxygen (O_2) Sensor, Proximity Distance Sensors, Engine Speed sensor, Throttle Position Sensor, Pressure Sensors, Knock Sensor & Mass Flow Sensor. Typical Sensors, Specifications & Microcontroller Interface Considerations, Sensor Calibration, Curve fitting.

Unit IV-Automotive Control System Design (9 Hours)

Digital Engine Control, Features, Control Modes for Fuel Control, Discrete Time Idle Speed Control, EGR Control, Variable Valve Timing Control, Electronic Ignition Control, Integrated Engine Control System, Summary of Control Modes, Cruise Control System, Cruise Control Electronics, Anti-locking Braking System, Electronic Suspension System, Electronic Steering Control, Four-Wheel Steering.

Unit V- Automotive Protocols and Future Trends (9 Hours)

The need for Protocol, Automotive Protocols: LIN, CAN, KWP2000& J1939, FlexRay, Test, Calibration and Diagnostics tools for networking of electronic systems like ECU Software and Testing Tools, ECU Calibration Tools, Vehicle Network Simulation. Advanced Trends in Automotive Electronics: AUTOSAR Architecture.

Learning Resources

Text Books:

1. William B. Ribbens, “Understanding Automotive Electronics- An Engineering
2. Perspective”, Seventh edition, Butterworth-Heinemann Publications.
3. Ronald K. Jurgen, “Automotive Electronics Handbook”, Mc-Graw Hill.

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Reference Books:

1. Kiencke, Uwe, Nielsen & Lars, “Automotive Control Systems for Engine, Driveline and Vehicle”, Second edition, Springer Publication
2. Tao Zhang & Luca Delgrossi – Vehicle Safety Communications: Protocols, Security and Privacy, Wiley.

Laboratory Experiments:

1. LCD interface for vehicle dashboard simulation (speed, RPM, temperature).
2. Motor control using PWM for automotive actuators (windows, wipers).
3. Predictive maintenance algorithm development with sensor data and edge AI.
4. Case study of two automotive communication protocols.
5. Study of hybrid automotive system functional design.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PCC-554-VLC–VLSI Embedded Laboratory - II		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	02	**Term work**: 25 Marks **Oral**: 25 Marks

Course Objectives: The course aims to:

1. Understand analog behavior of MOSFET & its usefulness in various applications.
2. Know sensors, actuators & standardization in IoT design.
3. Explore various automotive systems.

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

CO1: Design & simulate LF & HF CMOS circuits.

CO2: Design & implement IoT system for specific applications.

CO3: Design control circuits for automotive systems.

Lab Practicals

Guidelines:

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

Part A: Analog VLSI Design (Any 2)

1	To design cascode current mirror for output current of 100 µA. Prepare layout and simulate. Comment on output resistance.
2	To design, prepare layout and simulate CMOS differential amplifier for CMRR of 40 dB. Comment on ICMR.
3	To design, prepare layout and simulate multistage CMOS RF amplifier in 90 nm technology for voltage gain of 60 dB, bandwidth of 100 MHz, and source impedance of 50Ω.
4	To design CMOS RF amplifier for voltage gain of 60 dB. Suggest and design suitable techniques to enhance bandwidth. Simulate each added technique step by step. Comment on the improvement resulted each time. Prepare layout of the final schematic and simulate.
5	List the sources of cross talk. Explore in detail the existence of cross talk in each case. Explain the mitigation techniques. Prepare case study for one of them. Verify the cross talk and its mitigation through simulation.

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: Automative Embedded Systems (Any 2)	
1	LCD interface for vehicle dashboard simulation (speed, RPM, temperature).
2	Motor control using PWM for automotive actuators (windows, wipers).
3	Predictive maintenance algorithm development with sensor data and edge AI.
4	Case study of two automotive communication protocols.
5	Study of hybrid automotive system functional design.

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PEC-571A- VLC – Real Time Operating System		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Operating Systems (OS) and Computer Organization and Architecture
Process management, scheduling, threads

Course Objectives: The course aims to:

1. Expose the students to the fundamentals of interaction of OS with a computer and User computation.
2. Teach the fundamental concepts of how processes are created and controlled with OS.
3. Study on programming logic of modelling Process based on range of OS features.
4. Compare types and Functionalities in commercial OS.
5. Discuss the application development using RTOS.

