Amrutvahini Sheti and Shikshan Vikas Sanstha's

AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER

Amrutnagar, Ghulewadi, Sangamner - 422608

(An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune)

Curriculum Structure and Syllabus

of

Second Year B. Tech.

Electronics & Computer Engineering

(Effective from Academic Year 2026-27)

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Abbreviation

AEC - Ability Enhancement Course

AICTE - All India Council for Technical Education

CEP - Community Engagement Project

EEM - Entrepreneurship/Economics/Management Courses

MDM - Multidisciplinary Minor

MOOC - Massive Open Online Course

NEP - National Education Policy

NPTEL - National Programme on Technology Enhanced Learning

OE - Open Elective

PCC - Program Core Course

CCC – Cocurricular Course

PEO - Programme Educational Objectives

PSO - Program Specific Outcomes

SWAYAM - Study Webs of Active-learning for Young Aspiring Minds

UGC - University Grants Commission

VEC - Value Education Course

VSE - Vocational and Skill Enhancement Course

WK - Knowledge and Attitude Profile

CCE - Comprehensive and Continuous Evaluation

ISO - International Organization for Standardization

EOMS - Educational Organization Management System

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Institute Vision

To create opportunities for rural students to become able engineers and technocrats through continual excellence in engineering education.

Institute Mission

Our mission is to create self-disciplined, physically fit, mentally robust and morally strong engineers and technocrats with high degree of integrity and sense of purpose who are capable to meet challenges of ever advancing technology for the benefit of mankind and nature.

We, the management, the faculty and staff, therefore promise to strive hard and commit ourselves to achieve this objective through a continuous process of learning and appreciation of needs of time.

Department Vision

To contribute for improving wellbeing of the students from rural background by imparting interdisciplinary education in the field of Electronics and Computer Engineering.

Department Mission

M1: To impart basic understanding of Electronic principles and software engineering principles based on a strong foundation of basic sciences and mathematics.

M2: To train our students to become proficient at putting theory into practice, capable of lifelong learning and be aware of the social and environmental issues.

M3: To endow students with the knowledge, technical skills and values that prepare them to excel as engineers and leaders in their profession.

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ISO 21001:2018 - EOMS Policy

We, at AVCOE Sangamner, are committed to:

- Provide quality technical education to the rural students
- Provide conducive environment for all round development of the students.
- Develop as a premier institute for technical education & research as per the needs and expectations of all stake holders.
- Comply all applicable requirements.
- Develop students into technocrats having social responsibility.
- Keep abreast about the advances in technology and innovation.
- Enhance industry-institute interaction.
- Managing intellectual property.
- Maintain hygiene, health and safety for applicable requirements.
- Achieve continual improvement in academic and administrative processes.
- We shall strive to maintain Educational Organizational Management System.

Knowledge and Attitude Profile

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

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole- life cost, re-use of resources, net zero carbon, and similar Concepts, that supports engineering design and operations in a practice area.

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WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

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Program Outcomes (POs)

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. (WK1 to WK4)
PO3	Design / Development of Solutions	complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Team work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning Differences
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

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Program Educational Objectives (PEOs):

PEO1: Demonstrate technical competence in diverse fields of careers as engineers, consultants, technocrats and entrepreneurs.

PEO2: Contribute their Electronics and Computer Engineering expertise to design, development or maintenance of electronic systems, software systems, devices, instruments, or products.

PEO3: Demonstrate leadership, understand professional and ethical responsibilities and contribute for the betterment of the society.

PEO4: Communicate effectively, function well as a team member and manage projects in a multi-disciplinary environment.

PEO5: Pursue lifelong learning and adapt to the ever advancing technological changes.

Program Specific Outcomes (PSOs):

A graduate of the Electronics and Computer Engineering Program will demonstrate-

PSO1: An ability to identify, formulate and solve real world problems based on sound knowledge of hardware and software aspect of engineering systems.

PSO2: An ability to design electronics circuits, apply programming skills to develop software for embedded systems, IoT applications, desktop and web applications, conduct experiments, analyze and interpret data.

PSO3: Skill to use modern tools, instruments, equipment, integrated development environments, compilers and application software.

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Preface

It gives me immense pleasure to present the syllabus of the Second Year B.Tech. in Electronics and Computer Engineering. This curriculum has been carefully designed to meet the evolving requirements of industry, higher education, and emerging technologies while supporting the holistic development of students.

The curriculum provides a strong foundation in basic sciences, mathematics, electronics, and computer engineering principles. It integrates contemporary areas such as analog and digital electronic systems, communication technologies, computer organization and operating systems, programming and algorithmic problem solving, Internet of Things (IoT), data analytics, computational methods, entrepreneurship, and sustainable engineering practices.

The curriculum has been designed in alignment with the objectives and recommendations of the National Education Policy (NEP) 2020, the guidelines of the All India Council for Technical Education (AICTE), New Delhi, the University Grants Commission (UGC), and the academic framework of Savitribai Phule Pune University (SPPU). Special focus has been given to Outcome-Based Education (OBE), experiential learning, project-based activities, industry-relevant skills, professional ethics, environmental awareness, teamwork, leadership, and lifelong learning. The curriculum is designed to equip students with the technical competence, creativity, and adaptability required to excel as engineers, technocrats, entrepreneurs, and responsible contributors to society.

I sincerely acknowledge the valuable contributions of faculty members, industry experts, alumni, and members of the Board of Studies who have played a significant role in developing this curriculum. I am confident that this syllabus will enable students to acquire strong technical knowledge, practical skills, professional values, and the ability to adapt to rapidly advancing technologies in the field of Electronics and Computer Engineering.

Dr. S. B. Rahane
Head, Department of Electronics and Computer Engineering
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Program codes:

The institute has assigned a unique program code to each branch.

Table 1 – Program codes

Sr. No.	Program code	Code
UG Programs		
1	Electronics and Computer Engineering	EC

Subject code nomenclature:

The following nomenclature demonstrates the subject codes:

- **R-Year** (of designing/revising syllabus) – **Program code** (as given in table 1) - **Course Type** (as per NEP) – **Course Number** (101 – FY B. Tech Subject 1, 201 - SY B. Tech Subject 1, 301 - TY B. Tech Subject 1, 401 - B. Tech Subject 1 etc.)

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Guidelines for Examination Scheme:

The evaluation of students shall be based on continuous academic performance in a course based on Comprehensive Continuous Evaluation (CCE) and End Semester Examination (ESE). Components of the Examination System:

1. **Comprehensive Continuous Evaluation (CCE):**
   - CCE of 40 marks based on all the Units of course.
   - To design a Comprehensive Continuous Evaluation scheme for a theory subject of 40 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Table 3: Allocation of marks and structure (03 credit course)

Sr. No.	Examination	Conduction Marks	Marks	Coverage of Units
1	**CCE –I** (Class test – 1)	32	16	Units 1 & Unit 2 (8 Marks/Unit)
2	**CCE –II** (Assessment tools: Case Study, presentation, Open book test etc.)	32	16	Units 3 & Unit 4 (8 Marks/Unit)
3	**CCE –III** (Assessment tools: Assignments, seminar, quiz, course project, field visit etc.)	08	08	Unit 5

Table 4: Allocation of marks and structure (02 credit course)

Sr. No.	Examination	Conduction Marks	Marks	Coverage of Units
1	**CCE –I** (Class test – 1)	40	20	Units 1 & Unit 2 (10 Marks/Unit)
2	**CCE –II** (Assessment tools: Case Study, presentation, Open book test etc.)	20	10	Unit 3
3	**CCE –III** (Assessment tools: Assignments, seminar, quiz, course project, field visit etc.)	10	10	Unit 4

Timeline for conduction of CCE:
(Illustration for 03 credit course)

- Weeks 1- 4 : Completion of Unit 1 and 2
  Week 5 : Conduct CCE1 1 (16 marks)
- Weeks 6 - 8 : Completion of Unit 3 and 4
  Week 9 : Conduct CCE2 as (16 marks)
- Weeks 10 - 12 : Completion of Unit 5
  Week 13 : Conduct Seminar/Course project/Presentation/Quiz/Open Book test (8 marks)

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Evaluation and Feedback:

- **Unit Test:** Student answer papers will be evaluated promptly, and constructive feedback will be provided highlighting strengths and areas for improvement.
- **Assignments / Case Study:** Student submissions will be assessed as per the given rubric, and meaningful feedback will be provided to help students understand their performance and scope for enhancement.
- **Seminar Presentation:** Students will be evaluated based on content accuracy, delivery, and responses during the Q&A session. Feedback will be shared on communication skills and conceptual understanding.
- **Open Book Test:** Evaluation will focus on the depth of analysis and the ability to apply concepts. Feedback will emphasize students' critical thinking and problem-solving skills.
- **Mini Project:** Students will be assessed on problem identification, design approach, implementation quality, and documentation. Innovation, teamwork, and practical application of concepts will be strongly considered.
- **Field Visit:** Evaluation will be based on the student's report and reflection, focusing on understanding of real-world practices and their relevance to the course outcomes. Marks will reflect clarity, insight, and active participation.

2. End Semester Examination (ESE):

The ESE is a compulsory examination for all students. The ESE examination will be conducted at the end of the semester by the institute Department of Examination and Evaluation (DEE). The ESE will be based on 100% syllabus (All units covered). The ESE shall be of 60 marks (12 Marks / Unit for 03 credit course and 15 Marks / Unit for 02 credit course) conducted for all theory courses as mentioned in the programme structure.

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Syllabus Structure (Semester – III)

Sr. No.	Course Code	Course Type	Name of the Subject	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours	Self Learning Hours	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
Semester-III																			
1	R25-EC-PCC-201	Program Core course - 1	Analog and Digital Electronic Circuits	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
2	R25-EC-PCC-202	Program Core course - 2	Data Structures and Algorithms	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
3	R25-EC-PCC-203	Program Core course - 3	Computer Organization & Operating Systems	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
4	R25-EC-MDM-204	Multidisciplinary Course-1	MDM 1- Fundamentals of IoT	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
5	R25-EC-OEC-205	Open Elective-I	Open Elective- I	2	-	-	30	30	60	40	60	-	-	-	100	2	-	-	2
6	R25-EC-EEM-206	Entrepreneurship/Economics/ Management course	Financial Planning, Taxation and Investment	1	2	-	45	15	60	25	-	25	-	-	50	1	1	-	2
7	R25-EC-VEC-207	Value Education Course	Universal Human Values & Ethics	2	-	-	30	30	60	50	-	-	-	-	50	2	-	-	2
8	R25-EC-PCC-208	Program Core Course-Lab	Analog and Digital Electronic Circuits Lab	-	2	-	30	-	30	-	-	25	25	-	50	-	1	-	1
9	R25-EC-PCC-209	Program Core Course Lab	Data Structures and Algorithms Lab	-	2	-	30	-	30	-	-	25	25	-	50	-	1	-	1
10	R25-EC-CEP-210	Community Engagement Project / Field Project	Community/ Field Project	-	4	-	60	-	60	-	-	50	-	-	50	-	2	-	2
			Total	**17**	**10**	**0**	**345**	**255**	**660**	**275**	**300**	**125**	**50**	**0**	**750**	**17**	**5**	**0**	**22**

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Syllabus Structure (Semester – IV)

Sr. No.	Course Code	Course Type	Name of the Subject	Teaching Scheme (Hrs./week)						Examination Scheme and Marks						Credit			
				TH	PR	TUT	Contact Hours	Self Learning Hours	Total	CCE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
Semester-IV																			
1	R25-EC-PCC-211	Program Core course - 4	Analog and Digital Communication	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
2	R25-EC-PCC-212	Program Core course - 5	Signals & Systems	2	-	-	30	30	60	40	60	-	-	-	100	2	-	-	2
3	R25-EC-PCC-213	Program Core course - 6	Object Oriented Programming	3	-	-	45	45	90	40	60	-	-	-	100	3	-	-	3
4	R25-EC-OEC-214	Open Elective-II	Open Elective-II	2	-	-	30	30	60	40	60	-	-	-	100	2	-	-	2
5	R25-EC-MDM-215	Multidisciplinary Course-2	MDM2- Applied Mathematics	2	-	-	30	30	60	40	60	-	-	-	100	2	-	-	2
6	R25-EC-VSEC-216	Vocational Skill Course	Data Analytics with Python and R	1	2	-	45	15	60	-	-	25	25	-	50	1	1	-	2
7	R25-EC-AEC-217	Ability Enhancement Course	Modern Indian Language and Technical Writing	1	2	-	45	15	60	-	-	50	-	-	50	1	1	-	2
8	R25-EC-EEM-218	Entrepreneurship/Economics/ Management course	Entrepreneurship Development	2	-	-	30	30	60	50	-	-	-	-	50	-	2	-	2
9	R25-EC-PCC-219	Program Core Course-Lab	Analog and Digital Communication Lab	-	2	-	30	-	30	-	-	-	-	25	25	-	1	-	1
10	R25-EC-PCC-220	Program Core Course Lab	Object Oriented Programming Lab	-	2	-	30	-	30	-	-	-	25	-	25	-	1	-	1
11	R25-EC-VEC-221	Value Education Course	Electronic waste management	2	-	-	30	30	60	-	-	50	-	-	50	2	-	-	2
			Total	**18**	**8**	**0**	**390**	**270**	**660**	**250**	**300**	**125**	**50**	**25**	**750**	**16**	**6**	**0**	**22**

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Open Electives

Sr. No.	Offered by the Department	Open Elective – I	Open Elective - II
1	ETC	Business Analytics	Remote Sensing and GIS
2	ECE	Leadership and Organizational Behavior	Dairy and Food Processing Technology
3	IT	Cyber Security and Laws	Data Ethics and Visualization
4	Computer	Financial Literacy and Investment Planning	Digital Governance and Management Information Systems
5	Electrical	Project Management	Sustainable Rural Entrepreneurship and Development
6	Automation and Robotics	Supply Chain Management	Farm Automation
7	Civil	Mechanical Electrical and Plumbing Systems	Interior Design
8	AIDS	Road Safety and Civic Responsibility	Digital Marketing and E-business
9	Mechanical	Principles and Practices of Management	Agri-Tech Systems

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Semester - III

Sr. No.	Name of the course	Course Code	Course Coordinator	Signature
1	Analog and Digital Electronic Circuits	R25-EC-PCC-201	Prof. M. T. Kanawade	
2	Data Structures and Algorithms	R25-EC-PCC-202	Dr. S. B. Rahane	
3	Computer Organization & Operating Systems	R25-EC-PCC-203	Prof. A.Y. Autade	
4	MDM 1- Fundamentals of IoT	R25-EC-MDM-204	Prof. S. B. Dighe	
5	Leadership and Organizational Behavior	R25-EC-OEC-205	Dr. S. B. Rahane	
6	Financial Planning, Taxation and Investment	R25-EC-EEM-206	Prof. H. A. Shinde	
7	Universal Human Values & Ethics	R25-EC-VEC-207	Prof. H. A. Shinde	
8	Analog and Digital Electronic Circuits Lab	R25-EC-PCC-208	Prof. M. T. Kanawade	
9	Data Structures and Algorithms Lab	R25-EC-PCC-209	Dr. S. B. Rahane	
10	Community Engagement Project	R25-EC-CEP-210	Dr. S. B. Rahane	

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Semester – IV

Sr. No.	Name of the course	Course Code	Course Coordinator	Signature
1	Analog and Digital Communication	R25-EC-PCC-211	Prof. V. S. Phatangare	
2	Signals & Systems	R25-EC-PCC-212	Dr. S. S. Gundal	
3	Object Oriented Programming	R25-EC-PCC-213	Dr. V. S. Ubale	
4	MDM2- Applied Mathematics	R25-EC-MDM-214	Dr. S. K. Choudhary	
5	Dairy and Food Processing	R25-EC-OEC-215	Dr. S. B. Rahane	
6	Data Analytics with Python and R	R25-EC-VSEC-216	Prof. D. A. Mhaske	
7	Modern Indian Language and Technical Writing	R25-EC-AEC-217	Prof. S. B. Dighe	
8	Entrepreneurship Development	R25-EC-EEM-218	Prof. D. A. Mhaske	
9	Analog and Digital Communication Lab	R25-EC-PCC-219	Dr. S. S. Gundal	
10	Object Oriented Programming Lab	R25-EC-PCC-220	Prof. A. Y. Autade	
11	Electronic waste management	R25-EC-VEC-221	Dr. S. K. Choudhary	

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Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			III
Course:	**Analog and Digital Electronic Circuits**			**Course Code:**			R25-EC-PCC-201
Teaching Scheme (Hrs. /Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
03	-	-	03	40	60	-	-

Course Description:

This course provides a comprehensive introduction to the principles, analysis and design of analog and digital electronic circuits. In the analog portion, topics include semiconductor devices, amplifiers, operational amplifiers, frequency response and signal conditioning. The digital portion covers logic gates, Boolean algebra, combinational and sequential logic, flip-flops, counters, registers, and an introduction to digital integrated circuits.

Emphasis is placed on circuit analysis techniques, practical design considerations, and real-world applications. Laboratory work complements theory through hands-on experiments, simulation, and testing of electronic circuits. Upon completion, students will be able to analyze, design, and troubleshoot basic analog and digital electronic systems.

Relevance:

In essence, the combined knowledge of analog and digital circuits provides students with the skills to design, analyze, and implement robust electronic systems that interface with real-world signals, embedded systems, and communication technology.

Prerequisite: Basic Electronics, Semiconductor Physics

Bridge Content: - Introduction to simple PCB design for basic analog circuits and PCB realization using suitable PCB design software.

Course Objectives:

1. To study of EMOSFET characteristics, parameters and develop the ability to design the EMOSFET-based amplifier circuits.
2. To understand the concepts of feedbacks in amplifiers and oscillators.
3. To demonstrate and analyze operational amplifier circuits and their applications.
4. To describe and design combinational and sequential logic circuits.
5. To understand the concepts of sequential circuits and analyze sequential systems in terms of state machine models.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Analyze** EMOSFET characteristics and parameters, and Design basic EMOSFET amplifier circuits.	4
CO2	**Apply** feedback principles to Analyze and Design amplifiers and oscillators with desired performance characteristics.	4
CO3	**Analyze**, **design**, and **Implement** operational amplifier circuits for various practical applications.	4
CO4	**Analyze, Design** and **Implement** combinational and sequential logic circuits using appropriate digital components.	4
CO5	Model, **Analyze**, and **Interpret** sequential systems using state machines and state diagrams.	4

Course Content			
Unit 1	**MOSFET Circuits and Analysis**	**9 Hrs.**	**CO1**
MOSFET operation, Construction of n-channel E-MOSFET, E-MOSFET characteristics and parameters, non-ideal voltage current characteristics i.e. Finite output resistance, body effect, sub threshold conduction, breakdown effects and temperature effects, MOSFET DC Analysis, Load Line and Modes of operation, MOSFET Common Source amplifier circuit, Small signal model of MOSFET and its parameters, AC analysis of Common Source amplifier circuit.			
Exemplars / Practical Applications and usage: MOSFETs are used as Amplifiers, Switching Circuits, Analog Integrated Circuits, Digital Integrated Circuits, Power Electronics.			
Unit 2	**MOSFET Application**	**9 Hrs.**	**CO2**
MOSFET as switch, diode/active resistor, CMOS Inverter, Feedback Amplifiers: Four types of amplifiers. Feedback topologies, Effect of feedback, Voltage series and Current series FET feedback amplifiers and their analysis. Oscillators: Barkhausen criterion, stability with feedback, RC Phase Shift oscillator, Wein bridge oscillator.			
Exemplars / Practical Applications and usage: Audio Amplifiers, Signal Conditioning Circuits, Voltage Regulators, Instrumentation Amplifiers, Communication Systems, Signal Generators, Timing Circuits.			
Unit 3	**OP-AMP Applications**	**9 Hrs.**	**CO3**
OPAMP applications circuit design and analysis such as voltage follower, Integrator, Differentiator, Comparator, Schmitt trigger, Square and Triangular wave generator, instrumentation amplifier. ADC and DAC: Various types of ADCs and DACs and their performance parameters, study of successive approximation ADC and R-2R ladder type of DAC.			
Exemplars / Practical Applications and usage: Audio mixers and signal processing systems, Sensor signal conditioning, Biomedical instrumentation, Impedance matching, Analog computers, Waveform generation and Control systems.			
Unit 4	**Combinational and Sequential Logic Digital Circuits**	**9 Hrs.**	**CO4**
Combinational logic Circuit: Standard representations for logic functions, k-map representation of logic functions (SOP and POS forms), Code converters, Half- Adder, Full Adder, Half Subtractor, Full Subtractor, Comparator, 4:1 and 8:1 multiplexers and relevant de-multiplexers. Sequential logic Circuit: Shift registers, synchronous and asynchronous counters, ring and twisted ring counters, up and down counters.			
Exemplars / Practical Applications and usage: Processors , Calculators, Data storage, Data transfer, Serial-to-parallel and parallel-to-serial conversion, frequency counters			
Unit 5	**State Machines and its Application**	**9 Hrs.**	**CO5**
State diagram, state table, state reduction, state assignment, Mealy and Moore machines representation, Mealy and Moore machine implementation, Finite State Machines. Sequence Generator and Sequence detector. Performance parameters for a digital logic circuit such as speed, power dissipation, figure of merit, fan in, fan out, current, voltage, noise immunity.			
Exemplars / Practical Applications and usage: Traffic light controllers, Vending machines, and Washing machine controllers			

Course Projects:

Study and analysis of modern operational amplifiers and related ICs such as precision op-amps, low-noise op-amps, low-power op-amps, single supply op-amps, rail-to-rail op-amps, and monolithic instrumentation amplifiers, ADCs, DACs etc. from various semiconductor manufacturers. A group of 3–4 students shall study datasheets, application notes, specifications, performance parameters, and practical applications of selected devices, and design a simple application circuit based on the study. The designed circuit shall be implemented and tested on a PCB.

Textbooks:

1. Donald Neaman, "Electronic Circuits – Analysis and Design" Third edition, Mc Graw Hill.
2. Ramakant Gaikwad, "Op amps and Linear Integrated Circuits", Pearson Education.
3. R.P. Jain, "Modern digital electronics", 3rd edition, 12th reprint Tata McGraw Hill Publication, 2007.
4. M. Morris Mano, "Digital Logic and Computer Design" 4the Edition, Prentice Hall of India

Reference Books:

1. Millman Halkias, "Integrated Electronics"
2. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford press
3. Anand Kumar, "Fundamentals of Digital Circuits" 1st edition, Prentice Hall of India, 2001
4. Leach, Malvino, Saha, "Digital Principles and Applications" (SIE), 8th Edition.

