॥ योः क्रियावानू स पण्डितः ॥

SAVITRIBAI PHULE PUNE UNIVERSITY

(सावित्रीबाई फुले पुणे विद्यापीठ)

Formerly University of Pune

Syllabus Booklet

For

Third Year (T.E.)

ELECTRONICS AND COMPUTER ENGINEERING

2024 PATTERN

With effect from Academic Year 2026-27

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Nomenclature

AEC Ability Enhancement Course

CEP Community Engagement Project

MDM Multidisciplinary Minor

OE Open Elective

PCC Program Core Course

VEC Value Education Course

VSE Vocational and Skill Enhancement

Course WK Knowledge and Attitude

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 Third Year Electronics & Computer Engineering syllabus effective from the Academic Year 2026-27. The present curriculum will be implemented for Third Year of Engineering from the academic year 2026-27. Subsequently this will be carried forward for BE in AY 2027-28, respectively.

Electronics & Computer Engineering is a dynamic discipline that lies at the intersection of electronics engineering and Computer 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 Computer 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 Computer 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, Electronics and Telecommunication Engineering

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Third Year Electronics & Computer Engineering

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 modeling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals Required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a Practice area.
WK6	Knowledge of engineering practice(technology)in the practice areas In the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility o f 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.

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPCV4.0)-(August2024) Page 55.

Programme Outcomes (PO)

Programme Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. On successful completion of B.E. in Electronics and Telecommunication Engineering-Eletronics and Computer Engineering, graduating students/graduates will be able to:

PO1	Engineering knowledge	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2	Problem analysis	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/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, modeling, 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 modeling recognizing their limitations to solve complex Engineering problems.(WK2andWK6)
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,andWK7).

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 (GAPCV4.0)-(August2024) Page56.

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 behaviour 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).

Comprehensive Continuous Evaluation (CCE) of 30marks 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	12Marks	Units 1 & Unit 2 (6Marks/Unit)
2	Assignments/ Case Study	12Marks	Units 3 & Unit 4 (6Marks/Unit)
3	Seminar Presentation/ Open Book Test/ Quiz	06Marks	Unit 5

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:

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

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, 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, Create).

– **Implementation**: Schedule the test after completing Units 1and 2. Ensure the question paper is balanced and covers key concepts and applications.

- **Sample Question Distribution**

– Remembering (2Marks): Define key terms related to[Topic from Units 1 and 2].

– Understanding (2Marks): Explain the principle of [Concept] in [Context].

– Applying (2Marks): Demonstrate how [Concept]can be used in[Scenario].

– Analyzing (3Marks): Compare & contrast [Two related concepts] from Units 1and 2.

– Evaluating (3Marks): 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 Unit4.

– **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 Unit 5, followed by a Q&A session.

– **Deliverables:** Presentation slides, a summary report in 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 topic in that course. You can set your quizzes to be completed individually or in small groups.

– **Implementation:** Online tools and software can be used 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:**

– Weeks1-4:Cover Units1 and 2

– Week5: Conduct Unit Test (12marks)

– Weeks6-8: Cover Units 3 and 4

– Week9: Distribute and collect Assignments/Case Study(12marks)

– Weeks10-12: Cover Unit 5

– Week13: Conduct Seminar Presentations or Open Book Test or Quiz (6marks)

- **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 facts 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.

NEP 2020 Compliant Curriculum Structure Third Year Engineering (2024 Pattern)
Electronics & Computer Engineering

Level 5.0																
Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credits			
			Theory	Tutorial	Practical	CCE*	End-Sem	Term work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
Semester -V															
PCC 301-ECE	Programme Core Course 1	Database Management	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC 302-ECE	Programme Core Course 2	Microcontroller & Applications	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC 303-ECE	Programme Core Course 3	Advanced Java Programming	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC 304-ECE	Program Core Course Lab 1	Database Management Lab	-	-	2	-	-	25	-	25	50	-	-	1	1
PCC 305-ECE	Programme Core Course Lab 2	Advanced Java Programming & Microcontroller & Applications Lab	-	-	4	-	-	50	25	-	75	-	-	2	2
PEC 321 ECE	Programme Elective Course	Elective-I	3	-	-	30	70	-	-	-	100	3	-	-	3
PEC 322 ECE	Programme Elective Course Lab	Elective-I Lab	-	-	2	-	-	50	-	-	50	-	-	1	1
MDM 331 ECE	Multidisciplinary Minor	Artificial Intelligence & Data Science	-	2	2	-	-	25	-	25	50	-	2	1	3
OLE 341 ECE	Open Elective	Open Elective	2	-	-	15	35	-	-	-	50	2	-	-	2
ELC 342 ECE	Experiential Learning	Technical Seminar	-	-	2#	-	-	-	-	25	25	-	-	1	1
Total			**14**	**02**	**12**	**135**	**315**	**150**	**25**	**75**	**700**	**14**	**02**	**06**	**22**
			28 Hrs.			**700 Marks**						**22 Credits**			

Course Code	Program Elective-I	Course Code	Elective-I Lab
PEC321A-ECE	Computer Network	PEC322A-ECE	Computer Network
PEC321B-ECE	Operating System	PEC322B-ECE	Operating System
PEC321C-ECE	Data analytics using Python	PEC322C-ECE	Data analytics using Python
PEC321D-ECE	PLC Automation & Sensors	PEC322D-ECE	PLC Automation & Sensors

It shall be conducted for full class not batch wise

****Open Elective I - Courses like Marketing Management, Financial Risk Management, IPR and Cyber Laws Sustainability Development and other courses students can be opted from faculty Commerce and Management, Humanities and Inter-disciplinary bucket.**

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

Course Code	Program Elective-II	Course Code	Program Elective-II
PEC361A-ECE	Modern Communication System	PEC362A-ECE	Web Application Development
PEC361B-ECE	Deep Learning	PEC362B-ECE	RF & Microwave Engineering
PEC361C-ECE	Digital Image Processing	PEC362C-ECE	Network & Cyber Security
PEC361D-ECE	IoT Applications	PEC362D-ECE	Embedded AI Systems

Savitribai Phule Pune University, Pune

Maharashtra, India

T.E. -Electronics & Computer Engineering

2024 Pattern

Semester V

With effect from Academic Year 2026–27

Savitribai Phule Pune University
Third Year Electronics & Computer Engg (2024 Course)

PCC-301-ECE: Database Management

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

Prerequisite Courses, if any:

Companion Course, if any: Database Management Lab

Course Objectives:

The objective of this course is to provide students with

1. To understand fundamental database concepts, data models, and ER/EER design techniques for developing database systems.
2. To apply normalization techniques and relational database design principles for creating efficient and consistent databases.
3. To develop proficiency in SQL and PL/SQL for performing database queries, manipulation, and procedural programming tasks.
4. To understand parallel and distributed database and transaction management, concurrency control, and recovery mechanisms to ensure data integrity and reliability.
5. To explore NoSQL database models and evaluate their applications in handling large-scale and unstructured data.

Course Outcomes:

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

CO1: Describe the fundamental concepts of database management systems, including data models, ER/EER modeling, and relational database design principles.

CO2: **Apply** normalization techniques to design efficient relational database schemas and maintain data consistency and integrity.

CO3: **Develop** and **execute** SQL and PL/SQL programs for querying, manipulating, and managing relational databases effectively.

CO4: **Understand &Analyze** transaction management, concurrency control, and recovery techniques to ensure reliable and secure database operations.

CO5: **Evaluate** different NoSQL database models and their applications in managing large-scale and unstructured data systems.

Course Contents

Unit I	Introduction to Database Management	(09 Hours)

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, Keys-Super key, Candidate key, Primary key, Foreign key, 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, E-R diagrams, Extended E-R Features, Converting E-R & EER diagram into tables.

Case Study: Study of Architecture of any DBMS like Oracle or MySQL. Design a database schema for Hospital Management System which consist of record for Patients, Appointment and Medical Records

Mapping of Course Outcomes for Unit I	CO1: Describe the fundamental concepts of database management systems, including data models, ER/EER modeling, and relational database design principles.

Unit II	Relational Database Design	(09 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, 2NF, 3NF, and BCNF. **Case Study:** Design and Optimization of a Relational Database for a College Management System		
Mapping of Course Outcomes for Unit II	CO2: Apply normalization techniques to design efficient relational database schemas and maintain data consistency and integrity.	
Unit III	**Basis of SQL and PL/SQL**	**(09 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 sub queries, 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 **Case Study:** Design and Optimization of a Relational Database for Student Attendance Management System		
Mapping of Course Outcomes for Unit III	CO3: Develop and execute SQL and PL/SQL programs for querying, manipulating, and managing relational databases effectively.	
Unit IV	**Transactions and Distributed Databases**	**(09 Hours)**
Basic concepts of a Transaction, Transaction Management, Properties of Transactions: ACID, Concept of Schedule, Serial Schedule, and Serializability: Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules, Concurrency Control: Need, Locking Methods, Deadlock handling and Time-stamp based Protocols. **Introduction to Parallel Databases:** performance measures-throughput, response time, speed-up, scale-up, Interconnection Network Architectures, Architectures for parallel databases, **Introduction to distributed databases**: Distributed DBMS architectures, storing data in a Distributed, Distributed Query processing **Case Study:** Design Online Shopping Cart Transaction Management in an e-commerce platform, multiple users simultaneously add, update, and purchase products.		
Mapping of Course Outcomes for Unit IV	CO4: Understand & Analyze transaction management, concurrency control, and recovery techniques to ensure reliable and secure database operations.	
Unit V	**No SQL Databases**	**(09 Hours)**
Types of Data: structured, unstructured and semi structured data. NoSQL Database: Introduction, Need, Features. **Types of NoSQL Databases:** Key Value store, Document store, graph, wide column store, BASE properties, DATA consistency model, ACID vs. BASE MongoDB (with syntax and usage): CRUD operations, Indexing, Aggregation, Map Reduce, Replication, Shading. **Case Study:** Study NoSQL Database Selection for a Social Media Platform		
Mapping of Course Outcomes for Unit V	CO5: Evaluate different NoSQL database models and their applications in managing large-scale and unstructured data systems.	
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. Pramod Sadalage and Martin Fowler‖ NoSQL Distilled‖, Addison-Wesley Professional
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**: https://nptel.ac.in/courses/106105175 2. NPTEL Course **"Database Management System" Link:** https://nptel.ac.in/courses/106104135
1.Virtual Lab: Link: https://dmsl-virtual-lab.vercel.app/

Savitribai Phule Pune University
Third Year of Electronics and Computer Engineering (2024Course)

PCC-302-ECE: Microcontroller and Applications

Teaching/scheme	Credits	Examination Scheme
Theory: 03 Hours/Week	3	**CCE**: 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses, if any: Basic Electronics Engineering, Digital Electronics, Microprocessors, Computer Programming Fundamentals

Companion Course, if any: Laboratory Practical

Course Objectives:

The objective of this course is to provide students with

- To understand the architecture, organization, and programming concepts of 8051 and RL78 microcontrollers used in embedded systems.
- To learn hardware and software development tools required for microcontroller-based system design and implementation.
- To develop interfacing skills for various input/output devices, sensors, displays, and communication peripherals using embedded C programming.
- To implement timer, interrupt, serial communication, ADC, PWM, and motor control applications using microcontrollers.
- To develop interfacing using RL78 microcontroller.

Course Outcomes:

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

CO1: Understand the architecture, memory organization, instruction set, and operational features of 8051 microcontrollers.

CO2: Describe embedded system development tools and write embedded C programs for peripheral interfacing applications.

CO3: Develop microcontroller-based applications using sensors, displays, serial communication, and actuator interfacing techniques.

CO4: Develop embedded applications using RL78 microcontroller interfacing, timers, interrupts, and digital peripheral devices.

CO5: Develop industrial and real-time embedded systems using RL78 microcontroller for automation and monitoring.

Course Contents

Unit I	Introduction to Microcontroller Architecture	(09 Hours)

Microprocessor and microcontroller comparison, Harvard & Von Neumann architecture, RISC & CISC processors. Role of microcontroller in embedded system. Selection criteria of microcontroller. Overview of MCS-51 architecture, Block diagram and explanation of 8051, Port structure, memory organization, Interrupt structure, timers and its modes, serial communication modes. Overview of Instruction set, Programming of Timer 0 and Timer 1

#Exemplar	Study and programming of 8051 microcontroller architecture, timers, interrupts, and serial communication using Embedded C.
Mapping of Course Outcomes for Unit I	CO1

Unit II	Microcontroller Development Tools & Peripheral Interfacing	(09 Hours)
Software and Hardware tools for development of microcontroller-based systems such as assemblers, compliers, IDE, Emulators, debuggers, programmers, development board, DSO, Logic Analyzer. Interfacing LED with and without interrupt, Keypads, Seven Segment multiplexed Display, RGB LED, LCD, ADC Interfacing. All Programs in embedded c language		
#Exemplar	Interfacing and programming of LED, keypad, seven-segment display, LCD, RGB LED, and ADC using 8051 microcontrollers.	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	**Microcontroller Sensor and Actuator Interfacing**	**(09 Hours)**
Data transmission and reception using Serial port with PC. Interfacing of DAC, Temperature sensors, Stepper motor, Motion detectors, Relay, Buzzer, Opto-isolators, All programs in embedded C language. Case Study on Interfacing of Temperature Sensor and Relay with Microcontroller for Automatic Temperature Monitoring and Control System using Embedded C.		
#Exemplar	Development of automatic temperature monitoring and actuator control system using sensors, relay, buzzer, and serial communication.	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Introduction to RL78 Microcontroller & Embedded Programming**	**(09 Hours)**
Introduction to embedded systems, characteristics and applications of embedded systems, real-time embedded systems overview. Introduction to RL78, its architecture and features. Introduction to Renesas development tools, GPIO programming, digital input and output operations, LED, LCD, IR, LDR interfacing, push button interfacing, seven-segment display interfacing. Timers and interrupt concepts, delay generation using timers, interrupt handling mechanisms, external interrupts, and timer interrupts.		
Mapping of Course Outcomes for Unit IV	Development of RL78-based embedded applications using GPIO, timers, interrupts, LED, LCD, IR, LDR, and seven-segment interfacing.	
Mapping of Course Outcomes for Unit IV	CO4	
Unit IV	**RL78 Peripheral Interfacing and Industrial Applications**	**(09 Hours)**
ADC fundamentals in RL78, Motion detectors, Relay, Buzzer and temperature sensor interfacing, light sensor interfacing, UART communication, SPI communication, I2C communication, serial data transmission and reception. PWM generation using RL78, interfacing of DC motor interfacing, servo motor control. Low-power modes in RL78, HALT and STOP modes, watchdog timer operation, and real-time application concepts. Industrial automation using RL78, sensor-based monitoring systems, and introduction to IoT applications using RL78.		
#Exemplar	Implementation of RL78-based industrial automation using UART, SPI, I2C, motor control, and sensor interfacing.	
Mapping of Course Outcomes for Unit V	CO5	

Learning Resources
Textbooks: 1. Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems — Using Assembly and C," Second Edition, Pearson Education / Prentice Hall, 2007. 2. Kenneth J. Ayala, "The 8051 Microcontroller — Architecture, Programming and Applications," Third Edition, Cengage Learning, 2010. Alexander G. Dean, James M. Conrad, "Creating Fast, Responsive and Energy-Efficient Embedded Systems using the Renesas RL78 Microcontroller," First Edition, Micrium Press, 2012.
Reference Books: 1. Raj Kamal, "Embedded Systems — Architecture, Programming and Design," Third Edition, Tata McGraw-Hill, 2017. 2. K. V. Shibu, "Introduction to Embedded Systems," Second Edition, McGraw-Hill Education, 2016. 3. Frank Vahid, Tony D. Givargis, "Embedded Systems Design — A Unified Hardware/Software Introduction," First Edition, John Wiley & Sons, 2002. 4. James M. Conrad (Editor), "Embedded Systems Design, Analysis and Optimization using the Renesas RL78 Microcontroller," First Edition, Micrium Press, 2013. 5.
e Books: **1.** James W. Stewart, Joseph J. Mistovich, "The 8051 Microcontroller — Hardware, Software, and Interfacing," Prentice Hall. https://archive.org/details/8051microcontrol0000stew **2.** Myke Predko, "Programming and Customizing the 8051 Microcontroller," McGraw-Hill. https://archive.org/details/programmingcusto00pred **3.** Dogan Ibrahim, "Microcontroller Projects in C for the 8051,"Newnes/Elsevier. https://archive.org/details/microcontrollerp0000ibra **4.** Peter Marwedel, "Embedded System Design: Foundations of Cyber-Physical Systems and IoT," 4th Edition, Springer, 2021 : https://link.springer.com/book/10.1007/978-3-030-60910-8
MOOC / NPTEL/YouTube Links: 1. Microcontrollers and Applications – NPTEL IIT Kharagpur : https://nptel.ac.in/courses/108105167 2. Embedded Systems Design – NPTEL IIT Bombay: https://nptel.ac.in/courses/108104073 3. Microcontrollers and Applications NPTEL Online Certification :https://onlinecourses.nptel.ac.in/noc22_ec11 4. Embedded Systems Shape the World – University of Texas, Coursera : https://www.coursera.org/learn/embedded-systems-shape-the-world 5. Microcontroller Embedded C Programming Udemy; https://www.udemy.com/course/microcontroller-embedded-c-programming **Virtual Labs Links** 1 Microcontroller Virtual Lab – IIT Kharagpur — https://vlabs.iitb.ac.in/vlabs-dev/labs/microcontroller_lab 2 Embedded Systems Virtual Lab – Amrita Vishwa Vidyapeetham — https://www.vlab.co.in/broad-area-computer-science-and-engineering

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

PCC-303-ECE: Advanced Java Programming

Teaching/scheme	Credits	Examination Scheme
Theory: 03 Hours/Week	03	**CCE:** 30 Marks **End Sem:** 70 Marks

Prerequisite Courses, if any: Object Oriented Programming

Course Objectives:

The objective of this course is to provide students with

- To understand and apply Java Collection Framework and Java 8 features such as Lambda expressions, Stream API, and functional interfaces in Java application development.
- To learn database connectivity and persistence techniques using JDBC architecture and Hibernate framework.
- To understand web architecture concepts and develop dynamic web applications using Servlet technology.
- To design and create interactive web pages using JSP technology and implicit objects.
- To study and implement enterprise application development concepts using the Spring Framework, including Dependency Injection, MVC, and bean management.

Course Outcomes:

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

1. Apply Java Collection Framework and Java 8 features such as Lambda expressions, Stream API, and functional interfaces to develop efficient Java applications.
2. Develop database-driven applications using JDBC architecture and Hibernate framework for efficient data persistence and management.
3. Design and implement dynamic web applications using Servlet technology and web architecture concepts.
4. Create interactive and user-friendly web pages using JSP technology and implicit objects.
5. Develop enterprise-level Java applications using Spring Framework concepts such as Dependency Injection, MVC, and bean management.

Course Contents

Unit I	Introduction to Collection Framework and Java 8 Features	(09 Hours)

Introduction to Java Collections Framework: List, Set, Queue, Map, ArrayList, LinkedList, HashSet, HashMap, TreeMap **Introduction to Java features:** Lambda Expressions, Functional Interfaces, Stream API ,Default Methods in Interfaces , Static Methods in Interfaces

Mapping of Course	CO1

Outcomes for Unit I	

Unit II	JDBC and Hibernate Framework	(09Hours)
JDBC Architecture: JDBC Drivers, Connection Handling, CRUD Operations using JDBC, Transaction Management Commit and Rollback **Hibernate Framework:** ORM Concepts, Hibernate Configuration, Annotations, HQL Basics		
Mapping of Course Outcomes for Unit II	CO2	
Unit III	**Web Architecture and Servlet**	**(09 Hours)**
Introduction to Web Architecture: Client-Server Architecture, HTTP Protocol, Web Containers **Servlets:** Introduction to Servlets; Servlet Life cycle; Handling HTTP request and Responses; GET and POST methods, Purpose and use of Servlet Deployment descriptor File, Annotatios, ServletContext and ServletConfig, Session Management methods		
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**JSP (Java Server Pages)**	**(09 Hours)**
Java Sever Pages: Introduction to JSP; JSP Lifecycle; JSP syntax and directives; Scriplet, Expression and declaration; JSP Implicit objects; JSP directives; JSP Action Element;; Introduction to JSP Expression Language; Introduction to JSTL Core Tags		
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Spring Framework**	**(09 Hours)**
Introduction to Spring Framework and its Architecture ,Dependency Injection (DI) and Inversion of Control (IoC) ,Spring Container and Bean Life Cycle ,XML and Annotation-Based Configuration ,Spring MVC Architecture and Dispature Servlet, Database Connectivity using Spring JDBC / Spring and Hibernet		
Mapping of Course Outcomes for Unit V	CO5	

Learning Resources

Textbooks

1. Herbert Schildt, *Java: The Complete Reference*, McGraw Hill Education, Eleventh Edition, ISBN: 978-1260440232.
2. Kathy Sierra and Bert Bates, *Head First Servlets and JSP*, O'Reilly Media, Second Edition, ISBN: 978-8173665271.Craig Walls, *Spring in Action*, Manning Publications, Sixth Edition, ISBN: 978-1617297571

Reference Books:

1. Deitel and Deitel, *Java How to Program*, Pearson Education, Eleventh Edition, ISBN: 978-0134743356.
2. Richard Monson-Haefel, *Java Database Programming with JDBC*, O'Reilly Media, Second Edition, ISBN: 978-0596000882.
3. Gavin King, *Hibernate in Action*, Manning Publications, First Edition, ISBN: 978-1932394153.
4. Murach, *Murach's Java Servlets and JSP*, Mike Murach & Associates, Third Edition, ISBN: 978-1890774783.
5. Bryan Basham, Kathy Sierra and Bert Bates, *Head First Servlets and JSP*, O'Reilly Media, Second Edition, ISBN: 978-8173665271.
6. Hans Bergsten, *JavaServer Pages*, O'Reilly Media, Third Edition, ISBN: 978-0596005634.
7. Craig Walls, *Spring Boot in Action*, Manning Publications, First Edition, ISBN: 978-1617292545.
8. Ram Kulkarni, *Spring Framework for Beginners*, SPD Publications, Latest Edition.