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

CO1: Design the application using Real-Time operating systems

CO2: Develop the application using RTOS.

CO3: Write the application using real time kernel.

CO4: Develop the application using real time models and languages.

CO5 : Create the application using RTOS domains.

Course Contents

Unit I - REVIEW OF OPERATING SYSTEMS- (8 Hours)

Basic Principles - Operating System structures – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Introduction to Distributed operating system – issues in distributed system: states, events, clocks-Distributed scheduling Fault & recovery.

Unit II - FUNDAMENTALS of RTOS- (8 Hours)

Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS, Basic architecture of an RTOS, Scheduling Systems, Inter-process communication, Performance Matric in scheduling models, Interrupt management in RTOS environment, Memory management. File systems, I/O Systems, Advantage and disadvantage of RTOS. POSIX standards RTOS Issues - Selecting a Real Time Operating System, RTOS

Unit III - REAL TIME KERNEL (8 Hours)

VxWorks Scheduling and Task Management - Real-time scheduling, Task Creation, Intertask Communication, Pipes, Semaphore, Message Queue, Signals, Sockets, Interrupts I/O Systems - General Architecture, Device Driver Studies, Driver Module explanation, Implementation of Device Driver for a peripheral Case study using Vxworks

Unit IV- REAL TIME MODELS AND LANGUAGES - (7 Hours)

Event Based – Process Based and Graph based Models – Real Time Languages – RTOS Tasks – RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements

Unit V- RTOS APPLICATION DOMAINS- (7Hours)

Case studies- RTOS for Image Processing – Embedded RTOS for Network Communication RTOS for fault-Tolerant Applications – RTOS for Control Systems

Learning Resources

Text Books:

1. Silberschatz, Galvin, Gagne "Operating System Concepts", 6th ed, John.Wiley,2003.
2. D. M. Dhamdhere," Operating Systems, A Concept-Based Approach, TMH,2008
3. Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill, 2006.
4. Herma K., "Real Time Systems – Design for distributed Embedded Applications", Kluwer Academic, 1997.

Reference Books:

1. Labrossy J. J, Lawrence, "µC/OS-II, The real time Kernel", R & D Publication.
2. Dr Prasad K V K K, "Embedded Real Time Systems: Concepts, Design & Programming", Dreamtech Publication
3. VxWorks Programmers Guide.
4. VxWorks Reference Manual.

SWAYAM/ MOOC / eBOOKS

Real-Time Systems
By Prof. Rajib Mall, Prof. Durga Prasad Mohapatra | IIT Kharagpur, NIT Rourkela
https://onlinecourses.nptel.ac.in/noc25_cs156/preview

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PEC-571B- VLC - MIXED SIGNAL IC DESIGN		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses :

Course Objectives: The course aims to:

1. Know about mixed-signal devices and the need for testing these devices.
2. Study the various techniques for testing.
3. Learn about ADC and DAC based testing.
4. Understand the Clock and Serial Data Communications Channels
5. Study general-purpose measuring devices.

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

- **CO1:** Explain the fundamentals of various mixed signal circuits testing methodologies.
- **CO2:** Apply various testing methodologies for testing mixed signal circuits.
- **CO3:** Analyse the concepts of mixed signal testing for data converters and data communication.
- **CO4:** Model the various mixed signal circuits for the given specifications.
- **CO5:** Design and simulate sequential circuits

Course Contents

Unit I – MIXED SIGNAL TESTING - (8 Hours)

Common Types of Analog and Mixed- Signal Circuits – Applications of Mixed-Signal Circuits - Post-Silicon Production Flow - Test and Packing – Characterization versus Production Testing - Test and Diagnostic Equipment - Automated Test Equipments – Wafer Probers – Handlers – E-Beam Probers – Focused Ion Beam Equipment's – Forced –Temperature.