MOOCs Links and additional reading material:

e-Books:

1. https://ebooks.lpude.in/computer_application/ad/DCAP108_DIGITAL_CIRCUITS_AND_LOGIC_DESIG NS.pdf
2. https://mrce.in/ebooks/Analog%20Integrated%20Circuit%20Design%202nd%20Ed.pdf MOOC /

NPTEL/YouTube Links:

1. NPTEL Course "Analog Electronic Circuits" https://nptel.ac.in/courses/108105158
2. NPTEL Course on "Analog Circuits": https://nptel.ac.in/courses/108101094
3. NPTEL Course "Digital Circuits" by Prof. Santanu Chattopadhyay (IIT Kharagpur)
4. NPTEL Course "Digital Circuits" by Prof. Goutam Saha (IIT Kharagpur)

Virtual Labs Links:

1. http://vlabs.iitb.ac.in/vlabs/vlab_bootcamp/bootcamp/electronerds/index.html
2. http://vlabs.iitkgp.ernet.in/be/
3. https://nptel.ac.in/courses/108/105/ 108105113/
4. https://nptel.ac.in/courses/117/106/117106086/
5. https://nptel.ac.in/courses/108/105/108105132/
6. https://da-iitb.vlabs.ac.in/exp/generalized-simulator/
7. https://dld-iitb.vlabs.ac.in/

Strength of CO-PO-PSO Mapping

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	-	-	3	2	1
CO2	3	3	3	2	2	-	-	-	-	-	-	3	2	1
CO3	3	3	3	2	3	-	-	-	-	-	-	3	3	1
CO4	3	3	3	2	3	-	-	-	1	-	-	3	3	2
CO5	3	3	3	3	2	-	-	-	1	-	-	3	3	2
Avg.	3	3	2.8	2.2	2.4	-	-	-	0.4	-	-	3	2.6	1.4

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE 1	08	08			
CCE 2			08	08	
CCE 3					08
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE					ESE				
	CCE1		CCE2		CCE3					
CO	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
L1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:

1. Analog and Digital Communication
2. VLSI Design and Technology
3. Microcontroller Applications
4. Embedded System and Edge Computing
5. Power Electronics

Job Mapping:
Job opportunities that one can get after learning this course:

1. Electronics Hardware Maintenance Technician
2. Graduate Trainee Engineer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			III
Course:	**Data Structures and Algorithms**			**Course Code:**			R25-EC-PCC-202
Teaching Scheme (Hrs. /Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
03	-	-	03	40	60	-	-

Course Description:

This course introduces students to fundamental concepts of programming using C++ and emphasizes efficient data organization and algorithmic problem solving. It covers analysis of algorithms with respect to time and space complexity, along with searching and sorting techniques. Students gain in-depth understanding of linear data structures such as linked lists, stacks, and queues, including their implementations and applications. The course also explores non-linear data structures like trees and graphs, focusing on traversal, balancing, and optimization algorithms. Emphasis is placed on practical problem-solving through real-world examples. By the end of the course, students will be able to design, implement, and analyze efficient algorithms using appropriate data structures.

Relevance:

It builds a strong foundation for solving real-world programming problems and developing efficient software applications. It is essential for careers in software development, system design, and emerging fields like AI, data science, and embedded systems.

Prerequisite: Basic knowledge of programming concepts and problem-solving using C is required.

Bridge Content: - Debugging with Visual Studio Code, Introduction to competitive coding platforms, Introduction to Unit Testing

Course Objectives:

1. To introduce students to the fundamentals of C++ programming with object-oriented concepts.
2. To develop understanding of various searching and sorting algorithms and their performance.
3. To understand the concepts and applications of linear and non-linear data structures.
4. To implement and analyze data structures such as linked lists, stacks, queues, trees, and graphs using C++.
5. To enable students to apply data structures and algorithms to solve real-world problems efficiently.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	**Apply** object-oriented programming concepts using C++ for problem solving.	3
CO2	**Analyze** searching and sorting algorithms for efficiency	4
CO3	**Implement** various types of linked lists and understand their applications.	3
CO4	**Implement** stack and queue data structures and apply them in relevant problems.	3
CO5	**Apply** trees and graphs to represent and solve complex problems.	3

Course Content			
Unit 1	**Introduction to C++**	**9 Hrs.**	**CO1**
C++ program structure, syntax, fundamental data types, variables, constants and operators. Functions and parameter passing, friend functions, Classes and objects, Encapsulation, Constructors and destructors, Function overloading and operator overloading. Exception handling. Concept of inheritance, Polymorphism: compile-time and run-time polymorphism (introduction).			
Exemplars / Practical Applications and usage: System programming, operating systems, Game development, Embedded System, device drivers, scientific simulations, Artificial Intelligence/ Machine Learning Libraries.			
Unit 2	**Algorithms: Analysis, Searching, Sorting, and Hashing**	**9 Hrs.**	**CO2**
Algorithms: Iterative algorithms, Recursive Algorithms, Analysis of algorithms, Time and space complexity, Asymptotic notation- Big-O, Big-Θ, and Big- Ω Notation. Searching methods: Linear and Binary Search. Sorting methods: Bubble and Quick Sort. Concept of hashing and hash tables.			
Exemplars / Practical Applications and usage: Voter search, roll number lookup, product search on e-commerce platform, price sorting, merit list generation, sort employee records by salary.			
Unit 3	**Linked Lists**	**9 Hrs.**	**CO3**
Definition and importance of data structures, Classification of data structures. Singly Linked List: Creation, insertion, deletion, traversal, searching, sorting. Doubly Linked List: Creation, insertion, deletion, traversal. Circular Linked List: Creation, insertion, deletion, traversal.			
Exemplars / Practical Applications and usage: Managing a music playlist, Browser History Navigation, undo/redo operations, Round-Robin Scheduling			
Unit 4	**Stacks and Queues**	**9 Hrs.**	**CO4**
Stack: Concept, implementation using arrays and linked lists, Stack operations- push, pop, peek, Conversion of infix to postfix expressions using stack, evaluation of postfix expression using stack, Applications of stack. Queue: Implementation using arrays and linked lists, Queue operations- enqueue, dequeue, peek. Types of queues- Circular queue, Priority Queue. Applications of Queue.			
Exemplars / Practical Applications and usage: Expression parsing, compiler design, calculators, Ticket counters, call center queues, print job management, CPU Job Scheduling			
Unit 5	**Trees and Graphs**	**9 Hrs.**	**CO5**
Trees: Terminology, binary trees, binary search trees (BST). Threaded binary tree, Tree traversals: In-order, Preorder, Post-order, AVL trees: Rotations and balancing. Graphs: Representations (adjacency matrix, adjacency list), Graph traversal algorithms: Breadth-First Search (BFS), Depth-First Search (DFS), Dijkstra's Shortest Path Algorithm, Minimum Spanning tree-Kruskal's Algorithm, Prim's Algorithm.			
Exemplars / Practical Applications and usage: Mapping systems (like Google Maps), social media connections, File system navigation, friend recommendation on social media, organizational charts, search engines, database indexing			
Course Project:			
Student shall do Mandatory Course Project in the companion course Data Structures and Algorithms Lab			

Textbooks:

1. E. Balagurusamy, "Object-Oriented Programming with C++", McGraw Hill.
2. Ellis Horowitz, Sartaj Sahni, "Fundamentals of Data Structures in C++", Orient Blackswan.
3. Yashavant Kanetkar, "Data Structures Through C++", BPB Publications.

Reference Books:

1. Robert Lafore, "Object-Oriented Programming in C++", Sams Publishing.
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Pearson.
3. BjarneStroustrup, "The C++ Programming Language", Addison-Wesley.
4. Yedidyah Langsam, Moshe J. Augenstein and Aaron M. Tenenbaum, "Data structures using C and C++",Pearson.

MOOCs Links and additional reading material:

1. Fundamentals of Programming C++ (Richard L. Halterman).
2. Data Structures and Algorithm Analysis in C++, 3rd Edition (Clifford A. Shaffer).
3. Data Structures And Algorithms, IIT Delhi, https://nptel.ac.in/courses/106102064
4. Introduction to Data Structures, https://onlinecourses.swayam2.ac.in/cec24_cs17/preview

Strength of CO-PO-PSO Mapping

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	-	-	-	2	-	1	3	3	1
CO2	3	2	1	2	2	-	-	-	2	-	1	3	3	1
CO3	3	2	1	2	2	-	-	-	2	-	1	3	3	1
CO4	3	2	1	2	2	-	-	-	2	-	1	3	3	1
CO5	3	2	1	2	2	-	-	-	2	-	1	3	3	1
Avg.	3	2	1	2	2	-	-	-	2	-	1	3	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE 1	08	08			
CCE 2			08	08	
CCE 3					08
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE					ESE				
	CCE1		CCE2		CCE3					
CO	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
L1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L4		✓					✓			
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses: 1. Object Oriented Programming 2. Database Management Systems (DBMS) 3. Computer Networks and Security 4. Software Engineering 5. Artificial Intelligence & Machine Learning 6. Web Technologies
Job Mapping: Job opportunities that one can get after learning this course: 1. Junior Programmer / Application Developer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			III
Course:	**Computer Organizaton and Operating Systems**			**Course Code:**			R25-EC-PCC-203
Teaching Scheme (Hrs. /Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
03	-	-	03	40	60	-	-

Course Description:

This course introduces the organization and operation of modern computer systems and operating systems. It covers processor architectures such as CISC, RISC and RISC-V, computer arithmetic, memory hierarchy, cache memory and modern storage systems. The course also explains input-output organization and high-speed data transfer techniques used in present-day computing systems.

The course further introduces system software components including assemblers, compilers, loaders and linkers, along with fundamental operating system concepts such as process management, CPU scheduling, synchronization and deadlock handling.

Relevance:

The knowledge and skills acquired serve as a basis for bridging the gap between physical hardware components and software execution, providing the foundation for all modern computing.

Prerequisite: Digital Logic, number Systems, basic C programming, basic Data Structures like stacks and queues.

Bridge Content: -

Course Objectives:

1. To understand the organization, operation and performance evaluation of modern computer architectures and processors.
2. To study memory hierarchy, cache organization and modern storage technologies used in computing systems.
3. To understand input-output organization and high-speed data transfer mechanisms in computer systems.
4. To explain the role of system software components such as assemblers, compilers, loaders and linkers in program execution.
5. To understand operating system concepts including process management, scheduling, synchronization and deadlock handling.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Explain** the organization, arithmetic operations and performance aspects of modern computer architectures and processors.	2
CO2	**Analyze** memory hierarchy, cache organization and storage architectures in computing systems.	3
CO3	**Analyze** input-output organization and high-speed data transfer techniques used in modern computer systems.	3
CO4	**Explain** the role and functioning of assemblers, compilers, loaders and linkers in program execution.	2
CO5	**Analyze** process management, synchronization and deadlock handling mechanisms in operating systems.	3

Course Content			
Unit 1	**Computer Architecture and Performance**	**9 Hrs.**	**CO1**
A top level view of Computer function and interconnection. Instruction execution cycle. Modern processor architectures: CISC, RISC, and RISC-V architectures, Multicore and heterogeneous processors, SIMD and GPU computing concepts, Processor performance evaluation: CPI, MIPS, FLOPS, benchmarking, Introduction to AI accelerators and Tensor Processing Units (TPUs). Computer Arithmetic: The Arithmetic and Logic Unit, addition and subtraction of signed numbers, adder and fast adder, carry look ahead addition, multiplication of positive numbers, signed operand multiplication, integer division. Floating point representation and operations: IEEE standard, arithmetic operations, guard bits and truncation.			
Exemplars / Practical Applications and usage: Personal Computers, mobile phone, Embedded processors.			
Unit 2	**Computer Memory System**	**9 Hrs.**	**CO2**
Characteristics of memory system, The memory hierarchy. Cache Memory: Cache memory principles, Elements of cache design- cache address, size, mapping functions, replacement algorithms, write policy, line size, number of caches, single-level and multi-level cache organization, Principle of locality (temporal and spatial locality). Internal Memory: Semiconductor main memory, advanced DRAM organization. External Memory: Hard Disk organization, SSD and NVMe storage architecture, Memory and storage considerations in AI and embedded systems.			
Exemplars / Practical Applications and usage: Gaming and browsers, Laptop storage, main memory in PCs and mobiles, Cloud storage systems.			
Unit 3	**Input Output System**	**9 Hrs.**	**CO3**
External devices, I/O modules - Module function and I/O module structure. Programmed I/O: overview, I/O commands, Interrupt driven I/O- interrupt processing, design issues. Direct Memory Access: Drawbacks of programmed and interrupt driven I/O, Embedded I/O, DMA and high-speed data transfer techniques, USB, PCIe, SATA and NVMe interfaces.			
Exemplars / Practical Applications and usage: USB controller, network interface card, Embedded systems, microcontrollers, network communication.			
Unit 4	**Introduction to System Programming**	**9 Hrs.**	**CO4**
Introduction: Components of System Software, Language Processing Activities, Fundamentals of Language Processing. Assemblers: Elements of Assembly language programming. Simple assembler scheme, Structure of an assembler. Macro Definition, Macro Call and Macro Expansion. Compilers: Basic compiler function, Phases of compilation. Loaders: Loader Schemes: Compile and go, General Loader Scheme, Absolute loaders, subroutine linkages, relocating loaders, direct linking loaders. Linkers: Relocation and linking concepts, Static and dynamic linker.			
Exemplars / Practical Applications and usage: Operating systems, compilers, assemblers, Compiler design, code translation, embedded systems.			

Unit 5	Introduction to Operating System and Process Management	9 Hrs.	CO5

Introduction to OS: Architecture, Goals and Structures of O.S, Basic functions, Interaction of O.S. and hardware architecture, System calls, Batch, multi-programming. Multitasking, time sharing, distributed and real-time O.S.

Process Management: Concept, Process states, Process control, Threads. Scheduling: Types of scheduling, Scheduling algorithms. Concurrency: Inter-process communication, Mutual Exclusion, Semaphores, Classical Problems of Synchronization: Readers-Writers, Producer Consumer, and Dining Philosopher problem. Deadlock: Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection.

Exemplars / Practical Applications and usage:

Windows, Linux, Android, Payroll system, ATM machine, traffic control system, Supercomputer, Google Cloud, Online banking transaction.

Course Projects:

Textbooks:

1. W. Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson, 2015.
2. D.A. Patterson and J.L. Hennessy, "Computer Architecture: A Quantitative Approach, 5/E", Morgan Koffman, 2011.
3. D.A. Patterson and J.L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface, 5/E", Elsevier India, 2016.
4. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization, 5/E", McGraw Hill, 2011.

Reference Books:

1. A. Tanenbaum, "Structured Computer Organization", Prentice Hall of India, 1991, 4th Edition
2. J.P. Hayes, "Computer Architecture and Organization, 3/E", McGraw Hill, 1998.

MOOCs Links and additional reading material:

1. https://www.coursera.org/specializations/codio-introduction-operating-systems
2. Computer architecture and organization https://onlinecourses.nptel.ac.in/noc21_cs61/preview
3. NOC: Operating System Fundamentals, IIT Kharagpur https://nptel.ac.in/courses/106105214

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	-	-	-	-	-	-	2	2	1
CO2	3	3	3	2	2	-	-	-	-	-	-	2	3	2
CO3	3	2	3	2	3	-	-	-	-	-	-	2	3	3
CO4	2	3	2	2	2	-	-	-	1	-	-	3	2	2
CO5	2	3	2	3	2	-	-	-	1	-	-	3	2	3
Avg.	2.6	2.8	2.4	2.0	2.2	-	-	-	0.4	-	-	2.4	2.4	2.2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE 1	08	08			
CCE 2			08	08	
CCE 3					08
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE					ESE				
	CCE1		CCE2		CCE3					
CO	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
L1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L3		✓	✓		✓		✓	✓		✓
L4										
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:

- Database Management Systems
- Embedded Systems & Edge Computing
- Microcontroller Applications
- Cloud Computing

Job Mapping:
Job opportunities that one can get after learning this course:

- System Software Engineer
- Operating System Developer
- Computer Architecture Engineer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**		III	
Course:	**Fundamentals of IoT**			**Course Code:**		R25-EC-MDM-204	
Teaching Scheme (Hrs. /Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
03	-	-	03	40	60	-	-

Course Description:

The Fundamentals of IoT course introduces students to the core concepts, technologies, and applications that form the basis of the Internet of Things (IoT) ecosystem. It begins with an understanding of the evolution of IoT, embedded systems, and microcontroller fundamentals, laying a strong foundation for modern connected systems. The course explores essential hardware components such as sensors, actuators, and transducers, along with IoT architectural elements that enable real-time data acquisition and system interaction. It equips students with practical insights into IoT communication technologies, data management, cloud computing, and security challenges**,** which are crucial for designing scalable and reliable IoT solutions.

Course Relevance:

The Fundamentals of IoT course is highly relevant in the current digital era, where interconnected devices and intelligent systems are transforming industries and everyday life. This course provides essential knowledge of microcontrollers, embedded systems, sensors, communication protocols, and IoT architectures**,** forming the foundation for understanding smart and connected environments.

Prerequisite: Microcontroller, DTL

Bridge Content:

Course Objectives:

1. To understand the basics of IoT, embedded systems, and architecture**.**
2. To learn sensors, communication protocols, and networking concepts**.**
3. To gain knowledge of IoT security, data management, and cloud computing**.**
4. To apply IoT concepts in real-world smart applications.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Explain** the fundamentals of IoT, embedded systems, and their evolution.	2
CO2	**Identify** and **describe** IoT architecture, sensors, actuators, and their working principles.	2
CO3	**Apply** IoT communication protocols and networking technologies in practical scenarios.	3
CO4	**Analyze** security challenges, privacy issues, and solutions in IoT systems.	4
CO5	**Implement** data management and cloud computing concepts for IoT application.	3

Course Content

Unit 1	**Fundamentals of IoT**	**9 Hrs.**	**CO1**

Introduction to Microcontroller, Microprocessor and Embedded System with its characteristics, Definition and fundamentals of IoT, Historical background and evolution, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Logical Design of IoT.

Exemplars / Practical Applications and usage:

Enables real-time data collection, remote monitoring, and intelligent decision-making through connected devices and sensors.

Unit 2	Internet of Everything (IoE)/ Things in IoT	9 Hrs.	CO2
Architecture of IoT and its characteristics, Sensors and Transducers, Types of Sensors, Working principle and functionality of Light Dependent Resistor (LDR), LM35, Temperature and Humidity Sensor (DHT11), Infrared Senor (IR), Ultrasonic Sensor, Challenges and Advancement in Sensor technology, Actuator.			
Exemplars / Practical Applications and usage: IoT architectures enable real-time data sensing, actuator control, and smart automation in homes, industries, and agriculture.			
Unit 3	**IoT Communication Protocol**	**9 Hrs.**	**CO3**
Introduction to IoT networking: Gateways and routing, Universal Asynchronous Receiver and Transmitter (UART), Serial Peripheral Interface (SPI), Inter-Integrated Circuit (I2C), Synchronous Serial Port (SSP), IEEE 802.15.4, Modbus, HART, Zigbee, Bluetooth, LoRaWAN.			
Exemplars / Practical Applications and usage: Communication protocols enable reliable data exchange between IoT devices and controllers.			
Unit 4	**IoT Challenges and Security**	**9 Hrs.**	**CO4**
Key Issues and Challenges in implementing IoT solutions, IoT Security and privacy concerns: Security Requirements, Challenges for Secure IoT, Key elements of IoT Security: Identity establishment, Access control, Data and message security, Scalability and interoperability issues.			
Exemplars / Practical Applications and usage: Techniques like authentication, access control, and data encryption ensure secure and reliable IoT communication.			
Unit 5	**IoT Data Management and Cloud Computing**	**9 Hrs.**	**CO5**
Data Management: Importance of data management in IoT, Overview of IoT data lifecycle, Types of data, Big Data (BD), Characteristics of Big data. Cloud Computing: Introduction to Cloud Computing, characteristics, Cloud types: IaaS, PaaS, SaaS, Public cloud, Private cloud, Benefits and challenges of cloud computing.			
Exemplars / Practical Applications and usage: Used for storing, processing, and analyzing large volumes of IoT data in real time.			
Textbooks:			
1. Arshdeep Bahga, Vijay Madisetti, Internet of Things, A hands-on approach, Universities Press, 2015. 2. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education, 2017. 3. Sudip Misra, Chandana Roy, Anadarup Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0, CRC Press, 1st Edition,2021.			
Reference Books:			
1. Olivier Hersent, David Boswarthick, and Omar Elloumi," The Internet of Things: Key Applications and Protocols", Wiley Publications, 1st Edition. 2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press. 3. Adrian McEwen, Designing the Internet of Things, Wiley, 2013.			
MOOCs Links and additional reading material:			
1. Introduction of IoT: https://nptel.ac.in/courses/106105166 2. Internet of Things: Design Concepts and Use Cases: https://onlinecourses.swayam2.ac.in/ntr24_ed01/preview?			

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3. Design for Internet of things: https://nptel.ac.in/courses/108108098
4. Sensors and Actuators: https://nptel.ac.in/courses/108108147

Strength of CO-PO-PSO Mapping

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	-	-	-	-	-	2	1	1
CO2	3	2	2	-	2	-	-	-	-	-	-	3	2	2
CO3	2	3	3	2	3	-	-	-	-	-	-	3	3	3
CO4	2	3	2	3	2	-	-	-	-	-	-	2	2	3
CO5	2	2	3	2	3	-	-	-	-	-	-	3	3	3
Avg.	2.4	2.4	2	1.4	2.2	-	-	-	-	-	-	2.6	2.2	2.4

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE 1	08	08			
CCE 2			08	08	
CCE 3					08
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE					ESE				
	CCE1		CCE2		CCE3					
CO	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
L1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L3			✓	✓	✓			✓	✓	✓
L4				✓					✓	
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:

1. Programming for IoT Systems
2. Embedded Systems & Edge Computing
3. IoT for Smart Agriculture
4. Introduction to Industry 4.0 and Industrial Internet of Things

Job Mapping:

Job opportunities that one can get after learning this course:

1. Entry-level roles in IoT, Embedded systems, networking, and data-driven domains.
2. The knowledge gained supports various technical job roles across industries such as smart manufacturing, healthcare, smart cities, and automation.

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			III
Course:	**Financial Planning, Taxation and Investment**			**Course Code:**			R25-EC-EEM-206
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
01	02	-	02	25	-	25	-

Course Description:

This course provides a comprehensive understanding of financial management, investment analysis, taxation, and personal finance essential for engineering students. It introduces key financial concepts such as time value of money, financial decision-making, and budgeting. Students learn to evaluate investment avenues, analyze risk–return, and apply techniques like NPV and IRR for appraisal. By the end of the course, learners gain practical financial literacy required for professional and real-life decision-making.

Relevance:

This subject provides engineering students with essential financial knowledge for both professional and personal decision-making. It builds skills in investment analysis, tax management, and financial planning for real-life situations. Overall, it enhances financial literacy for better career and lifelong financial decisions.

Prerequisite: Students should have basic mathematical skills and an understanding of fundamental economic concepts. Familiarity with simple calculations, percentages, and logical reasoning is helpful.

Bridge Content: Revision of basic mathematical tools like percentages, simple & compound interest, and logical reasoning used in financial calculations and time value of money.