Savitribai Phule Pune University
Third Year Electronics & Computer (2024Course)

PCC-304-ECE: Database Management Lab

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

Prerequisite Courses, if any: -

Companion Course, if any: Database Management System

Course Objectives:

The objective of this course is to provide students with

1. Design relational database structures using SQL DDL commands for creation of database objects
2. Perform data manipulation and retrieval operations using SQL DML statements with appropriate operators, functions, joins, and sub-queries for effective data handling.
3. Develop procedural database programs using PL/SQL, including stored procedures, cursors, and triggers to implement business logic and automate database operations.
4. Apply NoSQL database concepts using MongoDB, performing CRUD operations along with aggregation, indexing, and Map Reduce techniques for semi-structured data processing.
5. Design and develop a complete database-driven application by applying the database development life cycle, including requirement analysis, conceptual and relational design, normalization, implementation, testing, and documentation with proper database connectivity

Course Outcomes:

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

CO1: Design and implement relational database schemas using SQL DDL statements and database objects such as tables, views, indexes, sequences, and synonyms for effective data organization.

CO2: **Apply** SQL DML operations for data manipulation and retrieval, including INSERT, SELECT, UPDATE, DELETE, joins, and sub-queries with appropriate use of operators and functions.

CO3: **Develop** PL/SQL programs to implement business logic, including stored procedures, parameterized cursors, and control structures for solving real-world database problems.

CO4: **Design and implement** database integrity and auditing mechanisms using PL/SQL triggers to track updates and deletions and maintain historical data in audit tables.

CO5: **Apply** NoSQL database concepts and develop database applications using MongoDB, including CRUD operations, aggregation, indexing, and Map Reduce, and integrate database systems through complete application development lifecycle with proper design, implementation, and testing.

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 need 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 student in the form of 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.

Lab Requirement

Operating System recommended :- 64-bit Open source Linux or its derivative
Programming tools recommended:- MYSQL/Oracle, MongoDB, ERD plus, ER Win

Group A- Database Programming Languages – SQL

1. To create and manage database structures like Table, View, Index, Sequence and Synonym using SQL DDL commands such as CREATE, ALTER, DROP, and TRUNCATE.

2.Develop database operations using SQL commands like INSERT, SELECT, UPDATE, and DELETE in a sample database application.

3.Design and develop SQL queries for a suitable database application using different types of Joins and Subqueries with SQL DML statements.

Group B- Database Programming Languages – PL / SQL

4.Write a Stored Procedure to Calculate Hostel Room Rent Fine for Late Payment

Schema:

- Student_Rent (Roll_no, Student_Name, Due_Date, Payment_Date, Status (P = Paid, U = Unpaid)

  Rent_Fine (Roll no, Fine_Date, Amount)

- Accept **Roll No** from user.
- Fetch **Due_Date and Payment_Date** from table.
- Calculate number of delayed days.
- Fine rules:
  - If delay ≤ 10 days → ₹0 fine
  - If delay between 11 and 20 days → ₹10 per day
  - If delay > 20 days → ₹25 per day
- After payment, update **Status = 'P'**

If fine exists, insert record into **Rent_Fine**

5.Write a PL/SQL block of code using parameterized Cursor that will merge the data available in the newly created table N_RollCall with the data available in the table O_RollCall. If the data in the first table already exist in the second table, then that data should be skipped.

6.Write a database trigger on Library table. The System should keep track of the records that are being updated or deleted. The old value of updated or deleted records should be added in Library_Audit table.

Group C- Database Programming Languages – No SQL

7.Mongo DB queries: Design and Develop Mango DB Queries using CRUD operations. (use CRUD operations, SAVE Method and logical operators)

8.Mango DB – Aggregation and Indexing: Design and Develop Mango DB Queries using Aggregation and Indexing with suitable example.

9.Mango DB Map reduces operations: Implement Map reduces operation with suitable example using Mango DB

10.Design and develop database application with following details:

- **Requirement Gathering and Scope finalization**

- **Database Analysis and Design:**
  - Design Entity Relationship Model, Relational Model, Database Normalization
  - Implementation:
  - Front End : Java/Perl/PHP/Python/Ruby/.net
  - Backend : MYSQL/Oracle/ MongoDB
  - Database Connectivity : ODBC/JDBC
- **Testing: Data Validation**

Group of students should submit the Project Report which will consist of documentation related to different phases of Software Development Life Cycle: Title of the Project, Abstract, Introduction, scope, Requirements, Data Modeling features, Data Dictionary, Relational Database Design, Database Normalization, Graphical User Interface, Source Code, Testing document, Conclusion

Virtual Lab:Link: https://dmsl-virtual-lab.vercel.app/

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

PCC-305-ECE: Advanced Java Programming & Microcontrollers and Applications Lab

Teaching Scheme	Credits	Examination Scheme
Practical : 04 Hours/Week	02	**Term Work:** 50 Marks **Practical** : 25 Marks

Companion Course, if any:

Course Objectives:

The objective of this course is to provide students with

- To develop hands-on skills in interfacing peripheral devices such as LED, LCD, DAC, and motors with 8051 and RL78 microcontrollers using embedded C programming.
- To understand and apply timer, interrupt, and multiplexing techniques for controlling displays, sensors, and actuators in embedded system applications.
- To develop and implement microcontroller-based circuits for real-time signal generation, motor control, and sensor-based monitoring using standard driver ICs and modules.

To familiarize students with industry-relevant development tools and hardware platforms including 8051 and RL78 for building practical embedded applications.

Course Outcomes:

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

CO1: Interface and program LED banks, seven-segment displays, LCD, and RGB LEDs with 8051 and RL78 microcontrollers using timer and interrupt operations.

CO2: Develop embedded C programs for DAC waveform generation, stepper motor control, and DC motor speed/direction control using 8051 microcontrollers.

CO3: Interface IR obstacle sensor, LDR, and LM35 temperature sensor with RL78 microcontroller for real-time detection and monitoring applications.

CO4: Apply ADC operation, echo pulse timing, and digital output control techniques using RL78 microcontroller for sensor-based embedded system development.

List of Experiments

Group A: Advanced Java Programming lab(Any six)

1. Student Record Management using Collection Framework: Implement a Java program using ArrayList, Hash-Map, and Iterator to store, search, update, and display student records

2.Employee Management using Java 8 Features: Develop a program using Lambda Expressions and Stream API to sort, filter, and display employee details.
3.Student Database Connectivity using JDBC: Create a Java application to perform CRUD (Create, Read, Update, Delete) operations on a student database using JDBC.
4.Employee Management System using Hibernate: Develop a Hibernate application to insert, update, and retrieve employee records from a MySQL database using annotations.
5.Login Validation using Servlet: Design a web application using Servlet to validate username and password entered by the user.
6.Online Feedback Form using Servlet: Create a feedback form application where user input is processed and displayed using Servlet technology.
7.Student Information Display using JSP: Develop a JSP page to accept and display student details using JSP implicit objects.
8.Simple Calculator using JSP: Create a JSP-based calculator to perform arithmetic operations such as addition, subtraction, multiplication, and division.
9.**Spring MVC Web Application:** Create a simple Spring MVC application to accept user input through a form and display the result on another page.
Group B: Microcontrollers and Applications Lab (Any six)
10.To interface an LED bank with the 8051-microcontroller using timer and interrupt operation for sequential LED blinking and timing control applications.
11.To interface a Seven Segment Display with the 8051 microcontrollers for displaying numeric digits and counter values using multiplexing technique.
12.To interface a DAC with the 8051 microcontrollers for generating different analog waveforms such as square, triangular, and sine waves.
13.To interface a stepper motor with the 8051 microcontrollers for controlling rotational direction, step angle, and speed operation.
14.To interface a 16×2 LCD display module with the 8051 microcontroller and display alphanumeric characters, messages, and system status information.
15To interface an RGB LED with the 8051 microcontrollers for generating different color combinations using digital output control technique.
16.To interface an IR obstacle detection sensor with the 8051 microcontrollers for detecting nearby objects and controlling indication devices based on sensor output.
17.To interface an LED with the RL78 microcontroller and write a program for LED blinking for understanding digital output port operations and delay generation.
18.To interface an IR obstacle detection sensor with the RL78 microcontroller for detecting nearby objects and controlling indication devices based on sensor output (Buzzer).
19.To interface a 16×2 LCD display module with the RL78 microcontroller and display alphanumeric characters, messages, and system status information.
20.To interface an LM35 temperature sensor with the RL78 microcontroller using ADC operation for real-time temperature measurement and monitoring applications.
Group C: Compulsory Experiments
21.**Spring Bean Configuration Program:** Develop a basic Spring application to demonstrate Dependency Injection using XML or Annotation-based configuration.
22.To interface a DC motor with the 8051-microcontroller using motor driver IC for controlling motor speed and direction in embedded control applications.

PEC-321-ECE Program Elective 1-Courses
(Choose any One Elective from Program Elective-1 Courses)

Program Elective-I
Computer Network
Operating System
Data analytics using Python
PLC Automation & Sensors

Savitribai Phule Pune University
Third Year of Electronics and Computer Engineering (2024Course)

PEC321A-ECE : Computer Network

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

Prerequisite Courses, if any: Basic Computer Hardware & Networking

Companion Course, if any: Laboratory Practical

Course Objectives:

The objective of this course is to provide students with

- Understand the fundamentals of computer networks and communication models.
- Learn network protocols, architectures, and routing mechanisms.
- Study data transmission, switching, and network security concepts.
- Gain knowledge of wireless, cloud, and modern networking technologies.
- Develop practical skills in network configuration and troubleshooting.

Course Outcomes:

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

CO1: Analyze the requirements of network types, topology and transmission media

CO2: Demonstrate error control, flow control techniques and protocols and analyze them

CO3: Demonstrate the subnet formation with IP allocation mechanism and apply various routing algorithms

CO4: Implement web applications and services using application layer protocols

CO5: Understand Applications of Computer Networking

Course Contents

Unit I	Introduction To Computer Networks	(09 Hours)

Definition of Networking, **Types of Networks:** Local area networks (LAN), Metropolitan area networks (MAN), Wide area networks (WAN), Wireless networks, Networks Software, Protocol, Design issues for the Network layers. **Network Models:** The OSI Reference Model, TCP/IP Model, Network Topologies, **Network Architectures:** Client-Server, Peer To Peer, Hybrid. **Network Devices:** Bridge, Switch, Router, Gateway, Internet, Intranet, and Extranet,**Transmission Media:** Guided Media, Unguided Media

#Exemplar	Study of Campus wide networking.
Mapping of Course Outcomes for Unit I	CO1

Unit II	Data Link Layer and Network Access	(09 Hours)

Functions of Data Link Layer, Framing Techniques, Error Detection and Error Correction, Flow Control and Error Control, **WAN Connectivity**: PPP and HDLC, **MAC Sub layer:** Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, CSMA/CD, CSMA/CA, **Switching Techniques:** Circuit, Packet, Message Switching. Introduction to Ethernet, IEEE 802.3, IEEE 802.11 a/b/g/n, IEEE 802.15 and IEEE 802.16 Standards, Introduction to VLAN.

#Exemplar	Demonstration of DLL protocols on Simulator
Mapping of Course Outcomes for Unit II	CO2

Unit III	Network Layer and IP Addressing	(09 Hours)
Introduction: Functions of Network layer. **Switching Techniques:** Circuit switching, Message Switching, Packet Switching. **IP Protocol**: Classes of IP (Network addressing), IPv4 , IPv6, Network Address Translation, Sub-netting , CIDR. **Network layer Protocols:** ARP, RARP, ICMP, IGMP. **Network Routing and Algorithms:** Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing, Path Vector. **Routing Protocols:** RIP, OSPF, BGP, MPLS. **Routing in MANET:** AODV, DSR, Mobile IP.		
#Exemplar	Demonstration of Routing Protocols on simulator.	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Transport and Application Layer**	**(09 Hours)**
Introduction to Transport layer. Elements of **Transport Layer Protocols:** Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, Congestion Control. **Transport Layer Protocols:** TCP and UDP, SCTP, RTP. **Introduction to Application Layer:** Introduction, Web and HTTP, Web Caching, DNS, **Email:** SMTP, MIME, POP3, Webmail, FTP, TELNET, DHCP, SNMP.		
#Exemplar		
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Applications of Computer Networking**	**(09 Hours)**
Communication Applications: Email communication, Instant messaging and chatting, Video conferencing, VoIP (Voice over Internet Protocol), **Business and Commercial Applications:** E-commerce systems, Online banking, Digital payment systems, Enterprise Resource Planning (ERP) Customer Relationship Management (CRM), **Cloud Computing Applications:** Cloud storage, Remote data Bac up, **Educational Applications:** E-learning platforms, ,Virtual classrooms, Online examinations, Digital libraries.		
#Exemplar	Study of Computer Applications	
Mapping of Course Outcomes for Unit V	CO5	

Learning Resources

Textbooks:

1. Fourauzan B.,"Data Communications and Networking", 5th Edition, Tata McGraw-Hill, Publications, ISBN:0–07 – 058408 – 7
2. Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson India, 2012.

Reference Books:

1. Kurose, Ross, “Computer Networking a Top Down Approach Featuring the Internet”, Pearson, ISBN-10: 0132856204
2. L. Peterson and B. Davie, “Computer Networks: A Systems Approach”, 5th Edition, Morgan-Kaufmann, 2012.
3. Douglas E. Comer & M.S Narayanan,”Computer Network & Internet”, Pearson Education
4. William Stallings, “Cryptography and Network Security: Principles and Practice”, 4th Edition
5. Pachghare V. K., “Cryptography and Information Security”, 3rd Edition, PHI,

MOOC / NPTEL/YouTube Links:

- nptel.ac.in/courses/106/105/106105183
- nptel.ac.in/courses/106/105/106105080
- nptel.ac.in/courses/106/105/106105081
- https://www.mooc-list.com/tags/computer-networking
- https://www.coursera.org/courses?query=computer%20network .

Case Study:

- http://www.worldcolleges.info/sites/default/files/Cisco_-_Ccie_Fundamental_Network_Design_And_Case_Studies.PDF
- http://vlabs.iitb.ac.in/vlabs-dev/labs_local/computer-networks/labs/explist.php

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PEC-322A-ECE: Computer Network Lab

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

Companion Course, if any:

Course Objectives:

1. To design and implement small size network and to understand various networking commands.
2. To learn various client/server environments to use application layer protocols.
3. To understand network layer routing protocols and its implementations.
4. To learn network programming
5. To understand the Computer Networking Applications.

Course Outcomes:

On completion of the course, learners will be able to

CO1: Analyze the requirements of network types, topology and transmission media

CO2: Demonstrate error control, flow control techniques and protocols and analyze them

CO3: Demonstrate the subnet formation with IP allocation mechanism and apply various routing algorithms

CO4: Develop Client-Server architectures and prototypes

CO5: Implement web applications and services using application layer protocols CO6: Use network security services and mechanisms

List of Experiments

Group A: Any six to be Performed

1.Setup a wired LAN using Layer 2 Switch. It includes preparation of cable, testing of cable using line tester, configuration machine using IP addresses, testing using PING utility and demonstrating the PING packets captured traces using Wireshark Packet Analyzer Tool.

2.Demonstrate the different types of topologies and types of transmission media by using a packet tracer

3.Using a Network Simulator (e.g. packet tracer) Configure Router for…
a) Configure a router using router commands and Configure Routing Information Protocol(RIP).
b) Configure Access Control lists – Standard & Extended.
c) Network Address Translation: Static, Dynamic & PAT (Port Address Translation)

4.Using a Network Simulator (e.g. packet tracer) Configure Routing Protocols,
a) Configure EIGRP – Explore Neighbor-ship Requirements and Conditions, its K Values Metrics Assignment and Calculation.
b) OSPF – Explore Neighbor-ship Condition and Requirement, Neighbor-ship states, OSPF Metric Cost Calculation.
c) WLAN with static IP addressing and DHCP with MAC security and filters.

5.Socket Programming in C/C++ on Linux.
a) TCP Client, TCP Server b) UDP Client, UDP Server

6.Introduction to server administration (server administration commands and their applications) and configuration of below Server: (Study/Demonstration Only)
a) FTP b) Web Server

7.Configure a wireless network mechanism: Wi-Fi router, Laptop/mobile devices, Wireshark tool

8.Setup a wired LAN using Layer 2 Switch. It includes preparation of cable, testing of cable using line tester, configuration machine using IP addresses, testing using PING utility and demonstrating the PING packets captured traces using Wireshark Packet Analyzer Tool.

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

PEC-321B-ECE: Operating Systems

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

Prerequisite Courses, if any: **Data Structure, Digital Electronics**

Companion Course, if any: **Operating System Lab**

Course Objectives:

1. To understand the fundamental concepts, structure, and services of Operating Systems.
2. To study process management, CPU scheduling, synchronization, and deadlock handling techniques.
3. To analyze memory management methods including paging, segmentation, and virtual memory.
4. To understand file systems, directory structures, and storage management techniques.
5. To explore modern Operating System concepts such as virtualization, cloud computing, mobile OS, RTOS, and security aspects.

Course Outcomes:

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

CO1: Explain the basic concepts, structure, services, and types of Operating Systems along with system calls and OS functionalities**.**

CO2: Analyze process scheduling, synchronization, inter-process communication, and deadlock handling techniques for efficient process management**.**

CO3: Apply memory management techniques such as paging, segmentation, virtual memory, and page replacement algorithms to improve system performance**.**

CO4: Illustrate file system organization, file allocation methods, directory structures, and disk scheduling techniques used in storage management.

CO5: Describe modern Operating System concepts including virtualization, cloud computing, mobile operating systems, real-time operating systems, and security mechanisms.

Course Contents

Unit I	Introduction to Operating System	(09Hours)

Operating system functions and characteristics, historical evolution of operating systems, issues in operating system design, User's view of the OS, Types of OS: Batch, time sharing, multiprogramming, distributed, network and real-time systems, Operating-System Services, Types of System Calls, System Programs, basic concepts of Kernel and Shell, command line interface and graphical user interface, introduction to Linux/UNIX environment and basic system utilities

#Exemplar	Study and demonstration of basic Linux/UNIX environment, operating system services, system utilities, command line interface (CLI), graphical user interface (GUI), and basic shell commands related to file and process management.