Unit II - MEASUREMENT PARAMERTS (8 Hours)

Yield - Measurement Terminology - Repeatability, Bias, and Accuracy - Calibrations and Checkers - Tester Specifications - Reducing Measurement Error with Greater Measurement Time – Guard bands - Effects of Measurement Variability on Test Yield - Effects of Reproducibility and Process Variation on Yield - Statistical Process Control

Unit III – DAC TESTING (8 Hours)

Basics of Data Converters -Principles of DAC and ADC Conversion, Data Formats, Comparison of DACs and ADCs, DAC Failure Mechanisms - Basic DC Tests - Transfer Curve Tests - Dynamic DAC Tests - Tests for Common DAC Applications

Unit IV- ADC TESTING (7 Hours)

ADC Testing Versus DAC Testing - ADC Code Edge Measurements - Edge Code Testing Versus Center Code Testing, Step Search and Binary Search Methods, Servo Method, Linear Ramp Histogram Method, Histograms to Code Edge Transfer Curves, Rising Ramps Versus Falling Ramps, Sinusoidal Histogram Method - DC Tests and Transfer Curve Tests - Dynamic ADC Tests - Tests for Common ADC Applications.

Unit V - COMMUNICATION CHANNEL MEASUREMENTS (7 Hours)

Synchronous and Asynchronous Communications - Time-Domain Attributes of a Clock Signal - Frequency-Domain Attributes of a Clock Signal - Communicating Serially Over a Channel - Bit Error Rate Measurement - Methods to Speed Up BER Tests in Production - Deterministic Jitter Decomposition - Jitter Transmission Tests.

Learning Resources

Text Books:

1. Gordon W. Roberts, Friedrich Taenzler, Mark Burns, "An Introduction to Mixed-signal IC Test and Measurement" Oxford University Press, Inc.2012
2. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2002.
3. Bapiraju Vinnakota, "Analog and mixed-signal test", Prentice Hall, 1998.

Reference Books:

1. Digital and Analogue Instrumentation: Testing and Measurement by Nihal Kularatna

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PEC-571C- VLC - Machine Learning		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

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

Course Objectives: The course aims to:

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

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

CO1: Compare Machine Learning paradigms for real time applications

CO2: Design regression models for predictive tasks and classification models (SVM, decision trees) for signal/label prediction.

CO3: Develop clustering models (K-Means, DBSCAN) and PCA-based solutions for defect detection or customer segmentation.

CO4: Construct feature engineering pipelines (scaling, encoding, and selection) to improve model performance in VLSI/telecom datasets.

CO5: Implement ensemble techniques like Random Forest, XGBoost and statistical tests like t-test to enhance accuracy in IC testing or power grid stability.

Course Contents

Unit I - Introduction to Machine Learning - (8 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 - (8 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 - (8 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).

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- (7Hours)

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

Learning Resources

Text Books:

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

Reference Books:

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

MOOC Courses:

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 & Communication Engineering (VLSI & Embedded Systems)		
PEC-571D - VLC - Robotics and Automation		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Microcontrollers & Basics of Robotics.

Course Objectives: The course aims to:

1. Introduce students to the fundamental concepts of robotics
2. Equip students with knowledge in robot kinematics, dynamics, transformations, grippers, and motion planning.
3. Provide an in-depth understanding of sensors and actuators, their principles, and how they integrate with robotic systems.
4. 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 to the design and implement complete microcontroller based robotic systems.

CO5: Analyze and evaluate the implementation of robotics in industrial environments through case studies and practical applications.

Course Contents

Unit I - Fundamentals of Robotics – I - (8 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 - Fundamentals of Robotics – II - (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, Grippers and End Effectors: Types: Mechanical, hydraulic, pneumatic, magnetic, vacuum grippers, Two-, three-, and multi-fingered grippers, Trajectory Planning.

Unit III - Sensors and Actuators of Robotics - (8 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- Microcontroller role in Robotics - (7 Hours)

Use of microcontrollers and embedded systems in robotics, Selection of microcontrollers for robotic application, Robot based manufacturing system, Pick and place robot, Sensor Integration and Signal Conditioning: Interfacing sensors with controllers, PID controllers in robotics.

