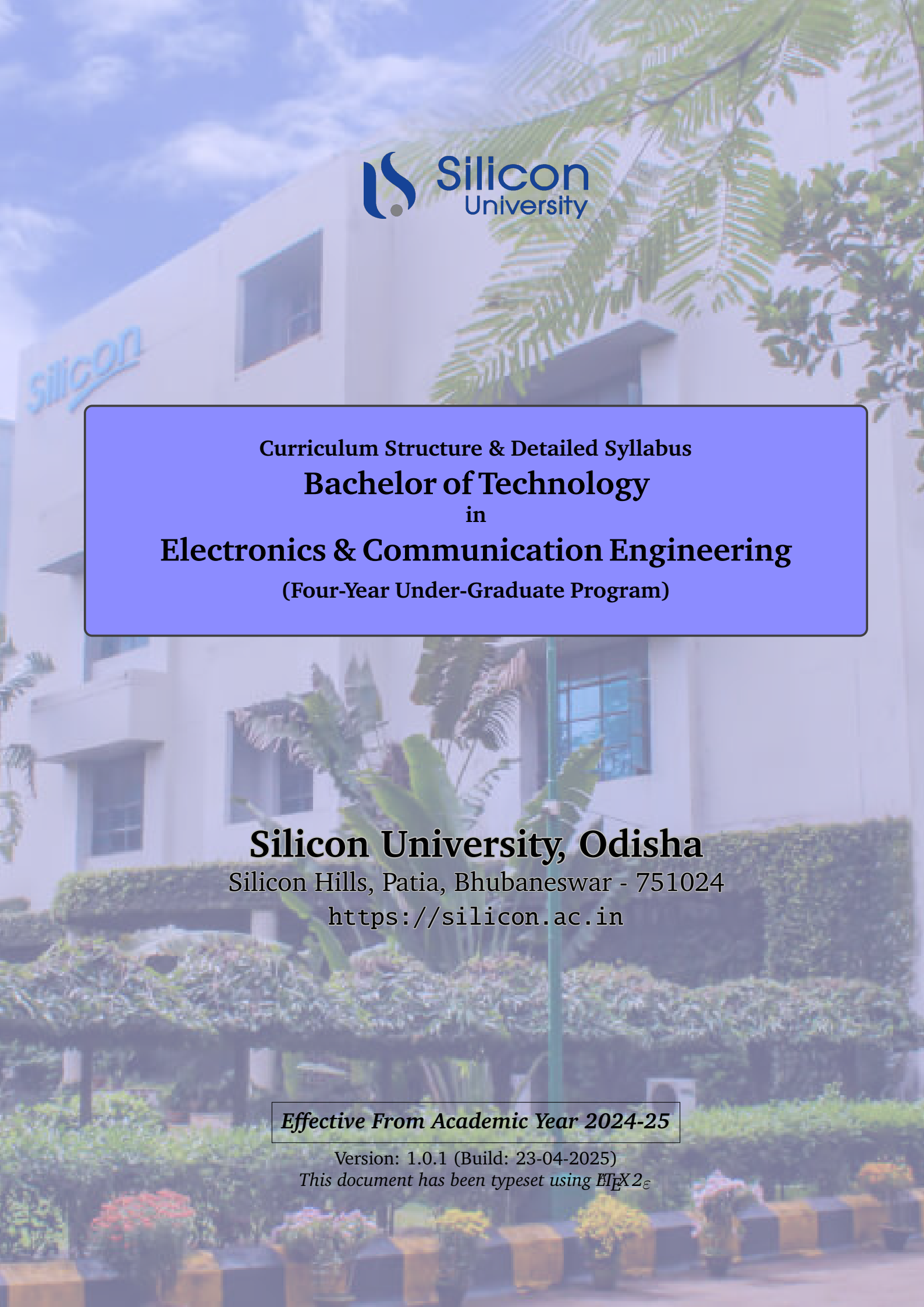

Curriculum Structure & Detailed Syllabus

# Bachelor of Technology

in

# Electronics & Communication Engineering

(Four-Year Under-Graduate Program)


## Silicon University, Odisha

Silicon Hills, Patia, Bhubaneswar - 751024

https://silicon.ac.in


*Effective From Academic Year 2024-25*


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# Approval History

| ACM# | Date | Resolutions |
|---|---|---|
| SU-1 | 27/04/2024 | The curriculum structure of B. Tech. (ECE) was approved in principle by the Academic Council. |
| SU-2 | 17/08/2024 | The curriculum structure of B. Tech. (ECE) and detailed syllabus of 1st Year was approved by the Academic Council. |
| SU-3 | 19/04/2025 | The amendments to the curriculum structure of B. Tech. (ECE) and the detailed syllabus up to 2nd Year was approved by the Academic Council. |

## Knowledge and Attitude Profile (WK's)

Knowledge and Attitude Profile (WK's) are linked to the Graduates Attributes (GAs) which indicate a graduate's potential to acquire competence at the appropriate level. NBA has defined 9 (nine) Knowledge and Attitude Profile (WK's) aligned with the Washington Accord for UG Engineering programs.

WK1. A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2. Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3. A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4. Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5. Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6. Knowledge of engineering practice (technology) in the practice 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.

## Program Outcomes (PO's)

Graduates Attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The Program Outcomes (POs) for UG Engineering programs as defined by NBA are:

PO1. **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).

PO2. **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).

PO4. **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).

PO5. **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).

PO6. **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).

PO7. **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8. **Individual & 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)

## Program Specific Outcomes (PSOs)

PSO1. Understand, analyze and apply the elementary concepts in Electronics and Communication Engineering to design, formulate and implement efficient systems in the broad areas related to signal processing, image processing, communication, VLSI and embedded systems.

PSO2. Develop the skills in modern technologies, tools & platforms to become a successful professional or entrepreneur, exhibit a passion for innovation & higher studies, and contribute as a responsible citizen with effective communication, strong moral values & professional ethics.

PSO3. Embrace various technological advancements in electronics & communication to design and create useful and competitive systems for real-world needs using modern platforms and tools to meet future challenges.

## Program Educational Objectives (PEOs)

PEO1. *Fundamental Knowledge & Core Competence*: To utilize the knowledge of mathematics, science and fundamentals of electronics & communication engineering required to become a successful professional and foster complex problem solving ability.

PEO2. *Proficiency for the Real World*: To acquire the skills to analyze, design, develop, and optimize novel acceptable electronics and communication systems as per the growing needs of the real world.

PEO3. *Leadership & Social Responsibility*: To exhibit leadership capability with professional, ethical, interpersonal skills, social & economic commitment with a sense of responsibility towards public policies, community services, humanity and environment.

PEO4. *Life-long Learning*: To grow professionally through continued education & training of technical and management skills, pursue higher studies, and engage in life-long learning.

## Course Categories & Definitions

| | |
|---|---|
| L | Lecture |
| T | Tutorial |
| P | Practical / Laboratory / Sessional |
| WCH | Weekly Contact Hours |
| UCR | University Core Course |
| UMC | University Mandatory Course (0-Credit) |
| PCR | Program Core Course |
| PEL | Program Elective Course |
| OEL | Open Elective Course |
| HNS | Honours (Choice-based) Course |
| MNR | Minor (Choice-based) Course |
| OOC | Open Online Course (on NPTEL / Swayam / Other) |
| INT | Summer Internship |
| PSI | Practice School / Industry Internship |
| PRJ | Project Work |
| SEC | Skill Enhancement Course |
| VAC | Value Addition Course |

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# Part I

# Curriculum Structure

# Induction Program

It is necessary for a newly admitted student to acclimatize to the environment of a college, create a bonding between the teacher and students, equip the students with communication skills, and get them acquainted with the academic & disciplined culture of institution & human values.

All students admitted to B.Tech. programs shall undergo a mandatory induction program after joining the institute and before the commencement of classes. Regular classes of the engineering programs shall begin only after the students have completed the induction program.

The induction program shall comprise of familiarization to the rules & regulations of the institute, examinations & evaluation system, departments/branches, campus facilities, official processes & important officials, curricular/ co-curricular/ extra-curricular activity clubs, innovation & research activities, etc. The program shall also comprise of lectures by eminent persons on adopting a disciplined & healthy life-style, career planning & emerging technologies, social awareness, human values & ethics to sensitize & motivate the students to become not only a successful engineer, but also a socially responsible citizen and contribute their part for social development and nation building.

Interaction with faculty advisors, mentors, senior students, individual/group physical activities, learning or exhibiting an art form/ literature, social service initiatives, and visits to important places of the city, and any other events/ activities deemed to be necessary, may also be included in the induction program.

Every new student must diligently attend & participate in all the activities of the induction program. Attendance in the activities shall be recorded. Students have to submit a daily report in prescribed format to the concerned faculty advisor on the next day. There will be a computer-based test with multiple-choice questions on a suitable date about a week after completion of the induction program.

Evaluation of Induction Program shall be done out of 100 marks, comprising of 3 components, namely: (i) 25 marks for attendance, (ii) 25 marks for the daily reports, and (iii) 50 marks for the computer-based multiple-choice test. A student has to score at least 50 marks in total to pass the induction program.

In case of failure, the student has to attend the induction program in the next academic year along with the newly admitted students, submit daily reports, and appear the computer-based test to score a pass mark.

# Curriculum Structure

## 1st Year B.Tech. (Common)

| Semester I | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| UCR | MT1001 | ODE & Matrix Algebra | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | CH1001 / PH1001 | Engineering Chemistry / Engineering Physics | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | EC1001 / EE1001 | Basic Electronics Engineering / Basic Electrical Engineering | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | ME1001 / ME1002 | Engineering Mechanics / Engineering Thermodynamics | 2 | 0 | 0 | 2 | 0 | 0 |
| UCR | CS1001 | Computer Programming | 3 | 0 | 0 | 3 | 0 | 0 |
| UMC | HS0001 / CH0001 | Constitution of India & Professional Ethics / Environmental Science & Engineering | 3 | 0 | 0 | 0 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| UCR | EC1002 / EE1002 | Basic Electronics Engineering Lab / Basic Electrical Engineering Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| UCR | CS1002 | Computer Programming Lab | 0 | 0 | 4 | 0 | 0 | 2 |
| SEC | HS1001 | Communicative & Technical English | 0 | 0 | 4 | 0 | 0 | 2 |
| UCR | EE1003 / ME1003 | Workbench Practices / Engineering Graphics | 0 | 0 | 2 | 0 | 0 | 1 |
| | | ***SUB-TOTAL*** | **17** | **0** | **12** | **14** | **0** | **6** |
| | | ***TOTAL*** | **29** | | | **20** | | |

**Note**: For some courses, the subjects have been mentioned as Subject-1 / Subject-2, i.e., with an OR option. Every student has to study both the subjects, however allocation of these subjects shall alternate between Semesters I and II. For example, if a student has been allocated *Engineering Chemistry* in Semester-I, then he/she will be allocated *Engineering Physics* in Semester-II, and vice-versa. The laboratory subjects will be as per the theory subjects allocated in the applicable semester. The same applies to all other courses provided with an OR option.

# 1st Year B.Tech. (Common)

| Semester II | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| UCR | MT1002 | Probability & Statistics | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | PH1001 / CH1001 | Engineering Physics / Engineering Chemistry | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | EE1001 / EC1001 | Basic Electrical Engineering / Basic Electronics Engineering | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | ME1002 / ME1001 | Engineering Thermodynamics / Engineering Mechanics | 2 | 0 | 0 | 2 | 0 | 0 |
| UCR | CS1003 | Data Structures & Algorithms | 3 | 0 | 0 | 3 | 0 | 0 |
| UMC | CH0001 / HS0001 | Environmental Science & Engineering / Constitution of India & Professional Ethics | 3 | 0 | 0 | 0 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| UCR | EE1002 / EC1002 | Basic Electrical Engineering Lab / Basic Electronics Engineering Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| UCR | CS1004 | Data Structures & Algorithms Lab | 0 | 0 | 4 | 0 | 0 | 2 |
| SEC | HS1002 | Corporate Communication Skills | 0 | 0 | 4 | 0 | 0 | 2 |
| UCR | ME1003 / EE1003 | Engineering Graphics / Workbench Practices | 0 | 0 | 2 | 0 | 0 | 1 |
| | | ***SUB-TOTAL*** | **17** | **0** | **12** | **14** | **0** | **6** |
| | | ***TOTAL*** | **29** | | | **20** | | |

**Note**: For some courses, the subjects have been mentioned as Subject-1 / Subject-2, i.e., with an OR option. Every student has to study both the subjects, however allocation of these subjects shall alternate between Semesters I and II. For example, if a student has been allocated *Engineering Chemistry* in Semester-I, then he/she will be allocated *Engineering Physics* in Semester-II, and vice-versa. The laboratory subjects will be as per the theory subjects allocated in the applicable semester. The same applies to all other courses provided with an OR option.

# 2nd Year B.Tech.(ECE)

| Semester III | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| PCR | MT2003 | Vector Calculus & Fourier Analysis | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | CS2001 | OOP Using Java | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | MG2001 / BL2001 | Management & Economics for Engineers / Biology for Engineers | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | EC2003 | Signals & Systems | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | EC2004 | Analog Electronic Circuits | 3 | 1 | 0 | 3 | 1 | 0 |
| PCR | EE2010 | Circuit Theory | 3 | 0 | 0 | 3 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| UCR | CS2004 | OOP Using Java Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | EC2005 | Analog Electronic Circuits Lab | 0 | 0 | 4 | 0 | 0 | 2 |
| PCR | EE2011 | Circuit Theory Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| INT | IP2001 | Summer Internship - I | 0 | 0 | 0 | 0 | 0 | 1 |
| | | ***SUB-TOTAL*** | **18** | **1** | **8** | **18** | **1** | **5** |
| | | ***TOTAL*** | **27** | | | **24** | | |

| Semester IV | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| PCR | MT2004 | Complex Analysis & Numerical Methods | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | CS2007 | Programming in Python | 3 | 0 | 0 | 3 | 0 | 0 |
| UCR | MG2001 / BL2001 | Management & Economics for Engineers / Biology for Engineers | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | EC2006 | Analog Communication | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | EC2007 | Digital Electronic Circuits | 3 | 1 | 0 | 3 | 1 | 0 |
| PEL | | Program Elective - I | 3 | 0 | 0 | 3 | 0 | 0 |
| HNS/MNR | | Honours / Minor - I | 3 | 0 | 0 | 3 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| UCR | CS2010 | Programming in Python Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | EC2008 | Digital Electronic Circuits Lab | 0 | 0 | 4 | 0 | 0 | 2 |
| PCR | EC2009 | Analog Communication Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| | | ***TOTAL*** | **27** | | | **23** | | |
| | | ***TOTAL (with Honours/Minor)*** | **30** | | | **26** | | |

# 3rd Year B.Tech.(ECE)

| Semester V | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| PCR | | Digital Communication | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | | Digital VLSI Design | 3 | 1 | 0 | 3 | 1 | 0 |
| PCR | | Digital Signal Processing | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | | Electromagnetic Waves | 3 | 1 | 0 | 3 | 1 | 0 |
| PEL | | Program Elective - II | 3 | 0 | 0 | 3 | 0 | 0 |
| PEL | | Program Elective - III | 3 | 0 | 0 | 3 | 0 | 0 |
| HNS/MNR | | Honours / Minor - II | 3 | 0 | 0 | 3 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| PCR | | Digital VLSI Design Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | | Digital Communication Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | | Digital Signal Processing Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | | Electromagnetic Waves Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| SEC | | Soft Skills & Interpersonal Skills | 0 | 0 | 2 | 0 | 0 | 1 |
| INT | | Summer Internship - II | 0 | 0 | 0 | 0 | 0 | 1 |
| | | ***TOTAL*** | **30** | | | **26** | | |
| | | ***TOTAL (with Honours/Minor)*** | **33** | | | **29** | | |

| Semester VI | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| PCR | | Microprocessors & Microcontrollers | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | | Microwave Engineering | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | | Control Systems Engineering | 3 | 0 | 0 | 3 | 0 | 0 |
| PEL | | Program Elective - IV | 3 | 0 | 0 | 3 | 0 | 0 |
| PEL | | Program Elective - V | 3 | 0 | 0 | 3 | 0 | 0 |
| PEL | | Program Elective - VI | 3 | 0 | 0 | 3 | 0 | 0 |
| HNS/MNR | | Honours / Minor - III | 3 | 1 | 0 | 3 | 1 | 0 |
| **PRACTICAL** | | | | | | | | |
| PCR | | Microprocessors & Microcontrollers Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | | High Frequency Engineering Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| SEC | / | Emerging Technologies Lab / Entrepreneurship & Innovation | 0 | 0 | 4 | 0 | 0 | 2 |
| SEC | | Professional & Technical Writing | 0 | 0 | 2 | 0 | 0 | 1 |
| VAC | | Yoga / NSS / NCC / PES / CPA * | 0 | 0 | 2 | 0 | 0 | 0 |
| | | ***TOTAL*** | **30** | | | **23** | | |
| | | ***TOTAL (with Honours/Minor)*** | **34** | | | **27** | | |

***Value Addition Courses**: Yoga - Yoga & Meditation, NSS - National Service Scheme, NCC - National Cadet Corps, PES - Physical Education & Sports, CPA - Creative & Performing Arts. Every student must invest at least 2 hours per week in the chosen course in one semester.

# 4th Year B.Tech.(ECE)

## (Without Practice School Option)

| Semester VII | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| OEL | | Open Elective - I | 3 | 0 | 0 | 3 | 0 | 0 |
| OOC | | MOOC - I | 0 | 0 | 0 | 3 | 0 | 0 |
| HNS/MNR | | Honours / Minor - IV | 3 | 1 | 0 | 3 | 1 | 0 |
| HNS/MNR | | Honours / Minor - V | 3 | 1 | 0 | 3 | 1 | 0 |
| **PRACTICAL** | | | | | | | | |
| PRJ | | Skill Lab & Project - I | 0 | 0 | 4 | 0 | 0 | 2 |
| INT | | Summer Internship - III | 0 | 0 | 0 | 0 | 0 | 1 |
| | | ***TOTAL*** | **7** | | | **9** | | |
| | | ***TOTAL (with Honours/Minor)*** | **15** | | | **17** | | |

| Semester VIII | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| OEL | | Open Elective - II | 3 | 0 | 0 | 3 | 0 | 0 |
| OOC | | MOOC - II | 0 | 0 | 0 | 3 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| UCR | | Presentation Skills & Technical Seminar | 0 | 0 | 2 | 0 | 0 | 1 |
| PRJ | | Project - II | 0 | 0 | 16 | 0 | 0 | 8 |
| | | ***TOTAL*** | **21** | | | **15** | | |

| | | | | |
|---|---|---|---|---|
| | | ***GRAND TOTAL*** | **200** | **160** |
| | | ***GRAND TOTAL (with Honours/Minor)*** | **220** | **178** |

Note:

1. Courses offered under each elective are given in “List of Electives” on Page 10.
2. Courses for Honours and Minor are given in “List of Tracks for Honours and Minor” on Page 11.
3. MOOC - Massive Open Online Course (on NPTEL / Swayam / Other).
4. Approved list of courses for MOOC (self study) shall be published by the department. Students are advised to complete them before the end of 8th semester.
5. The Value Addition Course (Yoga / NSS / NCC) may be assigned in a different semester depending on available capacity.

# 4th Year B.Tech.(ECE)

## (With Practice School Option in 7th Semester)

| Semester VII | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **PRACTICAL** | | | | | | | | |
| PSI | | Practice School / Industry Internship | 0 | 0 | 0 | 0 | 0 | 15 |
| INT | | Summer Internship - III | 0 | 0 | 0 | 0 | 0 | 1 |
| | | ***TOTAL*** | **0** | | | **16** | | |

| Semester VIII | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| OEL | | Open Elective - II | 3 | 0 | 0 | 3 | 0 | 0 |
| OOC | | MOOC - II | 0 | 0 | 0 | 3 | 0 | 0 |
| HNS/MNR | | Honours / Minor - IV | 3 | 1 | 0 | 3 | 1 | 0 |
| HNS/MNR | | Honours / Minor - V | 3 | 1 | 0 | 3 | 1 | 0 |
| **PRACTICAL** | | | | | | | | |
| PRJ | | Skill Lab & Project - I | 0 | 0 | 4 | 0 | 0 | 2 |
| | | ***TOTAL*** | **7** | | | **8** | | |
| | | ***TOTAL (with Honours/Minor)*** | **15** | | | **16** | | |

| | | | | |
|---|---|---|---|---|
| | | ***GRAND TOTAL*** | **179** | **160** |
| | | ***GRAND TOTAL (with Honours/Minor)*** | **197** | **178** |

Note:

1. Courses offered under each elective are given in “List of Electives” on Page 10.
2. Courses for Honours and Minor are given in “List of Tracks for Honours and Minor” on Page 11.
3. MOOC - Massive Open Online Course (on NPTEL / Swayam / Other).
4. Approved list of courses for MOOC (self study) shall be published by the department. Students are advised to complete them before the end of 8th semester.
5. The Value Addition Course (Yoga / NSS / NCC) may be assigned in a different semester depending on available capacity.

# 4th Year B.Tech.(ECE)

## (With Practice School Option in 8th Semester)

| Semester VII | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| OEL | | Open Elective - I | 3 | 0 | 0 | 3 | 0 | 0 |
| OOC | | MOOC - I | 0 | 0 | 0 | 3 | 0 | 0 |
| HNS/MNR | | Honours / Minor - IV | 3 | 1 | 0 | 3 | 1 | 0 |
| HNS/MNR | | Honours / Minor - V | 3 | 1 | 0 | 3 | 1 | 0 |
| **PRACTICAL** | | | | | | | | |
| PRJ | | Skill Lab & Project - I | 0 | 0 | 4 | 0 | 0 | 2 |
| INT | | Summer Internship - III | 0 | 0 | 0 | 0 | 0 | 1 |
| | | ***TOTAL*** | **7** | | | **9** | | |
| | | ***TOTAL (with Honours/Minor)*** | **15** | | | **17** | | |

| Semester VIII | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **PRACTICAL** | | | | | | | | |
| PSI | | Practice School / Industry Internship | 0 | 0 | 0 | 0 | 0 | 15 |
| | | ***TOTAL*** | **0** | | | **15** | | |

| | | | | |
|---|---|---|---|---|
| | | ***GRAND TOTAL*** | **179** | **160** |
| | | ***GRAND TOTAL (with Honours/Minor)*** | **197** | **178** |

Note:

1. Courses offered under each elective are given in “List of Electives” on Page 10.
2. Courses for Honours and Minor are given in “List of Tracks for Honours and Minor” on Page 11.
3. MOOC - Massive Open Online Course (on NPTEL / Swayam / Other).
4. Approved list of courses for MOOC (self study) shall be published by the department. Students are advised to complete them before the end of 8th semester.
5. The Value Addition Course (Yoga / NSS / NCC) may be assigned in a different semester depending on available capacity.