Mapping of Course Outcomes for Unit I	CO1	
Unit II	**Process Management& Synchronization**	**(09 Hours)**
Process Concept: Types of processes, process states and transitions, PCB, context switching, process scheduling. **Schedulers and Threads**: Long term, short term and medium term schedulers, multithreading, user-level and kernel-level threads. **CPU Scheduling**: Preemptive and Non-preemptive scheduling, FCFS, SJF, RR, Priority scheduling. **Synchronization and IPC**: Critical section problem, Semaphores, Mutexes, Producer-Consumer problem, message passing, shared memory. **Deadlocks**: Conditions, prevention, avoidance (Banker's Algorithm), detection and recovery.		
#Exemplar	Study and implementation of process scheduling algorithms, process synchronization techniques, inter-process communication methods.	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	**Memory Management**	**(09 Hours)**
Introduction to Memory Management: Need of Memory Management, Logical & Physical Address, Memory Hierarchy. Contiguous Memory Allocation: Fixed Partitioning, Dynamic Partitioning, Fragmentation. Paging Concept: Pages, Frames, Page Table, Address Translation. Paging Techniques: Multilevel Paging, Translation Lookaside Buffer(TLB), Effective Memory Access Time. Segmentation: Segmentation Architecture, Advantages & Disadvantages. Virtual Memory: Demand Paging, Swapping, Page Fault Handling. Page Replacement Algorithms: FIFO, LRU, Optimal, Second Chance. Modern Trends: Linux Memory Management, Virtualization, Docker Memory Concept.		
#Exemplar	Study and implementation of memory management techniques, paging and segmentation schemes.	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**File System**	**(09 Hours)**
File operation, Directory structure, File System structure, File Organization and Access, File Directories, File Allocation Methods, Secondary Storage Management, File Systems in Operating System (FAT, NTFS, EXT, and HFS). Disk Management: Secondary-Storage Structure- Disk structure, Disk scheduling algorithm (FIFO, SSTF, SCAN, C-SCAN, LOOK, C-LOOK), Disk reliability, Disk formatting, Boot-block, Bad blocks.		
#Exemplar	Study and demonstration of file system operations, file allocation methods, directory structures, disk scheduling algorithms.	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Modern Operating System Concepts**	**(09 Hours)**
Introduction to Modern Operating Systems, Virtual Machines and Virtualization, Basics of Cloud Computing, Embedded Operating Systems and Real-Time Operating Systems (RTOS), Mobile Operating Systems – Android and iOS overview, Multicore and Parallel Processing concepts, Basics of Cybersecurity in Operating Systems. **Modern Trends:** Linux Memory Management, Virtualization, Docker Memory Concept.		

#Exemplar	Study and demonstration of modern operating system concepts including virtualization.
Mapping of Course Outcomes for Unit V	CO5

Learning Resources

Textbooks:

1. Kanetkar, Y. (2017). UNIX shell programming. BPB Publications BPB Publications
2. Modern Operating Systems **Author:** Andrew S. Tanenbaum (later with Herbert Bos) **First published:** 1992; 5th edition released 2022
3. Stallings, W. (2018). Operating Systems: Internals and Design Principles (9th ed.). Pearson.
4. Rajib Mall. (2014). Real-Time Systems: Theory and Practice. Pearson Education India.

Reference Books:

1. Silberschatz, A., Galvin, P. B., & Gagne, G. (2018). Operating system concepts (10th ed.). Wiley.
2. Soyinka, W. (2020). Linux administration: A beginner's guide (8th ed.). McGraw Hill Education
3. Operating Systems Indian Author: Achyut S. Godbole First Published**:** 1999 (McGraw Hill Education India)
4. Tanenbaum, A. S., & Bos, H. (2022). Modern Operating Systems (5th ed.). Pearson.

E-Books:

1. **Operating System Concepts:** https://www.os-book.com/OS10/index.html
2. **Operating System Concepts: https://www.os-book.com/OS9/index.html**

MOOC / NPTEL/YouTube Links:

1. **Introduction to Operating Systems, IIT Madras:** https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_cs75
2. **Linux Programming & Scripting, IIT Madras:** https://nptel.ac.in/courses/117106113
3. **Operating System Fundamentals – IIT Kharagpur**

   https://www.digimat.in/nptel/courses/video/106105214/?utm_source
4. **Memory Management Introduction** Lecturehttps://www.youtube.com/watch?v=_pKbqFyG03s&utm_source

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

PEC-322B-ECE: Operating System Lab

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

Companion Course, if any:

List of Experiments

Group A: Any six to be Performed

1. Write a series of BASH shell commands for common system administration tasks, process control, disk usage monitoring and system information retrieval.
2. Develop a program using fork(), exec(), and wait() system calls to create and manage parent-child processes in Linux/UNIX operating system.
3. write a c program to simulate the CPU scheduling algorithm First Come First Serve (FCFS)
4. write a program to stimulate the CPU scheduling algorithm Shortest job first (Non- Preemption)
5. Write a C program to simulate the following contiguous memory allocation techniques a) Worst-fit b) Best-fit c) First-fit
6. To implement FIFO page replacement technique. a) FIFO b) LRU c) OPTIMAL
7. Write a C program to copy contents from one file to another.
8. Write a C program to count characters, words, and lines in a file.
9. Study of Virtual Machine (VM) and installation procedure.
10. Execute basic Linux commands for file and directory handling

11. Mini Project / Experiential Learning Component

12. Students shall complete one mini project based on Operating System concepts individually or in a group of maximum 3 students. The mini project should focus on implementation, simulation, analysis, or visualization of operating system techniques using suitable programming tools and platforms.

Suggested Mini Project Topics

- CPU Scheduling Simulator
- Banker's Algorithm for Deadlock Avoidance
- Page Replacement Algorithm Simulator
- Disk Scheduling Algorithm Simulator
- Linux Shell Command Interpreter
- Process Synchronization using Semaphores
- File Management System
- Real-Time Task Scheduler
- Virtual Memory Visualization Tool
- System Monitoring Dashboard

Virtual LAB Link

1. https://erpjietuniverse.in/virtual_lab/Operating_system/labs/index.html

https://naim30.github.io/OS-virtual-lab/

Savitribai Phule Pune University
Third Year of Electronics and Computer Engineering (2024Course)

PEC-321C-ECE: Data Analytics Using Python

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

Prerequisite Courses, if any: Programming Fundamentals of Python, Basic Mathematics & Statistics, and familiarity with Database/Spreadsheet concepts.

Companion Course, if any: Laboratory Practical

Course Objectives:

The objective of this course is to provide students with

- To introduce the fundamentals of Data Analytics and Python ecosystem.
- To understand data preprocessing and exploratory data analysis techniques.
- To apply statistical methods and probability concepts in data analysis.
- To understand machine learning algorithms for analytics applications.
- To introduce advanced analytics concepts including text analytics, time-series analysis, and Big Data tools.

Course Outcomes:

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

CO 1: Demonstrate proficiency in the Python data science ecosystem by efficiently importing, cleaning, manipulating, and aggregating diverse datasets using NumPy and Pandas.

CO 2: Perform exploratory data analysis (EDA) and data preprocessing by handling anomalies, scaling features, and creating static and interactive visualizations using Matplotlib, Seaborn, and Plotly.

CO 3: Apply statistical methods, hypothesis testing (such as t-tests and ANOVA), and regression analysis to derive meaningful insights and validate data-driven hypotheses.

CO 4: Design, implement, and evaluate machine learning models for classification, clustering, and dimensionality reduction using scikit-learn while addressing overfitting and underfitting.

CO 5: Implement advanced analytics techniques, including text processing, time-series forecasting, and scalable Big Data processing using PySpark and ETL pipelines.

Course Contents

Unit I	Introduction to Data Analytics & Python Ecosystem	(08 Hours)

Data Science, Introduction to Data Analytics, types of data analytics: Descriptive, Diagnostic, Predictive, Prescriptive and data analytics lifecycle. Python for Data Science including overview and advantages of Python in analytics. Data Handling in Python: Lists, tuples, dictionaries, sets, File handling in Python Working with CSV and text files. Python Libraries for Data Analytics. Introduction to NumPy including arrays, indexing, slicing, broadcasting, and mathematical operations. Introduction to Pandas including Series and DataFrame fundamentals. Data import and export using CSV, Excel, and JSON formats. Indexing, slicing, and filtering operations in Pandas. GroupBy operations, aggregation techniques, and pivot tables.

#Exemplar	Perform data import, cleaning, and manipulation using Python libraries such as NumPy and Pandas on structured datasets.

Mapping of Course Outcomes for Unit I	CO1	
Unit II	**Data Preprocessing & Exploratory Data Analysis**	**(08 Hours)**
Handling missing values and outliers. Data normalization and standardization, Feature selection, Data type conversions and feature scaling methods. Encoding categorical variables using Label Encoding and One-Hot Encoding techniques. Descriptive statistics including mean, median, mode, variance, standard deviation, Mean Deviation, skewness, and kurtosis. Introduction Exploratory Data Analysis. Exploratory Data Analysis (EDA) workflow. Data visualization using Matplotlib including line plots, bar plots, scatter plots, and histograms. Seaborn visualizations including Heatmaps, Pair plots, and boxplots. Introduction to Plotly for interactive visualization.		
#Exemplar	Apply preprocessing techniques and create statistical as well as graphical visualizations to identify patterns and insights from data.	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	**Statistical Analysis & Probability**	**(08 Hours)**
Probability distributions including normal, binomial, and Poisson distributions. Central Limit Theorem and sampling concepts. Correlation and covariance analysis. Basics and need of hypothesis and hypothesis testing, Hypothesis testing including z-test, t-test, and chi-square test. Concepts of p-value, significance level, and confidence intervals. One-way and two-way Analysis of Variance (ANOVA). Simple linear regression and multiple linear regression. Regression evaluation metrics including R^2, Mean Squared Error (MSE) and Root Mean Squared Error (RMSE).		
#Exemplar	Use probability distributions, hypothesis testing, ANOVA, and regression analysis for statistical interpretation and prediction.	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Machine Learning for Data Analytics**	**(08 Hours)**
Machine learning workflow including train-test split and cross-validation techniques. Classification algorithms including K-Nearest Neighbor (KNN), Naive Bayes, and Decision Tree. Logistic Regression and Support Vector Machine (SVM). Ensemble learning methods including Random Forest, Bagging, and Boosting. Clustering techniques including K-Means and Hierarchical Clustering. Dimensionality Reduction using Principal Component Analysis (PCA). Model evaluation using Confusion Matrix, Precision, Recall, and ROC-AUC. Concepts of overfitting, underfitting, and regularization techniques using L1 and L2 methods.		
#Exemplar	Implement supervised and unsupervised machine learning algorithms for classification, clustering, and model evaluation tasks	
Mapping of Course Outcomes for Unit IV	CO4	

Unit V	Advanced Analytics: Text, Time-Series & Big Data	(08 Hours)
Introduction to Text Analytics and Natural Language Processing (NLP) including text preprocessing techniques such as tokenization, stop-word removal, and stemming. Study of TF-IDF and sentiment analysis methods using Python libraries such as NLTK and spaCy. Introduction to Time-Series Analysis including trend, seasonality, moving averages, decomposition techniques, and forecasting using ARIMA models with statsmodels library. Introduction to PySpark including RDDs, DataFrames, and large-scale data processing techniques. Concepts of Data Pipeline and ETL (Extract, Transform, Load) processes for analytics applications. Simple case study based on end-to-end analytics project such as weather forecasting of product reviews Python-based analytics tools.		
#Exemplar	Develop basic analytics applications using text mining, time-series forecasting, and Big Data tools such as PySpark and Hadoop.	
Mapping of Course Outcomes for Unit V	CO5	

Learning Resources

Textbooks:

3. Wes McKinney, "Python for Data Analysis" Third Edition, O'Reilly Media, 2022.
4. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" Third Edition, O'Reilly Media, 2022.
5. Andreas C. Müller and Sarah Guido, "Introduction to Machine Learning with Python" First Edition, O'Reilly Media, 2016.
6. Peter Bruce, Andrew Bruce, and Peter Gedeck, "Practical Statistics for Data Scientists: 50 Essential Concepts" Second Edition, O'Reilly Media, 2020.
7. Tomasz Drabas and Denny Lee, "Learning PySpark" First Edition, Packt Publishing, 2017.

Reference Books:

1. Joel Grus, "Data Science from Scratch: First Principles with Python" Second Edition, O'Reilly Media, 2019.
2. Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda, "Applied Text Analysis with Python" First Edition, O'Reilly Media, 2018.
3. Aileen Nielsen, "Practical Time Series Analysis" First Edition, O'Reilly Media, 2019.
4. Anil Maheshwari, "Data Analytics: A Practical Guide to Data Analysis, Machine Learning, and Big Data" Second Edition, McGraw-Hill Education, 2021.

e-Books:

1. https://wesmckinney.com/book
2. https://www.statlearning.com
3. https://github.com/ageron/handson-ml3

MOOC / NPTEL/YouTube Links:

1. NPTEL Course "Introduction to Data Analytics" https://nptel.ac.in/courses/106106183
2. NPTEL Course on "Python for Data Science" https://nptel.ac.in/courses/106106212
3. NPTEL Course "Data Analytics with Python" by Prof. A. Ramesh (IIT Roorkee)
4. NPTEL Course "Machine Learning for Data Analytics" by Prof. Balaraman Ravindran (IIT Madras)
5. NPTEL Course "Big Data Computing" by Prof. Rajiv Misra (IIT Patna)

Virtual Labs Links

1. Data Science & Statistics Virtual Lab – IIT Kharagpur https://vlabs.iitkgp.ac.in/ds
2. Machine Learning Virtual Lab – Amrita Vishwa Vidyapeetham https://ml-lab.vlabs.ac.in
3. Probability and Statistics Virtual Lab – IIT Bombay https://vlabs.iitb.ac.in/vlabs-dev/labs/prob_stats
4. Data Visualization and EDA Virtual Lab – NITK Surathkal https://vlabs.nitk.ac.in/data-visualization-lab
5. Natural Language Processing Virtual Lab – IIIT Hyderabad https://nlp-vlab.iiit.ac.in

Savitribai Phule Pune University
Third Year of Electronics and Computer Engineering (2024 Course)

PEC-322C-ECE: Data Analytics using Python Lab

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

Companion Course, if any:

Course Objectives:

The objective of this course is to provide students with

- To understand Python programming and essential libraries such as NumPy, Pandas, Matplotlib, and Scikit-learn for data analytics applications.
- To apply data preprocessing, visualization, statistical analysis, and machine learning techniques on real-world datasets.
- To develop analytical models using classification, clustering, regression, and dimensionality reduction techniques for predictive analytics.

To implement text analytics, sentiment analysis, and case study-based data analytics solutions using modern tools and frameworks.

Course Outcomes:

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

CO1: Apply Python libraries and data preprocessing techniques for data manipulation, visualization, and exploratory data analysis.

CO2: Perform statistical analysis, hypothesis testing, and regression modeling for analytical problem solving.

CO3: Develop and evaluate machine learning models using classification, clustering, and dimensionality reduction techniques.

CO4: Design data analytics solutions using NLP, predictive analytics, and case study-based approaches on real-world datasets.

Suggested List of Laboratory Experiments (Any 6)

Group A (Any 4)

1. NumPy Array Creation and Mathematical Operations

Create 1D, 2D, and 3D NumPy arrays using array(), zeros(), ones(), arange(), and random() functions. Perform arithmetic operations, broadcasting, indexing, slicing, reshaping, matrix multiplication, transpose operations, and statistical calculations such as mean, median, variance, and standard deviation.

2. Advanced NumPy Matrix and Linear Algebra Operations

Implement matrix addition, subtraction, multiplication, determinant, inverse, eigenvalues, and eigenvectors using NumPy linear algebra functions. Demonstrate reshaping, stacking, splitting, and concatenation of arrays for scientific computing applications.

3. Pandas Data Import, Cleaning, and Transformation

Load CSV, Excel, and JSON datasets into Pandas DataFrames. Handle missing values using dropna() and fillna(), perform data type conversion, sorting, filtering using loc[] and iloc[], duplicate removal, and apply basic preprocessing techniques.

4. GroupBy Operations and Pivot Table Analysis using Pandas

Perform aggregation operations using GroupBy(), apply functions such as sum(), mean(), count(), and describe(), and create pivot tables for multidimensional data analysis and reporting.

5. Data Visualization using Matplotlib and Seaborn

Generate line plots, bar charts, histograms, pie charts, scatter plots, boxplots, pairplots, and heatmaps using Matplotlib and Seaborn with proper labels, legends, grids, and titles for exploratory data analysis.

Group B (Any 4)

6. Statistical Analysis and Probability Distributions
Implement normal, binomial, and Poisson distributions using SciPy and NumPy libraries. Plot probability distribution curves and calculate descriptive statistical measures such as mean, variance, skewness, and kurtosis.

7. Hypothesis Testing using t-test, Chi-square Test, and ANOVA
Perform one-sample t-test, independent t-test, chi-square test of independence, and one-way ANOVA on sample datasets. Interpret p-values and confidence intervals to validate statistical hypotheses.

8. Simple and Multiple Linear Regression Analysis
Develop simple and multiple linear regression models using Scikit-learn. Split dataset into training and testing sets, train the model, evaluate using R^2 score, MSE, and RMSE, and visualize regression line and residual plots.

9. Classification using KNN and Naive Bayes Algorithms
Implement K-Nearest Neighbor (KNN) and Gaussian Naive Bayes classifiers after feature scaling and preprocessing. Evaluate model performance using confusion matrix, accuracy, precision, recall, and F1-score metrics.

10. Decision Tree and Random Forest Classification
Train Decision Tree classifiers with controlled depth and visualize decision trees using plot_tree(). Implement Random Forest classification with multiple estimators and compare feature importance and prediction accuracy.

Group C (Any 2, one from 11 or 12 and one from 13 or 14)

11. Clustering and Dimensionality Reduction using K-Means and PCA
Apply PCA to reduce dataset dimensions into principal components. Determine optimal number of clusters using elbow method, implement K-Means clustering, visualize clusters using 2D scatter plots, and evaluate clustering using Silhouette Score.

12. Text Analytics and Sentiment Analysis using NLP
Perform text preprocessing including tokenization, stop-word removal, stemming, and TF-IDF vectorization using NLTK and spaCy libraries. Train a Logistic Regression model for sentiment prediction and evaluate sentiment polarity using VADER sentiment analysis.

13. Case Study: House Price Prediction using Linear and Multiple Regression
Aim: To predict house prices in a residential society using Simple and Multiple Linear Regression based on house features such as area, number of rooms, and age of property.
Problem Statement: A real estate agency wants to predict the selling price of houses in a society based on features like carpet area, number of bedrooms, age of building, and distance from city center using regression analysis. Consider suitable dataset.

14, Case Study: Student Admission Prediction using KNN Classification
Aim: To classify whether a student will get admission in a college based on academic and extracurricular features using K-Nearest Neighbor (KNN) classification algorithm.
Problem Statement: A college admission committee wants to predict whether a student will be admitted or not based on features like 12th percentage, entrance exam score, extracurricular activities, and family income category using KNN classification. Consider suitable dataset.

Note: Perform 04 practical's from group A and B each and 02 practical's must be performed from group C, one from practical's 11 or 12 and one from 13 or 14

Savitribai Phule Pune University

Third Year of Electronics and Computer Engineering (2024 Course)

PEC-321D-ECE PLC Automation and Sensors

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

Prerequisite Courses, if any:

Companion Course, if any: Laboratory Practical

Course Objectives:

The objective of this course is to provide students with

1. To understand the basic concepts, architecture, components, and operation of Programmable Logic Controllers (PLCs) used in industrial automation systems.
2. To develop PLC programming skills using ladder logic and other PLC programming functions for automation applications.
3. To understand process control systems, SCADA, HMI, and the interfacing techniques used in industrial automation.
4. To study various sensors and transducers used for industrial parameter measurement and control.
5. To analyze and implement PLC-based automation solutions for real-time industrial case studies and applications.

Course Outcomes:

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

CO1. Explain the architecture, components, memory organization, operation, and selection criteria of PLCs and compare PLC-based systems with conventional control systems.

CO2. Develop and analyze PLC programs using ladder logic, timers, counters, arithmetic, comparison, and data handling instructions for industrial automation tasks.

CO3. Describe process control techniques, SCADA, HMI systems, and demonstrate PLC interfacing for monitoring and control applications.

CO4. Identify, classify, and select suitable sensors and transducers for measurement of displacement, speed, and other industrial parameters.

CO5. Design and implement PLC-based automation solutions for industrial applications such as traffic light control, motor control, bottle filling, elevator systems, and room automation.

Course Contents

Unit I	PLC Overview	09 Hrs

Definition & History of PLC, Basic structure & Components of PLC, Principle of Operation,Selection of PLC, Why Use PLC, PLC I/O Modules, Memory & How it is used, PLC advantages &Disadvantages, PLC vs Computers, Overview of Micro PLCs. Conventional ladders vs PLC Ladder logic, What is Logic? Overview of Logic functions, Number systems & Codes, Hardwired Logic vs Programmed logic, Programming word level logic instructions,Relation of digital gate logic to contact/coil logic.

#Exemplar	Select a suitable PLC for a conveyor belt automation system and justify your choice.

Mapping of Course Outcomes for Unit I: CO1

Unit II	PLC Programming	09 Hrs

PLC Programming languages, Ladder diagrams, Relays, contactors, switches, sensors, output control devices, latching relays, ladder diagram elements. Programming. Development of a PLC ladder logic diagram for different tasks. PLC Timer & Counter functions, Arithmetic functions, Comparison functions, Jump functions, Data handling functions, Digital Bit functions, PLC matrix Functions.