Course Objectives:

1. To introduce students to the fundamental concepts, objectives and functions of financial management.
2. To develop understanding of personal financial planning process, emergency fund creation, risk management and basics of insurance to achieve individual financial goals.
3. To provide basic knowledge of Indian taxation structure including direct vs. indirect taxes, income heads, deductions, tax slabs and introduction to GST and ITR filing.
4. To acquaint students with various investment vehicles, risk-return analysis, investment criteria and portfolio creation while developing awareness about mis-selling in investment products.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Explain** the objectives of financial management and classify different types of financial decisions like investment, financing and dividend decisions, and apply cost-benefit analysis for financial planning	2
CO2	**Prepare** a basic personal financial plan considering life cycle stages, CTC structure, savings, and demonstrate knowledge of emergency fund & insurance for salaried professionals	3
CO3	**Differentiate** between direct and indirect taxes, identify various income heads and deductions u/s 80C, 80D	4
CO4	**Compare** different investment options like Equity, MF, FD, Gold, Crypto based on liquidity, safety & profitability, and construct a basic investment portfolio using SIP, STP, SWP strategies	4

Course Content			
Unit 1	**Financial Management**	**3 Hrs.**	**CO1**
Introduction to Financial Management, Objectives & Functions of Financial Management, Types of Financial Decisions: Investment Decision, Financing Decision, Dividend Decision, Sources of Finance: Short-term & Long-term, Financial Planning & Budgeting. Cost–Benefit Analysis (CBA).			
Exemplars / Practical Applications and usage: Case study on startup funding: Students analyze investment, financing & dividend decisions for a tech startup using cost-benefit analysis to select between equity vs debt.			
Unit 2	**Basics of Personal Finance**	**4 Hrs.**	**CO2**
Understanding Personal Finance. Rewards of Sound Financial Planning. Personal Financial Planning Process. Personal Financial Planning Life Cycle. Making Plans to Achieve Your Financial Goals. Common Misconceptions about Financial Planning, Emergency Fund & Risk Management, Basics of Insurance (Life & Health), Financial Planning for Salaried Professionals (CTC structure, deductions, savings)			
Exemplars / Practical Applications and usage: Personal finance plan for fresh graduate: Break down sample CTC of ₹6 LPA, calculate in-hand salary, plan emergency fund & select term + health insurance using life-cycle approach.			
Unit 3	**Overview of Indian Tax System**	**4 Hrs.**	**CO3**
Direct vs Indirect Taxes, Basics of Income Tax, Income Heads (Salary, House Property, Capital Gains, Other Sources), Deductions under sections (80C, 80D, etc.), Tax Slabs (Old vs New Regime), Introduction to GST (Concept & Structure), Filing of Income Tax Return (basic understanding)			
Exemplars / Practical Applications and usage: ITR filing simulation: Using sample Form-16, students identify income heads, compute taxable income with 80C/80D deductions, and compare tax liability under Old vs New regime.			
Unit 4	**Investment Planning**	**4 Hrs.**	**CO4**
Introduction to Investment Planning, Investment Criteria- liquidity, safety and Profitability, Investment vehicles (Gold, Bonds, Equity, FD, Insurance, MFs, ETFs, Post Office Savings, Real Estate etc.), Risk and Return associated with these investments, Return comparison over a period of time from different asset classes, Investment strategies, Mutual Funds as Investment Vehicle-Special focus on SIP, STP, and SWP, NFOs, Trading in Commodities, Derivatives and F&Os, Crypto currency, Creating an Investment Portfolio, Awareness of mis-selling in investment products.			
Exemplars / Practical Applications and usage: Portfolio construction: Compare 5-year returns of FD, Gold, Nifty-50 ETF & Mutual Fund; build ₹10,000/month SIP portfolio for 3 financial goals using STP/SWP strategy.			
Course Projects:			
1. Create a complete financial plan for a 22-year-old ECE engineer with first job offer of ₹6 LPA CTC in Bangalore. 2. You are CFO of a student IoT startup. Plan funding, budgeting & founder's personal investments after Series-A of ₹50 Lakhs.			
Textbooks:			
1. Prasanna Chandra – Financial Management: Theory and Practice, McGraw Hill. 2. I.M. Pandey – Financial Management, Vikas Publishing. 3. Rustagi R.P. – Fundamentals of Financial Management, Taxmann Publications. 4. Sanjeev Verma – Wealth Management and Financial Planning, Pearson. 5. V.K. Singhania & Monica Singhania – Direct Taxes: Law & Practice, Taxmann. 6. Mehrotra & Goyal – Indirect Taxes (GST), Sahitya Bhawan.			
Reference Books:			
1. Eugene F. Brigham & Joel F. Houston – Fundamentals of Financial Management, Cengage Learning. 2. Gitman & Zutter – Principles of Managerial Finance, Pearson.			

3. Bodie, Kane & Marcus – Investments, McGraw Hill.
4. Sharpe, Alexander & Bailey – Investments, Prentice Hall.
5. Herbert B. Mayo – *Investments: An Introduction*, Cengage.
6. T.S. Reddy & Y. Hari Prasad Reddy – *Financial Management*, Himalaya Publishing.
7. Dr. B.P. Tyagi – Fundamentals of Financial Management, Taxmann.
8. Dr. H.C. Mehrotra & Dr. V.P. Agarwal – Income Tax Law and Practice, Sahitya Bhawan.
9. V.S. Datey – Students' Guide to GST, Taxmann.

MOOCs Links and additional reading material:

1. Open Tuition (Free Finance & Taxation Lectures / Materials) – Free e-books and lessons on financial management & taxation. Wikipedia
2. HP LIFE Finance Courses – Free basics of finance, cash flow, profit/loss and funding insights. HP LIFE: Finance Courses Online Finance Courses – HP LIFE Free Online
3. Corporate Finance (IIM Bangalore) – Online course on time value of money, NPV, IRR, bonds & stocks fundamentals.
4. IIMB: Corporate Finance Course Corporate Finance – IIM Bangalore Online Course
5. Income Tax Swayam Content – Basic Indian income tax theory and practice material. SWAYAM Income Tax: Income Tax Course (Preview) Income Tax Course Preview Swayam2.ac.in

List of Practical: (Any Eight)

Experiment No. 1	**Capital Budgeting using Cost-Benefit Analysis**	**02 Hrs.**	**CO1**

Objective:

- To apply cost-benefit analysis for evaluating investment decisions in a business scenario.

Associated Tasks:

1. Given 2 project options for a college lab upgrade – Option A: 3D Printer ₹2L, Option B: IoT Kits ₹1.5L. Students calculate NPV, payback period and select best option using CBA template.

Exemplars and Utility:

For Option A, NPV = ₹2.8L, Payback = 2.1 years vs Option B NPV = ₹1.9L, Payback = 3 years. Decision: Select Option A due to higher NPV despite higher cost.

Experiment No. 2	**Sources of Finance – Case Analysis**	**02 Hrs.**	**CO1**

Objective:

- To classify short-term vs long-term sources of finance and justify financing decisions for a startup.

Associated Tasks:

1. Analyze case of ECE student startup needing ₹10L. Identify 3 short-term & 3 long-term sources. Prepare financing mix with justification of interest cost & risk.

Exemplars and Utility:

40% Bank loan @9% = long-term, 30% Trade credit = short-term, 30% Angel equity. Justification: Keeps EMI low, maintains ownership >70%.

Experiment No. 3	**Personal Monthly Budget Preparation**	**02 Hrs.**	**CO2**

Objective**:**

- To prepare a realistic monthly budget for a salaried professional using 50-30-20 rule

Associated Tasks:

1. Use sample CTC ₹6 LPA. Calculate in-hand salary, deduct EPF, TDS. Allocate expenses: 50% needs, 30% wants, 20% savings. Build Excel tracker.

Exemplars and Utility:

In-hand ₹42,000. Needs ₹21,000: Rent, food. Wants ₹12,600: OTT, travel. Savings ₹8,400: SIP +

Emergency fund. Shortfall areas identified.

Experiment No. 4	**Emergency Fund & Insurance Planning**	**02 Hrs.**	**CO2**

Objective:

- To determine adequate emergency fund size and select appropriate term + health insurance.

Associated Tasks:

- For 25-yr engineer with ₹35k monthly expense & 2 dependents, calculate 6-month emergency fund. Compare 3 term plans + 2 health plans for coverage, premium & claim ratio.

Exemplars and Utility:

Emergency fund = ₹2.1L in liquid fund. Selected: ₹1Cr term @₹8k/yr + ₹5L family floater @₹12k/yr based on 99.5% claim ratio.

Experiment No. 5	**Income Tax Calculation for Salaried Individual**	**02 Hrs.**	**CO3**

Objective:

- To compute taxable income and tax liability under Old vs New regime using Form-16 data.

Associated Tasks:

1. Given Form-16: Gross Salary ₹8L, HRA, 80C ₹1.5L, 80D ₹25k. Calculate tax under both regimes using latest slabs. Recommend better regime.

Exemplars and Utility:

Old Regime Tax = ₹33,800 with deductions. New Regime Tax = ₹41,600 with no deductions. Savings = ₹7,800. Recommend Old Regime.

Experiment No. 6	**Tax Saving Options Case Study**	**02 Hrs.**	**CO3**

Objective:

- To evaluate deductions u/s 80C, 80D, 80E and prepare tax saving investment plan.

Associated Tasks:

1. Case: Engineer, 27 yrs, ₹9 LPA, no savings yet. Identify ₹1.5L 80C + ₹25k 80D + ₹50k NPS options. Compare ELSS vs PPF vs NPS for lock-in, returns, risk.

Exemplars and Utility:

Selected: ₹50k ELSS, ₹70k PPF, ₹30k NPS, ₹25k health insurance. Total tax saved = ₹46,800. ELSS chosen for 3-yr lock-in + equity returns.

Experiment No. 7	**Comparison of Investment Options**	**02 Hrs.**	**CO4**

Objective:

- To compare risk, return, liquidity & safety of 5 asset classes for goal-based investing.

Associated Tasks:

1. Create comparison table for FD, Gold, Nifty-50 ETF, Debt MF, Crypto using 10-yr CAGR, liquidity in days, risk level. Rank for 3-yr goal.

Exemplars and Utility:

For 3-yr car goal: Debt MF > FD > Gold > ETF > Crypto. Debt MF: 7% return, T+1 liquidity, low risk. Crypto rejected due to high volatility.

Experiment No. 8	**Basic Portfolio Creation for Young Professional**	**02 Hrs.**	**CO4**

Objective:

- To construct a diversified SIP portfolio using asset allocation based on age & risk profile.

Associated Tasks:

1. Age 24, moderate risk, ₹10k/month SIP, 10-yr horizon for MBA. Use SIP + STP. Allocate: 60% Equity MF, 25% Debt, 10% Gold ETF, 5% Emergency liquid. Show projected corpus.

Exemplars and Utility:

₹10k SIP → 60% Large-cap, 25% Short-term debt, 10% Gold, 5% Liquid. Projected corpus @11% XIRR = ₹21.8L in 10 years. Rebalancing rule: yearly.

Experiment No. 9	**Detecting Mis-selling & Calculating Real Returns using XIRR**	**02 Hrs.**	**CO4**

Objective:

- To identify mis-selling in investment products and compute actual returns using XIRR for SIP/STP/SWP transactions.

Associated Tasks:

1. Given 2 brochures – 1 ULIP vs 1 Equity Mutual Fund. Students list all charges: premium allocation, admin, mortality, fund mgmt. Then use Excel XIRR on 3-year SIP cash flows for both to find real CAGR. Compare with advertised return.

Exemplars and Utility:

ULIP: Advertised 12%, but after charges XIRR = 6.8% due to 5% premium allocation + 2.25% admin charges. Equity MF: Advertised 12%, XIRR = 11.3% with only 1% expense ratio. Decision: MF selected. Mis-selling flag: "Guaranteed returns" in ULIP brochure violates IRDAI norms.

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	1	-	1	1	1	3	-	-	-
CO2	-	-	-	-	-	2	1	3	2	3	-	-	-	-
CO3	-	-	-	-	-	3	-	3	1	2	2	-	-	-
CO4	-	-	-	-	-	2	2	3	3	2	3	-	-	-
Avg.	-	-	-	-	-	2	0.75	2.5	1.75	2	2.75	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4
CCE 1	6			
CCE 2		6		
CCE 3			7	
CCE 4				6
TW	7	6	6	6
Total	13	12	13	12

Assessment Pattern

BT Level	CCE			
	CCE1	CCE2	CCE3	CCE4
CO	CO1	CO2	CO3	CO4
L1	✓	✓	✓	✓
L2	✓	✓	✓	✓
L3		✓	✓	✓
L4			✓	✓
L5				
L6				

BT Level	TW based on ARCV							
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8
CO	CO1	CO1	CO2	CO2	CO3	CO3	CO4	CO4
L1	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓
L3			✓	✓	✓	✓	✓	✓
L4					✓	✓	✓	✓
L5								
L6								

This course serves as a prerequisite for / maps with the following future courses:
-

Job Mapping:
Job opportunities that one can get after learning this course:

1. Financial Analyst / Investment Analyst
2. Tax Consultant / Accounts Executive
3. Personal Financial Planner / Wealth Manager
4. Banking Associate / Loan Officer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**	III		
Course:	**Universal Human Values and Ethics**			**Course Code:**	R25-EC-VEC-207		
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
02	-	-	02	50	-	-	-

Course Description: This course covers universal human values & professional ethics.

Universal human values: These are fundamental principles that transcend cultural, religious, and geographical boundaries, guiding human behavior and interactions. They include Truth, Non-violence, Compassion, Justice and Peace

Professional Ethics: This refers to the moral principles and rules that govern the conduct of individuals and organizations in specific professions. It ensures that professionals act with integrity, accountability, and responsibility like interconnectedness and implications

Course Relevance: To effectively integrate universal human values and professional ethics, several prerequisites are crucial. These include understanding the core concepts of human values, self-exploration, and the importance of harmony within oneself and with others. Additionally, a willingness to learn, critically evaluate, and apply these principles in various contexts is essential.

Prerequisite: --

Bridge Content: --

Course Objectives:

1. To develop a holistic, humane world-vision, and appreciate the essential complementarities between values and skills to ensure mutual happiness and prosperity
2. To elaborate on 'Self-exploration' as the process for Value Education
3. To understand the harmony at various levels starting from self and going towards family and society.
4. To elaborate on the salient aspects of harmony in nature and the entire existence
5. To explain how the Right understanding forms the basis of Universal human values and definitiveness of Ethical human conduct.
6. To provide the vision for a holistic way of living and facilitate transition from chaotic life to an orderly life.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Recognize** the concept of self-exploration as the process of value education and see they have the potential to explore on their own right. .	2
CO2	**Explore** the human being as the coexistence of self and body to see their real needs/basic aspirations clearly	2
CO3	Facilitate the **understanding** of harmony at various levels starting from self and going towards family, society & nature	2
CO4	**Provide** the vision for a holistic way of living and facilitate transition from chaotic life to an orderly life.	3

Course Content

Unit 1	**Introduction to Value Education**	**7 Hrs.**	**CO1**

Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity-the Basic Human Aspirations and their Fulfillment ,Right Understanding, Relationship and Physical Facility Happiness and Prosperity-Current Scenario , Method to Fulfill the Basic Human Aspirations.

Activities: Sharing about Oneself, Exploring Human Consciousness, Exploring Natural Acceptance

Exemplars / Practical Applications and usage:- Morning Assemblies- inspirational speeches, Role-Playing and Simulations- ethical dilemmas to teach decision-making			
Unit 2	**Harmony in the Human Being**	**8 Hrs.**	**CO2**
Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self , Understanding Harmony in the Self , Harmony of the Self with the Body, Programme to Ensure self-regulation and Health **Activities:** Exploring the difference of Needs of Self and body, Exploring Sources of Imagination in the Self, Exploring Harmony of Self with the body			
Exemplars / Practical Applications and usage:- Self-regulation-Cultivating a sense of responsibility in the self, Conscious Eating- Eating food based on the body's hunger and nutritional needs, Handling Conflict-understand the situation and responds calmly.			
Unit 3	**Harmony in the Family, Society and Nature(Existence)**	**7 Hrs.**	**CO3**
Harmony in the Family - the Basic Unit of Human Interaction "Trust' - the Foundational Value in Relationship, Respect- as the Right Evaluation, Values in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order, Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at all Levels **Activities:** Exploring the Feeling of trust, Exploring the Feeling of Respect, Exploring the Four Orders of Nature, Exploring Co-existence in existence.			
Exemplars / Practical Applications and usage:- Shared Responsibility-Distributing household chores and financial responsibilities, Volunteering-Contributing skills or time to local NGOs, schools, or supporting the elderly, fostering a feeling of trust, Regenerative Agriculture- Farming techniques that restore soil health rather than depleting it.			
Unit 4	**Implications of the Holistic Understanding – A Look at Professional Ethics**	**8 Hrs.**	**CO4**
Basis for Universal Human Values, Definitiveness of (Ethical) Human Conduct, Professional Ethics in the Light of Right Understanding, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession **Activities**: Exploring Ethical Human Conduct, Exploring Humanistic Models in Education, Exploring Steps of Transition towards Universal Human Order			
Exemplars / Practical Applications and usage:- Honesty- Being honest and transparent in dealings, Respect- Treating colleagues and clients with dignity, Fairness- Making decisions without favoritism.			
Textbooks:			
1. A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-7-3 (Printed Copy), 978-81- 957703-6-6 (e-book) 2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-5-9 (Printed Copy), 978-81-957703-0-4 (e-Book)			
Reference Books:			
1. P.L.Dhar, R. R. Gaur, 1990, Science and Humanism, Common Wealth Publishers. 2. A. Nagaraj, 1999, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak			

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3. B.P.Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
4. A.N.Tripathy, 2003, Human Values, New Age International Publishers.
5. E.G.Seebauer & Robert L.Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press
6. B.L.Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
7. M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.
8. M.K.Gandhi,"The Story of my Experiments with Truth", Discovery Publisher

MOOCs Links and additional reading material:

1. Swayam Course on"Understanding Human Being Nature and Existence Comprehensively" by Dr. Kumar Sambhav, Director, UP Institute of Design (UPID), Noida. https://onlinecourses.swayam2.ac
2. NPTEL Course on "Exploring Human Values: Visions of Happiness and Perfect Society" by Prof. A. K.Sharma, Department of Humanities and Social Sciences, IIT Kanpur. https://nptel.ac.in/courses/

E-Resources:-

1. https://fdp-si.aicte-india.org/download.php#1/
2. https://madhyasth-darshan.info/postulations/knowledge/knowledge-of-humane-conduct/
3. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

Strength of CO-PO-PSO Mapping

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	3	2	2	1	2	-	-	-
CO2	-	-	-	-	-	2	3	1	2	1	2	-	-	-
CO3	-	-	-	-	-	2	3	3	3	1	2	-	-	-
CO4	-	-	-	-	-	2	3	3	3	2	2	1	-	-
Avg.	-	-	-	-	-	2	3	2.25	2.5	1.25	2	0.25	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4
CCE 1	13			
CCE 2		12		
CCE 3			13	
CCE 4				12
ESE				
Total	13	12	13	12

Assessment Pattern:

BT Level	CCE			
	CCE1	CCE2	CCE3	CCE4
CO	CO1	CO2	CO3	CO4
L1	✓	✓	✓	✓
L2	✓	✓	✓	✓
L3				✓
L4				
L5				
L6				

This course serves as a prerequisite for / maps with the following future courses: -
Job Mapping:- Job opportunities that one can get after learning this course: -

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			III
Course:	**Analog and Digital Electronic Circuits Lab**			**Course Code:**			R25-EC-PCC-208
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
-	02	-	01	-	-	25	25

Course Description: This laboratory course provides practical exposure to the analysis, design, implementation, and testing of analog and digital electronic circuits. Students perform experiments on MOSFET amplifiers, feedback circuits, operational amplifier applications, DACs, combinational and sequential logic circuits, shift registers, and counters. The course emphasizes circuit realization, testing procedures, simulation, performance verification, and interpretation of results using modern electronic instruments and software tools.

Relevance: This course bridges theoretical electronic circuit concepts with practical implementation skills essential for electronics engineering. It develops the ability to design, analyze, troubleshoot, and validate analog and digital systems, which are fundamental for embedded systems, communication electronics, control systems, VLSI, and hardware development.

Prerequisite:

Basic Electronics, Semiconductor Devices, Electronic Circuit Analysis, Logic Gates and Boolean Algebra, Number Systems, and familiarity with basic simulation tools such as Multisim / LTspice.

Bridge Content: -

Basic Electronics, Semiconductor Devices, Network Theory, Logic Gates, Number Systems, Boolean Algebra, and Basic Circuit Simulation.

Course Objectives:

1. To design, build, and test MOSFET amplifier circuits and analyze their performance.
2. To understand feedback amplifier circuits and evaluate their characteristics.
3. To design and implement OP-AMP-based analog circuits for practical applications.
4. To design and verify digital combinational and sequential circuits.
5. To analyze, implement, and validate digital storage and counting circuits using standard ICs.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Design**, construct, and **analyze** MOSFET amplifier circuits and verify their performance characteristics.	4
CO2	**Design** and test feedback amplifier circuits and evaluate gain, resistance, and bandwidth.	4
CO3	**Design**, **implement**, and **test** OP-AMP-based analog circuits and DAC applications.	4
CO4	**Design** and **implement** combinational and sequential digital circuits using logic ICs.	4
CO5	**Analyze** and **validate** shift register, and counter circuits through hardware implementation.	4

List of Practical: (Any 08) **Group A [Any 4 to be performed]** (Two practical's performed on Simulation)			
Experiment No.1	**Design, build and test DC circuit for single stage CS amplifier and verify DC operating point.**	**02 Hrs.**	**CO1**

Objective:

- To understand the EMOSFET amplifier and ability to design the amplifier circuit .

Associated Tasks:

1. Define Design Requirements- Select MOSFET type (NMOS), Choose supply voltage VDD, Drain current ID, Drain–source voltage VDS, Ensure MOSFET operates in saturation region.
2. Design Circuit (DC Biasing) - Design gate voltage divider (R1,R2) to set VG, Calculate: Drain resistor RD, Source resistor RS, Use MOSFET DC equation to find: VGS, ID
3. DC Analysis (Theoretical) - Apply KVL and KCL, Calculate: VG, VS, VD.
4. Circuit Construction.
5. Experimental Testing- Measure DC operating parameter.
6. Verification of DC Operating Point - Compare Theoretical vs Experimental values, Confirm MOSFET operate in active (saturation) region.
7. Result Analysis

Exemplars and Utility:

Voltage amplification, Audio pre-amplifiers, Sensor signal conditioning, Analog IC building blocks.

Experiment No.2	**Design, build & test single stage CS amplifier, plot frequency response. Calculate Av, Ri, Ro & bandwidth.**	**02 Hrs.**	**CO1**

Objective:

- To understand the EMOSFET amplifier and ability to design the amplifier circuit.

Associated Tasks:

1. Assemble the CS amplifier.
2. Apply a small AC input.
3. Measure input and output voltages.
4. Sweep frequency from 10 Hz to 1 MHz.
5. Note gain at each frequency.
6. Plot Gain (dB) vs Frequency (log scale)
7. AC Analysis (Theoretical Calculations) - Voltage Gain Av, Input Resistance Ri, Output Resistance Ro, Bandwidth.

Exemplars and Utility:

Audio pre-amplifiers, Signal conditioning circuits¸ Communication systems.

Experiment No.3	**Design, build & test current series feedback amplifier & measure Rif, Rof, Avf & bandwidth.**	**02 Hrs.**	**CO2**

Objective:

- To understand the principle of current-series (series–series) feedback amplifier and to design, construct and test the circuit while measuring input resistance Rif, output resistance Rof, voltage gain with feedback Avf, and bandwidth.