# List of Electives

| Code | Elective # and Subjects |
|---|---|
| ***Program Elective - I*** | |
| EC2010 | Solid State Devices |
| EC2011 | Embedded C Programming |
| EE2007 | Soft Computing Techniques |
| ***Program Elective - II*** | |
| | IC Fabrication Technology |
| | IoT & Applications |
| | Fiber Optic Communications |
| ***Program Elective - III*** | |
| | Digital IC Design & Verification |
| | Embedded System Design |
| | Introduction to Machine Learning |
| | MEMS & Sensor Design |
| ***Program Elective - IV*** | |
| | Analog VLSI Design |
| | Real Time Embedded Systems |
| | Digital Image & Video Processing |
| | Satellite Communication Systems |
| ***Program Elective - V*** | |
| | Low Power VLSI Design |
| | Smart Sensors for IoT |
| | Mobile Communication & Networks |
| | Information Theory & Coding |
| ***Program Elective - VI*** | |
| | Design of Semiconductor Memories |
| | Industrial IoT |
| | Adaptive Signal Processing |
| | Antennas & Wave Propagation |
| ***Open Elective - I & II (Basket)*** | |
| | Applied Linear Algebra |
| | Stochastic Processes |
| | Numerical Optimization |
| | Simulation & Modelling |
| | Fluid Mechanics |
| | Power Plant Engineering |
| | Project Management |
| | Organizational Behaviour |
| | Entrepreneurship Development |
| | Securities Analysis, Investment & Trading |
| | Circular Economy |

# List of Tracks for Honours / Minor

| Code | Honours / Minor # and Subjects |
|---|---|
| ***Honours in Electronics & Communication Engineering*** | |
| EC2015 | Electronic Devices & Modeling |
| | Advanced Electronic Circuits |
| | Advanced Microprocessors & Microcontrollers |
| | Digital Video Processing & Computer Vision |
| | Mixed Signal Design |
| ***Minor in "Sustainable Energy & E-Mobility"*** | |
| EC2024 | Power Electronic Devices |
| | Renewable Energy Systems |
| | Basics of Power Systems |
| | Smart Grid |
| | Electric & Hybrid Vehicles |
| ***Minor in "Information Technology"*** | |
| CS2003 | Operating Systems |
| | Computer Organization & Architecture |
| | Algorithm Design & Analysis |
| | Fundamentals of DBMS |
| | Internet Technology & Applications |
| ***Minor in "Artificial Intelligence & Machine Learning"*** | |
| CS3013 | Data Mining & Data Warehousing |
| CS2014 | Artificial Intelligence |
| | Machine Learning |
| | Natural Language Processing |
| | Advanced Machine Learning |
| ***Minor in "Business Management"*** | |
| MG2002 | Marketing Management |
| | Human Resources Management |
| | Production and Operation Management |
| | Financial Management |
| | Business & Corporate Law |

**Note:**

1. Choice for Honours or Minor must be submitted before the end of 3rd Semester.
2. A student can opt for either Honours or Minor, but not both.
3. Once opted for Honours or Minor, the same cannot be changed or converted.
4. Unless adequate number of students opt for Honours or Minor, it shall not be offered for the batch.

# Part II

# Detailed Syllabus

| Category | Code | ODE & Matrix Algebra | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | MT1001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study the concepts of solution of system of linear equations using matrix methods, Eigen values & Eigen vectors of matrices with application, ordinary differential equations with applications, and Laplace transform & its applications to ordinary differential and integral equations. |
| **Pre-Requisites** | Knowledge of elementary calculus, coordinate geometry of two & three dimensions and matrix algebra is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Matrix algebra, System of linear equations, Rank, Vector space, Existence and uniqueness of solution of a system of linear equations. | **8 Hours** |
| **Module-2** | Eigen values and Eigen vectors, Complex matrices, Diagonalization of matrices, Positive definite matrix, Singular Value Decomposition (SVD) and pseudo inverse. | **8 Hours** |
| **Module-3** | Separable ordinary differential equation and modeling, Exact ODE and Integrating factor, Linear ODE, Bernoulli's Equation, Modeling electrical circuits, Homogeneous linear ODE of second order, Second order Linear ODE with constant coefficients. | **8 Hours** |
| **Module-4** | Non-homogeneous linear ODE, Solution of Non-homogeneous linear ODE using undetermined coefficients, Euler-Cauchy ODE and applications to electrical circuits, Laplace transform, Inverse Laplace transform. | **8 Hours** |
| **Module-5** | Shifting theorems, Transform of derivatives and integrals, Unit step function and Dirac delta function, Applications to derivatives, Differentiation and integration of transforms, Convolution, Integral equation, Solution of system of differential equations. | **10 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. E. Kreyszig, ***Advanced Engineering Mathematics***, 8th *Ed.*, Wiley India, 2015.
T2. G. Strang, ***Linear Algebra and Its Applications***, 4th *Ed.*, Cengage Learning, 2015.

**Reference Books**:

R1. S. Pal and S. C. Bhunia, ***Engineering Mathematics***, 1st *Ed.*, Oxford University Press, 2015.
R2. B. V. Ramana, ***Higher Engineering Mathematics***, 1st *Ed.*, McGraw Hill, 2017.

**Online Resources**:

1. https://nptel.ac.in/courses/111105035: by Prof. P. D. Srivastava, IIT Kharagpur
2. https://nptel.ac.in/courses/122104017: by Prof. S. K. Ray, IIT Kanpur
3. https://nptel.ac.in/courses/122102009: by Prof. S. R. K. Iyengar, IIT Delhi
4. https://nptel.ac.in/courses/111107063: by Dr. S. Gakkhar, IIT Roorkee
5. https://www.coursera.org/learn/linearalgebra2

6. https://www.coursera.org/learn/differentiation-calculus
7. https://www.coursera.org/learn/single-variable-calculus
8. https://alison.com/courses/Algebra-Functions-Expressions-and-Equations

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

| | |
|---|---|
| CO1 | Solve a system of linear equations by applying the appropriate method. |
| CO2 | Apply Eigen values and Eigen vector techniques to find SVD and pseudo inverse of a matrix. |
| CO3 | Apply first order ordinary differential equations to solve real-world problems. |
| CO4 | Apply second order ordinary differential equations to solve problems of electrical circuits. |
| CO5 | Apply the concept of Laplace transforms to solve differential and integral equations. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 2 | | | | | | | 2 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 2 | | | | | | | 2 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 3 | | | | | | | 2 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 3 | | | | | | | 2 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 3 | | | | | | | 2 | 1 | 1 |

| Category | Code | Engineering Chemistry | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CH1001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The purpose of this course is to understand the fundamentals and applications of chemical sciences in the field of engineering. The course addresses the principles of general and engineering chemistry, so that the students can apply the knowledge in their areas of expertise. |
| **Pre-Requisites** | Preliminary knowledge of mole concept, oxidation and reduction, combustion, electromagnetic wave, and nano-materials is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on examples and applications. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Water Treatments**: Types of hardness-Units, Alkalinity of water and its significance, Softening methods and Numerical problems based on these methods, Membrane-based processes, Dissolved Oxygen, Problems with Boiler feed water and its treatments. | **9 Hours** |
| **Module-2** | **Corrosion Science**: Definition and scope of corrosion, Dry and wet corrosion, Direct chemical corrosion, Electro-chemical corrosion and its mechanisms, Types of electro-chemical corrosion (Differential aeration, Galvanic, Concentration cell), Typical Electro-chemical corrosion like Pitting, Soil, Waterline, Factors affecting corrosion, Protection from corrosion. | **8 Hours** |
| **Module-3** | **Instrumental Techniques**: Fundamentals of Spectroscopy, Principles and applications of molecular spectroscopy such as UV-visible, IR, Elementary idea about XRD, SEM & TEM. | **8 Hours** |
| **Module-4** | **Energy Sciences**: Types of fuels, Calorific value, Determination of calorific value, Combustion and its calculations, Solid fuel – Coal analysis (Proximate and ultimate analysis), Liquidfuels – Concept of knocking, Anti-knocking, Octane and Cetane Nos, Battery Technology — Fundamentals of primary & secondary cells, Rechargeable batteries – Lead acid storage battery, Lithium ion battery, Fuel cells – Principles, Applications, Solar PV Cells. | **9 Hours** |
| **Module-5** | **Nanochemistry**: Nanomaterials, Classification of nanomaterials, Synthesis and characterization of noble metal nanoparticles (Gold and oxide-based nanoparticles) using Green Synthetic route, Stabilization of nanoparticles using capping agents, Applications of nanomaterials, Carbon based nanomaterials and their applications, Brief on Graphene and Fullerene. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:


T1. Jain & Jain, ***Engineering Chemistry***, 16th *Ed.*, Dhanpat Rai Publishing Company, 2015.
T2. Wiley-India Editorial Team, ***Engineering Chemistry***, 2nd *Ed.*, Wiley India, 2011.
T3. C. N. Banwell, ***Fundamentals of Molecular Spectroscopy***, 4th *Ed.*, McGraw-Hill Education, 2017.

**Reference Books**:

R1. S. S. Dara, ***Engineering Chemistry***, 12th *Ed.*, S. Chand Publisher, 2014.
R2. G. A. Ozin & A. C Arsenault, ***Nanochemistry - A Chemical Approach to Nanomaterials***, 2nd *Ed.*, RSC Publishing, 2008.
R3. J. M. Lehn, L. Cademartiri, ***Concepts of Nanochemistry***, 1st *Ed.*, Wiley-VCH, 2009.
R4. Y. R. Sharma, ***Elementary Organic Spectroscopy***, S Chand & Co Ltd., 2013.

**Online Resources**:

1. http://nptel.ac.in/courses/103105110/ - Fuel & Combustion
2. http://nptel.ac.in/courses/105104102/hardness.htm
3. http://nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf
4. https://chem.libretexts.org/Core/Analytical_Chemistry/Electrochemistry/Exemplars/Corrosion/Corrosion_Basics
5. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/spectrpy/infrared/infrared.htm
6. https://alison.com - Spectroscopic Technique, Colorimetry

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

| | |
|---|---|
| CO1 | Determine the hardness of water and apply difference processes to soften hard water. |
| CO2 | Utilize the knowledge of electro-chemistry and corrosion science for prevention of corrosion. |
| CO3 | Apply molecular spectroscopy to analyze organic compounds using spectrophotometer. |
| CO4 | Classify various fuels based on combustion parameters and understand the working principles of various batteries and solar photovoltaic cells. |
| CO5 | Explore synthesis & characterization of nanoparticles through green synthetic route. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| PO7 | **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9) |
| PO8 | **Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. |

*Cont'd. . .*

| | |
|---|---|
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | | 1 | 2 | 1 | 2 |
| CO3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | | | 1 | 2 | 1 | 1 |
| CO4 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | | | 1 | 2 | 1 | 2 |

| Category | Code | Engineering Physics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | PH1001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study various laws of physics and understand different phenomena using these principles. This knowledge is necessary for engineering students to understand the working of instruments and technologies, and also useful to prepare various engineering projects. |
| **Pre-Requisites** | Basic knowledge on waves, electrostatics, magnetism and mathematics is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Wave Optics**: Concept of wave and wave equation, Superposition of waves (two-beam and multiple beam), Huygen's principle, Interference, Theory of Newton's rings and its applications, Diffraction, Fresnel and Fraunhofer diffraction, Fraunhofer's diffraction from a single slit, Plane diffraction grating – theory and its applications. | **9 Hours** |
| **Module-2** | **Electromagnetic Waves**: Gradient of scalar field, Divergence and curl of vector field, Gauss divergence theorem and Stoke's theorem (statement only), Gauss's law in electromagnetism, Faraday's law of electromagnetic induction, Ampere's circuital law, Displacement current, Maxwell's electromagnetic equations, Electromagnetic waves – Wave equations in free space, Dielectric and conducting medium, Poynting's theorem and Poynting's vector. | **9 Hours** |
| **Module-3** | **Quantum Mechanics**: Introduction, Need of quantum mechanics, Particle nature of radiation - Black body radiation (no derivation), Photoelectric effect, Compton's effect and pair production, Concept of de-Broglie's matter waves, Heisenberg's uncertainty principle and its applications. | **8 Hours** |
| **Module-4** | **Schrödinger's Wave Equation & Applications**: Concept of wave function $\psi$ and interpretation of $\|\psi\|^2$, Schrödinger's time-dependent and time-independent wave equations, Expectation values, Operators in quantum mechanics, Eigenfunctions and Eigenvalues, Applications of Schrödinger's equation – Particle in a one dimensional box, Potential barrier. | **8 Hours** |
| **Module-5** | **Laser & Fiber Optics**: Radiation-matter interaction, Absorption of light, Spontaneous and stimulated emission of light, Population inversion, Types of Laser – Solid State Laser (Ruby), Gas Laser (He-Ne), Properties and applications of Laser; Optical Fiber – Structure and Principle, Types of optical fiber, Numerical aperture, Applications of optical fiber. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. D. R. Joshi, ***Engineering Physics***, 1st *Ed.*, Tata McGraw-Hill Publication, 2017.
T2. Md. M. Khan and S. Panigrahi, ***Principle of Physics***, Vol. I & II, Cambridge Univ. Press.

P.T.O

**Reference Books**:

R1. A. Ghatak, ***Optics***, 7th *Ed.*, McGraw-Hill Education, 2020.
R2. D. J. Griffith, ***Introduction to Electrodynamics***, 4th *Ed.*, Pearson Education, 2015.
R3. A. Beiser, ***Concept of Modern Physics***, 6th *Ed.*, McGraw-Hill Education, 2009.

**Online Resources**:

1. https://nptel.ac.in/courses/115102026/: by Prof. M. R. Shenoy, IIT Delhi
2. https://nptel.ac.in/courses/113104012/: by Prof. M. Katiyar and Prof. D. Gupta, IIT Kanpur
3. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2013/
4. http://www.ilectureonline.com/lectures/subject/PHYSICS
5. https://ocw.mit.edu/courses/physics

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

| | |
|---|---|
| CO1 | Analyze wave properties of light like interference and diffraction and apply them in communications. |
| CO2 | Develop Maxwell's equations from basic laws of electromagnetism and apply them to understand the properties of electromagnetic waves. |
| CO3 | Analyze wave-particle duality to understand radiation-matter interaction. |
| CO4 | Develop and apply Schrödinger's equations to fields like bound particle, potential barrier etc. |
| CO5 | Investigate the basic principle, properties, operations and applications of laser & optical fiber in different fields like communication, industry, medicine, research etc. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 1 | 1 | | | | | | 1 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | | | | | | 2 | 3 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | | | | | | 1 | 3 | 2 | 1 |
| CO4 | 3 | 2 | 2 | 2 | 2 | | | | | | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 3 | 2 | 2 |

| Category | Code | Basic Electronics Engineering | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | EC1001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objectives of this course is to study the concepts and functionalities of electronic devices, tools and instruments, general specifications and deployability of the electronic devices, and assemblies in engineering applications. |
| **Pre-Requisites** | Knowledge of physics, chemistry, and introductory idea of semiconductors studied at the higher secondary level is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, and planned lectures to make the sessions interactive with problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Semiconductor & Diodes**: Types of semiconductors, Majority and minority charge carriers, Energy Band diagram, Transport phenomena, Law of Mass Action, Drift and Diffusion Current; Semiconductor Diode – Ideal vs. Practical, Diode equivalent circuits, Diode Applications – Rectifiers, Clipper, Clamper, and Switch, Zener Diode – Operation and Applications. | **9 Hours** |
| **Module-2** | **Transistors**: Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying action, CB, CE, and CC configurations, Load line analysis, Fundamentals of biasing, Fixed biasing; Field Effect Transistor (FET) – Construction, Working principles, Characteristics of JFET & MOSFET. | **9 Hours** |
| **Module-3** | **Op-Amps, Oscillators, and Measuring Instruments**: Introduction, Characteristics of ideal Op-Amp, Virtual Ground Concept, Pin Configuration, Applications of Op-Amp – Inverting & Non Inverting Amplifier, Summing Amplifier, Differentiator, Integrator; Oscillators – Barkhausen's Criteria, RC phase shift oscillator, Wien bridge oscillator; Measuring Instruments – Construction & working of CRO, DSO, and Multimeter. | **8 Hours** |
| **Module-4** | **Digital Logic**: Number systems and its conversion, Signed & unsigned numbers, Binary arithmetic, 1's and 2's complement arithmetic, Basic & universal Logic gates, Boolean algebra and identities, Algebraic reduction using postulates of boolean algebra, Realization of boolean functions using universal logic gates. | **8 Hours** |
| **Module-5** | **Signals & Communication Systems**: Signals – Continuous & Discrete-time, Analog & Digital, Energy & Power, Spectrum of a signal, Fourier Transform (Exponential, Sine and Cosine); Communication Systems – Block diagram, Modulation, Time & Frequency domain representation of AM, Carrier & side-band power calculation, Generation (Square law modulator), Demodulation (Synchronous demodulator). | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. R. L. Boylestad and L. Nashelsky, ***Electronic Devices and Circuit Theory***, 11$^{th}$ *Ed.*, Pearson Education, 2015.

T2. A. Agarwal and J. Lang, ***Foundations of Analog and Digital Electronic Circuits***, 1st *Ed.*, Morgan Kaufmann, 2005.
T3. R. P. Singh and S. D. Sapre, ***Communication Systems: Analog and Digital***, 3rd *Ed.*, McGraw-Hill Education, 2014.

**Reference Books**:

R1. A. S. Sedra and K. C. Smith, ***Microelectronic Circuits***, 7th *Ed.*, Oxford University Press, 2009.
R2. V. K. Mehta and R. Mehta, ***Principles of Electronics***, 10th *Rev. Ed.*, S. Chand Publishing, 2006.
R3. A. Kumar, ***Fundamentals of Digital Circuits***, 3rd *Ed.*, PHI Learning, 2014.

**Online Resources**:

1. https://nptel.ac.in/courses/117103063/: by Prof. G. Barua, IIT Guwahati
2. https://nptel.ac.in/courses/108101091/: By Prof. M. B. Patil, IIT Bombay
3. https://nptel.ac.in/courses/122106025/: By Prof. T. S. Natarajan, IIT Madras
4. https://nptel.ac.in/courses/117107095/: Web Content by IIT Roorkee
5. https://nptel.ac.in/courses/122104013/: Web Content by IIT Kanpur
6. https://nptel.ac.in/courses/117106086/: By Prof S.Srinivasan, IIT Madras
7. https://nptel.ac.in/courses/117103064/: By Prof A. Mahanta, IIT Guwahati

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

| | |
|---|---|
| CO1 | Understand basic principles of semiconductor diodes and their applications. |
| CO2 | Understand the construction, characteristics, configurations, and applications of transistors. |
| CO3 | Analyze the characteristics of Op-Amps & use them to design circuits for various applications. |
| CO4 | Convert numbers using different number systems and apply boolean algebra on them. |
| CO5 | Explain different types of signals and their characteristics using Fourier analysis tools. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

P.T.O

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 2 | | | | | | 2 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 3 | | | | | | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | | | | | | 3 | 2 | 3 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | | | | | | 2 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 3 | | | | | | 2 | 2 | 2 | 1 |

| Category | Code | Basic Electrical Engineering | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | EE1001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to introduce the basic concepts of electricity and magnetism, DC & AC networks, principles of different electrical machines and measuring instruments, protection systems and safety requirements. |
| **Pre-Requisites** | Basic knowledge of intermediate physics and mathematics such as calculus, ordinary differential equations, matrices etc. is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Electric Circuits**: Charge & current, Ideal & practical sources, Source conversion, Characteristics of circuit elements, Kirchhoff's current and voltage laws, Current & voltage division rule; Resistive Network Analysis – Node voltage & Mesh current (controlled & uncontrolled sources), Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem; Transient Analysis – Introduction, Differential equations, Time-domain analysis of first-order RL & RC circuits, Time constant. | **12 Hours** |
| **Module-2** | **Single-phase AC Circuit Analysis**: Representation of sinusoidal waveforms, Peak and RMS values, Phasor representation, AC power analysis, Power factor, Improvement of power factor, Analysis of series & parallel AC circuits (R, L, C, RL, RC, RLC circuits), Series resonance, Q-factor. | **8 Hours** |
| **Module-3** | **Three-phase AC Circuit Analysis**: Representation of 3-phase AC voltage, Phase sequence, Balanced load and source, Voltage and current relationship in star and delta connections, AC power analysis; Introduction to generation, transmission, and distribution of power system network, Residential wiring, Earthing, Electrical safety. | **7 Hours** |
| **Module-4** | **Electromagnetism**: Magnetic flux, Reluctance, Series & parallel magnetic circuits, Magnetic materials, Hysteresis loop; Single-phase Transformer – Construction & working, Ideal and practical transformer, EMF equation, Equivalent circuit & phasor diagram of transformer on load and no-load, Shifting of impedances. | **8 Hours** |
| **Module-5** | **DC Machine**: Construction, Working of generator and motor, EMF equation of generator, Back EMF of Motor, Classification based on excitation system; **AC Machine**: Construction and working of a 3-phase induction motor, Synchronous speed, Concept of slip, Construction, working, and types of single-phase induction motor. | **7 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. C. K. Alexander and M. N. O. Sadiku, ***Fundamentals of Electric Circuits***, 6th *Ed.*, McGraw-Hill, 2017.
T2. E. Hughes, ***Electrical & Electronic Technology***, 9th *Ed.*, Pearson, 2004.
T3. G. Rizzoni, ***Principles and Applications of Electrical Engineering***, 5th *Ed.*, McGraw Hill, 2006.

**Reference Books**:

R1. A. E. Fitzgerald, D. E. Higginbotham, and A. Grabel, ***Basic Electrical Engineering***, 5th *Ed.*, Tata McGraw Hill.
R2. B. L. Theraja and A. K. Theraja, ***Textbook of Electrical Technology (Vol-I)***, 23rd *Ed.*, S. Chand & Co.Ltd., 2002.
R3. L. S. Bobrow, ***Foundations of Electrical Engineering***, Asian Edition, Oxford Univ. Press, 2013.

**Online Resources**:

1. https://nptel.ac.in/courses/108/105/108105053/: by Prof. G. D. Roy, Prof. N. K. De, and Prof. T. K. Bhattacharya, IIT Kharagpur
2. https://nptel.ac.in/courses/108/108/108108076/: By Prof. L. Umanand, IISc Bangalore
3. https://www.electrical4u.com/

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

| | |
|---|---|
| CO1 | Understand and analyze basic electrical network with direct current source. |
| CO2 | Measure current, voltage, and power of series RLC circuit excited by single-phase AC circuit. |
| CO3 | Analyze 3-phase electrical systems and explore the engineering of practical power systems. |
| CO4 | Explain different concepts of magnetic fields and apply them to single-phase transformers. |
| CO5 | Describe the working principles of rotating electrical machines. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | | | | | | 2 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 1 | | | | | | 3 | 3 | 2 |
| CO3 | 3 | 2 | 1 | 1 | 3 | 2 | | | | | | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 1 | 3 | 1 | | | | | | 3 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | | 2 | 2 | 1 |

| Category | Code | Engineering Mechanics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | ME1001 | | 2-0-0 | 2 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to introduce engineering mechanics with the knowledge of statics, force equilibrium and free body diagrams, analysis of structures, beams and associated stresses along with elementary ideas on kinematics, dynamics, and mass moment of inertia. |
| **Pre-Requisites** | Knowledge of physics & mathematics and basic analytical skills is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Introduction**: Basic concepts of vector analysis, Equilibrium of forces in two and three dimensions, Rectangular components of a force and its application, Varignon's theorem; Motion of a particle – Equation of motion, D'Alembert's principle, Planar cartesian & polar coordinates, Motion with constraints. | **8 Hours** |
| **Module-2** | **Virtual Work and Energy**: Virtual displacements, Principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom;<br>**Analysis of Structures**: Trusses, Assumptions, Simple plane truss, Analysis by method of joints and method of sections. | **6 Hours** |
| **Module-3** | **Center of Gravity & Moments of Inertia**: Centroid and Centre of Gravity, Centroid of simple and composite sections, Theorems of Pappus and Guldinus, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Area moment of inertia of standard sections and composite sections, Mass moment inertia of circular plate, Cylinder, Cone, Sphere, parallelepiped. | **7 Hours** |
| **Module-4** | **Stress & Strain**: Normal stress, Shear stress, State of stress at a point, Ultimate strength, Allowable stress, Factor of safety; Relationship between elastic constants, Mechanical properties of materials, Stress-Strain behaviour; Flexural Loading – Shear force and bending moment in beams, Shear force and bending Moment Diagrams, Bending and shear stresses. | **7 Hours** |
| | **Total** | **28 Hours** |

**Text Books**:

T1. M. K. Harbola, ***Engineering Mechanics***, 2nd *Ed.*, Cengage Learning, 2018.
T2. G. H. Ryder, ***Strength of Materials***, 3rd *Ed.*, Macmillan Press, 1969.