Unit V- Industrial Applications for Robotics - (7Hours)

Robotic Applications in Industries: Welding, spray painting, material handling, Assembly operations, packaging, inspection, CNC machine automation, Robotics in Specialized Environments: Underwater robots, aerial robots (drones), mobile robots, Humanoid and legged robots, Autonomous Guided Vehicles (AGVs), Case Studies and Emerging Trends: Robotics in warehouse automation and ASRS, 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 & Communication Engineering (VLSI & Embedded Systems)		
PEC-572A- VLC - Testing and Verification of VLSI Circuits		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: VLSI Design, Testing & Verification

Course Objectives: The course aims to:

1. Introduce the VLSI testing.
2. Introduce logic and fault simulation and testability measures
3. Study the test generation for combinational and sequential circuits
4. Study design for testability.
5. Study the fault diagnosis.

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

CO1: Understand VLSI Testing Process

CO2: Develop Logic Simulation and Fault Simulation

CO3: Develop Test for Combinational and Sequential Circuits

CO4: Understand the Design for Testability

CO5: Perform Fault Diagnosis.

Course Contents

UNIT I - INTRODUCTION TO TESTING - (8 Hours)

Introduction – Fundamentals of VLSI testing, VLSI Testing Process and Test Equipment – Challenges in VLSI Testing - Test Economics and Product Quality – Fault Modeling – Relationship Among Fault Models. Scope of testing and verification in the VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs

UNIT II - LOGIC & FAULT SIMULATION & TESTABILITY MEASURES - (8 Hours)

Simulation for Design Verification and Test Evaluation – Modeling Circuits for Simulation – Algorithms for True Value and Fault Simulation – Scope Controllability and Observability

UNIT III - TEST GENERATION FOR COMBINATIONAL SEQUENTIAL CIRCUITS - (8 Hours)

Algorithms and Representations – Redundancy Identification – Combinational ATPG Algorithms – Sequential ATPG Algorithms – Simulation Based ATPG – Genetic Algorithm Based ATPG

UNIT IV - DESIGN FOR TESTABILITY- (7 Hours)

Design for Testability Basics – Testability Analysis - Scan Cell Designs – Scan Architecture – Built in Self-Test – Random Logic Bist – DFT for Other Test Objectives. Test interface and boundary-scan. System testing and test for SOCs. IDDQ testing. Delay fault testing. BIST for testing logic and memories. Test automation

UNIT V FAULT DIAGNOSIS - (7 Hours)

Introduction and Basic Definitions – Relationship Among Fault Models. Fault Models for Diagnosis – Generation of Vectors for Diagnosis – Combinational Logic Diagnosis - Scan Chain Diagnosis – Logic BIST Diagnosis. Design verification techniques based on simulation, analytical and formal approaches. Functional verification. Timing verification. Formal verification. Basics of equivalence checking and model checking. Hardware emulation

Learning Resources

Text Books:

1. D. D. Gajski, N. D. Dutt, A.C.-H. Wu and S.Y.-L. Lin, High Level Synthesis: Introduction to Chip and System Design, Springer, 1st edition, 1992
2. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition, 2003.
3. G. De Micheli. Synthesis and optimization of digital circuits, 1st edition, 1994
4. M. Huth and M. Ryan, Logic in Computer Science modeling and reasoning about systems, Cambridge University Press, 2nd Edition, 2004
5. Bushnell and Agrawal, Essentials of Electronic Testing for Digital, Memory & Mixed-Signal Circuits, Kluwer Academic Publishers, 2000 A joint venture

Reference Books:

1. Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, 2nd Edition, Wiley, 2001.
2. Christopher M. Bishop, “Pattern Recognition and Machine Learning” ,Springer,2006.
3. Geoff Dougherty, “Pattern recognition and classification an Introduction”, Springer, 2013.
4. John Shae Taylor and Nello Cristianini, “Kernel methods for pattern analysis” Cambridge university press,2004

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PEC-572B-VLC–ASIC Design		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Design of Analysis & Algorithms and Machine Learning

Course Objectives: The course aims to:

1. Gain knowledge of the process of designing application specific algorithm for ASIC
2. Synthesize designs in EDA tool environment
3. Learn design methodologies, simulation and verification
4. Learn issues in Mixed signal ASIC design

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

CO1: Understand concepts and techniques of ASIC modeling and synthesis

CO2: Explore ASIC Physical Design flow

CO3: Perform static timing analysis, delay estimation and synchronization

CO4: Learn ASIC Construction and testing techniques

CO5: Understand practical aspects of mix analog digital design

Course Contents

Unit I - ASIC Modeling and Synthesis - (8Hours)