Associated Tasks:

1. Define Design Requirements - Study the concept of negative feedback in amplifiers, Understand the current-series feedback topology, Select MOSFET and supply voltage
2. Circuit Design - Design a CE amplifier with feedback resistor in the emitter path, Select suitable values of biasing resistors, collector resistor RC, emitter resistor RE and coupling capacitors, Incorporate feedback network for current-series feedback.
3. Theoretical Analysis - Calculate voltage gain with feedback Avf, Determine input resistance Rif

and output resistance Rof theoretically, Estimate expected bandwidth of the amplifier.

4. Circuit Construction - Implement the designed circuit on breadboard/trainer kit/ Multsim software, Connect signal generator, power supply, and CRO/DSO.
5. Experimental Testing - Apply a sinusoidal input signal, Measure input voltage and output voltage.
6. Measurement of Parameters - Calculate voltage gain with feedback, Measure input resistance Rif and output resistance Rof using appropriate methods, Determine bandwidth by measuring lower and upper cut-off frequencies
7. Verification and Observation - Compare theoretical and experimental values of gain, resistances, and bandwidth.
8. Result Analysis - Analyze the effect of negative feedback on gain, bandwidth, and stability of the amplifier.

Exemplars and Utility:

Audio amplifiers, Communication systems, Signal conditioning circuits, analog electronic circuit design, and Stability improvement in amplifier systems.

Experiment No.4	**Design, build & test integrator using Op-amp for given frequency fa and plot frequency response.**	**02 Hrs.**	**CO3**

Objective:

- To understand the applications of op-amp and ability to design of opamp based circuits .

Associated Tasks:

1. Build the circuit, experimentally observe output waveform.
2. Vary frequency.
3. Measure gain Vo/Vi at each frequency.
4. Plot Gain (dB) vs Frequency (log scale)

Exemplars and Utility:

Analog computers, Signal conditioning, Ramp and triangular waveform generation, Control systems, Active filters.

Experiment No.5	**Design, build & test Schmitt trigger using Op-Amp.**	**02 Hrs.**	**CO3**

Objective:

- To understand the applications of op-amp and ability to design of opamp based circuits .

Associated Tasks:

1. Identify all required components.
2. Draw the circuit diagram.
3. Apply sine wave input and observe output on CRO
4. Measure switching voltages using CRO - Upper Threshold Voltage (UTP), Lower Threshold Voltage (LTP).

Exemplars and Utility:

Wave shaping circuits, Zero-crossing detectors, Signal conditioning, Pulse generation.

Experiment No.6	**To design, build & test 2-bit, 3-bit, or 4-bit R-2R ladder DAC.**	**02 Hrs.**	**CO3**

Objective:

- To understand the working principle of a Digital-to-Analog Converter (DAC) using an R-2R ladder network and to design, construct, and test a 2-bit, 3-bit, or 4-bit R-2R ladder DAC and verify the analog output for different digital inputs.

Associated Tasks:

1. Define Design Requirements - Study the concept of Digital-to-Analog Conversion (DAC),

Understand the operation of the R-2R ladder network, Select appropriate resistor values R and 2R, Choose reference voltage Vref.

2. Circuit Design - Design the R-2R ladder network for 2-bit / 3-bit / 4-bit inputs, Connect digital inputs through switches or logic inputs, Use an operational amplifier as a summing amplifier for output conversion.
3. Theoretical Analysis - Calculate the expected analog output voltage for each digital input combination, Prepare the digital input vs analog output table.
4. Circuit Construction - Assemble the R-2R ladder DAC circuit on breadboard/trainer kit/ Multisim s/w, Connect reference voltage and digital input switches.
5. Experimental Testing - Apply different digital input combinations (0000 to 1111 for 4-bit), Measure the corresponding analog output voltage using a multimeter or CRO.
6. Verification of Output - Compare measured output voltages with theoretical values.

Exemplars and Utility:

Audio and video signal processing, Digital signal processing systems, Microcontroller-based control systems, Communication systems, Instrumentation and measurement systems.

Group B [Any 4 to be performed]			
Experiment No.1	**Design and implement 8:1 mux using 4:1 mux and verify its truth table. Also design and implement given 4 variables functions using IC74LS153 and verify its truth table.**	**02 Hrs.**	**CO 4**

Objective:

- To understand the working of multiplexers and to design and implement an 8:1 multiplexer using 4:1 multiplexers, as well as realize given 4-variable Boolean functions using IC 74LS153 and verify the corresponding truth tables.

Associated Tasks:

1. Define Design Requirements - Study the operation of multiplexer circuits, Identify input lines, select lines, and output, Understand the function and pin configuration of IC 74LS153 (Dual 4:1 Multiplexer).
2. Design of 8:1 Multiplexer using 4:1 Multiplexers - Use two 4:1 MUX for the first stage and one additional logic stage (or MUX) for final output selection, Assign input variables I0 to I7,Use three select lines S2,S1,S0, Develop the logic diagram.
3. Truth Table Preparation (Theoretical) - Prepare the truth table for the 8:1 multiplexer, Show how select lines determine the output.
4. Implementation using IC 74LS153 - Study the pin diagram of IC 74LS153, Configure the circuit to implement the given 4-variable Boolean functions, Connect appropriate inputs and select lines.
5. Circuit Construction - Implement the designed circuit on breadboard or digital trainer kit, Provide necessary power supply connections.
6. Experimental Testing - Apply different combinations of inputs and select lines, Observe and record the output values.
7. Verification of Truth Table - Compare experimental results with the theoretical truth table, Verify the correct implementation of the multiplexer and Boolean function.

Exemplars and Utility:

Data routing in digital systems, Implementation of Boolean functions, Communication systems and data selectors, Microprocessor and digital control circuits, Digital signal processing applications.

Experiment No.2	**Design and implement full adder and subtractor function using IC-74LS138.**	**02 Hrs.**	**CO4**

Objective:

- To understand the working of the 3-to-8 line decoder IC 74LS138 and to design and implement full adder and full subtractor functions using the decoder by realizing the required Boolean functions.

Associated Tasks:

1. Define Design Requirements - Study the function and pin configuration of IC 74LS138 (3-to-8 line decoder), Identify inputs A,B,C and outputs Y0 to Y7,Understand enable pins and active-low outputs.
2. Truth Table Preparation - Write the truth table for Full Adder (Sum and Carry), Write the truth table for Full Subtractor (Difference and Borrow).
3. Logic Expression Determination - Determine minterms for Sum and Carry using the full adder truth table, Determine minterms for Difference and Borrow using the full subtractor truth table.
4. Circuit Design using Decoder- Apply the three input variables to the inputs of IC 74LS138, Use appropriate decoder outputs corresponding to required minterms, Combine outputs using OR gates to obtain Sum, Carry, Difference, and Borrow.
5. Circuit Construction - Implement the designed circuit on a breadboard or digital trainer kit, Connect power supply and input switches.
6. Experimental Testing- Apply all possible input combinations (A,B,C), Observe the outputs for Sum, Carry, Difference, and Borrow.
7. Verification of Truth Table -Compare the experimental results with the theoretical truth tables, Confirm correct operation of the full adder and subtractor.

Exemplars and Utility:

Arithmetic logic units (ALU) in processors, Digital computation circuits, Binary arithmetic Operations, Fundamental building blocks in digital systems.

Experiment No.3	**Design &implement 3-bit gray to binary/binary to gray code converter using IC-74LS138.**	**02 Hrs.**	**CO4**

Objective:

- To understand the working of the 3-to-8 line decoder IC 74LS138 and to design and implement 3-bit Gray to Binary and Binary to Gray code converters using decoder logic and verify their truth tables.

Associated Tasks:

1. Define Design Requirements - Study the operation and pin configuration of IC 74LS138 (3-to-8 Decoder),Identify input lines A,B,,C and output lines Y0–Y7,Understand enable inputs and active-low outputs.
2. Truth Table Preparation - Write the 3-bit Binary to Gray code truth table, Write the 3-bit Gray to Binary code truth table.
3. Determine Boolean Expressions- Identify minterms for each output of the converter, Express Gray outputs and Binary outputs in terms of input variables.
4. Circuit Design using IC 74LS138 - Apply input variables to the decoder inputs, Use the corresponding decoder outputs for required minterms, Combine outputs using OR gates to obtain required converter outputs.
5. Circuit Construction - Implement the designed circuit on breadboard/digital trainer kit, Provide necessary power supply connections.
6. Experimental Testing - Apply all possible 3-bit input combinations, Observe and record the corresponding outputs.

7. Verification of Truth Table - Compare experimental outputs with theoretical truth tables, Confirm correct conversion between Gray and Binary codes.

Exemplars and Utility:

Error-minimizing digital communication systems, Rotary encoders and position sensors.

Digital counters and code conversion circuits, Data transmission systems, Digital system design and microprocessor interfaces.

Experiment No.4	**Study of Shift Register: Design and Implement 4-bit right shift and left shift register using D-flip flop.**	**02 Hrs.**	**CO5**

Objective:

- To study the operation of shift registers and to design and implement a 4-bit right shift and left shift register using D flip-flops, and verify the shifting of data with clock pulses.

Associated Tasks:

1. Define Design Requirements - Study the concept of shift registers in digital electronics, Understand the operation of D flip-flops,Identify clock input, data input, and output stages.
2. Circuit Design for Right Shift Register - Connect four D flip-flops in cascade, Apply serial data input to the first flip-flop , Connect the output of each flip-flop to the input of the next flip-flop to achieve right shifting.
3. Circuit Design for Left Shift Register - Modify the connections of D flip-flops so that data shifts in the left direction, Connect outputs appropriately to achieve left shifting with clock pulses.
4. Truth Table and Timing Analysis - Prepare the state table showing data movement during shifting, Draw the timing diagram showing clock and output changes,
5. Circuit Construction - Implement the designed circuit using D flip-flop ICs (such as 74LS74) on a breadboard or digital trainer kit, Provide clock pulses and input data.
6. Experimental Testing - Apply a sequence of input bits, Observe the shifting of data at outputs Q0,Q1,Q2,Q3
7. Verify the truth table - Verify that data shifts correctly to the right or left with each clock pulse.

Exemplars and Utility:

Data storage and transfer circuits, Serial-to-parallel and parallel-to-serial conversion, Digital communication systems, Microprocessor and memory interfacing, Arithmetic and logic operations in digital systems

Experiment No.5	**Study of Counters: Design and Implement 4-bit counter using Flip flop.**	**02 Hrs.**	**CO5**

Objective:

- To study the working of digital counters and to design and implement a 4-bit binary counter using flip-flops, and verify the counting sequence with the help of clock pulses.

Associated Tasks:

1. Define Design Requirements - Study the concept of digital counters, Understand the operation of flip-flops (JK or T flip-flops) used in counter circuits, Identify clock input and output stages.
2. Circuit Design - Design a 4-bit binary counter using four flip-flops connected in cascade, Configure the flip-flops to toggle with each clock pulse, Determine the counting sequence from 0000 to 1111 (0 to 15).
3. Truth Table Preparation - Prepare the state table showing the binary counting sequence, Identify the output states for each clock pulse,
4. Timing Diagram Analysis - Draw the timing diagram showing clock input and outputs Q0,Q1,Q2,Q3, Observe frequency division at each stage.
5. Circuit Construction - Implement the counter using flip-flop ICs (such as 74LS76 or 74LS73) on a breadboard or digital trainer kit, Connect clock source and power supply.

6. Experimental Testing - Apply clock pulses to the circuit, Observe output changes on LEDs or logic indicators.
7. Verification of Counting Sequence - Record the output sequence and compare it with the theoretical count sequence.

Exemplars and Utility:

Digital clocks and timers, Frequency division circuits, Event counting systems, Digital instrumentation, Microprocessor and digital control systems

Experiment No.6	**Design and implement MOD-N and MOD-NN using IC-74LS90 and draw timing diagram.**	**02 Hrs.**	**CO5**

Objective:

- To understand the operation of decade counter IC 74LS90 and to design and implement MOD-N and MOD-NN counters using the IC, and verify their counting sequence with the help of timing diagrams.

Associated Tasks:

1. Define Design Requirements- Study the operation and pin configuration of IC 74LS90 (Decade Counter), Understand the concept of MOD-N counters and truncated counters, Identify reset pins and clock inputs.
2. Determine Counting Sequence - Select required MOD value (N) for the counter, Determine the counting sequence from 0 to N−1, Identify the count at which the counter should reset.
3. Circuit Design for MOD-N Counter - Use IC 74LS90 outputs Q0,Q1,Q2,Q3 , Connect appropriate output pins to the reset inputs to reset the counter at the desired count,Draw the logic diagram for the MOD-N counter.
4. Circuit Design for MOD-NN Counter - Cascade two IC 74LS90 counters to obtain higher modulus counting, Connect clock and reset pins appropriately to achieve required counting sequence.
5. Circuit Construction - Implement the designed counter circuits on breadboard/digital trainer kit, Connect power supply and clock signal.
6. Experimental Testing - Apply clock pulses to the counter input, Observe the output count sequence on LEDs or logic indicators.
7. Timing Diagram Verification - Draw timing diagrams showing the relationship between clock input and output states, Verify the counter operation according to theoretical sequence.

Exemplars and Utility:

Digital clocks and timers, Frequency division circuits, Event counting applications, digital instrumentation systems, Microprocessor-based counting and control systems.

Textbooks:

1. Donald Neaman, “Electronic Circuits – Analysis and Design” Third edition, Mc Graw Hill.
2. Ramakant Gaikwad, “Op amps and Linear Integrated Circuits”, Pearson Education.
3. R.P. Jain, “Modern Digital Electronics”, 3rd edition, 12th reprint Tata McGraw Hill Publication, 2007.
4. M. Morris Mano, “Digital Logic and Computer Design” 4the Edition, Prentice Hall of India

Reference Books:

1. Millman Halkias, “Integrated Electronics”
2. David A. Bell, “Electronic Devices and Circuits”, 5th Edition, Oxford press
3. Anand Kumar, “Fundamentals of Digital Circuits” 1st edition, Prentice Hall of India, 2001
4. Leach, Malvino, Saha, Digital Principles and Applications (SIE), 8th Edition.

MOOCs Links and additional reading material:

e-Books:

1. https://ebooks.lpude.in/computer_application/ad/DCAP108_DIGITAL_CIRCUITS_AND_LOGIC_DESIG NS.pdf
2. https://mrce.in/ebooks/Analog%20Integrated%20Circuit%20Design%202nd%20Ed.pdf MOOC /

NPTEL/YouTube Links:

1. NPTEL Course "Analog Electronic Circuits" https://nptel.ac.in/courses/108105158
2. NPTEL Course on "Analog Circuits": https://nptel.ac.in/courses/108101094
3. NPTEL Course "Digital Circuits" by Prof. Santanu Chattopadhyay (IIT Kharagpur)
4. NPTEL Course "Digital Circuits" by Prof. Goutam Saha (IIT Kharagpur)

Virtual Labs Links:

1. http://vlabs.iitb.ac.in/vlabs/vlab_bootcamp/bootcamp/electronerds/index.html
2. http://vlabs.iitkgp.ernet.in/be/
3. https://nptel.ac.in/courses/108/105/108105113/
4. https://nptel.ac.in/courses/117/106/117106086/
5. https://nptel.ac.in/courses/108/105/108105132/
6. https://da-iitb.vlabs.ac.in/exp/generalized-simulator/
7. https://dld-iitb.vlabs.ac.in/

Strength of CO-PO-PSO Mapping

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	3				1			3	2	1
CO2	3	3	3	3	3				1			3	2	1
CO3	3	3	3	3	3				1			3	3	1
CO4	3	3	3	2	3				2			3	3	2
CO5	3	3	3	3	3				2			3	3	2
Avg.	3	3	2.8	2.8	3				1.4			3	2.6	1.4

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT Level	CCE based on ARCV							
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8
CO	CO1	CO1	CO3	CO3	CO4	CO4	CO5	CO5
L1	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓	✓	✓	✓	✓	✓	✓
L4	✓	✓	✓	✓	✓	✓	✓	✓
L5								
L6								

This course serves as a prerequisite for / maps with the following future courses: 1. Analog and Digital Communication 2. Fundamentals of IoT 3. Embedded System and Edge Computing 4. Power Electronics
Job Mapping: Job opportunities that one can get after learning this course: 1. Electronics Hardware Maintenance Technician 2. Graduate Trainee Engineer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			III
Course:	**Data Structures and Algorithms Lab**			**Course Code:**			R25-EC-PCC-209
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
-	02	-	01	-	-	25	25

Course Description:

This laboratory course provides hands-on experience in implementing core concepts of Data Structures and Algorithms using C++. Students begin with object-oriented programming fundamentals such as classes, constructors, and operator overloading. The course emphasizes practical implementation of searching and sorting algorithms to understand efficiency and logic building. Students develop and manipulate linear data structures including linked lists, stacks, and queues using arrays and linked representations. The lab further covers non-linear data structures such as binary search trees and graphs, including traversal algorithms. Through systematic programming exercises, students strengthen problem-solving skills and gain confidence in implementing efficient data handling techniques.

Relevance:

This lab course bridges theory and practice by enabling students to implement and test data structures used in real-world software systems. It enhances coding proficiency and prepares students for technical interviews, software development roles, and advanced computing courses.

Prerequisite: Basic knowledge of programming concepts and problem-solving using C is required.

Bridge Content: - Debugging with Visual Studio Code, Introduction to competitive coding platforms, Introduction to Unit Testing

Course Objectives:

1. To introduce basic C++ programming concepts such as classes, objects, constructors, and operator overloading for developing object-oriented solutions.
2. To develop problem-solving skills by implementing standard searching and sorting algorithms using C++.
3. To provide hands-on experience with dynamic data structures like linked lists, stacks, queues, and trees to reinforce their theoretical understanding.
4. To enable students to implement and traverse graphs using adjacency lists and apply depth first and breadth-first search algorithms

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	**Implement** object-oriented programming features in C++ to solve problems such as complex number arithmetic.	3
CO2	**Implement** searching and sorting algorithms and evaluate their performance for given data.	3
CO3	**Apply** appropriate data structures like linked lists, stacks, queues, and binary search trees to solve basic computational problems.	3
CO4	**Develop** graph-based solutions and perform BFS and DFS traversals using adjacency list representation.	3

List of Practical: (Any 08)			
Experiment No.1	**Program to demonstrate basic C++ concepts - classes, objects, constructors, and operator overloading for complex number arithmetic (Addition, Subtraction, Multiplication)**	**02 Hrs.**	**CO1**

Objective:

- To understand and implement core object-oriented programming concepts in C++ using classes, constructors, and operator overloading for complex number arithmetic.

Associated Tasks:

1. Define a Complex class with appropriate data members for real and imaginary parts and implement constructors for initialization.
2. Create member functions and overload operators (+, -, *) to perform addition, subtraction, and multiplication of complex numbers.
3. Instantiate objects of the Complex class and perform arithmetic operations using overloaded operators.
4. Display the results to verify correct functionality and object-oriented behavior.

Exemplars and Utility:

Mathematical modeling and engineering computations.

Experiment No.2	**Implement a) Linear Search and b) Binary Search algorithms using C++**	**02 Hrs.**	**CO2**

Objective:

- To implement and compare Linear Search and Binary Search algorithms in C++ for efficient data searching.

Associated Tasks:

1. Accept a list of elements and the key element to be searched from the user.
2. Implement Linear Search by sequentially comparing each element with the key.
3. Implement Binary Search by repeatedly dividing the search space.
4. Display the position of the element if found and analyze the search outcome.

Exemplars and Utility

Voter search, roll number lookup, product search on e-commerce platform

Experiment No.3	**Implement Bubble Sort algorithm using C++**	**02 Hrs.**	**CO2**

Objective:

- To implement the Bubble Sort algorithm in C++ and understand the concept of comparison-based sorting.

Associated Tasks:

1. Accept an array of elements from the user.
2. Compare adjacent elements and interchange them if they are in the wrong order.
3. Repeat the pass through the array until the list is completely sorted.
4. Display the sorted array and observe the number of passes required.

Exemplars and Utility:

Price sorting, merit list generation, sort employee records by salary.

Experiment No.4	**Implement Singly Linked List with insertion, deletion, and display operations.**	**02 Hrs.**	**CO3**

Objective:

- To implement a Singly Linked List in C++ and perform insertion, deletion, and display operations.

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Associated Tasks:

1. Design and implement Node and LinkedList classes with appropriate data members and constructors.
2. Implement function to insert a node at the end of linked list.
3. Implement deletion of a node based on given criteria such as position or value.
4. Traverse the linked list to display all elements and verify correct operations.

Exemplars and Utility:

Dynamic memory management, playlists, and symbol tables.

Experiment No.5	**Implement Doubly Linked List with insertion, deletion, and display operations.**	**02 Hrs.**	**CO3**

Objective:

- To implement a Doubly Linked List in C++ and perform insertion, deletion, and display operations.

Associated Tasks:

1. Design and implement Node and Doubly Linked List classes with appropriate data members and constructors.
2. Create member functions to insert nodes at required positions in the list.
3. Implement deletion of nodes while properly updating both previous and next links.
4. Traverse the list in forward (and reverse) direction to display elements and verify correct operations.

Exemplars and Utility:

Browser navigation, undo/redo operations, and playlist management

Experiment No.6	**Implement Stack using a) arrays and b) linked list.**	**02 Hrs.**	**CO3**

Objective:

- To implement Stack data structure using arrays and linked list in C++ and understand LIFO operations.

Associated Tasks:

1. Design and implement a Stack class using arrays and define basic stack operations such as push, pop, and peek.
2. Implement an alternative stack representation using linked list with dynamic memory allocation.
3. Perform stack operations and handle overflow and underflow conditions.
4. Display the stack contents to verify correct implementation in both approaches.

Exemplars and Utility:

Expression parsing, function calls, compiler design, calculators

Experiment No.7	**Evaluate postfix expression (input will be postfix expression)**	**02 Hrs.**	**CO3**

Objective:

- To evaluate a postfix expression using stack operations in C++.

Associated Tasks:

1. Accept a postfix expression as input from the user.
2. Scan the expression from left to right and push operands onto the stack.
3. Pop operands from the stack when an operator is encountered and perform the required operation.
4. Push the intermediate result back onto the stack and display the final evaluated result.

Exemplars and Utility:

Compilers, calculators, and expression parsing

Experiment No.8	**Implement Queue using a) arrays and b) linked list.**	**02 Hrs.**	**CO3**

Objective:

- To implement Queue data structure using arrays and linked list in C++ and understand FIFO operations.

Associated Tasks:

1. Design and implement a Queue class using arrays with basic operations such as enqueue, dequeue, and peek.
2. Implement an alternative queue representation using linked list with dynamic memory allocation.
3. Perform queue operations while handling overflow and underflow conditions.
4. Display queue contents to verify correct implementation in both approaches.

