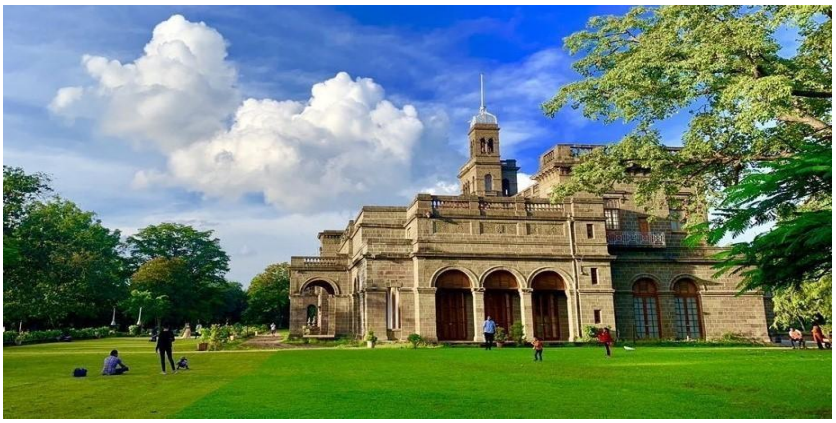
Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology



National Education Policy (NEP)-2020 Compliant Curriculum
TE – Third Year Engineering (2024 Pattern)

Electronics Engineering
(VLSI Design & Technology)

(With effect from Academic Year 2026-27)

www.unipune.ac.in

Contents

Nomenclature

CEP	Community Engagement Project
CO	Course Outcome
KAP	Knowledge and Attitude Profile
MDM	Multidisciplinary Minor
OE	Open Elective
PCC	Program Core Course
PO	Program Outcomes
VEC	Value Education Course
VSE	Vocational and Skill Enhancement Course
WK	Knowledge and Attitude Profile

Preface by Board of Studies

Dear Students and Teachers,

We, the members of Board of Studies Electronics and Telecommunication Engineering, are very happy to present the Third Year Electronics Engineering (VLSI Design & Technology) syllabus effective from the Academic Year 2026-27. The present curriculum will be implemented for the Third Year of Engineering from the academic year 2026-27. Subsequently this will be carried forward for BE in AY 2027-28, respectively.

Electronics Engineering (VLSI Design & Technology) Engineering is a dynamic discipline that lies at the intersection of Electronics engineering (VLSI Design & Technology). It provides the foundation for the design, development, and application of electronic systems and communication devices. This curriculum is designed to provide students with a comprehensive understanding of the fundamental principles, theories, and practices of Electronics and Telecommunication engineering, while also preparing them for the ever-evolving technological landscape.

The revised syllabus falls in line with the objectives of NEP-2020, Savitribai Phule Pune University, AICTE New Delhi, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements. Wherever possible, additional resource links of platforms such as NPTEL, Swayam are appropriately provided at the end of each course. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

This curriculum is the result of extensive consultation with academic experts, industry professionals, and alumni to ensure relevance and excellence. It is designed not only to meet the current industry standards but also to prepare students for higher studies and research in the field of Electronics and Telecommunication engineering.

We hope that this curriculum will inspire students to become competent professionals, responsible citizens, and contributors to the technological advancement of society.

Dr. S. D. Shirbahadurkar

Chairman

Board of Studies

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Dr. Manisha Dale	Dr. Urmila Patil

Knowledge and Attitude Profile (WK)

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

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

Program Outcomes (PO)

Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, attitude and behavior that students acquire through the program. On successful completion of B.E. in Electronics Engineering (VLSI Design & Technology) , graduating students/graduates will be able to:

PO1	Engineering Knowledge	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 toWK4 respectively to develop to the solution Of complex engineering problems.
PO2	Problem Analysis	Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1toWK4)
PO3	Design / Development of Solutions	Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and Environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex Engineering problems. (WK2 and WK6)
PO6	The Engineer and the World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal Framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & International laws. (WK9)
PO8	Individual and Collaborative Team Work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)
Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPCV 4.0) - (August 2024) Page 56.		

General Rules and Guidelines

- Course Outcomes (CO): Course Outcomes are narrower statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behavior that students acquire in their progress through the course.
- Assessment: Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of Program Educational Objectives and Program Outcomes.
- Evaluation: Evaluation is one or more processes, done by the Evaluation Team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which Program Educational Objectives or Program Outcomes are being achieved, and results in decisions and actions to improve the program

Guidelines for Examination Scheme

Theory Examination: The theory examination shall be conducted in two different parts Comprehensive Continuous Evaluation (CCE) and End-Semester Examination (ESE).

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	12 Marks	Unit 1 & Unit 2 (6 Marks/Unit)
2	Assignments/Case-Study	12 Marks	Units3 & Unit 4 (6 Marks/Unit)
3	Seminar Presentation/Open Book Test/Quiz	06 Marks	Unit 5

Comprehensive Continuous Evaluation (CCE) of 30 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 30 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	10 Marks	Unit 1 & Unit 2 (5 Marks/Unit)
2	Seminar Presentation/Open Book Test/Assignments/Case Study	05 Marks	Unit 3 & Unit 4

Comprehensive Continuous Evaluation (CCE) of 15 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 15 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Note: Students can opt for Open Electives offered by different faculty like Arts, Science, Commerce, Management, Humanities or Inter-Disciplinary studies.

Example Open Elective I-Financial Accounting, Digital Finance, Digital Marketing can be opted from Commerce and Management faculty.

And Elective II - Project Management, Business Analytical, and Financial Management can be opted from Inter-Disciplinary studies, Commerce and Management faculty respectively.

- *Unit Test*
  - **Format:** Questions designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyze, Evaluate, and Create).
  - **Implementation**: Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.
- *Sample Question Distribution*
  - Remembering (2 Marks): Define key terms related to [Topic from Units 1 and 2].
  - Understanding (2 Marks): Explain the principle of [Concept] in [Context].
  - Applying (2 Marks): Demonstrate how [Concept] can be used in [Scenario].
  - Analyzing (3 Marks): Compare & contrast [Two related concepts] from Units 1 and 2.
  - Evaluating (3 Marks): Evaluate the effectiveness of [Theory/Model] in [Situation].
- **Assignments / Case Study:** Students should submit one assignment or one Case Study Report based on Unit 3 and one assignment or one Case Study Report based on Unit 4.
  - **Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.
  - **Implementation:** Distribute the assignments or case study after covering Units 3 and 4.

    Provide clear guidelines and a rubric for evaluation.
- *Seminar Presentation:*
  - **Format:** Oral presentation on a topic from Unit5, followed by a Q & A session.
  - **Deliverables:** Presentation slides, a summary reporting 2 to 3 pages, and performance during the presentation.
  - **Implementation:** Schedule the seminar presentations towards the end of the course. Provide students with ample time to prepare and offer guidance on presentation skills.
- *Open Book Test:*
  - **Format:** Analytical and application-based questions to assess depth of understanding.
  - **Implementation:** Schedule the open book test towards the end of the course, ensuring it covers critical aspects of Unit 5.
- *Quiz:*
  - **Format:** Quizzes can help your students practice existing knowledge while stimulating interest in learning about new topics in that course. You can set your quizzes to be completed individually or in small groups.

- **Implementation:** Online tools and software can be used to create quiz. Each quiz is made up of a variety of question types including multiple choice, missing words, true or false etc.

- *Example Timeline for conducting CCE:*
  - Weeks 1-4: Cover Units 1 and 2
  - Week 5: Conduct Unit Test (12 marks)
  - Weeks 6-8: Cover Units 3 and 4
  - Week 9: Distribute and collect Assignments/Case Study (12 marks)
  - Weeks 10-12: Cover Unit 5
  - Week 13: Conduct Seminar Presentations or Open Book Test or Quiz (6 marks)

- *Evaluation and Feedback:*
  - **Unit Test:** Evaluate promptly and provide constructive feedback on strengths and areas for improvement.
  - **Assignments/Case Study:** Assess the quality of submissions based on the provided rubric. Offer feedback to help students understand their performance.
  - **Seminar Presentation:** Evaluate based on content, delivery, and engagement during the Q&A session. Provide feedback on presentation skills and comprehension of the topic.
  - **Open Book Test**: Evaluate based on the depth of analysis and application of concepts. Provide feedback on critical thinking and problem-solving skills.

End-Semester Examination (ESE)

End-Semester Examination (ESE) of 70 marks written theory examination based on all the unit of course syllabus scheduled by university. Question papers will be sent by the University through QPD (Question Paper Delivery) . University will schedule and conduct ESE at the end of the semester.

- *Format and Implementation:*
  - **Question Paper Design:** Below structure is to be followed to design an End-Semester Examination (ESE) for a theory subject of 70 marks on all 5 units of the syllabus with questions set as per Bloom's Taxonomy guidelines and 14 marks allocated per unit.
  - **Balanced Coverage**: Ensure balanced coverage of all units with questions that assess different cognitive levels of Bloom's Taxonomy: Remember, Understand, Apply, Analyze, Evaluate, and Create. The questions should be structured to cover:
    * Remembering: Basic recall of acts and concepts.
    * Understanding: Explanation of ideas or concepts.
    * Applying: Use of information in new situations.

* Analyzing: Drawing connections among ideas.
* Evaluating: Justifying a decision or course of action.
* Creating: Producing new or original work (if applicable).

- **Detailed Scheme for 70 Marks:** Unit-Wise Allocation (14 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.
- **Detailed Scheme for 35 Marks:** Unit-Wise Allocation (08 Marks for Unit-I, 09 Marks for Unit-II, Unit III and Unit IV). Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

NEP 2020 Compliant Curriculum Structure

Third Year Engineering (2024 Pattern)

Electronics Engineering (VLSI Design & Technology)

Level 5.0															
Course Code	Course Type	Course Name	Teaching Scheme (Hours./week)			Examination Scheme & Marks						Credits			
			TH	Tutorial	PR	CCE*	End-Sem	Term work	PR	Oral	Total	TH	Tutorial	PR	Total
Semester - V															
PCC-301-ECV	Program Core Course 1	Microcontrollers & Applications	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-302-ECV	Program Core Course 2	Analog & Digital CMOS Design	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-303-ECV	Program Core Course 3	ASIC Design	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-304-ECV	Program Core Course Lab 1	Microcontrollers & Applications Lab	-	-	2	-	-	25	25	-	50	-	-	1	1
PCC-305-ECV	Program Core Course Lab 2	Analog & Digital CMOS Design & ASIC Design Lab	-	-	4	-	-	50	25	-	75	-	-	2	2
PEC -321-ECV	Program Elective Course	Elective-I	3	-	-	30	70	-	-	-	100	3	-	-	3
PEC- 322-ECV	Program Elective Course Lab	Elective-I Lab	-	-	2	-	-	50	-	-	50	-	-	1	1
MDM- 331-ECV	Multidisciplinary Minor	Machine Learning	-	2	2	-	-	25	-	25	50	-	2	1	3
OLE -341 -ECV	Open Elective	Open Elective	2	-	-	15	35	-	-	-	50	2	-	-	2
ELC -342-ECV	Experiential Learning	Technical Seminar	-	-	2#	-	-	-	-	25	25	-	-	1	1
			14	02	12	135	315	150	50	50	700	14	02	06	22
			28 Hours			700 Marks						22 Credits			

Course Code	Program Elective-I
PEC-321A - ECV	System on Chip
PEC-321B - ECV	Advanced Java Programming
PEC-321C - ECV	Computer Networks
PEC-321D - ECV	Digital Signal Processing

2 It shall be conducted for full class not batch wise

*Note: Students can opt for Open Electives offered by different disciplines/faculty like Arts, Science, Commerce, Management, Humanities or Inter-Disciplinary studies. Example – Open Elective I- IPR and Cyber Laws, Sustainability Development, Digital Personal Data Protection, The Constitution of India, Marketing Management, Financial risk Managements.

NEP 2020 Compliant Curriculum Structure

Third Year Engineering (2024 Pattern)

Electronics Engineering (VLSI Design & Technology)

Level 5.0														
Course Code	Course Type	Course Name	Teaching Scheme (Hours./week)			Examination Scheme and Marks						Credits			
			TH	Tutorial	PR	CCE*	End-Sem	Term work	PR	Oral	Total	Theory	Tutorial	PR	Total
Semester -VI															
PCC-351-ECV	Program Core Course 1	Embedded System Design	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-352-ECV	Program Core Course 2	Design for Testability	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-353-ECV	Program Core Course Lab	Embedded System Design Lab	-	-	2	-	-	25	25	-	50	-	-	1	1
PCC-354-ECV	Program Core Course Lab	Design for testability Lab	-	-	2	-	-	25	-	25	50	-	-	1	1
PEC-361-ECV	Program Elective Course	Elective II	3	-	-	30	70	-	-	-	100	3	-	-	3
PEC-362-ECV	Program Elective Course	Elective III	3	-	-	30	70	-	-	-	100	3	-	-	3
PEC-363-ECV	Program Elective Course Lab	Elective II Lab	-	-	2	-	-	25	25	-	50	-	-	1	1
MDM-371-ECV	Multidisciplinary Minor	Database Management System	-	1	2	-	-	25	-	25	50	-	1	1	2
VSE-372-ECV	Vocational & Skill Enhancement Course	Mini-Project	-	-	2	-	-	50	-	-	50	-	-	1	1
ELC-381-ECV	Experiential Learning Course	Internship/ OJT	-	-	8	-	-	-	-	50	50	-	-	4	4
Total			12	01	18	120	280	150	50	100	700	12	1	09	22
			31 Hours			700 Marks						22 Credit			

Course Code	Program Elective-II	Course Code	Program Elective-III
PEC-361A-ECV	Reconfigurable Computing	PEC-362A- ECV	Semiconductor IC Fabrication Technology
PEC-361B- ECV	Web Technology	PEC-362B- ECV	Power Converters and Applications
PEC-361C- ECV	Network & Cyber Security	PEC-362C- ECV	Artificial Intelligence
PEC-361D- ECV	Digital Image Processing	PEC-362D- ECV	Broad Band Communication

***Comprehensive Continuous Evaluation**

Following subjects are common with E&TC Engineering

Semester V

Branch - Electronics Engineering (VLSI Design & Technology)	**Branch - Electronics & Telecommunication Engineering**
PCC-301-ECV Microcontrollers & Applications	PCC-301-ETC Microcontrollers & Applications
PEC321B – ECV Advanced Java Programming	PEC321A - ETC Advanced Java Programming
PEC321C – ECV Computer Networks	PEC321B - ETC Computer Networks
PEC321D – ECV Digital Signal Processing	PEC321C - ETC Digital Signal Processing
MDM- 331-ECV Machine Learning	MDM- 331-ETC Machine Learning
OLE -341 -ECV Open Elective	OLE -341 -ETC Open Elective
ELC -342-ECV Technical Seminar	ELC -342-ETC Technical Seminar

Semester VI

Branch - Electronics Engineering (VLSI Design & Technology)	**Branch - Electronics & Telecommunication Engineering**
PCC-351-ECV Embedded System Design	PCC-351-ETC Embedded System Design
PEC-361B-ECV Web Technology	PEC-361A - ETC Web Technology
PEC361C- ECV Network & Cyber Security	PEC361C - ETC Network & Cyber Security
PEC361D – ECV Digital Image Processing	PEC361B - ETC Digital Image Processing
PEC-362C- ECV Artificial Intelligence	PEC- 362C -ETC Artificial Intelligence
MDM-371-ECV Database Management System	MDM-371-ETC Database Management System
VSE-372-ECV Mini-Project	VSE-372-ETC Mini-Project
ELC-381-ECV Internship/ OJT	ELC-381-ETC Internship/ OJT

Savitribai Phule Pune University, Pune

Maharashtra, India

TE - Electronics Engineering

(VLSI Design & Technology)

2024 Pattern

Semester-V

With effect from Academic Year 2026–27

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PCC-301-ECV: Microcontrollers and Applications		
Teaching scheme	**Credits**	**Examination Scheme**
Theory: 03 Hours/Week	03	**CCE**:30 Marks **End-Semester:**70 Marks

Prerequisite Courses, if any: Digital logic design, Electronic Components and Hardware, Basics of C Language.

Companion Course, if any: Microcontrollers and Applications Lab

Course Objectives:

- To understand architecture and features of 8051 & LPC2148 Microcontroller.
- To learn interfacing of real-world peripheral devices with Microcontroller
- To implement programming with embedded C
- To design and develop Microcontroller based embedded application
- To demonstrate real-life applications using Microcontrollers

Course Outcomes:

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

CO1: Understand the fundamentals of 8051 microcontroller.

CO2: Interface of peripheral components with 8051 microcontroller.

CO3: Describe the architecture, features, and memory organization of the ARM7 based LPC2148 microcontroller.

CO4: Design the interrupt driven embedded applications using the LPC2148 interrupt controller and peripheral interfaces.

CO5: Interface with the peripherals using communication protocol data transmission and reception.

Course Contents

Unit I	**Introduction to Microcontrollers**	**(09 Hours)**

Introduction to Microcontroller, Comparison between Microprocessors and Microcontrollers Architecture: Von Neumann vs. Harvard architecture, Introduction to Hardwire and ISA Architecture, CISC vs. RISC and pipeline execution, Evolution and Comparison between 8,16-,32 and 64-bit microcontrollers, Selection Criteria of Microcontrollers, Introduction to 8-bit microcontroller (8051), features, Block diagram, Register model, Memory organization, Interrupt Structure. Serial Communication.

Mapping of Course Outcomes for Unit I	CO1: Understand the fundamentals of 8051 microcontroller.

Unit II	Programming with 8-bit Microcontroller (8051)	(08 Hours)
Pin out diagram of 8051, Port Structure, Timer / Counter, Delay Calculation and Programming, Programming of ports, Interfacing of LED, LCD, LDR, 7- segment display, Relays, Buzzer, with Embedded C programs. Application: Design of Data Acquisition System.		
Mapping of Course Outcomes for Unit II	CO2: Interface of peripheral components with 8051 microcontroller.	
Unit III	**ARM7 Processor Fundamentals & Architecture**	**(08 Hours)**
Introduction to ARM processors and its versions, ARM Core data flow model, programmers' model, modes of operations, Registers, CPSR, SPSR Comparison of ARM7, ARM9 & ARM11 processors. ARM7 Based Microcontroller LPC2148: Features, Architecture (Block Diagram and Its Description, Memory Map, GPIO, Pin Connect Block.		
Mapping of Course Outcomes for Unit III	CO3: Describe the architecture, features, and memory organization of the ARM7 based LPC2148 microcontroller.	
Unit IV	**ARM7 Based Microcontroller Interfaces**	**(09 Hours)**
System Control Block: Phase Locked Loop (PLL) configuration, Power Control, and VPB (VLSI Peripheral Bus) Divider. Timers: Architecture of 32-bit timers (Timer 0 and Timer 1), match registers, and pre-scalers. Interrupt structure of LPC2148, interfacing with LED, GLCD, KEYPAD, simple LPC2148 GPIO Programming examples Using timers of LPC2148 to generate delay.		
Mapping of Course Outcomes for Unit IV	CO4: Design the interrupt driven embedded applications using the LPC2148 interrupt controller and peripheral interfaces.	
Unit V	**Real World Interfacing With ARM**	**(09 Hours)**
Serial communication programming for transmission and reception from computer programming for UART. Analog-to-Digital Converter (ADC): Features of the 10-bit ADC, conversion times, and channels. Digital-to-Analog Converter (DAC): Generating analog output waveforms GSM and GPS module interfacing, EEPROM interface using I2C, SDCARD using SPI.		
Mapping of Course Outcomes for Unit V	CO5: Interface with the peripherals using communication protocol data transmission and reception.	

Learning Resources

Text Books:

1. Muhamad Ali Mazadi, Janice Gillispie Mazadi, Rolin D McKinlay ―The 8051 Microcontroller & Embedded Systems (Using Assembly and C)‖ 2nd Edition, PHI.
2. Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and

Optimizing System Software", ELSEVIER.

3. LPC 214x User manual (UM10139): - www.nxp.com

Reference Books:

1. Kenneth J. Ayala, 'The 8051 Microcontroller Architecture, Programming and Applications', Cengage Learning. Second edition.
2. Ajay Deshmukh, 'Microcontrollers Theory and Applications', TATA McGraw Hill.
3. Dr. K.V.K Prasad, "Embedded / Real-Time Systems: Concepts, Design and Programming
4. Black Book", Dream Tech Publishers
5. Michael Barr and Anthony Massa, "Programming Embedded Systems: With C and GNU Development

MOOC/NPTEL Courses:

1. NPTEL Course **"Microcontroller and Applications"**

Link: https://nptel.ac.in/courses/117/104/117104072/
https://nptel.ac.in/courses/108/105/108105102/
http://digimat.in/nptel/courses/video/106105193/L05.html

2. NPTEL Course **"vlabs.iitb.ac.in"**

Link: http://vlabs.iitb.ac.in/vlabs-dev/labs/8051-Microcontroller- Lab/labs/index.php

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course) PCC-302-ECV: Analog and Digital CMOS Design		
Teaching/Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 Hours / week	**03**	**CCE**:30 Marks **End-Semester:**70 Marks

Prerequisite Courses, if any:

1. Basics of Semiconductor devices like MOSFET, BJT, and DIODE.
2. Basics of Passive devices like capacitor, inductor, and resistor.
3. Basics of operational amplifiers.

Companion Course, if any: Analog and Digital CMOS Design Lab

Course Objectives:

- To provide knowledge of the different types of MOS devices and their use.
- To understand and design the different types of amplifiers
- To demonstrate the analysis and design of comparators using CMOS
- To study CMOS design rules and layout design.
- To study design issues and delay models.
- To understand power and design interconnect.