**Reference Books**:

R1. J. L. Meriam and L. G. Kraige, ***Engineering Mechanics: Statics***, 8th *Ed.*, Wiley India, 2014.
R2. R. K. Rajput, ***Strength of Materials: Mechanics of Solids***, 7th *Ed.*, S. Chand Publications, 2018.
R3. S. Timoshenko, D. H. Young, S. Pati, and J. V. Rao, ***Engineering Mechanics***, 5th *Ed.*, McGraw-Hill Education, 2013.

**Online Resources**:

1. https://nptel.ac.in/courses/122104015/: by Prof. M. Harbola, IIT Kanpur.
2. https://nptel.ac.in/courses/105105108/: by Prof. S. Bhatacharya, IIT Kharagpur)

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

| | |
|---|---|
| CO1 | Understand and analyze using the principles of mechanics to solve problems in statics. |
| CO2 | Articulate virtual work and investigate the nature of forces in the members of simple trusses. |
| CO3 | Explain area and mass moments of inertia and their application in structural design. |
| CO4 | Describe the mechanics of deformable bodies and mechanical properties of materials. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

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

| Category | Code | Engineering Thermodynamics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | ME1002 | | 2-0-0 | 2 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to introduce laws of thermodynamics with emphasis on various equilibrium processes and their applications in practical domains like power plants, refrigerators and internal combustion engines. |
| **Pre-Requisites** | Knowledge of physics & mathematics and basic analytical skills is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Introduction, Basic concepts, System, Control volume, Surrounding, Boundaries, Universe, Types of systems, Macroscopic and microscopic viewpoints, Concept of continuum, Thermodynamic equilibrium, State, Property, Process, Exact & inexact differentials, Point & path functions, Cycle, Quasi-static process, Reversibility and irreversibility, Pressure measurement, Zeroth law of thermodynamics, Temperature, Principles of thermometry, Constant volume gas thermometer, Temperature scale. | **7 Hours** |
| **Module-2** | Pure Substances, p-v, T-v, T-s and h-s diagrams, Phase Transformations, Triple point and critical state, properties during change of phase, Dryness Fraction, Property tables. Brief discussionon the First law for cycle, closed system and open system (steady flow energy equation, SFEE), Perpetual Motion Machines, PMM1. | **7 Hours** |
| **Module-3** | Introduction to Second Law of Thermodynamics, Kelvin-Planck and Clausius' Statements and their Equivalence, Corollaries, PMM2, Carnot's Principle and Cycle, Entropy, Clausius' Inequality, Principle of Entropy and its application, T-s plot. | **7 Hours** |
| **Module-4** | Applications of Thermodynamics, Brief description and working principles of Steam Power Plant, Refrigerators and Heat pump, I.C. Engines (two-stroke and four-stroke, petrol and diesel) and Aircraft Propulsion Engines, Brayton Cycle, Rankine Cycle, Comparison. | **7 Hours** |
| | **Total** | **28 Hours** |

**Text Books**:

T1. R. E. Sonntag and C. Borgnakke, ***Fundamentals of Thermodynamics***, 7th *Ed.*, John Wiley, 2014.
T2. Y. A. Cengel and M. A. Boles, ***Thermodynamics – An Engineering Approach***, 7th *Ed.*, McGraw-Hill Education,2011.

**Reference Books**:

R1. P. K. Nag, ***Engineering Thermodynamics***, 5th *Ed.*, McGraw-Hill Education, 2013.
R2. Y. V. C. Rao, ***An Introduction to Thermodynamics***, 2nd *Ed.*, University Press, 2004.

P.T.O

**Online Resources**:

1. https://nptel.ac.in/courses/112105123/: by Prof. S. Chakraborty, IIT Kharagpur
2. https://www3.nd.edu/~powers/ame.20231/notes.pdf
3. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/

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

| | |
|---|---|
| CO1 | Articulate the concepts of thermodynamic properties, equilibrium, temperature and pressure. |
| CO2 | Apply first laws of thermodynamics to analyze turbine, compressors, heat exchangers and nozzles by using steam table and ideal gas equation. |
| CO3 | Analyze the limitations of the First law and evaluate the available energy and irreversibility. |
| CO4 | Analyze power cycles and refrigeration cycles and their applications in the real world. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

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

| Category | Code | Computer Programming | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CS1001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to introduce fundamentals of computer programming using the C programming language starting with simple programs to advanced topics like structures, pointers, file processing and pre-processor directives for solving various engineering problems through computer programming. |
| **Pre-Requisites** | Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course. Prior experience with any other programming language will be beneficial. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Introduction to computers and programming, operating system, compilers, interpreters, algorithm, flowchart, pseudocode etc., structure of C program, character set, identifier, keywords, constants, variables, data types, operators, expressions, statements, operator precedence and associativity, type conversion, input/output statements. | **8 Hours** |
| **Module-2** | Decision making and branching: if, if-else, nested if-else, else-if ladder and switch constructs, iterative execution of code using loops: while, for, do-while, nested loops, controlling loop behavior using jump statements (break, continue, goto) and exit statements. | **8 Hours** |
| **Module-3** | Arrays (1-D & 2-D), declaration and initialization of arrays, accessing array elements, operations on arrays - insertion, deletion, searching, sorting (selection sort), merging etc., character arrays and strings, initialization, input & output of strings, operations on strings, array of strings, string handling functions. | **9 Hours** |
| **Module-4** | User-defined functions, declaration and definition, parameter passing by value, functions returning values, idea on call by reference, passing arrays to functions, recursion, storage classes - auto, register, static, extern, Structures and Unions - definition, initialization, accessing members, array of structures, arrays within structures, structures and functions, self-referential structures. | **9 Hours** |
| **Module-5** | Understanding pointers, declaration, initialization, accessing variables using pointers, pointer expressions, scale factor, chain of pointers, using pointers with arrays, strings, functions and structures, dynamic memory management, pre-processor directives, command line arguments, basics of file handling. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. E. Balagurusamy, ***Programming in ANSI C***, 7th *Ed.*, McGraw-Hill Education, 2017.
T2. Y. Kanetker, ***Let Us C***, 16th *Ed.*, BPB Publications, 2018.

**Reference Books**:

R1. B. W. Kernighan and D. M. Ritchie, ***The C Programming Language***, 2nd *Ed.*, Pearson Education, 2015.
R2. H. Schildt, ***C: The Complete Reference***, 4th *Ed.*, McGraw-Hill, 2017.
R3. A. Kelley and I. Pohl, ***A Book on C***, 4th *Ed.*, Pearson Education, 2008.
R4. B. Gottfried, ***Schaum's Outline of Programming with C***, 3rd *Ed.*, McGraw-Hill, 2017.

**Online Resources**:

1. https://nptel.ac.in/courses/106104128: by Prof. S. Nandakumar, IIT Kanpur
2. https://nptel.ac.in/courses/106105171: Prof. A. Basu, IIT Kharagpur
3. https://nptel.ac.in/courses/106106210: by Prof. J. Viraraghavan, IIT Madras
4. http://www.stat.cmu.edu/~hseltman/c/CTips.html
5. http://www.c-faq.com/
6. https://www.learn-c.org/
7. http://www2.its.strath.ac.uk/courses/c/

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

| | |
|---|---|
| CO1 | Formulate logic of a problem and write C programs using variables, expressions and I/O. |
| CO2 | Develop structured C programs involving decision making using different control constructs. |
| CO3 | Solve problems involving similar set of data items and write C programs using arrays. |
| CO4 | Design modular C programs and handle heterogeneous data items using structures & unions. |
| CO5 | Develop complex C programs with file processing using advanced features of C programming. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | | | | | | | 2 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 2 | | | | | | | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 1 | 2 | | | | | | | 2 | 3 | 2 | 2 |
| CO4 | 3 | 2 | 1 | 2 | | | | | | | 2 | 3 | 2 | 2 |
| CO5 | 3 | 3 | 1 | 2 | | | | | | | 2 | 3 | 2 | 2 |

| Category | Code | Constitution of India & Professional Ethics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UMC | HS0001 | | 3-0-0 | 0 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this mandatory course is to provide understanding of basic concepts of Indian Constitution and various organs created by the constitution including their functions. This course also introduces a holistic perspective towards life by understanding of the human reality and the rest of existence. |
| **Pre-Requisites** | Basic knowledge of Indian history, overall idea on India's political system, a positive bent of mind, zeal to know the essence of human existence and nature. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required and each session is planned to be interactive. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Introduction to Indian Constitution, Preamble, Salient Features, Fundamental Rights, Fundamental Duties, Features of Federal Structure, The Union Legislature – The Parliament, The Lok Sabha and Rajya Sabha, Composition, Powers and Functions. | **9 Hours** |
| **Module-2** | Union Executive, President of India (with powers and functions), Vice-President, The Council of Ministers and the Prime Minister – Powers and Functions; State Government, The State Legislature -– Composition, Powers and Functions, State Executive – Governor, Chief Minister, and State Council of Ministers. | **9 Hours** |
| **Module-3** | Professional Ethics, Basic terms – Moral, Ethics, Ethical Dilemma, Emotional Intelligence, View on Ethics by Aristotle, Governing Factors of an Individual's Value System, Personal and Professional Ethics. | **7 Hours** |
| **Module-4** | Profession, Professional, Professionalism, Professional Accountability, Professional Risks, Profession and Craftsmanship, Conflict of Interest, Ethics in Engineering – Purpose and Concept of Engineering Ethics, Engineering as Social Experimentation, Issues in Engineering Ethics, Engineers' Responsibility – Safety & Risk, Risk-Benefit Analysis, Causes of an Accident, Preventive Measures. | **9 Hours** |
| **Module-5** | Value Education, Self-exploration as the Process for Value Education, Basic Human Aspirations – Continuous Happiness and Prosperity, Current Scenario, Method to Fulfill the Basic Human Aspirations, Harmony in the Human Being, Family, Society and Nature or Existence. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:


T1. D. D. Basu, ***Introduction of Constitution of India***, 22nd *Ed.*, LexisNexis, 2015.
T2. R. Subramanian, ***Professional Ethics***, 2nd *Ed.*, Oxford University Press, 2017.
T3. R. R. Gaur, R. Asthana, and G. P. Bagaria, ***A Foundation Course in Human Values and Professional Ethics***, 2nd *Ed.*, Excel Books, 2019..


**Reference Books**:


R1. M. Laxmikanth, ***Indian Polity***, 5th *Ed.*, McGraw Hill, 2011.

R2. K. Subas, ***An Introduction to India's Constitution and Constitutional Law***, 5th *Ed.*, National Book Trust India, 2011.
R3. C. E. Harris, M. S. Pritchard, and M. J. Robins, ***Engineering Ethics – Concepts and Cases***, 4th *Ed.*, Cengage Learning, 2012.
R4. A. N. Tripathi, ***Human Values***, 3rd *Ed.*, New Age International, 2019.

**Online Resources**:

1. https://nptel.ac.in/courses/129106411: by Prof. S. Bhat, IIT Madras
2. https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf
3. https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text

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

| | |
|---|---|
| CO1 | Describe basics of Indian constitution, fundamental laws and rights of Indian citizen. |
| CO2 | Articulate the union executive system and constitutional institutions of center and state. |
| CO3 | Understand basic purpose of profession, professional ethics and various moral and social issues. |
| CO4 | Realize the rights, responsibilities, and ethical principles of an Engineer at various levels. |
| CO5 | Understand importance of human values and live with harmony in family, society, and nature. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| 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 & 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 2 | 1 | 1 | 1 | 1 | 1 | | 1 | |
| CO2 | | | | | | 2 | 2 | 3 | 2 | 1 | 2 | | 1 | |
| CO3 | | | | | | 3 | 3 | 3 | 2 | 1 | 2 | | 2 | |
| CO4 | | | | | | 2 | 3 | 3 | 2 | 2 | 2 | | 2 | |
| CO5 | | | | | | 3 | 3 | 3 | 2 | 1 | 3 | | 2 | |

| Category | Code | Environmental Science & Engineering | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UMC | CH0001 | | 3-0-0 | 0 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to introduce essential aspects of environmental science for engineering students. The course covers ecology, ecosystems, air and water pollution, management of municipal solid wastes, hazardous wastes and e-waste, along with environmental laws and UN conferences. |
| **Pre-Requisites** | Basic knowledge of physics, chemistry and biology is required for this course. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required with focus on importance of environment, examples and case studies. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Ecology, Ecosystems and Biogeochemical Cycles: Introduction to environmental science and engineering, Ecological perspective, Ecosystems and processes, Trophic pyramids, Biodiversity of species, Water, Oxygen, Nitrogen and Carbon cycle, Environmental gradient and tolerance levels of environmental factors. | **9 Hours** |
| **Module-2** | Water and Wastewater Treatment: Water quality standards and parameters, water table, aquifer, pre-treatment, conventional treatment processes of water, DO, BOD, COD and microbial wastewater treatment. | **9 Hours** |
| **Module-3** | Atmospheric Chemistry, Soil Chemistry and Noise Abatement: Atmospheric chemistry, air pollution and associated control equipment, climate change, soil chemistry, noise standards, noise measurement and noise abatement. | **8 Hours** |
| **Module-4** | Waste Management: Types and management of MSW (Municipal Solid Waste), hazardous waste and e-waste, Introduction to LCA (Life Cycle Assessment). | **8 Hours** |
| **Module-5** | EIA, EIS, Environmental Laws and Human Health: Environmental Audit, EIA (Environmental Impact Assessment), EIS (Environmental Impact Statement), Indian environmental laws, UN Conferences, Human population and the environment. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. G. M. Masters and W. P. Ela, ***An Introduction to Environmental Engineering and Science***, 3rd *Ed.*, PHI Learning, 2015.
T2. G. Kiely, ***Environmental Engineering***, Spl. Indian Edition, McGraw Hill, 2007.

**Reference Books**:

R1. M. L. Davis and S. J. Masten, ***Principles of Environmental Engineering and Science***, 2nd *Ed.*, McGraw-Hill, 2017.
R2. H. D. Kumar and U. N. Dash, ***Environmental Studies***, 2nd *Ed.*, IndiaTech Publishers, 2017.

**Online Resources**:

1. http://nptel.ac.in/courses/120108002/: Aquatic Biodiversity and Environmental Pollution.
2. http://nptel.ac.in/courses/120108004/: Environment Management.

3. http://nptel.ac.in/courses/120108005/: Municipal Solid Waste Management.
4. https://www.epa.gov/environmental-topics/: All Current Environmental Issues.

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

| | |
|---|---|
| CO1 | Describe the concepts of ecology, ecosystems, and biogeochemical cycles in the environment. |
| CO2 | Explain the process of water and wastewater treatment for prevention of water pollution. |
| CO3 | Understand the pollutants in the environment and explore the principles for their eradication. |
| CO4 | Explore waste minimization and management of different types of wastes generated. |
| CO5 | Understand EIA, EIS, and other environmental laws for prevention of pollution. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| PO7 | **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9) |
| PO8 | **Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | 2 | 1 | 3 | 1 | 2 | | 1 | 2 | | 1 | |
| CO2 | 2 | 2 | 3 | 2 | 1 | 3 | 1 | 2 | | 1 | 2 | | 1 | |
| CO3 | 2 | 2 | 3 | 2 | 1 | 3 | 1 | 1 | | 1 | 2 | | 1 | |
| CO4 | 2 | 2 | 3 | 2 | 1 | 3 | 2 | 2 | | 1 | 2 | | 1 | |
| CO5 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 2 | | 1 | 2 | | 1 | |

| Category | Code | Probability & Statistics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | MT1002 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to familiarize the perspective engineers with the knowledge and concepts of probability and statistics which are essential to study non-deterministic systems. |
| **Pre-Requisites** | Basics of sets, counting techniques, differential and integral calculus of one variable and coordinate geometry of two and three dimensions. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Measures of central tendencies, Elementary probability, Conditional probability, Bayes' Rule (related problems only), Random variable, Binomial & Hypergeometric distribution, Mean and variance. | **8 Hours** |
| **Module-2** | The Poisson approximation to Binomial Distribution, Poisson Process, Geometric Distribution & Multinomial Distribution, Continuous random variables, Normal Distribution, Normal Approximation to the Binomial Distribution, Uniform Distribution, Exponential Distribution, Joint Discrete Distribution. | **9 Hours** |
| **Module-3** | Populations and Samples, Sampling Distribution of Mean ($\sigma$ known), Sampling Distribution of Mean ($\sigma$ unknown) & Sampling Distribution of Variance; Point Estimation of mean, Interval Estimation of mean, Tests of hypotheses and errors involved, Hypotheses concerning one mean, Inference concerning two mean, Estimation of variance, Hypotheses concerning one variance, Hypotheses concerning two variances. | **10 Hours** |
| **Module-4** | Estimation of Proportions, Hypotheses Concerning proportion (one & several), Analysis of $r \times c$ table (Contingency table), Goodness of fit. | **7 Hours** |
| **Module-5** | The method of least squares, Inferences based on the least square estimation, Curvilinear Regression, Checking the adequacy of the model, Correlation, Analysis of Variance, General principle, Completely Randomized Design, Randomized Block Design. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. R. A. Johnson, ***Miller & Freund's - Probability and Statistics for Engineers***, 8th *Ed.*, PHI Learning, 2011.

**Reference Books**:

R1. W. Mendenhall, R. J. Beaver, and B. M. Beaver, ***Probability and Statistics***, 14th *Ed.*, Cengage Learning, 2014.

R2. R. E. Walpole, R. H. Myers, S. L. Myers, and K. E. Ye, ***Probability & Statistics for Engineers & Scientists***, 9th *Ed.*, PHI Learning, 2012.

**Online Resources**:

1. https://nptel.ac.in/courses/111/105/111105041/: by Prof. S. Kumar, IIT Kharagpur
2. https://ocw.mit.edu/courses/mathematics/18-440-probability-and-random-variables-spring-2014/lecture-notes/

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

| | |
|---|---|
| CO1 | Apply the concepts of probability and random variables to evaluate probabilities of events. |
| CO2 | Apply different discrete and continuous probability models to solve real life problems. |
| CO3 | Apply the concepts of sampling to estimate population parameters and test hypothesis. |
| CO4 | Test the goodness of a model and apply it to real life problems. |
| CO5 | Apply regression model and ANOVA to study the characteristics of data sets. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | | | | | | 2 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 2 | 1 | 1 |
| CO3 | 3 | 2 | 3 | 2 | 2 | | | | | | 2 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 3 | 2 | 1 |

| Category | Code | Data Structures & Algorithms | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CS1003 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | To understand the abstract data types and to solve problems using data structures such as stacks, queues, linked lists, hash tables, binary trees, heaps, binary search trees, graphs and writing programs for these solutions. |
| **Pre-Requisites** | Knowledge of programming in C, specifically on structures, pointers, functions, recursion etc., are required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Introduction to data structures, classification of data structures, algorithmic notation, complexity of algorithms, asymptotic notations, abstract data types. Arrays - introduction, representation of arrays (row and column major representation), basic operations on array (traverse, insert, delete, search), sparse matrix, representation of sparse matrix using triplet form, operations on sparse matrix (addition, transpose) | **8 Hours** |
| **Module-2** | ADT Stack - stack model, representation of stack using array, basic operations with analysis, applications- recursion, and conversion of infix to post fix expression, evaluation of postfix expression. ADT Queue - queue model, representation using array, basic operations with analysis, circular queue, introduction to priority queue and double ended queue. | **8 Hours** |
| **Module-3** | Linked list - introduction, types of linked list (single, double, circular), representation in memory, operations on linked list (traverse, search, insert, delete, sort, merge) in each type with analysis. Representation of polynomial and its operations (addition, multiplication), implementation of stack and queue using linked list. | **9 Hours** |
| **Module-4** | Tree - terminology, representation, binary tree - tree traversal algorithms with and without recursion. Binary search tree, Operations on Binary Search Tree with analysis, threaded binary tree, general tree, Height balanced tree (AVL tree), m-way search trees, B-trees. Graph - terminology, representation (adjacency matrix, incidence matrix, path matrix, linked representation), graph traversal (BFS, DFS), Dijkstra's single source shortest path algorithm, Warshall's all pair shortest path algorithm, topological sort. | **9 Hours** |
| **Module-5** | Sorting algorithms - bubble sort, selection sort, insertion sort, quick sort, merge sort, radix sort, heap sort. Hashing- hash functions and hashing techniques. collision resolution techniques- linear probing, quadratic probing, chaining. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. M. A. Weiss, ***Data Structures and Algorithm Analysis in C***, 2nd *Ed.*, Pearson Education, 2002.
T2. E. Horowitz, S. Sahni, S. A-Freed, ***Fundamentals of Data Structures in C***, 2nd *Ed.*, Univ. Press, 2008.

**Reference Books**:

R1. A. M. Tenenbaum, Y. Langsam, and M. J. Augenstein, ***Data Structures Using C***, 3rd *Ed.*, Pearson Education, 2007.
R2. J. P. Tremblay and P. G. Sorenson, ***An Introduction to Data Structures with Applications***, 2nd *Ed.*, McGraw Education, 2017.
R3. S. Lipschutz, ***Data Structures***, 1st *Revised Ed.*, McGraw Education, 2014.

**Online Resources**:

1. https://nptel.ac.in/courses/106/106/106106127/: By Prof. H. A. Murthy, Prof. S. Balachandran, and Dr. N. S. Narayanaswamy, IIT Madras
2. https://nptel.ac.in/courses/106/102/106102064/: By Prof. N. Garg, IIT Delhi
3. https://nptel.ac.in/courses/106/106/106106130/: By Dr. N. S. Narayanaswamy, IIT Madras
4. https://www.geeksforgeeks.org/data-structures/

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

| | |
|---|---|
| CO1 | Analyze performance of algorithms and implement operations on arrays and sparse matrices. |
| CO2 | Apply the basic operations of stacks and queues to solve real world problems. |
| CO3 | Implement different types of linked list operations and their applications. |
| CO4 | Represent data using trees & graphs to use them in various real life applications. |
| CO5 | Analyze various sorting algorithms and explore different hashing techniques. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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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**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 1 | | | | | 1 | 2 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 2 | 2 | | | | | 1 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | | | | | 1 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | | | | | 1 | 2 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 2 | | | | | 1 | 2 | 3 | 1 |

| Category | Code | Basic Electronics Engineering Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | EC1002 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this practical course if to learn the concepts and functionalities of the electronic devices, tools and instruments. Students will understand general specifications and deployability of the electronic devices and assemblies, and also develop confidence in handling and usage of electronic devices, tools and instruments in engineering applications. |
| **Pre-Requisites** | Knowledge on intrinsic and extrinsic Semiconductors, Physics and Chemistry of Higher Secondary Science level. |
| **Teaching Scheme** | Regular laboratory experiments to be conducted under the supervision of teachers and demonstrators with the help of ICT, as and when required along with pre-lab session and demonstration for each experiment. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Identification of electronic components and devices (Testing of semiconductor diodes and transistors using digital multi-meter). |
| 2 | Understand and use oscilloscope, signal generator to view waveforms and measure amplitude and frequency of a given waveform. |
| 3 | Generate V-I characteristics of semiconductor diode and determine its DC and AC resistances. |
| 4 | Implement clipper circuits (positive clipper and negative clippers) and observe its output waveforms and compare them with theoretically analyzed results. |
| 5 | Design half-wave and full-wave rectifier circuits without and with capacitor filter, record the waveforms and measure average & RMS values of the rectified output. |
| 6 | Generate and analyze the static characteristics of BJT in CE configuration. |
| 7 | Design the DC biasing (Fixed) circuit of transistor in CE configuration and determine its operating point. |
| 8 | Analyze the static characteristics of FET in CS configuration. |
| 9 | Apply Op-Amp in inverting, non-inverting, integrating and differentiating configurations & record their input-output waveforms. |
| 10 | Understand and verify truth tables of various logic gates. |
| 11 | Apply NAND and NOR as Universal logic gates. |
| 12 | Analyze and implement of R.C phase shift Oscillator using Op-AMP. |
| 13 | Design and simulate BJT and FET I/O characteristics using OrCAD PSpice/ Multisim. |
| 14 | Design and analysis of AM modulator and demodulator. |

**Text Books**:

T1. R. L. Boylestad and L. Nashelsky, ***Electronic Devices and Circuit Theory***, 11$^{th}$ *Ed.*, Pearson Education.
T2. A. S. Sedra and K. C. Smith, ***Microelectronic Circuits***, 7$^{th}$ *Ed.*, Oxford University Press.