Exemplars and Utility:

CPU scheduling, print spooling, and service request handling

Experiment No.9	**Implement Binary Search Tree with insertion, and traversal (inorder, preorder, postorder).**	**02 Hrs.**	**CO3**

Objective:

1. Implement a Binary Search Tree (BST) in C++ and perform insertion, and traversal operations.

Associated Tasks:

1. Design and implement Node and BST classes with appropriate data members and constructors.
2. Implement recursive insertion of nodes while maintaining Binary Search Tree properties.
3. Develop recursive functions for inorder, preorder, and postorder tree traversals.
4. Create a driver program to insert sample data and display traversal outputs.

Exemplars and Utility:

Indexing, searching, and hierarchical data representation in software systems

Experiment No.10	**Implement Graph using adjacency matrix. Perform BFS or DFS traversals.**	**02 Hrs.**	**CO4**

Objective:

- To implement and demonstrate Depth First Search (DFS) traversal of a graph using an adjacency matrix

Associated Tasks:

1. Read the number of vertices and the adjacency matrix representing the graph.
2. Initialize the visited array to keep track of visited vertices.
3. Start DFS traversal from the first vertex (vertex 0).
4. Recursively visit all unvisited adjacent vertices following DFS logic

Exemplars and Utility:

Mapping systems (like Google Maps), social media connections, network analysis.

Mandatory Course Project	**CO1-4**

Develop an application that solves a real-world problem or simulates a practical system using appropriate data structures, implemented in C++.

General Guidelines-

- **Team Size:**

  Individual or group of up to 3 students.

- **Selection of Topic:**

  Students must choose a problem where the use of one or more data structures is essential. Project must be **interactive** (menu-based or GUI-based).

  Some suggested domains- Railway reservation system, Hospital Queue System, College Result Processing, Phone Book.

- **Mandatory Technical Requirements:**
  Use of **at least one data structure** (e.g., Linked List, Stack, Queue, Tree, Graph). Implement **searching and/or sorting algorithms**.
  Include **basic object-oriented concepts** like classes, constructors, and operator overloading.
  Basic usage of exception handling.
  Demonstrate simple unit testing capability.
- **Documentation Must Include:**
  Project Title and Abstract
  Problem Statement
  Data Structures Used and Justification System Design / Flowchart / Class Diagram Sample Input /Output
  Code (with comments) Conclusion and Future Scope.

Mandatory Hackathon / Coding Contest participation	**CO1-4**
Students to participate in online Hackathon / Coding Contest	

Textbooks:

1. E. Balagurusamy, "Object-Oriented Programming with C++", McGraw Hill
2. Ellis Horowitz, Sartaj Sahni, "Fundamentals of Data Structures in C++", Orient Blackswan
3. Yashavant Kanetkar, "Data Structures Through C++", BPB Publications

Reference Books:

1. Robert Lafore, "Object-Oriented Programming in C++", Sams Publishing
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Pearson
3. BjarneStroustrup, "The C++ Programming Language", Addison-Wesley
4. YedidyahLangsam, Moshe J. Augenstein and Aaron M. Tenenbaum, "Data structures using C and C++",Pearson

MOOCs Links and additional reading material:

1. Fundamentals of Programming C++ (Richard L. Halterman)
2. Data Structures and Algorithm Analysis in C++, 3rd Edition (Clifford A. Shaffer)
3. Data Structures And Algorithms, IIT Delhi, https://nptel.ac.in/courses/106102064
4. Introduction to Data Structures, https://onlinecourses.swayam2.ac.in/cec24_cs17/preview

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	-	-	2	2	1	1	3	3	1
CO2	3	2	1	2	2	-	-	2	2	1	1	3	3	1
CO3	3	2	1	2	2	-	-	2	2	1	1	3	3	1
CO4	3	2	1	2	2	-	-	2	2	1	1	3	3	1
Avg.	3	2	1	2	2	-	-	2	2	1	1	3	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern								
	CCE based on ARCV (Expt. 1 to 8), Course Project, Hackathon/Coding Contest participation							
BT Level	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8
CO	CO1	CO2	CO2	CO3	CO3	CO3	CO3	CO4
L1	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓	✓	✓	✓	✓	✓	✓
L4								
L5								
L6								

This course serves as a prerequisite for / maps with the following future courses:

1. Object Oriented Programming
2. Database Management Systems (DBMS)
3. Computer Networks and Security
4. Software Engineering
5. Artificial Intelligence and Machine Learning
6. Web Technologies

Job Mapping:
Job opportunities that one can get after learning this course:
Junior Programmer / Application Developer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			III
Course:	**Community Engagement Project**			**Course Code:**			R25-EC-CEP-210
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
-	04	-	02	-	-	50	-

Course Description:

The Community Engagement Project (CEP) is an experiential learning course that integrates community engagement with engineering practice. The course enables students to interact with local communities, identify real-world problems, and develop appropriate solutions using Electronics and Computer Engineering concepts. Students will engage in field visits, surveys, awareness activities, and technical solution development.

Relevance:

The course will enhance social responsibility, teamwork, communication, and problem-solving skills through field-based activities and community interaction.

Prerequisite:

1. Basic understanding of social and ethical responsibilities.
2. Problem solving skills
3. Practical skills are required to ensure the data collected is valid and useful.

Bridge Content: --

Course Objectives:

1. To enable students to apply concepts learned in the classroom to real-life situations.
2. To train students in the practicalities of field research, including data collection (through surveys and interviews), observation techniques.
3. To foster empathy and social responsibility.
4. To empower students to identify community-specific needs and design practical, data-driven interventions that provides tangible benefits to the local population.
5. To cultivate essential professional competencies such as leadership, adaptability, and interpersonal communication.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Identify** and **Analyze** local community needs and challenges by engaging with stakeholders and evaluating real-world problems.	4
CO2	**Design** and Implement practical, creative, and context-specific solutions using engineering principles to address community issues.	6
CO3	**Demonstrate** and document outcomes effectively	4
CO4	**Evaluate** impact and sustainability of solution	4

Course Content

Implementation Stages-

Stage 1: Community Engagement

- Identification of village/urban area
- Interaction with stakeholders (local authorities/NGOs/community members)
- Identification of real-world problems

Stage 2: Survey and Awareness Activities

- Conduct surveys and data collection
- Organize awareness programs (health, environment, energy, digital literacy)

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- Field-based learning activities

Stage 3: Technical Integration

- Design and implement software or hardware prototype solutions using Electronics and Computer engineering principles to address community issues.

Implementation Guidelines-

Students will work in groups of 3–4
Each group will be assigned a mentor
Project must be community-based and problem-driven
Solution should include technical contribution from Electronics and Computer Engineering domain

Sample Project Areas:

The below lists are not exhaustive, and students may also choose areas/topics other than those listed.

1. Water facilities and drinking water availability
2. Health and hygiene
3. Stress levels and coping mechanisms
4. Health intervention programs
5. Horticulture
6. Herbal plants
7. Botanical survey
8. Zoological survey
9. Aqua culture
10. Inland fisheries
11. Animals and species
12. Nutrition
13. Traditional and Modern health care methods
14. Food habits
15. Air pollution
16. Sound pollution
17. Water pollution
18. Plantation
19. Soil protection
20. Renewable energy
21. Plant diseases
22. Yoga awareness and practice
23. Health care awareness programs and their impact
24. Use of chemicals on fruits and vegetables
25. Organic farming
26. Crop rotation
27. Floury culture
28. Access to safe drinking water
29. Sericulture
30. Study of species
31. Food adulteration
32. Incidence of Diabetes and other chronic diseases
33. Human genetics
34. Blood groups and blood levels
35. Animal husbandry
36. Mother and child health

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37. Use of renewable energy
38. Chemicals in daily life

Mandatory Requirements:

Activity (Log) book (weekly progress record)
Two-page project proposal
Field visit and survey documentation
Community interaction proof
Awareness program execution

Documentation Format:

1. Title Page
2. Certificate
3. Problem Statement
4. Survey and Data Collection
5. Analysis
6. System Design (Block Diagram and Circuit)
7. Implementation
8. Results and Impact
9. Challenges and Learning
10. Conclusion
11. References
12. Annexure

Textbooks:

1. Waterman, A. Service-Learning : A Guide to Planning, Implementing, and Assessing Student Projects. Routledge, 1997.
2. Beckman, M., and Long, J.F. Community-Based Research: Teaching for Community Impact. Stylus Publishing, 2016.
3. Dostilio, L.D., et al. The Community Engagement Professional's Guide book : A Companion to The Community Engagement Professional in Higher Education. Stylus Publishing, 2017

MOOCs Links and additional reading material:

1. Community Engagement & Social Responsibility
   https://onlinecourses.swayam2.ac.in/e-learning/preview/ugc23_ge04
2. Smart India Hackathon-2025: Problem Statement Details
   Agriculture / Smart Cities / Healthcare / Education / AI / IoT
   https://www.sih.gov.in/sih2025PS
3. Smart India Hackathon-2024: Problem Statement Details
   Agriculture / Healthcare / Smart Cities / Sustainability / Transportation / AI / Cybersecurity
   https://www.sih.gov.in/sih2024PS

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	2	-	1		3	1	3	3	2	2	2	2	2
CO2	2	2	2	2	2	3	1	3	3	2	2	2	2	2
CO3	-	-	-	-	2	3	2	3	3	2	2	2	2	2
CO4	-	-	-	-	-	3	2	3	3	2	2	2	2	2
Avg.	0.5	1	0.5	0.75	1	3	1.5	3	3	2	2	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Assessment Pattern				
BT Level	TW based on ARCV as per CEP activity logbook			
CO	CO1	CO2	CO3	CO4
L1	✓	✓	✓	✓
L2	✓	✓	✓	✓
L3	✓	✓	✓	✓
L4	✓	✓	✓	✓
L5		✓		
L6		✓		

This course serves as a prerequisite for / maps with the following future courses:
-

Job Mapping: Job opportunities that one can get after learning this course:

1. CSR (Corporate Social Responsibility) Manager
2. NGO Program Coordinator
3. Outreach Officer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**		IV	
Course:	**Analog and Digital Communication**			**Course Code:**		R25-EC-PCC-211	
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
03	-	-	03	40	60	-	-

Course Description:

This course introduces the fundamental principles of analog and digital communication systems, analog and digital modulation techniques, transmitters and receivers. The course also explains the effect of noise in communication systems. In digital communication, source coding and error detection techniques are discussed to realize the errors introduced between the information flow. Advancement of digital communication in the form of software defined radio and Cognitive radio at introductory level is also discussed to understand the upcoming application.

Course Relevance:

This course provides the foundation for understanding modern analog and digital communication systems used in wireless, satellite, and data communication networks. The knowledge of information theory, source coding, and error control coding enables efficient bandwidth utilization and error-free data transmission in digital systems. The concepts of SDR and CR learned in this course are directly applicable to technologies such as mobile communication, internet data transfer, broadcasting systems, and advanced wireless communication, preparing students for careers in communication engineering and related industries.

Prerequisite: Fundamentals of Signals and Systems

Bridge Content: --

Course Objectives:

1. To introduce analog and digital communication systems with modulation, transmission and reception techniques.
2. To learn Digital modulation, information theory concepts and source coding techniques.
3. To understand Software Defined Radio and Cognitive Radio concepts, applications and implementation challenges.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Understand** and **evaluate** analog communication systems for Amplitude modulation generation and detection methods, AM receivers, the effect of noise on CW and AM systems.	3
CO2	**Understand** and **evaluate** analog communication systems for Frequency and Phase modulation generation and detection methods, FM receivers.	3
CO3	**Understand** the digital modulation and describe different Digital modulation techniques.	2
CO4	**Understand** information measures and source coding techniques and apply and Evaluate error control coding methods.	3
CO5	**Understand** and **Describe** Software Defined Radio and Cognitive Radio concepts, architectures, platforms, and applications.	2

Course Content			
Unit 1	**AM Transmitter and Receiver**	**9 Hrs.**	**CO1**
Random Processes as Signals, Power Spectra, Low pass and band pass random processes. Block diagram of communication system, Noise, Types of Noise, The need of modulation, Amplitude modulation, QAM, Generation and detection of DSBFC, DSBSC, SSB with mathematical modeling and waveforms.			

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Vestigel sideband, AM receiver- TRF and Super-heterodyne concept of image frequency, double spotting. Noise in CW Systems, Effect of Noise on AM.			
Exemplars / Practical Applications and usage: Amplitude Modulation in AM radio, air traffic control, two-way radios (walkie-talkies), amateur radio, and advanced digital systems like QAM in Wi-Fi/cable modems.			
Unit 2	**FM Transmitter and Receiver**	**9 Hrs.**	**CO2**
Frequency modulation, Phase modulation, Spectrum analysis of FM signal, Narrow and wideband FM, Direct and Armstrong methods to generate FM signal, FM Detection: Slope detector, balanced slope detector and Phase Locked Loop (PLL). Comparison of AM FM and PM. FM Super-heterodyne receiver			
Exemplars / Practical Applications and usage: Frequency Modulation (FM) and demodulation in FM radio broadcasting, high-fidelity music transmission, television sound, satellite communications, and two-way radios (police, aviation)			
Unit 3	**Introduction to Digital Communication**	**9 Hrs.**	**CO3**
Advantages of digital communication systems, Elements of Digital Communication systems, , Sampling, Natural and Flat top sampling, Bandpass Sampling, Sampling of Random Processes, The quantization problem, Pulse Modulation: Pulse Amplitude Modulation (PAM), PPM, PWM, Quantization of Signals,, types of Quantization: Uniform & Non-Uniform, Mid-rise & Mid-tread Quantizer, Quantization error Companding: A-law & μ-law, Pulse Code Modulation (PCM), Companding in PCM systems. Delta modulation (DM), Adaptive delta modulation, Noise in PCM and DM systems, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Quadrature PSK, Differential PSK , Quadrature Amplitude Shift Keying (QASK), Minimum Shift Keying (MSK).			
Exemplars / Practical Applications and usage: Ethernet network, in many micro-controllers for generating control signals, phone modems, High speed digital communication system.			
Unit 4	**Source coding and Error Control Coding**	**9 Hrs.**	**CO4**
Generation and Detection: Concept of amount of information and its properties, Average information or Entropy and its properties, Information rate, Mutual information and its properties. Source Coding: Shannon's theorem, Shannon-Fanon coding, Huffman coding, Need of Error control coding, Error Detection, Parity , Checksum for error detection, Linear block codes, Decoding of Linear block codes, syndrome detection, Error probability after coding.			
Exemplars / Practical Applications and usage: RFID tags and readers**,** home appliance remote controls, Optical Fiber Communication. Digital Communication Systems , Software Implementation Projects; text ,audio& video compression Cryptography, Storage Devices- CDs, DVDs, Blu-ray discs, QR Codes, Satellite communication			
Unit 5	**Software Defined Radio and Cognitive Radio**	**9 Hrs.**	**CO5**
Software Defined Radio: Definition, Need of SDR, Architecture, Operational requirements, SDR Platforms, GNU Radio for SDR, Applications of SDR. Cognitive Radio: Defining CR: History, Applications and Related Concepts, Definition of Cognitive Radio Network, Spectrum Management, Computational Platforms. CR Terminology Standardization Application of SDR in Advance Communication System - Case Study, Challenges and Issues, Implementation, Parameter Estimation –Environment, Location, other factors, Vertical Handoff, Network Interoperability. Case Study: CR for Public Safety –PSCR , Modes of PSCR, Architecture of PSCR.			
Exemplars / Practical Applications and usage: Application of SDR in telecommunication, Defense, Military, Amateur Radio etc Cognitive Radio in DSA, IoT, Smart Grid Management.			

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Textbooks:

Text Books:

1. George Kennedy, "Electronic Communication Systems" 5th Edition, McGraw-Hill.
2. B P Lathi, Zhi Ding, "Modern Analog and Digital Communication Systems", 4th Edition, Oxford University Press.
3. Bernard Sklar, Digital Communication,2/E, Pearson Education India, 2009
4. Ali A. M. H, "Software Defined Radio: Theory and Practice", 2nd edition, (2023) by. Fayed publisher.

Reference Books:

1. Taub, Schilling and Saha, "Principles of Communication Systems", 4th Edition, McGraw Hill.
2. A.B Carlson, P B Crully, J C Rutledge, "Communication Systems", 5th Edition, Tata McGraw Hill.
3. Wayne Tomasi, "Electronic Communications System", 5th Edition, Pearson Education.
4. Ranjan Bose, Information Theory coding and Cryptography‖, McGraw-Hill, 2nd Ed
5. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition.
6. Markus Dillinger, Siemens A.G., Kambiz Madani, Nancy Alonistioti, "Software Defined Radio: Architectures, Systems and Functions, wiley, 2003.
7. Joseph Mitola," Software Radio Architecture: Object-Oriented Approaches to Wireless Systems Engineering" John Wiley and sons, 2000.

MOOCs Links and additional reading material:

1. Analog and Digital Communication- https://onlinecourses.nptel.ac.in/noc26_ee03
2. Basics of Software Defined Radio- https://onlinecourses.nptel.ac.in/noc22_ee78

Strength of CO-PO-PSO Mapping

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	1	1	-	1	-	2	3	1	2
CO2	3	2	1	-	1	1	1	-	1	-	2	3	1	2
CO3	3	2	1	-	1	1	1	-	1	-	2	3	1	2
CO4	3	2	1	-	1	1	1	-	1	-	2	3	1	2
CO5	3	-	1	-	2	1	1	-	1	-	2	3	1	2
Avg.	3	2	1	-	1.2	1	1	-	1	-	2	3	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE 1	08	08			
CCE 2			08	08	
CCE 3					08
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE					ESE				
	CCE1		CCE2		CCE3					
CO	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
L1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓		✓		✓	✓		✓	
L4										
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:

1. Wireless Sensor Network
2. Wireless and Cellular Communication
3. Digital Signal Processing
4. Computer Network and Security

Job Mapping:

Job opportunities that one can get after learning this course:

1. Telecom industries
2. Computer networking

Program:	**S. Y. B. Tech (E&CE)**				**Semester:**		IV
Course:	**Signals and Systems**				**Course Code:**		R25-EC-PCC-212
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
02	-	-	02	40	60	-	-

Course Description:

The goal of this course is to build an understanding of the fundamental concepts of signals and systems found in engineering and its applications. The methods used to characterize and analyze continuous time signal and system is the primary focus. In this course, students will learn transform techniques (Fourier transform and Laplace transform) that will help them understand advance technologies such as digital communication systems, feedback control systems, satellite and mobile communications, multimedia, Biomedical signal processing etc.

Course Relevance:

Signals and Systems course contains the foundational math and concepts (like convolution, Fourier/Laplace transforms, filtering) to understand how information in the form of signals is processed by devices (systems). The course underpins the modern technology from Wi-Fi and cell phones (communications) to medical imaging and robotics (control), acting as the bridge between raw data and practical engineering applications in electronics, Computers, and beyond.

Prerequisite: Fundamental mathematics, Calculus.

Bridge Content: -- Calculus. Discrete mathematics

Course Objectives:

1. To introduce signals, its operations with examples and to classify signals into different categories.
2. To classify systems into different categories.
3. To analyze the Liner Time Invariant (LTI) systems and finding the system response in time domain.
4. To acquire knowledge about Fourier Series and Transforms, and its significance in signal analysis.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	**Understand** types of signals, systems and **apply** the mathematical operations on signals and determine response of a system for any arbitrary input signal using the convolution process.	3
CO2	**Apply** and **analyze** the signals in frequency domain using Fourier Transform	4
CO3	**Apply** Laplace transform for continuous time signals and perform circuit **analysis**.	3
CO4	**Apply** Z- transform to discrete time signals and perform system analysis	3

Course Content			
Unit 1	**Introduction to Signals & Time-domain Analysis of LTI Systems**	**8 Hrs.**	**CO1**

Signals: Introduction, classification and types of signals Operations on signals (CT and DT): Amplitude scaling, signal addition, subtraction, time shifting, time reversal, time scaling. Systems: Introduction, Classification of systems using input-output relationship: static and dynamic, causal and non-causal, Linear and Non- linear, time variant and time invariant, stable and unstable, invertible and non- invertible. System interconnections LTI system Analysis: Introduction to convolution, convolution sum, methods of finding convolution sum: tabular, graphical, convolution integral, computation of convolution integral using graphical method, significance of correlation, auto-correlation, cross-correlation.

Exemplars / Practical Applications and usage:

Examples of real life signals such as: Speech, ECG, EEG, EMG etc.

Introduction to the modern applications of the convolution such as speech recognition and natural language processing (NLP)			
Unit 2	**Fourier Analysis**	**7 Hrs.**	**CO3**
Introduction to Fourier Series: Fourier Series (FS) representation of periodic Continuous-Time (CT) signals using trigonometric and exponential forms (one example each), Dirichlet conditions for the existence of Fourier Series, Gibbs phenomenon. Fourier Transform (FT): Fourier Transform representation of aperiodic CT signals; Dirichlet conditions for the existence of Fourier Transform; evaluation of magnitude and phase response; Fourier Transform of standard CT signals; properties and their significance; Fourier Transform for periodic signals.			
Exemplars / Practical Applications and usage: Applications of Fourier Transform in spectral analysis, communication, filtering, and biomedical signal processing.			
Unit 3	**Laplace Transform and Applications**	**8 Hrs.**	**CO4**
Definition of Laplace transform, Limitations of Fourier transform and need of Laplace transform, ROC, Laplace transform of standard periodic and aperiodic functions, properties of Laplace transform, Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion, stability considerations in S domain, Application of Laplace Transforms: RL, RC, RLC Circuit analysis, transfer function and impulse response.			
Exemplars / Practical Applications and usage: Laplace transform for data mining and Machine Learning, for filter design and PID controller analysis.			
Unit 4	**Z Transform**	**7 Hrs.**	**CO5**
Introduction, definition, ROC, its applications to discrete-time signal and system analysis. properties of the Z-transform, standard Z-transform pairs, inverse Z-transform by partial fraction method, the relationship between the Z-transform and the Fourier transform			
Exemplars / Practical Applications and usage: Application of Z transform for circuit analysis			
Textbooks:			
Text Books: 1. Simon Haykins and Barry Van Veen, “Signals and Systems”, Wiley India, 2nd Edition. 2. A Nagoor Kani, “Signals & Systems Simplifies” Mc Graw Hill Education 2nd Edition 3. Alan Openheim and Alan Willesky Signals & Systems Prentice-Hall Publication, 2nd Edition.			
Reference Books:			
1. John G. Proakis and Dimitris G. Manolakis, "Digital signal Processing: Principles, Algorithms, and Applications", 4E. Sept. 2007. 2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016. 3. Charles Phillips, “Signals, Systems and Transforms”, Pearson Education, 3rd Edition 4. Ramesh Babu, “ Signals and Systems”, SCITECH Publication, 2nd edition.			
MOOCs Links and additional reading material:			
1. Principles of Signals and Systems: https://nptel.ac.in/courses/108104100 2. Signals and Systems: https://onlinecourses.nptel.ac.in/noc21_ee28/preview			

Strength of CO-PO-PSO Mapping														
CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	-	1	1	-	1	1	1	2	3	1	2
CO2	3	3	1	-	1	1	-	1	1	1	2	3	1	2
CO3	3	3	1	-	1	1	-	1	1	1	2	3	1	2
CO4	3	3	1	-	1	1	-	1	1	1	2	3	1	2
Avg.	3	3	1	-	1	1	-	1	1	1	2	3	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4
CCE 1	10	10		
CCE 2			10	
CCE 3				10
ESE	15	15	15	15
Total	25	25	25	25

Assessment Pattern

BT Level	CCE				ESE			
	CCE1		CCE2	CCE3				
CO	CO1	CO2	CO3	CO4	CO1	CO2	CO3	CO4
L1	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓	✓	✓	✓	✓	✓	✓
L4		✓				✓		
L5								
L6								

This course serves as a prerequisite for / maps with the following future courses:

1. Digital Signal Processing
2. Digital Image Processing
3. Wireless and Cellular Communication

Job Mapping:
Job opportunities that one can get after learning this course:

1. Telecom sector

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**		IV	
Course:	**Object Oriented Programming**			**Course Code:**		R25-EC-PCC-213	
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
03	-	-	03	40	60	--	-

Course Description:
This course introduces the Object-Oriented Programming (OOP**)** paradigm using the Java language. It focuses on shifting from procedural to object-oriented thinking to develop robust, scalable, and reusable software.