#Exemplar	Explain industrial applications of timers, counters in production systems.

Mapping of Course Outcomes for Unit II: CO2

Unit III	Process control, HMI & SCADA	09 Hrs

Types of processes, structure of control systems, on/off control, PID Control, Motion control, SCADA (Supervisory control and data acquisition): Block diagram, RTU (Remote terminal unit), Functions of RTU, MTU (Main terminal unit), functions of MTU, operating interfaces& applications, HMI (Human Machine Interface, Interfacing technique of PLC with HMI.		
#Exemplar	Develop a simple PLC-HMI application for motor control	
Mapping of Course Outcomes for Unit III: CO3		
Unit IV	**Sensors and parameters Measurement**	**09 Hrs**
Need of sensors and transducers, transducers definition, classification, performance characteristics and selection criteria. Displacement Measurement: -LVDT and RVDT, optical and proximity sensors. Speed Measurement: Tachometer, Encoders.		
#Exemplar	Explain the need for sensors and transducers in industrial automation.	
Mapping of Course Outcomes for Unit IV: CO4		
Unit V	**Case Studies Using PLC Automation**	**09 Hrs**
Object counter , On-off control, Traffic light control , Motor in forward and reverse direction, Elevator Control, Filling of Bottles ,Room Automation		
#Exemplar	Identify suitabe sensor for force,torque and pressure measurement	
Mapping of Course Outcomes for Unit V: CO5		
Learning Resources		
Textbooks: 1. Programmable Logic Controllers,Frank D. Petruzella, McGraw-Hill Education 2. Programmable Logic Controllers and Industrial Automation,Madhuchhanda Mitra & Samarjit Sen Gupta, Penram International Publishing 3. 3.Instrumentation and Control Systems Author: S. Bhaskar Tata McGraw-Hill 4. 4.Transducers and Instrumentation D. V. S. Murty PHI Learning		
Reference Books: 1. Programmable logic controllers & Industrial Automation- Madhuchandra Mitra, Samarjeet Sen Gupta Penram International Pvt. Ltd., Fourth reprint, 2012 2. Programmable Logic Controllers, W. Bolton, Elsevier, Fourth Edition,2015 3. Programmable Logic Controllers, Principles & Applications ‖ John W. Wobb, Ronald, A. Rais, PHI publishing, Fifth Edition 4. Introduction to Programmable Logic Controllers, Garry Dunning, Thomson, Delmar Learning, 3rd Edition.		
e-Books: 1.https://www.mheducation.ca/programmable-logic-controllers-ise-9781265616786-can?utm_source=chatgpt.com 2.https://openlibrary.org/books/OL35952135M/SCADA?utm_source=chatgpt.com		
MOOC / NPTEL/YouTube Links: 1.NPTEL Course on ―Industrial Automation and Control Link: https://nptel.ac.in/courses/108/105/108105062		

Savitribai Phule Pune University Third Year of Electronics & Computer Engineering (2024 Course)		
PCC-322D-ECE: PLC Automation & Sensors Lab		
Teaching/scheme	**Credits**	**Examination Scheme**
Practical:02 Hours/Week	01	**Term Work:** 50 Marks
Companion Course, if any:		
List of Experiments		
Group A: Any four to be Performed		
1. Simulate & implement basic logic gates ladder logic program.		
2. Simulate & implement simple start/stop ladder logic.		
3. Simulate & implement PLC program example with on delay,off delay and retentive on delay timer.		
4. Design & simulate traffic light ladder logic diagram.		
5. Star Delta PLC Ladder Diagram		
Group B: Any four to be Performed		
1.Interfacing of LDR with PLC		
2.Interfacing of Ultrasonic sensor with PLC		
3.Interfacing of Proximity sensor with PLC		
4.Interfacing of Temperature sensor with PLC		
5.Interfacing of encoder with PLC		
Virtual LAB Link **1. https://mechsimulator.com/tools/plc-ladder-logic/?utm_source=chatgpt.com** **2. https://tryplc.com/?utm_source=chatgpt.com** **3. https://accautomation.ca/series/easyplc-software-suite/?utm_source=chatgpt.com**		

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

MDM-331-ECE: Artificial Intelligence & Data Science Lab

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

Companion Course, if any: Artificial Intelligence & Machine Learning

Course Objectives:

1. To understand & implement fundamental search algorithms and knowledge representation techniques in Artificial Intelligence.
2. To gain hands-on experience in data preprocessing & exploratory data analysis (EDA)
3. To formulate & evaluate machine learning models for classification, regression & clustering tasks.
4. To expose students to modern tools, libraries (such as Pandas, NumPy, Scikit-Learn) & cloud-based data science environments like Kaggle.
5. To foster teamwork, technical documentation writing and structured engineering design through mini-projects.

Course Outcomes:

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

CO1: Apply informed & uninformed search strategies to solve complex AI benchmark problems.
CO2: Perform data cleaning, transformation & visualization to extract insights from raw datasets.
CO3: Build & evaluate fine-tune predictive models using regression and classification techniques.
CO4: Implement unsupervised learning techniques to uncover hidden patterns within structured data.
CO5: Design & deploy a working prototype/mini-project solving a real-world AI/Data Science challenge**.**

Guidelines for Student's Lab Journal

The students Lab Journal should contain following related to every experiment –

1. Title of the experiment
2. Mapped Objective and mapped outcome
3. Software and Tools used.
4. Brief theory, algorithm/flowchart.
5. Sample input/output - test cases with example inputs and corresponding outputs.
6. Conclusions.

Guidelines for Laboratory/ TW Assessment

1. Continuous assessment of laboratory work is to be done based on overall performance.
2. Each lab assignment/experiment assessment will assign grade/marks based on parameters with appropriate weightage.
3. Suggested parameters for overall assessment as well as each laboratory assignment include:
   - ✓ Timely completion.
   - ✓ Performance.
   - ✓ Punctuality and neatness.

Suggested List of Laboratory Experiments

Group A (Artificial Intelligence lab) (Any 4)

1.**Uninformed Search:** Implement Breadth-First Search (BFS) or Depth-First Search (DFS) to navigate a synthetic grid or maze environment. (Dataset: Pyamaze / Synthetic Maze Data)

2 **Informed Search:** Implement the A* Search or Greedy Best-First Search algorithm for pathfinding or finding shortest routes. (Dataset: Road Distance & Routes)

3 **Heuristic Optimization:** Implement the Traveling Salesperson Problem (TSP) using a heuristic approach (e.g., Genetic Algorithm or Hill Climbing). (Datasets: TSP City Coordinate)

4 **Adversarial Search:** Implement the Minimax algorithm with Alpha-Beta Pruning using a standard board game simulation setup. (Dataset: Chess Game)

5 **Knowledge Representation:** Build a Rule-Based Expert System or a diagnostic tree logic pipeline for an automated application. (Dataset: Car Evaluation)

6 **Constraint Satisfaction:** Solve a Constraint Satisfaction Problem (CSP) like the Cryptarithmetic problem or Graph Coloring using backtracking. (Dataset :Sudoku Puzzles)

Group B (Data Science Lab) (Any 5)

1. Data Cleaning & EDA: Handle missing values, outliers, identify data types, and perform baseline visualizations (histograms, box plots). (Dataset: Titanic - Machine Learning from Disaster)

2. Regression Modeling: Implement Simple and Multiple Linear Regression to analyze feature correlations and predict numerical continuous targets. (Boston Housing Dataset)

3.Supervised Classification: Implement a Logistic Regression /Decision Tree model; Analyze accuracy using Confusion Matrices. (Iris Species Classification)

4.Unsupervised Clustering: Implement K-Means clustering to discover distinct consumer segments or data distribution profiles. (Mall Customers Segmentation)

5. Feature Engineering: Apply categorical encoding (One-Hot, Label), data scaling (Minimax) & feature selection criteria. (House Prices - Advanced Regression)

6.Model Evaluation & Tuning: Apply k-Fold Cross-Validation and Hyper-parameter Tuning using Grid Search CV on an ensemble classifier (e.g., Random Forest).(Credit Card Fraud Detection)

Group C (Mini Projects) (Any one)

Mini-Project 1: Natural Language Processing (NLP) Sentiment Analysis System

Objective: Develop an end-to-end sentiment classification application using text processing methodologies (TF-IDF or Word Embeddings) Kaggle Dataset Link: IMDB Movie Reviews Dataset

Mini-Project 2: Multi-Feature Predictive Analytics Dashboard

Objective: Build a data pipeline that performs complex extraction, correlation mapping, predictive modelling (Regression/Time-Series/Classification) & presents outcomes through an interactive frontend dashboard (Streamlit or PowerBI). Kaggle Dataset Link: Uber Rides Dataset

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

MDM-331-ECE: Artificial Intelligence & Data Science

Teaching/scheme	Credits	Examination Scheme
Tutorial :02 Hours/Week	02	**Term Work: 25 Marks** **Oral: 25Marks**

Prerequisite Courses, if any: Basis Programming in Python, Fundamentals of Probability & Statistics

Companion Course, if any: Artificial Intelligence & Machine Learning

Course Objectives:

- Students can learn with practical skills to install and configure essential AI and Data Science tools including Anaconda and PyCharm.
- Students to work proficiently across industry-standard IDEs and cloud-based platforms such as Jupyter, Google Colab, and VS Code.
- Develop hands-on competence in Python data engineering libraries : NumPy, Pandas, and Scikit-learn for data manipulation and machine learning.
- Build the ability to create meaningful data visualizations and analytics dashboards using Python libraries and Power BI.

Course Outcomes:

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

CO1: Install and configure AI & Data Science software environments including Anaconda, PyCharm, and associated Python packages.

CO2: Utilize multiple IDEs and cloud platforms (Jupyter Notebook, Google Colab, VS Code, Kaggle) to develop and run data science workflows.

CO3: Apply Python data engineering libraries — NumPy, Pandas, Scikit-learn — to process, clean, and model real-world datasets.

CO4: Design and build analytical dashboards and visualizations using Matplotlib, Seaborn, Plotly, and Power BI for effective data storytelling

Course Contents

Unit I	Software & Installation	(04 Hours)
sets the foundation by getting students comfortable with Anaconda and PyCharm, including environment management and first-time Python runs.		
Mapping of Course Outcomes for Unit I	CO1: Install and configure AI & Data Science software environments including Anaconda, PyCharm, and associated Python packages	
Unit II	**IDEs & Platforms**	**(04 Hours)**
Explores the wider ecosystem -Jupyter, Google Colab, VS Code, and Kaggle helping students understand which tool fits which workflow		
Mapping of Course Outcomes for Unit II	CO2: Utilize multiple IDEs and cloud platforms (Jupyter Notebook, Google Colab, VS Code, Kaggle) to develop and run data science workflows.	
Unit III	**Data Engineering & Libraries**	**(04 Hours)**
Dives into the Python data stack: NumPy, Pandas, Scikit-learn, and an intro to deep learning frameworks, culminating in a full data pipeline exercise.		

Mapping of Course Outcomes for Unit III	CO3: Apply Python data engineering libraries -NumPy, Pandas, Scikit-learn to process, clean, and model real-world datasets.	
Unit IV	**Visualization & Analytics**	**(04 Hours)**
Python plotting libraries (Matplotlib, Seaborn, Plotly) and Power BI, finishing with a capstone dashboard project.		
Mapping of Course Outcomes for Unit IV	CO4: CO4: Design and build analytical dashboards and visualizations using Matplotlib, Seaborn, Plotly, and Power BI for effective data storytelling	
Learning Resources		
Textbooks: 1. Wes McKinney — Python for Data Analysis (3rd Edition), O'Reilly Media, 2022. 2. Jake VanderPlas — Python Data Science Handbook, O'Reilly Media, 2023. 3. Aurélien Géron — Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow (3rd Ed.), O'Reilly, 2022.		
Reference Books: 1. Sebastian Raschka & Vahid Mirjalili — Python Machine Learning, Packt Publishing, 2022. 2. Joel Grus — Data Science from Scratch (2nd Ed.), O'Reilly Media, 2019. 3. Chris Albon — Machine Learning with Python Cookbook, O'Reilly Media, 2018.		
e-Websites Books: 1. Official NumPy Documentation : https://numpy.org/doc/ 2. Official Pandas Documentation : https://pandas.pydata.org/docs/ 3. Scikit-learn User Guide : https://scikit-learn.org/stable/user_guide.html 4. Power BI Documentation : https://learn.microsoft.com/en-us/power-bi/		
MOOC / NPTEL/YouTube Links: 1. NPTEL: Introduction to Machine Learning (IIT Madras) : https://nptel.ac.in/courses/106106139 2. Coursera : IBM Data Science Professional Certificate : https://www.coursera.org/professional-certificates/ibm-data-science 3. YouTube : Corey Schafer Python Tutorials : https://www.youtube.com/@coreyms		

OLE-341-ECE Open Elective -Courses (Choose any One Elective from Open Elective bucket)

Open Elective-I
IPR and Cyber Laws
Sustainability Development
Digital Personal Data Protection
Marketing Management

Note: Students can opt for Open Electives offered by different discipline/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.

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

CEP-342-ECE: Technical Seminar

Teaching/scheme	Credits	Examination Scheme
Practical:02 Hours/Week	01	**Oral/Presentation:** 25Marks

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:

The course aims to:

1. To develop research orientation and technical communication skills in emerging Computer Engineering and Artificial Intelligence domains.
2. To enable students to critically review, analyze, and synthesize contemporary research papers, white papers, patents, and technical standards.
3. To promote interdisciplinary thinking aligned with NEP-2020 multidisciplinary philosophy.
4. To inculcate ethical awareness, sustainability perspective, and societal impact analysis of AI systems.
5. 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 semi-nar preparation

Guidelines for Conduct of Technical Seminar

The Technical Seminar shall be research-oriented and domain-specific, focusing strictly on recent development in E&TC Engineering, IoT .

Guidelines for Technical Seminar

- Topic must be from emerging Computer Engineering, Artificial Intelligence and Data Science domains (preferably last 3–5 years).
- Must involve a minimum of 5 recent research papers (IEEE, ACM, Elsevier, Springer etc).
- Student should be summarizing paper – Reading abstracts and finding ideas, conclusion, 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 (Week 1–2)
  - 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 (e.g., AI/ML, Cy-bersecurity, Cloud Computing, IoT). Students identify 2–3 broad domains of interest.
  - The precise topic is finalized and approved by a departmental seminar committee.
- Literature Survey & Problem Understanding (Week 2–4)
  - Students must: Refer minimum 5–8 recent research papers (IEEE, Springer, Elsevier, ACM etc.)
  - Use scholarly databases like IEEE Xplore, Google Scholar, ScienceDirect
  - Prepare a literature survey matrix, including:
    - Author/year
    - Methodology used
    - Key findings
    - Limitations
  - Identify: Research gaps and Challenges in existing approaches
- Synopsis Preparation & Presentation (Week 4–5)
  - Submit a 2–3 page synopsis including: Introduction, Literature insights, Objectives, Pro-posed 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 (Week 5–8)
  - 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 (Week 8–10)
  - Submit first draft of the report
  - Guide provides feedback on: Technical content quality, Structure and coherence, Referenc-ing and plagiarism,
  - Students must revise based on suggestions by the guide
- Pre-Seminar Presentation (Mock Evaluation) (Week 10–11)
  - 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 (Week 11–12)
  - Submit: Final hard copy (if required), Soft copy (PDF format)
  - Ensure:Proper formatting, Plagiarism compliance (<20%), Correct referencing using refer-ence managers like Zotero and Mendeley Desktop
- Final Seminar Presentation & Viva Voce (Week 12–13)
  - Presentation duration: 10–15 minutes, Followed by Q&A session (5–10 minutes)

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 duration of about 12to 15 minutes.
- Each student is expected to present atleast twice during the semester and the student is evaluated 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

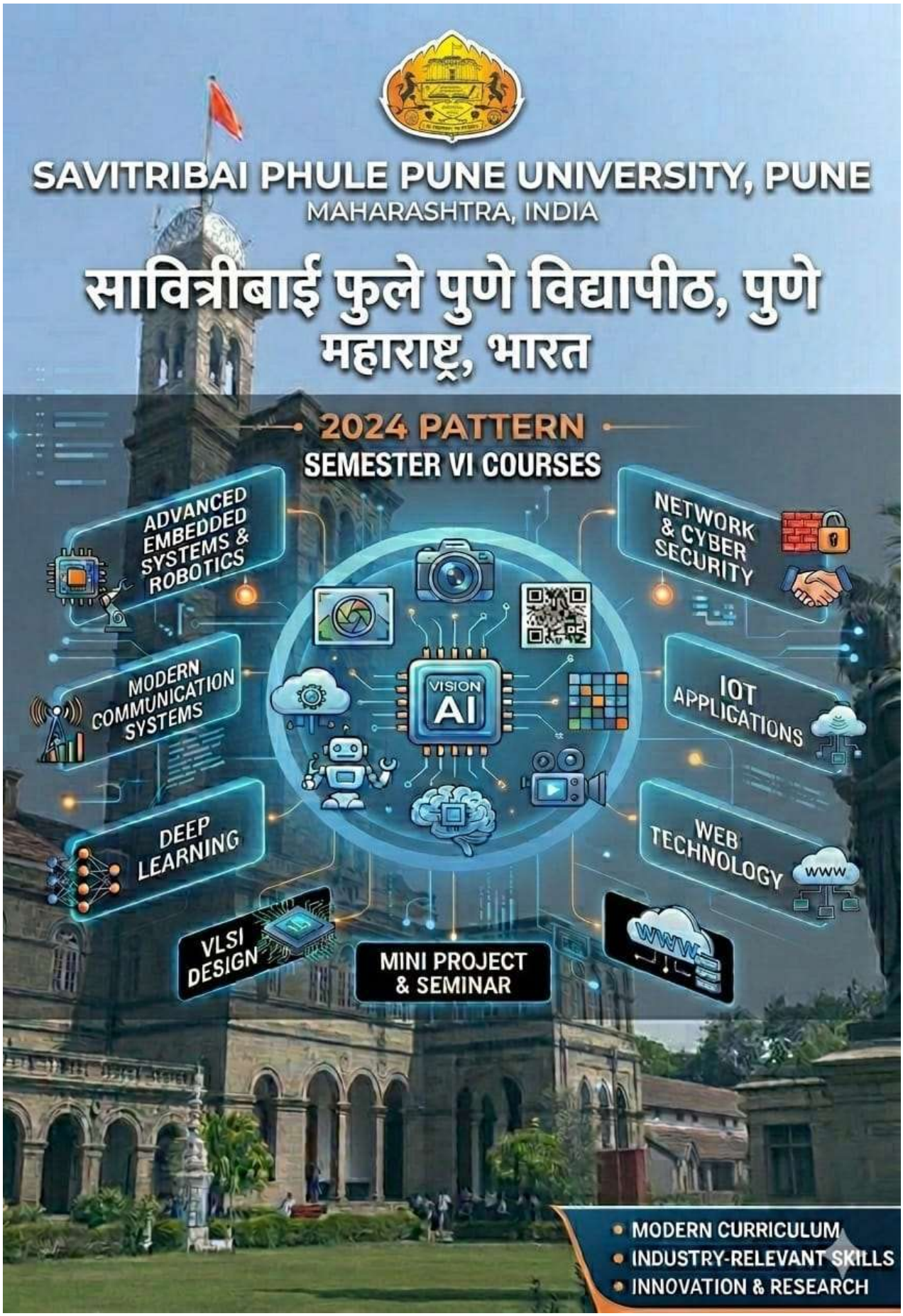
Cover Page & Certificates: Standard institutional format.

Abstract: A single, dense paragraph (200–250 words) capturing the domain background, prob-lem 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, mathemat-ical 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.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Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

PCC-351-ECE:VLSI Design

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

Prerequisite Courses, if any: Analog and Digital Electronic Circuits

Companion Course, if any: VLSI Design Lab

Course Objectives:

The objective of this course is to-

1. Introduce programmable logic devices, FPGA architectures and modern FPGA design methodologies using EDA tools.
2. Develop HDL based digital system design skills for combinational, sequential and finite state machine-based circuits.
3. Understand CMOS inverter operation, CMOS logic design techniques and layout design principles in VLSI systems.
4. Explain semiconductor memory architectures, memory cell operations and peripheral memory circuits used in VLSI systems.
5. Provide knowledge of SPICE-based simulation and analysis techniques for CMOS circuit verification and performance evaluation.

Course Outcomes:

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

CO1: Explain FPGA architecture and FPGA design flow.

CO2: Design HDL models for combinational, sequential and FSM-based digital systems.

CO3: Analyze CMOS inverter characteristics, CMOS logic circuits and layout design methodologies.

CO4: Illustrate semiconductor memory architectures and operation of SRAM, DRAM and Flash memories.