**Reference Books**:

R1. V. K. Mehta and R. Mehta, ***Principles of Electronics***, 3rd *Ed.*, S. Chand Publishing, 1980.

**Online Resources**:

1. http://vlab.co.in/ba_labs_all.php?id=1
2. http://iitg.vlab.co.in/?sub=59&brch=165

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

| | |
|---|---|
| CO1 | Recognize electronic components, measuring instruments, semiconductor diodes and their use. |
| CO2 | Determine the characteristics of transistors and use them in various electronic circuits. |
| CO3 | Explore design and testing of Op-Amp and design circuits for various applications using them. |
| CO4 | Design and test digital circuits using logic gates for different applications. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

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

| Category | Code | Basic Electrical Engineering Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | EE1002 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this practical course is to expose the students to different electrical components and basic safety rules and regulations, give hands on practice about different measuring and protection equipment and their operations to understand and verify the concept of electrical & magnetic circuits and electric machines. |
| **Pre-Requisites** | Basic knowledge of different electrical components and different analysis techniques of electrical and magnetic circuits. Topics taught in Basic Electrical Engineering theory class are essential to conduct the experiments. |
| **Teaching Scheme** | Regular laboratory experiments conducted under supervision of the teacher. Demonstration will be given for each experiment. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Measurement of power consumption & power factor of a fluorescent lamp and its power factor improvement. |
| 2 | Measurement of winding resistances of a DC compound machine. |
| 3 | Power & power factor measurement of three-phase load by two-wattmeter method. |
| 4 | Connection and testing of a single-phase energy meter. |
| 5 | Determination of open circuit characteristics (OCC) of a DC shunt generator. |
| 6 | Calculation of power & power factor in series R-L-C circuit excited by single-phase supply. |
| 7 | Determination of no-load parameters through OC Test of single-phase transformer. |
| 8 | Study of capacitor start and run single-phase induction motor/fan motor. |
| 9 | Study and verification of Thevenin's Theorem and Norton's Theorem. |
| 10 | Draw the B-H curve of a magnetic Specimen. |
| 11 | Starting of three-phase induction motor. |
| 12 | Voltage Regulation & efficiency of single-phase transformer by direct loading. |

**Text Books**:

T1. A. Husain, ***Fundamentals of Electrical Engineering***, 4th *Ed.*, Dhanpat Rai & Co., 2016.
T2. B. L. Thereja & A. K. Thereja, ***A Textbook of Electrical Technology***, 23rd *Ed.*, S. Chand & Co.

**Reference Books**:

R1. J. B. Gupta, ***A Textbook of Electrical Science***, S. K. Kataria & Sons, 2013.
R2. B. R. Gupta and V. Singhal, ***Electrical Science***, S. Chand & Co, 2005.

**Online Resources**:

1. https://nptel.ac.in/courses/108/105/108105053/: by Prof. G. D. Roy, Prof. N. K. De, and Prof. T. K. Bhattacharya, IIT Kharagpur
2. https://nptel.ac.in/courses/108/108/108108076/: By Prof. L. Umanand, IISc Bangalore
3. https://www.electrical4u.com/
4. www.electronics-tutorials.ws/dc-circuits

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

| | |
|---|---|
| CO1 | Get an exposure to common electrical components and their ratings. |
| CO2 | Develop electrical circuits and measure its characteristics using different measuring instruments and deploy different protective devices of appropriate ratings. |
| CO3 | Understand the usage of common electrical measuring instruments. |
| CO4 | Understand the basic characteristics of transformers and electrical machines. |
| CO5 | Verify different network theorems and magnetic properties. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| 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). |
| 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). |
| PO8 | **Individual & 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | | 2 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| CO2 | 2 | | | 2 | | 1 | | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| CO3 | 1 | | | 3 | | 2 | | 2 | 1 | 1 | 1 | 2 | 1 | 2 |
| CO4 | 1 | | | 2 | | 2 | | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| CO5 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | 1 | 2 | 1 | 2 |

| Category | Code | Computer Programming Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CS1002 | | 0-0-4 | 2 | 100 |

| | |
|---|---|
| **Objectives** | To enable the students to analyze problems, formulate and implement solutions using the C programming language. The students will write C programs using proper logic to solve a problem and execute them on a computer. |
| **Pre-Requisites** | Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course. |
| **Teaching Scheme** | Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise of programming assignments. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Introduction to computers and Linux operating system. |
| 2, 3 | Get acquainted with the programming environment - Linux commands and VI-editor. |
| 4 | Editing, compiling, executing, and debugging of simple C programs. |
| 5 | Programs using operators and formatted input/output statements. |
| 6 | Decision making using `if`, `if-else`, `else-if` ladder, nested `if`. |
| 7 | Decision making using `switch-case` construct. |
| 8, 9 | Loop control structure (`while`, `do-while`, `for`) with jump statements. |
| 10 | Nested loops (printing various formats) |
| 11, 12 | 1-D arrays including operation like searching, sorting, merging etc. |
| 13 | Handling 2-D arrays such as matrix operations. |
| 14, 15 | Programs on strings using various string handling functions (library functions) |
| 16, 17 | Designing user-defined functions. |
| 18, 19 | Programs on recursion. |
| 20 | Designing user defined functions for string manipulation. |
| 21 | Passing arrays (both 1D and 2D) to functions. |
| 22, 23 | Structure, array of structure, nested structure. |
| 24 | Dynamic memory management. |
| 25 | Self-referential structure (create and display operation of single linked list) |
| 26, 27 | File handling - reading from and writing to files. |
| 28 | Command-line argument, pre-processor directives. |

**Text Books**:

T1. E. Balagurusamy, ***Programming in ANSI C***, 7th *Ed.*, McGraw-Hill Education, 2017.
T2. Y. Kanetker, ***Let Us C***, 16th *Ed.*, BPB Publications, 2018.

**Reference Books**:

R1. B. W. Kernighan and D. M. Ritchie, ***The C Programming Language***, 2nd *Ed.*, Pearson Education, 2015.
R2. H. Schildt, ***C: The Complete Reference***, 4th *Ed.*, McGraw-Hill, 2017.
R3. A. Kelley and I. Pohl, ***A Book on C***, 4th *Ed.*, Pearson Education, 2008.

R4. B. Gottfried, ***Schaum's Outline of Programming with C***, 3rd *Ed.*, McGraw-Hill, 2017.

**Online Resources**:

1. https://www.w3resource.com/c-programming-exercises/
2. https://www.includehelp.com/c-programming-examples-solved-c-programs.aspx
3. https://www.onlinegdb.com/online_c_compiler
4. https://www.tutorialspoint.com/compile_c_online.php

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

| | |
|---|---|
| CO1 | Construct C programs for mathematical operations using control statements. |
| CO2 | Develop C programs for Array and String manipulation. |
| CO3 | Construct modular programs for better maintenance and reusability. |
| CO4 | Manipulate heterogeneous data using structure and union. |
| CO5 | Create and manipulate files using C programs. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 2 | | | | | | | 2 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 1 | 2 | | | | | | | 2 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 3 | 2 | | | | | | | 2 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 1 | 2 | | | | | | | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 1 | 2 | | | | | | | 2 | 2 | 1 | 1 |

| Category | Code | Communicative & Technical English | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| SEC | HS1001 | | 0-0-4 | 2 | 100 |

| | |
|---|---|
| **Objectives** | The objectives of this laboratory course are to provide practice sessions to enhance students' communication ability in the four language skills with focus on technical communication. |
| **Pre-Requisites** | Basic knowledge of general communication skills in english is required. |
| **Teaching Scheme** | Regular laboratory classes with various tasks designed to facilitate technical communication through pair and/or team activities with regular assessments, presentations, discussions, role-playing, audio-visual supplements, writing activities, business writing practices and vocabulary enhancement. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Introduction to the course and diagnostic test. |
| 2 | JAM: content development, structuring and delivery. |
| 3 | Group presentation. |
| 4 | Effective Verbal Communication exercises: plain English, bias-free language, formal and informal style, usage etc. |
| 5 | Activities on non-verbal communication. |
| 6 | Sounds of English: Vowels and consonants. |
| 7 | Sounds of English: Transcription. |
| 8 | Sounds of English: Syllable and stress. |
| 9 | Sounds of English: Rhythm. |
| 10 | Sounds of English: Intonation I. |
| 11 | Sounds of English: Intonation II. |
| 12 | Role play on simulated business contexts considering different channels of business communication. |
| 13 | Listening comprehension. |
| 14 | Practice on elements of business writing. |
| 15 | Composing effective paragraphs with unity, coherence, cohesion, progression. |
| 16 | Process writing. |
| 17 | Writing memos. |
| 18 | Emails and email etiquette. |
| 19 | Business letter I. |
| 20 | Business letter II. |
| 21 | Error correction: usage and grammar. |
| 22 | Reading Comprehension I: Essay – skimming, scanning, inferential comprehension, critical reading. |
| 23 | Reading Comprehension II: Short story – Analysing the tone of the author. |

*Cont'd. . .*

| Experiment-# | Assignment/Experiment |
|---|---|
| 24 | Reading Comprehension III: News editorial – Differentiating facts from opinion. |
| 25 | Reading Comprehension IV: Texts on Science and Technology – Identifying discourse markers. |
| 26 | Reading Comprehension V: Texts on Science and Technology – Intensive reading and note-taking. |
| 27 | Note-making and summary writing. |
| 28 | Verbal Advantage: vocabulary exercises. |

**Text Books**:

T1. M. A. Rizvi, ***Effective Technical Communication***, 2nd *Ed.*, Tata McGraw Hill, 2017.
T2. M. Raman and S. Sharma, ***Technical Communication: Principles and Practices***, 3rd *Ed.*, Oxford University Press, 2015.
T3. B. K. Das, K. Samantray, R. Nayak, S. Pani, and S. Mohaty, ***An Introduction to Professional English & Soft Skills***, Cambridge Univ. Press, 2009.

**Reference Books**:

R1. J. Seeley, ***The Oxford Guide to Effective Writing and Speaking: How to Communicate Clearly***, 3rd *Ed.*, Oxford University Press, 2013.
R2. S. Kumar and P. Lata, ***Communication Skils***, Oxford University Press, 2011.
R3. T. Panigrahi, ***Communicative Competence***, 1st *Ed.*, Notion Press, 2024.

**Online Resources**:

1. https://nptel.ac.in/courses/109/106/109106094/: by Prof. A. Iqbal, IIT Madras
2. https://nptel.ac.in/courses/109/104/109104031/: by Dr. T. Ravichandran, IIT Kanpur
3. https://ocw.mit.edu/courses/comparative-media-studies-writing/21w-732-5-introduction-to-technical-communication-explorations-in-scientific-and-technical-writing-fall-2006/download-course-materials/

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

| | |
|---|---|
| CO1 | Communicate with clarity, fluency and impact. |
| CO2 | Develop comprehensive understanding of communication concepts, its importance, types, barriers and principles. |
| CO3 | Communicate effectively in business set-ups. |
| CO4 | Compose coherent, clear and impactful business correspondences. |
| CO5 | Practice sub-skills of reading and become adept readers. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| 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 & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. |

*Cont'd. . .*

| | |
|---|---|
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| CO2 | | | | | | 1 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 |
| CO3 | | | | | | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 |
| CO4 | | | | | | 1 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 |
| CO5 | | | | | | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 |

| Category | Code | Workbench Practices | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | EE1003 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this practical course is to provide hands-on exposure on tools, fasteners, computers, electrical wiring, electronic components & instruments, soldering & desoldering, making of PCB, and using other advanced tools necessary for creating working models and prototypes for engineers of circuit branches. |
| **Pre-Requisites** | Familiarity with some hand tools used in home is desired. |
| **Teaching Scheme** | Regular experiments and jobs using tools and instruments under supervision of the teacher. Demonstration will be given for each experiment. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | General introduction & familiarity with tools (measuring, marking, holding, and cutting tools), Fitting (Limit, Fit, Tolerance)and Fastening (different types of screws, rivets, nuts & bolts). |
| 2 | Disassembling and assembling of Desktop Computer System and recognize its parts. |
| 3 | Study of cables, wires, switches, fuses, MCB, and fuse carriers in an electrical network. |
| 4 | Study of earthing and electrical safety, demonstration of the precautionary steps in case of electrical shocks. |
| 5 | Calculation of current and power for series and parallel connected lamp load. |
| 6 | Study and design of house wiring. |
| 7 | Study of digital measuring equipment and calculation of energy consumption in an electrical system. |
| 8 | Study of basic electronic & electrical components (such as Resistor, Capacitor, Inductor, Potentiometer, Diode, Transistor, Sensors, ICs, etc.) for circuit design. |
| 9 | Study of PCB assembling tools (such as Soldering iron, De-soldering pump, Pliers, Cutters, Wire strippers, Crimping tool, Micro-soldering, Hot air soldering and de-soldering station etc.) |
| 10 | Study of different measuring and testing tools such as Multimeter, Digital Storage Oscilloscope (DSO), Clamp meter, and Function generator etc. |
| 11 | Familiarization with EDA tools (such as Eagle or XCircuit) with general purpose components for designing PCB of simple circuits. |
| 12 | Fabrication & testing of single-sided and double-sided PCB for selected applications using general purpose instruments. |

**Text Books**:


T1. B. H. Deshmukh, ***Electrical Materials and Wiring Practices***, Nirali Prakashan, 2018.

T2. G. Haldar, ***Electronics Course Book: Basic Components, IC boards, SMD, Logic Gates, Transistors, Resistors, Capacitors, Diodes, Audio Circuit and More***, GRPV Arts and Office Supplies, 2024.

T3. R. S. Khandpur, ***Printed Circuit Boards: Design, Fabrication, Assembly and Testing***, 1st *Ed.*, McGraw Hill,2006.

**Reference Books**:

R1. H. Joshi, ***Residential, Commercial and Industrial Electrical Systems: Protection, Testing and Commissioning, Vol-3***, McGraw-Hill Education, 2008.
R2. S. Monk, ***Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards***, 1st *Ed.*. McGraw-Hill, 2014.
R3. J. Varterisian, ***Fabricating Printed Circuit Boards***, 1st *Ed.*, Newnes, 2002.
R4. A. Kemp, ***The Makerspace Workbench: Tools, Technologies and Techniques for Making***, O'Reilly Media, 2013.

**Online Resources**:

1. https://bharatskills.gov.in/pdf/E_Books/Electrcian_SEM1_TP.pdf
2. https://bharatskills.gov.in/pdf/E_Books/Electrician_SEM2_TP.pdf
3. https://bharatskills.gov.in/Home/StudyMaterial?var=WSdYV6aWadK8jUuNKxoBWg==
4. https://onlinecourses.swayam2.ac.in/nou20_cs08/preview
5. https://www.lanl.gov/safety/electrical/docs/arc_flash_safety.pdf
6. https://www.ee.iitb.ac.in/~pcpandey/courses/ee616/pcblayout_c_aug07.pdf
7. https://nptel.ac.in/courses/108/108/108108157/
8. https://nptel.ac.in/courses/122/106/122106025/
9. https://nptel.ac.in/courses/108/101/108101091/

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

| | |
|---|---|
| CO1 | Utilize appropriate tools for various workbench jobs within their limits, fits, and tolerance. |
| CO2 | Disassemble and reassemble a computer System and replace its components. |
| CO3 | Identify and utilize common electrical components with propery safety mechanisms. |
| CO4 | Design house wiring and measure energy consumption using digital meters. |
| CO5 | Identify and use basic electronic components, PCB assembling, measuring and testing tools. |
| CO6 | Design and fabricate PCBs for different applications and assemble electronic components. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |

*Cont'd. . .*

| | |
|---|---|
| PO7 | **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9) |
| PO8 | **Individual & 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | |
| CO2 | 1 | 1 | | | 3 | 1 | | 2 | | 1 | 2 | | | |
| CO3 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| CO4 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | | | |
| CO5 | 2 | 2 | 1 | | 1 | | | 1 | | 1 | 1 | 2 | | |
| CO6 | 1 | 2 | 3 | | 3 | 1 | | 2 | | 1 | 1 | 1 | 2 | |

| Category | Code | Engineering Graphics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | ME1003 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this laboratory course is to learn engineering drawing standards, conventions & practices, develop drawing skills in 2D & 3D, and use computer-aided drawing software to create meaningful engineering drawings. |
| **Pre-Requisites** | Basic understanding of 2D and 3D geometry is required. |
| **Teaching Scheme** | Regular laboratory classes using drawing tools under supervision of the teacher. Demonstration will be given for each drawing assignment using both conventional and CAD software tools as per requirement. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Principles of Engineering Graphics and their significance (lettering & scale) and usage of Drawing instruments. |
| 2 | Orthographic projections, Principles of orthographic projections, Projections of points and lines. |
| 3 | Projections of different planes. |
| 4 | Projection of solids, 3D to 2D views, Machine component diagrams, Sectional views of simple and compound solid models. |
| 5 | Principles of Isometric projection, Isometric Scale & Views, Isometric views of planes and solids. |
| 6 | Development of surface and intersection of surfaces. |
| 7 | Engineering curves and conics. |
| 8 | Introduction to AutoCAD, its GUI, toolbars and commands, shortcut keys. |
| 9 | 2D AutoCAD drawing using basic tools, Draw & Modify menu commands. |
| 10 | Orthographic projection drawings of various models using AutoCAD. |
| 11 | Isometric drawing & 3D modeling in AutoCAD, different solid editing options. |
| 12 | 3D modeling of simple & compound models, and machine components using AutoCAD. |

**Text Books**:

T1. N. D. Bhat, M. Panchal, ***Engineering Drawing***, Charotar Publishing House, 2008.
T2. M. B. Shah, B. C. Rana, ***Engineering Drawing and Computer Graphics***, Pearson Education, 2008.
T3. S. Tickoo, ***AutoCAD 2020 Work Book***, BPB Publications, 2020.

**Reference Books**:

R1. R. K. Dhawan, ***A Text Book of Engineering Drawing***, S. Chand Publications, 2007.
R2. K. Venugopal, ***Engineering Drawing and Graphics***, 3rd *Ed.*, New Age International, 1998.

**Online Resources**:

1. http://nptel.ac.in/courses/112103019
2. https://nptel.ac.in/courses/112/102/112102101/
3. https://freevideolectures.com/course/3420/engineering-drawing

4. https://www.autodesk.in/campaigns/autocad-tutorials
5. https://help.autodesk.com/view/ACD/2020/ENU/

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

| | |
|---|---|
| CO1 | Understand and apply the concepts of lettering and dimensioning for drafting of machine drawings and building drawings and different conics and curves. |
| CO2 | Recognize and be familiar with the orthographic projections of points, lines, planes and solids. |
| CO3 | Visualize the real product from isometric projections, solid and sectional views. |
| CO4 | Draw 2D engineering drawings using various draw and modify tools of AutoCAD. |
| CO5 | Design various machine components and building structure by using AutoCAD. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 1 | 2 | | | | 2 | 1 | 1 | 1 | | 1 |
| CO2 | 2 | 2 | 2 | 1 | 2 | | | | 2 | 1 | 1 | 1 | | 1 |
| CO3 | 2 | 2 | 3 | 1 | 2 | | | | 2 | 1 | 1 | 1 | | 1 |
| CO4 | 2 | 2 | 3 | 1 | 2 | | | | 2 | 1 | 1 | 2 | | 1 |
| CO5 | 2 | 2 | 3 | 1 | 2 | | | | 2 | 1 | 1 | 2 | | 2 |

| Category | Code | Data Structures & Algorithms Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CS1004 | | 0-0-4 | 2 | 100 |

| | |
|---|---|
| **Objectives** | Develop skills to design and analyze simple linear and non linear data structures, strengthening the ability of students to identify and apply the suitable data structure for the given real world problem. |
| **Pre-Requisites** | Knowledge of programming in C, specifically on structures, pointers, functions, recursion etc., are required. |
| **Teaching Scheme** | Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise of programming assignments. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Operations on arrays – insert, delete, merge. |
| 2 | Selection Sort, Bubble sort. |
| 3 | Linear Search and Binary search. |
| 4 | Representation of sparse matrix. |
| 5, 6 | Addition and transpose of sparse matrix. |
| 7 | Implementation of stack using array. |
| 8 | Conversion of infix to postfix expression. |
| 9 | Evaluation of postfix expression. |
| 10 | Operations of queue using array. |
| 11 | Operations of circular queue. |
| 12, 13 | Single linked list operations. |
| 14, 15 | Double linked list operations. |
| 16 | Circular linked list operations. |
| 17 | Stack using linked list. |
| 18 | Queue using linked list. |
| 19 | Polynomial addition using linked-list. |
| 20, 21 | Binary Search Tree operations. |
| 22, 23 | Graph traversal (BFS, DFS). |
| 24 | Warshall's shortest path algorithm. |
| 25, 26 | Implementation Insertion Sort and Quick Sort. |
| 27, 28 | Implementation of Merge Sort and Heap Sort. |

**Text Books**:

T1. E. Horowitz, S. Sahni, S. Anderson-Freed, ***Fundamentals of Data Structures in C***, 2nd *Ed.*, Universities Press, 2008.

T2. M. A. Weiss, ***Data Structures and Algorithm Analysis in C***, 2nd *Ed.*, Pearson Education, 2002.

**Reference Books**:

R1. A. K. Rath and A. K. Jagadev, ***Data Structures Using C***, 2nd *Ed.*, Scitech Publication, 2011.

R2. Y. Kanetkar, ***Data Structures Through C***, 2nd *Ed.*, BPB Publication, 2003.

**Online Resources**:

1. https://nptel.ac.in/courses/106/106/106106127/: By Prof. H. A. Murthy, Prof. S. Balachandran, and Dr. N. S. Narayanaswamy, IIT Madras
2. https://nptel.ac.in/courses/106/102/106102064/: By Prof. N. Garg, IIT Delhi
3. https://nptel.ac.in/courses/106/106/106106130/: By Dr. N. S. Narayanaswamy, IIT Madras

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

| | |
|---|---|
| CO1 | Implement various operations on array and sparse matrix. |
| CO2 | Design functions to implement basic operations on stack & queue and apply them to solve real world problems. |
| CO3 | Implement single, double & circular linked list and apply them in various real life applications. |
| CO4 | Construct binary search tree and perform traversal, insertion, deletion, and search operations on it. |
| CO5 | Perform BFS and DFS traversal operations in a graph and implement various sorting and searching algorithms. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | 2 | 1 | 1 | | | | | 1 | 2 | 2 | 1 |
| CO2 | 2 | 2 | 3 | 2 | 1 | 1 | | | | | 1 | 2 | 1 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 1 | 1 | | | | | 1 | 2 | 1 | 1 |
| CO4 | 2 | 2 | 2 | 3 | 1 | 1 | | | | | 1 | 2 | 2 | 1 |
| CO5 | 2 | 2 | 3 | 3 | 1 | 1 | | | | | 1 | 2 | 3 | 1 |

| Category | Code | Corporate Communication Skills | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| SEC | HS1002 | | 0-0-4 | 2 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this laboratory course is to give students adequate practice in a simulated professional environment with focus on communication skills with professionalism in a typical corporate set up. |
| **Pre-Requisites** | Knowledge of communicative and technical english is required. |
| **Teaching Scheme** | Regular laboratory classes with various tasks designed to facilitate communication and soft skills through pair and/or team activities with regular assessments, presentations, discussions, role-playing, audio-visual supplements, writing activities, business writing practices and vocabulary enhancement. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Aspects of Inter-cultural communication and cultural conditioning. |
| 2 | Barriers to cross-cultural communication. |
| 3 | Personality test and personality development. |
| 4 | Team work and its stages. |
| 5 | Team work and leadership: Simulation. |
| 6 | Negotiation skills: Role-play. |
| 7 | Persuasive presentation I. |
| 8 | Persuasive presentation II. |
| 9 | Writing a blog. |
| 10 | Vlog making and presentation I. |
| 11 | Vlog making and presentation II. |
| 12 | Emotional Intelligence: its importance in the workplace. |
| 13 | Time management. |
| 14 | Social media etiquette. |
| 15 | Business etiquette. |
| 16 | Assertiveness at work: Role-play. |
| 17 | Power point presentation I. |
| 18 | Power point presentation II. |
| 19 | Power point presentation III. |
| 20 | Power point presentation IV. |
| 21 | Mind mapping. |
| 22 | Creative and critical thinking for problem solving. |
| 23 | Six thinking hats: Problem solving and decision making in meetings. |
| 24 | Verbal Ability I: synonyms and antonyms. |
| 25 | Verbal Ability II: One word substitution. |

*Cont'd. . .*

| Experiment-# | Assignment/Experiment |
|---|---|
| 26 | Verbal Ability III: Error correction. |
| 27 | Verbal Ability IV: Odd one out. |
| 28 | Verbal Ability V: Analogy. |

**Text Books**:

T1. S. B. Bachu, ***Corporate Communication Skills for Professionals***, 1st *Ed.*, White Falcon Publishing, 2021.
T2. M. A. Rizvi, ***Effective Technical Communication***, 2nd *Ed.*, Tata McGraw-Hill, 2017.
T3. M. Raman and S. Sharma, ***Technical Communication: Principles and Practice***, 3rd *Ed.*, Oxford University Press, 2015.