Course Outcomes:

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

CO1: Analyze and simulate basic MOS analog circuits (PSPICE)

CO2: Design and verify CMOS amplifiers & Op-Amps

CO3: Design CMOS logic circuits from Boolean expressions

CO4: Build CMOS design and draw stick diagram

CO5: Study the model to calculate delays.

Course Contents

Unit I	**MOS Devices & Analog Building Blocks**	**(09 Hours)**
MOS Transistor fundamentals (operation regions, I–V characteristics), CMOS device modelling: Large-signal model (square-law basics), Small-signal model (low-frequency), Passive components (brief): Capacitor & Resistor **Basic Analog Sub-circuits:** MOS Switch, MOS Diode, Current Sources & Sinks, Current Mirrors, Source degeneration		
Mapping of Course Outcomes for Unit I	CO1: Analyze and simulate basic MOS analog circuits (PSPICE)	

Unit II	CMOS Amplifiers & Op-Amps	(09 Hours)
CMOS Amplifiers: Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures **CMOS Operational Amplifiers:** Two-stage Op-Amp design, Miller compensation, Gain, bandwidth, slew rate (concepts) , Power-Supply Rejection Ratio of Two-Stage Op Amps (basic idea), Measurement, Techniques of Op Amp.		
Mapping of Course Outcomes for Unit II	CO2: Design and verify CMOS amplifiers & Op-Amps.	
Unit III	**Digital CMOS Logic & Circuit Design**	**(09 Hours)**
CMOS inverter: Structure and Operation, DC characteristics, Switching threshold, Noise margins, Static and dynamic power dissipation, Delay Analysis **CMOS logic gates:** NAND, NOR gate design, Boolean realization using CMOS, Static CMOS Logic Gates, Pass transistor logic, Transmission gates, CMOS Combinational Logic Design (Methodology and design Examples)		
Mapping of Course Outcomes for Unit III	CO3: Design CMOS logic circuits from Boolean expressions.	
Unit IV	**CMOS Technologies and CMOS design rules**	**(09 Hours)**
CMOS Technologies and CMOS design rules: MOS fabrication process, Inverter cross-section, Layout design rules, Gate layouts, Stick diagrams: Inverter, NAND, NOR Multiplexer, Adder, Flip-flop, **Basic subsystem design:** Design for Boolean expression, Multiplexers Adders, Shift registers, CMOS enhancement process		
Mapping of Course Outcomes for Unit IV	CO4: Build CMOS design and draw stick diagrams.	
Unit V	**Delay, Power & Interconnect in CMOS**	**(09 Hours)**
Delay: RC delay model, Linear delay model, Logical effort, Delay in multistage logic network, gate diffusion capacitance **Power:** Dynamic power, Static (leakage) power, Power-delay trade off **Interconnect:** Wire capacitance & resistance, Interconnect delay impact, interconnect impact, interconnect engineering, logical effort with wires **Design Issues:** Scaling challenges (overview), Basic CAD/manufacturing concerns, pitfalls and fallacies.		
Mapping of Course Outcomes for Unit V	CO5: Study the model to calculate delays.	

Learning Resources
Text Books: 1.CMOS VLSI design - CMOS VLSI Design, A Circuits and Systems Perspective Fourth Edition ,Neil H. E. Weste, David Money Harris 2. Analysis and Design of Analog Integrated Circuits- Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, Wiley India, Fifth Edition, 2010.
Reference Books: 1. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edn, 2013. 2. Design of Analog CMOS Integrated Circuits- Behzad Razavi, TMH Edition. 3. CMOS Digital Integrated Circuits analysis and design- Sung-Mo Kang, Yusuf Leblebici, Tata McGraw-Hill Edition.
MOOC / NPTEL Courses: 1. NPTEL Course "CMOS Analog VLSI Design", Prof. A.N. Chandorkar, IIT Bombay nptel.ac.in/courses/117101105 2. NPTEL Course "CMOS Digital VLSI Design "By Prof. Sudeb Dasgupta | IIT Roorkee https://onlinecourses.nptel.ac.in/noc25_ee11/preview

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course) PCC -303-ECV: ASIC DESIGN		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 Hours./ week	**03**	**CCE**:30 Marks **End-Semester:**70 Marks

Prerequisite Courses, if any:

- Digital Electronics
- CMOS
- Verilog/ VHDL

Companion Course, if any: ASIC Design Laboratory

Course Objectives:

- To explain the fundamentals of ASIC Design.
- To introduce design flow of physical IC design.
- To identify the issues at various stages of VLSI physical design.
- To explore low power design techniques.
- To make them comfortable with industry-based case study.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Describe design flow, components of ASIC and SoC design

CO2: Analyze the techniques and algorithms for floor planning, routing and placement of cells in physical IC Design.

CO3: Analyze clock tree synthesis and timing constraints

CO4: Describe low power design techniques and algorithms.

CO5: Apply ASIC Construction and testing techniques

Course Contents

Unit I	**Introduction to ASIC**	**(09 Hours)**

ASIC Design flow, Types of ASIC and Comparisons, Full custom, Semi-custom and Programmable ASICs, Gate array-based ASIC, Channelled gate array, Channel less gate array, Structured gate array, Programmable logic devices-FPGA, ASIC cell libraries, IC Design Technologies.

Mapping of Course Outcomes for Unit I	CO1: Describe design flow, components of ASIC and SoC Design

Unit II	**Partitioning, Floor planning and Placement**	**(08 Hours)**

Introduction, partitioning at different levels, partitioning techniques: constructive and iterative improvement, Floor planning and Placement: Floor-planning and placement differences, Design style specific issues, Floor planning and placement algorithms	
Mapping of Course Outcomes for Unit II	CO2: Analyze the techniques and algorithms for floor planning, routing and placement of cells in physical IC Design.

Unit III	**Routing and Clocking**	**(08 Hours)**
Routing: Introduction, Types of Routing, Grid Routing, Global Routing, Detailed Routing, Power and Ground Routing, Interconnect Modelling and Layout Compaction, Clock Design, Clock Routing, Static Timing Analysis and Timing Closure.		
Mapping of Course Outcomes for Unit III	CO3: Analyze clock tree synthesis and timing constraints.	

Unit IV	**Low Power Design techniques**	**(09 Hours)**
Techniques to reduce dynamic power and static power, clock gating, supply voltage reduction, leakage reduction techniques, gate level design for low power, architecture level techniques for low power, and algorithmic level techniques for low power.		
Mapping of Course Outcomes for Unit IV	CO4: Describe low power design techniques and algorithms.	

Unit V	**Physical Design of a Digital Block**	**(09 Hours)**
Netlist to CIF: Overview of the complete physical design flow, Floor planning and power grid design, Placement and optimization of standard cells, Clock Tree Synthesis (CTS) and buffering, Routing (global and detailed) with congestion analysis, Foundry design rules, Parasitic extraction and timing analysis, Power analysis (short circuit current drop, dynamic/static power)		
Mapping of Course Outcomes for Unit V	CO5 : Apply ASIC Construction and testing techniques	

Learning Resources

Text Books:

1. M.J.S. Smith, “Application Specific Integrated Circuits”, Pearson, (2003).
2. D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, “Embedded System Design: Modeling, Synthesis and Verification” Springer, (2009).
3. S.Pasricha and N.Dutt, “On-Chip Communication Architectures System on Chip Interconnect”, Morgan Kaufmann, (2008).

Reference Books:

1. H. Gerez, “Algorithms for VLSI Design Automation”, John Wiley, (199 8).
2. J..M.Rabaey, A. Chandrakasan and B.Nikolic, “Digital Integrated Circuit Design Perspective”, PHI, (2nd Edition), (2003).

3. D. A.Hodges, “Analysis and Design of Digital Integrated Circuits”, McGraw-Hill Higher Education, (3rd Edition), (2004).
4. Hoi-Jun Yoo, Kangmin Lee and Jun Kyong Kim, “Low-Power NoC for High-Performance SoC Design”, CRC Press, (1st Edition), (2008).

MOOC / NPTEL Courses:

1. NPTEL Course on “VLSI Design Flow: RTL to GDS”, By Prof. Sneh Saurabh, IIT Delhi, Link: https://onlinecourses.nptel.ac.in/noc23_ee137/preview

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024Course)		
PCC-304-ECV: Microcontrollers & Application Lab		
Teaching scheme	**Credits**	**Examination Scheme**
Practical: 02 Hours/ Week	01	**Termwork :**25 Marks **Practical :**25 Marks

Prerequisite Courses, if any: Digital logic design, Electronic Components and Hardware, Basics of C Language.

Companion Course, if any : Microcontrollers & Application

Course Objectives:

- To develop practical skills in programming and interfacing peripheral devices with 8051 and LPC2148 microcontrollers.
- To understand the operation of embedded peripherals and communication protocols.
- To design, implement, and test microcontroller-based embedded applications.

Course Outcomes:

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

CO1: Implement and test interfacing programs using **8051** and **LPC2148**.

CO2: Develop embedded applications using on-chip peripherals and communication interfaces.

CO3: Analyze the performance and verify the functionality of microcontroller-based embedded systems.

List of Experiments

Guidelines for Instructor's Manual

The instructor's manual/Lab Manual is to be developed as a hands-on resource and reference. The instructor's manual needs to include prologue (about university/program/ institute/ department/foreword/ preface), curriculum of course, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/guidelines, references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students in the form of a journal.

Journal consists of prologue, Certificate, table of contents handwritten write-up of each assignment

Content of write-up:

- Title,
- Objectives,
- Problem Statement,

- Outcomes,
- software and Hardware requirements,
- Theory Concept in brief, algorithm, flowchart, test cases, Test Data Set (if applicable), mathematical model (if applicable),
- Results & Discussion
- Conclusion.
- Date of Completion,
- Assessment grade/marks and assessor's sign,

Program codes with sample output of all performed assignments are to be submitted as hardcopy.

Microcontroller and Application Lab

Group A (Any Three) 8051
1. Interacting of LEDS—Different programs (flashing, Counter, BCD, HEX,)
2. Interfacing of multiplexed 7-segment display (counting application)
3. Waveform generation using DAC
4. Interfacing of Stepper motor to 8051- software delay using Timer
5. Interfacing of Relay and Buzzer
Group B (Any Five) LPC 2148
6. Interfacing LPC2148 with GLCD to display images on it.
7. Interfacing of 4x4 matrix keyboard with LPC 2148.
8. Using built-in ADC of LPC2148 for displaying its values (Programming built-in ADC with interrupt and without interrupt).
9. Interfacing GPS with LPC2148 for finding current location latitude and longitude values.
10. Interfacing and programming of on-chip RTC.
11. Interfacing EEPROM to LPC2148 using I2C protocol.
12. Interfacing SD card to LPC2148 using SPI.
Virtual LAB Links:
13. Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University
Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)
PCC-305-ECV: Analog and Digital CMOS Design & ASIC Design Lab

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hours / week	02	Term work: 50 Marks Practical: 25 Marks

Analog and Digital CMOS Design Lab

Prerequisite Courses, if any: –

- Basics of Semiconductor devices like MOSFET, BJT, and DIODE.
- Basics of Passive devices like capacitor, inductor, and resistor.
- Basics of operational amplifiers.

Companion Course, if any: Analog and Digital CMOS Design

Course Objectives:

- To understand the design, simulation and analysis of CMOS analog and digital circuits using VLSI design tools.
- To develop CMOS based combinational, sequential and analog circuits including layouts and stick diagrams.
- To evaluate the performance of VLSI circuits through simulation, verification and layout implementation.

Course Outcomes:

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

CO1: Design, simulate, and analyze CMOS analog circuits such as amplifiers, current mirrors, comparators, and oscillators.

CO2: Design, implement, and verify CMOS combinational and sequential logic circuits using VLSI design tools.

CO3: Develop CMOS layouts and stick diagrams, and evaluate circuit performance using simulation and design verification techniques.

List of Laboratory Experiments

Group A (any 5)

1. Design, Simulate and estimate frequency response of common source / common drain amplifier.
2. Design, Simulate and estimate frequency response of Cascode amplifier.
3. Analysis the performance of differential operational amplifiers for various types of loads.
4. Design and simulate the non-inverting comparator.

5.Design the MOS based current mirror circuit
6.To design and implement Voltage based Oscillator
Group B (any 5)
7. Design CMOS Ring Oscillator.
8. Design and simulate given Boolean expression using CMOS.
9. Design and simulate half and full adder using CMOS.
10.Design 2:1 Mux using Transmission gates
11.Design the CMOS layout of D latch
12. Study stick diagrams in detail. Design the CMOS EXOR gate and draw the stick diagram of it.
Virtual LAB Links: https://vlsi-iitg.vlabs.ac.in/CMOS_simulator.html https://iitg.ac.in/cseweb/vlab/vlsi/ **Note: Additional 2 experiments to be performed using the virtual labs.**
ASIC Design Lab
Prerequisite Courses: Digital Electronics
Companion Course: ASIC Design
Course Objectives : • To provide hands-on experience in modeling, simulation, synthesis, and verification of combinational and sequential digital circuits using Verilog/VHDL and ASIC design tools. • To develop skills in CMOS circuit design, layout creation, implementation, and verification of fundamental VLSI building blocks such as logic gates, latches, memory cells, and oscillators. • To enable students to design, simulate, and analyze analog CMOS circuits including amplifiers, current mirrors, oscillators, and differential amplifiers, with emphasis on performance evaluation and optimization.
Course Outcomes (COs): **After successful completion of the course, students will be able to:** **CO1:** Design, simulate, synthesize, and verify digital circuits using Verilog/VHDL, and analyze ASIC design parameters such as area, timing, power, and delay. **CO2:** Implement and verify CMOS layouts of digital VLSI circuits and evaluate their functionality and physical design characteristics. **CO3:** Design and analyze analog CMOS circuits and evaluate their performance based on gain, frequency response, power consumption, and other relevant parameters.

List of Laboratory Experiments: (Any 8)

PART A (Any 4)

Lab focuses on Verilog/VHDL design, synthesis, and simulation, targeting ASIC workflows, Power, LUTs, critical timings and delay estimations

1. Design, Synthesis and Simulation of 4-bit Adder (Ripple Carry)
2. Design, Synthesis and Simulation of RAM/ROM using Verilog/VHDL (behavioral modeling).
3. Design, Synthesis and Simulation of 4-bit Parallel adders
4. Design, Synthesis and Simulation of 4-bit asynchronous up/down counter
5. Design, Synthesis and Simulation of 4-bit synchronous counter

PART B (Any 3)

6. Design, layout and implementation of CMOS Inverter, NAND and NOR
7. Design, layout and implementation of CMOS D-Latch
8. Design, layout and implementation of 1-bit RAM cell
9. Design, layout and implementation of Ring Oscillator

PART C (Any 1)

10. To design, simulate and estimate frequency response of common source, gate and drain amplifier
11. To design, simulate MOS based current mirror circuit and implement voltage-controlled oscillator
12. Analyze the performance of CMOS differential amplifier for various load

Virtual Labs:

VLSI Virtual Laboratory by IIIT Hyderabad:

https://cse14iith.vlabs.ac.in/List%20of%20experiments.html

PEC – 321 – ECV Program Elective 1 Courses

(Choose any One Elective from Program Elective-1 Courses)

Program Elective-I
System on Chip
Advanced Java Programming
Computer Networks
Digital Signal Processing

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-321A-ECV : Elective I : System on Chip		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 Hours/ week	**03**	**CCE : 30 Marks** **End-Semester: 70 Marks**

Prerequisite Courses, if any :

- Digital Electronics and Digital System Design
- Verilog / HDL Programming
- Microprocessors / Microcontrollers and Embedded Systems
- VLSI Design Fundamentals and CMOS VLSI Design

Companion Course, if any : System on Chip Lab

Course Objectives:

- To understand SoC architecture and design methodology.
- To learn IP-based VLSI design concepts.
- To study embedded processors, buses, memory, and interfaces.
- To analyze SoC verification, testing, and physical implementation.
- To develop practical skills using HDL / FPGA / EDA tools.

Course Outcomes:

On completion of the course, learner will be able to –

CO1: Explain SoC concepts and architecture.

CO2: Analyze processor, bus, and memory integration.

CO3: Design RTL blocks for SoC subsystems.

CO4 : Perform simulation, verification, synthesis and implementation flow

CO5: Develop basic FPGA-based SoC prototypes.

Course Contents

UNIT I	**Introduction to System on Chip**	**(08 Hours)**
Evolution from IC to SoC; Difference between ASIC, FPGA, SoC; System Architecture; System Complexity; Components of the system; Hardware & Software; An approach for SoC Design; SoC design flow; SoC definition, benefits, and challenges; Advantages and challenges of SoC; Components of SoC; Applications of SoC in mobiles, automotive, IoT		
Mapping of Course Outcomes for Unit I	CO1: Explain SoC concepts and architecture.	
UNIT II	**SoC Architecture and IP Design**	**(09 Hours)**

Introduction to SoC processors; Processor core selection (ARM, RISC-V, DSP); Basic concepts in processor architecture and processor micro architecture; Basic elements in Instruction handling; Hard IP, Soft IP, Firm IP; Reusable IP cores; Bus architectures: AMBA, AXI, AHB, APB; Buffers: minimizing pipeline delays; Branches; NoC (Network on Chip) basics; Memory subsystem **More Robust Processors:** Vector processors and vector instructions extensions, VLIW Processors, Superscalar Processors.		
Mapping of Course Outcomes for Unit II	CO2: Analyze processor, bus, and memory integration.	
UNIT III	**RTL Design and Integration**	**(09 Hours)**
HDL modelling using Verilog / System Verilog; RTL coding for SoC blocks; FSM design; UART, SPI, I2C controller basics; Integration of processor + peripherals; Clocking and reset strategies; **Verification and Testing** Functional verification flow; Testbench design; Assertions basics; Simulation using ModelSim / Xilinx ISE / Vivado ; Scan chain basics; BIST concept; SoC testing challenges		
Mapping of Course Outcomes for Unit III	CO3: Design RTL blocks for SoC subsystems.	
Unit IV	**Floor planning**	**(09 Hours)**
Concept of floor planning ; Floor planning: Abutted and Non-abutted floorplan techniques, floorplan control parameters, input and outputs of the floorplan; Partitioning; need of partitioning, rules of partitioning, methods of partitioning; Die size estimation ; Core area calculation ; Aspect ratio determination ; Placement: goal of placement, coarse placement, I/O pad placement ; legalization, placement blockage, keep-out margin; Routing: netlist, congestion, fixed-die routing, variable-die routing; Standard cell rows creation ; Pin planning.		
Mapping of Course Outcomes for Unit IV	CO4: Perform simulation and verification and synthesis and implementation flow	
Unit V	**Physical Design and Implementation**	**(09 Hours)**
Synthesis flow; Overview of backend VLSI design flow; Frontend vs Backend design comparison; Netlist to GDSII flow; Role of physical design engineer; Design constraints (SDC constraints) in modern VLSI and Inputs for Physical Design; Gate level netlist; Technology library files (.lib): LEF/DEF files; Timing analysis and reports ; Power intent files (UPF/CPF); Power planning : Power mesh/grid , VDD and VSS routing. Placement and Routing: Standard cell placement; Global placement; Detailed placement Placement optimization; Timing-driven placement; FPGA prototyping of SoC; Low-power SoC techniques.		
Mapping of Course Outcomes for Unit V	CO5: Develop basic FPGA-based SoC prototypes.	

Learning Resources

Text Books:

1. Michael J. Flynn, Wayne Luk, “Computer System Design: System on Chip”, John Wiley and sons.
2. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”,2nd Edition, Prentice Hall.
3. Wayne Wolf, “Computers as Components, Elsevier”, 3rd Edition

Reference Books:

1. M. Wolf, “Principles of Embedded Computing System Design”, 4th Edition, Morgan Kaufmann Publications.
2. Michael.D. Ciletti, “Advanced Digital Design with the Verilog (TM) HDL”, 2nd Edition, Pearson.
3. J. Bhasker, “A Verilog HDL Primer”, 3rd Edition, Star Galaxy Press.
4. Rochit Rajsuman, “System-on-a-Chip Design and Test”, 1st Edition, Artech House

MOOC / NPTEL Courses:

1. NPTEL Course on “Hardware modelling using Verilog”, by Prof. Indranil Sengupta IIT Kharagpur
Link of the course: https://nptel.ac.in/courses/106105165

2 NPTEL Course on “Embedded Systems”, by Prof. Santanu Choudhary IIT Delhi
Link of the course: https://nptel.ac.in/courses/106105161

3. NPTEL Course on “VLSI Physical Design”, by Prof. Indranil Sengupta IIT Kharagpur
Link of the course: https://nptel.ac.in/courses/106105161

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-321B-ECV: Elective I :Advanced Java Programming		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory :03Hours/Week	03	**CCE ::**30 Marks **End - Semester:**70 Marks
Prerequisite Courses, if any: - Object-Oriented Programming		
Companion Course, if any: Advanced Java Programming Lab		

Course Objectives:

- To implement Java Collection Framework interfaces, classes, iterators, and sorting techniques for efficient data management.
- To develop interactive graphical user interface (GUI) applications using Swing and JavaFX.
- To apply Servlets, JSP, and MVC architecture principles to build dynamic web applications.
- To utilize JDBC and Hibernate frameworks to develop database-driven Java applications.
- To develop, test, and deploy RESTful web applications using the Spring Boot framework.

Course Outcomes:

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

CO1: Develop Java applications using Collection Framework classes, interfaces, iterators and object sorting techniques

CO2: Design and develop GUI applications using Swing, JavaFX

CO3: Apply Servlets, JSP, and MVC architecture to develop dynamic web applications.