IC Design Technologies, Types of ASICs and Comparisons, Full-custom, Semi-custom, Standard-cell, FPGA vs ASIC, ASIC Design Flow, Verilog HDL Based logic Design and Test bench, ASIC Cell libraries, logic level optimization. CMOS Logic - I/O Cells, combinational logic cells, Sequential Logic cells. Programmable ASICs, Programmable ASIC I/O cells, EDA Tools, Programmable ASIC Design Software's – Logic Synthesis, Simulation, Hardware Description Languages (Verilog / VHDL / SystemVerilog).

Unit II - ASIC Physical Design - (8 Hours)

Introduction to Physical Design, Role of physical design in ASIC flow, Front-end vs. Back-end design, Key steps in physical design, System Specifications, Architecture Design, Logic and Circuit Design, Physical Design, CADTools, System partitioning, Estimating ASIC Size, Power Dissipation, Physical Design Steps– Design netlist, Partitioning Strategies, Floor planning, Placement, Routing, Design Reuse, Clock, Tree Synthesis, Timing Closure, Power planning.

Unit III - ASIC Timing Analysis - (8 Hours)

Introduction to Timing Analysis, Static timing analysis, Dynamic timing analysis, Key timing terms: delay, slack, setup, hold, skew, jitter, Timing constraints, Timing Constraints, Clock constraints (frequency, uncertainty, jitter, skew), Input/output delay constraints, Multi-cycle paths, False paths, Asynchronous paths, Timing optimization, ASIC library design, Delay estimation, mixed mode design and simulation, issues, Clocking and Timing Issues, Clock skew (local vs. global skew), Clock jitter and uncertainty, Clock domain crossing (CDC) issue, Metastability and synchronization techniques, Study of Industry tools (Synopsys Primetime, Cadence Tempus, Mentor Graphics, Ansys Red Hawk for power/timing)

Unit IV- ASIC Verification and Testing - (7 Hours)

Different Chip Test Methods, Design for Testability (DFT), Need for DFT, Fault Models, Scan Test, Partial Test, Digital scan standards, BIST architecture, Memory Testing, BILBO, Boundary Scan, Self-Test, JTAG, and ATPG, On-chip debugging features, Physical verification : Layout vs. Schematic (LVS), Design Rule Check (DRC), Electrical Rule Check (ERC), Power verification, Verification Languages (System Verilog, Vera, e, Specman, UVM), Directed testing vs. random testing.

Unit V- Mixed Signal ASIC Design- (7Hours)

Mixed Signal ASIC Design, Practical aspects of mix analog digital design, Difference between digital, analog, and mixed-signal design, Challenges in mixed-signal design, Mixed-Signal ASIC Design Flow, Gate level mixed mode simulation. A brief introduction to signal integrity effects in ASIC design, Low-power design in mixed-signal SoCs, Noise and Signal Integrity in Mixed-Signal ASICs, Synthesis and Testing, Applications (IoT, SoCs, communication, automotive, biomedical, etc.), Mixed-signal simulators.

Learning Resources

Text Books:

1. Smith Michael, "Application Specific Integrated Circuits" Pearson Education.
2. Soin R S, Maloberti F, Franca J, "Analogue-digital ASICs: circuit techniques, design tools and applications", IEE Publications.
3. Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, "Digital Systems Testing and Testable Design"
4. Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, "VLSI Test Principles and Architectures"

Reference Books:

1. Singh Raminderpal, "Signal Integrity Effects in Custom IC and ASIC Designs", Wiley Publications.
2. Khosrow Golshan , "Physical Design Essentials An ASIC Design Implementation Perspective"
3. Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu, "VLSI Physical Design: From Graph Partitioning to Timing Closure"
4. J. Bhasker & Rakesh Chadha, "Static Timing Analysis for Nanometer Designs: A Practical Approach"
5. Emre Salman, Eby G. Friedman, "Mixed-Signal Systems-on-Chip Design"
6. Luciano Lavagno, Louis Scheffer, Grant Martin, "EDA for IC Implementation, Circuit Design, and Process Technology"

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
PEC-572C- VLC - Cloud Architecture Protocols		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses : Computer Networks, Operating Systems

Course Objectives: The course aims to:

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

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

CO1: Classify cloud service/deployment models using NIST taxonomies and deconstruct virtualization architectures.