**Reference Books**:

R1. P. A. Argenti and J. Forman, ***The Power of Corporate Communication: Crafting the Voice and Image of Your Business***, 1st *Ed.*, Tata McGraw-Hill, 2003.
R2. J. Seely, ***The Oxford Guide to Writing and Speaking***, 3rd *Ed.*, Oxford University Press, 2013.
R3. B. K. Mitra, ***Effective Technical Communication - A Guide for Scientists and Engineers***, 1st *Ed.*, Oxford University Press, 2006.

**Online Resources**:

1. https://archive.nptel.ac.in/courses/109/105/109105144/: by Prof. S. Singh, IIT Kharagpur
2. https://archive.nptel.ac.in/courses/109/106/109106129/: by Dr. Ay. I. Viswamohan, IIT Madras
3. https://archive.nptel.ac.in/courses/109/104/109104030/: by Dr. T. Ravichandran, IIT Kanpur
4. https://www.ef.com/wwen/english-resources/
5. https://owl.purdue.edu/owl/purdue_owl.html
6. https://www.usingenglish.com/
7. http://www.english-test.net

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

| | |
|---|---|
| CO1 | Understand aspects of communication at the workplace and check the barriers. |
| CO2 | Hone persuasive communication skills. |
| CO3 | Enhance interpersonal communication at the corporate workplace. |
| CO4 | Make impactful group/solo presentations and communicate with clarity. |
| CO5 | Enhance verbal ability for better communication. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| 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 & 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. |

*Cont'd. . .*

| | |
|---|---|
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO2 | | | | | | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO3 | | | | | | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| CO4 | | | | | | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| CO5 | | | | | | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 |

| Category | Code | Vector Calculus & Fourier Analysis | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | MT2003 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to provide the knowledge of vector calculus, partial differential equations & Fourier Transforms which are essential for study of various electrical systems. |
| **Pre-Requisites** | Knowledge of calculus of single variable, coordinate geometry of two and three dimensions and ordinary differential equations is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Periodic function and Fourier series, Euler formula, Even and odd functions, Half range expansions. | **7 Hours** |
| **Module-2** | Fourier integrals, Fourier cosine transform, Fourier sine transform, Fourier transform. | **7 Hours** |
| **Module-3** | Vector line integrals, Line integrals independent of path, Double integrals, Green's theorem in plane surfaces, Surface integrals, Triple integrals, Gauss divergence theorem, Stoke's theorem. | **10 Hours** |
| **Module-4** | Partial Derivatives, Chain Rule, Maxima & Minima in several variables; Vector and scalar functions and fields, Derivatives, Directional derivative & gradient of a scalar field, Divergence & Curl of a vector field. | **8 Hours** |
| **Module-5** | Basic Concepts of PDEs, One Dimensional Wave Equation and its solutions, One Dimensional Heat Equation and its solutions, Two dimensional heat equation, Laplace Equation, Solution of Laplace equation in cylindrical and spherical coordinates. | **10 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. E. Kreyszig, ***Advanced Engineering Mathematics***, 8th *Ed.*, Wiley India, 2015.

**Reference Books**:

R1. S. Pal and S. C. Bhunia, ***Engineering Mathematics***, 1st *Ed.*, Oxford University Press, 2015.
R2. B. V. Ramana, ***Higher Engineering Mathematics***, 1st *Ed.*, McGraw-Hill, 2017.

**Online Resources**:

1. https://nptel.ac.in/courses/122104017: by Prof. S. K. Ray, IIT Kanpur
2. https://nptel.ac.in/courses/111107063: by Dr. S. Gakkhar, IIT Roorkee
3. https://nptel.ac.in/courses/111105093: by Prof S. De, IIT Kharagpur
4. https://nptel.ac.in/courses/111107111: by Prof. Agrawal and Pandey, IIT Roorkee
5. https://nptel.ac.in/courses/111104519: by Prof. Prof. P. Mohanty, IIT Kanpur

P.T.O

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

| | |
|---|---|
| CO1 | Determine the Fourier series of functions. |
| CO2 | Obtain the Fourier integral and Fourier transform of functions. |
| CO3 | Explain the concepts vector integral calculus and their applications. |
| CO4 | Describe the concepts vector differential calculus and their applications. |
| CO5 | Solve partial differential equations and interpret the solution |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 2 | 2 | | | | | | 1 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 3 | | | | | | 2 | 3 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 3 | | | | | | 1 | 3 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 3 | | | | | | 2 | 2 | 1 | 1 |
| CO5 | 2 | 2 | 2 | 3 | 3 | | | | | | 2 | 3 | 1 | 1 |

| Category | Code | OOP Using Java | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CS2001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to introduce the key concepts of object-oriented programming (OOP) using Java as the programming language. |
| **Pre-Requisites** | Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course. Prior experience with a programming language will be beneficial. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Object oriented concepts: Object oriented systems development life cycle; Java Overview: Java Virtual Machine, Java buzzwords, Data types, Operators, Control statements, Class fundamentals, Objects, Methods, Constructors, Overloading, Access modifiers. | **8 Hours** |
| **Module-2** | Inheritance: Basics of Inheritance, Using super & final keyword, Method overriding, Abstract classes, Defining & importing packages, Access protection, Interfaces. | **8 Hours** |
| **Module-3** | Exception handling: Exception fundamentals, Types, Understanding different keywords (try, catch, finally, throw, throws), User defined exception handling; Threads: Thread model, Use of Thread class and Runnable interface, Thread synchronization, Multithreading, Inter-thread communication. | **9 Hours** |
| **Module-4** | Input/Output: Files, Stream classes, Reading console input; String manipulation: Basics of String handling, String class, StringBuilder, StringBuffer, String Tokenizer; Collection overview, Collection interfaces, Collection classes – ArrayList, LinkedList, Set, Tree; Accessing a collection using iterator & for-each statement. | **8 Hours** |
| **Module-5** | Basic GUI Programming: Working with windows, Frames, Graphics, Color and font; Swing fundamentals; Event handling: Delegation event model, Event classes, Sources, Listeners; Introduction to JDBC: Architecture of JDBC, JDBC Drivers, Interfaces of JDBC API, Create a simple JDBC application. | **9 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. J. Keogh, ***J2EE: The Complete Reference***, 11th *Ed.*, McGraw Hill, 2017.
T2. Y. D. Liang, ***Introduction to Java Programming***, 9th *Ed.*, Pearson Education, 2012.

**Reference Books**:

R1. B. Bates, K. Sierra, ***Head First Java***, 2nd *Ed.*, O'Reilly Media, 2005.
R2. E. Balaguruswamy, ***Programming with Java - A Primer***, 4th *Ed.*, McGraw-Hill, 2009.
R3. T. Budd, ***An Introduction to Object-Oriented Programming***, 3rd *Ed.*, Pearson Education, 2009.
R4. I. Horton, ***Beginning Java***, 7th *Ed.*, Wrox Publications, 2011.

**Online Resources**:

1. https://nptel.ac.in/courses/106105191/: by D. Samanta, IIT Kharagpur
2. https://docs.oracle.com/javase/tutorial/
3. http://www.javatpoint.com/java-tutorial
4. http://www.w3schools.in/java/
5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-00-introduction-to-computer-science-and-programming-fall-2008/video-lectures/lecture-14/

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

| | |
|---|---|
| CO1 | Apply object oriented principles to develop Java programs for real life applications. |
| CO2 | Employ inheritance techniques for developing reusable software. |
| CO3 | Develop robust & concurrent programs using exception handling and multi-threading. |
| CO4 | Design programs using I/O operations, string classes, and collection framework. |
| CO5 | Design GUI applications using Swing and Database connectivity. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| 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). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | | 2 | | | | | 2 | 3 | | 3 |
| CO2 | 3 | 3 | 3 | 2 | | 3 | | | | | 2 | 3 | | 3 |
| CO3 | 3 | 3 | 3 | 2 | | 3 | | | | | 2 | 3 | | 3 |
| CO4 | 3 | 2 | 2 | 2 | | 2 | | | | | 2 | 3 | | 3 |
| CO5 | 3 | 3 | 2 | 2 | | 3 | | | | | 2 | 3 | | 3 |

| Category | Code | Management & Economics for Engineers | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | MG2001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to familiarize the students with elementary principles of management and economics, provide the tools needed for analyzing time value of money in engineering decision making, profit/revenue data, and make economic analysis for projects and alternatives. |
| **Pre-Requisites** | Basic knowledge on interest formula and derivatives is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with focus on real-world problem solving. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Introduction, Engineering Economics, It's meaning & importance, Basic problems of an economy, The concept of time value of money, Concept of Interest, Time value of equivalence, Compound interest factors, Cash flow diagrams, Calculation of time value of equivalence, Present worth comparison, Future worth comparison, Pay-back period comparison. | **9 Hours** |
| **Module-2** | Equivalent annual worth comparison method, Rate of return, Internal rate of return, Incremental IRR analysis, Depreciation Analysis - Methods of depreciation, Straight line method, Declining balance method, SOYD Method & MACRS method; Analysis of public project, Cost-benefit analysis. | **9 Hours** |
| **Module-3** | Theory of demand, Elasticity of demand, Price elasticity of demand, Measurement of elasticity of demand, Income elasticity & cross elasticity of demand, Law of supply, Elasticity of supply, Determination of price, Cost & Revenue concepts, Break-even analysis. | **8 Hours** |
| **Module-4** | Concept of Management, Management - Art or Science, Managerial skills, Levels and types of management, Managerial environment, Functions of Management: Planning and its features & process, Types of plan, Effective planning, Organizing and its process, Formal & informal organization, Directing and its elements, Staffing and functions, Controlling & its features and process, tools of controlling. | **8 Hours** |
| **Module-5** | Marketing Function: Modern concept of marketing, Marketing vs. Selling, Marketing Mix: Product and types of product, Product life cycle, Price, Factors affecting pricing, Pricing strategies, Distribution channel - Role & functions, Selection of a distribution channel, Promotion & types of promotion, Promotional strategies; HRM Function: Human resource management, Manpower planning, Recruitment, Selection, Induction, Training & development, Placement, Wage & Salary administration. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. J. L. Riggs, D. D. Bedworth, and S. U. Randhawa, ***Engineering Economics***, 4th *Ed.*, McGraw-Hill, 2004.
T2. H. L. Ahuja, ***Principles of Micro Economics***, 16th *Ed.*, S. Chand & Co, 2008.
T3. S. A. Sherlekar, ***Modern Business Organisation and Management***, Himalaya Publishing House, 2016.

**Reference Books**:

R1. C. S. Park, ***Contemporary Engineering Economics***, 6th *Ed.*, Pearson Education, 2015.
R2. A. Koutsoyiannis, ***Modern Micro Economics***, 2nd *Ed.*, Palgrave Macmillan UK, 2003.
R3. P. C. Tulsian and V. Pandey, ***Business Organization & Management***, 1st *Ed.*, Pearson Education, 2002.
R4. K. Keller and K. Jha, ***Marketing Management***, 13th *Ed.*, Pearson Education, 2018.

**Online Resources**:

1. https://nptel.ac.in/courses/112107209: by Dr. P. K. Jha, IIT Roorkee
2. https://nptel.ac.in/courses/110107150: by Prof. U. Lenka, IIT Roorkee
3. https://nptel.ac.in/courses/110104068: by Prof. J. Chatterjee and Dr. S. S. Mishra, IIT Kanpur
4. https://nptel.ac.in/courses/122105020: by Prof. K. Chakravarti, IIT Kharagpur
5. https://nptel.ac.in/courses/110105069: by Prof. A. Malik, IIT Kharagpur

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

| | |
|---|---|
| CO1 | Understand the concepts of engineering economics and its applications. |
| CO2 | Solve problems related to engineering economics and analyze decision alternatives. |
| CO3 | Evaluate how changes in demand and supply affect market and production. |
| CO4 | Apply the concepts of management to become a good manager and a team player. |
| CO5 | Adopt appropriate marketing policies and manage human resources in an efficient manner. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| 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 & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 2 | 1 | 1 | | 3 | 2 | | 1 | 2 |
| CO2 | | | | | | 3 | 1 | 1 | | 3 | 2 | | 1 | 3 |
| CO3 | | | | | | 2 | 1 | 1 | | 3 | 2 | | 1 | 2 |
| CO4 | | | | | | 2 | 3 | 3 | | 3 | 2 | | 1 | 3 |
| CO5 | | | | | | 2 | 3 | 3 | | 3 | 2 | | 2 | 2 |

| Category | Code | Biology for Engineers | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | BL2001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to integrate the knowledge of engineering and modern biology to solve problems encountered in living systems, analyze a problem from engineering and biological perspective, anticipate specific issues in working with living systems, and evaluate possible solutions. |
| **Pre-Requisites** | Basic knowledge of biology, chemistry, and physics is adequate. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on applications of biology in engineering. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Bioinspired Materials and Mechanisms**: Photosynthesis (photovoltaic cells, bionic leaf), Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train), Human Blood substitutes - Haemoglobin-based oxygen carriers (HBOCs). | **10 Hours** |
| **Module-2** | **Biomolecules-based Technology**: Carbohydrates (transformation of carbohydrates into renewable energy, biodegradable plastics and organic chemicals), Nucleic acids (biochips and biosensors), Forensics - Automated DNA sequencing, Proteins (cellular agriculture to produce tissue mimicking meat), Lipids (biodiesel), Enzymes (AI mediated enzyme engineering). | **9 Hours** |
| **Module-3** | **Human Organ Systems and Bio Designs (I)**: Eye as a camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye), Brain as a CPU system (architecture, signal transmission, brain-machine interactions), Heart as a pump system (reasons for blockages of blood vessels, Nanobots to remove artery blockage, vein detection patches). | **8 Hours** |
| **Module-4** | **Human Organ Systems and Bio Designs (II)**: Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine); Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems), Muscular and skeletal systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis). | **8 Hours** |
| **Module-5** | **Genetics and Bioinformatics**: Mendelian and non-mendelian genetics, Mutation, Central dogma of molecular biology, Genetic disorders, Genetic code; Nucleotide and protein databases - EMBL, DDBJ, GenBank, UniProt, PDB, Tools used in bioinformatics - BLAST, FASTA, Machine learning applications in bioinformatics: Gene sequence analysis, Protein structure analysis, Establish phylogenetic relationship. | **7 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. Y. Bar-Cohen, ***Biomimetics: Nature-Based Innovation***, 1st *Ed.*, CRC Press, 2012.
T2. S. Fox and K. Rompolski, ***Human Physiology***, 16th *Ed.*, McGraw-Hill eBook, 2022.

T3. L. Cromwell, F. J. Weibel, and E. A. Pfeiffer, ***Biomedical Instrumentation & Measurements***, 2nd *Ed.*, Pearson Education, 2015.
T4. Any other book(s) and/or study material(s) as advised by the teacher.

**Reference Books**:

R1. S. Singh and T. Allen, ***Biology for Engineers***, 1st *Ed.*, Vayu Education, 2020.
R2. V. Sharma, A. Munjal, and A. Shanker, ***A Textbook of Bioinformatics***, 2nd *Ed.*, Rastogi Publications, 2018.

**Online Resources**:

1. https://nptel.ac.in/courses/102106065: by Prof. M. M. Gromiha, IIT Madras
2. https://nptel.ac.in/courses/121106008: Dr. M. Dixit and Prof. G. K. Suraishkumar, IIT Madras
3. https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009

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

| | |
|---|---|
| CO1 | Correlate the concepts of biology in engineering for innovative materials and products. |
| CO2 | Leverage biomolecules in food, pharma, energy, and other engineering domains. |
| CO3 | Critically analyze organ systems and improve design of bio-medical equipment. |
| CO4 | Design solutions for health challenges like prosthetics, organ regeneration, and medical devices. |
| CO5 | Determine the connection between genetic alterations, diseases, and inheritance pattern. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| 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). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 2 | 3 | | 2 | 3 | | | | | 2 | 1 | 2 | 2 |
| CO2 | | 1 | 2 | | 2 | 3 | | | | | 2 | 1 | 1 | 2 |
| CO3 | | 1 | 2 | | 2 | 2 | | | | | 2 | 1 | 2 | 2 |
| CO4 | | 1 | 2 | | 2 | 2 | | | | | 2 | 1 | 2 | 2 |
| CO5 | | 3 | 1 | | 3 | 3 | | | | | 2 | 3 | 2 | 2 |

| Category | Code | Signals & Systems | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2003 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study the presentation of various signals in time and spectrum domains, and stability & causality of LSI systems. |
| **Pre-Requisites** | Fundamental knowledge of basic mathematics is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Signals: Introduction, Classification: continuous/ discrete-time, commonly used continuous-time signals and discrete-time Signals, Analog/ digital signal, Periodic/ aperiodic, Even/ odd, Energy/ power, Deterministic/ random, Operation on Continuous-time and Discrete time signals: Addition, Multiplication, Differentiation/Difference, Integration/Accumulation, Shifting, Scaling, Folding and Convolution (graphical and analytical), Correlation of Discrete-Time signals & its properties. | **8 Hours** |
| **Module-2** | System and LTI/LSI System: Introduction, Classification for both continuous time and discrete time - Linear/ Non-linear, Time varying/ time invariant,Causal/ non-causal,Dynamic/ static,Stable/ unstable and Invertible/ Non-invertible, Continuous time and Discrete time LSI system, System representation through differential equations and difference equations, Response of LSI system and convolution Integral/convolution Sum, Characterization of causality and stability of linear shift invariant(LSI). | **8 Hours** |
| **Module-3** | Analysis by Fourier series and Fourier Transform: Orthogonal and Orthonormal signal set, Fourier series, convergence of the Fourier series, Trigonometric Fourier series and exponential Fourier series, Continuous time Fourier Transform, convergence of the Fourier transform, Fourier transform of some useful signals, properties of the Fourier transform, the notion of a frequency response and its relation to the impulse response, Parseval's theorem: Energy spectral density, Power spectral density. | **9 Hours** |
| **Module-4** | Analysis by Laplace Transform: Introduction, Region of Convergence for Laplace transform, and properties of ROC, Laplace transform of some useful signals, properties of the Laplace transform, the inverse Laplace transform and Unilateral Laplace Transform and their properties, Initial value and final value theorem, solution of differential equation using Laplace transform. | **9 Hours** |
| **Module-5** | Analysis by Z-Transform: Discrete-time system analysis using the Z- transform, Mapping from S-plane to Z-plane,Z-transform, The Region of Convergence, Z-transform of some useful sequences, Properties of Z- transform,Inverse Z-transform. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, ***Signals and Systems***, 2nd *Ed.*, Prentice Hall India, 1992.

T2. S. Haykin and B. V. Veen, ***Signals and Systems***, 2nd *Ed.*, John Wiley & Sons, 2002.
T3. B. P. Lathi, ***Principles of Signal Processing and Linear Systems***, 2nd *Ed.*, Oxford University Press, 2009.

**Reference Books**:

R1. A. Ambardar, ***Analog and Digital Signal Processing***, 2nd *Ed.*, Brooks/Cole Publishing, 1999.
R2. H. P. Hsu, ***Signal and System - Schaum's Outlines***, 2nd *Ed.*, McGraw Hill, 2011.
R3. M. J. Roberts, ***Signals and Systems - Analysis using Transform methods and MATLAB***, 2nd *Ed.*, McGraw Hill, 2003.
R4. A. N. Kani, ***Signals and System***, 2nd *Ed.*, McGraw Hill Education, 2010.

**Online Resources**:

1. https://nptel.ac.in/courses/117104074/: by Prof. K.S. Venkatesh, IIT Kanpur
2. https://nptel.ac.in/courses/108105065/: by Prof. T.K. Basu, IIT Kharagpur
3. https://nptel.ac.in/courses/108104100/: by Prof. A. K. Jagannatham, IIT Kanpur
4. https://nptel.ac.in/courses/108105059/: by Prof. S. Mukhopadhyay, IIT Kharagpur
5. https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/

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

| | |
|---|---|
| CO1 | Compare different types of signals and systems. |
| CO2 | Analyze various types of LSI systems responses. |
| CO3 | Represent continuous and discrete systems in time & frequency domains using different transforms. |
| CO4 | Investigate the system stability and causality using Laplace Transform and Z-Transform. |
| CO5 | Analyze discrete time signals and systems using Z-transform. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | | | | | 2 | 2 | 2 | |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | | | | | 2 | 1 | 1 | |
| CO3 | 3 | 3 | 3 | 3 | 3 | 1 | | | | | 3 | 2 | 1 | |
| CO4 | 2 | 3 | 3 | 3 | 3 | 1 | | | | | 3 | 2 | 1 | |
| CO5 | 2 | 3 | 3 | 3 | 3 | 1 | | | | | 3 | 3 | 1 | |

| Category | Code | Analog Electronic Circuits | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2004 | | 3-1-0 | 4 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to be familiar with Transistor (BJT, JFET and MOSFET) amplifiers, differential amplifiers and their implementations along with studying their characteristics & applications. |
| **Pre-Requisites** | Knowledge of semiconductor diodes and bipolar junction transistors is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Bipolar Junction Transistor(BJT) and its AC Analysis: Introduction to BJT DC Biasing Circuits, Design of different Biasing Circuits, Bias Stability, Introduction to BJT small signal model, $r_e$ and $h$-models of different configurations (CB, CE, and CC), $r_e$ and $h$-models of different biasing circuits, Effect of $R_S$ and $R_L$, Standard ICs. | **11 Hours** |
| **Module-2** | Field Effect Transistor(FET) and its AC Analysis: JFET DC Biasing Circuits(Fixed, Self and Voltage divider), MOSFET DC Biasing Circuits, Introduction to JFET and MOSFET small signal model, Small signal model of different configurations (CG, CD, and CS), Small signal model of different biasing circuits of MOSFET, Effect of $R_S$ and $R_L$, Standard ICs. | **11 Hours** |
| **Module-3** | Compound Configurations: CMOS and its circuit realization, Darlington pair, Current Mirror, Cascade & Cascode configuration. Frequency Response Analysis: Low Frequency Response of BJT, High Frequency Response of BJT, Low Frequency Response of FET, Miller's Effect, Multistage Frequency Effects, Gain-Bandwidth Relation. | **11 Hours** |
| **Module-4** | Operational Amplifiers: Introduction to OP-AMP, Applications of OP-AMP: Summing, Buffer, Log Differentiator, Schmitt Trigger and Integrator, Introduction to Differential Amplifier, DC and AC Analysis of Differential Amplifier, Instrumentation Amplifier, Active Filters, Standard ICs. | **11 Hours** |
| **Module-5** | Feedback Amplifiers: Introduction, Feedback Topologies, Derivation of different parameters ($Z_i$, $Z_o$, $A_v$, $A_i$), Practical feedback circuits, Standard ICs; Oscillators: Introduction to Oscillators, High Frequency Oscillators: Hartley and Crystal Oscillators, Standard ICs; Power Amplifiers: Introduction to Power Amplifiers, Classification of Power Amplifiers: Class A, Class B, Class C, Push-Pull Amplifiers. | **12 Hours** |
| | **Total** | **56 Hours** |

**Text Books**:


T1. A. S. Sedra and K. C. Smith, ***Microelectronic Circuits: Theory and Applications (International Version)***, 7th *Ed.*, Oxford University Press, 2017.