CO4: Develop Java database applications using JDBC and Hibernate frameworks to perform CRUD operations efficiently.

CO5: Apply Spring Boot to develop simple REST APIs and test them using Postman.

Course Contents

Unit I	**Collection Framework**	**(08 Hours)**

Introduction to Collection Framework, need and advantages of Collection Framework, overview of Collection interfaces and methods. List interface using Array List and Linked List, set interface using HashSet and TreeSet, Queue interface using Priority Queue, and Map interface using HashMap. Iteration using Iterator and basic object sorting using Comparable and Comparator interfaces.

Exemplar: Develop Java applications using Collection Framework interfaces, classes, iterators, and sorting techniques for efficient data storage and manipulation.

Mapping of Course Outcomes for Unit I	CO1 : Develop Java applications using Collection Framework classes, interfaces, iterators, and object sorting techniques

Unit II	GUI Programming in Java	(08 Hours)
JVM-based GUI frameworks, Swing: Introduction to SWING, Swing class hierarchy, Difference between Swing and AWT, Advantages over AWT, Swing components such as Label, Button, Text Field, Table, Menus, Scrollbar and layout managers and types. **Event Handling:** Events and Event classes, event listeners, Delegation event model, mouse and keyboard events, Adapter classes **Java Fx:** Introduction to Java, Java FX architecture		
Exemplar: Develop interactive GUI applications using Swing and students understand modern GUI concepts such as properties and binding in JavaFX.		
Mapping of Course Outcomes for Unit II	CO2 :Design and develop GUI applications using Swing, JavaFX	
Unit III	**Java Web Development using Servlets and JSP**	**(09 Hours)**
Java Servlets: Introduction to Servlets, Servlet Life Cycle, Creating Simple Servlets, Handling HTTP Requests and Responses, GET and POST Methods, Session Management using Cookies and Http Session. **Java Server Pages (JSP):** Introduction to JSP, Difference between Servlet and JSP, JSP Directives and Implicit Objects, Expression Language (EL), Form Handling using JSP. **MVC Pattern in Web Applications**: Introduction to MVC Architecture, Role of Model, View and Controller, Integration of Servlet and JSP in MVC-based Web Applications.		
Exemplar: Develop a web application using Servlet and JSP to accept student details through an HTML form, process the data in Servlet, and display the submitted information using JSP.		
Mapping of Course Outcomes for Unit III	CO3: Apply Servlets, JSP, and MVC architecture to develop dynamic web applications.	
Unit IV	**Java Database Persistence & ORM Frameworks**	**(09 Hours)**
Introduction to JDBC: Need of JDBC, JDBC Architecture, Types of Drivers, JDBC API, Steps for Database Connectivity. JDBC Programming: Loading Driver, Establishing Connection, Statement & Prepared Statement, Result Set Handling. **JDBC CRUD Operations**: Insert, Update, Delete, Select Queries, Exception Handling **Introduction to Hibernate**: Hibernate Architecture, Hibernate Mapping Types, Hibernate O/R Mapping, Hibernate annotations. Hibernate Query Language		
Exemplar: Develop a Hibernate-based employee management application using annotation mapping and HQL queries for CRUD operations.		
Mapping of Course Outcomes for Unit IV	CO4: Develop Java database applications using JDBC and Hibernate frameworks to perform CRUD operations efficiently.	
Unit V	**Spring Boot: Core Concepts and REST API**	**(09 Hours)**

	Development	
Introduction to Spring Boot: Features and Advantages, Spring Boot Architecture, Installation and Environment Setup using Maven, Creating and Running a Simple Spring Boot Application. Spring Boot Concepts: Project Structure, Dependency Management, Application Properties, Spring Boot Annotations, Spring Boot DevTools. REST API Development: Introduction to REST Architecture, Creating REST APIs using @RestController, Handling HTTP GET, POST, PUT, and DELETE Requests, Request Mapping, Path Variables, JSON Response Handling, Testing APIs using Postman.		
Exemplar: Develop a simple Student Management REST API using Spring Boot to perform basic operations such as adding, viewing, and deleting student details, and test the APIs using Postman.		
Mapping of Course Outcomes for Unit V	CO5: Apply Spring Boot to develop simple REST APIs and test them using Postman implementation.	

Learning Resources

Textbooks:

1. Dream tech Press, Core and Advanced Java, Black Book, Dream tech Press / Wiley India, 2018, ISBN-13: 9789386052216.
2. C. Bauer, G. King, and G. Gregory, Java Persistence with Hibernate, 2nd ed. Shelter Island, NY, USA: Manning Publications, 2015.
3. H. Schildt, Java: The Complete Reference, 12th ed. New York, NY, USA: McGraw-Hill Education, 2021.
4. K. Sierra and B. Bates, Head First Java, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.
5. M. Konda, Just Hibernate. Sebastopol, CA, USA: O'Reilly Media, 2013.

Reference Books:

1. Joel Murach and Michael Urban, Murach's Java Servlets and JSP, 3rd Edition, Mike Murach & Associates, 2014, ISBN-13: 9781890774783.
2. Laurentiu Spilca, Spring Start Here: Learn What You Need and Learn It Well, 1st Edition, Manning Publications, 2021, ISBN-13: 9781617298691JDBC™ API Tutorial and Reference, Third Edition, Maydene Fisher, Jon Ellis, Jonathan Bruce, Addison Wesley

MOOC/NPTEL Courses:

1. https://www.udemy.com

   Spring Boot Course: Learn Spring Boot & Build Web APIs

   Java Web Services & Java EE Microservices: JSP Servlets JBDC

   Java for Swing (GUI) Development

2. https://www.coursera.org:Advanced Java
3. https://nptel.ac.in/courses/106106220: Introduction to database system

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-321C-ECV: Elective I :Computer Networks		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory:03 Hours/Week	03	**CCE :** :30 Marks **End - Semester :**70 Marks

Prerequisite Courses, if any: - Communication Engineering

Companion Courses, if any: - Program Elective Course Lab 1 (**PEC-322C-ECV)**

Course Objectives:

- To understand fundamental concepts of computer networks and layered architecture
- To understand different techniques for framing, error and flow control
- To understand concepts of routing and transport mechanisms
- To understand concepts of transport layer protocol performance
- To understand concepts of web based networking applications

Course Outcomes:

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

CO1: Analyze network architecture and models

CO2: Analyze, datalink layer protocols for error and flow control

CO3: Apply IP addressing and routing techniques

CO4: Apply transport layer services and protocols.

CO5: Apply application layer protocols for network services and applications.

Course Contents

Unit I	**Fundamentals of Computer networks**	**(09 Hours)**

Data Communications, Networks, Network Topologies, Types of Computer Networks, Protocols and Standards, Design Issues for the Layers, Network Models: The OSI Model, TCP/IP Protocol suite. Transmission Media: Guided and Unguided (Wireless). Uses of Computer Networks.

Exemplar: HDMI cable carrying audio/video signals to a TV.

Mapping of Course Outcomes for Unit I	CO1 : Analyse network architecture and models

Unit II	**Data link layer**	**(09 Hours)**

Function of Data Link Layer. Design Issues: Services to Network Layer, Framing, Error Detection and Correction: Basic Concept, Linear Block Code, CRC Code, Checksum, Flow Control: Stop and Wait, Sliding Window, Error Control: Stop and Wait ARQ, Go-Back-N, ARQ, Selective Repeat ARQ, Medium Access Control: Controlled Access (Reservation, Polling, Token Passing), Random Access(ALOHA,CSMA,CSMA/CD,CSMA/CA), Link Layer Addressing: MAC Address and its Types, ARP, HDLC protocol.		
Exemplar: Multiple users sending data through satellite channels.		
Mapping of Course Outcomes for Unit II	CO2 : Analyze, datalink layer protocols for error and flow control	
Unit III	**Network layer**	**(09 Hours)**
Introduction to Network Layer: Network-Layer Services, Packet Switching, Forwarding of IP Packets, IPv4 addresses, Subnetting and CIDR, Network Layer Protocols: Internet Protocol (IP), ICMPv4. **Next Generation IP:** IPv6 Addressing, IPv6 Protocol, Transition from IPv4 to IPV6. Unicast & Multicast Routing: Introduction, Routing Algorithms, Unicast Routing Protocols, Introduction, Multicasting Basics, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, IGMP, Distance Vector, Link State, Path Vector, Routing in Internet: RIP, OSPF, BGP		
Exemplar: Google Maps finding the best route, similar to routing in network		
Mapping of Course Outcomes for Unit III	CO3 : Apply IP addressing and Routing techniques	
Unit IV	**Transport layer**	**(09 Hours)**
Process to process delivery, Elements of Transport Layer Protocols: Addressing, Connection establishment, Connection release, Flow control and buffering, Transmission control protocol (TCP), User Datagram Protocol (UDP), Congestion control, Quality of service (QOS), Stream Control Transmission Protocol (SCTP), Socket Programing.		
Exemplar: WhatsApp voice/video calls using UDP for real-time communication		
Mapping of Course Outcomes for Unit IV	CO4 : Apply transport layer services and protocols	
Unit V	**Application layer**	**(09 Hours)**
Introduction– Principles of application layer, client-server and peer-to-peer models; World wide web (WWW), HTTP– request/response; DNS (DNS hierarchy, DNS Resource Records, DNS Name Resolution, DNS messages); Email– SMTP, MIME, POP3, IMAP, webmail, message format, FTP– basics, File transfer process; TELNET– Remote login, limitations; DHCP– Dynamic host configuration, IP allocation, Management; SNMP– Network management, monitoring.		
Exemplar: Using WhatsApp, Gmail, or YouTube applications		

Mapping of Course Outcomes for Unit V	CO5: Apply application layer protocols for network services and applications.

Learning Resources

Textbooks:

1. Behrouz A. Forouzan, "Data Communications and Networking", Tata McGraw-Hill Publications, 5th Edition, 2012, ISBN: 0-07-058408-7.
2. Andrew S. Tanenbaum and David J. Wetherall, "Computer Networks", Pearson India, 5th Edition, 2012.

Reference Books:

1. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Pearson Education, 6th Edition, 2012, ISBN-10: 0132856204.
2. Larry L. Peterson and Bruce S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann, 5th Edition, 2012.
3. Douglas E. Comer and M. S. Narayanan, "Computer Networks and Internets", Pearson Education, 6th Edition, 2014.
4. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson Education, 4th Edition, 2006.
5. V. K. Pachghare, "Cryptography and Information Security", PHI Learning, 3rd Edition, 2019.

e-Books

1. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach", Online Resource. Link:https://people.cs.clemson.edu/~jmarty/courses/kurose/KuroseCh1-2.pdf
2. Behrouz A. Forouzan, "Data Communications and Networking", Online Book. Link: http://eti2506.elimu.net/Introduction/Books/Data%20Communications%20and%20Networking%20By%20Behrouz%20A.Forouzan.pdf
3. Peter L. Dordal, "An Introduction to Computer Networks", Loyola University Chicago, Online Book. Link:http://intronetworks.cs.luc.edu/current/ComputerNetworks.pdf
4. Tutorials Point, "Data Communication and Computer Network Tutorial", Online Reference Material. Link:https://www.tutorialspoint.com/data_communication_computer_network/data_communication_computer_network_tutorial.pdf

MOOC/NPTELCourses:

1. NPTEL Course on: Computer Networks, Prof. Sujoy Ghosh, IIT Kharagpur. Link: https://onlinecourses.swayam2.ac.in
2. NPTEL Course on: Introduction to Computer Networks & Internet Protocols, Prof. Sudeb

Dasgupta, IIT Roorkee.
Link: https://onlinecourses.swayam2.ac.in

3. NPTEL Course on: Computer Networks and Internet Protocol, Prof. Dheeraj Sanghi, IIT Kanpur.
Link: https://nptel.ac.in

4. NPTEL Course on: Computer Networks, Prof. Bhaskaran Raman, IIT Bombay.
Link: https://nptel.ac.in/courses/106/105/106105183/

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-321D-ECV: Elective I: Digital Signal Processing		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory: 03Hours/Week	03	**CCE** :30 Marks **End - Semester:**70 Marks

Prerequisite Courses, if any: Signals & Systems

Companion Course, if any: Digital Signal Processing Lab

Course Objectives:

- To understand the sampling, aliasing and block schematic of digital signal processing.
- To introduction of transforms for analysis of systems using Z transform.
- To introduction of efficient transform and its application to analyze DT signals.
- To design and implementation of IIR, FIR digital filters.
- To design and implementation of 1-D and 2-D signal processing applications

Course Outcomes:

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

CO1: Interpret and process discrete/ digital signals and represent DSP systems.

CO2: Analyze the digital systems using the Z-transform techniques.

CO3: Implement efficient transform and its application to analyze DT signals.

CO4: Design and implement FIR and IIR filters.

CO5: Apply DSP techniques for various 1-D and 2-D signal processing applications

Course Contents

Unit I	**DSP Preliminaries**	**(09 Hours)**

Discretization of Analog Signals: Advantages of Digital over Analog signal processing Sampling theorem in time domain, recovery of analog signals, and analytical treatment with examples, mapping between analog frequencies to digital frequency, Concept of Interpolation and decimation in signal processing, Representation of signals as vectors, concept of Basis function and orthogonality, Basic elements of DSP and its requirements, Introduction to DSP processor (TMS 320 XX 6713).

Exemplar: Analyze discrete-time signals and determine the output and representation of a basic DSP system using signal processing techniques.

Mapping of Course Outcomes for Unit I	CO1: Interpret and process discrete/ digital signals and represent DSP systems.

Unit II	Z-Transform	(08 Hours)
Need for Z-transform, relation between Laplace transform and Z transform, relation between Fourier transform and Z transform, Concept of ROC and Properties of ROC, Relation between pole locations and time domain behavior, causality and stability considerations for LTI systems, Solution of difference equations using Z transform.		
Exemplar: Apply Z-transform techniques to analyze discrete-time signals and digital systems and determine their system response.		
Mapping of Course Outcomes for Unit II	CO2: Analyze the digital systems using the Z-transform techniques.	
Unit III	**DFT**	**(09 Hours)**
Frequency domain sampling, DFT, Properties of DFT, circular convolution, Computation of linear convolution using circular convolution, FFT, decimation in time (DIT) and decimation in frequency (DIF) using Radix-2 FFT algorithm for 4 point and 8-point sequences, DFT & FFT computation complexity for 4 point and 8-point sequences, Linear filtering (Block convolution or long sequence convolution) using overlap add and overlap save method.		
Exemplar: Implement efficient transforms (DFT/FFT) and apply them for frequency-domain analysis of discrete-time signals.		
Mapping of Course Outcomes for Unit III	CO3: Implement efficient transform and its application to analyze DT signals.	
Unit IV	**Digital Filter Design**	**(09 Hours)**
Concept of analog filter design. IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Butterworth filter design, Characteristics of Butterworth filters IIR filter realization using direct form, cascade form and parallel form. Windowing techniques: Gibbs phenomenon, characteristics and comparison of different window functions, Linear phase conditions: impulse and phase and group delays, Design of linear phase FIR filter using windows: Rect, Hanning, Hamming, Blackmann & Kaiser, Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters, FIR filter realization using Direct Form, Cascade and linear phase structure.		
Exemplar: Design and implement IIR, FIR digital filters to meet specified frequency response requirements.		
Mapping of Course Outcomes for Unit IV	CO4: Design and implement IIR, FIR filters.	
Unit V	**Applications of DSP**	**(08 Hours)**

Biomedical Applications, Speech Processing, Wireless communication, IoT Applications, Image processing basics, Industry 4.0 case studies.	
Exemplar: Apply DSP techniques to analyze and process 1-D and 2-D signals for real-world applications.	
Mapping of Course Outcomes for Unit V	CO5: Apply DSP techniques for various 1-D and 2-D signal processing applications.

Learning Resources

Textbooks:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Prentice Hall, 4th Edition.
2. Dr. Shaila Apte, "Digital Signal Processing", Wiley India Publication, 2nd Edition.
3. S. Salivahanan, C. Ghanapriya , "Digital Signal Processing", McGraw Hill, 2nd Edition.

Reference Books:

1. Ifeachor E.C, Jervis B. W, "Digital Signal Processing: Practical approach", Pearson Publication, 2nd Edition.
2. Li Tan, "Digital Signal Processing: Fundamentals and Applications", Academic Press, 3rd Edition.
3. Schaum's Outline of "Theory and Problems of Digital Signal Processing", 2nd Edition.
4. Oppenheim, Schafer, "Discrete-time Signal Processing", Pearson Education, 1st Edition.
5. K.A. Navas, R. Jayadevan, "Lab Primer through MATLAB", PHI, Eastern Economy Edition.

MOOC/NPTEL Courses:

1. NPTEL Course on "Digital Signal Processing"

Link of the Course: https://nptel.ac.in/courses/117/102/117102060/

2. NPTEL Course on "Digital Signal Processing"

Link of the Course: https://nptel.ac.in/courses/108/105/108105055

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-322A-ECV: Elective I Lab : System on Chip Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 Hours. / Week	01	**Term work**: 50 Marks

Prerequisite Courses, if any :

- Digital Electronics and Digital System Design
- Verilog / HDL Programming
- Microprocessors / Microcontrollers and Embedded Systems
- VLSI Design Fundamentals and CMOS VLSI Design

Companion Course, if any : System on Chip

Course Objectives:

- To understand SoC architecture and design methodology.
- To analyze SoC verification, testing, and physical implementation.
- To develop practical skills using HDL / FPGA / EDA tools.

Course Outcomes:

CO1: Design and simulate combinational digital circuits using Hardware Description Languages (HDL) such as Verilog or VHDL.

CO2: Design and simulate sequential digital circuits using Hardware Description Languages (HDL) such as Verilog or VHDL.

CO3: Implement processor-based SoC components, including memory, peripherals, buses, and interfaces, using FPGA development platforms.

CO4: Verify the correctness of SoC designs using Verilog testbenches, functional simulation, and assertion-based verification techniques.

List of Laboratory Experiments (Hardware/Programs/Simulation Software)

Group A: HDL / Simulation practical (Any 4)

1. Write Verilog code for 8-bit ALU. Simulate it by writing test bench code.
2. Design UART transmitter. Write a Verilog code for UART.
3. Design SPI controller. Write a Verilog code for SPI Controller. Simulate it by writing test bench code.
4. Design I2C controller basics Write a Verilog code for I2C Controller. Simulate it by writing test bench code.

5. Design FSM-based traffic controller using Verilog. Simulate it by writing test bench code.
Group B: SoC Integration practical (Any 3)
1. Integrate processor + RAM + GPIO module 2. Design timer/counter peripheral. 3. Address decoder for memory mapped I/O 4. Bus interfacing using AMBA concept
Group C: Verification practical (Any 2)
1. Write test bench for UART 2. Functional simulation of integrated SoC 3. Assertion-based simple verification

Guidelines for Students Lab Journal	
1	Title of the experiment
2	Problem Statement
3	Logic Design of given problem statement
4	Logic diagram with IC number pin connections
5	Observation table / Truth table
6	Timing diagram
7	Result table
8	Conclusions
9	Mention real life examples concerned with the respective experiments
Guidelines for Laboratory / Term Work Assessment	
1	Continuous assessment of laboratory work based on overall performance and laboratory performance of students.
2	Each laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
3	Suggested parameters include timely completion, performance, efficiency, punctuality, and neatness.

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-322B-ECV: Elective I Lab: Advanced Java Programming Lab		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 02 Hours/Week	01	**Term Work:** 50

Companion Course, if any: **Advanced Java Programming**

Course Objectives:

- To familiarize students with advanced Java programming concepts, Collection Framework, GUI development, event handling, and JavaFX for building interactive desktop applications.
- To develop the ability to design and implement database-driven and web-based applications using Servlets, JSP, JDBC, Hibernate, and related enterprise Java technologies.
- To enable students to create enterprise-level solutions using Spring Boot, REST APIs, and modern Java frameworks for solving real-world software development problems.

Course Outcome:

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

CO1: Apply Java Collection Framework, GUI components, event handling mechanisms, and JavaFX features to develop interactive desktop applications.

CO2: Develop database-driven and web-based applications using Servlets, JSP, JDBC, Hibernate, and related enterprise Java technologies.

CO3: Design and implement RESTful and full-stack Java applications using Spring Boot, modern frameworks, and database integration to address real-world requirements.

List of Experiments

Perform Any 9 from 1 to 15 and Mini Project Compulsory

1. Develop a Java program to store student information using Array List and perform operations such as insertion, deletion, searching, updating, and traversal using Iterator.
2. To implement Set interface for duplicate removal and sorting, and Queue interface using Priority Queue for task processing.
3. Develop a Java program to create a student database using HashMap. Store roll number and student name as key-value pairs and traverse the records using Iterator. Create a student class and sort student records by roll number using Comparable and by name using Comparator.
4. Develop a GUI which accepts the information regarding the marks for all the subjects of a student in the examination. Display the result for a student in a separate window.
5. Write a program to create a frame using Swing. Implement mouse Clicked, mouse Entered () and mouse Exited () events. The frame should become visible when the mouse enters it

6. Design a Simple JavaFX Form demonstrating: Text Field input, Button click event, Binding of Text Field text property to Label
7. Develop a JSP-based Employee Information application to collect employee details and display the entered information using JSP implicit objects and Expression Language (EL).
8. Create a simple calculator application using servlet.
9. Create a login form and implement state management using Cookies and Http Session in a Java web application.
10. Develop a Java program using JDBC to perform insert, update, delete, and display operations on a student database table.
11. Develop program to Execute HQL Queries for Data Retrieval
12. Develop Annotation-Based Student Management System
13. Create a simple Spring Boot application to display a welcome message and demonstrate project execution using Maven.
14. Create a simple REST API using Spring Boot to display student information and test the API using Postman.
15. Create a Spring Boot application to accept student details and display the information using REST API and JSON response.
16. Mini Project
Virtual LAB Links: 1. https://java-iitd.vlabs.ac.in/

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-322C-ECV: Elective I Lab : Computer Networks Lab		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 02 Hours/Week	01	**Termwork** :50

Prerequisite Courses, if any: Communication Engineering

Companion Course, if any: Program Elective Course 1 (**PEC-321A-ECV)**

Course Objectives:

- To apply fundamentals of computer networks, networking devices, and routing protocols.
- To apply configuration and simulation of network services, servers, and communication protocols.
- To develop networks for specific applications and real-world requirements.