CO5: Simulate CMOS circuits using SPICE for timing, power and transient analysis.

Course Contents

Unit I	FPGA Architecture and Design Flow	(09 Hours)

Introduction to Programmable Logic Devices: PROM, PAL, PLA and FPGA. FPGA Architecture Fundamentals: Logic Blocks, Configurable Interconnects, I/O Blocks, Clock Management and Embedded Resources Overview of Different FPGA Families: Features, Specifications and Applications. FPGA Design Flow using EDA Tools: Design Entry, Functional Simulation, Synthesis, Implementation, Timing Analysis and Programming

#Exemplar	Traffic light control, Industrial automation, Robotics control, Motor control, Digital signal processing, Image processing, Video processing, ASIC prototyping

Mapping of Course Outcomes for Unit I: CO1

Unit II	HDL-Based Digital System Design	(09 Hours)

Introduction to VHDL: Features, Data Objects, Data Types, operators. Program structure - Library declarations, Entity, and Architecture Concurrent statements, Sequential statements. Modeling styles: Behavioral, Dataflow, and Structural. Modeling of Combinational Circuits (Logic Gates, Half Adder, Full Adder, Multiplexer) Modeling of Sequential circuits (D-Flip Flop, Synchronous Counters, Shift Register, Ring Counter), Modeling of Finite State Machines. Introduction to Verilog (Simple examples of Logic Gates,

Half Adder)		
#Exemplar	FPGA-based hardware verification/ prototyping	
Mapping of Course Outcomes for Unit II: CO2		
Unit III	**CMOS Logic Design and Layout Concepts**	**(08 Hours)**
CMOS Inverter: Circuit Operation and Working Principle Static Characteristics of CMOS Inverter: Voltage Transfer Characteristics (VTC), Noise Margin and Switching Threshold Dynamic Characteristics of CMOS Inverter: Propagation Delay, Rise Time, Fall Time and Power Dissipation Design of CMOS Inverters under Various Constraints such as Area, Speed and Power Consumption CMOS Logic Gates and Pull-up/Pull-down Network Design Pass Transistor Logic and Transmission Gate Logic MOS Layers Stick/Layout Diagrams and Layout Design Rules		
#Exemplar	Semiconductor Integrated Circuit Chips	
Mapping of Course Outcomes for Unit III: CO3		
Unit IV	**Semiconductor Memories**	**(10 Hours)**
Semiconductor memories, Memory array organization, SRAM: 6T SRAM Cell, Operation, Design Strategy, Leakage Currents, Read/Write Circuits. **DRAM:** 3T and 1T DRAM Cell Operation, Operation Modes, Leakage Currents, Refresh Operation and Input/output Circuits **Flash Memory**: Working Mechanism, NOR Flash and NAND Flash ,Peripheral Circuits: Sense Amplifier and Decoder		
#Exemplar	Semiconductor memories for Computers, Laptops, Portable and Handheld Devices/Gadgets, Microcontrollers, Embedded Systems, IoT Systems, Storage Devices.	
Mapping of Course Outcomes for Unit IV: CO4		
Unit V	**SPICE Simulation and CMOS Circuit Analysis**	**(09 Hours)**
Introduction to SPICE and Circuit Simulation SPICE Netlist Structure and Syntax MOSFET Modeling and Device Parameters DC, AC and Transient Analysis Modeling CMOS Inverter using SPICE Modeling of CMOS Logic Gates and Combinational Circuits. Power and Timing Analysis of CMOS Circuits		
#Exemplar	Modeling and Simulation , Semiconductor circuit prototyping, VLSI design validation	
Mapping of Course Outcomes for Unit V: CO5		
Learning Resources		
Textbooks: 1. Neil H. Weste and Kamran, Principles of CMOS VLSI Design, Pearson Publication. 2. Wayne wolf, Modern VLSI Design - IP Based Design, Pearson Education, 4th Edition. 3. Stephen Brown , Zvonko Vranesic, Fundamentals of Digital Logic with VHDL Design, McGraw Hill.		
Reference Books: 1. John F. Wakerly, Digital Design, Principles and Practices, Prentice Hall Publication. 2. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, TMH 3. Charles Roth, Digital System Design using VHDL, McGraw Hill Publication. 4. Douglas Perry, VHDL, McGraw Hill Publication. 5. Samir Palnitkar, Verilog HDL 2/e, Pearson Education. 6. R. Jacob Baker; Harry W.Li., David E. Boyce, CMOS Circuit Design, Layout and Simulation, IEEE Press, Prentice Hall of India.		
e-books: Free Range VHDL: https://github.com/fabriziotappero/Free-Range-VHDL- book/blob/master/free_range_vhdl.pdf		
MOOC / NPTEL: CMOS Digital VLSI Design**: https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee85**		

PCC-352-ECE: Embedded Systems & Robotics		
Teaching/scheme	**Credits**	**Examination Scheme**
Theory: 03Hours/Week	03	**CCE**: 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses, if any: Microcontrollers & Applications

Companion Course, if any:

Course Objectives:

1. To introduce students to the fundamentals of embedded systems, their characteristics, and the architecture and applications of ARM Cortex processor series.
2. To provide understanding of ARM Cortex-M4 processor architecture, clock configuration, memory organization, and GPIO programming using STM32F4xx microcontroller.
3. To enable students to understand and implement GPIO input/output programming on STM32F4xx for interfacing various peripherals such as LEDs, push buttons, buzzers, seven-segment displays, and 16x2 LCD.
4. To develop practical knowledge of STM32F4xx ARM microcontroller programming for ADC configuration, sensor interfacing, timer applications, PWM motor control, and embedded system design.
5. To provide knowledge of robot fundamentals, robot configurations, sensors, programming, and control techniques used in industrial and service robotics applications.

Course Outcomes:

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

CO1: Understand embedded systems and ARM Cortex processor-based firmware development.

CO2: Configure STM32F4xx clocks, GPIO ports, and alternate functions while understanding ARM Cortex-M4 architecture and processor operation for embedded system applications.

CO3: Interface and write an embedded C program for different Peripherals using STM32F4x.

CO4: Design an advanced embedded system using STM32F4xx.

CO5: Explain and apply fundamental concepts of robotics to develop simple robotic control systems.

Course Contents

Unit I	Introduction to Embedded Systems and ARM Cortex Processors	(09 Hours)

Introduction to Embedded Systems, Embedded Systems VS. General Computing Systems, Characteristics and Applications of Embedded Systems, factors to be considered in selecting a controller, CORTEX A, CORTEX M, CORTEX R processors series, versions, features and applications, Arm Cortex- M Features, Advantages & Applications, Firmware development using CMSIS standard for ARM Cortex.

#Exemplar	Fundamentals of embedded systems, their characteristics, applications, processor selection factors, and the features of ARM Cortex-A, M, and R series, CMSIS

Mapping of Course Outcomes for Unit I: CO1

Unit II	Introduction to ARM CORTEX M4 Based Microcontroller	(09 Hours)

Introduction to ARM CORTEX M4 microprocessor core, programmer model, Processor Modes, Memory Map, STM32F4xx Architecture(Functional Block Diagram), STM32F4xx Clock and SYSCLK, Peripheral Clock, PLL clock, General-purpose I/Os (GPIO): Features, I/O port control registers, data registers, Bit

handling Registers, GPIO Clock Configuration using RCC, Alternate Function Register		
#Exemplar	Configure the ARM Cortex-M4 based STM32F4xx microcontroller's clock system and GPIO peripheral using register-level programming	
Mapping of Course Outcomes for Unit II: CO2		
Unit III	**GPIO Programming and Interfacing with Peripherals using STM32F4xx**	**(09 Hours)**
GPIO Input Programming, GPIO Output Programming, LED Interfacing and Blinking using STM32F4xx, Push Button & buzzer Interfacing, Seven Segment Display Interfacing, 16X2 LCD Interfacing with STM32F4xx, UART basic Programming.		
#Exemplar	Input output peripheral Interfacing and Programming, Display System, Alarm system	
Mapping of Course Outcomes for Unit III: CO3		
Unit IV	**Advanced Peripheral Interfacing with STM32F4xx**	**(09 Hours)**
ADC features of the STM32F4xx Arm, ADC Configuration registers, Interfacing of MQ3 & LM35 sensor with STM32F4xx Arm. Timer & Counter in STM32F4XX, Delay programming, Interface Ultrasonic Sensor HCR-04, DC motor Interfacing with STM32F4xx with PWM. Interfacing of MPU6050 with STM32F4xx.		
#Exemplar/ Case Studies	Smart Environmental Monitoring and Advance Robot	
Mapping of Course Outcomes for Unit IV: CO4		
Unit V	**Fundamentals of Robotics and Robot Control Systems**	**(09 Hours)**
Introduction to Robotics: Definition of Robot, History & Evolution Robot vs Automation vs AI Industrial and Service Applications (Manufacturing, Healthcare, Agriculture, Domestic), **Robot Anatomy & Types:** Parts of Robot, DOF, Configurations (Cartesian, SCARA, Articulated, Delta), Electrical Drives, Gripper & Tools. **Sensors in Robotics:** Role of sensors in robot operation, Internal Sensors (Position, Velocity) ,External Sensors (Force, Proximity, Vision) **Programming & Control:** Teach Pendant, Basic Commands, Simulation.		
#Exemplar	Design and simulate an industrial pick-and-place robotic system using sensors, grippers, and programmed motion control for manufacturing and service applications	
Mapping of Course Outcomes for Unit V: CO5		

Learning Resources

Textbooks:

1. STM32 Arm Programming for Embedded Systems, MicroDigitalEd., Illustrated Edition, 2018
2. The Definitive Guide to ARM_ Cortex_-M3 and Cortex-M4 Processors, Third Edition-Joseph Yiu, Elsevier Publication
3. Introduction to Embedded systems- Shibu Kizhakke Vallathai, Tata McGraw Hill Publication
4. Introduction to Robotics: Mechanics and Control, Pearson Education.
5. Programming with STM32: Getting Started with the Nucleo Board and C/C++, McGraw Hill Education

Reference Books:

1. RM0390 Reference manual, STM32F446xx advanced Arm®-based 32-bit MCUs
2. PM0214 Programming manual STM32F3 Series, STM32F4 Series, STM32L4 Series and STM32L4+ Series Cortex®-M4 programming manual.
3. STM32F405xx STM32F407xx Arm® Cortex®-M4 32b MCU+FPU, 210DMIPS, up to 1MB Flash/192+4KB RAM, USB OTG HS/FS, Ethernet, 17 TIMs, 3 ADCs, 15 comm. interfaces & camera.
4. Mikell P. Groover – "Industrial Robotics: Technology, Programming and Applications

MOOC / NPTEL/YouTube Links: https://nptel.ac.in/courses/106/105/106105193/

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

PCC-353-ECE: VLSI Design Lab

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

Guidelines for Student's Lab Journal

The students Lab Journal should contain the following contains related to every experiment as applicable.

- Title of the experiment
- Objective
- Apparatus with their detailed specifications. (Hardware / Software)
- Brief theory related to the experiment.
- Connection diagram /Circuit diagram / Block diagram / Flowchart.
- Observation table
- Sample calculations / Software Program
- Results and Waveforms
- Conclusions.

Guidelines for Laboratory/ TW Assessment

- Continuous assessment of laboratory work is to be done based on overall performance and Laboratory performance of the student.
- Each Laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory assignment include timely completion, performance, efficiency, punctuality, and neatness.

Suggested List of Laboratory Experiments (Any 10)

Group A: Hardware Practical's (Any 5)	
1.	Design, simulate and implement a D Flip-Flop using VHDL on FPGA board.
2.	Design, simulate and implement any one type of counter using VHDL on the FPGA board
3.	Design, simulate and implement a Arithmetic Logic Unit (ALU) using VHDL on FPGA board.
4.	Design, simulate and implement a traffic signal controller FSM using VHDL on FPGA board.
5.	Design, simulate and implement a Read Only Memory (ROM)/ Random Access Memory (RAM) using VHDL on FPGA board.
6.	Design, simulate and implement a Parity generator using Verilog HDL on FPGA board.
Group B: Software Practical's (Any 4)	
7.	Design, Simulation and Performance Analysis of CMOS Inverter layout using Microwind
8.	Design and Simulation of CMOS NAND Gate Layout using Microwind
9.	Design and Simulation of 6T SRAM Cell Layout using Microwind
10.	Simulate and analyze the DC and transient characteristics of a CMOS inverter using SPICE.
11.	To design and simulate CMOS NAND and NOR gates using SPICE.
Group C: Experiential Learning	
12.	Experiential Learning through Industrial/Research Laboratory Visit to Semiconductor Manufacturing, VLSI Design and Semiconductor R&D Facilities.

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

PCC-354-ECE: Embedded Systems & Robotics Lab

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

Course Objectives:

1. To understand the architecture and programming of STM32F4xx microcontrollers using Embedded C.
2. To develop skills in interfacing basic I/O devices such as LEDs, LCDs, keypads, and switches.
3. To gain knowledge of sensor interfacing and data acquisition using various sensors (temperature, ultrasonic, gas, humidity).
4. To design and implement embedded control systems involving communication (UART) and actuators (motors) using PWM.

Course Outcomes:

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

CO1: Apply Embedded C programming to develop applications on **STM32F4xx microcontroller**.

CO2: Interface and control **basic peripherals** like LED, LCD, seven segment display, and keypad.

CO3: Acquire and process data from **various sensors** and display results effectively.

CO4: Design embedded systems integrating **communication protocols and actuator control** (UART, PWM, motors).

Guidelines for Student's Lab Journal

The students Lab Journal should contain the following contains related to every experiment as applicable.

- Title of the experiment
- Objective
- Apparatus with their detailed specifications. (Hardware / Software)
- Brief theory related to the experiment.
- Connection diagram /Circuit diagram / Block diagram / Flowchart.
- Observation table
- Sample calculations / Software Program
- Results and Waveforms
- Conclusions.

Guidelines for Laboratory/ TW Assessment

- Continuous assessment of laboratory work is to be done based on overall performance and Laboratory performance of the student.
- Each Laboratory assignment assessment should assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory assignment include timely completion, performance, efficiency, punctuality, and neatness

Suggested List of Laboratory Experiments (Any 10)

Group A (Any 6)

1.	Interfacing LED using STM32F4xx
2.	Interfacing Seven Segment LED using STM32F4xx
3.	Interfacing 16X2 LCD using STM32F4xx
4.	Interfacing 4x4 Matrix Keyboard and 16X2 LCD using STM32F4xx
5.	Interfacing Ultrasonic Sensor HC-SR04 with STM32F4xx.
6.	Interfacing switch/LDR and buzzer/LED with STM32F4xx.

7.	Interface LM35 Temperature Sensor and show it on 16x2 LCD using STM32F4xx.
Group B: (Any 3)	
8.	Embedded C program to transmit a character from keyboard using on chip UART for STM32F4xx
9.	To control speed and direction of DC Motor using PWM Block for STM32F4xx
10.	Interfacing DHT11 Sensor with with STM32F4xx.
11.	Interfacing MQ3 with STM32F4xx.
Group C: (Any 1)	
10.	Interface MPU6059 Sensor with STM32F4xx and show all reading on 16x2 LCD
11.	Interface servo motor to rotate arm of robot with STM32F4xx
12	Simulate the interfacing of stepper motor with STM32F4xx

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

PCC-361A-ECE: Modern Communication Systems

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

Prerequisite Courses, if any: Communication Systems

Companion Course, if any:

Course Objectives:

1. Understand the fundamentals of analog and digital communication systems and advanced modulation techniques used in modern communication networks.
2. Analyze wireless, mobile, optical, satellite, and radar communication systems and their practical applications.
3. Understand the architecture, components, and communication models of Internet of Things (IoT) systems and embedded platforms.
4. Study modern communication technologies including multiple access techniques, optical communication, satellite systems, and wireless sensor networks.
5. Apply concepts of AI, machine learning, and predictive analytics in IoT-enabled smart communication systems.

Course Outcomes:

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

CO1: Understand and analyze the fundamentals of digital communication, advanced digital modulation techniques, multiple access methods, and their applications in modern communication systems.

CO2: Understand modern wireless and mobile communication technologies

CO3: Understand the principles, components, and performance of optical communication systems.

CO4: Understand and analyze satellite communication principles, orbital mechanics, satellite subsystems, modern satellite networks, frequency bands, transponders, and emerging Trends.

CO5: Understand and analyze radar system principles, radar parameters, radar antennas, radar scanning techniques, and real-world radar applications in air traffic control & military guidance systems.

Course Contents

Unit I	Introduction to Modern Communication	(09Hours)
Digital Modulation Techniques ASK, FSK, PSK, DPSK, QPSK, QAM, **Multiple Access Techniques** FDMA, TDMA, CDMA, OFDMA, Applications Each. Need for Digital Communication		
Mapping of Course Outcomes for Unit I	CO1	
Unit II	**Wireless and Mobile Communication**	**(09 Hours)**
Techniques of Mobile Communication Systems Architecture GSM, Architecture CDMA Systems LTE and LTE-Advanced, **Wireless Sensor Networks** Architecture, Routing Techniques, Applications **Advanced Wireless Technologies**, **Wireless Sensor Networks** Architecture, Routing Techniques, Applications 5G Communication, 6G Communication. **Wireless Technologies** Wi-Fi Bluetooth, ZigBee.		
Mapping of Course Outcomes for Unit II	CO2	

Unit III	Optical Communication System	(09 Hours)

Introduction to Optical Communication, Basic Optical Communication System Block Diagram, Principle of Light Propagation, Total Internal Reflection (TIR), Acceptance Angle and Numerical Aperture, Types of Optical Fibers, Optical Sources, Optical Detectors, Types of Optical Losses, Optical Components, OTDR.		
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Satellite Communication**	**(09 Hours)**
Introduction to Satellite Communication: History, Need and Applications of Satellite Communication, Basic Satellite Communication System Architecture. Orbital Mechanics: Kepler's Laws, Types of Satellite Orbits – GEO, MEO, LEO, Polar and Sun-Synchronous Orbits, Comparison of Satellite Orbits. Satellite Systems and Technologies: Satellite Launching Techniques, Frequency Bands used in Satellite Communication (L, S, C, X, Ku, Ka Bands), Satellite Transponders – Working Principle and Types, High Throughput Satellites (HTS), Small Satellites (CubeSats and Nano-Satellites). Modern Satellite Communication Networks: LEO Satellite Constellations (Starlink, OneWeb), Satellite Internet Services, VSAT Systems, Satellite-based IoT Communication, Integration of Satellite Communication with 5G		
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Radar Systems**	**(09 Hours)**
Introduction to Radar Basic Principle of Radar ,Radar Range Equation ,Block Diagram of Radar System Radar Frequencies and Bands ,Pulsed Radar and Continuous Wave Radar ,Radar Parameters Range, Resolution ,Accuracy ,Maximum Unambiguous Range, Radar Antennas, Parabolic Reflector Antenna ,Phased Array Antenna .Radar Scanning Techniques, Case Studies Air Traffic Control Radar, Weather Monitoring Radar, Military Missile Guidance Radar		
Mapping of Course Outcomes for Unit V	CO5	
Learning Resources		
Textbooks: 1. Modern Digital and Analog Communication Systems Author: B. P. Lathi Edition/Volume: 4th Edition, Oxford University Press. 2. Optical Communication Author: John M. Senior Edition/Volume: 3rd Edition, Pearson 3. Satellite Communications Author: Dennis Roddy Edition/Volume: 4th Edition, McGraw Hill 4. Radar Engineering Author: G. S. N. Raju Edition/Volume: I.K. International Publication 5. Mobile Communications Author: Jochen Schiller Edition/Volume: 2nd Edition, Pearson Education		
Reference Books: 1. Communication Systems Author: Simon Haykin Edition/Volume: 5th Edition, Wiley 2. Principles of Communication Systems Authors: Herbert Taub, Donald Schilling Edition/Volume: 3rd Edition, McGraw Hill 3. Fiber Optics and Optoelectronics Author: R. P. Khare Edition/Volume: Oxford University Press 4. Satellite Communication Engineering Authors: Wilbur L. Pritchard, Henri G. Suyderhoud Edition/Volume: Pearson Publication Principles of Modern Radar Authors: Mark A. Richards, James Scheer Edition/Volume: SciTech Publication.		

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

PCC-361B-ECE: Deep Learning

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

Prerequisite Courses, if any: Artificial Intelligence, Machine Learning

Companion Course, if any:

Course Objectives:

1. To learn the basic concepts, architectures and working principles of deep learning and artificial neural networks.
2. To become proficient in the design, training, and evaluation of deep learning models using modern frameworks and tools in Python.
3. To apply deep learning techniques like Convolutional Neural Networks and Recurrent Neural Networks to solve real world problems.
4. To study the performance of deep learning models with respect to optimization methods, activation functions, loss functions and regularization techniques.
5. To study advanced deep learning applications and new trends in fields like healthcare, agriculture, autonomous systems and embedded intelligence.