T2. R. L. Boylestad and L. Nashelsky, ***Electronic Devices and Circuit Theory***, 11th *Ed.*, Pearson Education, 2013.

T3. J. V. Wait, L. P. Huelsman, and G. A. Korn, ***Introduction to Operational Amplifier Theory and Applications***, McGraw-Hill USA, 1992.
T4. J. Millman and A. Grabel, ***Microelectronics***, 2nd *Ed.*, McGraw-Hill Education, 2017.

**Reference Books**:

R1. J. Millman and C. C. Halkias, ***Integrated Electronics: Analog and Digital Circuits and Systems***, 2nd *Ed.*, TMH Publications, 2017.
R2. A. Malvino and D. J. Bates, ***Electronic Principles***, 7th *Ed.*, McGraw-Hill, 2017.
R3. P. Horowitz and W. Hill, ***The Art of Electronics***, 2nd *Ed.*, Cambridge University Press, 1989.
R4. P. R. Gray, P. J. Hurst, R. G. Meyer, and S. H. Lewis, ***Analysis and Design of Analog Integrated Circuits***, 5th *Ed.*, John Wiley & Sons, 2009.

**Online Resources**:

1. https://nptel.ac.in/courses/117101106: by Prof A.N.Chandorkar, IIT Bombay
2. https://nptel.ac.in/courses/108102095: by Prof S. C. Dutta Roy, IIT Delhi
3. http://www.electrical4u.com/circuit-analysis.htm
4. http://www.allaboutcircuits.com
5. https://www.electronics-tutorials.ws/

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

| | |
|---|---|
| CO1 | Design different biasing methods and small signal models of BJT and estimate the performance parameters of different amplifier configurations. |
| CO2 | Analyze the structural behavior, characteristics and different biasing configurations of JFET and MOSFET. |
| CO3 | Understand and analyze the structural configuration of multi-stage amplifier and plot its frequency response. |
| CO4 | Study the construction and characteristics of an Op-Amp and design circuits for various linear applications using Op-Amp. |
| CO5 | Design various industrial circuits such as oscillators & negative feedback amplifiers using transistors and validate their experimental results. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |

*Cont'd. . .*

| | |
|---|---|
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | | | | | | 1 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 2 | | | | | | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 3 | | | | | | 1 | 3 | 1 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | | | | | | 1 | 3 | 3 | 3 |

| Category | Code | Circuit Theory | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EE2010 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is that the student should be able to analyze any circuit configuration, synthesize circuits with any given specification of network functions, and test and improve the design as required. |
| **Pre-Requisites** | Basics of Circuit analysis, Laplace transform, Fourier transform, and Differential equations are required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Network Theorems: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Maximum power transfer theorem, Millman's theorem (AC & DC Networks); Coupled Circuits: Introduction, Dot Convention, Coefficient of coupling, Electrical equivalent of magnetically coupled coils, Series and parallel connection of coupled coils, Transformer as a magnetically coupled circuit; Resonance: Introduction, Series Resonance, Parallel Resonance, Quality factor, Bandwidth and Selectivity for series and parallel resonant circuits, Frequency Response Curve. | **11 Hours** |
| **Module-2** | Laplace Transform & its Application: Fundamentals of Laplace & Inverse Laplace Transform, initial and final value theorem; Fundamentals of Switching behavior of RL, RC & RLC circuits. Application Of Laplace Transform to Transient Analysis: Response of RL, RC & RLC network with step, sinusoidal, impulse, and ramp input. | **8 Hours** |
| **Module-3** | Fourier Series and Fourier Transform: Periodic and Aperiodic functions, Fourier Series Analysis of Continuous Time Signals, Fourier Transform, Properties, Circuit analysis with Fourier Series and Fourier Transform; Filters: Introduction to Filters, Frequency Response Curve, Filter Transfer functions and cut-off frequencies. | **7 Hours** |
| **Module-4** | Two-Port Networks: Introduction, z, y, ABCD and h-parameters, Reciprocity and Symmetry, Interrelation of two-port parameters, Interconnection of two-port networks; Network Functions & Response: Transfer function and driving point function for one & two-port networks, Concept of poles and zeros, Significance & Restriction on location of Poles and Zeros. | **9 Hours** |
| **Module-5** | Network Synthesis: Hurwitz polynomial and its Properties, Positive real functions and their properties, Concepts of network synthesis, Realization of R-L, R-C, and L-C functions in Cauer-I, Cauer-II, Foster-I and Foster-II forms. | **7 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. M. E. Van Valkenburg, ***Network Analysis***, 3rd *Ed.*, Pearson Education, 2015.
T2. C. K. Alexander and M. N. O. Sadiku, ***Fundamentals of Electric Circuits***, 5th *Ed.*, Tata McGraw-Hill, 2013.

T3. W. H. Hayt, J. Kemmerly, J. D. Phillips, and S. M. Durbin, ***Engineering Circuit Analysis***, 9th *Ed.*, McGraw-Hill Education, 2020.

**Reference Books**:

R1. S. Ghosh, ***Network Theory: Analysis And Synthesis***, 1st *Ed.*, Prentice Hall of India, 2009.
R2. P. K. Satpathy, P. Kabisatapathy, S. P. Ghosh, and A. K. Chakraborty, ***Network Theory***, 1st *Ed.*, Tata McGraw-Hill, 2009.
R3. A. Chakrabarti, ***Circuit Theory: Analysis and Synthesis***, 7th *Ed.*, Dhanpat Rai & Co., 2013.
R4. J. D. Irwin and R. M. Nelms, ***Basic Engineering Circuit Analysis***, 11th *Ed.*, Wiley, 2015.

**Online Resources**:

1. https://nptel.ac.in/courses/108102042/: by Prof. S. C. Dutta Roy, IIT Delhi
2. https://nptel.ac.in/courses/108106075/: by Prof. V. G. K. Murti, IIT Madras
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/lecture-notes/

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

| | |
|---|---|
| CO1 | Describe network theorems, coupled circuits, and resonant circuits and apply them to solve complex network problems. |
| CO2 | Explain the switching phenomena of electrical circuits and evaluate transient and steady-state performance using Laplace Transformation. |
| CO3 | Analyze filter circuits and sinusoidal, and non-sinusoidal signals using the Fourier series and Fourier transform and its application in electrical & electronics circuit analysis. |
| CO4 | Determine two-port network parameters and their practical application to electrical and electronic circuits. |
| CO5 | Identify Network Functions and synthesize one port network using Foster and Cauer forms. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4). |
| 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). |
| PO8 | **Individual & 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. |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | | 2 | 2 | | | 1 | 1 | | 2 | 2 | 1 | 1 |
| CO2 | 2 | 2 | | 2 | 3 | | | 1 | 1 | | 3 | 2 | 1 | 1 |
| CO3 | 2 | 2 | | 2 | 3 | | | 1 | 1 | | 3 | 2 | 1 | 1 |
| CO4 | 2 | 2 | | 1 | 2 | | | 1 | 1 | | 2 | 2 | 1 | 1 |
| CO5 | 2 | 2 | | 1 | 2 | | | 1 | 1 | | 1 | 2 | 1 | 1 |

| Category | Code | OOP Using Java Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CS2004 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of the course is to apply object oriented programming principles and implement object oriented programming using JAVA language. |
| **Pre-Requisites** | Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course. Prior experience with any other object oriented programming language will be beneficial. |
| **Teaching Scheme** | Regular laboratory classes with the use of ICT whenever required, demonstration through practical simulation of code using IDE. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Understanding Java platform, compilation, and execution of a java program. |
| 2 | Overview of Eclipse IDE. |
| 3 | Use of class, use of control statements, data types, operators. |
| 4 | Implement class, object, constructor, methods, and other OOP features. |
| 5 | Inheritance Basics, more uses of constructor, method overriding, use of final. |
| 6 | Object class, practical use of abstract class. |
| 7 | Using Interface for achieving multiple inheritance, implementation of package. |
| 8 | Exception handling fundamentals, java built-in exceptions, use of Scanner class for console input, use of own Exception subclass. |
| 9 | Java thread life cycle model and implementation approach, thread priority, implementation of synchronization. |
| 10 | I/O Basics, byte stream and character streams, reading and writing files, text processing using Java pre-defined StringBuilder and StringBuffer classes. |
| 11 | Basics of Java collection framework, implementation of collections in Java with different programs. |
| 12 | GUI basics and Window fundamentals, working with different Component, Container and Layout Managers. |
| 13 | Event handling for interactive GUI application, working with JDBC. |
| 14 | Mini Project. |

**Text Books**:

T1. J. Keogh, ***J2EE: The Complete Reference***, 11th *Ed.*, McGraw Hill, 2017.
T2. Y. D. Liang, ***Introduction to Java Programming***, 9th *Ed.*, Pearson Education, 2012.

**Reference Books**:

R1. B. Bates, K. Sierra, ***Head First Java***, 2nd *Ed.*, O'Reilly Media, 2005.
R2. T. Budd, ***An Introduction to Object-Oriented Programming***, 3rd *Ed.*, Pearson Education, 2009.
R3. I. Horton, ***Beginning Java***, 7th *Ed.*, Wrox Publications, 2011.

**Online Resources**:

1. https://nptel.ac.in/courses/106105191/: by D. Samanta, IIT Kharagpur
2. https://docs.oracle.com/javase/tutorial/
3. http://www.javatpoint.com/java-tutorial
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-00-introduction-to-computer-science-and-programming-fall-2008/video-lectures/lecture-14/

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

| | |
|---|---|
| CO1 | Apply object oriented programming to develop Java programs for real-life applications. |
| CO2 | Employ inheritance techniques for developing reusable software. |
| CO3 | Develop robus and concurrent programs using exception handling and multi-threading. |
| CO4 | Design programs using I/O operations, String classes and collection framework. |
| CO5 | Design GUI applications using Swing and database connectivity. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| 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). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | | 3 | | | | | 3 | 1 | | 2 |
| CO2 | 3 | 3 | 3 | 2 | | 3 | | | | | 2 | 2 | | 2 |
| CO3 | 3 | 3 | 3 | 2 | | 3 | | | | | 2 | 2 | | 2 |
| CO4 | 3 | 3 | 2 | 3 | | 3 | | | | | 3 | 2 | | 2 |
| CO5 | 3 | 3 | 3 | 3 | | 3 | | | | | 3 | 2 | | 2 |

| Category | Code | Analog Electronic Circuits Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2005 | | 0-0-4 | 2 | 100 |

| | |
|---|---|
| **Objectives** | The objective of the course is to design, implement and test transistor biasing, amplifying action and frequency response. Also study the linear and nonlinear applications of amplifiers. |
| **Pre-Requisites** | Basic analytical and logical understanding including knowledge of basic electronics is required. |
| **Teaching Scheme** | Regular laboratory experiments to be conducted under supervision of the teacher with focus on implementation in hardware/software tools. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Design and simulate BJT bias circuit and compare the results.. |
| 2 | Design and simulate JFET bias circuit and compare the results. |
| 3 | Design and simulate MOSFET bias circuit and compare the results. |
| 4 | Design and simulate BJT common-emitter circuit and compare DC and AC performance. |
| 5 | Design and simulate JFET common-source circuit and compare DC and AC performance |
| 6 | Design and simulate MOSFET common-source circuit and compare DC and AC performance |
| 7, 8 | Determining the frequency response of a common-emitter amplifier: low frequency, high frequency and mid frequency response and compare with simulated results. |
| 9, 10 | Differential amplifier circuits: DC bias & AC operation with & without current source. |
| 11 | Analysis of RC Coupled Multi Stage Amplifier. (2 Stages). |
| 12, 13 | Study of Darlington Circuit and Current Mirror Circuits. |
| 14 | OP-Amp Frequency Response and Compensation. |
| 15 | Application of Op-Amp as differentiator, integrator, square wave generator. |
| 16 | Obtain the band width of FET/BJT using Square wave testing of an amplifier. |
| 17, 18 | Study of Feedback Amplifier (Voltage series, Voltage shunt, Current series, and Current shunt configurations). |
| 19, 20 | RC phase shift oscillator/Wien-Bridge Oscillator using Op-Amp, Crystal Oscillator |
| 21, 22 | Class A and Class B Power Amplifiers. |

**Text Books**:

T1. R. L. Boylestad and L. Nashelsky, ***Electronic Devices and Circuit Theory***, 10th *Ed.*, Pearson Education, 2009.

**Reference Books**:

R1. L. K. Maheshwari and M. M. S. Anand, ***Laboratory Experiments and PSPICE Simulations in Analog Electronics***, PHI Learning, 2006.

R2. L. K. Maheshwari and M. M. S. Anand, ***Laboratory Manual for Introductory Electronics Experiments***, John Wiley & Sons, 1980.

R3. K. A. Navas, ***Electronics Lab Manual, Vol-2***, 6th *Ed.*, PHI Learning, 2018.

**Online Resources**:

1. http://www2.ece.ohio-state.edu/ee327/
2. https://wiki.analog.com/university/courses/alm1k/alm_circuits_lab_outline
3. https://wiki.analog.com/university/courses/electronics/labs

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

| | |
|---|---|
| CO1 | Design, assemble and test BJT biasing circuits. |
| CO2 | Analyze the DC and AC performance of BJT and FET. |
| CO3 | Understand the frequency response of single & multi-stage BJT and compare the results. |
| CO4 | Study operational amplifier and its various applications. |
| CO5 | Analyze and design various wave shaping circuits. |
| CO6 | Implement different oscillator circuits and analyze power amplifier characteristics. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 2 | | | | | | 2 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 2 | | | | | | 2 | 3 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 3 | 3 | | | | | | 1 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | | | | | | 1 | 3 | 1 | 2 |
| CO5 | 3 | 2 | 2 | 3 | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO6 | 3 | 2 | 3 | 3 | 3 | | | | | | 1 | 3 | 3 | 2 |

| Category | Code | Circuit Theory Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EE2011 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of the course is to provide a practical working knowledge of network theory and record the experimental data effectively and correctly. |
| **Pre-Requisites** | Basic knowledge of electrical & electronics engineering, Laplace transform and differential equations is required. |
| **Teaching Scheme** | Regular laboratory experiments to be conducted using hardware and software tools under the supervision of the teacher. Demonstration along with required safety measures will be explained for each experiment. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Verification of Network Theorems (Superposition, Thevenin, Norton, Maximum Power Transfer) both in DC & AC. |
| 2 | Determination of two-port network parameters: Open Circuit(z), Short Circuit(y), Hybrid(h) and Transmission (ABCD) parameters |
| 3 | Frequency response of Low Pass and High Pass Filters. |
| 4 | Determination of self-inductance, mutual inductance, and coupling coefficient of a magnetic coupled circuit. |
| 5 | Study of resonance in R-L-C series & parallel circuit. |
| 6 | Verification of Network Theorems by modeling and simulation (Superposition, Thevenin, Norton, Maximum Power Transfer) both in DC & AC. |
| 7 | Modeling of two-port networks and determination of parameters by simulation. |
| 8 | Frequency response of Low pass, High pass, and Band pass Filters using simulation. |
| 9 | Modeling and simulation of DC and AC Transients in electrical circuits. |
| 10 | To study the characteristics of Single-tuned and double-tuned circuits. |
| 11 | Spectral analysis of a non-sinusoidal waveform. |

**Text Books**:


T1. M. E. Van Valkenburg, ***Network Analysis***, 3rd *Ed.*, Pearson Education, 2015.

T2. C. K. Alexander and M. N. O. Sadiku, ***Fundamentals of Electric Circuits***, 5th *Ed.*, Tata McGraw-Hill, 2013.

T3. W. H. Hayt, J. Kemmerly, J. D. Phillips, and S. M. Durbin, ***Engineering Circuit Analysis***, 9th *Ed.*, McGraw-Hill Education, 2020.


**Reference Books**:


R1. S. Ghosh, ***Network Theory: Analysis And Synthesis***, 1st *Ed.*, Prentice Hall of India, 2009.

R2. P. K. Satpathy, P. Kabisatapathy, S. P. Ghosh, and A. K. Chakraborty, ***Network Theory***, 1st *Ed.*, Tata McGraw-Hill, 2009.

R3. A Chakrabarti, ***Circuit Theory: Analysis and Synthesis***, 7th *Ed.*, Dhanpat Rai & Co., 2013.

R4. J. D. Irwin and R. M. Nelms, ***Basic Engineering Circuit Analysis***, 11th *Ed.*, Wiley, 2015.


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**Online Resources**:

1. https://nptel.ac.in/courses/108102042/: by Prof. S. C. Dutta Roy, IIT Delhi
2. https://nptel.ac.in/courses/108106075/: by Prof. V. G. K. Murti, IIT Madras
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/lecture-notes/

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

| | |
|---|---|
| CO1 | Correlate between frequency and circuit parameters at resonance condition. |
| CO2 | Design and analyze different configurations in electrical networks using modern software. |
| CO3 | Employ concept of coupled circuits to electrical machines. |
| CO4 | Analyze sinusoidal & non-sinusoidal signals using Fourier series and transform. |
| CO5 | Design various filters and tuned amplifiers, and examine their frequency response. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4). |
| 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 & 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. |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | | 2 | 2 | | 1 | 2 | 1 | | 1 | 2 | 1 | |
| CO2 | 2 | 2 | | 2 | 3 | | 1 | 2 | 1 | | 3 | 2 | 2 | 1 |
| CO3 | 2 | 2 | | 2 | 3 | 1 | 1 | 2 | 1 | | 2 | 1 | | |
| CO4 | 3 | 3 | | 3 | 3 | | 1 | 2 | 1 | | 3 | 2 | 1 | |
| CO5 | 2 | 2 | | 2 | 3 | | 1 | 2 | 1 | | 3 | 2 | 1 | |

| Category | Code | Complex Analysis & Numerical Methods | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | MT2004 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to provide the knowledge of analytic functions, poles & zeros, residue calculus, and numerical methods, along with the applications of these methods in engineering. |
| **Pre-Requisites** | Knowledge of calculus of single variables, coordinate geometry of two and three dimensions, matrix algebra and ordinary differential equations is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Basics of Complex Numbers, Derivatives, Analytic Functions, C-R Equations, Basic elementary Complex functions. | **8 Hours** |
| **Module-2** | Complex Line Integration, Integral Theorems, Complex Power Series and Taylor Series. | **8 Hours** |
| **Module-3** | Laurent Series, Residue Integration and its application for evaluation of real integrals. | **8 Hours** |
| **Module-4** | Error Analysis, Solution of Nonlinear Equations, Bisection Method, Fixed-Point Iteration Method, Secant Method, Newton Method, Interpolation by Polynomials: Lagrange Interpolation, Newton Divided Differences, Newton's forward & backward Interpolation. | **9 Hours** |
| **Module-5** | Numerical Differentiation and Integration, Trapezoidal, Simpson's Rules, Composite Rules, Error Formulae, Gaussian Quadrature Rules, Solution of Differential Equations by Euler Method, Modified Euler Method, and Runge-Kutta Methods. | **9 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. E. Kreyszig, ***Advanced Engineering Mathematics***, 8th *Ed.*, Wiley India, 2015.

**Reference Books**:

R1. S. Pal and S. C. Bhunia, ***Engineering Mathematics***, 1st *Ed.*, Oxford University Press, 2015.
R2. B. V. Ramana, ***Higher Engineering Mathematics***, 1st *Ed.*, McGraw-Hill, 2017.

**Online Resources**:

1. https://nptel.ac.in/courses/111105035: by Prof. P. D. Srivastava, IIT Kharagpur.
2. https://nptel.ac.in/courses/122104017: by Prof. S. K. Ray, IIT Kanpur.
3. https://nptel.ac.in/courses/122102009: by Prof. S. R. K. Iyengar, IIT Delhi.
4. https://nptel.ac.in/courses/111107063: by Dr. S. Gakkhar, IIT Roorkee.
5. https://nptel.ac.in/courses/112102316: by Prof. A. Gupta, IIT Delhi.
6. https://nptel.ac.in/courses/111101165: by Prof. S. Baskar, IIT Bombay.
7. https://nptel.ac.in/courses/111107107: by Prof. A. K. Nayak, IIT Roorkee.

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

| | |
|---|---|
| CO1 | Explain the fundamental concepts of Analytic function. |
| CO2 | Evaluate complex line integral and find the Taylor's series expansion of analytic functions. |
| CO3 | Expand functions in Laurent's Series and evaluate integrations using residues. |
| CO4 | Find the root of nonlinear and transcendental equations using numerical methods and interpolate data. |
| CO5 | Perform numerical integration and solve ODE using various numerical methods. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | | | | | | 1 | 2 | 1 | 1 |
| CO2 | 2 | 2 | 2 | 2 | 2 | | | | | | 1 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 3 | 3 | | | | | | 1 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 3 | 1 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 2 | 1 | 1 |

| Category | Code | Programming in Python | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CS2007 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to develop programming skills in Python which is rich in tools & libraries and is popularly used for solving real-life computing problems in many engineering domains. |
| **Pre-Requisites** | Basics of programming, algorithms and problem solving skills are required. Prior experience with a programming language will be beneficial. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with programming & problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Introduction to Python**: Introduction, Features of Python, Data types, Variables, Literals, Input/output statements, Keywords, Identifiers, Operators, Precedence and associativity, Expressions, Control statements. | **8 Hours** |
| **Module-2** | **Data Structures**: Lists - Operations, Slicing, Built-in list functions, List comprehension, Tuples - Accessing elements, Operations using built-in tuple functions, Dictionaries - Accessing values in dictionaries, Built-in dictionary functions, Sets, Functions, Recursion, Anonymous functions; Modules: Creating modules, Import statement, Packages. | **9 Hours** |
| **Module-3** | **Object Oriented Programming**: Creating class and object, Using a class and its methods, Constructor; Inheritance: Types of inheritance, Overriding methods, Encapsulation and information hiding, Polymorphism, Operator overloading, Method overloading and overriding, Abstract method and class. | **8 Hours** |
| **Module-4** | **File Handling**: Types of files, Opening & closing, Reading & writing, Binary files; Command line arguments; Exception Handling: Errors, Types of exception, try, except, and finally, assertion; Database Connectivity: Connect with a SQL database, Executing queries, Transactions, SQLDB database connection parameters, Insert, Update, Delete operations. | **7 Hours** |
| **Module-5** | **Data Handling, Visualization, and GUI Programming**: Regular Expressions - Match & Search functions, Quantifiers, Pattern; NumPy: Introduction, Creating of arrays and matrices; Panda: Creating a DataFrame, DataFrame operations, Data manipulation and aggregation, Reshaping DataFrame objects; Matplotlib: Introduction, creating basic plots (line plot, scatter plot, bar chart, histogram), Customizing plots; Graphical User Interface: GUI toolkits, Creating GUI widgets with Tkinter, Creating layouts, Radio buttons, Checkboxes, Dialog boxes. | **10 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:


T1. R. N. Rao, ***Core Python Programming***, 2nd *Ed.*, DreamTech Press, 2019.