Course Outcomes:

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

CO1: Analyze computer networks using networking devices, routing protocols, network utilities, and packet analysis tools.

CO2: Simulate network services, servers, and protocols, and analyze network communication using simulation and packet analysis tools.

CO3: Develop a network for certain applications.

List of Experiments

Group A: Any four to be Performed

1. Implementation of LAN using suitable multiuser windows operating system and demonstrating client-server and peer to peer mode of configuration.
2. Learn MAC Address with switch using network Simulator.
3. Simulate various Networks (LAN, WAN) using relevant network devices on simulator and use network commands a) Ping b) Ipconfig c) Netstat d)Tracert/Traceroute/ Tracepath e) NS lookup.
4. Configure router using RIP /BGP, using a Network Simulator (e.g., packet tracer).
5. Illustrate the details of the live type of traffic (ARP, Frame analysis, ethernet) from the interface using packet capture and analysis tools.

Group B: (Any three to be Performed)

6. Simulate leaky bucket/token bucket.

7. Execute Telnet, DHCP Server using a simulator.
8. Capture packets in LAN and observe the working of protocols using PING / TRACEROUTE / PATHPING.
9. Execute Proxy, web Server using simulator.
10. Configure servers like HTTP / FTP and understand packet sequence and data flowing between client-servers using packet analysis tools.
Group C: Course Project (Any one to be performed)
11. Project: Build a network and perform traffic analysis using wireshark
12. Project: Wi-fi based home automation using IOT

Guidelines for Students Lab Journal	
1	Title of the experiment
2	Problem Statement
3	Apparatus
4	Theory
5	Procedure
6	Results
7	Conclusions
8	Mention real life examples concerned with the respective experiments
Guidelines for Laboratory / Term Work Assessment	
1	Continuous assessment of laboratory work based on overall performance and laboratory performance of students.
2	Each laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
3	Suggested parameters include timely completion, performance, efficiency, punctuality, and neatness.

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-322D-ECV: Elective I Lab : Digital Signal Processing Lab		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 02Hours/Week	01	**Term work**: 50 Marks

Companion Course, if any: Digital Signal Processing

List of Experiments

Group A: All compulsory

CO1: Apply DSP concepts and techniques to analyze discrete-time signals and systems using sampling theory, Z-transform, DFT/IDFT, convolution methods, and FIR/IIR filter realization structures through simulation and implementation tools.

1. Verify the sampling theorem and aliasing effects with various sampling frequencies. Also implement the sampling theorem using VLAB.
2. Find the z-transform of a given difference equation, compute its pole zero plot and comment on its stability.
3. Compute DFT and IDFT for a 4-point sequence using N=4 and N= 8 (using zero padding)
4. Find N-point circular convolution using formula and verify its results. Implement linear filtering using circular convolution
5. Implement IIR structures using Direct form I/ II/ Cascade form. Implement FIR structures using Direct Form/Cascade/Linear phase structures.

Group B: Any Three to be Performed

CO2: Design, implement, and evaluate FIR and IIR digital filters using transformation techniques, window methods, FFT-based analysis, and efficient filtering algorithms for discrete-time signal processing applications.

6. Design a Butterworth filter using Bilinear Transformation, for given specifications (passband gain and pass band edge frequency, stopband attenuation and stop band edge frequencies OR order of the filter, passband range and sampling frequency)
7. Design the symmetric FIR low pass filter for which desired frequency response is expressed as

Hd (w)= {(e^ (-jwτforlwl≤ wc) and 0 elsewhere

The length of the filter should be M = 7 and Wc=1 radians/sample.

Make use of the Rectangular/ Hamming/ Hanning/Blackman/ Kaiser window

8. Implementation of High Pass FIR or IIR filter for a given sequence
9. Compute the DFT by writing a function for a long sequence (of length 32 or above). Calculate the computational complexity. Compare the time required by DFT & FFT functions.
10. Implement the linear filtering using the Overlap Add or Overlap Save method.
Group C: Course Project (Any 1 Group of 3 Students)
CO3: Apply DSP techniques to analyze speech signals, perform multirate processing, and implement image compression applications.
11.Find the pitch frequency of given speech signal
12. Generate a signal as addition of two or more different frequencies of sinusoidal signal. Decimate and interpolate it by the given factor. Plot the input and output signals.
13. Implement image compression using DCT and calculate the compression ratio.
Virtual LAB Links: Link of the Virtual Lab: http://vlabs.iitkgp.ernet.in/dsp/#

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
MDM-331-ECV: Machine Learning		
Teaching Scheme	**Credits**	**Examination Scheme**
Tutorial :02Hours/Week **Practical:**02Hours/Week	**Tut**:02 **Practical:** 01 **Total:**03	**Termwork**:25 Marks **Oral:** 25 Marks

Pre-requisite Courses, if any: Engineering Mathematics (Linear Algebra, Probability & Statistics, Calculus), Digital signal processing, Data Structures and Algorithms

Companion Course, if any : Machine Learning Lab

Course Objectives:

- To introduce the fundamentals of Artificial Intelligence, Machine Learning, and data-driven systems.
- To develop students' ability to preprocess, analyze, and visualize engineering datasets.
- To enable students to implement Machine Learning algorithms using Python-based tools.
- Introduce emerging technologies such as Edge AI, Tiny ML, IoT, and Generative AI.
- Prepare students for industry-oriented AI projects, internships, research, and multidisciplinary applications.

Course Outcomes:

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

CO1: Explain Machine Learning fundamentals, workflow and AI applications in Electronics Engineering.

CO2: Apply data preprocessing, visualization, and exploratory analysis techniques using Python libraries.

CO3: Implement Supervised MachineLearning Algorithms for predication and classification problems.

CO4: Apply Unsupervised learning techniques and Analyze engineering datasets using clustering approaches.

CO5: Develop AI base mini-projects using modern tools, real-world datasets and emerging AI technologies.

Course Contents		
Unit I	**Introduction to Artificial Intelligence and Machine Learning**	**Tut : 1,2,3,4**
Introduction to Artificial Intelligence, Machine Learning, and Deep Learning, Applications of Machine Learning in: Electronics and Telecommunication Engineering: Signal Processing, Smart Communication Systems, Healthcare, IoT and Smart Devices, Industrial Automation, Types of Machine Learning: Supervised Learning, Unsupervised Learning, Reinforcement Learning (Overview), Machine Learning Workflow: Data Collection, Data Preprocessing, Model Training, Model Evaluation, Deployment, Introduction to Python Ecosystem: NumPy, Pandas, Matplotlib, Scikit-learn, Google Colab, Emerging Trends: Generative AI, AI Assistants, Edge AI, TinyML, AIoT, AI in 5G/6G Systems		
Case Studies (Anyone):AI applications in Smart Phones, Recommendation Systems, AI-enabled Communication Systems, Generative AI applications		
Mapping of Course Outcomes for Unit I	CO1: Explain Machine Learning fundamentals, workflow and AI applications in Electronics Engineering.	
Unit II	**Data Preprocessing and Exploratory Data Analysis**	**Tut:5,6,7**
Introduction to datasets and dataset formats, Open-source datasets and data collection methods, Data Preprocessing Techniques: Handling missing values, Data cleaning, Feature selection, Feature scaling, Data normalization, Standardization, Training and Testing datasets, Exploratory Data Analysis (EDA): Statistical analysis, Correlation analysis, Histograms, Scatter plots, Heatmaps, Data visualization techniques, Introduction to Responsible AI and bias in datasets.		
Case Studies (Anyone): Telecom Traffic Dataset Analysis, IoT Sensor Data Analysis, Student Performance Dataset Visualization.		
Mapping of Course Outcomes for Unit II	CO2: Apply data preprocessing, visualization, and exploratory analysis techniques using Python libraries.	
Unit III	**Supervised Machine Learning Techniques**	**Tut:8,9,10**
Introduction to Supervised Learning, Regression Techniques: Linear Regression, Multiple Linear Regression, Classification Techniques: Logistic Regression, K-Nearest Neighbors (KNN), Decision Tree, Random Forest, Model Evaluation Metrics: Accuracy, Precision, Recall, F1 Score, Confusion Matrix, Concept of Cross Validation, Applications in: Signal Classification, Predictive Maintenance,		

Medical Diagnosis, Spam Detection, Network Traffic Analysis.		
Case Studies (Anyone): House Price Prediction, Email Spam Classification, Predictive Maintenance in Industry, Signal Classification System.		
Mapping of Course Outcomes for Unit III	CO3: Implement Supervised Machine Learning Algorithms for predication and classification problems.	
Unit IV	**Unsupervised Learning and Emerging AI Concepts**	**Tut:11,12,13**
Introduction to Unsupervised Learning, Clustering Techniques: K-Means Clustering, Hierarchical Clustering (Overview), Dimensionality Reduction: PCA (Overview), Anomaly Detection Concepts, Introduction to Neural Networks and Deep Learning, Overview of: Edge AI, Tiny ML, Explainable AI (XAI), AI in Embedded Systems, AI in Cyber security, Applications in: Smart Healthcare, Image Processing, Autonomous Systems, Smart Agriculture, Industrial Automation.		
Case Studies (Anyone): Customer Segmentation using K-Means, Smart Healthcare Monitoring, AI-based Traffic Analysis, AI-enabled Embedded System.		
Mapping of Course Outcomes for Unit IV	CO4: Apply Unsupervised learning techniques and Analyze engineering datasets using clustering approaches.	
Unit V	**Industry-Oriented AI Applications and Mini Project**	**Tut:14,15,16**
AI Project Development Cycle, Working with Real-world Datasets: Kaggle datasets, GitHub, repositories, Open-source AI resources, Introduction to: AI APIs, Cloud AI tools, Generative AI tools, Prompt Engineering Basics, AI Ethics and Responsible AI, Industry Applications: AI in Telecommunication, AI in IoT, AI in Robotics, AI in Smart Manufacturing, AI in Healthcare.		
Case Studies (Anyone):AI-based Chatbot Demonstration, Smart Attendance Prediction System, AI-enabled IoT Monitoring System, AI-based Signal Analytics.		
Mapping of Course Outcomes for Unit V	CO5: Develop AI based mini-projects using modern tools, real-world datasets and emerging AI technologies.	

List of Suggested Mini Projects (Not limited to following topics)

1. Smart Attendance Prediction System
2. Telecom Traffic Analysis
3. ECG Signal Classification
4. Predictive Maintenance System
5. Smart Agriculture Monitoring
6. AI-based Image Classification
7. IoT Sensor Data Analytics
8. Voice Command Recognition
9. AI Chatbot using ML APIs
10. Smart Communication Network Analysis

Suggested Software and Tools

- Python
- GoogleColab
- Jupyter Notebook
- Scikit-learn
- TensorFlow/Keras
- Kaggle
- GitHub
- PowerBI/Tableau (Optional)

Industry-Oriented Components

- Use of Kaggle datasets
- Exposure to GitHub repositories
- AI model demonstrations
- Mini Hackathon/AI Challenge
- Technical presentation and report writing
- Exposure to Generative AI tools and APIs
- Industry dataset analysis

Expected Skill Development

After completion of this course, students will be able to:

- Work with real-world datasets
- Develop and evaluate Machine Learning models
- Apply AI concepts to Electronics applications
- Understand emerging AI technologies
- Participate in internships, hackathons, and AI competitions
- Prepare for higher studies and industry roles in AI/ML domains

Learning Resources

Textbooks:

1. AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras and Tensor Flow, O'Reilly Publications.
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press.
3. Andreas Müller and Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Publications.

Reference Books:

1. Tom M. Mitchell, Machine Learning, Mc Graw Hill Education.
2. Ian Good fellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press.
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.

MOOC/NPTEL Courses:

1. NPTEL–Introduction to Machine Learning
2. Machine Learning by Andrew Ng–Coursera
3. Math Works Machine Learning On ramp
4. Google AI Courses
5. Kaggle Micro Courses

Machine learning Lab
Companion Course: **Machine learning**
List of Experiments
Group A: Any Eight to be Performed
1. Perform installation and familiarization of the Python programming environment using Google Colab.
2. Visualize engineering datasets using graphs, histograms, and scatter plots with Matplotlib.
3. Perform data preprocessing and cleaning operations on real-world datasets.
4. Apply feature scaling, normalization, and standardization techniques using Python tools.
5. Implement Linear Regression algorithm for prediction of engineering parameters.
6. Develop classification models using Logistic Regression for real-world datasets.
7. Implement K-Means clustering algorithm for grouping and pattern analysis of datasets.
8. Demonstrate dimensionality reduction using Principal Component Analysis (PCA).
9. Explore AI APIs and cloud-based AI tools for Machine Learning applications.
10. Develop and implement a mini-project using Machine Learning techniques and real-world datasets.

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
ELC-342-ECV: Technical Seminar		
Teaching/scheme	**Credits**	**Examination Scheme**
Practical: # 02 Hours/Week	01	**Oral:** 25 Marks

The "Technical Seminar" course is a critical milestone designed to bridge the gap between structured classroom learning and independent research. It prepares students for their Final Year Projects by cultivating literature retrieval, critical analysis, and technical communication skills.

Course Objectives:

- To develop research orientation and technical communication skills in emerging Computer Engineering and Artificial Intelligence domains.
- To enable students to critically review, analyze, and synthesize contemporary research papers, white papers, patents, and technical standards.
- To promote interdisciplinary thinking aligned with NEP-2020 multidisciplinary philosophy.
- To inculcate ethical awareness, sustainability perspective, and societal impact analysis of AI systems.
- To prepare students for industry, higher education, entrepreneurship, and innovation ecosystems.

Course Outcomes:

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

CO1: Identify and select emerging and relevant technical topics through literature survey.

CO2: Analyze and synthesize information from research papers, journals, and credible sources.

CO3: Demonstrate effective technical communication skills through oral presentation.

CO4: Prepare a structured technical report following academic writing standards.

CO5: Use modern tools (presentation software, plagiarism checkers, referencing tools) for seminar preparation

Guidelines for Conduct of Technical Seminar

The Technical Seminar shall be research-oriented and domain-specific, focusing strictly on recent development in Electronics Engineering (VLSI Design & Technology), IoT.

Guidelines for Technical Seminar

- Topic must be from emerging Electronics Engineering, VLSI domains (preferably last 3–5 years).
- Must involve a minimum of 5 recent research papers (IEEE, ACM, Elsevier, Springer etc).
- Students should be summarizing papers – Reading abstracts and finding ideas, conclusions, and advantages of their approaches and the drawbacks of the papers. They should understand the results from

a research paper to related research problems. Comparing the approach - Identify weaknesses and strengths in recent research articles in the subject.

- Practical sessions on how to read, analyze and summarize research papers should be arranged.
- Should not be a basic textbook topic.
- Must include: Problem statement, State-of-the-art analysis, Comparative study, Ethical & societal impact, Interdisciplinary themes aligned with NEP encouraged.
- Topic should be approval by a faculty panel/ Seminar coordinator/ Head of the department.

Seminar Process

- Orientation, Topic Finalization and Guide allocation (Week1–2)

– Conduct an orientation session explaining: Objectives of the technical seminar, Evaluation criteria and expected outcomes

– Each student must submit: Title of the seminar, Problem statement, Relevance to current technology trends, Approval by guide is mandatory before proceeding

– Students are assigned a faculty guide based on specialization alignment. Students identify 2–3 broad domains of interest.

– The precise topic is finalized and approved by a departmental seminar committee.

- Literature Survey & Problem Understanding (Week2–4)

– Students must: Refer minimum 5–8 recent research papers (IEEE, Springer, Elsevier, and ACM etc.)

– Use scholarly databases like IEEE Explore, Google Scholar, Science Direct

– Prepare a literature survey matrix, including:

* Author/year

* Methodology used

* Key findings

* Limitations

– Identify: Research gaps and Challenges in existing approaches

- Synopsis Preparation & Presentation (Week4–5)

– Submita2–3-page synopsis including: Introduction, Literature insights, Objectives, Proposed

seminar scope

- Conduct a Synopsis Presentation (5–7 minutes): Evaluate clarity of understanding, Receive feedback for improvement
- Approval required before proceeding to full report

- In-depth Study & Content Development (Week5–8)

- Students should: Deeply analyze concepts, models, architectures, or case studies, Include diagrams, flowcharts, and comparative tables
- Weekly review meetings with guide: Track progress, Ensure conceptual clarity,
- Emphasis on: Critical analysis (not just description), Real-world applications

- Draft Report Submission & Review (Week8–10)

- Submit first draft of the report
- Guide provides feedback on: Technical content quality, Structure and coherence, Referencing and plagiarism,
- Students must revise based on suggestions by the guide

- Pre-Seminar Presentation (Mock Evaluation) (Week10–11)

- Conduct a mock presentation simulating final evaluation
- Focus on: Presentation skills, Time management, Handling questions
- Peer and faculty feedback should be incorporated

- Final Report Submission (Week11–12)

- Submit: Final hard copy (if required), Softcopy (PDF format)
- Ensure: Proper formatting, Plagiarism compliance (<20%), Correct referencing using reference managers like Zotero and Mendeley Desktop

- Final Seminar Presentation & Viva Voce (Week12–13)

- Presentationduration:10–15minutes, Followed by Q&A session (5–10minutes)
  - Evaluation based on: Depth of understanding, Analytical ability, Communication skill

Method of Evaluation

- During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for a duration of about 12to 15 minutes.
- Eachstudentisexpectedtopresentatleasttwiceduringthesemesterandthestudentisevaluated based on that.
- At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report.
- A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance.

Seminar Report

The final technical report should be highly structured (20 to 25 pages), strictly technical, and clear of marketing jargon. The recommended structure includes

•Cover Page & Certificates: Standard institutional format.

•Abstract: A single, dense paragraph (200–250 words) capturing the domain background, problem identified, state-of-the-art solutions analyzed, and key takeaways.

- Chapter 1: Introduction: Overview of the technology, historical context, motivation, and scope.
- Chapter 2: Literature Survey: A comprehensive critical analysis of the referred papers. It is highly recommended to synthesize this into a structured matrix, tabular form
- Chapter 3: System Architecture / Technical Core: Detailed breakdown of algorithms, mathematical formulations, protocols, or structural pipelines.
- Chapter 4: Comparative Analysis / Applications: Deep dive into current real-world deployment challenges, performance metrics (latency, accuracy, scale), and limitations.
- Chapter 5: Conclusion & Future Scope: Summarizing the insights gleaned and highlighting concrete pathways for prospective final-year project extensions.

References: Strictly formatted in standard IEEE

Learning Resources

1. Raman,M.,& Sharma,S.(2015). Technical Communication: Principles and practice (3rd ed.). Oxford University Press.
2. Kothari, C.R. (2014). Research Methodology: Methods and Techniques (3rd ed.). New Age International Publishers.

Savitribai Phule Pune University,Pune

Maharashtra, India

TE - Electronics Engineering VLSI Design & Technology 2024 Pattern

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Semester VI

With effect from AcademicYear2026–27

Savitribai Phule Pune University

Third Year of Electronics Engineering (VLSI Design &Technology) (2024 Course)

PCC-351-ECV Embedded System Design

Teaching Scheme:	Credits:	Examination Scheme:
Theory: 03 hrs./ week	03	CCE : 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Microcontroller and Applications

Companion Course, if any:

Embedded System Design Lab

Course Objectives:

- To analyze embedded system fundamentals, processor architectures, and design methodologies.
- To implement real-time operating system concepts and task management using Free RTOS.
- To examine embedded Linux architecture, boot process, and device driver concepts.
- To develop embedded applications using STM32 Microcontrollers and peripheral interfacing through STM32CubeIDE.
- To apply software testing, debugging, and Edge AI concepts to solve real-world embedded applications.

Course Outcomes:

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

CO1: Explain embedded system fundamentals, processor architecture, design metrics, and development lifecycle models.

CO2: Analyze RTOS concepts including Scheduling, Synchronization, Inter task Communication, and Free RTOS basics.

CO3: Illustrate embedded Linux concepts including boot process, kernel configuration, device drivers, and cross-compilation.

CO4: Develop embedded applications using STM32 Microcontrollers and STM32CubeIDE for peripheral interfacing.