Course Outcomes:

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

CO1: Discuss deep learning along with the libraries and implement feed forward neural networks.

CO2: Apply forward propagation, backpropagation, gradient descent and optimization techniques for training neural networks.

CO3: Apply CNN to solve complex real world problems

CO4: Understand architecture and working of recurrent neural network

CO5: Analyze various applications of deep learning

Course Contents

Unit I	Introduction to Deep Learning	(09Hours)

Biological Neurons and Model of Artificial Neuron. Neural Network Architectures: Single Layer Network, Multi-Layer Feed Forward Neural Networks, and Feedback Networks. Perceptron Model and Learning in Perceptron, Limitation of Learning in Perceptron. Learning rules and activation functions, Single layer and multilayer Perceptron. Difference between Artificial intelligence, Machine learning and Deep learning. Architecture of Deep Neural Network, Tensor Flows and Keras. Deep Learning libraries, Building the Simplest Neural Network in Simple Python: AND gate, OR Gate, NOR gate, NAND, EX-OR etc. Deep Learning Tools: Caffe, Theano, Torch.

#Exemplar	Deep Mind, Apha Go, Boston Dynamics.
Mapping of Course Outcomes for Unit I	Discuss deep learning along with the libraries and implement feed forward neural networks.

Unit II	Deep Feed Forward Networks	(09 Hours)

Artificial Neural Network, activation function, multi-layer neural network. Parameters Affecting Deep Learning: Normalization, Data Size, Regularization, Weight Initialization, Training Neural Network: Risk minimization, loss function, Backpropagation, regularization, model selection, and optimization, Back propagation networks, Architecture of Backpropagation (BP) Networks, loss function, hyper parameter and its tuning during training, Overfitting and Under fitting, Methods to avoid Overfitting and Under fitting, Vanishing Gradient Problem.		
#Exemplar	SGD ,RMS prop	
Mapping of Course Outcomes for Unit II	Apply forward propagation, backpropagation, gradient descent and optimization techniques for training neural networks.	
Unit III	**Convolutional Neural Networks (CNN)**	**(09 Hours)**
Introduction to Convolution Neural Network (CNN), Basic architecture of CNN, Components of CNN Convolution Layer -The Kernel (Filter), Stride and padding in CNN, Calculation of image size after application of filter, Pooling layer, Classification- Fully Connected Layer (FC Layer), Softmax Classification, various architectures of CNNs Designing a Convolutional Neural Network, Various Nonlinear activation function used in ANN like Sigmoid Function, Threshold Function, ReLU (rectified linear unit) Function, Hyperbolic Tangent Function, Applications of CNNs		
#Exemplar	LeNet, AlexNet, VGG, ResNet.	
Mapping of Course Outcomes for Unit III	Apply CNN to solve complex real world problems	
Unit IV	**Recurrent Neural Networks (RNN)**	**(09 Hours)**
Introduction to Recurrent Neural Network (RNN), Need for Recurrent Neural Networks, Feedforward Neural Network vs. Recurrent Neural Network, Architecture of Recurrent Neural Networks, Working principle of RNN, Long Short-Term Memory (LSTM) Networks. Advantages and disadvantages of Recurrent Neural Network, Two Issues of Standard RNNs, Applications of RNN. Difference between Recurrent Neural Networks and Recursive Neural Networks.		
#Exemplar	Google, Bing	
Mapping of Course Outcomes for Unit IV	Understand architecture and working of recurrent neural network	
Unit V	**Applications of Deep Learning**	**(09 Hours)**
Various application areas of deep learning, to build and train Convolutional Neural Network in Python, Speech Recognition using deep learning, Natural Language Processing using deep learning, Object/Image classification using deep learning, Deep Learning Applications in Agriculture, Handwritten Digit Recognition using CNN.		
#Exemplar	Sentiment Analysis, Plant disease detection	
Mapping of Course Outcomes for Unit V	Analyze various applications of deep learning	
Learning Resources		
Textbooks: 1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI, 2007 2. Deep Learning By Ian Goodfellow, YoshuaBengio and Aaron Courville 3. Neural Networks and Learning Machines, 3d Edition Book by Simon S. Haykin		

Reference Books:

1. Deep Learning with Python 1st Edition by Francois Chollet
2. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems by GeronAurelien
3. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998
4. Grokking Deep Learning by Andrew W. Trask

MOOC / NPTEL/YouTube Links:

1. NPTEL Course "Deep Learning", By Prof. Sudarshan Iyengar , IIT Ropar
2. https://nptel.ac.in/courses/106106184
3. https://towardsdatascience.com/convolutional-neural-networks-explained-9cc5188c4939
4. https://www.geeksforgeeks.org/introduction-to-recurrent-neural-network/
5. https://www.simplilearn.com/tutorials/deep-learning-tutorial/rnn

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

PCC-361C-ECE: Digital Image Processing

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

Prerequisite Courses, if any: Signals and Systems and Digital Signal Processing

Companion Course, if any: PEC363-ECE: Elective II & III Laboratory

Course Objectives:

1. To understand the fundamentals of digital image processing.
2. To study image enhancement and filtering techniques.
3. To learn image segmentation and feature analysis methods.
4. To understand image compression and restoration techniques.
5. To study object recognition and deep learning concepts in image processing.

Course Outcomes:

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

CO1: Apply knowledge of mathematics for image understanding and analysis.

CO2: Implement image enhancement and filtering techniques.

CO3: Design and realize various algorithms for image segmentation and feature analysis.

CO4: Apply image compression and restoration techniques.

CO5: Describe and apply object recognition and deep learning techniques for image analysis.

Course Contents

Unit I	DIP Fundamentals	(09Hours)
Fundamental steps of Image Processing, Components of Image Processing system, Image formation, Image sampling and quantization, Image types, Image histogram, Color fundamentals, Color models, Pixel connectivity, Pseudo color image processing.		
Mapping of Course Outcomes for Unit I	CO1: Apply knowledge of mathematics for image understanding and analysis.	
Unit II	**Image Enhancement and Filtering**	**(09 Hours)**
Image enhancement in the spatial domain, Basic gray level transformations, Histogram processing, Enhancement using arithmetic and logic operations, Basic spatial filtering, Smoothing and sharpening spatial filters, Intensity transformation, Contrast stretching, Histogram equalisation, Introduction to frequency domain enhancement.		
Mapping of Course Outcomes for Unit II	CO2: Implement image enhancement and filtering techniques.	
Unit III	**Image Segmentation and Feature Analysis**	**(09 Hours)**

Point, line and edge detection, Thresholding techniques, Region-based segmentation, Edge linking and boundary detection, Hough transform, Boundary representation, Introduction to feature extraction.		
Mapping of Course Outcomes for Unit III	CO3: Design and realise various algorithms for image segmentation and feature analysis.	
Unit IV	**Image Compression and Restoration**	**(09 Hours)**
Fundamentals of redundancies, Basic compression methods: Huffman coding, Concept of Discrete Cosine Transform (DCT),JPEG Compression standard,YCbCr transformation, Introduction to MPEG standard, Motion estimation and compensation, Introduction to video compression, Noise models, Restoration using spatial filtering, Wiener filtering, Introduction to Fourier transform and frequency domain restoration.		
Mapping of Course Outcomes for Unit IV	CO4: Apply image compression and restoration techniques.	
Unit V	**Object Recognition and Deep Learning**	**(09 Hours)**
Object Recognition: Patterns and pattern classes, Recognition based on decision theoretic methods, Structural methods, Character recognition, Content based image retrieval, Image classification, Introduction to Deep Learning using CNN, Applications of Digital Image Processing in healthcare and industry.		
Mapping of Course Outcomes for Unit V	CO5: Describe and apply object recognition and deep learning techniques for image analysis	
Learning Resources		
Textbooks: 1. Pearson Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods, Pearson, 4th Edition, 2023. S. Sridhar, Digital Image Processing, Oxford University Press, 2nd Edition, 2016.		
Reference Books: 2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, Latest Reprint Edition. 3. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine Vision, Cengage Learning, 4th Edition, 2014. 4. William K. Pratt, Digital Image Processing, John Wiley & Sons, 4th Edition, 2007. 5. S. Jayaraman, S. Esakkirajan and T. Veerakumar, Digital Image Processing, McGraw-Hill Education, 2nd Edition, 2009.		
MOOC / NPTEL/YouTube Links: 1. NPTEL Course: Digital Image Processing 2. NPTEL Course: Computer Vision and Image Processing		

Savitribai Phule Pune University Third Year of Electronics and Computer Engineering (2024Course)		
PEC361D-ECE: IoT Applications		
Teaching/scheme	**Credits**	**Examination Scheme**
Theory: 03 Hours/Week	03	**CCE**: 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses, if any: Basics of Electronics, Digital Electronics, Microcontrollers, Embedded Systems, Programming in Python, and Computer Networks.

Companion Course, if any: Laboratory Practical

Course Objectives:

The objective of this course is to provide students with

1. To introduce the fundamentals, architecture, and embedded system concepts of Internet of Things.
2. To provide knowledge of IoT hardware components, sensor/actuator interfacing, and hardware design techniques.
3. To study IoT communication models, networking architectures, and communication protocols used in IoT systems.
4. To understand IoT cloud integration, security mechanisms, and data analytics techniques for IoT applications.
5. To explore IoT applications and case studies in smart homes, healthcare, smart cities, industry, and agriculture.

Course Outcomes:

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

CO1: Understand IoT architecture and identify suitable embedded hardware platforms for IoT applications.

CO2: Interface sensors and actuators with IoT boards and perform data acquisition operations.

CO3: Implement IoT communication using MQTT/CoAP protocols and compare short-range and long-range communication technologies.

CO4: Integrate IoT systems with cloud platforms and apply basic security and analytics techniques.

CO5: Analyze IoT case studies and design IoT application prototypes for real-world applications.

Course Contents

Unit I	**Introduction to IoT and Embedded Systems**	**(09 Hours)**
Introduction to Internet of Things (IoT), definition, characteristics, scope, and applications of IoT systems. IoT architecture layers including perception layer, network layer, and application layer with their functionalities and interactions. IoT enabling technologies, IoT Issues and Challenges, Embedded systems concepts and their role in IoT applications. Study of microcontrollers and development boards such as Arduino, ESP32, and Raspberry Pi used for IoT system development. IoT ecosystem components including devices, sensors, gateways, cloud platforms, and applications along with machine-to-machine communication and real-world IoT deployment scenarios.		
#Exemplar	Analyze IoT architecture and embedded hardware platforms for smart applications.	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	**IoT Hardware and Sensor Interfacing**	**(09 Hours)**
Study of various sensors and interfacing with Arduino Uno and ESP 32 for temperature, humidity, motion, ultrasonic and light sensors, Interfacing of Actuators such as motors, relays, LEDs, and buzzers with Arduino Uno and ESP 32. Details of ADC and DAC concepts, GPIO programming, of ESP 32 and interfacing methods for embedded hardware systems. Interfacing of LED, ultrasonic sensor with		

Raspberry Pi, Power management techniques for low-power IoT devices and battery-operated systems using ESP 32. Hardware design considerations including scalability, reliability, signal conditioning, and embedded circuit design for IoT applications.		
#Exemplar	Interface sensors and actuators with Arduino/ESP32 for data acquisition.	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	**IoT Communication Protocols and Networking**	**(09 Hours)**
IoT communication models including device-to-device, device-to-cloud, and device-to-gateway communication architectures. Study of IoT communication protocols such as MQTT, CoAP, HTTP, and AMQP with their features and applications. Short-range wireless communication technologies including Bluetooth, Zigbee, and Wi-Fi. Long-range communication technologies including LoRa, NB-IoT, and cellular communication systems for wide-area IoT applications. IoT networking layers, addressing concepts, interoperability issues, and challenges in heterogeneous IoT networks.		
#Exemplar	Implement MQTT/CoAP communication using IoT networking technologies	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Cloud, Security and Data Analytics for IoT**	**(09 Hours)**
Introduction to IoT cloud platforms including IoT and cloud, Cloud services SaaS, PaaS, IaaS, Security in cloud, Fog computing, AWS IoT, Azure IoT, and Google Cloud IoT for device connectivity and cloud integration. IoT data storage, data acquisition, dashboard creation, and visualization techniques for monitoring systems. IoT security challenges including device authentication, data encryption, secure communication, privacy protection, and cyber threats in IoT environments. IoT data analytics techniques including preprocessing, filtering, visualization, trend analysis, and predictive analytics. Case studies related to cloud-connected IoT applications and secure IoT deployments.		
#Exemplar	Develop cloud-connected IoT systems with security and analytics features.	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**IoT Applications and Case Studies**	**(09 Hours)**
Applications of IoT in smart homes including home automation and energy management systems. Smart city applications such as traffic monitoring, waste management, smart parking, and smart lighting systems. Healthcare IoT applications including patient monitoring systems, wearable devices, and telemedicine solutions. Industrial IoT applications including predictive maintenance, robotics, industrial automation, and smart manufacturing systems. Agriculture IoT applications including smart irrigation, crop monitoring, and environmental sensing systems. Case studies of successful IoT deployments and application prototype design methodologies.		
#Exemplar	Develop IoT prototypes for smart home, healthcare, agriculture, and industrial applications.	
Mapping of Course Outcomes for Unit V	CO5	
Learning Resources		
Textbooks: 1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-On Approach," First Edition, Universities Press, 2014. 2. Raj Kamal, "Internet of Things: Architecture and Design Principles," Second Edition, McGraw		

Hill Education, 2017.
3. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things," First Edition, Wiley Publications, 2013.
4. Charalampos Doukas, "Building Internet of Things with Arduino," First Edition, CreateSpace Independent Publishing, 2012.
5. Matt Richardson and Shawn Wallace, "Getting Started with Raspberry Pi," Third Edition, O'Reilly Media, 2014.

Reference Books:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases," First Edition, CRC Press, 2017.
2. Dieter Uckelmann, Mark Harrison and Florian Michahelles, "Architecting the Internet of Things," First Edition, Springer Publications, 2011.
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things," First Edition, Cisco Press, 2017.
4. Brian Russell and Drew Van Duren, "Practical Internet of Things Security," First Edition, Packt Publishing, 2016.
5. Peter Waher, "Learning Internet of Things," First Edition, Packt Publishing, 2015.

e Books:

1. https://www.oreilly.com/library/view/internet-of-things/9781491931073/
2. https://www.oreilly.com/library/view/designing-the-internet/9781118430620/
3. https://www.packtpub.com/en-us/product/learning-internet-of-things-9781783553532
4. https://docs.aws.amazon.com/iot/
5. https://learn.microsoft.com/en-us/azure/iot/

MOOC / NPTEL/YouTube Links:

1. https://nptel.ac.in/courses/106105166
2. https://www.coursera.org/learn/iot
3. https://www.edx.org/learn/internet-of-things-iot
4. https://www.youtube.com/watch?v=zJ-LqeX_fLU
5. https://www.youtube.com/playlist?list=PLBlnK6fEyqRhqzJT87LsdQKYZBC93ezDo

Virtual Labs Links

1. https://www.vlab.co.in/
2. https://wokwi.com/
3. https://www.tinkercad.com/circuits
4. https://vlab.amrita.edu/?sub=3&brch=79

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

PCC-362A-ECE: Web Application Development

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

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

1. To understand and apply the fundamentals of HTML, CSS, and Bootstrap for designing responsive and visually appealing web pages.
2. To learn the core concepts of JavaScript for developing interactive and dynamic web applications.
3. To implement DOM manipulation, event handling, and form validation techniques for dynamic webpage development using JavaScript.
4. To understand the fundamentals of React framework, including components, JSX, props, and state management for building reusable user interfaces.
5. To develop dynamic single-page web applications using advanced React concepts such as event handling, routing, forms, and conditional rendering.

Course Outcomes:

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

CO1: Design and develop responsive and visually appealing web pages using HTML, CSS, and Bootstrap

CO2: Apply JavaScript concepts to create interactive and dynamic web applications.

CO3: Implement DOM manipulation, event handling, and form validation techniques to develop dynamic web pages.

CO4: Develop reusable user interface components using React concepts such as JSX, props, state, and components.

CO5: Build dynamic single-page web applications using advanced React features including routing, forms, event handling, and conditional rendering.

Course Contents

Unit I	Introduction to Web Technologies	(09Hours)

HTML: Getting started with HTML, Why HTML, Tags and Elements, Attributes, Properties, Headings list, Links, Tables, Images, HTML Form, Media (Audio, Video), Semantic HTML5 Elements. **CSS:** Why CSS, Types of CSS, How to use CSS, Properties, Classes, Child-Class (Nested CSS), Colors, Text, Background, Border, Margin, Padding, Positioning (flex, grid, inline, block), Animation, Transition. **BOOTSTRAP:** Why Bootstrap, CSS over Bootstrap, How to Use Bootstrap, Bootstrap Grid System, Bootstrap Responsive, Bootstrap Classes, Bootstrap Components (i.e., Button, Table, List, etc.),Bootstrap as a Cross Platform

Mapping of Course Outcomes for Unit I	CO1

Unit II	Fundamentals of JavaScript	(09 Hours)

Introduction to JavaScript, Features of JavaScript, Variables, Data Types, Operators, Conditional Statements, Control Structures, Loops, Functions, Function Parameters, Return Values, Arrays, Strings, Array and String Operations, JavaScript with HTML and CSS, Dynamic Styling, Show/Hide Elements.

Mapping of Course Outcomes for Unit II	CO2

Unit III	Advanced JavaScript and Dynamic Webpage Development	(09 Hours)

DOM Manipulation, HTML Element Access, Dynamic Content Updating, Event Handling, Mouse Events, Keyboard Events, Button Events, Form Validation, Input Validation, Login and Registration Validation, Dynamic Webpage Development using JavaScript.		
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Fundamentals of React Framework**	**(09 Hours)**
Introduction to React, Features of React, Advantages of React, React Environment Setup, Components in React, Functional Components, JSX Syntax, Creating and Rendering Components, Props in React, Passing Data Between Components, Reusable Components, State Management, useState Hook, Updating Dynamic Data.		
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Advanced React Concepts and Dynamic Web Application Development**	**(09 Hours)**
Event Handling in React, Button Events, Form Events, Input Handling, Forms in React, Controlled Components, Form Validation Basics, Conditional Rendering, Lists and Keys, React Routing Basics, Navigation Between Pages, Single Page Application (SPA) Concept.		
Mapping of Course Outcomes for Unit V	CO5	
Learning Resources		

Textbooks:

1. Kogent Learning Solutions Inc, Web Technologies*: HTML, JavaScript, PHP, JAVA, JSP, XML and AJAX*, Blackbook, Dreamtech Press, Second Edition, ISBN: 9788177228496.
2. Raymond Camden, Andy Matthews, JQuery Mobile Web Development Essentials, Packt Publishing, Second Edition, ISBN: 9781782167891.
3. Eloquent JavaScript – Eloquent JavaScript by Marijn Haverbeke, third edition, ISBN-13: 978-1593279509
4. Learning React – Learning React by Alex Banks and Eve Porcello,second edition, ISBN-13: 978-1492051725

Reference Books:

1. Steven M. Schafer, HTML, XHTML and CSS, Wiley India Edition, Fourth Edition, ISBN: 978-81-265-1635-3.
2. Dr. Hiren Joshi, Web Technology and Application Development, DreamTech, First Edition, ISBN: 978-93-5004-088-1.
3. Ivan Bayross, Web Enabled Commercial Application Development Using HTML, JavaScript, DHTML and PHP, BPB Publications, 4th Edition, ISBN: 9788183330084.
4. Brain Fling, Mobile Design and Development, O'Reilly, First Edition, ISBN: 978-81-8404-817-9.
5. Adam Bretz & Colin J Ihrig, Full Stack JavaScript Development with MEAN, SPD, First Edition, ISBN: 9780992461256.
6. David Flanagan, JavaScript: The Definitive Guide – Master The World's Most-Used Programming Language,

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

PCC-362B-ECE: RF & Microwave Engineering

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

Prerequisite Courses, if any:

Companion Course, if any: PEC 363 ECE - Programme Elective Course Lab

Course Objectives:

1. To understand the fundamentals of RF and Microwave Engineering.
2. To analyze microwave components and devices.
3. To study microwave transmission lines and waveguides.
4. To understand RF communication systems and microwave measurements.
5. To study modern microwave applications in wireless and satellite communication.

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

CO1: Understand RF and microwave frequency spectrum and propagation.

CO2: Explain microwave passive and active components.

CO3: Understand and analyze transmission line theory, impedance matching techniques & waveguide characteristics used in RF and microwave communication systems.