CO2: Analyze encapsulation protocols and data center fabrics using routing algebras and congestion control formalisms.

CO3: Analyze the components of a virtualised data centre and review the performance of Data archiving solutions.

CO4: Implement /identity cryptographic protocols via state-machine models and Zero Trust policy algebras.

CO5: Quantify system resilience using queueing theory, failure distributions and resource optimization heuristics.

Course Contents

Unit I - Cloud Ontology & Architectural Frameworks - (8 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 - (8 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 - (8 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. A. Azodolmolky, Cloud Networking: Understanding Cloud-Based Data Center Networks. Waltham, MA: Morgan Kaufmann, 2014.

SWAYAM/ MOOC / eBOOKS

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 & Communication Engineering (VLSI & Embedded Systems)		
PEC-572D- VLC - Wireless Sensor Networks		
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:

1. Understand basic WSN Technology and its supporting Protocols.
2. Learn routing protocols and their design issues in WSN.
3. Understand sensor- management, sensor- network middle ware and operating systems.
4. Understand WSN layers' issues and their protocols.
5. Understand implementation issues of Wireless Sensor Networks.

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 and Deploy Wireless Sensor Network for different Applications.

Course Contents

Unit I – Fundamentals of Wireless Sensor Networks - (8 Hours)

Motivation for a Network of Wireless Sensor Nodes, Sensing and Sensors Wireless Networks, Performance metrics in WSNs, Types of WSN, Challenges and Constraints. Applications to: Health care, Agriculture, Traffic and others

Unit II - Wireless Sensor Network Architecture - (8 Hours)

Node Architecture; the sensing subsystem, processor subsystem, communication interface, LMote, XYZ, Hogthrob node architectures. Power Management - Through local power, processor, communication subsystems and other means, time Synchronization need, challenges and solutions overview for ranging techniques. Security Fundamentals, challenges and attacks of Network Security, protocol mechanisms for security, security protocols used in different wireless sensor networks

Unit III - Operating Systems - (8 Hours)

Functional and nonfunctional Aspects, short overview of prototypes, Design Considerations for WSN OS, different WSN Operating Systems and their Architecture- Tiny OS, SOS, Contiki, LiteOS, Sensor grid, SOS, MANTIS, Comparative Analysis, Programming tools

Unit IV- Wireless Sensor Network Protocol Stack - (7 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 V- Designing and Deploying WSN Applications - (7 Hours)

Case Study- Designing and Deploying WSN Applications, Early WSN Deployments, General Problems, General Testing and Validation, Requirements Analysis, The Top-Down Design Process, Bottom-Up Implementation Process.

Learning Resources

Text Books:

1. Dargie W. , Poellabauer C., "Fundamentals of wireless sensor networks: theory and practice", John Wiley and Sons.
2. Anna Forster, "Introduction to Wireless Sensor Networks ", Wiley-IEEE Press.
3. Sohraby K., Minol, D., Znati T., "Wireless sensor networks: technology, protocols, and applications", John Wiley and Sons.
4. Hart J. K., Martinez K., "Environmental Sensor Networks: A revolution in the earth system science", Earth-Science Reviews.
5. Feng Zhao, Leonidas J.Guibas,"Wireless Sensor Networks: An Information Processing Approach".

Reference Books:

1. Shuang-Hua Yang., "Wireless Sensor Networks: Principles, Design and Applications ", Springer.
2. Anna Hac., "Wireless Sensor Network Designs", Wiley–Blackwell

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
SEM-581-VLC - Seminar I		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 04 Hours/Week	02	**Term Work** : 25 Marks **Practical** : 25 Marks

Course Description:

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

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

- **Deepen Technical Knowledge:** To enable students to explore a specialized topic within E&TC 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 knowledge-able 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.
- **Prepare for Thesis/Dissertation:** To serve as a foundational step for the Master's thesis/dissertation, allowing students to explore potential research areas.