Relevance:
The knowledge and skills acquired serve as a basis for Multi-Class Development, Interactive GUIs, event-driven programming.

Prerequisite: Fundamental of Programming like Control Flow, Data Types and Operators and Functions/Methods.

Bridge Content: -

Course Objectives:

1. Make the students familiar with basic concepts and techniques of object-oriented programming in Java.
2. Develop an ability to write programs in Java for problem solving.
3. Differentiate between procedural and object-oriented programming approaches.
4. Develop multi-class Java applications that solve real-world problems.
5. Create efficient, user-friendly graphical interfaces with event handling.
6. Manage complex data sets using the Java Collections Framework.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Explain** the basic principles of the Java programming language.	2
CO2	**Develop** Java programs by applying the concepts of classes and objects	3
CO3	**Implement** programs using Inheritance, interfaces, and packages in Java	3
CO4	**Analyze** multithreading and exception handling mechanisms to create robust Java programs.	4
CO5	**Construct** graphical applications using the Graphics class, AWT packages, and manage file I/O operations in Java	3

Course Content			
Unit 1	**Java Fundamentals**	**9 Hrs.**	**CO1**
Evolution of Java, Comparison of Java with other programming languages, Java features, Java Environment, Simple Java Program, Java Tokens, Java Statements, Constants, variables, data types. Declaration of variables, giving values to variables, Scope of variables, arrays, Symbolic constants, Typecasting, Getting values of variables, Standard default values, Operators, Expressions, Type conversion in expressions, Operator precedence and associativity			
Exemplars / Practical Applications and usage: Software development, web applications, Android applications, and enterprise systems.			

Unit 2	**Classes, Methods and Objects in Java**	**9 Hrs.**	**CO2**
Class Fundamentals, Declaring Objects, Assigning Object reference variables, Methods, Constructors, The This keyword, Garbage collection, finalize method, overloading methods, using objects as parameters, Argument passing, returning objects, Recursion, access control, static, final, arrays, strings class, Command line arguments.			
Exemplars / Practical Applications and usage: Designing real-world entities such as Student, Employee, Bank Account, and Product for enterprise applications, desktop software, and Android application development			
Unit 3	**Inheritance, Packages and Interfaces**	**9 Hrs.**	**CO3**
Inheritance: Basics, Using Super, Creating Multilevel hierarchy, Constructors in derived class, Method overriding, dynamic method dispatch, Using Abstract classes, Using final with inheritance, Packages: Java API Packages, Using System Packages, creating accessing and using a package, importing packages, adding a class to a Package, Hiding classes Interfaces: Define, implement and extend, Accessing Interface variables, Default interface methods, using static method in interface.			
Exemplars / Practical Applications and usage: Developing real-world applications like banking, library, and student management systems.			
Unit 4	**Multithreading, Exception handling**	**9 Hrs.**	**CO4**
Introduction to multithreading: Introduction, creating thread and extending thread class. Stopping and blocking a thread, Life Cycle of a Thread, using thread methods, Concept of Exception handling: Introduction, Types of errors, Exception handling syntax, multiple catch statements, using final statement, throwing our own exceptions I/O basics, reading console inputs, Writing Console output			
Exemplars / Practical Applications and usage: Building real-time systems like messaging apps, simulations, and schedulers.			
Unit 5	**Graphics Programming and File Handling**	**9 Hrs.**	**CO5**
Graphics class, Lines, Rectangle, circles and ellipses, Introduction to AWT packages, handling events on AWT components, Introduction to Swing package, components and containers , Layout Managers , Model-View-Controller (MVC) Architecture ,Multi-Document Interface (MDI) & Menus. Managing input/output files: Concept of streams, Stream Classes, Byte stream, Character stream, Using Stream, creation of files, reading/writing a file.			
Exemplars / Practical Applications and usage: Developing GUI-based applications, Creating interactive user interfaces, processing input/output in applications like log systems and editors.			
Course Projects: -			
Build a Smart Inventory & Billing System			
Textbooks:			
1. E Balagurusamy, "Programming with JAVA", Tata McGraw Hill, 6th Edition 2. Herbert Schildt, Java: The complete reference, Tata McGraw Hill, 7th Editon			
Reference Books:			
1. Matt Weisfeld, "The Object-Oriented Thought Process", Pearson Cox Brad, "Object –Oriented Programming: An Evolutionary Approach", Addison –Wesley 2. Y. Daniel Liang (2010), "Introduction to Java programming", Pearson Education, India, 7th Edition			

MOOCs Links and additional reading material:

1. Programming in Java - https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_cs47
2. NOC: Fundamentals of Object Oriented Programming, IIT Roorkee - https://nptel.ac.in/courses/106107574

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	1	1	-	2	1	-
CO2	3	3	2	1	2	-	-	-	1	1	-	3	2	1
CO3	3	3	3	2	2	-	-	-	1	1	-	3	3	2
CO4	2	3	2	3	2	-	-	-	1	1	-	2	3	2
CO5	2	2	3	2	3	-	-	-	1	1	-	2	3	3
Avg.	2.6	2.6	2.2	1.8	2.2	-	-	-	1	1	-	2.4	2.4	1.6

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5
CCE 1	08	08			
CCE 2			08	08	
CCE 3					08
ESE	12	12	12	12	12
Total	20	20	20	20	20

Assessment Pattern

BT Level	CCE					ESE				
	CCE1		CCE2		CCE3					
CO	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
L1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L3		✓	✓	✓	✓		✓	✓	✓	✓
L4				✓					✓	
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses:

- Artificial Intelligence and Machine Learning
- Database Management Systems
- Web Technology

Job Mapping:
Job opportunities that one can get after learning this course:

- Java Developer
- Software Engineer
- Backend Developer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**		**IV**	
Course:	**Applied Mathematics**			**Course Code:**		**R25-EC-MDM-214**	
Teaching Scheme (Hrs./Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
2	--	--	02	40	60	--	--

Course Description

This course develops mathematical concepts and techniques required to analyze and solve engineering problems. It covers probability and statistics, differential equations, vector calculus, and numerical methods with applications in engineering and computational systems. The course emphasizes mathematical modeling, problem-solving, data analysis, and numerical computation.

Relevance

The course provides essential mathematical tools for subjects such as Robotics, Artificial Intelligence and Machine Learning, Embedded Systems, and IoT. It develops analytical and computational skills required for solving real-world engineering problems.

Prerequisite: Linear Algebra and Calculus, Differential Equations.

Bridge Content -

Course Objectives:

1. To develop understanding of probability and statistical methods for data analysis in engineering systems.
2. To develop the ability to solve higher-order linear differential equations and apply partial differential equations to model and analyse engineering problems.
3. To develop the ability to apply vector calculus concepts and integral theorems for modeling and analyzing motion, force, and field-related problems in automation and robotics.
4. To apply numerical methods for solving complex engineering and robotic system problems.

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

CO	Course Outcome	Bloom's Level
CO1	**Apply** probability distributions and statistical techniques to **Analyze** and interpret data in engineering and robotic systems.	3
CO2	**Solve** higher-order linear and simultaneous differential equations and **Apply** partial differential equations to engineering applications.	3
CO3	**Apply** vector calculus and integral theorems to **Analyze** engineering systems involving robotic motion, force fields, and spatial transformations.	3
CO4	Use numerical methods to **Solve** complex algebraic and differential equations in engineering and robotic simulations.	3

Course Contents			
Unit 1	**Probability Theory and Statistics**	**8 Hrs.**	**CO1**

Statistics -Measures of central tendency; measures of dispersion, correlation coefficient; regression analysis, Fitting of the curve by Least Square method.

Probability -Bayes' theorem; probability distributions (Binomial, Poisson, Normal,); Hypothesis Testing – Chi-square test.

Exemplars / Practical Applications, Usage:

Analysis of engineering and business data, identification of relationships between variables, predict trends, risk assessment, quality control, reliability analysis, and data-driven decision-making.

Unit 2	Linear Differential Equations and Applications of Partial Differential Equations	8 Hrs.	CO2

Linear differential equations of higher order; complementary function; particular integral by shortcut method and method of variation of parameters, simultaneous linear Differential equation, Applications in engineering. Applications of partial differential equations: wave equation, one-dimensional and two-dimensional heat flow equations and their solutions with applications in engineering problems

Exemplars / Practical Applications, Usage:
Modeling of engineering systems such as electrical circuits, mechanical vibrations, dynamic systems. Wave propagation in engineering structures, materials, and communication systems.

Unit 3	Vector Calculus	8 Hrs.	CO3

Vector algebra, Gradient-directional derivative, divergence and curl of vector functions, solenoidal and irrotational vector fields.
Vector Integration –Line Integral, Surface integral, Green's lemma, Gauss's Divergence Theorem, Stoke's Theorem.

Exemplars / Practical Applications, Usage:
Analyze electric and magnetic fields, fluid flow, force fields, and spatial variations in physical systems. Calculate quantities such as flux, circulation, and field distributions in electrical, communication, and electromagnetic engineering systems.

Unit 4	Numerical Methods	8 Hrs.	CO4

Solution of algebraic equations using Gauss elimination; Jacobi method; Gauss-Seidel method; Cholesky decomposition; numerical solution of ordinary differential equations using Euler's method, Modified Euler's method, and Runge-Kutta methods; Application in simulation of engineering and robotic systems.

Exemplars / Practical Applications, Usage:
Solution of complex engineering equations and simulate dynamic systems where analytical solutions are difficult to obtain. Robotics and engineering simulations for modeling motion, system response, control, and performance.

Textbooks:

- Higher Engineering Mathematics – *B. S. Grewal*
- Advanced Engineering Mathematics – *Erwin Kreyszig*
- Probability and Statistics for Engineers and Scientists – *Ronald E. Walpole et al.*
- Numerical Methods for Engineers – *Steven C. Chapra*

Reference Books:

- Introduction to Probability Models – *Sheldon M. Ross*
- Applied Numerical Methods with MATLAB for Engineers and Scientists – *Steven C. Chapra*
- Operations Research – *Hamdy A. Taha*
- Signals and Systems – *Alan V. Oppenheim & Alan S. Willsky*

MOOCs / NPTEL Links and additional reading material:

1. **Statistics & Probability**: Prof. S. Dharmaraja, IIT Delhi
   https://youtu.be/1NPBMF2T8Iw?si=NFlZByxt-xPgKIcM
2. **Applications to Linear Differential Equations and Partial Differential Equations**: Prof. A. K. Nandakumaran, P. S. Datti & Raju K. George, IISc Bangalore
   https://youtu.be/NBcGLLU90fM?si=6ifrbk6-47PXTaEY
3. **Transforms :** By Prof. Adrijit Goswami , IIT Kharagpur.

https://youtu.be/sbDuvBc8m8M?si=UnDx0dD52KrPXlqy

4. **Vector Calculus :** By Prof. Hari Shankar Mahato , IIT Kharagpur.
   https://youtu.be/MPGPX7UkKsU?si=zzEUCSkLxQVUsr0g
5. **Numerical Methods for Engineering Systems** : By Prof. Saurabh Basu , IIT Guwahati.
   https://youtu.be/pOtnzAXlXvI?si=oHNUDpbvTY8L5RCv

Strength of CO-PO-PSO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	2	2	-	-	-	-	2	2	1	-	2	2	1	1
CO2	3	3	-	-	-	-	2	2	1	-	2	3	2	1
CO3	3	3	-	-	-	-	2	2	1	-	2	3	3	2
CO4	3	3	-	-	-	-	2	2	1	-	2	2	3	3
Avg.	2.75	2.75	-	-	-	-	2.00	2.00	1.00	-	2.00	2.5	2.25	1.75

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4
CCE 1	10	10		
CCE 2			10	
CCE 3				10
ESE	15	15	15	15
Total	25	25	25	25

Assessment Pattern

BT Level	CCE				ESE			
	CCE1		CCE2	CCE3				
CO	CO1	CO2	CO3	CO4	CO1	CO2	CO3	CO4
L1	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓	✓	✓	✓	✓	✓	✓
L4								
L5								
L6								

This course serves as a prerequisite for / maps with the following future courses:

1. Artificial Intelligence
2. Machine Learning
3. Programming for IoT systems
4. Embedded Systems for Robotics
5. Robotics and Automation

Job Mapping:

Job opportunities that one can get after learning this course:

1. Automation Engineer
2. Robotics Engineer
3. Control Systems Engineer
4. Data Analyst / Data Scientist (Industrial Applications)
5. AI/ML Engineer
6. Embedded Systems Engineer
7. Mechatronics Engineer
8. Simulation and Modelling Engineer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			IV
Course:	**Data Analytics with Python and R**			**Course Code:**			R25-EC-VSEC-216
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
01	02	-	02	-	-	25	25

Course Description:

This course provides hands-on experience in data analytics using Python and R, covering core concepts such as data manipulation, preprocessing, and visualization. Students learn to work with libraries like NumPy, Pandas, Matplotlib, and Seaborn for effective data analysis. It also introduces R programming fundamentals, including loops, functions, and data frames. The course emphasizes practical skills for importing, processing, and analyzing real-world datasets.

Relevance:

This course equips students with practical skills in data analysis and visualization, which are highly demanded in industries like IT, finance, and research. It helps in building a strong foundation for careers in data science, analytics, and machine learning.

Prerequisite:

1. Basic knowledge of programming concepts.
2. Familiarity with mathematics/statistics fundamentals.

Bridge Content: --

Course Objectives:

1. To understand the fundamentals of data analytics and basic concepts of Python and R programming.
2. To apply Python libraries like NumPy, Pandas, Matplotlib, and Seaborn for data manipulation and visualization.
3. To analyze datasets using data preprocessing techniques such as handling missing values, normalization, and binning.
4. To develop programs in R using loops, functions, and data frames for data handling tasks.
5. To evaluate and interpret results from data analysis to support decision-making.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Understand** the basic concepts of data analytics and programming in Python and R.	2
CO2	**Apply** Python libraries to perform data manipulation, analysis, and visualization.	3
CO3	**Perform** data preprocessing techniques such as handling missing values, normalization, and data formatting.	3
CO4	**Implement** R programs using loops, functions, and data frames for data analysis tasks.	3
CO5	**Analyze** and interpret datasets to derive meaningful insights for decision-making.	4

List of Practical: (Any 08)			
Experiment No.1	**To perform array processing using Numpy package in Python.**	**02 Hrs.**	**CO1**

Objective:
- To understand the basic environment setup for Python and R programming.
- To learn fundamental syntax and perform simple data operations.

Associated Tasks:
1. Install and configure Python (Anaconda/Jupyter) and R (RStudio).
2. Write basic programs for input/output and simple calculations.

Exemplars and Utility:
Demonstration of basic programs like arithmetic operations and variable usage.
Helps students build a strong foundation for further data analytics experiments.
Useful for developing confidence in handling programming tools and environments.

Experiment No.2	**To import, export and analyse data in Python using Pandas library.**	**02 Hrs.**	**CO1**

Objective:
- To understand data types and data structures in Python and R.
- To perform basic operations on arrays, lists, and data frames.

Associated Tasks:
1. Create and manipulate lists, tuples, arrays (Python) and vectors, matrices, data frames (R).
2. Write programs to store and retrieve data efficiently.

Exemplars and Utility:
Examples of handling structured data using lists and data frames.
Helps in organizing and managing data for analysis tasks.

Experiment No.3	**To perform data visualization in Python with Matplotlib.**	**02 Hrs.**	**CO2**

Objective:
- To understand the basics of data visualization using Matplotlib.
- To create different types of plots for representing data effectively.

Associated Tasks:
1. Install and import Matplotlib library in Python environment.
2. Create plots such as line chart, bar graph, histogram, and pie chart.
3. Customize plots using labels, titles, legends, and colors.

Exemplars and Utility:
Visualization of datasets using different graph types for better understanding.
Helps in identifying patterns, trends, and relationships in data.
Useful for presenting analytical results in a clear and meaningful way.

Experiment No.4	**To perform data visualization in Python with Seaborn.**	**02 Hrs.**	**CO1, CO2**

Objective:
- To understand advanced data visualization techniques using Seaborn.
- To explore statistical plots for better data interpretation.

Associated Tasks:
1. Install and import Seaborn library along with Matplotlib.
2. Create plots such as scatter plot, box plot, heatmap, and pair plot.

Exemplars and Utility:
Visualization of complex datasets with enhanced and attractive plots.

Experiment No.5	**To perform following Data preprocessing on a given dataset-** • **Dealing with Missing Values in Python** • **Data Formatting in Python** • **Data Normalization in Python** • **Binning in Python**	**02 Hrs.**	**CO3**

Objective:
- To understand the importance of data preprocessing in data analytics.
- To learn techniques like handling missing values, formatting, normalization, and binning.

Associated Tasks:
1. Handle missing data using methods like deletion and imputation.
2. Perform data formatting and normalization using appropriate techniques.

Exemplars and Utility:
Demonstration of cleaning and preparing raw datasets for analysis.
Helps improve data quality and accuracy of analytical results.

Experiment No.6	**Write a program in R to understand the basics of R programming, including data types, variables, and basic operations.**	**02 Hrs.**	**CO5**

Objective:
- To understand fundamental concepts of R programming such as data types and variables.
- To perform basic operations and computations in R.

Associated Tasks:
1. Write R programs to declare variables and use different data types (numeric, character, logical).
2. Perform arithmetic and logical operations using R.
3. Execute simple scripts in R Studio to observe outputs.

Exemplars and Utility:
Examples of basic R programs for calculations and data handling.
Helps in building a strong foundation for advanced data analysis in R.
Useful for beginners to become familiar with R programming environment.

Experiment No.7	**Implement R-Loops with different examples.**	**02 Hrs.**	**CO4**

Objective:
- To understand the concept and usage of loops in R programming.
- To implement different types of loops for iterative operations.

Associated Tasks:
1. Write programs using for, while, and repeat loops in R.
2. Execute examples such as printing sequences, summation, and factorial calculation.

Exemplars and Utility:
Examples demonstrating loop-based solutions for repetitive tasks.
Helps in automating calculations and data processing steps.

Experiment No.8	**Learn the basic of functions in R and implement with examples.**	**02 Hrs.**	**CO4**

Objective:
- To understand the concept of user-defined and built-in functions in R.
- To learn how to create and use functions for reusable code.

Associated Tasks:
1. Write user-defined functions in R with parameters and return values.
2. Use built-in functions for basic operations and data handling.

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3. Execute examples such as sum, average, and factorial using functions.

Exemplars and Utility:

1. Examples of modular programming using functions in R.
2. Helps in reducing code redundancy and improving program structure.
3. Useful for developing efficient and reusable data analysis programs.

Experiment No.9	**Implement data frames in R. Write a program to join columns and rows in a data frame using c bind() and r bind() in R.**	**02 Hrs.**	**CO4**

Objective:

- To understand the structure and usage of data frames in R.
- To learn how to combine data using column and row binding functions.

Associated Tasks:

1. Create and manipulate data frames in R with different data types.
2. Use cbind() to join columns and rbind() to combine rows.
3. Perform basic operations like accessing, modifying, and summarizing data.

Exemplars and Utility:

Examples demonstrating merging datasets using cbind() and rbind().

Helps in organizing and managing structured data efficiently.

Experiment No.10	**Write a program in R to import and export data in different formats such as CSV and Excel.**	**02 Hrs.**	**CO4**

Objective:

- To understand methods of importing and exporting data in R.
- To work with different file formats such as CSV and Excel.

Associated Tasks:

1. Write programs to import data using functions like read.csv() and read_excel().
2. Export data to files using write.csv() and similar functions.
3. Verify and manage data after import/export operations.

Exemplars and Utility:

Examples of reading and writing datasets in CSV and Excel formats.

Useful for data sharing, storage, and integration across different platforms.

Textbooks:

1. Chantal D. Larose, Daniel T. Larose, Data Science Using Python and R, Wiley, 1st Edition, ISBN-13: 9781119526810
2. Chantal D. Larose, Daniel T. Larose, Shaukat Ali Shahee, Fundamentals of Data Science Using Python and R, Wiley India, ISBN: 9789363860759

Reference Books:

1. Jake Vander Plas and O'Reilly, ―Python Data Science Handbook: Essential Tools for Working with Data‖
2. Wes McKinney and O'Reilly, ―Python for Data Analysis‖, 2nd Edition.
3. Joel Grus and O'Reilly, ―Data Science from Scratch: First Principles with Python‖.
4. David L. Olson, Desheng Dash Wu, et al., Business Analytics with R and Python, Springer, 1st Edition, ISBN (eBook): 978-981-97-4772-6
5. Hadley Wickham, Garrett Grolemund, R for Data Science, O'Reilly, 1st Edition, ISBN-13: 9781491910396

MOOCs Links and additional reading material:
1. https://swayam.gov.in/nd1_noc20_cs46/ 2. https://www.coursera.org/learn/data-analysis-with-python

Strength of CO-PO-PSO Mapping

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	2	0	0	0	0	0	2	2	1	2
CO2	2	3	0	2	3	0	0	0	0	0	2	2	2	3
CO3	2	3	0	3	2	0	0	0	0	0	2	3	2	2
CO4	2	2	2	2	3	0	0	0	0	0	2	2	3	2
CO5	3	3	2	3	2	0	0	0	2	0	3	3	2	2
Avg.	2.4	2.6	0.8	2.0	2.4	0	0	0	0.4	0	2.2	2.4	2.0	2.2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

	CCE based on ARCV							
BT Level	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8
CO	CO1	CO1	CO2	CO1-2	CO3	CO5	CO4	CO4
L1	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓
L3			✓	✓	✓	✓	✓	✓
L4						✓		
L5								
L6								

This course serves as a prerequisite for / maps with the following future courses:

- Data Science & Visualization
- Big Data Technologies
- Machine Learning

Job Mapping:

- Data Analyst: Perform data cleaning, visualization, and interpretation to support business decisions.
- Junior Data Scientist: Apply basic analytics, preprocessing, and programming skills for model building.
- Data Engineer (Entry-Level): Handle data processing, transformation, and integration tasks.

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**		III	
Course:	**Modern Indian Language and Technical Writing**			**Course Code:**		R25-EC-AEC-217	
Teaching Scheme (Hrs. /Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credits**	**CCE**	**ESE**	**TW**	**PR**
1	2	-	2	-	-	50	-

Course Description: Modern Indian Language & Technical Writing focuses on developing effective communication, technical writing, and professional documentation skills. The course enhances students' reading, writing, speaking, and presentation abilities required in academic and professional environments while promoting expression through Indian languages and cultural understanding.