CO4: Design and analyze RF amplifiers and oscillators, and perform microwave measurements for the evaluation of RF and microwave systems.

CO5: Apply microwave Engineering concepts in radar, satellite and wireless systems.

Course Contents

Unit I	Introduction to RF and Microwave Engineering	(9Hrs.)
Fundamentals of RF and Microwave Engineering: RF and Microwave Frequency Spectrum, Electromagnetic Spectrum, Applications of RF and Microwave Systems, Microwave Bands and Standards, Advantages and Limitations of Microwave Communication, RF Propagation Mechanisms, Microwave Communication System Block Diagram, Microwave Antennas Overview, RF Safety and EMI/EMC Concepts, S-Parameters, Scattering Matrix, Properties of S-Parameters, Measurement Technique.		
Mapping of Course Outcomes for Unit I	CO1	
Unit II	**Microwave Components and Devices**	**(9 Hrs.)**
Microwave Components: Active and passive, Semiconductor Microwave Devices, Power dividers, Directional Couplers, Attenuators, IMPATT Diode, Gunn Diode, Schottky Diode, Reflex Klystron, Magnetron, Traveling Wave Tube (TWT), Microwave Integrated Circuits (MICs).		
Mapping of Course Outcomes for Unit II	CO2	
Unit III	**Transmission Lines and Waveguides**	**(9Hrs.)**

Transmission Line Theory: Primary Constants of Transmission Line (R, L, C, G), Characteristic Impedance, Propagation Constant, Reflection Coefficient, Standing Wave Ratio (SWR), Smith Chart, Impedance Matching Techniques. Waveguides: Rectangular and Circular Waveguides, TE, TM and TEM Modes, Dominant Mode, Cutoff Frequency, Phase Velocity, Group Velocity, Wave Impedance. Applications: Applications of Transmission Lines and Waveguides in RF and Microwave Systems.		
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**RF Circuits and Microwave Measurements**	**(9Hrs.)**
Principle of operation and application: RF Amplifiers, Low Noise Amplifier (LNA), RF Oscillators, Mixer and Frequency Conversion, Network Analyzer, Spectrum Analyzer, Microwave Signal Generators , RF Transceiver Architecture, Measurement of Impedance, Noise Figure, Power, Frequency, VSWR, Q-Factor, Attenuation		
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Modern RF and Microwave Applications**	**(9 Hrs.)**
Radar Systems, Satellite Communication Systems, RF Front End for 4G/5G, Microwave Integrated Circuits (MIC), Monolithic Microwave IC (MMIC), RF MEMS, Software Defined Radio (SDR), Microwave Remote Sensing, Microwave Biomedical Applications, IoT and Smart Antenna Systems.		
Mapping of Course Outcomes for Unit V	CO5	
Learning Resources		
Textbooks: 1. Samuel Y. Liao, "Microwave Devices and Circuits", PHI, 3rd Edition, 2014. 2. F. Gustrao, "RF & Microwave Engineering", Wiley, 2nd edition, 2012. 3. D. M. Pozar, "Microwave Engineering", Wiley, 4th Edition, 2013.		
Reference Books: 1. Robert E. Collin, "Foundations for Microwave Engineering", 2nd Edition. 2. Leo L. Tsai, "Microwave Circuit Design using Linear and Nonlinear Techniques", John Wiley Sons, 2020. 3. G. S. N. Raju, "Microwave Engineering", 1st Edition. 4. R.S. Rao, "Microwave Engineering", PHI, 2nd Edition, 2012 5. Travis F. Collins, "Software Defined Radio for Engineers", 1st Edition. 6. Jose E. Schutt-Aine, "Microwave Active Devices and Circuits for Communication", 1st Edition. 7. 5G NR: The Next Generation Wireless Access Technology — Authors: Erik Dahlman, Stefan Parkvall and Johan Skold, 2nd Edition.		
MOOC / NPTEL Courses: Video lectures on Microwave Engineering: https://onlinecourses.nptel.ac.in/noc24_ee115/preview		

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

PEC362C-ECE: Network & Cyber Security

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

Prerequisite Courses, if any: Computer Network, IPR and Cyber Laws

Companion Course, if any:

Course Objectives:

The objective of this course is to provide students with

1. To understand of basic concepts and approaches in cryptography and network security.
2. To acquire the basic knowledge of symmetric key cryptography.
3. To learn standard algorithms and protocols employed to provide confidentiality, integrity & authenticity.
4. To apply algorithmic strategies for authentication.
5. To develop problem solving abilities using Cyber Security.

Course Outcomes:

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

CO1: Understand basic concept of data security and different approaches in network and cyber security.
CO2. Implement different cryptographic approaches.
CO3.Understand and implement encryption mechanisms in Public Key cryptography.
CO4.Understand and implement various authentication mechanisms.
CO5.Apply security tools in various environments for network and cyber security.

Course Contents

Unit I	Introduction	(09 Hours)
Overview of Network Security, Importance and Challenges of Network Security, Goals and Objectives of Network Security, Basic Terminologies in Network Security. Introduction to Cryptography, Security Threats, Vulnerability, Active and Passive attacks, Security services and mechanism, Conventional Encryption Model. Types of Network Threats, Common Network Vulnerabilities, Network Intrusions and Unauthorized Access, Software vulnerabilities: Buffer overflow, Cross-site scripting, Ransomware, SQL- injection, Sniffing		
#Exemplar	Phishing,Malware,DDos, Man-in-the-Middle, Password sniffing, Email monitoring.	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	**Symmetric Cryptography**	**(09 Hours)**
Math Background: Modular Arithmetic, Euclidean and Extended Euclidean algorithm, Prime numbers, Fermat and Euler's Theorem. Substitution &Transposition Techniques, Block Ciphers (DES, AES): Feistal Cipher Structure, Simplifies DES, DES, Double and Triple DES, Block Cipher Design Principles, AES, Blowfish.		
#Exemplar	ATM cards and banking systems, Wi-Fi security, Messaging apps.	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	**Asymmetric Cryptography**	**(09Hours)**
Principles of Public-Key Cryptography, RSA Algorithm, Key Management, Diffie-Hellman Key Exchange, Elgamal Algorithm, Elliptic Curve Cryptography, X.509 certificate.Digital Signatures: Implementation,		

Algorithms, Standards (DSS), Authentication Protocol.		
#Exemplar	Secure Websites (HTTPS), Digital Signatures, Email Encryption, Cryptocurrency and Blockchain.	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Authentication**	**(09 Hours)**
Key Management: Key Distribution Techniques, Kerberos. Hash and MAC Algorithms: Authentication Requirement, Functions, Message Authentication Code, Hash Functions, Security of Hash Functions and Macs, MD5 Message Digest Algorithm, Secure Hash Algorithm, Digital Signatures.		
#Exemplar	ATM Card and PIN, Mobile Phone Unlock, Online Banking Two-Factor Authentication (2FA).	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Ethical Hacking and Security Tools**	**(09 Hours)**
Introduction to Ethical Hacking, Anonymity, Information Gathering, Scanning Networks and Tools, Vulnerability Analysis. Security in Networks: Firewalls and Intrusion Detection/Prevention Systems (IDS/IPS), Virtual Private Networks (VPNs), Network Access Control (NAC), Secure Sockets Layer/Transport Layer Security (SSL/TLS), Network Security Appliances. Email Security – PGP, S/MIME.		
#Exemplar	Website Vulnerability Testing, Mobile App Security, Nessus, Kali Linux, Nmap.	
Mapping of Course Outcomes for Unit V	CO5	
Learning Resources		
Textbooks: 1. William Stallings; "Cryptography and Network Security-Principles and Practices" 6th Edition, Pearson Education, 2014, ISBN13:9780133354690. 2. Bernard Menezes, "Network Security and Cryptography", 1st Edition, Cengage Learning, 2010, ISBN 81-315-1349-1. 3. Raef Meeuwisse, "Cybersecurity for Beginners", 2nd Edition, Cyber Simplicity, 2017, ISBN-9781911452157.		
Reference Books: 1. William Stallings, "Network Security Essentials", ISBN 978-0134444284, Pearson, Sixth Edition (2017). 2. Michael Gregg, "The Network Security Test Lab: A Step-By-Step Guide", Dreamtech Press, 2015, ISBN-10:8126558148. 3. V.K. Pachghare, "Cryptography and Information Security", 2nd Edition, PHI, 2015, ISBN-978-81-203-5082- 4. Rafay Baloch, "Ethical Hacking and Penetration Testing Guide" , ISBN 978-1788620586, Packt Publishing, First Edition (2017).		
e-Books: 1.https://www.computer-pdf.com/security -Handbook of Applied Cryptography, Ethical Hacking, Cyber Security for Beginners		

MOOC / NPTEL/YouTube Links:

1. Prof. Indranil Sen Gupta, "Ethical Hacking" NPTEL Course By | IIT Kharagpur
2. https://onlinecourses.nptel.ac.in/noc22_cs13/preview
3. Prof. Gaurav S. Kasbekar, "Network Security", NPTEL Course By IIT Bombay, https://onlinecourses.nptel.ac.in/noc25_ee54/preview
4. Prof. Ranjan Bose, "Information Theory, Coding and Cryptography", NPTEL Course By IIT Delhi, https://nptel.ac.in/courses/108102117

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024Course)

PCC-362D-ECE: Embedded AI Systems

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

Prerequisite Courses, if any: Microcontrollers and Applications and AI / Machine Learning

Companion Course, if any: Embedded AI Systems Laboratory

Course Objectives:

1. **Understand foundational concepts** of combining embedded systems hardware constraints with AI applications.
2. **Evaluate and select** appropriate edge computing hardware platforms (Microcontrollers, GPUs, FPGAs) for local intelligence tasks.
3. **Implement RTOS concepts** to handle predictable, real-time timing execution of resource-constrained systems.
4. **Apply optimization methods** such as model quantization, pruning, and structural distillation to neural networks.
5. **Design and deploy** real-world Edge AI applications including computer vision, speech analytics, and industrial anomaly tracking.

Course Outcomes:

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

CO1: Differentiate between traditional embedded systems and Embedded AI frameworks while designing edge automation models.

CO2: Compare and interface various hardware compute nodes, sensor devices, and high-speed communication buses used for AI accelerations.

CO3: Build predictable and power-optimized multi-tasking software codebases using micro-kernel architectures like Free RTOS.

CO4: Optimize deep learning architectures via structural compression methodologies for targeted embedded edge execution frameworks.

CO5: Build secure, low-latency Edge AI algorithms tailored for domain-specific contexts like smart grids, predictive healthcare, and automated robotics

Course Contents

Unit I	Introduction to Embedded Systems & AI	(09Hours)

Definition and characteristics of embedded systems Classification: standalone, real-time, networked, mobile Embedded system components: processor, memory, I/O, power supply Introduction to Artificial Intelligence in embedded context AI vs traditional programming Need for AI in embedded systems: automation, intelligence at edge Applications: smart devices, robotics, healthcare, automotive

Mapping of Course Outcomes for Unit I	CO1	
Unit II	**Embedded Hardware Platforms for AI**	**(09 Hours)**
Microcontrollers vs Microprocessors ARM Cortex-M architecture (M0, M3, M4, M7) GPU, DSP, FPGA for AI acceleration Popular AI hardware platforms: Arduino, Raspberry Pi NVIDIA Jetson Nano STM32, ESP32 Interfacing: GPIO, UART, SPI, I2C, ADC/DAC Sensors and actuators for AI applications (camera, IMU, microphone)		
Mapping of Course Outcomes for Unit II	CO2	
Unit III	**Embedded Software & RTOS**	**(09 Hours)**
Bare-metal programming concepts Real-Time Operating System (RTOS) fundamentals Task states, scheduling algorithms (preemptive, cooperative) Free RTOS: tasks, queues, semaphores, mutexes Memory management in embedded systems Interrupt handling and latency Power management and low-power design		
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Machine Learning for Embedded Systems**	**(09 Hours)**
Introduction to TinyML ML pipeline: data collection → training → inference Neural Networks basics: ANN, CNN, RNN Model optimization techniques: Quantization (INT8, FP16) Pruning Knowledge distillation Model compression Frameworks for embedded AI: TensorFlow Lite (TFLite) Edge Impulse ONNX Runtime PyTorch Mobile Deploying ML models on microcontrollers Inference on edge devices		
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Edge AI Applications & Case Studies**	**(09 Hours)**
Edge AI vs Cloud AI — comparison, advantages Computer Vision on embedded systems: Object detection (YOLO-Tiny, Mobile-Net) Face recognition Gesture recognition Speech & Audio AI: Keyword spotting Voice recognition on microcontrollers Anomaly detection in IoT Embedded AI in: Smart healthcare (wearables, biosensors) Autonomous vehicles & drones Industrial IoT (predictive maintenance) Smart agriculture Security and privacy in embedded AI systems Future trends: neuromorphic computing, on-device learning		
Mapping of Course Outcomes for Unit V	CO5	
Learning Resources		
Textbooks: 1. TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers" by Pete Warden and Daniel Situnayake, O'Reilly Media. 2. "Embedded Realtime Systems: Concepts, Design & Programming" by Dr. K.V.K.K. Prasad, Dreamtech Press. 3. "Introduction to Embedded Systems" by Shibu K V, McGraw Hill Education.		

Reference Books:

1. "Real-Time Concepts for Embedded Systems" by Qing Li and Caroline Yao, CRC Press / CMP Books.
2. "Definitive Guide to Arm Cortex-M3 and Cortex-M4 Processors" by Joseph Yiu, Newnes Press .
3. "Edge AI: Models, Architectures and Applications" by Xiaofei Liao and Laurence T. Yang, CRC Press

MOOC / NPTEL/YouTube Links:

1. NPTEL Course: "Introduction to Embedded System Design" by Prof. Badri N. Subudhi (IIT Jammu) or Prof. Santanu Chattopadhyay (IIT Kharagpur).
2. NPTEL Course: "Edge NVidia AI and IoT Solutions / Deep Learning" related catalogs provided under the Swayam portal.
3. Harvard SEAS OpenCourse / YouTube Series: "TinyML (CS249r): Machine Learning with Ultra-Low Power Embedded Systems" curated by Prof. Vijay Janapa Reddi.

Instructions to the Students and teachers

1. Under PEC-363-ECE , 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-361-ECE: Program Elective 2 Course Labs (Choose any One Elective from Program Elective-2 Courses)

Program Elective II
Modern communication Systems
Deep Learning
Digital Image Processing
IoT Applications

Section-II

PEC-362-ECE Program Elective 3-Courses (Choose any One Elective from Program Elective-3 Courses)

Program Elective-III
Web Application Development
RF & Microwave Engineering
Network & Cyber Security
Embedded AI System

Savitribai Phule Pune University Third Year of Electronics & Computer Engineering (2024 Course)		
PCC-363A-ECE: Elective: II Modern Communication System Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Term Work:** 25 Marks **Practical** : 25 Marks
Companion Course, if any:		

List of Experiments (Modern communication Systems)		
Sr. No.	**Unit No.**	**List of Experiment**
Group A: Any Three to be Performed		
1	**I**	Study of Digital Communication System Block Diagram
2		ASK Modulation and Demodulation using MATLAB/Simulation
3		FSK Modulation and Demodulation Experiment
4		PSK and QPSK Modulation Techniques
5		QAM Modulation and Constellation Diagram Analysis
6		Study and Comparison of FDMA, TDMA, CDMA and OFDMA
Group B: Any Three to be Performed		
7	**II**	Study of GSM Architecture and Mobile Communication System
8		Wireless Communication using Bluetooth Module
9		Wi-Fi Communication and Data Transfer Experiment
10		ZigBee Based Wireless Sensor Network Experiment
11		Study of LTE, 5G and 6G Communication Architecture
12	**III**	Measurement of Numerical Aperture of Optical Fiber
13		Study of Optical Fiber Losses and Attenuation
14		Characterization of Optical Source and Optical Detector
15		OTDR Demonstration and Fiber Fault Analysis
16	**IV**	Study of Satellite Communication System Block Diagram
17		Study of Satellite Frequency Bands and Transponders
18		GPS Based Satellite Communication Experiment
19	**V**	Study of Radar System Block Diagram and Radar Range Equation
20		Study of Radar Antennas and Radar Scanning Techniques

Virtual LAB Links:

1. https://vlab.amrita.edu/?sub=3&brch=79
2. https://vlab.amrita.edu/?sub=3&brch=165
3. https://vlab.amrita.edu/?sub=3&brch=75
4. https://www.mathworks.com/academia/tutorials.html
5. https://www.radartutorial.eu/

Savitribai Phule Pune University Third Year of Electronics & Computer Engineering (2024 Course)		
PCC-363A-ECE: Elective: III Web Application Development Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Term Work:** 25 Marks **Practical** : 25 Marks
Companion Course, if any:		
List of Experiments		
Group B: Web Application Development		

Unit 1: Introduction to Web Technologies

Assignment 1: Personal Portfolio Webpage using HTML, CSS and Bootstrap

Create a responsive personal portfolio webpage containing: Profile Information, Educational Details, Skills Section, Image and Hyperlinks, Contact Form, Bootstrap Components (Buttons, Tables, Cards), CSS Styling and Responsive Layout

Unit 2: Fundamentals of JavaScript

Assignment 2: Simple Calculator using JavaScript

Develop a basic calculator application using JavaScript to perform: Addition, Subtraction, Multiplication, Division

Use: Variables, Operators, Functions, Conditional Statements, HTML and CSS for UI Design

Unit 3: Advanced JavaScript and Dynamic Webpage Development

Assignment 3: Student Registration Form with Validation

Create a dynamic student registration form using JavaScript with: Name, Email, Mobile Number fields, Input Validation, Password Validation, Button Events, DOM Manipulation, Dynamic Error Message Display

Unit 4: Fundamentals of React

Assignment 4: Student Information Management using React Components

Develop a React application containing: Functional Components, JSX Syntax, Props, useState Hook, Dynamic Data Display, Reusable Components for Student Details

Unit 5: Advanced React Concepts and Dynamic Web Application Development

Assignment 5: To-Do List or Quiz Application using React

Develop a mini dynamic web application using React with: Form Handling, Event Handling, Conditional Rendering, List Rendering with Keys, Navigation using React Router, Add/Delete Task or Quiz Question Functionality

Savitribai Phule Pune University Third Year of Electronics & Computer Engineering (2024 Course)		
PCC-363B-ECE: Elective: II Deep Learning Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Term Work:** 25 Marks **Practical** : 25 Marks
Companion Course, if any:		
List of Experiments		
Group A (Perform Any 5)		
1. Study of various packages: Tensorflow, keras,Theano and Pytorch.		
2. Implementing Artificial Neural Network training process in Python		
3. Implementation of AND/NAND gate using feed forward Neural Network		
4. Implementation of OR/NOR gate using feed forward Neural Network		
5. Implementation of EX-OR gate using feed forward Neural Network		
6. Implementation of AND/OR/NOT Gate using Single Layer Perceptron		
Group B (Perform Any 2)		
7. Implementation of XOR Gate Using Radial Basis Function Network		
8. Implementation of XOR Gate Using Multi-Layer Perceptron/ Error Back Propagation		
9. To Build and train a Convolutional Neural Network in Python.		
10. Time Series Prediction Using Recurrent Neural Network (RNN)		
Group C (Perform Any 2)		
11. Plant disease detection system using CNN.		
12. Handwritten Digit Recognition using CNN.		
13. Case study of Traffic Signs Recognition using CNN & Keras in Python.		
14. Case study Chatbot implementation using CNN in Python		
Virtual LAB Link **Virtual LAB Links:** **1. Lab Name:** Machine Learning Lab **Link of the Virtual Lab: https://ml-iitr.vlabs.ac.in/** **2. Lab Name:** AI-Deep Learning Virtual Labs: AI Made Easy **Link of the Virtual Lab: https://vlab.spit.ac.in/ai/**		

Savitribai Phule Pune University Third Year of Electronics & Computer Engineering (2024 Course)		
PCC-363B-ECE: Elective: III RF & Microwave Engineering Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Term Work:** 25 Marks **Practical** : 25 Marks

Course Objective:

1. To understand the fundamentals of RF and Microwave Engineering.
2. To analyze microwave components and devices.
3. To study microwave transmission lines and waveguides.
4. To understand RF communication systems and microwave measurements.
5. To study modern microwave applications in wireless and satellite communication

Course Outcome:

CO1: Understand RF and microwave frequency spectrum and propagation
CO2: Explain microwave passive and active components.
CO3: Understand and analyze transmission line theory, impedance matching techniques, and waveguide characteristics used in RF and microwave communication systems.
CO4: Design and analyze RF amplifiers and oscillators.
CO5: Apply microwave Engineering concepts in radar, satellite and wireless systems

Companion Course, if any:

List of Experiments

Group B:

1. Study of RF and Microwave Frequency Bands and Applications
2. Measurement of Radiation Pattern of Microwave Antenna
3. Determine the Voltage Standing Wave Ratio (VSWR), reflection coefficient, and unknown impedance using slotted line methods.
4. Measurement of wavelength & frequency of Microwaves.
5. Measure the radiation pattern, impedance, and gain of a horn or parabolic antenna at microwave frequencies.
6. Microwave Components: Study the properties of various microwave components like E-plane, H-plane, Magic Tee, isolators, and circulators.
7. Plot the V-I characteristics of a Gunn Diode and determine its threshold voltage.
8. Measure the power distribution and coupling factors of directional couplers.
9. Measurement of port characteristics of Microwave Tee, Isolator, & Circulator.
10. Measure the radiation pattern, impedance, and gain of a horn or parabolic antenna at microwave frequencies.