CO5: Apply testing, debugging, and Edge AI techniques for real world embedded applications.		
Course Contents		
Unit I	**Fundamentals of Embedded Systems & Processor Architecture**	**(09 Hours)**
Introduction to Embedded Systems, Classification and Characteristics of Embedded Systems, Design Metrics and Optimization, Processor Architecture, Microcontrollers vs Microprocessors vs SoC, ARM Cortex Architecture Overview, Embedded Hardware-Software Co-design, Embedded Design Lifecycle, Software Development Models: Waterfall Model, Applications of Embedded Systems in Industry.		
Exemplar: Airbag System in a Car/ Smart Washing Machine/ Mars Pathfinder/ Smart Home system		
Mapping of Course Outcomes for Unit I	**CO1:** Explain embedded system fundamentals, processor architecture, design metrics, and development lifecycle models.	
Unit II	**Real-Time Operating Systems**	**(09 Hours)**
Real-time System Concepts, Tasks and Threads, Scheduling Algorithms, Context Switching, Priority Inversion, Deadlock, Mutual Exclusion, Semaphore and Mutex, Intertask Communication, Memory Management in RTOS, Introduction to Free RTOS.		
Exemplars: Smart Traffic Signal Control System based on Free RTOS and Equivalent		
Mapping of Course Outcomes for Unit II	**CO2:** Analyze RTOS concepts including Scheduling, Synchronization, Inter task Communication, and Free RTOS basics.	
Unit III	**Embedded Linux Systems**	**(08 Hours)**
Need for Embedded Linux, Embedded Linux Architecture, Boot Process, Bootloaders, U-Boot, Kernel Configuration, Device Drivers, File Systems, Cross Compilation, Debugging Tools.		
Exemplar: Smart IP Camera (CCTV) based on Embedded Linux, Smart TVs. Routers, Set-top boxes, ATM machines, Automotive infotainment systems and Equivalent		
Mapping of Course Outcomes for Unit III	**CO3:** Illustrate embedded Linux concepts including boot process, kernel configuration, device drivers, and cross-compilation	

Unit IV	STM 32 Programming and Peripheral Interfacing	(09 Hours)
Introduction to STM32 Microcontrollers, Introduction to STM32CubeIDE, GPIO Programming, Timers, Interrupts, ADC/DAC, UART Communication, SPI Communication, I2C Communication, Sensor Interfacing, Actuator Interfacing, Mini Application Development.		
Exemplar: **STM32-Based Smart Greenhouse Monitoring Systems and equivalent examples**		
Mapping of Course Outcomes for Unit IV	**CO4:** Develop embedded applications using STM32 Microcontrollers and STM32CubeIDE for peripheral interfacing.	
Unit V	**Embedded Software Testing, Edge AI and Industry Applications**	**(09 Hours)**
Unit Testing, Integration Testing, Hardware Debugging, JTAG Debugging, Simulators and Emulators, Introduction to Edge AI, Tiny ML Basics, Deployment using Tensor Flow Lite, Deployment using Edge Impulse. **Industry Applications:** Smart Agriculture, EV Charging Systems, Industrial Automation, Smart Healthcare, Automated Vending Systems.		
Exemplar: STM32-Based Tiny ML Smart Agriculture System.		
Mapping of Course Outcomes for Unit V	**CO5:** Apply testing, debugging, and Edge AI techniques for real-world embedded applications.	

Learning Resources

Textbooks:

1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw Hill , 4th Edition 2020
2. Frank Vahid & Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley Oct 2021.
3. Yifeng Zhu, Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, E-Man Press, Jan 2023.

Reference Books:

1. Richard Barry, Using the Free RTOS Real Time Kernel, Oct 2024

2. Brian Amos, Hands-On RTOS with Microcontrollers: Building Real-Time Embedded Systems using Free RTOS, STM32 MCUs, and SEGGER Debug Tools, Packet,2nd Edition 2023-24
3. Christopher Hallinan, Embedded Linux Primer: A Practical Real-World Approach, Pearson,2nd Edition 2011
4. Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, Linux Device Drivers, O'Reilly,3rd Edition, Publication Year-2005
5. Muhammad Ali Mazidi, Shujen Chen, Eshragh Ghaemi, STM32 Arm Programming for Embedded Systems, Micro DigitalEd., 1st Edition 2019
6. Pete Warden & Daniel Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, O'Reilly, 2020
7. Cem Ünsalan, Berkan Höke, Eren Atmaca, Embedded Machine Learning with Microcontrollers, Oct 2025

MOOC/NPTEL Courses:

1. NPTEL Course on "Embedded System Design with ARM" Link of the Course: https://nptel.ac.in/courses/106/105/106105193/

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology)(2024 Course) PCC-352- ECV Design for Testability		
Teaching Scheme:	**Credits:**	**Examination Scheme:**
Theory: 03 hrs./ week	**03**	**CCE: 30 Marks** **End Sem (Theory): 70 Marks**

- **Prerequisite Courses, if any:**

Digital Electronics

Companion Course, if any:

Design for testability Laboratory

Course Objectives:

- To describe the Testability of Combinational Circuits.
- To explain the Testability of Sequential Circuits.
- To illustrate the concepts of Built in Self-Test.
- To demonstrate the design for Testability of Memory Circuits.
- To illustrate Self Checking Circuits using various techniques.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Explain about Stuck at Faults in digital circuits.

CO2: Discuss about various testable designs of Multilevel Combinational Circuits.

CO3: Interpret the concept of controllability and observability and design rules of Ad-Hoc Design.

CO4: Explain various test Pattern generation techniques for BIST and describe various techniques of Output Response Analysis.

CO5: Illustrate basic concepts of Self-checking circuits.

Course Contents

Unit I	**Introduction of Design for Testability**	**(08 Hours)**
Types of faults, Need of Design for Testability (DFT), DFT Guideline, Testability, Fault models, Path sensitizing, Test pattern generation, Sequential circuit test, Built In Self Test, JTAG & Boundary scan, TAP Controller.		
Mapping of Course	**Explain about Stuck at Faults in digital circuits.**	

Outcomes for Unit I		
Unit II	**Design for Testability for Combinational Circuits**	**(08 Hours)**
Stuck at Faults, Fault diagnosis by Path Sensitization Technique, Reed Muller's expansion technique, OR AND-OR design, Automatic Synthesis of Testable Logic, Testable design of Multilevel Combinational Circuits.		
Mapping of Course Outcomes for Unit II	**Discuss various testable design of Multilevel Combinational Circuits.**	
Unit III	**Design for Testability for Sequential Circuits**	**(08 Hours)**
Controllability and observability, Ad-Hoc Design Rules for Improving Testability, Scan Path Technique for testable Sequential Circuit design, Level Sensitive Scan Design (LSSD), Random Access Scan Technique, partial Scan, and Boundary Scan.		
Mapping of Course Outcomes for Unit III	**Learn the concept Controllability and observability and design rules of Ad-Hoc Design.**	
Unit IV	**Built-In Self-Test**	**(08 Hours)**
Test Pattern generation for BIST, Output Response Analysis, Circular BIST, Built-In logic Block observer, Self-Testing using an MISR and Parallel Shift register Sequence generator, LSSD On-Chip Self-Test. BIST Techniques for RAM Chips.		
Mapping of Course Outcomes for Unit IV	**Explain various test Pattern generation techniques for BIST and describe various techniques of Output Response Analysis.**	
Unit V	**Self - Checking Circuits**	**(08 Hours)**
Basic concepts of Self checking circuits, Design of Totally Self Checking checker- Self Checking using m/n codes, Equality Checkers, Berger code, Self-Checking Combinational Circuits, Self -Checking Sequential Circuit.		
Mapping of Course Outcomes for Unit V	**: CO5:** Illustrate basic concepts of Self-checking circuits.	
Learning Resources		
Text Books: 1. Lala, Parag K. An Introduction to Logic Circuit Testing, Morgan & Claypool, 2009.		

2. Parag K. Lala, Digital Circuits Testing and Testability, Academic Press, 1997.

3. M. Abramovili, M.A. Breues, A. D. Friedman, Digital Systems Testing and Testable Design , Jaico publications, 2001.

Reference Books:

1. Zainalabedin Navabi, Digital System Test and Testable Design Using HDL Models and Architectures, Springer, 2011.

2. Parag K. Lala, Fault Tolerant & Fault Testable Hardware Design , PS Publications, 2002.

3. Weste and Eshraghian, Principles of CMOS VLSI Design, Pearson Education, 2 nd edition, 2000.

MOOC / NPTEL Courses:

1. NPTEL Course on “Digital VLSI Testing”, By Prof. Santanu Chattopadhyay, IIT Kharagpur, Link: https://onlinecourses.nptel.ac.in/noc20_ee76/ preview

Savitribai Phule Pune University

Third Year of Electronics Engineering (VLSI Design & Technology)(2024 Course)

PCC-353- ECV Embedded System Design Lab

Teaching Scheme:	**Credits:**	**Examination Scheme:**
Practical:02Hours/Week	01	**TermWork**:25Marks **Practical**: 25 Marks

Companion Course, if any:

Embedded System Design (PCC-351-ECV)

Course Objective: To make students understand

- To understand real-time embedded systems GPIO operations, timing mechanisms and hardware interfacing using STM32 microcontrollers and modern IDE tools.
- To learn Complex and communication-driven embedded and Real-Time Operating Systems (RTOS)
- To understand Integration of Intelligent Algorithms with hardware constraints to solve complex, real-world societal and industrial challenges.

Course Outcome:

Students will be able to:

CO1: Design and implement automated, hardware-interfaced embedded systems by configuring STM32 GPIOs, hardware timers for delays and integrating DC motor control circuits.

CO2: Develop and evaluate scalable, deterministic embedded solutions.

CO3: Develop and evaluate an intelligent, data-driven Edge AI application Smart Embedded Application.

List of Experiments

Group A: Any Three Experiments to be Performed

1. LED blinking on STM 32 microcontroller using GPIO output pins
2. Interface push button and LED using GPIO input pins
3. Timer Programming on STM32 Microcontrollers
4. DC Motor Interacting with STM 32 Microcontroller

Group B: Any Five Experiments to be Performed

5. ADC and Sensor Interfacing a) Interface temperature/LDR sensor with STM32 b) Read analog values using ADC
6. Transmit and receive data between STM32 and PC/another device
7. SPI/I2C Communication (Interface EEPROM/LCD/sensor module using SPI or I2C protocol)
8. Task Scheduling using Free RTOS
9. Inter task Communication in Free RTOS (Implement semaphore/mutex/queue communication)
10. Embedded Linux Experiment a) Kernel configuration and boot process study using U-Boot b) Basic Linux command execution / cross-compilation demo
Group C: Any one Mini project/Case study in a Group of 3-4 Students
11. Case Study/Mini project: Edge AI / Smart Embedded Application Build an application such as: Smart agriculture monitoring/ Smart vending machine not limited to this can be considered. 12: Case Study/Mini project: Edge AI / Smart Embedded Application Home automation system/ Smart healthcare monitoring not limited to this can be considered.
Virtual LAB Links: 1. https://vlabs.iitkgp.ac.in/rtes/ 2. https://esd-coep.vlabs.ac.in/List%20of%20experiments.html 3. https://esd-iitr.vlabs.ac.in/

Guidelines for Students Lab Journal	
1	Title of the experiment
2	Problem Statement
3	Ckt/Logic Design of given problem statement
4	Diagram with theory for operation
5	Experimentation
6	Observation/ Result table

7	Graphs if any
8	Conclusions
9	Mention real life examples concerned with the respective experiments
Guide lines for Laboratory/Term Work Assessment	
1	Continuous assessment of laboratory work based on overall performance and laboratory performance of students.
2	Each laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
3	Suggested parameters include timely completion, performance, efficiency, punctuality, and neatness.

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course) PCC-354- ECV Design for Testability Lab		
Teaching Scheme:	**Credit:**	**Examination Scheme:**
Practical: 02 hrs./ week	**01**	**Oral:** 25 Marks **Term Work:** 25 Marks

Prerequisite Courses, if any:

Digital Electronics

Companion Course, if any:

Design for testability

Course Objectives

- To introduce the fundamental concepts of Design for Testability (DFT), fault models, and testing methodologies used in VLSI and ASIC design.
- To develop the ability to design, simulate, and verify test circuits such as PRBS generators, test pattern generators, BIST architectures, and scan-based testing structures using HDL.
- To provide hands-on experience in fault detection, fault simulation, boundary scan testing, and evaluation of testability features in digital circuits.

Course Outcomes:

CO1: Apply Design for Testability techniques to improve the controllability, observability, and testability of digital circuits.

CO2: Design, simulate, and verify test pattern generators, scan-based circuits, hardware locks, and Built-In Self-Test (BIST) architectures using HDL tools.

CO3: Analyze and detect faults in digital systems using various fault models, fault simulation techniques, and boundary scan testing methodologies.

List of Laboratory Experiments: (Any 8)

1. Study of Design for Testability by using various parameters.
2. To design ,Synthesis and simulate PRBS generator.
3. To design ,Synthesis and simulate logic for testability for 4 bit shift register.
4. Design and simulation for three level OR-AND-OR design.
5 To design combinational logic circuits, create stuck at fault and simulate with a without faults.

6. To design a logic circuit for hardware lock which accepts certain test patterns, open write test bench and Simulate. 7. To design and simulate test pattern sequence generator which sends typical patterns to certain "Logic Under Test "(LUT) periodically. The LUT accepts the pattern and generates a signal if the pattern is correct. 8. To design and simulate Built In Self-Test (BIST) logic circuits for a typical 8*8 RAM 9. To design and simulate logic circuits for various fault models. 10. To demonstrate boundary Scan check process.
Virtual Labs: VLSI Design Testing Laboratory by NITK SURATHKAL: https://vlsi-nitk.vlabs.ac.in/List%20of%20experiments.html

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology)(2024 Course) PCC-361A- ECV Reconfigurable Computing		
Teaching Scheme:	**Credits:**	**Examination Scheme:**
Theory: 03 Hrs. / Week	**03**	**CCE: 30 Marks** **End Sem (Theory): 70 Marks**

Prerequisite course if any:

Basic Knowledge of Programmable Logic Devices

Course Objectives:

- To understand various computing architectures
- To analyse the reconfigurable computing requirements
- To evaluate of FPGA design in view of reconfiguration
- To examine various applications of reconfigurable computing

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

CO1: Explore various computing methods.

CO2: Explain Architecture and Design Characteristics of Reconfigurable Devices

CO3: Analyze different processing fabric reconfigurable architectures.

CO4: Study of various Reconfigurable computing systems and Reconfiguration management

CO5: Analyze different reconfigurable architectures.

Course Contents

Unit I	**Introduction to Reconfigurable Computing**	**(08 Hours)**
Types of computing and introduction to RC: General Purpose Computing, Domain-Specific Processors, Application Specific Processors; Reconfigurable Computing, Fields of Application; General-Purpose Computing Issues		
Mapping of Course Outcomes for Unit I	**CO1:** Explore various computing methods.	
Unit II	**Architecture and Design Characteristics of Reconfigurable Devices**	**(08 Hours)**

Reconfigurable Device Characteristics, Configurable, Programmable, and Fixed-Function Devices; Metrics: Density, Diversity, and Capacity; Interconnects, Requirements, Delays in VLSI Structures; Partitioning and Placement, Routing; Computing Elements, LUTs, LUT Mapping, ALU and CLBs; Retiming.		
Mapping of Course Outcomes for Unit II	**CO2:** Explain Architecture and Design Characteristics of Reconfigurable Devices	
Unit III	**Reconfigurable Processing Fabric Architectures**	**(08 Hours)**
Reconfigurable Processing Fabric Architectures: Fine-grained & Coarse-grained structures; RPF Integration into Traditional Computing Systems: Independent Reconfigurable Coprocessor Architectures, Loosely coupled RPF and processor architecture, Tightly coupled RPF and processor.		
Mapping of Course Outcomes for Unit III	**CO3: Analyze different processing fabric reconfigurable architectures.**	
Unit IV	**Reconfigurable computing systems and Reconfiguration management**	**(08 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.		
Mapping of Course Outcomes for Unit IV	**CO4: Study of various Reconfigurable computing systems and Reconfiguration management**	
Unit V	**Applications of Reconfigurable Computing**	**(08 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.		
Mapping of Course Outcomes for Unit V	**CO5: Analyze different reconfigurable architectures.**	

Learning Resources
Text Book: 1. Scott Hauck André DeHo, Reconfigurable Computing, 1st Edition, Morgan Kaufmann, eBook ISBN: 9780080556017, Hardcover ISBN: 9780123705228 **2.** C Bobda, Introduction to Reconfigurable Computing: Architectures, Algorithms, and Applications, Springer, 2007.
Reference Books: 1. Maya Gokhale, Paul Ghaham, "Reconfigurable Computing", Springer Publication 2. Andre Dehon, "Reconfigurable Architectures for General Purpose Computing" PhD thesis.

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology)(2024 Course) PEC-361B- ECV Web Technology (Program Elective - II)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory: 03 Hours/Week	**03**	**CCE: 30 Marks** **End Semester (Theory): 70 Marks**

Prerequisite Courses if any :

Object-Orientated Programming, Advanced JAVA Programming

Companion Course:

PEC-363-section I Lab (Web Technology Laboratory)

Course Objectives:

- To understand the fundamental concepts of HTML and CSS used in creating basic web pages
- To design interactive web pages using JavaScript, DOM manipulation, event handling, and modern ES6 features
- To learn the concepts of jQuery and PHP for developing interactive and dynamic web pages
- To understand the principles of component-based architecture and implement dynamic user interfaces using React.js
- To understand the fundamentals of web security, secure web communication, cyber threats, and Search Engine Optimization (SEO) techniques for improving website security, visibility, and performance.

Course Outcomes:

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

CO1: Recall and design basic web pages using HTML and CSS used in standard web page development.

CO2: Develop interactive webpages using basic JavaScript concept, DOM manipulation, event handling and ES6 feature

CO3: Develop interactive and dynamic web pages using jQuery and PHP with form handling, event handling, and database connectivity concepts.

CO4: Develop basic single-page web applications using React js components and state management.

CO5: Apply basic web security practices and SEO techniques to analyze and improve website

security and visibility.

Course Contents

Unit I	**Introduction to HTML and CSS**	**(08 Hours)**

Web Fundamentals: Architecture of WWW, HTTP/HTTPS protocols, servers, client–server model, URL structure, and the role of Web Browsers vs. Web Servers.

HTML: Structure of HTML Document, HTML Tags and Elements, Text Formatting, Lists, Links, Images, Tables, Forms and Input Controls.

CSS: Introduction to CSS, CSS Syntax and Selectors, Styling Text, Colors, Backgrounds, Margins, Padding, Inline, Internal and External CSS, Basic Webpage Layout using CSS. Introduction to BOOTSRAP and its components.

Exemplar: Create the structural skeleton for an "Electronic Component Data Sheet" and enhance the readability by designing using CSS.

Task 1: Use a text editor to write an HTML document that includes a <header> for the component name, a <table> for pin configurations, and a <form> for a "Request Quote" section.

Task 2: Create an external CSS file. Implement the Box Model to create distinct margins and padding between the table and the form. Use a two-column layout to place the image of the component next to its description.

Mapping of Course Outcomes for Unit I	**CO1:** Recall and design basic web pages using HTML and CSS used in standard web page development.

Unit II	**Client-side Technology: JavaScript and DOM**	**(10 Hours)**

Introduction to JavaScript: Features and importance of JavaScript, Client-side vs Server-side scripting, JavaScript syntax and structure, Embedding JavaScript in HTML. Variables, Data Types and Operators, Control Statements and Functions, Arrays and Strings.

DOM Manipulation and Event Handling: Accessing HTML elements, Event handling basics (on click, on change, on mouse over), Basic Form Validation.

Introduction to ES6 Features: let and const, Arrow Functions, Template Literals, Default Parameters.

Exemplar: Enhance a blogging application using JavaScript by implementing an “Add Entry” feature to dynamically add and display blog posts using DOM manipulation and event handling.

Mapping of Course Outcomes for Unit II	**CO2**: Develop interactive webpages using basic JavaScript concept, DOM manipulation, event handling and ES6 feature	
Unit III	**Web Scripting using jQuery and PHP**	**(10 Hours)**
JQuery: Introduction to jQuery, Loading jQuery, selecting elements, changing styles, creating, appending and removing elements, handling events, jQuery Effects, Form Handling using jQuery, Basic Validation using jQuery. **PHP:** Introduction to PHP, Features, Demo code, PHP SCRIPTS, PHP conditional statements and Loops, Functions, String manipulation, Arrays & Functions, pattern matching, Form handling, Cookies and Sessions tracking, File Handling, Exception Handling, E-mail validations, MySQL with PHP.		
Exemplar: Design an Interactive Calculator Webpage using jQuery Develop a Student Registration Web Application using PHP and MySQL		
Mapping of Course Outcomes for Unit III	**CO3:** Develop interactive and dynamic web pages using jQuery and PHP with form handling, event handling, and database connectivity concepts.	
Unit IV	**Introduction to React.js**	**(10 Hours)**
Introduction to Front-End Frameworks and React.js, Features and Advantages of React.js, Setting up React Environment using Node.js and npm, Introduction to JSX Syntax, Components in React,Props and State Management, Event Handling, Lists, Keys & Forms, Component Lifecycle, Introduction to React Hooks (use State, use Effect), React router, Styling in react.		
Exemplar: Basic Single Page Application (SPA). Implement a React component named Counter that displays a numeric value starting at 0. Use the use State hook to manage the count. Execute an event handler that increments the count when a button is clicked. Additionally, apply conditional rendering to display the text 'High Alert!' in red only when the count exceeds 10.		
Mapping of Course Outcomes for Unit IV	**CO4:** Develop basic single-page web applications using React js components and state management.	
Unit V	**Web Security and Search Engine Optimization (SEO)**	**(07 Hours)**

Introduction to Web Security: Basics of Web Security, Need of Web Security, Cyber Threats, Malware, Phishing, Website Vulnerabilities, Web Attacks, Secure Browsing Practices.

Web Security Mechanisms: HTTPS, SSL/TLS, Authentication & Authorization, Password Security, Firewalls, Cookies & Sessions, Basic Secure Coding Concepts.

Introduction to SEO: Introduction to Search Engine Optimization, Working of Search Engines, Web Crawlers & Indexing, Importance of SEO, Types of SEO (On-page, Off-page, Technical SEO).