Course Outcomes: 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 technology 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, SpringerLink, arXiv, Google Scholar), reputable conference proceedings, and established industry standards. Wikipedia and unverified blogs are generally not acceptable as primary sources.
  - Critical Analysis: Beyond mere summarization, students are expected to critically analyze the literature, identifying different approaches, their advantages/disadvantages, open issues, and potential future directions.
  - Note-Taking & Organization: Maintain systematic notes and organize research material effectively.
- 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 methodologies, 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 directions, 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 delivery. 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" by 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

ME (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)

Semester III

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

Prerequisite Courses :

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

Course Objectives: The course aims to:

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

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

- **CO1** : **Define** research and **explain** its essential characteristics with examples from engineering and science fields.
- **CO2** : Identify and **apply** different types of research (basic, applied, qualitative, quantitative, exploratory, descriptive, etc.) to specific problems.
- **CO3** : **Analyze** the outcomes of research such as publications, patents, and technological contributions, and understand their societal and industrial impacts.
- **CO4** : **Apply** ANOVA and ANCOVA techniques for effective experimental data analysis and interpretation of results.
- **CO5** : **Understand** and **apply** the basics of Intellectual Property Rights (IPR) to safeguard innovative research and prevent unethical practices.

Course Contents

Unit I - Definition and Characteristics of Research:- (12 Hours)

Basic of Research : Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that describe 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 Books

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers' Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed), Singapore, 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-zueI9b64QGMcfn5Ckv_8W5Z1d3vMBY
2. https://onlinecourses.swayam2.ac.in/cec20_hs17/preview
3. https://onlinecourses.nptel.ac.in/noc23_ge36/preview

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

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

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
OJT-602-VLC - On Job Training / Internship		
Teaching Scheme	**Credits**	**Examination Scheme**

Course objectives :

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

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

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

Course Description:

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

Guidelines

- **Purpose:** Internships are designed to bridge the gap between academic learning and industry practice. They aim to provide hands-on experience, expose students to the industrial environment, develop technical and soft skills (communication, teamwork, problem-solving), and help in career exploration.
- **Internship Duration and Academic Credentials**
  - 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
  - A intern is expected to spend 10 - 12 hours per week on Internship, Training will result in about 160-170 hours of total internship duration.
  - The minimum requirement regarding Internship duration should not be below 8 weeks
- **Type of Internship**
  - o Industry/Government Organization Internship: Working directly with a company or government body.
  - o Research Internship: Focused on research projects, often in collaboration with academic institutions or R&D labs.
  - o Innovation/Entrepreneurship: Working on developing new products, processes, or even starting a venture.
  - o 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 company 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 & Communication Engineering (VLSI & Embedded Systems)		
SEM-603-VLC - Seminar - II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 06 Hours/Week	03	**Term Work:25 Marks** **Practical: 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 professional area.
  - methods of collecting and analyzing information on the achievements of science and technology in the target area and beyond.
  - proficiency in preparing publications on the topic of research
  - experience in data integration from different fields of science and technology and building evidence-based judgments.
  - methods of planning an experiment, taking into account the peculiarities of the field of professional activity.

Responsibility of the students:

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

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

Course Contents

Seminars / Assignments

1. Introductory lesson: clarification of the project topic, analysis of the assignment.
2. The structure of scientific texts: abstract, article, presentation, research report, master's thesis.
3. An analytical review on the research topic, its goals and objectives. Related works. Sources of information: open sources, journals, databases and collections of publishers. Citation rules. Scientific ethics. Plagiarism. Presentation and discussion of an in-depth analytical review on the research topic.
4. Scientific novelty. Intellectual property. Patent search: goals and objectives, patent databases, rules for compiling a patent search report.
5. Critical analysis of the related works. Identification and evaluation of methods used by other researchers. Choosing or developing your own method its rational.
6. Research Design Stage: clarification of the requirements for the object being developed (software, hardware and software system, technical product).
7. Formulation of criteria for the project goal achieving. Determination of ways to confirm the achievement of the set goal. Experimental study of the object under development.
8. Experiment planning.

9. Preliminary report on the Research Project. Discussion of the preliminary results of the project. Recommendations for improvement and revision.