T2. V. Guttag, ***Introduction to Computation and Programming Using Python with Application to Understanding Data***, 2nd *Ed.*, PHI Learning, 2016.

T3. W. McKinney, ***Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter***, 3rd *Ed.*, O'Reilly Media, 2022.

**Reference Books**:

R1. P. Barry, ***Head First Python***, 2nd *Ed.*, O'Reilly Media, 2010.
R2. A. Downey, ***Think Python***, 2nd *Ed.*, Green Tea Press, 2015.
R3. E. Matthes, ***Python Crash Course: A Hands-On, Project-Based Introduction to Programming***, 3rd *Ed.*, No Starch Press, 2023.
R4. J. Zelle, ***Python Programming: An Introduction to Computer Science***, 3rd *Ed.*, Franklin, Beedle & Associates, 2016.

**Online Resources**:

1. https://nptel.ac.in/courses/106106182: By Prof. S. Iyengar, IIT Ropar
2. https://nptel.ac.in/courses/106106145: By Prof. M. Mukund, IIT Madras
3. https://nptel.ac.in/courses/106106212: By Prof. R. Rengasamy, IIT Madras
4. https://nptel.ac.in/courses/106107220: By Prof. A. Ramesh, IIT Roorkee

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

| | |
|---|---|
| CO1 | Compile and debug basic python programs, and solve problems using control structures. |
| CO2 | Apply the data structure for real life problems and design modular python programs. |
| CO3 | Develop applications using object oriented programming concepts using python. |
| CO4 | Apply the concept of file handling and database connectivity in real life problems. |
| CO5 | Utilize advanced tools & libraries for data analysis and develop GUI based applications. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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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**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | | 1 | | | | | 2 | 2 | 3 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 1 | 2 | | | | | 3 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 2 | | | | | 2 | 2 | 3 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 2 | 1 | | | | | 2 | 2 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 1 | 3 | 2 | | | | | 3 | 2 | 3 | 2 |

| Category | Code | Analog Communication | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2006 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study electronic communication systems, modulation techniques, digital transmission of analog signal, random variables, sources of noise and noise in Amplitude and Frequency modulation. |
| **Pre-Requisites** | Knowledge of signals and systems, trigonometry, and probability theory is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Signals and Spectra: An Overview of Electronic Communication Systems, Types of Signals, Fourier Transform, Properties of Fourier Transform, Orthogonal Signals. | **8 Hours** |
| **Module-2** | Amplitude Modulation Systems: Need for modulation, Double Side Band with Carrier (DSB-C) and Suppressed Carrier (DSB-SC), Modulators - Square-law, Switching, Balanced, Detectors - Square-law, Envelope, Synchronous, Single Side Band Suppressed Carrier (SSB-SC), Frequency & Phase discrimination methods, Coherent detection, Vestigial Side Band (VSB) Modulation & Demodulation, Frequency Division Multiplexing, Radio Transmitter and Receiver (Super Heterodyne Receiver). | **9 Hours** |
| **Module-3** | Angle Modulation: Angle Modulation, Narrow & Wide band FM, FM Modulators - Direct method (Varactor diode), Indirect method (Armstrong), Detectors - Simple slope, Balanced Slope, Phase Locked Loop (PLL); Pulse Modulation: Sampling Theorem, Modulation - Pulse Amplitude, Pulse Width, and Pulse Position. | **9 Hours** |
| **Module-4** | Mathematical Representation of Noise: Sources of Noise, Frequency-domain representation, Superposition of Noises, Linear Filtering, Noise Bandwidth;Noise in AM System: Framework for Amplitude Demodulation, Calculation of Signal to Noise Ratio - SSB-SC, DSB-SC, and DSB-C. | **8 Hours** |
| **Module-5** | Noise in FM System: An FM Receiving System, Calculation of Signal to Noise Ratio, Comparison of FM and AM, Pre-emphasis and De-emphasis, SNR improvement, Threshold in FM. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. H. Taub, D. L. Schilling, and G. Saha, ***Principles of Communication System***, 4th *Ed.*, Tata McGraw Hill, 2013.

T2. R. P. Singh and S. D. Sapre, ***Communication Systems : Analog and Digital***, 3rd *Ed.*, McGraw Hill Education, 2012.

**Reference Books**:

R1. M. Salehi and J. G. Proakis, ***Communication System Engineering***, 2nd *Ed.*, PHI, 2002.

R2. S. Haykin and M. Moher, ***Communication Systems***, 5th *Ed.*, John Wiley & Sons, 2009.

R3. B. P. Lathi, Z. Ding, and H. M. Gupta, ***Modern Digital and Analog Communication Systems***, 4th *Ed.*, Oxford University Press, 2017.

**Online Resources**:

1. https://nptel.ac.in/courses/117105143: by Prof. G. Das, IIT Kharagpur
2. https://nptel.ac.in/courses/108104091: by Prof A. K. Jagannatham, IIT Kanpur
3. https://nptel.ac.in/courses/117105144: by Prof. S. S. Das, IIT Kharagpur
4. https://nptel.ac.in/courses/117102059: by Prof. S. Prasad, IIT Delhi

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

| | |
|---|---|
| CO1 | Explain different types of signals and their characteristics using Fourier analysis tools. |
| CO2 | Describe the fundamental concepts of amplitude modulation and demodulation. |
| CO3 | Articulate different types of modulation schemes and modulated analog signals. |
| CO4 | Perform analysis of noise signals in frequency domain and linear filtering of noise. |
| CO5 | Analyze the performance of FM systems in presence of noise signals. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | 2 | | | | | 2 | 2 | | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 1 | 2 | | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 2 | 3 | | 1 |
| CO4 | 2 | 2 | 3 | 2 | 3 | 2 | | | | | 1 | 3 | | |
| CO5 | 3 | 2 | 3 | 3 | 3 | 2 | | | | | 2 | 3 | 1 | |

| Category | Code | Digital Electronic Circuits | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2007 | | 3-1-0 | 4 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to understand the concepts & techniques associated with digital systems and their design & implementations in VLSI technology. |
| **Pre-Requisites** | Knowledge of basic eectronics and fundamentals of number systems is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Introduction: Review of Boolean Algebra and Logic gates; Codes: Binary codes and their application: BCD Code, Excess-3 Code, 2-4-2-1 Code, 8-4-(-2)-(-1) code and Gray code, Code converters; Combinational Logic Design: Boolean Algebra and Identities, Algebraic Reduction using Boolean algebra; Standard Representation for Logic Functions: Sum-of-Products (SOP)and Product-of-Sums (POS) forms, Canonical SOP and POS forms; K-map representation and simplification of logic functions using K-map, Minimization of 2, 3, 4 variable logical functions; Don't care conditions. | **11 Hours** |
| **Module-2** | Combinational Logic Components: Adders, Subtractors, Carry-Look-Ahead Adder, Binary Multiplier, Equality Detector and Comparator, BCD to 7-Segment Display, Multiplexer, De-Multiplexer, Decoders, Encoder (Priority Encoder), Design of Combinational Circuits using Multiplexer and Decoder. | **11 Hours** |
| **Module-3** | Sequential Logic Design: Latches & Flip flops: S-R, D, JK & T Flip Flops. Master-Slave JK FF, Flip Flop Conversion; Finite State Machines: Mealy and Moore models: FSM Design using Melay and Moore based model, Sequence detector; Synchronous Counters: Up counter, Down Counter, Up-Down Counter, Mod-N Counters & Random Sequence Counter. | **12 Hours** |
| **Module-4** | Asynchronous Counter: Up & Down using positive and negative edge trigger Flip Flop, Up-Down Counter, Mod-N Asynchronous counter; Shift Registers: SISO, SIPO, PIPO & PISO, Bi-directional shift register, Universal Shift Register, Ring Counter, Johnson Counter; Data Converters: ADCs and DACs; Basic Operational Characteristics and Parameters: Noise margin, Propagation delay, Fan-in, Fan-out; Semiconductor Memories: Basics of ROM, SRAM & DRAM. | **11 Hours** |
| **Module-5** | Verilog HDL: Introduction to Verilog HDL, Verilog design codes using different modeling styles: Data flow, Behavioral, Gate level and Structural Modeling, Data types, Synthesis and Simulation, Verilog Testbench code for design simulation, Port mapping by order, Port mapping by name; Verilog Design Codes for Combinational Circuit: Basic Logic gates - Adder, Subtractor, Mux, De-Mux, Decoder, Encoder; Verilog Design Codes for Sequential Circuit: Latches, Flip Flops & Counters. | **11 Hours** |
| | **Total** | **56 Hours** |

**Text Books**:

T1. M. M. Mano and M. D. Ciletti, ***Digital Design: With an Introduction to Verilog HDL***, 5th *Ed.*, Pearson Education, 2013.

T2. D. P. Leach, A. P. Malvino, and G. Saha, ***Digital Principles and Applications***, 8th *Ed.*, McGraw Hill Education, 2014.
T3. S. Palnitkar, ***Verilog HDL: A Guide to Digital Design and Synthesis***, 2nd *Ed.*, Prentice Hall, 2003.

**Reference Books**:

R1. D. V. Hall, ***Digital Circuits and Systems***, International Student Edition, McGraw-Hill Education, 1989.
R2. R. P. Jain, ***Modern Digital Electronics***, 4th *Ed.*, McGraw-Hill Education, 2009.
R3. A. A. Kumar, ***Fundamentals of Digital Circuits***, 3rd *Ed.*, PHI Learning, 2014.
R4. W. H. Gothmann, ***Digital Electronics - An Introduction to Theory and Practice***, 2nd *Ed.*, PHI Learning, 1982.

**Online Resources**:

1. https://nptel.ac.in/courses/117106086: by Prof. S. Srinivasan, IIT Madras
2. https://nptel.ac.in/courses/117103064: by Prof. Mahanta and Prof. Palanthinkal, IIT Guwahati
3. https://nptel.ac.in/courses/108105113: by Prof. S. Chattopadhyay, IIT Kharagpur
4. https://nptel.ac.in/courses/108105132: by Prof. G. Saha, IIT Kharagpur

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

| | |
|---|---|
| CO1 | Design basic and universal boolean functions using logic gates. |
| CO2 | Design and analyze combinational logic circuits. |
| CO3 | Design and analyze sequential logic circuits and explain finite state machine. |
| CO4 | Design, analyze and implement memory array using sequential network for digital logic and investigate performance of CMOS based logic circuits in modern VLSI technology. |
| CO5 | Simulate and synthesize various digital circuits using HDL in industry standard tools. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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) |

P.T.O

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 3 | 2 | 1 | | | | | | 3 | 1 | |
| CO2 | 2 | 3 | 2 | 3 | 3 | 1 | | | | | | 3 | 1 | |
| CO3 | 2 | 3 | 2 | 3 | 3 | 1 | | | | | | 3 | 1 | |
| CO4 | 2 | 3 | 2 | 3 | 2 | 1 | | | | | 2 | 3 | 1 | |
| CO5 | 2 | 3 | 2 | 3 | 2 | 1 | | | | | 2 | 3 | 1 | |

| Category | Code | Solid State Devices | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PEL | EC2010 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study the underlying physics of semiconductor devices and designing different semiconductor devices for applications in industry and various other domains. |
| **Pre-Requisites** | Knowledge of solid state physics including quantum physics of electrons in isolated atom and group of atoms is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Introduction: Review of quantum mechanics, Electrons in periodic lattices, E-K diagrams, Energy bands in solids; Electrons and holes in semiconductors: Silicon crystal structure, Donors and acceptors in the band model, Effective mass, Density of states(D(E)), Thermal equilibrium, Fermi-Dirac distribution function(f(E)) for electrons and holes, Fermi energy, Derivation of equilibrium concentration of electrons (n) and holes (p) from D(E) and f(E), Fermi level and carrier concentrations, np product and intrinsic carrier concentration. | **10 Hours** |
| **Module-2** | Electrons, holes and their transport phenomena in semiconductors: Carrier concentrations at extremely high and low temperatures - complete ionization, partial ionization and freeze-out, Energy-band diagram and Fermi-level, Variation of Ef with doping concentration and temperature; Carrier drift: Electron and hole mobilities, Drift current and conductivity and resistivity; Carrier diffusion: diffusion current, Total current density, Thermal generation, Electron-hole recombination. | **9 Hours** |
| **Module-3** | PN Junction & Schottky diodes: P-N junction characteristics; Building blocks of the pn junction theory, Energy band diagram and depletion layer of a pn junction, Built-in potential, Carrier injection under forward bias-Quasi-equilibrium boundary condition; current continuity equation, I-V characteristics, Reverse biased P-N junction: Avalanche breakdown, Zener diode, Schottky diode: I-V characteristics, Comparison between Schottky barrier diode and pn-junction diode. | **8 Hours** |
| **Module-4** | MOS Capacitor and MOSFET: The MOS structure, Energy band diagrams, Surface accumulation, Surface depletion, Flat-band condition and flat-band voltage, Threshold condition and threshold voltage, C-V characteristics of ideal MOS capacitor, Basic structure of MOSFET, MOSFET Vt, Qinv and I-V Characteristics. | **8 Hours** |
| **Module-5** | IC Fabrication Process: Oxidation, Diffusion, Ion implantation, Photolithography, Etching, Chemical vapor deposition, Sputtering and twin tube CMOS process. | **7 Hours** |
| | **Total** | **42 Hours** |

P.T.O

**Text Books**:

T1. D. A. Neamen, ***Semiconductor Physics and Devices***, 4th Ed., McGraw-Hill, 2012.
T2. G. Streetman and S. K. Banerjee, ***Solid State Electronic Devices***, 7th Ed., Pearson, 2014.

**Reference Books**:

R1. S. M. Sze and K. N. Kwok, ***Physics of Semiconductor Devices***, 3rd Ed., John Wiley & Sons, 2006.
R2. C. T.Sah, ***Fundamentals of Solid State Electronics***, 1st Ed., World Scientific Publishing Co., 1991.
R3. D. A. Neamen and D. Biswas, ***Semiconductor Physics and Devices***, 4th Ed., Tata McGraw-Hill Education, 2012.

**Online Resources**:

1. https://nptel.ac.in/courses/115102103/: by Prof. M. R. Shenoy, IIT Delhi
2. https://nptel.ac.in/courses/113104012/: by Prof. D. Gupta, IIT Kanpur

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

| | |
|---|---|
| CO1 | Analyze charge carrier statistics and calculate various parameters of semiconductor devices. |
| CO2 | Investigate carrier transport phenomena to calculate the conductivity of semiconductor devices. |
| CO3 | Apply the concepts to investigate the electronic properties of diodes under different conditions. |
| CO4 | Investigate the V I characteristics of MOS capacitor and MOSFET. |
| CO5 | Describe and explain the basic fabrication steps in CMOS technology. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | | | | | | | 1 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | | | | | | | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 1 | | | | | | | 2 | 2 | 1 | 2 |
| CO4 | 3 | 1 | 2 | 2 | | | | | | | 2 | 3 | 1 | 2 |
| CO5 | 3 | 2 | 3 | 3 | | | | | | | 1 | 3 | 1 | 1 |

| Category | Code | Embedded C Programming | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PEL | EC2011 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to learn the in-depth concepts of embedded C programming techniques, GPIO, peripheral operations, and serial communication standards by leveraging industry standard MCUs. |
| **Pre-Requisites** | Knowledge of computer programming and basic electronics is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on design & programming activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **C Programming**: Names, Types, and Type declarations, Storage classes, Linkage and Scope, Character constants, Arrays, Other types, Operators and Expressions, Increment and Decrement operators, Precedence and Associativity, Program Flow and Control, Functions, Recursion, Demonstration and practice. | **8 Hours** |
| **Module-2** | **Advanced Topics in C**: Pointers, Multidimensional arrays, Structures, Input and Output, Memory Management, Miscellaneous functions, Demonstration and practice. | **9 Hours** |
| **Module-3** | **Introduction to STM MCU**: Principal MCU components, Bit Serial Ports, S/W for MCU programming, STM project development, Memory-Mapped peripherals, Core memory addresses, Peripheral memory addresses; HAL_GPIO module – GPIO pin hardware, LED Test demonstration, Enabling multiple outputs, Push-Button test; Clock speed – Setting the PIN clock speed, Demonstration and practice. | **9 Hours** |
| **Module-4** | **Interrupts, Timer and UART**: NVIC specifications; Interrupt Process – External Interrupts; STM timer peripherals, Timer configurations, LED test programs; UART & USARTs – Transmit and Receive programming, Demonstration and practice. | **8 Hours** |
| **Module-5** | **ADC and PWM**: ADC Functions – ADC module with HAL, Conversion modes, Channels, Groups, and Ranks, Demonstrations; General purpose timer PWM signal generation, Timer H/W architecture, PWM signals with HAL; Introduction to I2C, SPI, Demonstration and practice. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:


T1. P.S. Deshpande and O. G. Kakde, ***C and Data Structures***, 1st *Ed.*, Dreamtech Press, 2003.
T2. E. Balagurusamy, ***Programming in ANSI C***, 7th *Ed.*, McGraw-Hill Education, 2017.
T3. C. Noviello, ***Mastering STM32***, 2nd *Ed.*, Leanpub, 2022.
T4. M. A. Mazidi, S. Chen, and E. Ghaemi, ***STM32 Arm Programming for Embedded Systems (Using C Language with STM32 Nucleo)***, 1st *Ed.*, Microdigitaled, 2018.


**Reference Books**:


R1. K. R. Venugopal and S. R. Prasad, ***Mastering C***, 3rd *Ed.*, McGraw-Hill Education, 2017.
R2. T. V. Sickle, ***Programming Microcontrollers in C***, 2nd *Ed.*, LLH Publishing, 2001.

**Online Resources**:

1. https://nptel.ac.in/courses/106104128: By Prof. S. Nandakumar, IIT Kanpur
2. https://nptel.ac.in/courses/106105171: By Prof. A. Basu, IIT Kharagpur
3. https://nptel.ac.in/courses/106105193: By Prof. I. Sengupta and Prof. K. Datta, IIT Kharagpur
4. https://nptel.ac.in/courses/108105102: By Prof. S. Chattopadhyay, IIT Kharagpur

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

| | |
|---|---|
| CO1 | Explain the concepts of C programming required to program any MCU. |
| CO2 | Develop advanced C programming skills for embedded system applications. |
| CO3 | Program an Industry standard MCU using embedded C programming. |
| CO4 | Describe interrupts, timers, and UART operations for real-time applications. |
| CO5 | Analyze the ADC and PWM operations using embedded C programming techniques. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | | | | | | 1 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 2 | | | | | | 1 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 | | | | | | 2 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | | | | | | 2 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 1 | | | | | | 2 | 3 | 3 | 3 |

| Category | Code | Soft Computing Techniques | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PEL | EE2007 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to introduce the concepts of various soft computing techniques like fuzzy logic, neural networks, Genetic algorithm etc., along with optimization techniques/evolutionary computation, and their applications in different fields of engineering. |
| **Pre-Requisites** | Knowledge of engineering mathematics and the basics of programming is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Basic Tools of Soft Computing**: Evolution of Computing - Soft Computing constituents, Difference between soft computing and hard computing, Characteristics of Soft computing and its applications, Fuzzy logic, Basics of fuzzy logic theory, Crisp and fuzzy sets, Operations on Fuzzy Sets, Membership Functions, Fuzzy relations. | **8 Hours** |
| **Module-2** | **Fuzzy Logic Systems**: Fuzzy rules, Propositions, Implications and inferences, Zadeh's compositional rule of inference, Methods of Defuzzification; Fuzzy Logic Controller: Fuzzy Inference System, Mamdani, Takagi and Sugeno architectures, Examples and applications of fuzzy logic controllers. | **10 Hours** |
| **Module-3** | **Artificial Neural Networks**: Biological background of Neural Networks and its architecture, Single layer feed forward network, Multi-layer feed forward network, Recurrent networks, Early neural network architectures - Rosenblatt's Perceptron, ADALINE network, MADALINE network, Examples and applications of neural networks. | **8 Hours** |
| **Module-4** | **Training of ANN**: Back propagation algorithm, Effect of tuning parameters of the back propagation algorithm, Radial Basis Function networks & Least Square training algorithm, Kohenen self–organizing map and learning vector quantization networks, Recurrent neural networks, Simulated annealing neural networks, Adaptive Neuro-fuzzy inference systems (ANFIS). | **10 Hours** |
| **Module-5** | **Evolutionary Computing**: Basics of Genetic Algorithm and its architectures, GA operators - Encoding, Crossover, Selection, Mutation; Introduction to other optimization techniques and hybrid evolutionary algorithms. | **6 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. J. S. R. Jang, C. T. Sun, and E. Mizutani, ***Neuro-Fuzzy & Soft Computing - A Computational Approach to Learning and Machine Intelligence***, 1st *Ed.*, PHI Learning, 2015.

T2. S. Rajasekaran and G. A. V. Pai, ***Neural Networks, Fuzzy Systems and Evolutionary Algorithms : Synthesis and Applications***, 2nd *Revised Ed.*, PHI Learning, 2017.

**Reference Books**:

R1. F. O. Karry and C. De Silva, ***Soft Computing and Intelligent Systems Design - Theory, Tools and Applications***, 1st *Ed.*, Pearson Education, 2009.

R2. S. Haykin, ***Neural Networks : A Comprehensive Foundation***, 2nd *Ed.*, Pearson Education,1997.
R3. T. J. Ross, ***Fuzzy Logic with Engineering Applications***, 3rd *Ed.*, Wiley, 2011.

**Online Resources**:

1. https://nptel.ac.in/courses/127105006: by Prof. D. K. Pratihar, IIT Kharagpur
2. https://nptel.ac.in/courses/106105173: Prof. D. Samanta, IIT Kharagpur
3. https://nptel.ac.in/courses/117105084: Prof. S. Sengupta, IIT Kharagpur

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

| | |
|---|---|
| CO1 | Explain the fundamentals of fuzzy logic and apply its concepts to solve various problems. |
| CO2 | Apply fuzzy principles & inference and implement them for designing fuzzy systems. |
| CO3 | Apply different types of neural networks in electrical & electronics engineering problems. |
| CO4 | Analyze effectiveness of neural networks for solving complex engineering problems. |
| CO5 | Explore evolutionary computation techniques & its application to genetic algorithm. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 2 | 1 | 1 | | | | | 1 | 1 | 1 | |
| CO2 | 3 | 3 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 1 | 1 | 3 | 2 | | | | | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 1 | 1 | 3 | 2 | | | | | 1 | 2 | 2 | 2 |
| CO5 | 3 | 3 | 1 | 1 | 2 | 1 | | | | | 1 | 1 | 2 | 2 |

| Category | Code | Electronic Devices & Modeling | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| HNS | EC2015 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study advanced topics on electronic devices to evaluate & extract their model parameters and modeling of diode, Bipolar Junction Transistor, Metal-Oxide-Semiconductor Transistor and LASER. |
| **Pre-Requisites** | Knowledge of semiconductor material, electronics devices & circuits is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | PN–Junction and Schottky Diodes: DC Current-Voltage Characteristics, Static Model, Large-Signal Model, Small-Signal Model, Schottky Diode and its implementation in SPICE2, Temperature and Area Effects on the Diode Model Parameters, SPICE3, HSPICE and PSPICE Models. | **8 Hours** |
| **Module-2** | Bipolar Junction Transistor(BJT): Transistor Conversions and Symbols, Ebers Moll Static Model, Ebers-Moll Large-Signal Model, Ebers-Moll Small-Signal Model, Gummel-Poon Static Model, Gummel-Poon Large-Signal Model, Gummel-Poon Small-Signal Model, Temperature and Area Effects on the BJT Model Parameters, Power BJT Model, SPICE3, HSPICE and PSPICE Models. | **9 Hours** |
| **Module-3** | Metal-Oxide-Semiconductor Transistor (MOST): Structure and Operating Regions of the MOST, LEVEL1 Static Model, LEVEL2 Static Model, LEVEL1 and LEVEL2 Large-Signal Model, LEVEL3 Static Model, LEVEL3 Large-Signal Model, The Effect of Series Resistances, Small-Signal Models, The Effect of Temperature. | **9 Hours** |
| **Module-4** | BJT Parameter Measurements: Input and Model Parameters, Parameter Measurements. MOST Parameter Measurements: LEVEL1 Model Parameters, LEVEL2 Model (Long-Channel) Parameters, LEVEL2 Model (Short-Channel) Parameters, LEVEL3 Model Parameters, and Measurements of Capacitance. | **8 Hours** |
| **Module-5** | Modeling of LASER Diode: Rate equations, Numerical schemes - Small signal modeling and Large signal modeling, Equivalent circuits. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. G. Massobrio and P. Antognetti, ***Semiconductor Device Modeling with SPICE***, 2nd *Ed.*, McGraw-Hill Education, 2010.