SEO Tools & Optimization Techniques: Keyword Research, Meta Tags, Backlinks, Page Ranking, Mobile Friendly Websites, Google Search Console, SEO Analysis Tools, Social Media Optimization.

Exemplar:

1. Comparison of SEO optimization techniques used by educational, commercial, and social media websites. Students may choose websites with teacher approval. Tools Required: Google Chrome Browser, Internet Connection Online SEO Tools: SEO Site Checkup, GT metrix, Google Page Speed Insights.
2. Case studies on cyber-attacks.

Mapping of Course Outcomes for Unit V	**CO5**: Apply basic web security practices and SEO techniques to analyze and improve website security and visibility.

Learning Resources

Textbooks:

1. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", 2nd Edition, Pearson Education, 2007, ISBN 978-0131856035.

2. E. Enge, S. Spencer, and J. Stricchiola, "The Art of SEO", 3rd Edition. Sebastopol, CA, USA: O'Reilly Media, 2015. ISBN: 9781491948965.Steven Holzner, "PHP: The Complete Reference", McGraw Hill Professional, 2008

Reference Books:

1. David Flanagan," JavaScript: The Definitive Guide", 7th Edition, O'Reilly Media, 2020.
2. W. Stallings, Network Security Essentials: Applications and Standards, 6th Edition,Noida, India: Pearson Education, 2019.

e-Books:

1. https://goalkicker.com/ReactJSBook/
2. https://ibcomputerscience.xyz/wp-content/uploads/2017/09/1469306509-aab008e7ca1d715326928dade3196b2d-Web-Technologies-A-Computer-Science-Perspective-J.-

Jackson-Pearson-2007-BBS.pdf

3. https://eloquentjavascript.net/

MOOC / NPTEL/YouTube Links:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/aic22_ge30
2. https://www.coursera.org/specializations/seo
3. https://www.youtube.com/@GoogleSearchCentral
4. https://www.youtube.com/@Codevolution
5. https://www.coursera.org/specializations/web-design

e-**Resources:**

1. https://owasp.org/www-project-web-security-testing-guide
2. https://getbootstrap.com/docs/5.0/getting-started/introduction/
3. https://github.com/the-road-to-learn-react

Free Extra Certification:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/aic20_sp11
2. https://www.freecodecamp.org/learn/javascript-algorithms-and-data-structures/
3. https://www.coursera.org/specializations/front-end-development-using-react-specialization
4. https://www.freecodecamp.org/learn/front-end-development-libraries/
5. https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr25_ed123
6. https://www.coursera.org/professional-certificates/google-digital-marketing-ecommerce
7. https://academy.hubspot.com/courses/seo-training-course

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)		
PEC-361C- ECV Network and Cyber Security (Program Elective II)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory: 03 Hours/Week	03	**CCE:** 30 Marks **End Semester (Theory):**70 Marks

Prerequisite Courses, if any: Computer Network

Companion Course, if any: PEC-363C-section I Lab (Network and Cyber Security Lab)

Course Objectives:

- To understand the fundamentals of computer security, security principles, security attacks, and basic Cryptography techniques
- To learn advanced approaches of encryption, decryption and authentication algorithms
- To understand the internet security protocols, authentication techniques and countermeasures
- To understand the cyber threats, malware, system vulnerabilities, and web security issues
- To understand the cyber laws, data privacy regulations and governance frameworks

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

CO1: Apply basic cryptographic techniques for enhancing security.

CO2: Explain advanced cryptographic techniques and Authentication algorithms.

CO3: Interpret internet security protocols and authentication mechanisms and counter measures.

CO4: Illustrate cyber security threats, malware behavior, system vulnerabilities, and web security issues.

CO5: Analyze cyber laws, data privacy regulations, and cyber governance frameworks.

Course Contents

Unit I	**Fundamentals of Network security and Cryptography**	**(09 Hours)**

Need for security, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security, Substitution techniques (Caesar cipher, Vernam cipher , Playfair cipher), Transposition techniques (Rail fence and Columnar transposition), Symmetric and Asymmetric key cryptography, Steganography.

Exemplar : Online banking applications protect customer accounts using passwords, OTPs, and

encryption to prevent unauthorized access and financial fraud.encryption to prevent unauthorized access and financial fraud.		
Mapping of Course Outcomes for Unit I	**CO1:** Apply basic cryptographic techniques for enhancing security.	
Unit II	**Symmetric, Asymmetric Cryptography and Authentication**	**(09 Hours)**
Block Cipher, Stream Cipher, Modes of operation in Block Cipher, Symmetric Key Algorithms (DES, AES), Asymmetric Key Algorithms (RSA, Diffie-Hellman Key Exchange), Authentication algorithms, SHA, MAC, Passwords, Authentication Tokens, Certificate-based Authentication, Biometric Authentication, Kerberos, Key Distribution Center (KDC).		
Exemplar: Secure Authentication and Encrypted Communication System		
Mapping of Course Outcomes for Unit II	**CO2:** Explain advanced cryptographic techniques and Authentication algorithms.	
Unit III	**Internet Security Protocols**	**(09 Hours)**
Secure Socket Layer (SSL), Transport Layer Security (TLS), Secure Hyper Text Transfer Protocol (SHTTP), Time Stamping Protocol (TSP), Electronic Money, Email Security, Security in 5G, Virtual Private Network (VPN), IoT Security, IPsec, Countermeasures: Firewall, Secure Inter-branch Payment Transactions, Virtual E-Lections.		
Exemplar: Network Security Analysis using Wireshark		
Mapping of Course Outcomes for Unit III	**CO3:** Interpret internet security protocols and authentication mechanisms and counter measures.	
Unit IV	**Foundations of Cyber Security**	**(09 Hours)**
Definition and Importance of Cyber Security, Cyber Security Goals, Cyberspace and its Components, Challenges in Cyberspace: Threats, Vulnerabilities and Risks. Evolution of Cybersecurity, Cyber Attacks and Malware, Intrusion Detection and Prevention Systems, Securing Your Digital Presence: Password Security and Management, Multi-Factor Authentication (MFA), Social Engineering & Online Scams, Secure Browsing and Phishing Awareness, Ransomware. Common Web Vulnerabilities: SQL Injection, Cross Site Scripting (XSS), Cross Site Request Forgery (CSRF).		
Exemplar: Wanna Cry ransomware, phishing and social engineering incidents, MFA bypass scenarios, AI-enabled deep fake attacks, IDS/IPS deployment examples (Snort/Suricata), and email		

authentication mechanisms.		
Mapping of Course Outcomes for Unit IV	**CO4:** Illustrate cyber security threats, malware behavior, system vulnerabilities, and web security issues.	
Unit V	**Cyber Ethics and Cyber Governance**	**(09 Hours)**
Cyber Laws, Cyber Crimes: Definition, Classification and The Vicious Cycle of Cybercrime. Cyber Ethics and Professional Responsibility: Ethical Hacking Concepts, Responsible Use of Social Media, Professional Ethics for Engineers. Data Privacy and Cyber Governance: Personal Data Protection Concepts, Data Breach and Privacy Risks, Cyber Security Policies and Governance, National Cyber Security Policy (India), International Cyber Security Standards, Introduction to: ISO/IEC 27001, GDPR (General Data Protection Regulation), Careers in Cyber Security.		
Exemplar: Misuse of organizational computer resources violating professional ethics and cyber policies.		
Mapping of Course Outcomes for Unit V:	**CO5:** Analyze cyber laws, data privacy regulations, and cyber governance frameworks	

Learning Resources

Textbooks:

1. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson Education, 4th Edition, 2006.
2. Atul Kahate, "Cryptography and Network Security", McGraw Hill, 3rd Edition, 2013.
3. Nilakshi Jain and Ramesh Menon, "Cyber Security and Cyber Laws", Wiley India, 1st Edition, 2020.
4. William Stallings and Lawrie Brown, "Computer Security: Principles and Practice", Pearson Education, 4th Edition, 2017.

Reference Books:

1. Behrouz A. Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", McGraw Hill, 2nd Edition, 2012.
2. Mark Stamp, "Information Security: Principles and Practice", Wiley India, 2nd Edition, 2011.
3. W.M. Arthur Conklin and Greg White, "Principles of Computer Security", TMH, 4th Edition, 2015.

4. Neal Krawetz, "Introduction to Network Security", CENGAGE Learning Distributor, 1st Edition, 2007.
5. Bernard Menezes, "Network Security and Cryptography", CENGAGE Learning Distributor, 1st Edition, 2010.
6. Michael E. Whitman and Herbert J. Mattord, "Principles of Information Security", Cengage Learning, 6th Edition, 2017.
7. Surya Prakash Tripathi, Ritendra Goel and Praveen Kumar Shukla, "Information Security, Cyber Laws and Cyber Forensics", Wiley India, 1st Edition, 2014

MOOC / NPTEL Courses:

1. NPTEL Course on: Introduction to Cyber Security, Prof. Indranil Sengupta, IIT Kharagpur. Link:https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
2. NPTEL Course on: Cyber Security and Privacy, Prof. Saji K. Mathew, IIT Madras. Link:https://nptel.ac.in/courses/106106248
3. NPTEL Course on: Ethical Hacking, Prof. Indranil Sengupta, IIT Kharagpur. Link:https://nptel.ac.in/courses/106105217
4. NPTEL Course on: Internet Crimes and Cyber Security, Prof. K.V.K. Santhy and Prof. B. Md. Irfan, NALSAR University of Law. Link:https://nptel.ac.in/courses/129106894

Savitribai Phule Pune University

Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)

PEC-361D- ECV Digital Image Processing (Program Elective -II)

Teaching Scheme	**Credits**	**Examination Scheme**
Theory: 03 Hours/Week	03	**CCE:** 30 Marks **End Semester (Theory):** 70 Marks

Prerequisite Courses, if any:

Signals and Systems, Digital Signal Processing

Companion Course, if any:

PEC-363D-section I Lab (Digital Image Processing Laboratory)

Course Objectives:

- To understand the fundamentals of digital image processing, image representation, and color models.
- To understand the image enhancement techniques in spatial and frequency domains.
- To learn image segmentation and feature extraction methods.
- To learn image compression techniques for efficient storage and transmission.
- To understand theAI-driven computer vision systems and emerging real-world applications.

Course Outcomes:

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

CO1: Explain the fundamentals of digital image processing, image representation, and color models for image analysis.

CO2: Apply spatial domain enhancement and filtering techniques for image quality improvement and noise reduction.

CO3: Implement frequency domain enhancement and image segmentation techniques for image analysis and feature extraction

CO4: Analyze image compression techniques using DCT and DWT for evaluating compression performance**.**

CO5: Apply computer vision and AI techniques to study intelligent image and video processing solutions for real-world applications.

Course Contents

Unit I	**Fundamentals of Digital Image Processing**	**(09 Hours)**

Fundamental steps in image processing, components of Image Processing, Image formation in the eye, Image Sampling and Quantization, types of images, Image Histogram, image file formats, basic relationships between pixel, mathematical operations performed on images, set operations, color fundamentals, Color Models – RGB, CMY, HSI, chromaticity diagram		
Exemplar: Smart Traffic Monitoring System using CCTV Image Acquisition Study how digital cameras acquire traffic images and how preprocessing improves vehicle detection accuracy.		
Mapping of Course Outcomes for Unit I	**CO1: Explain** the fundamentals of digital image processing, image representation, and color models for image analysis.	
Unit II	**Image Enhancement in Spatial Domain**	**(09 Hours)**
Introduction to Image Enhancement, Need for Image Enhancement, Image enhancement fundamentals Spatial Domain Fundamentals, Concept of spatial domain processing, Point processing operations, Neighborhood processing operations, Relationship between pixels and masks .Gray-Level Transformations, Image negative, Log transformation, Power-law (Gamma) transformation, Piecewise linear transformation, Contrast stretching, Gray-level slicing, Bit-plane slicing. Spatial Filtering Techniques, Smoothing Filters: Mean filter, Weighted average filter, Median filter Sharpening Filters, Gradient operators, Laplacian filtering, High-boost filteringNoise Models and Noise Reduction, Gaussian noise, Salt and pepper noise, Periodic noise, Noise removal using spatial filters.		
Exemplar Medical X-ray Image Enhancement Analyze how enhancement techniques improve visibility of fractures and abnormalities in medical images		
Mapping of Course Outcomes for Unit II	**CO2: Apply** spatial domain enhancement and filtering techniques for image quality improvement and noise reduction.	
Unit III	**Image Enhancement and Segmentation in Frequency Domain**	**(09 Hours)**
Introduction to Frequency Domain Processing, Fundamentals of frequency domain image processing Spatial domain vs frequency domain processing, Concept of spatial frequency: Low-frequency components, High-frequency components. Frequency Domain Image Enhancement, Low-Pass Filtering (Image Smoothing), Ideal Low Pass Filter (ILPF), Butterworth Low Pass Filter (BLPF), Gaussian Low Pass Filter (GLPF). High-Pass Filtering (Image Sharpening), Ideal High Pass Filter		

(IHPF), Butterworth High Pass Filter (BHPF), Gaussian High Pass Filter (GHPF), Image Segmentation Techniques, Edge-Based Segmentation, Detection of discontinuities: Roberts operator, Prewitt operator, Sobel operator, Canny edge detector, Threshold-Based Segmentation: Global thresholding, Adaptive thresholding, Region-Based Segmentation, Region growing, Region splitting and merging.		
Exemplar: Defect Detection in Manufacturing Industry .Study segmentation methods used for identifying cracks and defects in electronic components or mechanical parts.		
Mapping of Course Outcomes for Unit III	**CO3: Implement** frequency domain enhancement and image segmentation techniques for image analysis and feature extraction	
Unit IV	**Image Compression**	**(08 Hours)**
Need of Image Compression, Image compression model, Types of image compression- Lossy and lossless, Huffman coding for image compression, Compression using Discrete Cosine Transform, 8X8 block DCT, processing pipeline, Wavelet based compression- DWT, Compression ratio, relative data redundancy, compression ratio vs quality trade-off.		
Exemplar: Use of DCT in JPEG Image compression		
Mapping of Course Outcomes for Unit IV	**CO4: Analyze** image compression techniques using DCT and DWT for evaluating compression performance**.**	
Unit V	**AI-Driven Computer Vision Systems and Applications**	**(09 Hours)**
Introduction to computer vision, AI-assisted image processing, Basics of machine learning for images Object detection concepts, Face recognition fundamentals, Real-time video processing, Embedded vision systems, Edge AI and IoT vision devices, Ethical issues in AI-based vision systems, Emerging applications: Autonomous vehicles, Smart cities, Healthcare diagnostics, Agriculture monitoring		
Exemplar: Face Recognition System for Smart Attendance. Analyze the working of AI-based face recognition systems used in modern educational institutions and industries		
Mapping of Course Outcomes for Unit V	**CO5: Apply** computer vision and AI techniques to study intelligent image and video processing solutions for real-world applications.	

Textbooks:

1. Gonzalez & Woods, “Digital Image Processing”, Pearson Education, 4th Edition, 2018.
2. Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, Digital Image Processing Using MATLAB, 3rd Edition,2020.

3. Computer Vision: Algorithms and Applications — Richard Szelisk, Publication Springer,2022

Reference Books:

1. Jain Anil K., “Fundamentals Digital Image Processing”, Prentice Hall India, 4th Edition. Reprint 2015
2. Khalid Sayood, "Introduction to Data Compression", 5th Edition, Morgan Kaufmann,Elseveir 2026
3. 3Deep Learning for Vision Systems — Mohamed Elgendy,1st Edition,Manning Publications ,2020
4. Learning OpenCV 4 Computer Vision with Python 3 — Joseph Howse & Joe Minichino,3rd Edition 2020

MOOC / NPTEL Courses:

1. Digital Image Processing (IIT kharagpur) : https://nptel.ac.in/courses/117105135
2. Digital Image Processing. https://nptel.ac.in/courses/117/105/117105079
3. Digital Image Processing.” https://nptel.ac.in/courses/106/105/106105032

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course) PCC-362A-ECV Semiconductor IC Fabrication Technology (Elective-III)		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory: 03 Hours/Week	03	**CCE**: 30 Marks **End Semester (Theory):** 70 Marks

Prerequisites if any:

- Semiconductor Physics
- Electronic Devices
- Basic Chemistry and Material Science

Course Objectives:

- To understand semiconductor materials and device fundamentals
- To learn wafer preparation and crystal growth techniques used for silicon substrate manufacturing.
- To study various IC fabrication processes
- To understand CMOS, NMOS, and Bipolar fabrication technologies
- To develop awareness of modern nanotechnology and advanced semiconductor

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

CO1: Understand the fundamentals of semiconductor materials and device physics related to IC fabrication.

CO2: Describe wafer preparation methods and substrate manufacturing processes.

CO3: Explain major IC fabrication steps

CO4: Analyze CMOS, NMOS, Bipolar, and BiCMOS fabrication processes used in integrated circuit manufacturing.

CO5: Apply knowledge of semiconductor fabrication techniques to modern VLSI technologies.

Course Contents:

Unit I	**Semiconductor Fundamentals**	**(07 Hours)**

Classification of materials: Conductors, Insulators, Semiconductors, Intrinsic and Extrinsic Semiconductors, Energy band theory, Electrons and holes , Carrier concentration and mobility, Drift and diffusion current , PN junction basics , Semiconductor materials used in IC fabrication (Si, Ge, GaAs)

Mapping of Course Outcomes for Unit I	**CO1:** Understand the fundamentals of semiconductor materials and device physics related to IC fabrication.	
Unit II	**Wafer Preparation and Crystal Growth**	**(09 Hours)**
Silicon as semiconductor material, Crystal structure of silicon , Electronic grade silicon production, Crystal growth techniques: Czochralski method , Float Zone method , Ingot slicing and wafer formation, Lapping, polishing, cleaning, Epitaxial growth, Wafer specifications and defects		
Mapping of Course Outcomes for Unit II	**CO2:** Describe wafer preparation methods and substrate manufacturing processes.	
Unit III	**Oxidation, Lithography and Etching**	**(09 Hours)**
Thermal oxidation process , Silicon dioxide properties, Photolithography process steps , Photoresists: Positive and Negative, Mask generation , Wet etching and Dry etching , Plasma etching , Process limitations		
Mapping of Course Outcomes for Unit III	**CO3:** Explain major IC fabrication steps	
Unit IV	**Doping, Diffusion and Thin Film Deposition**	**(09 Hours)**
Impurity doping concepts , Diffusion process , Ion implantation , Annealing , Thin film deposition: CVD, PVD, Sputtering; , Metallization techniques , Interconnection layers		
Mapping of Course Outcomes for Unit IV	**CO4:** Analyze CMOS, NMOS, Bipolar, and BiCMOS fabrication processes used in integrated circuit manufacturing.	
Unit V	**CMOS Fabrication, Packaging and Testing**	**(08 Hours)**
NMOS fabrication process , PMOS fabrication process , CMOS fabrication using twin-tub / n-well / p-well , CMOS process flow , Packaging techniques , IC testing methods , Yield, reliability and failure analysis , CMOS scaling trends , FinFET and advanced transistor structures, SoC fabrication concepts **Overview of modern VLSI technology** : Scaling of MOSFET devices in deep submicron and nanometer technologies, Fabrication challenges in advanced technology nodes (FinFET, GAAFET), Semiconductor fabrication for AI, IoT, FPGA and SoC devices		
Mapping of Course Outcomes for Unit V	**CO5:** Apply knowledge of semiconductor fabrication techniques to modern VLSI technologies	
Textbooks:		

1. James D. Plummer, Michael D. Deal, Peter B. Griffin, “Silicon VLSI Technology: Fundamentals, Practice and Modeling”
2. Sorab K. Ghandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide
3. S. M. Sze, VLSI Technology
4. Quirk & Serda – *Semiconductor Manufacturing Technology*

Reference Books:

1. James M. Fiore, Semiconductor Devices:Theory and Application. 2E,
2. Peter Y. Yu, Manuel Cardona, **Fundamentals of Semiconductors**-Physics and Materials Properties, 4E, Springer
3. Dieter K. Schroder, Semiconductor Material And Device Characterization,

Savitribai Phule Pune University

Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)

PCC-362B-ECV Power Converters and Applications (Program Elective-III)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs./week	03	CCE: 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

- Basic Electrical Engineering
- Basic Electronics Engineering
- Basic Mathematics

Course Objectives:

- To study different power devices viz. SCR, MOSFET,IGBT and GTO .Their turn on requirements and triggering/driver circuits.
- To understand working, and performance analysis of various power converter circuits such as controlled rectifiers, inverters and choppers.
- To know various ratings, protection circuits and applications of power electronics devices.

Course Outcomes: On completion of the course, learner will be able -

CO1: Understand the functionality of SCR, MOSFET & IGBT along with their triggering / driver circuits

CO2: Analyse performance parameters of the AC to DC converters (Controlled Rectifiers)

CO3: Understand operation of single and three phase DC to AC converters (Inverters)

CO4: Evaluate the performance parameters of DC TO DC converters and switch mode regulators (DC Choppers)

CO5: Understand device ratings, protection circuits and applications of power devices.

Course Contents

Unit I	Study of Power Devices	(08 Hours.)

Basic Construction and VI characteristics of SCR. Synchronized gate pulse triggering circuit for SCRs using UJT oscillator. Block diagram / logic for triggering circuit using microcontroller. Use of pulse transformer and Opto- Isolator in triggering circuit. Typical gate drive requirements and circuit for Power MOSFET, IGBT and GTO. Comparison of SCR, Power MOSFET, IGBT and GTO.