Virtual LAB Link:

1. https://www.antenna-Theory.com/basics/main.php?utm_source=chatgpt.com
2. https://vlab.amrita.edu/?utm_source.

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

PCC-363C-ECE: Elective: II Digital Image Processing Laboratory

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

Course Objectives:

1. To implement basic image processing operations using suitable software tools.
2. To analyze image enhancement and filtering techniques.
3. To implement image segmentation and feature extraction methods.
4. To study image compression and restoration techniques.
5. To explore object recognition and deep learning applications in image processing.

Course Outcome:

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

CO1: Implement basic image processing operations using MATLAB / Python / OpenCV.
CO2: Apply image enhancement and filtering techniques on digital images.
CO3: Implement image segmentation and feature extraction algorithms.
CO4: Perform image compression and restoration operations.
CO5: Develop basic applications related to object recognition and deep learning.

Guidelines

1. Use MATLAB / SCILAB / Python / OpenCV for implementation.
2. For Group A, recommended not to use inbuilt functions.
3. Minimum 07 experiments should be performed.
4. At least 02 experiments should be implemented using Python/OpenCV.
5. Additional experiments may be performed using virtual laboratory platforms.

List of Experiments

Group A: Any Three to be Performed

1 **Group A (All Compulsory)**

1. Perform Basic Image Operations
a. Obtain Negative image
b. Obtain Flip image
c. Perform image resizing and cropping

2. Implement Gray Level and Bit Plane Operations
a. Gray level slicing
b. Bit plane slicing
c. Intensity transformation

3. Read an Image, Plot Histogram and Perform Histogram Equalization

4. Implement Spatial Filtering Techniques
a. Smoothing filters
b. Sharpening filters

5. Implement Edge Detection Techniques using:
a. Sobel Operator
b. Prewitt Operator

Group B (Any Two)

6. Implement Region-Based Image Segmentation
7. Implement Image Compression using DCT / Huffman Coding
8. Implement Noise Models and Restoration Filters

9. Implement Fourier Transform-based Image Enhancement
10. Implement Simple Object Recognition / Image Classification using OpenCV or CNN

Mini Project

Students may carry out a mini-project based on real-world applications of Digital Image Processing using MATLAB / Python / OpenCV.

Suggested Application Areas

- Face detection
- Object detection
- Medical image analysis
- Character recognition
- Traffic sign recognition
- Image classification using CNN

Mini-project may be completed individually or in a group of a maximum 03 students.

Virtual LAB Link

Virtual Labs - IIIT Hyderabad

1. OpenCV Official Documentation

Savitribai Phule Pune University Third Year of Electronics & Computer Engineering (2024 Course)		
PCC-363C-ECE: Elective: III Network & Cyber Security Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Term Work:** 25 Marks **Practical** : 25 Marks
Companion Course, if any:		
List of Experiments		
Any Six Perform		
1. Use Wireshark tool to capture packets and do traffic analysis for TCP,UDP,HTTP and DNS.		
2. Perform scanning using tools like Nmap and identify open ports and running services on a host.		
3. Study password policies, use tools like brute force/dictionary attack simulators and analyze strong vs weak passwords.		
4. Write a program to implement Caesar Cipher/ Playfair Cipher/Polyalphabetic Cipher/Hill Cipher.		
5. Write a program to implement Data Encryption Standard for sample data.		
6. Write a program to implement Advanced Encryption Standard for sample data.		
7. Write a program to implement Diffe-Hellman key exchange algorithm.		
8. Write a program to implement Simple RSA Algorithm with any numbers.		
9. Write a program to implement MD5 or SHA algorithm to generate Hash value.		
10. Configure firewall rules ,Block/allow specific ports and IP addresses and test network access control.		
11. Implement Email security using PGP.		
Virtual Labs Links https://www.netacad.com https://tryhackme.com https://portswigger.net		

Savitribai Phule Pune University
Second Year of Electronics and Computer Engineering (2024 Course)

PCC-363D-ECE: Elective: II IoT Applications Laboratory

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

Companion Course, if any:

Course Objectives:

The objective of this course is to provide students with

1. To develop basic interfacing skills using Arduino and ESP32 development boards for IoT applications.
2. To implement sensor and actuator interfacing techniques for monitoring and automation systems.
3. To study wireless communication and cloud connectivity using ESP32-based IoT systems.
4. To develop and implement simple IoT-based real-time applications and case studies using embedded platforms.

Course Outcomes:

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

CO1: Interface sensors, actuators, and peripheral devices using Arduino and ESP32 boards.

CO2: Acquire, process, and control real-time data for IoT monitoring and automation applications.

CO3: Implement wireless communication and cloud-based IoT applications using ESP32.

CO4: Develop and demonstrate simple IoT-based smart systems for real-world applications.

Guidelines for Laboratory/ TW Assessment

Continuous assessment should be carried out based on timely completion, execution, and demonstration of Arduino and ESP32 based IoT laboratory experiments and case studies.

Assessment should be based on the ability to write, compile, debug, and successfully execute Arduino IDE programs for sensor interfacing, wireless communication, cloud connectivity, and automation applications.

Students should demonstrate correct interfacing of sensors, actuators, relay modules, Wi-Fi/Bluetooth modules, and IoT devices with proper circuit connections, troubleshooting, and hardware handling skills.

Evaluation should include oral examination based on IoT architecture, Arduino and ESP32 programming, MQTT communication, cloud platforms, sensor interfacing, wireless networking, and IoT application development concepts.

Students should maintain a well-documented laboratory journal containing objectives, circuit diagrams, algorithms, source code, observations, outputs, cloud dashboards/screenshots, and conclusions for each experiment and case study.

Suggested List of Laboratory Experiments (Any 10)

Group A: Arduino Based Practical's (Any 3)

1. Interfacing LED and Push Button with Arduino for digital input and output operations.

2. Interfacing Temperature and Humidity Sensor (DHT11/DHT22) with Arduino for environmental monitoring.
3. Interfacing of 16x2 LCD with Arduino board for display of message or information.
4. Interfacing LDR Sensor with Arduino for automatic light intensity measurement.
5. Interface RGB LED with Arduino board and program to display all possible color.
6. Interfacing Buzzer and PIR Motion Sensor with Arduino for motion detection alarm system.

Group B: ESP32 Based Practical's (Any 3)

1. Interfacing IR Sensor and Buzzer with ESP32 for object detection and alarm system applications.
2. Interfacing DHT11 temperature and humidity sensor with ESP32 for environmental monitoring and temperature and humidity values display on LCD.
3. Interfacing temperature and light sensor with ESP32 for sensor data acquisition and display temperature and light sensor on LCD.
4. Interfacing Ultrasonic Sensor with ESP32 for distance measurement and displaying distance values on LCD.
5. Interfacing Soil Moisture Sensor with ESP32 for smart irrigation and water level monitoring applications.

Group C: Case Studies (Perform 2: one from 12 or 13 and one from 13 and 14)

Arduino Based Case Studies

Smart Street Light System using Arduino

Implementation of an automatic street lighting system using LDR sensor and Arduino. The street light turns ON automatically during low light conditions and turns OFF during daytime for energy saving applications.

Home Security Alarm System using Arduino

Implementation of a simple security system using PIR motion sensor, buzzer, and Arduino. The buzzer generates an alarm whenever human motion is detected near the protected area.

ESP32 Based Case Studies

IoT Weather Monitoring System using ESP32

Implementation of a weather monitoring system using ESP32 and DHT11 sensor. Temperature and humidity data are transmitted over Wi-Fi and displayed on a cloud dashboard or mobile device.

Smart Irrigation Monitoring System using ESP32

Implementation of a smart irrigation system using ESP32 and soil moisture sensor. The system monitors soil moisture level and indicates water requirement for agricultural applications.

Savitribai Phule Pune University
Third Year of Electronics & Computer Engineering (2024 Course)

PCC-363D-ECE: Elective: III -Embedded AI Systems Laboratory

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

Companion Course, if any:

Course Objectives

1. Configure peripheral buses to read multi-modal sensor arrays securely.
2. Implement multitasking codebases with deterministic scheduling and shared memory control.
3. Formulate end-to-end telemetry collections, model generation, and network compressions.
4. Port optimized deep learning models onto power-bounded physical microcontroller topologies.
5. Design responsive, low-latency applications solving localization, vision, and sensory classification tasks.

Course Outcomes:

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

CO1: Interface digital sensors using serial protocols to extract streaming time-series data.
CO2: Develop synchronized multi-threaded embedded applications utilizing scheduling, queues & mutexes.
CO3: Build custom dataset loggers and execute numerical quantization to compress edge models.
CO4: Deploy embedded audio and kinetic gesture classifiers for real-time edge processing.
CO5: Build integrated machine vision pipelines and predictive anomaly networks for edge deployment.

List of Experiments

Group B: Any Six to be Performed

1 Bare-Metal Interfacing & Sensor Data Acquisition -Interface digital sensors (such as an IMU or digital microphone) with a microcontroller via I2C/SPI & stream raw telemetry data to a serial monitor

2 Free-RTOS Task Management & Scheduling-Implement a multi-tasking software architecture using Free-RTOS. Create three independent tasks running at different priorities

3.Resource Synchronization using Free RTOS Mutexes and Queues-Develop an application where multiple tasks read from a shared sensor resource using a Mutex to avoid data corruption. Pass the synchronized data to a processing task using Free-RTOS Queues.

4.Data Collection Pipeline for TinyML Edge Models-Build a data logging utility to collect real-world physical training data (e.g., specific hand gestures using an accelerometer or voice samples via a microphone).

5.Quantization & Compression Analysis of a Neural Network-Train a basic Artificial Neural Network (ANN) or Convolutional Neural Network (CNN) in Python (Keras/TensorFlow).

6.TinyML Keyword Spotting (KWS) on a Microcontroller-Design, train, and deploy an audio classification model. The microcontroller must recognize a specific vocal keyword (e.g., "ON", "OFF", or "STOP") in real time using a digital microphone and toggle an physical actuator/LED based on the command.

7.Gesture/Movement Recognition Using Accelerometer Data-Deploy an optimized classifier model that processes real-time 3-axis accelerometer data. The system must accurately distinguish between at least 3 distinct kinetic actions (e.g., waving, shaking, running) on the edge device.
8.Edge Computer Vision: Embedded Object Detection or Face Tracking-Implement an optimized vision pipeline on an edge-capable platform to read real-time camera frames and run local inference to detect objects or recognize specific faces using a lightweight model framework like MobileNet or YOLO-Tiny.
9.Mini-Project: Smart Industrial/Healthcare Anomaly Detector-Build a complete end-to-end prototype for predictive maintenance or smart healthcare. The system must collect real-time data, process it predictably under Free-RTOS, pass it through an on-device anomaly detection ML model, and trigger an alert if abnormal behavior is identified.

Savitribai Phule Pune University
Third Year of Electronics and Computer Engineering (2024 Course)

MDM-371-ECE: Cloud Computing & Deployment

Teaching Scheme	Credits	Examination Scheme
Tutorial: 01 Hours/Week **Practical:** 02 Hours/Week	2	**Term Work:**25 marks **Practical :** 25 marks

Prerequisite Courses:

Course Objectives:

1. To understand the fundamental concepts, architecture, and service models of cloud computing and deployment platforms.
2. To develop practical knowledge of cloud storage systems, distributed data management, and cloud-based database services.
3. To learn virtualization and containerization technologies for creating and managing virtual cloud environments.
4. To deploy and manage applications using cloud platforms such as AWS.
5. To understand cloud security mechanisms, risk management, authentication, monitoring, and secure cloud deployment practices.

Course Outcomes:

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

1. Explain cloud computing concepts, service models, deployment models, and cloud architecture used in modern computing environments.
2. Configure and manage cloud storage services, distributed data systems, and cloud databases for data-intensive applications.
3. Create and manage virtual machines and containers using virtualization and containerization tools.
4. Deploy, monitor, and manage applications on cloud platforms using industry-standard cloud services and deployment techniques.
5. Apply cloud security principles, identity management, monitoring tools, and secure deployment strategies in cloud environments.

Course Contents

Unit I	Fundamentals of Cloud Computing and Deployment	(07 Hours)

Introduction to Cloud Computing, Characteristics and Advantages of Cloud Computing, Cloud Service Models: SaaS, PaaS, IaaS, Cloud Deployment Models: Public, Private, Hybrid, Community, Cloud Architecture Basics, Cloud Migration Concepts, Introduction to Cloud Deployment Process, Trends in Cloud Computing

Mapping of Course Outcomes for Unit I : CO1		
Unit II	**Cloud Storage and Data Management**	**(07 Hours)**
Introduction to Cloud Storage, Direct Attached Storage (DAS), Network Attached Storage (NAS), Storage Area Network (SAN), Cloud Data Stores, Distributed Data Storage, File Systems in Cloud Data, Backup and Recovery, Cloud Database Services		
Mapping of Course Outcomes for Unit II: CO2		
Unit III	**Virtualization and Containerization**	**(07 Hours)**
Introduction to Virtualization, Types of Virtualization, Virtual Machines and Hypervisors, CPU, Network, and Storage Virtualization, Virtual Infrastructure in Cloud, Virtualization Security, Introduction to Docker Containers, Introduction to Kubernetes , Container Deployment Basics		
Mapping of Course Outcomes for Unit III : CO3		
Unit IV	**Cloud Platforms and Cloud Applications**	**(06 Hours)**
Introduction to AWS Cloud Platform, AWS EC2 Instance Creation and Management, AWS S3 Storage Service, Introduction to DynamoDB, Cloud-Based Application Deployment, OpenStack Architecture Overview, Continuous Deployment Concepts , Introduction to CI/CD Pipeline		
Mapping of Course Outcomes for Unit IV: CO4		
Unit V	**Cloud Security and Monitoring**	**(06 Hours)**
Introduction to Cloud Security, Risks and Challenges in Cloud Computing, Data Security and Privacy, Authentication and Authorization, Confidentiality, Integrity, and Availability (CIA), Secure Cloud Deployment, Cloud Monitoring and Logging, Identity and Access Management (IAM)		
Mapping of Course Outcomes for Unit V : CO5		
Learning Resources		
Textbooks: 1. Srinivasan, J. Suresh, "Cloud Computing: A Practical Approach for Learning and Implementation", Pearson, ISBN: 978-81-317-7651-3 2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", McGraw Hill Education, ISBN-13:978-1-25-902995-0		
Reference Books: 1. James Bond ,"The Enterprise Cloud", O'Reilly Media, Inc. ISBN: 9781491907627 2. Dr. Kris Jamsa, "Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more", Wiley Publications, ISBN: 978-0-470-97389-9 3. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", 2010, The McGraw-Hill. 4. Gautam Shrof, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications", Cambridge University Press, ISBN: 9780511778476 1. Tim Mather, Subra K, Shahid L.,"Cloud Security and Privacy", Oreilly, ISBN-13 978-81- 8404-815-5		

MOOC / NPTEL Courses:

1. Cloud Computing https://onlinecourses.nptel.ac.in/noc21_cs14/preview?
2. Cloud Computing and Distributed System: https://onlinecourses.nptel.ac.in/noc21_cs15/preview?
3. https://www.digimat.in/nptel/courses/video/106105167/L01.html
4. https://www.digimat.in/nptel/courses/video/106105167/L03.html
5. https://www.digimat.in/nptel/courses/video/106105167/L20.html

Suggested List of Laboratory Experiments	
1.	Study and prepare a report on cloud deployment models used in industries.
2.	Create accounts on AWS Educate or Microsoft Azure for Students.
3.	Create and configure cloud storage using AWS S3 or Google Drive API
4.	Upload, manage, and share files using cloud storage services.
5.	Install and configure Virtual Box or VMware
6.	Create and manage a virtual machine.
7.	Launch and configure an AWS EC2 virtual machine.
8	Deploy a simple web application on AWS or Azure
9	Create and manage cloud storage buckets using AWS S3
10	Configure IAM users and access permissions in AWS

Savitribai Phule Pune University
Third Year of Electronics and Computer Engineering(2024Course)

VSE-372-ECE: Mini Project

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

Prerequisite Courses, if any:

1. Analog & Digital Electronics Circuits
2. Microntroller and Applications, DBMS, AI & ML
3. Object Oriented Programming

Companion Course, if any: Nil

Course Objectives:

1. To provide industry-oriented technical skills relevant to modern Electronics and Computer industries.
2. To enhance practical knowledge in embedded systems, IoT, PCB design, industrial automation, FPGA/VLSI, Data base management, AI & ML, Embedded Systems
3. To develop vocational and employability skills through hands-on training and mini projects.
4. To improve problem-solving, teamwork, communication skills.
5. To bridge the gap between academic learning and industrial requirements.

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 Computer (ECE) 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.

A) Selection: Domains for projects may be from the following, but not limited to:

1	Front End development
2	Electronic Communication Systems
3	IoT
4	Embedded Systems
5	Full stack development

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 SWAYAM Platform
   Useful for:
2. 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 - Computer Engineering (2024 Pattern)**		
ELC381-ECE- Internship/On Job Training		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 08 Hours/Week	04	Oral : 50 Marks

Course Objectives:

The course aims to:

1. To expose students to real-world industry practices.
2. To bridge the gap between academic learning and practical implementation.
3. Develop professional competency, ethics, communication, and teamwork skills.
4. To encourage self-learning and problem-solving abilities.
5. 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

1. Students should opt for an internship/OJT 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.
2. Students must have to opt for technical internship after V semester and before VI semester, preferably during winter break (After 15 Dec – Jan End)
3. Undergoing a training Programme / Course at a particular organization for specified duration is NOT considered as winter internship
4. 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
5. Students should take a challenging task, may be a small portion, and apply the knowledge gained to solve it.
6. 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.
7. 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.
8. Student need to submit Synopsis, Permission letter and offer letter to Internship coordinator before proceeding to internship.
9. Internship completion will be considered only after submission of valid documents at the end of internship like Completion certificate, Report and presentation of work done, feedback from industry etc.

10. Student will appear for term work /oral evaluation where he/she will present the work done before mentor(s) /Examiners 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 and implementation
  - Database design and integration
  - Software testing and debugging
  - API integration and deployment
  - Use of version control systems
  - Documentation practices
- Phase III – Project Execution
  - Module development
  - Testing and validation
  - Performance optimization
  - Client interaction (if applicable)
  - Team collaboration
- Phase IV – 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 may be carried out in any one 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 , ASME Press
2. Stuart Walesh, Engineering Your Future: The Professional Practice of Engineering
3. Eliyahu M. Goldratt, The Goal: A Process of Ongoing Improvement
4. AICTE Internship policy : AICTE Internship Policy: Guidelines & Procedures
   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. Chapter 1 – Organization Profile
    - Company overview
    - Vision and mission
    - Products/services
    - Organizational structure
3. Chapter 2 – Problem Statement and Objectives
    - Project title
    - Need of project
    - Objectives
    - Scope
4. Chapter 3 – Technologies and Methodology
    - Software/hardware tools used
    - Development methodology
    - System architecture
    - Database design
5. Chapter 4 – Work Carried Out
    - Tasks completed
    - Screenshots/results
    - Challenges faced
    - Solutions implemented
6. Chapter 5 – Learning Outcomes
    - Technical learning
    - Professional skills acquired
    - Industry exposure
    - Future scope
7. Chapter 6 – Conclusion
    - Summary of work
    - Achievements
    - Suggestions

References : IEEE format references

preferred Appendices

- Source code snippets
- Certificates
- Additional screenshots

Savitribai Phule Pune University, Pune

Maharashtra, India

Task Force for Curriculum Design and Development

Programme Co-ordinator: Prof.Satish Asane & Prof. Prashant Kathole DYPTC, Varale -Talegaon, Pune.

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Team Members for Course Design

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PEC362A-ECE-Web Application Developments	
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PEC362B-ECE-RF & Microwave Engineering	
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PEC362D-ECE-Embedded AI Sytems	
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MDM-371-ECE-Cloud Computing & deployment	
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