10. Final assessment: Project defense in the form of a presentation as seminar

Learning Resources

Text Books

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

2. Sirotinina, N. (2012). History and methodology of computer science. Siberian Federal University. 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 & Communication Engineering (VLSI & Embedded Systems)		
RPR-604-VLC - Research Project - I		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 18 Hours/Week	09	**Term Work :** 25 Marks **Oral :** 25 Marks

Course Description:

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

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

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

1. Demonstrate an ability to plan a research project, such as is required in a research proposal prior to the launch of their work
2. Demonstrate an ability to comply with ethical, safety, and documentation processes appropriate to their project
3. Demonstrate expert knowledge in the subject of their research project, such as through a integrated literature survey
4. Demonstrate expert knowledge in the research methods appropriate to generating reliable data for their research questions
5. Demonstrate the ability to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
6. Demonstrate an ability to relate their original data to existing literature, or to create an novel synthesis of existing materials
7. Demonstrate an ability to assemble their findings into a substantial piece of writing that presents a clear thesis and a cohesive, evidence-based argument
8. Demonstrate an ability to balance description, analysis, and synthesis within their project report
9. Demonstrate an ability to reflect on the strengths and weaknesses of their research and methodology, 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 highlight open problems that are relevant to societal or industrial needs.
- CO 3 : Evaluate various solution techniques to determine the most feasible solution within given constraints for the chosen dissertation problem.
- CO 4 : Apply E&TC engineering principles related to requirements gathering and design to produce relevant documentation.
- CO 5 : Write a dissertation report that details the research problem, objectives, literature review, and solution architecture.

Guidelines

1. **General Guidelines :**

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

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

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

Phase 1: Informal conversations

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

Phase 2: Identify topic

The first formal step in the module involves identifying a preliminary project title and writing an abstract of no more than 200 words. This requires submitting a completed registration form. Writing an abstract for a research proposal or for completed research work is an important transferable skill. Students who do not submit a completed registration form will be assigned a project. The project title is understood to be provisional. Supervisors will be assigned to students after the project title/ abstract forms have been submitted. Supervision: A supervisor is required. The main responsibilities of the supervisor are to assist the student with project management and to advise the student on criteria for assessment. You can expect your supervisor to read and comment on a full draft of your research proposal and of your project.

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

Some key points in our advice to students on compliance:

1. allow at least two weeks between submitting an ethics application and the date of your first data collection

2. your supervisor must approve (and sign!) your ethics application before you submit it at departmental level

3. after your protocols have been approved, append a copy of your ethical approval certificate to the dissertation and project proposal.

Phase 3: Project proposal

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

Phase 4: Term-1 research

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

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

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

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

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

Phase 5: Submit project report

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

Additional Information

- **Research notebook :** Students are strongly advised to maintain a research notebook, either digital or paper, and to keep this up to date. A research notebook can prove useful should examiners query research methods, research integrity, or research process.

- **Preventing data loss:** Protect yourself against loss of research material and writing by 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 have 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 discuss options with their supervisors, and they should keep in mind that efficient citation is one element in the criteria for assessment.

Savitribai Phule Pune University, Pune

Maharashtra, India

ME (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)

Semester IV

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Communication Engineering (VLSI & Embedded Systems)		
SEM-651-VLC - 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:

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

Savitribai Phule Pune University Master of Engineering (2025 Course) – Electronics & Comm Eng (VLSI & Embedded Systems)		
RPR-652-VLC - Research Project-II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 36 Hours/Week	18	**Term Work:**100 Marks **Oral :** 50 Marks

Prerequisite : Research Project Stage-I

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

- **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 E&TC.

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

1. **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
2. **CO2 : Plan** their project in advance, using a proposal to describe their undertaking, describe how it will be managed, and reflect upon its value
3. **CO3 : Relate** their original research to existing literature on the subject and relate their work to general themes in their relevant scholarly literature
4. **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
5. **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 considered for the improvement with existing/known algorithms/systems, comparative analysis, 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
  * Anaysis and originality of results
  * Qulity of documentation and adherence to format
  * Viv-voce performance and clarity of understanding
  * Contribution to knowledge or innovation

Task Force for Curriculum Design and Development

Programme Co-ordinator

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