Mapping of course Outcomes for Unit I	**CO1: To understand functionality of SCR, MOSFET & IGBT along with their triggering / driver circuits.**	
Unit II	**AC to DC Power Converters (Controlled Rectifiers)**	**(09 Hours.)**
Study of Single phase Semi converter (H.C.B.R) & Full converter (F.C.B.R.) using SCR for R And R-L loads (continuous conduction only) along with relevant waveforms. Inversion mode of operation for F.C.B.R feeding active load (continuous conduction) for firing angle greater than 90 degree with waveform for output voltage and load current. Derivation for Average and RMS output voltage. Numerical to find out performance parameters like output voltage, ripple factor and power factor. Effect of Freewheeling diode on F.C.B.R and significance of power factor.		
Mapping of course Outcomes for Unit II	**CO2: To analyse performance parameters of the AC to DC converters (Controlled Rectifiers)**	
Unit III	**DC to AC Converters (Inverters)**	**(09 Hours.)**
Single phase half bridge and full bridge square wave inverter for R and R-L load using MOSFET / IGBT and its performance analysis. Study of functional diagrams of IC SG 3525 and IR 2110 used in practical Inverter circuits. Operation of Three Phase voltage source inverter for balanced star connected R load with 120 and 180 degree mode of operation along with waveform and equation for output voltage. (No derivations and numerical).		
Mapping of course Outcomes for Unit III	**CO3 : To understand operation of single phase and three phase DC to AC converters (Inverters)**	
Unit IV	**DC to DC Converters (DC Choppers)**	**(09 Hours.)**
Operation of basic step down chopper for R and R+L load (continuous conduction) using Power MOSFET / IGBT as controlled switch along with proper waveform and equation for output voltage. Various control strategies for choppers. Study of Buck converter and Boost Converter along with relevant waveforms. (No derivations and numerical)		
Mapping of course Outcomes for Unit IV	**CO4:** To evaluate the performance parameters of DC TO DC converters and switch mode regulators (DC Choppers)	
Unit V	**Power Electronics Applications**	**(08 Hrs.)**
Important voltage and current ratings of power devices. Overvoltage, Overcurrent, dv/dt and di/dt		

protection circuits for SCR. Applications: Fan Regulator Circuit using Triac- Diac, Block diagram of On-line and Off- line UPS. Fly back converter SMPS and Full Bridge converter SMPS. Case study of Solar roof top PV system and block diagram explanation. (No derivations and numerical)	
Mapping of Course Outcomes for Unit V	**To understand device ratings, protection circuits and applications of power devices.**
Learning Resource	
Text Books: 1. M. H. Rashid- Power Electronics: Devices, Circuits and Applications - 4th edition, Pearson education, New Delhi. 2. DR. P.S. Bimbhra -Power electronics- 6th edition, Khanna Publishers New Delhi. 3. Alok Jain – Power Electronics and applications – 2nd edition, Penram International (India) Pvt.ltd.	
Reference Books 1. Dr. P.C.Sen- Modern Power Electronics- 2nd Revised edition, S.Chand Publisher, New Delhi. **2.** Dr.M. D. Singh and K. B. Khanchandani - Power Electronics-2nd Revised edition TMH Publisher	

Savitribai Phule Pune University

Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)

PEC-362C-ECV Artificial Intelligence (Program Elective III)

Teaching Scheme	**Credits:**	**Examination Scheme**
Theory:03Hours/Week	**Theory:**03Hours/Week	**Theory:**03Hours/Week

Prerequisite Courses, if any:

Nil

Companion Course, if any:

PEC-363C-ECV: Program Elective Course Lab (Elective 3)

Course Objectives:

- To understand the fundamentals of Artificial Intelligence (AI), environment and problem-solving approaches used in AI systems.
- To learn the search techniques like uninformed, heuristic, optimal applicable to real world AI problems.
- To understand the knowledge representation techniques, inference mechanisms for development of expert systems.
- To understand the Realization of planning, learning and analysis concept for intelligent decision support by expert systems.
- To learn the applications in the field of AI with knowledge of ethics for future technologies.

Course Outcomes:

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

CO1: Explain intelligent agents, environment and problem solving in AI.

CO2: Implement AI based search and optimization techniques related to real world AI problems.

CO3: Develop knowledge-based AI models with the help of inference mechanism and rule value approach.

CO4: Apply AI planning and learning techniques in the analysis of expert system towards intelligent decision making.

CO5: Assess the AI techniques for real world application along with ethical, social, and future challenges.

Course Contents

Unit I	**Introduction to Artificial Intelligence, Intelligent Agents and Problem Solving in AI**	**(09Hours)**

Introduction: Definition and Concept of AI, History and Evolution of AI, Characteristics of Intelligent Systems, Benefits and Limitations of AI, Intelligent Agents: Definition, Structure, Types. Agents and Environments, Types of Environments: Observability: Fully Observable, Partially Observable, Predictability: Deterministic, Stochastic, Dynamics: Static, Dynamic, Continuity: Discrete, Continuous, Interaction and Agents: Single Agent, Multi-Agent, Independence of Action Sequence: Episodic, Sequential, Agent`s Knowledge: Known and Unknown Environment. Problem Solving Agents, Problem Solving Approach to Typical AI Problem, State Space Search, Search Strategies: Uninformed, Informed, Heuristics. Constraint Satisfaction Problems, Constraint Propagation, Backtracking and look ahead strategies Search.		
Exemplar: Google Assistant, Netflix, Google Map, Robotic Vaccum Cleaner, Chess, Pocker Game, Calculator, Airline Booking System.		
Mappig of Course Outcomes for Unit I	**CO1:** Explain intelligent agents, environment and problem solving in AI.	
Unit II	**Search Techniques**	**(09Hours)**
Uniformed Search Techniques: Breadth First Search (BFS), Depth First Search (DFS), Uniform Cost Search. Informed (Heuristic) Search Techniques: Best First Search, Greedy Search. Optimal Search: A* Algorithm. Heuristic Function, Generate and Test, Hill Climbing, Beam Search, Tabu Search. Constraint Satisfaction Problems (CSP), Game Playing: Minimax Algorithm, Alpha-Beta Pruning, Introduction to Reinforcement Learning Concepts, AI based Optimization Techniques.		
Exemplar: Shortest Route-Finding Problem, Puzzle Problem, Social Media Friend Search, Maze solving Robot, GPS Navigation, Robot Navigation, Advanced Game Engines, Autonomous Vehicles and Robotics, Alpha Go, Robot Navigation, Airline Scheduling System.		
Mapping of Course Outcomes for Unit II	**CO2**: Implement AI based search and optimization techniques related to real world AI problems.	
Unit III	**Knowledge Representation and Inference**	**(09Hours)**
Knowledge Based Agents: Knowledge Representation, Types of Knowledge, Structured Representation of Knowledge, The Wumpus World problem, Logical Agents. Propositional Logic: Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic, Predicate Logic, First Order Logic: Representation Revisited, Syntax and Semantics of First Order Logic, Knowledge Engineering in First Order Logic. Rule based Expert System, Rules. Inference Mechanism: Unification, Reasoning, Resolution, Forward Chaining, Backward Chaining Rule Value Approach. Knowledge		

Representation: Conceptual Dependency, Frames, Semantic nets.		
Exemplar: Amazon and Alexa, Netflix, Google Assistant, BBC Interactive News, Chatbots, IBM Watson, ChatGPT, Microsoft Copilot, Tesla Autonomous Driving AI.		
Mapping of Course Outcomes for Unit III	**CO3**: Develop knowledge-based AI models with the help of inference mechanism and rule value approach.	
Unit IV	**Planning, Learning and Analysis in Expert Systems**	**(09Hours)**
AI Planning: Block World Problem in Artificial Intelligence, Goal Tree in AI Problem Solving, Non-linear Planning for Intelligent Systems, Hierarchical Planning in AI, Goal Stack Planning Techniques. AI Learning Concepts: Definition of Learning in AI, Forms of Learning, Learning by Taking Advice, Learning in AI Problem Solving, Inductive Learning, Explanation Based Learning (EBL), Formal Learning Theory, Ensemble Learning Methods. AI Expert Systems: Intelligent Systems vs Expert Systems, Architecture of AI Expert Systems, Roles and Applications of Expert Systems, Knowledge Acquisition in AI Systems, Meta Expert System Shells. Analysis in Expert System: Knowledge Base, Inference Engine, Explanation Facility, Mechanism: Rule Matching, Handling Uncertainty, Reasoning.		
Exemplar: Automated Warehouse Robots, GPS Route Planning, Spam Email filtering, Medical Diagnosis Systems, Banking Fraud Detection, Intelligent Tutoring System, Industrial Equipment Logs to Perform Fault Diagnosis and Suggest Repairs.		
Mapping of Course Outcomes for Unit IV	**CO4:** Apply AI planning and learning techniques in the analysis of expert system towards intelligent decision making.	
Unit V	**Emerging AI Applications and Ethics**	**(08Hours)**
AI in Natural Language Processing (NLP), Speech Recognizer, Computer Vision, Healthcare, Education, Banking and Finance, Transportation and Smart Mobility. Cyber Security, E-Commerce and Business, Social Media, Security. AI in Robotics: Robotic Sensors, Domestic Robots, Agricultural Robots, Edge AI & Tiny ML basics. Philosophy and Ethics of AI: Ethical Issues, Safety, Privacy and Surveillance, Manipulation of behavior, Bias in Decision Systems, Social Impact of AI Systems. Future AI Technologies: Explainable AI (XAI), Generative AI (Gen AI), Case Study.		
Exemplar: Digital payments, Smart Harvesting, Self Driving Cars, Smart Navigation, Green AI, Face Recognition, Chatbots, Google Translate, Smart Cities, Autonomous Assistants, Workflow Automation.		

Mapping of Course Outcomes for Unit V	**CO5**: Assess the AI techniques for real world application along with ethical, social, and future challenges.

Learning Resources

Textbooks:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence- A Modern Approach", Pearson Education/Prentice Hall of India, Fourth Edition, 2020.
2. Sam Bhagwat, "Principles of building AI Agents", Independently published, First Edition, 2025.
3. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley Publishing Company, Third Edition,1992.
4. Alger Fraley, "Artificial Intelligence and Generative AI Bible", Algo Ray Publishing, First Edition, 2023.
5. Paula Boddington, "Towards a code of Ehics for Artificial Intelligence", Springer International Publishing, First Edition, 2017.
6. Pete Warden, Daniel Situnayake, Frank Vahid, Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction" Willey Publisher, First Edition, 2002.

Reference Books:

1. Saroj Kausik, "Artificial Intelligence" Cengage Learning, Second Edition, 2022.
2. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 1st Edition, 2005.
3. Deepak Khemani, "A First Course in Artificial Intelligence", Tata McGraw Hill Education India, 2013.
4. George F. Luger,"Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Pearson Education, 6th Edition, 2008.
5. Elaine Rich, Kevin Knight and Shivshankar Nair, "Artificial Intelligence", Tata Mc-Graw Hill Education India, 3rd Edition, 2009.

MOOC/NPTEL Courses:

1. https://cse.iitkgp.ac.in/~pallab/artificial_intelligence_autumn_2020/index.html
2. http://nptel.ac.in/courses/106105077/
3. https://onlinecourses/.nptel.ac.in/noc25_cs137/preview
4. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
5. https://onlinecourses.nptel.ac.in/noc23_ge40/preview
6. https://plato.stanford.edu/entries/ethics-ai/
7. https://intelligence.org/files/ EthicsofAI.pdf

Savitribai Phule Pune University

Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)

PCC-362D-ECV Broadband Communication (Program Elective- III)

Teaching Scheme	Credits	Examination Scheme
Theory: 03 Hours/Week	03	**CCE:**30 Marks **End Semester (Theory):** 70 Mark

Prerequisite Courses, if any: Cellular Network

Companion Course, if any: Broadband Communication Laboratory

Course Objectives:

- To understand the fundamentals of broadband communication technologies and Quality of Service (QoS) requirements in modern telecom networks.
- To learn the Fiber Optic Communication Systems, GPON/EPON technologies, FTTH architecture, and WDM concepts used in broadband networks.
- To learn the evolution, architecture, and advancements of mobile broadband technologies from 3G to 5G.
- To understand the knowledge of broadband wireless technologies and their applications in present-day communication systems.
- To understand the practical and industry-oriented skills related to broadband networking, configuration, deployment, and troubleshooting.

Course Outcomes:

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

CO1: Explain various broadband technologies used in the telecom industry and the significance of Quality of Service (QoS) parameters.

CO2: Analyze fibre optic communication technologies, GPON/EPON systems, FTTH architecture, and WDM concepts used in broadband networks.

CO3: Analyze the architecture, features, and technological advancements of mobile broadband technologies from 3G to 5G networks.

CO4: Evaluate broadband wireless technologies and their applications in modern communication networks.

CO5: Analyze industry-oriented networking tools and practices, configuration and broadband deployment.		
Unit I	**Introduction to Broadband Ecosystem & Industry Overview**	**(09 Hours)**
Evolution from PSTN TO Gigabit Internet, Broadband Market Landscape (ISP, Telecom Operator, Data Centers, Internet Architecture & Service provider, Multiplexing in Broadband TDM ,FDM . Broadband performance metrics (Latency, Throughput, Jitter) QoS & SLA concepts		
Exemplar: Draw and explain the end-to-end architecture of Internet service delivery from Data Centres to End Users. **OR** Identify the roles of ISPs, Telecom Operators, Internet Exchange Points (IXPs), and Content Delivery Networks (CDNs).		
Mapping of Course Outcomes for Unit I	**CO1:** Explain various broadband technologies used in the telecom industry and the significance of Quality of Service (QoS) parameters.	
Unit II	**Introduction to Fibre Optic Communication for Broadband Networks**	**(09 Hours)**
Optical communication bands, selection of optical sources and photodetectors, types of optical fibres (brief introduction), GPON and EPON – concepts and architecture, FTTH- concept (ONT, OLT, and BNG) fiber network planning fundamentals.		
Exemplar : FTTH Deployment Case Study- Study a real-world FTTH deployment by BSNL FTTH, JioFiber, Airtel Xstream Fiber, or Tata Play Fiber.		
Mapping of Course Outcomes for Unit II	**CO2:** Analyze fibre optic communication technologies, GPON/EPON systems, FTTH architecture, and WDM concepts used in broadband networks.	
Unit III	**Broadband Access Networks (ISP Technologies)**	**(09 Hours)**
Introduction to DWDM (Architecture, DWDM Principles, advantages, Deployment) Wireless broadband concepts -Wi-Fi (IEEE 802.11), WiMAX (IEEE 802.16),3G, 4G LTE, 5G overview, Satellite broadband communication - Internet System(overview), Spectrum management.		
Exemplar: Study a telecom backbone network employing DWDM technology. **OR** Case Study: Analyze how DWDM enables high-capacity transmission for long-haul and metro networks.		
Mapping of Course Outcomes for Unit III	**CO3**: Analyze the architecture, features, and technological advancements of mobile broadband technologies from 3G to 5G networks configuration and	

	broadband deployment.	
Unit IV	**Wireless Broadband Communication**	**(09 Hours)**
Introduction to Cloud Computing, Evolution of cloud computing, Cloud service models: IaaS ,PaaS, SaaS. Data centre basics, Challenges in traditional cloud networking. Edge computing basics, Cloud Networking basics. Introduction to SDN, Traditional vs SDN networking, Control plane and data plane, SDN architecture, OpenFlow basics.Virtual networking concepts Traffic engineering in cloud, QoS management, Dynamic bandwidth allocation, Security in SDN-cloud networks, QoS management.		
Exemplar: Create a timeline showing the evolution from traditional computing to virtualization, cloud computing, edge computing, and distributed cloud architectures.		
Mapping of Course Outcomes for Unit IV	**CO4:** Evaluate broadband wireless technologies and their applications in modern communication networks.	
Unit V	**Broadband Switching and Networking Protocols with Emerging Technologies**	**(09 Hours)**
Ethernet IP, TCP, UDP, ATM, Traditional MPLS, Advanced Routing Protocols OSPF/ BGP/ IS-IS, SDN based MPLS, FRAME RELAY, SONET/SDH Network performance using QoS, Network virtualization Concepts. AI in Network Management, Broadband for IoT, Introduction to 6G Evolution.		
Exemplar: Prepare a protocol comparison chart and discuss their role in broadband networks. **OR** B) Analyze how MPLS improves traffic engineering and QoS.		
Mapping of Course Outcomes for Unit V:	**CO5:** Analyze industry-oriented networking tools and practices, configuration and broadband deployment.	
Learning Resources		
Textbooks: 1. Forouzan, B. A., Data Communications and Networking, 5th Edition, McGraw-Hill Education, 2012. 2. Stallings, W., High-Speed Networks and Internets: Performance and Quality of Service, 2nd Edition, Pearson Education/Prentice Hall, 2001. 3. Keiser, G., Optical Fiber Communications, 5th Edition, McGraw-Hill Education, 2013. 4. Black, U., Broadband Networking: ATM, SDH and SONET, 2nd Edition, Prentice Hall, 1999.		
Reference Books:		

1. Samaswami, R., Sivarajan, K. N., and Sasaki, G. H., Optical Networks: A Practical Perspective, 3rd Edition, Morgan Kaufmann Publishers, 2009.
2. Rappaport, T. S., Wireless Communications: Principles and Practice, 2nd Edition, Pearson Education, 2002.
3. Tanenbaum, A. S. and Wetherall, D. J., Computer Networks, 5th Edition, Pearson Education, 2011.
4. Agrawal, G. P., Fiber-Optic Communication Systems, 4th Edition, Wiley India, 2010.
5. Nicopolitidis, P., Obaidat, M. S., Papadimitriou, G. I., and Pomportsis, A. S., Modeling and Simulation of Computer Networks and Systems: Methodologies and Applications, 1st Edition, Elsevier, 2015.

MOOC / NPTEL Courses:

1. NPTEL Course "**Computer Networks And Internet Protocol"** Link of the Course: https://nptel.ac.in/courses/106105183
2. NPTEL Course "**Wireless Ad Hoc and Sensor Networks"**Link of the Course: https://nptel.ac.in/courses/106105160

Instructions to the Students and teachers

1. Under PEC-363-ETC, Program Elective Laboratory any one subject to be chosen from Section–I and one from Section -II to be taken.
2. Total number of practicals to be performed will be 11 including 5 from Section-I and 5 from Section-II
3. One mini project either from Section-I or from Section-II should be executed which is included in the list of 11 practicals.

Section-I

PEC-363-ECV: Program Elective II Course Labs

(Choose any One elective from program Elective-II course)

Program Elective II
Reconfigurable Computing
Web Technology
Network and Cyber Security
Digital Image Processing

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course) PEC-363A-ECV Reconfigurable Computing Laboratory (Program Elective - II)		
Teaching Scheme: **Practical: 02 hrs./ week**	**Credit: 01**	**Examination Scheme:** Term Work: 25 Marks Practical: 25 Marks

Prerequisite Courses, if any:

Basic Knowledge of Programmable Logic Devices

Companion Course, if any:

Reconfigurable Computing

Course Objectives:

- To introduce the architecture and design principles of reconfigurable computing systems, including FPGA resources such as LUTs, configurable logic blocks (CLBs), and routing structures.
- To develop skills in designing, implementing, and verifying digital systems using HDL on FPGA platforms through modular and hierarchical design methodologies.
- To provide practical experience with FPGA design tools for synthesis, placement, routing, timing analysis, and hardware implementation of reconfigurable systems.

Course Outcomes

CO1: Design and implement combinational and sequential digital circuits using LUTs, configurable logic blocks, and HDL on FPGA platforms.

CO2: Develop modular, hierarchical, and reconfigurable FPGA-based designs such as arithmetic units, shifters, multipliers, and ALUs, and verify their functionality.

CO3: Analyze FPGA implementation results including synthesis reports, resource utilization, placement, routing, and timing performance using industry-standard FPGA design tools.

List of Experiments

1.	Implement Boolean function using LUT concept.
2.	To Implement Half adder/Full using FPGA Configurable Logic Blocks.
3.	Implement multiplier using bit-level logic
4.	To Observe and analyze placement report and routing delay after synthesis

5.	To design and implement a multicontext (4) 4 LUT and implement using HDL and Download on FPGA.
6.	Top level modular and hierarchical designs of Adder and Subtractor such that they can be replaced.
7.	An adaptive design of LED shifter (Right & Left shift)
8.	Implementation of ALU block
9.	Implement and study complete FPGA Design Flow using Vivado

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Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)

PEC-363B-ECV Web Technology Lab (Program Elective - II)

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

Companion Course, if any: **PEC-361B-ECV Web Technology**

Course Objective:

- To design and develop responsive and attractive web pages using modern web technologies.
- To build interactive and dynamic web pages using client-side and server-side programming with database connectivity.
- To develop component-based web applications using modern frameworks and development tools.

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

CO1: Design and develop responsive, attractive, and user-friendly web pages using modern web technologies.

CO2: Build interactive and dynamic web pages by integrating client-side scripting, server-side programming, and database connectivity.

CO3: Develop component-based web pages using modern frameworks and development tools.

List of Experiments

Group A: Any Three Experiments to be Performed

1. To analyze various IoT development boards and IoT platforms used in IoT and Industrial IoT applications.
2. Design a 'Professional Resume' using HTML elements such as headings, images, lists, tables, hyperlinks, etc. Apply an external CSS style sheet to transform its visual design.
3. Design and style a student registration form using HTML forms and CSS properties.
4. Design a student registration form with basic form validation using JavaScript
5. Design an interactive web page to demonstrate DOM manipulation and event handling using buttons, text fields, and mouse events.