Course Relevance: The course improves communication proficiency, technical documentation, and workplace interaction skills. It supports employability, professional communication, report writing, and overall personality development for engineering students.

Prerequisite: Basic reading, writing, and communication skills in English and/or any Modern Indian Language.

Bridge Content: Fundamentals of language communication, grammar basics, vocabulary enhancement, and introduction to professional writing practices.

Course Objectives:

1. To develop effective communication skills in Modern Indian Language and English for academic and professional use.
2. To enhance technical writing, documentation, and professional correspondence skills.
3. To prepare students for software project documentation, presentations, and workplace communication.
4. To develop digital professionalism, presentation abilities, and awareness of modern collaborative tools.

Course Outcomes: After learning the course, students will be able to:

CO	Course Outcome	Bloom's Level
CO1	**Demonstrate** effective oral and written communication skills in Modern Indian Language and professional environments.	2
CO2	**Apply** principles of technical and professional communication for preparing emails, resumes, reports, and presentations.	3
CO3	**Develop** technical content and documentation such as project abstracts, manuals, blogs, and software-related documents.	3
CO4	**Prepare** software project documents and use digital collaboration tools for professional and academic activities.	3

Course Contents			
Unit 1	**Expressing Ourselves in Mother Tongue**	**3 Hrs.**	**CO1**
Effective oral and written communication in mother tongue, Self-introduction, Group discussion and public speaking, Formal letters, Notices and applications, Vocabulary for science and technology, Translation of common technical terms into mother tongue, Importance of regional language in professional and social life			

Exemplars:
- Writing formal applications and notices in mother tongue
- Delivering self-introduction and public speeches
- Translation of technical terms into regional language
- Preparing vocabulary lists related to science and technology

Case Studies:
- Case study on effective communication in regional language during social interaction
- Case study on the importance of mother tongue in education and professional life

Unit 2	Fundamentals of Technical and Professional Communication	4 Hrs.	CO2

Principles of technical writing, Clarity, accuracy, brevity and coherence, Grammar, punctuation and sentence construction, Official email writing and correspondence, Resume/CV writing, Interview skills and group discussion techniques, Professional profile creation on LinkedIn.

Exemplars:
- Drafting professional emails and official correspondence
- Preparing resumes/CVs and LinkedIn profiles
- Conducting mock interviews and group discussions
- Creating professional presentation slides

Case Studies:
- Case study on professional communication in workplace environments
- Case study on resume screening and interview performance techniques

Unit 3	Technical Writing and Content Development	4 Hrs.	CO3

Project abstract writing, technical report writing, User manuals and installation guides, writing code comments and README files, Preparation of meeting agenda and minutes, Documentation standards in projects, Blog writing on technology topics, writing for websites and mobile apps, Proposal writing for start-up ideas and innovation pitching

Exemplars:
- Writing project abstracts and technical reports
- Preparing user manuals and installation guides
- Writing code comments and README documentation
- Creating blogs on emerging technology topics

Case Studies:
- Case study on technical documentation practices in software companies
- Case study on start-up proposal writing and innovation pitching

Unit 4	Software Project Documentation and Digital Presentation Skills	4 Hrs.	CO4

Need of documentation in software projects, Overview of SDLC, Software Requirement Specification (SRS) basics, Project proposal writing, Bug report writing, Test report writing, Release notes and version documentation, Report writing tools and formatting techniques, PPT design principles and effective slide creation, Seminar presentation skills, Digital etiquette and online professionalism, Responsible use of AI-assisted writing tools, Introduction to GitHub, Basics of Competitive Programming, Flex/Logo/Poster design basics

Exemplars:
- Preparing Software Requirement Specification (SRS) documents
- Writing bug reports, test reports, and release notes
- Designing technical posters, logos, and presentations
- Creating GitHub repositories with documentation

Case Studies:
- Case study on documentation workflow in software development projects

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- Case study on collaborative project management using GitHub
- Case study on responsible use of AI-assisted writing tools in academics and industry

List of Practical			
Experiment no. 1	**Effective Oral Communication and Public Speaking in Mother Tongue**	**2 Hrs.**	**CO1**
Problem Statement: Prepare and deliver a self-introduction and short speech in mother tongue on a technical or social topic. **Associated Task:** Deliver self-introduction and short speech in regional language. **Exemplars:** Public speaking, verbal communication. **Utilities/Tools:** PPT, microphone			
Experiment no. 2	**Formal Application, Notice, and Letter Drafting**	**2 Hrs.**	**CO1**
Problem Statement: Draft formal applications, notices, and official letters for academic and professional communication. **Associated Task:** Prepare formal written communication documents **Exemplars:** Applications, notices, official letters **Utilities/Tools:** MS Word, Google Docs			
Experiment no. 3	**Professional Resume and LinkedIn Profile Development**	**2 Hrs.**	**CO2**
Problem Statement: Create a professional resume/CV and LinkedIn profile for internship and placement opportunities. **Associated Task:** Create professional profile documents **Exemplars:** Resume/CV, LinkedIn profile **Utilities/Tools:** MS Word, LinkedIn			
Experiment no. 4	**Official Email Writing and Group Discussion Practice**	**2 Hrs.**	**CO2**
Problem Statement: Draft professional emails and participate in group discussion activities on technical topics. **Associated Task:** Draft professional emails and participate in GD activity **Exemplars:** Email communication, group discussion **Utilities/Tools:** Gmail, presentation tools			
Experiment no. 5	**Project Abstract and Technical Report Preparation**	**2 Hrs.**	**CO3**
Problem Statement: Prepare a project abstract and technical report for a mini project using standard documentation practices. **Associated Task:** Prepare technical project documentation **Exemplars:** Project abstract, technical report **Utilities/Tools:** MS Word, report templates			
Experiment no. 6	**UI/UX Design Prototype Creation using tools**	**2 Hrs.**	**CO3**
Problem Statement: Design a simple user interface prototype for a website or mobile application using UI/UX design principles. **Associated Task:** Create wireframes and interface prototypes for digital applications **Exemplars:** Login page design, mobile app interface, dashboard prototype **Utilities/Tools:** Figma, Canva, Adobe XD or similar UI/UX design tools			
Experiment no. 7	**Technology Blog and Technical Content Writing**	**2 Hrs.**	**CO3**
Problem Statement: Write a technical blog/article on emerging technologies for digital platforms. **Associated Task:** Write blog/article on emerging technology topics **Exemplars:** Technical blog, web content			

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Utilities/Tools: Blogger, Word processor

Experiment no. 8	**Software Requirement Specification and Project Proposal Writing**	**2 Hrs.**	**CO4**

Problem Statement: Prepare a Software Requirement Specification (SRS) document and project proposal for a software system.
Associated Task: Prepare SRS and software project proposal
Exemplars: SRS document, proposal report
Utilities/Tools: Documentation templates

Experiment no. 9	**Bug Reporting and Software Test Documentation**	**2 Hrs.**	**CO4**

Problem Statement: Create bug reports and software test reports for identifying and documenting software issues.
Associated Task: Create testing and maintenance reports
Exemplars: Bug report, test report
Utilities/Tools: Testing/report tools

Experiment no. 10	**Technical Presentation and GitHub Repository Documentation**	**2 Hrs.**	**CO4**

Problem Statement: Create a technical presentation and maintain project documentation using GitHub repository tools.
Associated Task: Create presentation and upload project documentation
Exemplars: PPT presentation, GitHub repository
Utilities/Tools: PowerPoint, GitHub, Canva

Experiment no. 11	**AI-Assisted Technical Writing and Documentation**	**2 Hrs.**	**CO4**

Problem Statement: Exploring the Use of Artificial Intelligence Tools for Effective Technical Writing and Professional Documentation

Associated task:

- Select any one AI tool such as ChatGPT, Google Gemini, or Grammarly.
- Choose any engineering-related topic of your interest.
- Use the selected AI tool to:
  - Generate technical content
  - Improve grammar and sentence formation
  - Organize the document professionally
  - Create headings, summaries, or conclusions
- Prepare a technical report containing:
  - Introduction to the AI tool
  - Engineering topic details
  - Screenshots/prompts used with the AI tool
  - Advantages and limitations of the tool
  - Ethical considerations in AI usage
  - Conclusion and learning outcomes
- Submit the final report in PDF format.

Exemplars: AI-generated technical report, AI-assisted content editing, professional documentation using AI tools
Utilities/Tools: ChatGPT, Google Gemini, Grammarly, MS Word/PDF editor

Textbooks:

1. M. Ashraf Rizvi, Priyadarshi Patnaik, Effective Technical Communication, 3rd Edition, McGraw Hill Education, 2024.
2. Meenakshi Raman, Sangeeta Sharma, Technical Communication: Principles and Practice, 3rd Edition, Oxford University Press, 2015.
3. Meenakshi Raman, Sangeeta Sharma, Fundamentals of Technical Communication, Oxford University Press, 2011.

Reference Books:

1. Gerald J. Alred, Charles T. Brusaw, Walter E. Oliu, Handbook of Technical Writing, 12th Edition, Bedford/St. Martin's, 2019.
2. William Zinsser, On Writing Well, 30th Anniversary Edition, HarperCollins Publishers, 2006.
3. Phillip A. Laplante, Technical Writing: A Practical Guide for Engineers and Scientists, 2nd Edition, CRC Press, 2012.
4. Markel M. H., Technical Communication, 11th Edition, Bedford/St. Martin's, 2015.

MOOCs Links and additional reading material:

1. Technical Communication for Engineers – www.onlinecourses.nptel.ac.in/noc24_ge37/preview
2. Technical English for Engineers – www.onlinecourses.nptel.ac.in/noc24_hs175/preview
3. Introduction to Technical Writing – www.coursera.org/learn/technical-writing-introduction
4. Technical Communication Specialization – www.coursera.org/specializations/technical-communication
5. Writing Effective Technical Documentation – www.coursera.org/learn/writing-effective-technical-documentation-course
6. Google Technical Writing Courses – www.developers.google.com/tech-writing
7. SWAYAM Online Courses – www.swayam.gov.in
8. GitHub Documentation and README Examples – www.github.com
9. LinkedIn Learning – Professional Communication Courses – www.linkedin.com/learning
10. Technical Writing and Programming Articles – www.geeksforgeeks.org
11. Purdue OWL Writing Resources – www.owl.purdue.edu
12. Atlassian Documentation Guidelines – www.atlassian.com/software/confluence/resources/guides/documentation

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	–	–	1	–	1	2	3	1	1	3	1	1
CO2	1	2	1	1	2	–	1	2	3	2	1	3	2	2
CO3	1	2	2	1	2	–	1	2	2	2	1	3	2	2
CO4	1	2	2	2	3	–	1	2	2	2	2	3	3	2
Avg.	1	1.75	1.67	1.33	2	–	1	2	2.5	1.75	1.25	3	2	1.75

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT Level	CCE based on ARCV										
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8	Exp. 9	Exp. 10	Exp.11
CO	CO1	CO1	CO2	CO2	CO3	CO3	CO3	CO4	CO4	CO4	CO4
L1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L3			✓	✓	✓	✓	✓	✓	✓	✓	✓
L4											
L5											
L6											

This course serves as a prerequisite for / maps with the following future courses:
This course provides foundational communication, technical writing, documentation, and presentation skills required for advanced courses such as Software Engineering, Web Development, UI/UX Design, Project Work, and Technical Seminar. It also supports future learning in software documentation, professional communication, research, entrepreneurship, internship training, and collaborative software development practices.

Job Mapping:

- Technical Content Writer
- Documentation Assistant
- Technical Support Executive
- Digital Content Creator

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			IV
Course:	**Entrepreneurship Development**			**Course Code:**			R25-EC-EEM-218
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
02	-	-	02	50	-	-	-

Course Description:

This course aims to develop an entrepreneurial mindset among degree-level students by providing comprehensive knowledge of entrepreneurship concepts, processes, and practices. It introduces the role of entrepreneurs in economic development and emphasizes entrepreneurship as a viable and desirable career option, particularly for engineering and technology graduates. The course builds a strong foundation in identifying business opportunities, setting entrepreneurial goals, and developing essential skills such as communication, analytical thinking, and problem-solving.

The course further explores the functioning of a market economy, the concept of cost, and the role of government in business activities. Students are exposed to different forms of business ownership, including starting a new venture, managing an existing enterprise, and operating a franchise, along with an understanding of legal structures applicable to businesses.

Relevance:

This course equips students with essential entrepreneurial knowledge and practical skills required to identify business opportunities, create viable business plans, and manage enterprises effectively.

Prerequisite: There is no formal prerequisite for this syllabus. However, a basic understanding of economics, management principles, and general awareness of business environments will be beneficial for better comprehension at the degree level.

Bridge Content: - It may include basic concepts of economics, fundamentals of management, introduction to business terminology, and elementary accounting principles to ensure students have a common foundation before undertaking the course.

Course Objectives:

1. To provide students with an understanding of the fundamentals of entrepreneurship and the role of entrepreneurs in economic development.
2. To explain the functioning of a market economy, cost concepts, and different forms of business ownership.
3. To enable students to develop a structured business plan through market research, location planning, and marketing strategies.
4. To equip students with knowledge of business operations including human resource management, accounting practices, and legal, ethical, and social responsibilities.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Understand** fundamentals of entrepreneurship and identify business opportunities.	2
CO2	**Explain** market economy concepts and forms of business ownership.	2
CO3	**Develop** a basic business plan using market research and marketing strategies.	4
CO4	**Apply** principles of business operations, accounting, and legal responsibilities.	3

Course Content			
Unit 1	**Fundamentals of Entrepreneurship**	**7 Hrs.**	**CO1**
Entrepreneur: Present and Past, Entrepreneurship for an Engineer, Identify Business Opportunities and Set Goals. Entrepreneurs Skills: Communication Skills, Math Skills, Problem-Solving Skills.			
Exemplars / Practical Applications and usage: Case studies of successful entrepreneurs and start-ups in engineering and technology sectors. Identification of real-world business opportunities based on local, societal, or technological needs.			
Unit 2	**Market Economy and Ownership**	**7 Hrs.**	**CO2**
Entrepreneurs in a Market Economy: An Economy, The Concept of Cost, Government in a Market Economy. Select a Type of Ownership: Run an Existing Business, Own a Franchise or start a Business, Choose the legal form business			
Exemplars / Practical Applications and usage: Analysis of real-world business ownership models such as startups, franchises, and SMEs operating in a market economy.			
Unit 3	**Business Plan**	**8 Hrs.**	**CO3**
Develop a Business Plan: Necessity a business plan, What goes into a business Plan? Create an effective business plan. Identity and Meet a Market Need: The value of market research, How to perform market research, Identify your competition. Choose Location & Setup for Business: Choose a retail business location, Choose a location for a non-retail business, Obtain space and design the physical layout, Purchase equipment, supplies and inventory. Market Business: The Marketing mix-product, distribution, price, The Marketing mix-promotion, Set marketing goals			
Exemplars / Practical Applications and usage: Preparation of a real-time business plan based on market research, customer needs, and competitive analysis. Application of marketing mix strategies and location planning for launching and sustaining a business venture.			
Unit 4	**Operation of Business**	**8 Hrs.**	**CO4**
Hire and Manage a Staff: Hire Employees, Create a compensation package, Manage staff, Record Keeping and Accounting: Set up a record keeping system, Understand basic accounting, Tracking inventory Meeting Legal, Ethical, and Social Obligation: Understanding legal requirements, Ethical issues in business, meeting social responsibilities.			
Exemplars / Practical Applications and usage: Practical exposure to employee hiring, compensation planning, and basic accounting practices used in small and medium enterprises. Application of legal, ethical, and social responsibility principles in day-to-day business operations.			
Course Projects:			
1. Market Feasibility Study of a Small Business or Franchise Idea: Conduct market research to analyze customer needs, competitors, pricing, and demand to evaluate the feasibility of starting a new business or franchise in a selected area.			
Textbooks:			
1. Cynthia L. Greene, _Entrepreneurship Ideas in Action_, South Western Publishing Company (A Division of Thomson Learning Inc.,), First Edition.2000. 2. G.S. Batra, _Entrepreneurship Development_, Deep & Deep Publications : 1st Edition.			

Reference Books:

1. G. S. Batra , "Development of Entrepreneurship ", Deep and Deep Publications, New Delhi
2. Ashwathappa, "Human Resource Management", Mc-Graw-Hill Education (India) Pvt. Ltd.
3. M.Y. Khan and P. K. Jain, "Financial Management", Mc-Graw-Hill Education (India) Pvt. Ltd.
4. Kenneth C. Laudon and Jane P. Laudon, "Management Information Systems", EighthEdit ion, Pearson Education.

MOOCs Links and additional reading material:

1. https://onlinecourses.nptel.ac.in/noc25_mg81/preview
2. https://www.coursera.org/browse/business/entrepreneurship?utm_source
3. https://onlinecourses.swayam2.ac.in/ntr25_ed103/preview?utm_source

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	--	--	1	--	--	1	1	1	2	1	--
CO2	2	2	1	--	--	2	--	1	1	1	2	2	--	--
CO3	2	3	3	2	--	1	--	--	2	2	3	3	1	--
CO4	2	2	2	--	--	3	2	2	2	2	3	2	--	--
Avg.	2	2	2	1	--	2	1	1	2	2	2	2	1	--

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4
CCE 1	13			
CCE 2		12		
CCE 3			13	
CCE 4				12
Total	13	12	13	12

Assessment Pattern

BT Level	CCE			
	CCE1	CCE2	CCE3	CCE4
CO	CO1	CO2	CO3	CO4
L1	✓	✓	✓	✓
L2	✓	✓	✓	✓
L3			✓	✓
L4			✓	
L5				
L6				

This course serves as a prerequisite for / maps with the following future courses: -
Job Mapping: Job opportunities that one can get after learning this course: 1. Entrepreneur / Startup Founder 2. Business Development Executive / Manager 3. Project Coordinator / Project Executive

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**	IV		
Course:	**Analog and Digital Communication Lab**			**Course Code:**	R25-EC-PCC-219		
Teaching Scheme				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**OR**	**PR**
-	02	-	01	-	-	25	-

Course Description:
This course will cover the concept of modulation, followed by a detailed discussion of analog modulation and demodulations techniques of AM and FM. The course will also cover sampling and quantization, various modulation and demodulation techniques in digital communication. It also discusses source coding, error detection & correction algorithms. It also covers use of various software tools such as MATLAB to test the hardware

Relevance:
The knowledge and skills acquired serve as a basis for wireless communications, signal processing

Prerequisite: Signal and System, Analog and Digital Circuits

Bridge Content: - Calculus, Fourier series representation, Analog to Digital signal conversion process.

Course Objectives:

1. To provide an in-depth introduction of modulation process and different techniques of amplitude and frequency modulation
2. To demonstrate the Sampling Theorem by converting a continuous analog signal into discrete samples using Pulse Amplitude Modulation **(**PAM**)** techniques
3. To design and simulate a Pulse Code Modulation (PCM) system, Delta and adaptive delta modulation using MATLAB and Simulink to understand the step-by-step process of converting an analog signal into a digital bit stream (encoding) and recovering the original signal (decoding).
4. To introduce digital communication and various digital modulation schemes like ASK,FSK PSK and QPSK
5. To identify the need of data coding and error detection/correction mechanism.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Analyze** the different techniques of amplitude modulation and frequency modulation	4
CO2	**Differentiate** between Natural and Flat-top sampling based on pulse shape and **Validate** the Nyquist criteria by observing how the original signal is perfectly reconstructed when the sampling rate is sufficient.	4
CO3	Ability to model sampling, quantization, and encoding, and to **analyze** the impact of quantization noise on signal recovery.	4
CO4	**Evaluate** various digital modulation schemes like ASK,FSK PSK and QPSK	4
CO5	**Test** SDR application in GNU Radio	3

List of Practical: (Any 10)			
Experiment No. 1	**AM Generation and Detection: Measurement of modulation index by graphical method.**	**02 Hrs.**	**CO1**

Objective:

- To Generate the AM (DSB-FC)signal and detect it using diode rectifier detector

Associated Tasks:

1. Draw the block diagram of AM Modulator & Demodulator.
2. Identify different Blocks of AM Modulator & Demodulators
3. Adjust and apply modulating and carrier signal to get proper AM Signal.
4. Observe Modulated signal & measure modulation index.
5. Draw modulating signal , carrier signal, modulated signal & demodulated signal for m<1,m=1 & m>1

Exemplars and Utility:

National radio broadcasts, satellite TV, TV picture, music and video transmission instruments.

Experiment No. 2	**FM Generation and Detection: Measurement of modulation index and Bandwidth & detection by Phase Lock Loop (IC 565)**	**02 Hrs.**	**CO1**

Objective:

- To Generate the FM signal and detect it using IC 565 PLL

Associated Tasks:

1. Draw the block diagram of FM Modulator and Demodulator.
2. Identify different Blocks of FM Modulator and Demodulators
3. Adjust and apply modulating and carrier signal to get proper FM Signal.
4. Observe Modulated signal and note change in frequency.
5. Calculate modulation index and bandwidth.
6. Draw modulating signal , carrier signal, modulated signal & demodulated signal

Exemplars and Utility:

National radio broadcasts, satellite TV, TV sound, music and video transmission instruments

Experiment No. 3	**Verification of Sampling Theorem by using PAM Techniques (Flat top and Natural sampling) and reconstruction of original signal**	**02 Hrs.**	**CO2**

Objective:

- To Verify Sampling Theorem by using PAM Techniques (Flat top and Natural sampling) and reconstruct the original signal, also Observe Aliasing Effect.

Associated Tasks:

1. Draw the block diagram of Flat top and Natural sample signal generation and reconstruction.
2. Identify different blocks as per diagram on kit
3. Adjust and apply modulating & sampling signal (which satisfy Nyquist criteria) to get proper PAM (Flat top and Natural sampling) Signal.
4. Observe PAM and reconstructed signal
5. Draw modulating signal, sampling signal, sampled signal and reconstructed signal for both techniques
6. Adjust and apply modulating and sampling signal (which not satisfy Nyquist criteria) to get PAM (Flat top and Natural sampling) Signal.
7. Observe aliasing effect in time domain & Repeat step 5

Exemplars and Utility:
Ethernet network, in many micro-controllers for generating control signals, phone modems, High speed digital communication system

Experiment No. 4	**Pulse Code Modulation and Demodulation/ Study of Pulse Code Modulation (PCM) and its demodulation Scheme through SIMULINK Models on MATLAB**	**02 Hrs.**	**CO3**

Objective:
- To study the block diagram of PCM modulator and demodulator

Associated Tasks:
1 Draw the block diagram of PCM modulator and demodulator.
1. Identify different blocks of PCM modulator and demodulator on kit
2. Observe and draw signals at the output of each block.
6. Calculate bit rate, quantization error, and bandwidth.