6. Design a Calculator web page using jQuery to perform basic arithmetic operations such as addition, subtraction, multiplication, and division with input validation using alert/prompt messages for invalid values.
Group B: Any Two Experiments to be Performed
7. Develop a student registration web application using PHP with form handling, email validation, session tracking, file handling, and MySQL database connectivity
8. Develop a React.js application to display student information using functional components and props.
9. Create a simple student registration React.js form application with state handling and event management.
10. Demonstration of HTTPS and SSL certificate verification on websites
11. Analyze website security using online vulnerability scanners
Group C: Course Project (Any One to be performed in Group of 3 or 4 Students)
12. Analyze website SEO score using Google Search Console OR create SEO-friendly webpage using meta tags and headings.

13. Mini Project
Virtual LAB Links: Additional (min. 2) Practical's are to be performed using Virtual Lab. 1.Basics of HTML Virtual Lab (IIT Delhi) URL: https://html-iitd.vlabs.ac.in 2. Computer Programming Lab (IIIT Hyderabad) URL:https://cse02-iiith.vlabs.ac.in 3.Cryptography Lab (IIIT Hyderabad) URL:https://cse29-iiith.vlabs.ac.in 4.Network Security Virtual Lab URL:https://ns-amrt.vlabs.ac.in
Note: 1.One practical from Group A and B should be performed as simulation practical (using any avail-able tool). 2.Additional (min. 2) practicals are to be performed using Virtual Lab. (Optional if Virtual Labs are there)

Guidelines for Students Lab Journal

1	Title of the experiment
2	Problem Statement
3	Brief theory related to the experiment.
4	Algorithm/Flowchart.
5	Mathematical analysis if required.
6	Conclusions
7	Mention real life examples concerned with the respective experiments
	Guidelines for Laboratory / Term Work Assessment
1	Continuous assessment of laboratory work based on overall performance and laboratory performance of students.
2	Each laboratory assignment assessment should assign grades/marks based on parameters with appropriate weightage.
3	Suggested parameters include timely completion, performance, efficiency, punctuality, and neatness.
4	Program codes with sample output of all performed assignments are to be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environment awareness, instead of attaching printed papers as part of write-ups, use of drive/pendrive containing student programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.
5	Use of open-source software is encouraged. Based on the concepts learned.

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Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)

PEC-363C-ECV Network & Cyber Security Lab (Program Elective - II)

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

Prerequisite Courses, if any: Nil

Companion Course, if any: **PEC-361C-ECV Network & Cyber Security**

Course Objectives:

- To implement various encryption, decryption algorithms, internet security protocols, authentication and countermeasures
- To Illustrate cyber threats, malware, system vulnerabilities, and web security issues
- To analyze cyber laws, data privacy regulations and governance frameworks

Course Outcomes:

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

CO1: Apply encryption, decryption algorithms, authentication protocol and its countermeasures to detect threats.

CO2: Analyze the cyber threats, vulnerabilities, threats, cyber laws and government regulations.

CO3: Implement a real-life application for cyber/network security.

Group A: Any Three Experiment to be Performed

1. Write a program for Encryption and Decryption (Substitution/Transposition)
2. Implementation of Steganography and analyse its features in terms of security.
3. Perform SQL Injection Analysis and Prevention
4. Network Packet Analysis and Threat Monitoring using Wireshark
5. Password Security and Hash Cracking using John the Ripper
(evaluate password strength and cracking resistance)

Group B: Any Two Experiments to be Performed

6. Network Packet Analysis and Threat Monitoring using Wireshark
(TCP 3-way handshake, DNS lookup, ARP, HTTP vs HTTPS, Packet fragmentation)
7. Perform active reconnaissance and vulnerability identification and Port Scanning using Nmap

8. Write a Program to implement Asymmetric Key Cryptography (RSA/DiffieHelmon)	
Group C: Course Project/Case study (any 1 to be performed in Group of 3 or 4 Students)	
9. Case Study Based Cybersecurity Problem Solving using CyLab Security Academy (Formerly picoCTF).	
10. Project: Cyber Ethics and Data Privacy Risk Assessment	
1. Guidelines for Students Lab Journal	
1	Title of the experiment
2	Problem Statement
3	Ckt/Logic Design of given problem statement
4	Diagram with theory for operation
5	Experimentation
6	Observation/ Result table
8	Conclusions
9	Mention real life examples concerned with the respective experiments
Guidelines for Laboratory / Term Work Assessment	
1	Continuous assessment of laboratory work based on overall performance and laboratory performance of students.
2	Each laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
3	Suggested parameters include timely completion, performance, understanding, Participation in experiment conduction and post experiment skills

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Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course)

PEC-363D-ECV Digital Image Processing Lab (Program Elective - II)

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

Companion Course, if any:

PEC-361D-ECV Digital Image Processing

Course Objectives:

- To introduce students to fundamental image processing techniques using MATLAB/Python/OpenCV for image acquisition, visualization, enhancement, and transformation.
- To develop practical skills in image analysis and processing methods such as histogram processing, filtering, edge detection, thresholding, and image compression techniques
- To enable students to implement image processing and computer vision techniques for solving real-world problems through experiments and mini-projects.

Course Outcomes:

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

CO1: Implement basic image processing operations including image reading, display, histogram analysis, enhancement, filtering, and geometric transformations using MATLAB/Python/OpenCV/Equivalent.

CO2: Analyze and apply image processing techniques such as edge detection, thresholding, spatial filtering, DCT, and performance evaluation metrics (MSE, PSNR) for image enhancement and compression.

CO3: Develop computer vision applications for image classification and pattern recognition using programming tools and real-world datasets.

List of Experiments

Group A: Any Three Experiments to be Performed

1. Perform Reading and displaying images using MATLAB/Python/OpenCV/Equivalent
2. Write a program to generate histogram for an image and plot histogram
3. Write a program to perform histogram equalization

4. Perform the following basic operations on image a. Obtain a Negative image b. Obtain the Flip image	
5. Perform the following basic operations on image a. Point Detection b. Line Detection c. Edge Detection d. Thresholding	
Group B: Any Two Experiments to be Performed	
6 Write a program to perform various mathematical operations & logical operations on an image	
7. Implement various smoothing spatial filters	
8. Implement and study the effect of Different Mask (Sobel, Prewitt and Roberts)	
9. Perform Block-based Discrete Cosine Transform (8X8 DCT) on an image and reconstruct the image	
10. Compute and compare objective evaluation metrics (MSE, PSNR) between an original image and its lossy compressed version	
Group C: Course Project **(Any One Case Study/Project to be performed in Group of 3 or 4 Students)**	
11. Case Study/ Project: Handwritten Character Recognition	
Note: Practicals can be performed using any MATLAB/Python/OpenCV/equivalent	
Guidelines for Students Lab Journal	
1	Title of the experiment
2	Flow Chart
3	Algorithm
4	Code
5	Test cases
6	Result
7	Conclusions
8	Mention real life examples concerned with the respective experiments
Guidelines for Laboratory / Term Work Assessment	
1	Continuous assessment of laboratory work based on overall performance and laboratory performance of students.
	Each laboratory assignment assessment should assign grade/marks based on parameters

2	with appropriate weightage.
3	Suggested parameters include timely completion, performance, efficiency, punctuality, and neatness.
Guidelines for Students Lab Journal	
1	Title of the experiment
2	Flow Chart
3	Algorithm
4	Code
5	Test cases
6	Result
7	Conclusions
8	Mention real life examples concerned with the respective experiments
Guidelines for Students Lab Journal	
1	Continuous assessment of laboratory work based on overall performance and laboratory performance of students.
2	Each laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
3	Suggested parameters include timely completion, performance, efficiency, punctuality, and neatness.

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Third Year of Electronics Engineering VLSI and Design Technology (2024 Course)

MDM371-ECV Data Base Management Systems (Multidisciplinary Minor)

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 01(Tutorial) Hrs. / week	01	TW:25 Marks

Prerequisite Courses, if any:

1. Data Structures

Companion Course, if any: Database Management Lab

Course Objectives:

- To understand fundamental concepts of database from its design to its implementation.
- To analyze database requirements and determine the entities involved in the system and with one another.
- To manipulate database using SQL Query to create, update and manage Database.
- Be familiar with the basic issues of transaction processing and concurrency control.
- To learn and understand Parallel Databases and Distributed Databases.

Course Outcomes:

On completion of the course, learner will be able to -

CO1: Ability to implement the underlying concepts of a database system.

CO2: Design and implement a database schema for a given problem-domain using data model.

CO3: Formulate, using SQL/DML/DDL commands, solutions to a wide range of query and update problems.

CO4: Implement transactions, concurrency control, and be able to do Database recovery.

CO5: Able to understand various Parallel Database & Distributed Databases Architectures .

Course Contents

Unit I	Introduction to DBMS	(03 Hrs.)

Introduction to Database Management Systems, Purpose of Database Systems, Database-System Applications, Data Abstraction and Database System Structure.

Relational Model: Structure of relational databases, Domains, Relations, Relational algebra – fundamental operators and syntax, relational algebra queries, tuple relational calculus.

Entity-Relationship model: Basic Concepts, Entity Set, Relationship Sets and Weak Entity Sets, Mapping Cardinalities, Keys, E-R diagrams, Design Issues, Extended E-R Features, Converting E-R & EER diagram into tables.		
Mapping of Course Outcomes for Unit I	**CO1:** Ability to implement the underlying concepts of a database system.	
Unit II	**Relational Database Design**	**(03 Hours.)**
Basic concepts, CODD's Rules, Relational Integrity: Domain, Referential Integrities, Enterprise Constraints, Database Design: Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, Algorithms for Decomposition, 2NF, 3NF, 4NF and BCNF.		
Mapping of Course Outcomes for Unit II	**CO2:** Design and implement a database schema for a given problem- domain using data model.	
Unit III	**Basics of SQL**	**(03 Hours.)**
DDL, DML, DCL, Structure: Creation, Alteration, Defining constraints – Primary key, Foreign key, Unique key, Not null, Check, IN operator, Functions - Aggregate Functions, Built-in Functions – Numeric, Date, String Functions, Set operations, sub-queries, correlated subqueries, Use of group by, having, order by, join and its types, Exist, Any, All, view and its types. **Transaction control commands**: Commit Rollback, Save-point PL /SQL Concepts: Cursors, Stored Procedures, Stored Function, Database Triggers.		
Mapping of Course Outcomes for Unit III	**CO3:** Formulate, using SQL/DML/DDL commands, solutions to a wide range of query and update problems.	
Unit IV	**Database Transactions Management**	**(03 Hours.)**
Basic concepts of a Transaction, Transaction Management, Properties of Transactions, Concept of Schedule, Serial Schedule, Serializability: Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules, Concurrency Control: Need, Locking Methods, Deadlock handling and Time-stamp based Protocols.		
Mapping of Course Outcomes for Unit IV	**CO4:** Implement transactions, concurrency control, and be able to do Database recovery.	
Unit V	**Parallel & Distributed Databases**	**(03 Hrs.)**

Introduction to Database Architectures: Multi-user DBMS Architectures,

Parallel Databases: Performance Parameters for Parallel Databases, Types of Parallel Database Architecture, Evaluating Parallel Query in Parallel Databases and Virtualization on Multicore processors.

Distributed Databases: Distributed Database Management System, Factors Encouraging DDBMS, Advantages of Distributed Databases, Types of Distributed Databases, Architecture of Distributed Databases

Mapping of Course Outcomes for Unit V	**CO5:** Able to understand various Parallel Database & Distributed Databases Architectures.

Learning Resources

Text Books:

1. A. Silberschatz, H.F. Korth and S. Sudarshan , "Database System Concepts", McGraw Hill, 6th Edition.
2. C.J. Date, A. Kannan, S. Swamynathan "An introduction to Database Systems", Pearson, 8th Edition.

Reference Books:

1. Martin Gruber, "Understanding SQL", Sybex Publications.
2. Ivan Bayross, "SQL- PL/SQL", BPB Publications, 4th Edition.
3. S.K. Singh, "Database Systems: Concepts, Design and Application", Pearson, Education, 2nd Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Database Management System"**

Link of the Course: **https://nptel.ac.in/courses/106/106/106106220/**

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Third Year of Electronics Engineering (VLSI Design & Technology) (2024Course)

MDM-372-ECV Mini Project (Vocational & Skill Enhancement Course)

Teaching Scheme	Credits	Examination Scheme
Theory:02Hours/Week	01	**Term Work**:50 Marks

Prerequisite Courses, if any:

- Digital Electronics
- Electronics Circuits
- Electronics Skill Development Lab

Companion Course, if any: Nil

Course Objectives:

- To provide industry-oriented technical skills relevant to modern Electronics and Telecommunication industries.
- To enhance practical knowledge in embedded systems, IoT, PCB design, industrial automation, FPGA/VLSI and communication systems.
- To develop vocational and employability skills through hands-on training and mini projects.
- To improve problem-solving, teamwork, communication skills.
- To bridge the gap between academic learning and industrial requirements.999

Course Outcomes:

On completion of the course student will be able to

CO1: Identify and select an appropriate problem statement for a mini project considering industrial requirements and practical applications

CO2: Develop the ability to understand, plan, and implement a team-based mini project by following industrial Practices and safety standards relevant to the Electronics and Telecommunication (E&TC) industry.

CO3: Design and implement embedded and IoT-based applications.

CO4: Develop PCB layouts and troubleshoot electronic systems.

CO5: Analyze and test the miniproject rigorously.

CO6: Demonstrate vocational, teamwork, presentation, and entrepreneurship skills through projects.

A) Execution of Mini Project

1	Project group shall consist of not more than 3 students per group.
2	Mini Project Work should be carried out in the Design / Projects Laboratory.
3	Project designs ideas can be necessarily adapted from recent issues of electronic design magazines.
4	Use of Hardware devices/components is mandatory.
5	Schematic-to-layout validation shall be carried out.
6	PCB bare board validation report shall be generated.
7	Assembly of components and enclosure design is mandatory.
B) Selection: Domains for projects may be from the following, but not limited to:	
1	Instrumentation and Control Systems
2	Electronic Communication Systems
3	IoT
4	Embedded Systems
5	Power Electronics
6	Mechatronic Systems
7	Microcontroller based projects should preferably use Microchip PIC controllers / ATmega controller / AVR microcontrollers/ Rasberry Pi.
8	Biomedical Electronics
9	FPGA/VLSI
C) Monitoring: (for students and teachers both): Suggested Plan for various activities to be monitored by the teacher.	
Week 1 & 2:	Formation of groups, Problem identification and Finalization & Distribution of work.
Week 3 & 5	PCB design using an appropriate EDA tool, design fundamentals and standards, Schematic capture and PCB layout tools, Soldering, testing, and troubleshooting (Two days PCB design workshop).
Week 6 to 9	Arduino based smart industry-based applications using various communication protocols, IoT architecture and cloud connectivity using various IOT Platforms.
Week 10 &11	Testing of final product, Preparation, Checking & Correcting of the Draft Copy of Report
Week 12	Demonstration and Group presentations. Log book for all these activities shall be

	maintained and produced at the time of examination.
D. Report writing: A project report with following contents shall be prepared:	
1	Title page
2	Acknowledgement
3	Abstract
4	Table of Content
5	Introduction
6	Problem Statement Objective
7	Literature survey
8	Methodology with block diagrams & Design calculation circuitdiagram , Product Enclosure Development
9	Implementation of project
10	Result & discussion, Future Scope
11	Conclusion, References
12	Bill of Material (BOM) with cost
13	Schematic Diagram, PCB Layout
14	Test Results with Conclusion

Textbooks:

1. Programming Arduino: Getting Started with Sketches — Simon Monk, McGraw-Hill TAB, 3rd Edition.
2. Arduino Cookbook — Michael Margolis, O'Reilly Media, 3rd Edition.
3. Internet of Things — Raj Kamal, McGraw-Hill Education, 1st Edition, 2017

Reference Books:

1. Embedded Systems - SoC, IoT, AI and Real-Time Systems — Raj Kamal, McGraw-Hill Education India, 4th Edition, 2020.
2. Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards — Simon Monk, McGraw-Hill Education TAB, 1st Edition, 2014.
3. Industrial Electronics and Control — S. K. Bhattacharya & S. Chatterjee, McGraw-Hill Education, 1st Edition 2019.
4. Embedded Realtime Systems Programming — Iyer & Gupta, McGraw-Hill Education India, 1st

Edition, 2003.

MOOC/ NPTEL Courses:

NPTEL Courses Portal

Recommended Courses:

1. https://onlinecourses-archive.nptel.ac.in/noc18_cs05/preview https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee168 https://onlinecourses-archive.nptel.ac.in/noc18_cs05/preview
2. SWAYAM Platform

https://onlinecourses.swayam2.ac.in/e-learning/preview/aic20_sp04

https://swayam.gov.in/explorer?category=Engineering_and_Technology

Savitribai Phule Pune University Third Year of Electronics Engineering (VLSI Design & Technology) (2024 Course) ELC-381-ECV (Program Elective - II) -Internship (Experimental Learning Course)		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 08 Hours/Week	04	**Oral:** 50Marks

Course Objectives:

- To expose students to real-world industry practices.
- To bridge the gap between academic learning and practical implementation.
- Develop professional competency, ethics, communication, and teamwork skills.
- To encourage self-learning and problem-solving abilities.
- Encourage innovation, entrepreneurship, and research aptitude.

Course Outcomes:

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

CO1: Apply theoretical knowledge to solve real-world engineering problems.

CO2: Demonstrate technical competency in tools/technologies used in industry.

CO3: Exhibit professional ethics and teamwork.

CO4: Prepare technical reports and deliver effective presentations on industrial training experience.

CO5: Analyze industrial processes and suggest feasible improvements or innovations.

Guidelines

Students should opt for a internship/JOT that would provide them to gain ample field knowledge in the relevant field of engineering such that theoretical knowledge gained in the class can be applied to solve the practical/ field problem.

Students must have to opt for technical internship (minimum 100 hrs.) after V semester and before VI semester, commencement preferably during winter break (December & January).

Undergoing a training programme / Course at a particular organization for specified duration is NOT considered as summer internship

However, student can attend such programs mentioned in above to learn new tools for short duration that would help for solving the problem undertaken in the internship

Students should take a challenging task, may be a small portion, and apply the knowledge gained

to solve it.

Internship can also involve data collection from different sources, including generating experimental data, collection of data from field etc. The data may be analyzed later on.

Different central and state government organizations, CSIR labs, premier institutions like IITs and IIMs, DRDO, public sector undertaking organizations, top IT companies may be considered for internships.

Student need to submit Synopsis, Permission letter and offer letter to Internship coordinator before proceeding to internship.

Internshipcompletionwillbeconsideredonlyaftersubmissionofvaliddocumentsattheend of internship like Completion certificate, Report and presentation of work done, feedback from industry etc.

Student will appear for term work evaluation where he/she will present the work done before mentor(s) at the end of internship.

Suggested Internship Activities

Students are expected to perform the following activities during internship:

Phase I

- Orientation and Requirement Study
- Understanding organization structure
- Study of workflow and operational processes
- Requirement analysis and project allocation
- Understanding tools and technologies used

Phase II–Technical Learning and Development

- Coding/implementation of hardware design
- Selection of inputs/ sensors/ Database design
- Hardware/ Software testing and debugging
- Integration of design and deployment
- Specification Documentation

Phase III–Project Execution

- Module development
- Testing and validation

- Performance optimization
- Customer /Client interaction (if applicable)

Phase IV–Team collaboration

- Documentation and Presentation
- Preparation of internship report
- Preparation of project demonstration

Final presentation and viva-voce.

Deliverables

- Internship Joining Report
- Weekly Logbook
- Mid-term Progress Report
- Supervisor Feedback (Initial)

Internship Structure

The internship maybe carried out in anyone of the following domains:

- Software Development
- Artificial Intelligence and Machine Learning
- Data Science and Analytics
- Cloud Computing and DevOps
- Cyber Security
- Web and Mobile Application Development
- IoT and Embedded Systems
- Networking and System Administration
- Automation and Robotics Software
- Research and Development
- Entrepreneurship and Startup Projects
- Government/NGO Technical Projects

Nature of Internship

Students shall undergo internship/training in one of the following:

- Registered companies/startups
- Government organizations

- Research institutions
- Recognized industry-academic collaborative projects

Internships may be conducted in offline, online, or hybrid mode, subject to proper approval and verification.

Writing Learning Resources

1. W. J. King and James G. Skakoon, The Unwritten Laws of Engineering, Second edition, ASMEPress,2019.
2. Stuart Walesh, Engineering Your Future: The Professional Practice of Engineering, John Wiley & Sons, 3rd edition, 2012.
3. Eliyahu M. Goldratt, " The Goal: A Process of Ongoing Improvement", 40th edition 2024, North River Press.
4. AICTE Internship policy: AICTE Internship Policy: Guidelines & Procedures.
5. AICTE Internship Portal: https://internship.aicte-india.org

Guidelines for Internship Report

1. Preliminary Pages
    - Cover Page
    - Certificate from Organization
    - Certificate from Department
    - Acknowledgement
    - Abstract
    - Table of Contents
2. Chapter1–Organization Profile
    - Company overview
    - Vision and mission
    - Products/services
    - Organizational structure
3. Chapter2–Problem Statement and Objectives
    - Project title
    - Need of project

- Objectives
- Scope

4. Chapter3–Technologies and Methodology
    - Software/hardware tools used
    - Development methodology
    - System architecture
    - Database design/ sensors
5. Chapter4–Work Carried Out
    - Tasks completed
    - Screenshots/res99ults
    - Challenges faced
    - Solutions implemented
6. Chapter5–Learning Outcomes
    - Technical learning
    - Professional skills acquired
    - Industry exposure
    - Future scope
7. Chapter6–Conclusion
    - Summary of work
    - Achievements
    - Suggestions

References: IEEE format references

preferred Appendices

- Source codes nippets
- Certificates
- Additional screenshots