Exemplars and Utility:
Telephony, space communication and satellite transmission systems, Compact Disks(CD), recording systems

Experiment No. 5	**Delta and Adaptive delta Modulation and Demodulation**	**02 Hrs.**	**CO3**

Objective:
- To study the block diagram of Delta and Adaptive delta Modulation and Demodulation

Associated Tasks:
1 Draw the block diagram of Delta and Adaptive delta Modulation and Demodulation.
7. Identify different blocks of Delta and Adaptive delta Modulation and Demodulation on kit
8. Apply sine wave as input , Observe and draw signals at the output of each block
3. Calculate Step Size, Slope - input signal, DM Signal & ADM signal.
4. Observe and comment on slope overload distortion in DM & ADM
5. Now change input frequency of sine wave and Observe granual noise in DM and ADM.

Exemplars and Utility:
Voice and Audio Coding, ECG signal processing, Video and Image Coding

Experiment No. 6	**To study the ASK , BPSK and FSK Digital modulation and demodulation techniques**	**02 Hrs.**	**CO4**

Objective:
- To study the ASK , BPSK and FSK Digital modulation and demodulation techniques

Associated Tasks:
1 Draw the block diagram of ASK, BPSK and FSK Modulator and Demodulator.
2 Identify different blocks on kit
3 Apply sine wave as input to modulator , Observe & draw signals at the output of each block
4 Repeat steps 2 to 3 for FSK and BPSK.

Exemplars and Utility:
RFID tags and readers, home appliance remote controls, Optical Fiber Communication.

Experiment No.7	**Performance analysis of Linear Block Code using MATLAB/Simulink.**	**02 Hrs.**	**CO5**

Objective:
- To implement the encoding and decoding of a linear block code using MATLAB
- MATLAB and verify the result with theoretical one.

Associated Tasks:

1. Input the message vector (k-bits) and define the parity matrix P
2. Construct the generator matrix G
3. Perform matrix multiplication (mod 2) to encode, using mod (M*G, 2).
4. Introduce a bit error to test the syndrome calculation and correction.
5. Run the code and verify the output in the command window.
6. Compare it with theoretical one.

Exemplars and Utility:

Cryptography, Storage Devices- CDs, DVDs, Blu-ray discs, QR Codes, Satellite communication

Experiment No.8	**To perform modulation and demodulation of QPSK and sketch the relevant waveforms/ To write and simulate the MATLAB code for QPSK Technique.**	**02 Hrs.**	**CO4**

Objective:

- To study the QPSK modulation and demodulation techniques

Associated Tasks:

1 Draw the block diagram of QPSK Modulator and Demodulator.
2 Identify different blocks on kit
3 Apply sine wave as input to modulator , Observe & draw signals at the output of each block

Exemplars and Utility:

Wireless Communication, Cable Modems, Military Communication, RFID Systems

Experiment No.9	**Write program for generation and evaluation of variable length source coding (Huffman coding) using MATLAB**	**02 Hrs.**	**CO5**

Objective:

- To simulate binary Huffman coding to determine code words, average length, entropy, and coding efficiency.

Associated Tasks:

1 Define the source symbols and their probabilities of occurrence.
2 Generate the Huffman code dictionary based on these probabilities using the huffmandict function.
3 Encode a sample sequence of symbols into a binary stream using the created dictionary with the huffmanenco function.
4 Decode the binary stream back into the original symbols using the huffmandeco function to verify the process.
5 Calculate the average code length and source entropy.
6 Evaluate the coding efficiency by comparing the average code length to the entropy.

Exemplars and Utility:

Barcode and QR Codes, Telecommunications- for compressing voice and text data, Compiler Design

Experiment No.10	**To study Simulation of any digital communication system using MATLAB**	**02 Hrs**	**CO5**

Objective:

To build block schematic for communication system from signal generation, modulation, demodulation (signal recovery) on GNU Radio platform to realize SDR.

Associated Tasks:

1. Build block diagram for one by one operation by deciding the parameters and input values necessary for the block.
2. Realize the working of the system as per the set values.

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3. Alter the input parameters and note the changes

Exemplars and Utility:

SDR in advance communication system.

SDR in smart city

Textbooks:

1. George Kennedy, "Electronic Communication Systems" 5th Edition, McGraw-Hill.
2. B P Lathi , Zhi Ding, "Modern Analog and Digital Communication Systems", 4th Edition Oxford University Press.
3. Bernard Sklar, Digital Communication,2/E, Pearson Education India, 2009
4. Ali A. M. H, "Software Defined Radio: Theory and Practice", 2nd edition, (2023) by. Fayed publisher.
5. Matlab Handbook

Reference Books:

1. Taub, Schilling and Saha, "Principles of Communication Systems", 4th Edition, McGraw Hill.
2. A.B Carlson, P B Crully, J C Rutledge, "Communication Systems", 5th Edition, Tata McGraw Hill.
3. Wayne Tomasi, "Electronic Communications System", 5th Edition, Pearson Education.
4. Ranjan Bose, ―Information Theory coding and Cryptography‖, McGraw-Hill, 2nd Ed
5. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition.
6. Markus Dillinger, Siemens A.G., Kambiz Madani, Nancy Alonistioti, "Software Defined Radio: Architectures, Systems and Functions, wiley, 2003.
7. Joseph Mitola," Software Radio Architecture: Object-Oriented Approaches to Wireless Systems Engineering" John Wiley and sons, 2000.

MOOCs Links and additional reading material:

1. https://share.google/qrse6gZ4GtwVRmtmh

Strength of CO-PO-PSO Mapping

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	2								2	2	1
CO2	3	1	1	2								2	2	1
CO3	3	1	1	2								2	2	1
CO4	3	1	1	2								2	2	1
CO5	3	1	1	2								2	2	1
Avg.	3	1	1	2								2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

	CCE based on ARCV									
BT Level	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8	Exp. 9	Exp. 10
CO	CO1	CO1	CO2	CO3	CO3	CO4	CO5	CO4	CO5	CO5
L1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L4	✓	✓	✓	✓	✓	✓		✓		
L5										
L6										

This course serves as a prerequisite for / maps with the following future courses: 1. Wireless Sensor Network 2. Wireless and Cellular Communication 3. Digital Signal Processing 4. Computer Network and Security
Job Mapping: Job opportunities that one can get after learning this course: 1. Telecommunication Sector, Industrial Automation, Networking

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			IV
Course:	**Object Oriented Programming Lab**			**Course Code:**			R25-EC-PCC-220
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
-	02	-	01	-	-	-	25

Course Description:

This course is designed to provide students with practical experience in developing software applications using the principles of Object-Oriented Programming (OOP). The laboratory sessions focus on implementing core OOP concepts such as classes, objects, inheritance, polymorphism, abstraction, and encapsulation using the Java programming language.

Students will learn to design, code, debug, and test Java programs through hands-on exercises and mini-projects. The course also introduces exception handling, file handling, multithreading, graphical user interfaces, and collection frameworks to help students build robust and scalable applications.

Relevance:

The Object Oriented Programming Lab using Java course is highly relevant in the field of computer science and software development as it provides practical knowledge of modern programming techniques used in real-world applications. Object-oriented programming is widely adopted in software industries for developing scalable, secure, and maintainable applications.

Prerequisite: Basic knowledge of programming concepts and problem-solving using C /C++ is required.

Bridge Content: --

Course Objectives:

1. Make the students familiar with basic concepts and techniques of object-oriented programming in Java.
2. Develop an ability to write programs in Java for problem solving.
3. Differentiate between procedural and object-oriented programming approaches.
4. Develop multi-class Java applications that solve real-world problems.
5. Create efficient, user-friendly graphical interfaces with event handling.
6. Manage complex data sets using the Java Collections Framework.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Develop** simple Java programs using basic programming constructs.	3
CO2	**Design** and **implement** Java applications using object-oriented concepts such as classes, inheritance, and polymorphism.	3
CO3	**Apply** advanced Java features including packages, interfaces, abstract classes, exception handling, multithreading, and GUI programming in application development.	3
CO4	**Use** file handling techniques and integrated Java concepts to develop practical and interactive software applications.	3

List of Practical: (Any 08)			
Experiment No.1	**Write some simple programs in Java such as** **1. To find factorial of number.** **2. To display first 50 prime numbers.** **3. To find sum and average of N numbers.**	**02 Hrs.**	**CO1**
Objective: • To understand the basic structure and syntax of Java programs.			

- To implement arithmetic and logical operations in Java.
- To use loops and conditional statements effectively.

Associated Tasks:

1. To find factorial of number.
   - Write a Java program to calculate the factorial of a given number using loops.
   - Accept input from the user.
   - Display the factorial result.
2. To display first 50 prime numbers.
   - Use conditional statements and loops to check prime numbers.
3. To find sum and average of N numbers.
   - Write a Java program to accept N numbers from the user.
   - Calculate and display the sum and average of the entered numbers.

Exemplars and Utility:

Fundamentals of Java programming.

Experiment No.2	**Write a program in Java to implement a Calculator with simple arithmetic operations such as add, subtract, multiply, divide, factorial etc. using switch case and other simple java statements**	**02 Hrs.**	**CO1**

Objective:

- To develop a simple Java-based Calculator using switch-case statements and basic Java programming concepts.

Associated Tasks:

1. Accept user input using the Scanner class.
2. Display a menu of calculator operations.
3. Use switch-case to select the required operation.
4. Perform arithmetic calculations:
5. Display the result of the selected operation.
6. Handle invalid choices and division by zero.
7. Use loops and conditional statements where necessary.

Exemplars and Utility

Can be applied in small business or daily calculations like:

bill calculation

percentage calculation

profit/loss calculation

Experiment No.3	**Write a program in Java to create a player class. Inherit the classes Cricket player, Football player and Hockey player from player class**	**02 Hrs.**	**CO2**

Objective:

- To develop a Java program that demonstrates the concept of inheritance

Associated Tasks:

1. Create a base class named Player.
2. Define common data members such as player name and age.
3. Create derived classes:
   - CricketPlayer
   - FootballPlayer
   - HockeyPlayer

4. Inherit the properties of the Player class into derived classes.
5. Create methods to display player information.
6. Use objects of derived classes to access inherited members.
7. Demonstrate the concept of inheritance in Java.

Exemplars and Utility:

Used to understand the concept of inheritance in Object-Oriented Programming (OOP).

Experiment No.4	**Write a Java program which imports user defined package and uses members of the classes contained in the package**	**02 Hrs.**	**CO3**

Objective:

- To develop a Java program that demonstrates the creation of a user-defined package and the use of classes and members contained in that package by importing it into another Java program.

Associated Tasks:

1. Create a user-defined package in Java.
2. Define classes inside the package.
3. Add methods and data members to the package classes.
4. Compile the package classes properly.
5. Import the package into another Java program.
6. Create objects of imported classes.
7. Access and use methods of the package classes.
8. Demonstrate modular programming and code reusability.

Exemplars and Utility:

Useful for creating libraries and APIs.

Experiment No.5	**Write a Java program which implements interface.**	**02 Hrs.**	**CO3**

Objective:

- To develop a Java program that demonstrates the implementation of an interface and shows how abstraction and multiple inheritance concepts are achieved using interfaces in Java.

Associated Tasks:

1. Create an interface in Java.
2. Declare abstract methods inside the interface.
3. Create a class that implements the interface.
4. Define the methods declared in the interface.
5. Create objects of the implementing class.
6. Call interface methods using the object.
7. Demonstrate abstraction and interface implementation.

Exemplars and Utility:

Useful in designing large-scale software applications.

Experiment No.6	**Write a java program to represent Abstract class with example.**	**02 Hrs.**	**CO3**

Objective:

- To develop a Java program that demonstrates the concept of an Abstract Class and abstract methods using inheritance and method overriding.

Associated Tasks:

1. Create an abstract class in Java.
2. Declare abstract and non-abstract methods inside the abstract class.
3. Create a subclass that extends the abstract class.
4. Override the abstract methods in the subclass.

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5. Create objects of the subclass.
6. Access inherited and overridden methods.
7. Demonstrate abstraction and runtime behavior.

Exemplars and Utility:

Useful for designing frameworks and templates.

Experiment No.7	**Write a java program which use try and catch for exception handling**	**02 Hrs.**	**CO3**

Objective:

- To develop a Java program that demonstrates Exception Handling using try and catch blocks to handle runtime errors and prevent abnormal termination of the program.

Associated Tasks:

1. Understand the concept of exceptions in Java.
2. Use the try block to write risky code.
3. Use the catch block to handle exceptions.
4. Handle common runtime exceptions such as division by zero.
5. Display appropriate error messages.
6. Prevent program crashes due to exceptions.
7. Demonstrate safe program execution

Exemplars and Utility:

Widely used in real-world software applications.

Experiment No.8	**Write a java program for producer and consumer problem using Threads.**	**02 Hrs.**	**CO3**

Objective:

- To develop a Java program that demonstrates inter-thread communication using the Producer–Consumer problem with the help of Threads, synchronization, and shared resources.

Associated Tasks:

1. Create a shared resource (buffer) for communication between threads.
2. Implement a Producer thread to produce data.
3. Implement a Consumer thread to consume data.
4. Use synchronized, wait(), and notify() methods.
5. Ensure proper coordination between Producer and Consumer.
6. Prevent race conditions and data inconsistency.
7. Demonstrate inter-thread communication.

Exemplars and Utility:

Forms the basis of real-world systems like:
messaging systems
task scheduling
data pipelines

Experiment No.9	**Write a java program that works as a simple calculator. Use a Grid Layout to arrange Buttons for digits and for the + - * % operations. Add a text field to display the result.**	**02 Hrs.**	**CO3**

Objective:

- To develop a Java GUI-based simple calculator using AWT Grid Layout**,** which performs basic arithmetic operations such as addition, subtraction, multiplication, modulus and displays results in a text field.

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Associated Tasks:

1. Create a graphical user interface (GUI) using Java AWT.
2. Use GridLayout to arrange buttons in a structured format.
3. Add buttons for digits (0–9) and operations (+, -, *, %).
4. Add a TextField to display input and results.
5. Handle button click events using ActionListener.
6. Perform arithmetic operations based on user input.
7. Display output in the text field.
8. Ensure basic user interaction in the calculator.

Exemplars and Utility:

Useful for building basic desktop applications.

Experiment No.10	**Write a Java program that reads a file and displays the file on the screen, with a line number before each line?**	**02 Hrs.**	**CO4**

Objective:

- To develop a Java program that reads data from a file and displays its content on the screen with line numbers, using file handling concepts in Java.

Associated Tasks:

1. Create or use an existing text file.
2. Use Java file handling classes such as File Reader and Buffered Reader.
3. Read the file line by line.
4. Maintain a line counter.
5. Display each line with its corresponding line number.
6. Handle possible file-related exceptions using try-catch.
7. Close the file resource properly after reading.
8. Demonstrate basic file input operations in Java.

Exemplars and Utility:

Commonly used in log file analysis systems.

Experiment No.11	**Course Project**	**02 Hrs.**	**CO1-4**

Develop an application that solves a real-world problem or simulates a practical system using appropriate concepts, implemented in java.

General Guidelines-

- **Team Size:**
  Individual or group of up to 4 students.
- **Selection of Topic:**
  Students must choose a problem where the use of one or more data structures is essential. Project must be interactive (menu-based or GUI-based).
  Some suggested domains-Student Management System, Bank Management System, Online Quiz System, Chat Simulation using Threads etc.
- **Mandatory Technical Requirements:**
  Object-Oriented Programming (OOP) Concepts, User Interaction, Data Handling, Exception Handling, GUI using **AWT/Swing/JavaFX**
- **Documentation Must Include:**
  Project Title, Abstract, Problem Statement
  Object Oriented concepts and Justification System Design/Flowchart/Class Diagram Sample Input/Output
  Code (with comments) and Conclusion and Future Scope.

Textbooks:

1. E Balagurusamy, "Programming with JAVA", Tata McGraw Hill, 6th Edition
2. Herbert Schildt, Java: The complete reference, Tata McGraw Hill, 7th Editon

Reference Books:

1. Matt Weisfeld, "The Object-Oriented Thought Process", Pearson Cox Brad, "Object –Oriented Programming: An Evolutionary Approach", Addison –Wesley
2. Y. Daniel Liang (2010), "Introduction to Java programming", Pearson Education, India, 7th Edition

MOOCs Links and additional reading material:

1. https://nptel.ac.in/courses/106/105/106105191/

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	1	1	-	2	2	1
CO2	3	3	2	1	2	-	-	-	1	1	-	3	2	2
CO3	3	3	3	2	2	-	-	-	1	1	-	3	3	2
CO4	2	3	2	3	2	-	-	-	1	1	-	2	3	2
CO5	2	2	3	2	3	-	-	-	1	2	-	2	3	3
Avg.	2.6	2.6	2.2	1.8	2.2	-	-	-	1	1.2	0	2.4	2.6	2.0

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT Level	CCE based on ARCV							
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8
CO	CO1	CO1	CO2	CO3	CO3	CO3	CO3	CO4
L1	✓	✓	✓	✓	✓	✓	✓	✓
L2	✓	✓	✓	✓	✓	✓	✓	✓
L3	✓	✓	✓	✓	✓	✓	✓	✓
L4								
L5								
L6								

This course serves as a prerequisite for / maps with the following future courses:

- Artificial Intelligence and Machine Learning
- Database Management Systems
- Web Technology

Job Mapping:

Job opportunities that one can get after learning this course:

- Java Developer
- Software Engineer
- Backend Developer

Program:	**S. Y. B. Tech (E&CE)**			**Semester:**			IV
Course:	**Electronics Waste Management**			**Course Code:**			R25-EC-VEC-221
Teaching Scheme (Hrs. / Wk.)				**Examination Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**CCE**	**ESE**	**TW**	**PR**
02	-	-	02	50	-	-	-

Course Description:

This course provides a comprehensive understanding of electronic waste (E-waste), its sources, composition, and the environmental and health challenges associated with its rapid growth. It introduces students to the life cycle of electrical and electronic equipment, focusing on scientific methods of collection, handling, recycling, and recovery of valuable materials. The course also examines national and international regulatory frameworks, including Extended Producer Responsibility (EPR), and the roles of various stakeholders in effective E-waste management. Emphasis is placed on sustainable practices, circular economy principles, green electronics, and emerging technologies that support environmentally responsible management of E-waste. Through case studies and problem-based learning, students develop the ability to analyze real-world E-waste issues and propose sustainable solutions.

Relevance:

With frequent technological upgrades, shorter product life cycles, and increased consumer demand, E-waste has become one of the fastest-growing waste streams globally, posing serious environmental, health, and sustainability challenges.

Prerequisite: Environmental Studies

Bridge Content: -

Course Objectives:

1. Introduce students to the concept, sources, and impacts of electronic waste.
2. Enable understanding of E-waste handling, recycling, and recovery technologies.
3. Familiarize students with national and international E-waste regulations and policies.
4. To impart life skills about E waste management in routine daily life to minimize the hazards.

Course Outcomes: After learning the course, students will be able to

CO	**Course Outcome**	**Bloom's Level**
CO1	**Explain** sources, composition, and impacts of E-waste.	2
CO2	**Analyze** E-waste handling and recycling technologies.	4
CO3	**Analyze** the E – waste management measures proposed under national and global legislations.	4
CO4	**Propose** solutions for effective E-waste management.	3

Course Content			
Unit 1	**Introduction to E-Waste**	**7 Hrs.**	**CO1**
Definition and classification of E-waste, Sources and categories of EEE (Electrical & Electronic Equipment), Composition of E-waste and hazardous substances, Global and Indian E-waste scenario Environmental and human health impacts, Informal vs. formal E-waste sectors, Basic principles of E waste management, Component of E waste management.			

Exemplars / Practical Applications and usage: Recycling and recovery of valuable materials from discarded electronic devices in authorized E-waste recycling facilities to reduce environmental pollution and resource depletion.			
Unit 2	**E-Waste Handling and Recycling Technologies**	**8 Hrs.**	**CO2**
E-waste life cycle and material flow analysis, Collection, segregation, storage, and transportation, Dismantling and pre-processing techniques, Recycling technologies: Mechanical separation, Pyrometallurgy, Hydrometallurgy, Bio-leaching, Recovery of precious and rare earth metals, Occupational health and safety issues.			
Exemplars / Practical Applications and usage: Recovery of precious metals such as gold, silver, and copper from discarded electronic devices using modern recycling technologies in authorized E-waste processing facilities.			
Unit 3	**Legal and Policy Framework**	**8 Hrs.**	**CO3**
International conventions: Basel Convention, Stockholm Convention, Indian regulatory framework: E-Waste (Management) Rules, 2022 & amendments, Extended Producer Responsibility (EPR), Role of stakeholders: producers, consumers, recyclers, government, Institutional mechanisms and compliance, Role of CPCB, SPCB, and Urban Local Bodies.			
Exemplars / Practical Applications and usage: Implementation of Extended Producer Responsibility (EPR) by electronics manufacturers to ensure environmentally compliant collection, recycling, and disposal of E-waste as per regulatory requirements.			
Unit 4	**Sustainable E-Waste Management & Future Trends**	**7 Hrs.**	**CO4**
Sustainable electronics and eco-design, 3R principle and circular economy, Consumer awareness and public participation, Case studies (India & global), Emerging technologies in E-waste recycling, Challenges and future opportunities.			
Exemplars / Practical Applications and usage: Design and manufacturing of environmentally sustainable electronic products using circular economy principles to improve resource efficiency and reduce E-waste generation.			

Textbooks:

1. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi, 2008.
2. Hester R.E., and Harrison R.M, Electronic Waste Management, RSC publication, 2009.
3. Bhagat-Ganguly, Varsha, E-Waste Management: Challenges and Opportunities in India, Routledge, New Delhi, 2021.
4. Nautiyal, Navtika Singh and Shuchita Agarwal, Future of e-Waste Management: Challenges and Opportunities, Thomson Reuters, 2021. ISBN 13. 978-9390529858.

Reference Books:

1. Fowler B, Electronic Waste – 1st edition, (Toxicology and Public Health Issues), Elsevier, 2017.
2. Hugo Marcelo Veit, Andréa Moura Bernardes, Electronic Waste: Recycling Techniques, 1st edition, Springer, 2105.
3. Anshu Priya, Management of Electronic Waste: Resource Recovery, Technology and Regulation, John Wiley & Sons, 2024. ISBN:9781119894339.

MOOCs Links and additional reading material:

1. NOC: Electronic Waste Management - Issues And Challenges, IIT Kharagpur
   https://nptel.ac.in/courses/105105169

Strength of CO-PO-PSO Mapping														
CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	2	3	1	-	-	-	2	1	-
CO2	2	3	2	2	2	2	3	-	-	-	-	3	2	2
CO3	2	3	2	-	-	3	3	2	-	-	-	2	1	-
CO4	2	3	3	2	2	2	3	1	1	1	1	3	2	2
Avg.	2.25	2.75	1.75	1	1	2.25	3	1	0.25	0.25	0.25	2.5	1.5	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4
CCE 1	13			
CCE 2		12		
CCE 3			13	
CCE 4				12
Total	13	12	13	12

Assessment Pattern:

BT Level	CCE			
	CCE1	CCE2	CCE3	CCE4
CO	CO1	CO2	CO3	CO4
L1	✓	✓	✓	✓
L2	✓	✓	✓	✓
L3		✓	✓	✓
L4		✓	✓	
L5				
L6				

This course serves as a prerequisite for / maps with the following future courses:

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Job Mapping:
Job opportunities that one can get after learning this course:

- Electronic Waste Management Industry