T2. D. K. Schroder, ***Semiconductor Material and Device Characterization***, 3rd *Ed.*, John Wiley & Sons, 2006.

**Reference Books**:

R1. R. S. Muller, T. I. Kamins, and M. Chan, ***Device Electronics for Integrated Circuits***, 3rd *Ed.*, John Wiley & Sons, 2003.

R2. H. C. Casey, ***Devices for Integrated Circuits : Silicon and III-V Compound Semiconductors***, 1st *Ed.*, John Wiley & Sons, 1999.

**Online Resources**:

1. https://nptel.ac.in/courses/117106033/: by Prof. S. Karmalkar, IIT Madras
2. https://nptel.ac.in/courses/117101058/: by Prof. A. N. Chandorkar, IIT Bombay
3. https://nptel.ac.in/courses/108105066: by Prof. D. Prasad, et. al., IIT Kharagpur

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

| | |
|---|---|
| CO1 | Understand, extract and implement the static characteristics of Diode including the effect of temperature and area on the Diode Model Parameters. |
| CO2 | Understand, extract and implement the static characteristics of BJT including the effect of temperature and area on the BJT Parameters. |
| CO3 | Formulate the structural behavior of MOSFET with their LEVELs and analyze its effect on series resistances, Small-Signal models & temperature. |
| CO4 | Evaluate and extract the Model parameters of different LEVELs of BJT and MOSFET before implementation in industry. |
| CO5 | Formulate the structural behavior of optoelectronic device LASER, Small-Signal models and Large signal model. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | | | 1 | | | | 2 | 1 | 1 |
| CO2 | 3 | 3 | 1 | 1 | 3 | 1 | | 2 | | | | 2 | 2 | 2 |
| CO3 | 3 | 3 | 1 | 1 | 3 | 1 | | 2 | | | | 2 | 1 | 2 |
| CO4 | 3 | 3 | 1 | 3 | 3 | | | 2 | | | | 3 | 1 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 1 | 1 | | 2 | | | | 3 | 1 | 1 |

| Category | Code | Operating Systems | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| MNR | CS2003 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to understand the fundamental concepts, techniques & algorithms, and internal working principles of a computer operating system to become a system designer or an efficient application developer. |
| **Pre-Requisites** | Knowledge of computer programming and data structures is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | **Introduction**: Overview, Evolution of operating system, Types of systems - Batch Processing, Multiprogramming, Time Sharing systems; Personal Computers, Parallel, Distributed, and Real-time Systems; Operating System Services, System components, System calls. | **7 Hours** |
| **Module-2** | **Process Management**: Process concepts, states, PCB, Process scheduling queues, queuing diagram, Types of schedulers, Operations on process; Interprocess communication - shared memory, message passing, Concept of buffering, Thread overview, Benefits of multi-threaded program, User and kernel threads, Multi-threading models, Issues with multi-threading - thread cancellation, thread pools, thread specific data; CPU Scheduling: Dispatcher, Scheduling - Criteria, Algorithms - FCFS, SJF, SRTF, RR, Priority, Multi-level Queue (MLQ), MLQ with Feedback. | **9 Hours** |
| **Module-3** | **Process Synchronization**: Background, Bounded-buffer – Shared-memory solution to Producer-consumer problem, Race condition, Critical section problem - Peterson's solution, Synchronization hardware: TestAndSet(), swap() instructions, Semaphores - Counting and binary semaphore, spinlocks, Classical problems of synchronization - Bounded-buffer problem, Readers-writers problem, Dining-philosophers problem, Monitors; Deadlock: System model, characterization, Resource-allocation graph, Methods for handling deadlocks, Deadlock prevention & avoidance, Banker's algorithm, Deadlock detection & recovery. | **9 Hours** |
| **Module-4** | **Memory Management**: Background, Logical & physical address space, Dynamic loading & dynamic linking, Swapping, Contiguous memory allocation, Dynamic storage allocation problem, Overlays, Paging, Segmentation; Virtual Memory: Background, Demand paging, Page fault, Basic page replacement policy, Page replacement algorithms - FIFO, OPT, LRU, LRU Approximation, LFU, MFU, Thrashing, Working-set model. | **9 Hours** |

*Cont'd. . .*

| Module-# | Topics | Hours |
|---|---|---|
| **Module-5** | **Secondary Storage Structure**: Overview of mass storage structure, Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, LOOK, CLOOK, Swap-space management, RAID structure; File System: Concept, Access methods, Directory structure, Directory implementation, Allocation methods, Free space management, Access control list; I/O System: Polling, Interrupts, DMA; Case Studies: The LINUX System visual representations of your data, Avoiding common pitfalls. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. A. Silberschatz, P. B. Galvin, and G. Gagne, ***Operating System Concepts***, 8th *Ed.*, Wiley, 2009.
T2. M. Milenković, ***Operating Systems: Concepts and Design***, 2nd *Ed.*, Tata McGraw-Hill, 2001.

**Reference Books**:

R1. A. S. Tanenbaum, ***Modern Operating Systems***, 3rd *Ed.*, PHI, 2009.
R2. P. B. Prasad, ***Operating Systems and System Programming***, 2nd *Ed.*, Scitech Publications, 2015.

**Online Resources**:

1. https://nptel.ac.in/courses/106102132/: by Prof. S. Bansal, IIT Delhi
2. https://nptel.ac.in/courses/106108101/: by Prof. P. C. P. Bhatt, IISc Bangalore
3. https://nptel.ac.in/courses/106106144/: by Prof. C. Rebeiro, IIT Madras
4. https://nptel.ac.in/courses/106105214/: by Prof. S. Chattopadhyay, IIT Kharagpur
5. https://www.cse.iitb.ac.in/~mythili/os/: Notes & slides by Prof. M. Vutukuru, IIT Bombay
6. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-828-operating-system-engineering-fall-2012/lecture-notes-and-readings/

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

| | |
|---|---|
| CO1 | Explore principles behind various types of operating systems, system components, system calls, protection mechanisms and services. |
| CO2 | Explain different schedulers, scheduling policies, and design new scheduling algorithms for real life problems. |
| CO3 | Describe the significance of process synchronization through classical synchronization problems and deadlock handling mechanisms. |
| CO4 | Describe the working principle of main memory, cache memory and virtual memory organization and solve memory related problems. |
| CO5 | Articulate secondary storage management, and analyze the performance of various disk scheduling algorithms. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4). |

*Cont'd. . .*

| | |
|---|---|
| PO3 | **Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | | 2 | | | | | 2 | 2 | 2 | |
| CO2 | 3 | 3 | 3 | 1 | | 2 | | | | | 2 | 3 | 3 | 1 |
| CO3 | 3 | 3 | 3 | 1 | 1 | 2 | | | | | 2 | 3 | 3 | 1 |
| CO4 | 3 | 3 | 3 | 1 | 1 | 2 | | | | | 1 | 3 | 3 | 1 |
| CO5 | 2 | 2 | 2 | 1 | 1 | 2 | | | | | 1 | 3 | 3 | 1 |

| Category | Code | Data Mining & Data Warehousing | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| MNR | CS3013 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to analyze large, complex, information-rich data in various domains, study the concepts and applications of data warehouses and discover useful patterns by applying data mining techniques. |
| **Pre-Requisites** | Knowledge of database management systems, probability, statistics and programming language are required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Data Warehousing: Basic concepts & applications of Data Warehouse, Difference between operational databases and data warehouses, OLTP and OLAP systems, Three-tier architecture of Data Warehouse, ETL Process, Data Marts, Data staging area, Metadata. | **8 Hours** |
| **Module-2** | Data Mining Concepts: Basic concepts & applications of Data Mining, KDD process, Data Objects and attributes types, Basic Statistical Descriptions of Data including central tendency, variation, spread, standard deviation and Boxplot analysis. Data similarity & dissimilarity. Data Pre-processing: Data cleaning, binning, integration, reduction & transformation, Redundancy & Correlation Analysis: Pearson's coefficient, Chi-Square & Covariance. | **10 Hours** |
| **Module-3** | Mining Frequent Patterns, Associations and Correlations: Introduction, Market Basket Analysis, Association rule mining, Support, Confidence, Lift, Frequent Item-sets, Closed frequent Item-sets & Maximal frequent Item-set & generation, Apriori algorithm, FP-Growth algorithm, Evaluation of association patterns, Association analysis & correlation analysis. | **8 Hours** |
| **Module-4** | Classification: Basic concepts & applications of Classification, Decision Tree Induction, Information Gain, Bayes Theorem, Naive Bayesian Classifier, K Nearest Neighbor; Neural Network: Perception, Multilayer Feed-Forward Neural Network, Multilayer Perceptron Model, Handling the class imbalance problem. | **8 Hours** |
| **Module-5** | Clustering: Basic concepts & applications of Clustering, Partition-based Clustering: K-Means algorithm, K-Medoid algorithm, Hierarchical clustering: Agglomerative & Divisive methods, Density-based Clustering: DBSCAN, Graph-based clustering. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. J. Han, M. Kamber, and J. Pei, ***Data Mining: Concepts and Techniques***, 3rd *Ed.*, Morgan Kaufmann, 2011.

T2. R. Thareja, ***Data Warehousing***, 1st *Ed.*, Oxford University Press, 2009.

P.T.O

**Reference Books**:

R1. A. Berson and S. J. Smith, ***Data Warehousing, Data Mining & OLAP***, 1st *Ed.*, McGraw Hill Education, 2017.
R2. P. N. Tan, M. Steinbach, A. Karpatne, and V. Kumar, ***Introduction to Data Mining***, 2nd *Ed.*, Pearson Education, 2019.

**Online Resources**:

1. https://nptel.ac.in/courses/106/105/106105174/: by Prof. P. Mitra, IIT Kharagpur
2. http://infolab.stanford.edu/~ullman/mining/2003.html: notes by Stanford University
3. https://www.cse.iitb.ac.in/~krithi/courses/631/anand.ppt: by Prof. A. Deshpande, IIT Bombay

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

| | |
|---|---|
| CO1 | Elucidate the concepts and applications of Data Warehouse and its components. |
| CO2 | Explain the fundamental concepts of Data Mining and its applications. |
| CO3 | Construct frequent patterns, association rules and determine correlations using data mining techniques. |
| CO4 | Compare different classification algorithms and apply the same to the real life problems. |
| CO5 | Apply different clustering algorithms for solving real life problems in various domains. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | 3 | | | | | | | 2 | 3 | 1 | 1 |
| CO2 | 2 | 2 | 2 | 2 | | | | | | | 2 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 2 | | | | | | | 3 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | | | | | | | 3 | 3 | 2 | 2 |
| CO5 | 2 | 3 | 2 | 3 | | | | | | | 3 | 3 | 2 | 2 |

| Category | Code | Power Electronic Devices | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| MNR | EC2024 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study different types of power semiconductor devices and their switching characteristic, including the operation and characteristics of various power electronic converters. |
| **Pre-Requisites** | Knowledge of physics, calculus, ordinary differential equations and basic electronics is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Power Semiconductor Devices: Switching and V-I characteristic of devices: Transistor Family: BJT, IGBT, and MOSFET, Thyristor family: SCR, TRIAC; Series and parallel grouping of SCR, SCR triggering methods, SCR: Over voltage, Over Current, dv/dt, di/dt, Gate Protection, Snubber circuit. | **10 Hours** |
| **Module-2** | AC to DC Converter: Phase Controlled Converter: Principle of phase controlled converter operation, single phase full converter with R, R-L and R-L-E load, 3 phase full converter with R, R-L and R-L-E load, single phase semi converter with R, R-L and R-L-E load. | **10 Hours** |
| **Module-3** | AC to AC Converter: Single phase bi-directional controllers with R and R-L load, Single phase cycloconverters – Step up and Step down, Applications. | **6 Hours** |
| **Module-4** | DC to DC Converter: First quadrant, second quadrant, first and second quadrant, third and fourth quadrant converter; Switching Mode Regulators: Buck regulators, Boost regulators, Buck-Boost regulators; Isolated Converters: Flyback & Forward Converter, Applications. | **8 Hours** |
| **Module-5** | DC to AC Converter: Voltage Source Inverter (VSI) - Single phase Bridge Inverters, 3-Phase Inverters - 180° mode conduction, 120° mode conduction, Voltage control of 3-Phase Inverters by Sinusoidal PWM (PWM VSI), Current Source Inverter (CSI); Power Electronics Applications: UPS, SMPS, Induction Heating, AC/DC drives speed control. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. M. H. Rashid, ***Power Electronics: Devices, Circuits, and Applications***, 4th *Ed.*, Pearson Education, 2017.
T2. P. S. Bhimbra, ***Power Electronics***, 6th *Ed.*, Khanna Publishers, 2014.

**Reference Books**:

R1. M. D. Singh and K. B. Khanchandani, ***Power Electronics***, 2nd *Ed.*, McGraw-Hill, 2017.
R2. P. C. Sen, ***Power Electronics***, 1st *Ed.*, McGraw Hill India, 2001.

P.T.O

**Online Resources**:

1. https://nptel.ac.in/courses/108101038/: by Prof. Fernandes and Chatterjee, IIT Bombay.
2. https://nptel.ac.in/courses/108/102/108102145/: by Prof. G. Bhuvaneshwari, IIT Delhi.
3. https://ocw.mit.edu/courses/6-334-power-electronics-spring-2007/pages/lecture-notes/

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

| | |
|---|---|
| CO1 | Articulate the characteristics of power semiconductor devices and fundamentals of thyristors. |
| CO2 | Analyze the operation of AC-DC converters and its application in the practical field. |
| CO3 | Interpret the operation of AC-AC converters and analyze their performance. |
| CO4 | Design and analyze the operation of DC-DC converters and their use in DC drives. |
| CO5 | Investigate the operation of DC–AC converters, SPWM modulation technique and applications. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | 2 | 2 | 1 | | | | | 1 | 3 | 2 | |
| CO2 | 3 | 2 | 2 | 3 | 3 | 1 | | | | | 1 | 3 | 3 | 2 |
| CO3 | 3 | 1 | 2 | 2 | 3 | 2 | | | | | 1 | 3 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 3 | 2 | | | | | 1 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 2 | 2 | | | | | 2 | 2 | 2 | 1 |

| Category | Code | Marketing Management | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| MNR | MG2002 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to obtain a comprehensive understanding of marketing principles and strategies, analyzing market environments, consumer behavior, and developing effective approaches to product management, pricing, promotion, distribution, and digital marketing. |
| **Pre-Requisites** | Basic knowledge on fundamentals of management and economics is desired. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with focus on real-world case studies and examples. |

## Evaluation Scheme

| Attendance | Teacher's Assessment | Mid-Term | End-Term | Total |
|---|---|---|---|---|
| 10 | 20 | 20 | 50 | 100 |

## Detailed Syllabus

| Module-# | Topics | Hours |
|---|---|---|
| **Module-1** | Marketing: Meaning, scope and importance, Evolution of marketing, Understanding marketing in new perspective, Marketing environment, Information system and marketing research - Importance, scope and steps of marketing research process, Understanding consumer behaviour, Analysing business markets, Customer relationship management. | **9 Hours** |
| **Module-2** | Understanding consumer behaviour, Analysing business markets, Customer relationship management; Managing Mix: Product - Concept and classification, New product development, Product-mix and product line strategies, Product life cycle strategies, Branding, packaging, labelling and warranty. | **8 Hours** |
| **Module-3** | Promotion Programme: Advertising, Sales promotion, Public relations, Publicity and personal selling; Pricing: Price determination, Pricing policies and strategies. | **8 Hours** |
| **Module-4** | Channel Decision: Nature of marketing channels, Types of channel flows, Channel functions, Functions of distribution channel, Structure and design of marketing channels, Channel co-operation, Conflict and competition, Retailers and wholesalers. | **9 Hours** |
| **Module-5** | Distribution logistics and Supply chain management, Marketing channels, Retailing, Wholesaling and physical distribution, Marketing and information economy, Direct and online marketing. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. V. S. Ramaswamy and S. Namakumari, ***Marketing Management***, 6th *Ed.*, Sage Publications, 2018.
T2. K. Karunakaran, ***Marketing Management***, 1st *Ed.*, Himalaya Publishing House, 2010.
T3. T. N. Chabra and S. K. Grover, ***Marketing Management***, 1st *Ed.*, Dhanpat Rai & Co., 2016.

**Reference Books**:

R1. P. Kotler and K. L. Keller, ***Marketing Management***, 15th *Ed.*, Pearson Education, 2016.
R2. P. Baines, C. Fill, S. Rosengren, and P. Antonetti, ***Marketing***, 5th *Ed.*, Oxford University Press, 2019.
R3. C. W. Lamb, J. F. Hair, D. Sharma, C. McDaniel, ***Marketing***, 1st *Ed.*, Cengage Learning, 2013.
R4. J. P Mahajan and A. Mahajan, ***Marketing Management***, 1st *Ed.*, Vikas Publishing House, 2014.

**Online Resources**:

1. https://nptel.ac.in/courses/110104068: by Prof. J. Chatterjee and Dr. S. S. Mishra, IIT Kanpur
2. https://nptel.ac.in/courses/110104070: by Prof. J. Chatterjee and Dr. S. S. Mishra, IIT Kanpur
3. https://nptel.ac.in/courses/110108141: by Prof. R. Srinivasan, IISc Bangalore
4. https://ddceutkal.ac.in/Syllabus/MCOM/Marketing_Management.pdf

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

| | |
|---|---|
| CO1 | Explain marketing, marketing mix and impact of marketing on business strategies. |
| CO2 | Conduct marketing research and understand consumer behaviour, products & their life cycle. |
| CO3 | Design effective promotional strategies for publicity and product positioning in the market. |
| CO4 | Determine pricing policies as per market dynamics and effectively utilize marketing channels. |
| CO5 | Implement supply chain management and leverage digital tools for direct and online marketing. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO3 | **Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| PO7 | **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9) |
| PO8 | **Individual & 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | | | |
| CO2 | | | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | | | |
| CO3 | | | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | | 1 | |
| CO4 | | | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | | 1 | |
| CO5 | | | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | | 1 | 1 |

| Category | Code | Programming in Python Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| UCR | CS2010 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this laboratory course is to develop problem solving skills using python programming language and prepare the students use python tools & libraries for solving advanced engineering problems. |
| **Pre-Requisites** | Knowledge of programming and basic problem solving skills are required. |
| **Teaching Scheme** | Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise programming assignments. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Write, compile, test, and debug simple Python programs. |
| 2 | Write programs using control structures (if, if-elif-else). |
| 3 | Write programs using loop control structure (while & for loops). |
| 4 | Write programs based on the concept of lists and tuples |
| 5 | Write programs based on the concept of set and dictionaries. |
| 6 | Develop the Python programs step-wise by defining functions and calling them, function with variable number of parameters. |
| 7 | Write programs for creating class, object, methods and constructor. |
| 8 | Write programs for demonstrating inheritance, and method overriding. |
| 9 | Write programs on operator overloading, method overloading, and abstract classes. |
| 10 | Write programs on file handling, exception handling, and database connectivity. |
| 11 | Write programs using regular expressions, Numpy arrays and matrices. |
| 12 | Panda module, data frame from CSV file, reshaping & data aggregation. |
| 13 | Programs for creating different types of plots using Matplotlib libraries. |
| 14 | Creating widgets using Tkinter and designing layouts with radio buttons, checkboxes, and dialogue boxes. |

**Text Books**:


T1. R. N. Rao, ***Core Python Programming***, 2nd *Ed.*, DreamTech Press, 2019.

T2. V. Guttag, ***Introduction to Computation and Programming Using Python with Application to Understanding Data***, 2nd *Ed.*, PHI Learning, 2016.

T3. W. McKinney, ***Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter***, 3rd *Ed.*, O'Reilly Media, 2022.


**Reference Books**:


R1. P. Barry, ***Head First Python***, 2nd *Ed.*, O'Reilly Media, 2010.

R2. A. Downey, ***Think Python***, 2nd *Ed.*, Green Tea Press, 2015.

R3. E. Matthes, ***Python Crash Course: A Hands-On, Project-Based Introduction to Programming***, 3rd *Ed.*, No Starch Press, 2023.

R4. J. Zelle, ***Python Programming: An Introduction to Computer Science***, 3rd *Ed.*, Franklin, Beedle & Associates, 2016.

**Online Resources**:

1. https://nptel.ac.in/courses/106106182: By Prof. S. Iyengar, IIT Ropar
2. https://nptel.ac.in/courses/106106145: By Prof. M. Mukund, IIT Madras
3. https://nptel.ac.in/courses/106106212: By Prof. R. Rengasamy, IIT Madras
4. https://nptel.ac.in/courses/106107220: By Prof. A. Ramesh, IIT Roorkee

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

| | |
|---|---|
| CO1 | Develop programs using various features of the Python programming language. |
| CO2 | Develop programs using built-in as well as user-defined functions in Python. |
| CO3 | Apply object-oriented concepts, perform file processing & exception handling. |
| CO4 | Explore regular expressions, NumPy and Panda modules of Python for solving real-life problems. |
| CO5 | Visualize data using matplotlib libraries and design GUI based applications. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| 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). |
| PO8 | **Individual & 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. |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | | 2 | 3 | | 2 | 1 | | 2 | 2 | 3 | 1 |
| CO2 | 3 | 3 | 3 | | 2 | 3 | | 2 | 1 | | 3 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | | 3 | 3 | | 2 | 2 | | 2 | 2 | 3 | 1 |
| CO4 | 2 | 3 | 3 | | 3 | 3 | | 3 | 2 | | 2 | 2 | 3 | 1 |
| CO5 | 3 | 3 | 3 | | 3 | 3 | | 3 | 2 | | 3 | 2 | 3 | 2 |

| Category | Code | Digital Electronic Circuits Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2008 | | 0-0-4 | 2 | 100 |

| | |
|---|---|
| **Objectives** | The objective of the course is to provide hands-on exposure on logic gates, implementation using Boolean algebra, designing digital circuits like counters, registers and apply the knowledge to formulate digital systems using HDL. |
| **Pre-Requisites** | Knowledge of basic electronics is required. |
| **Teaching Scheme** | Regular laboratory experiments to be conducted under supervision of the faculty with use of ICT as and when required, sessions are planned to be interactive with focus on implementation in hardware & software tools. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, EX-NOR, Invert & Buffer gates, use of Universal (NAND & NOR) Gates. |
| 2 | Gate-level minimization: 2-level and multilevel implementation of Boolean functions. |
| 3 | Design, implement and test a given design example with (i) NAND Gates only (ii) NOR Gates only and (iii) Using a minimum number of Gates. |
| 4 | Combinational Circuits: design, assemble and test: adders & subtractors. |
| 5 | Design, assemble & test code converters: binary code to gray code, gray code to binary and 7 segment displays. |
| 6 | Study of Multiplexer, Demultiplexer. Implement a function using multiplexer. |
| 7 | Design of Binary to Octal decoder and Implementation of Boolean function using decoder. |
| 8 | Flip-Flop: assemble, test & investigate operation of SR, D, J-K & T flip-flops. |
| 9 | Shift Registers: Design and investigate the operation of all types of shift registers. |
| 10 | Counters: Design, assemble and test various ripple & synchronous counters. |
| 11 | Binary Multiplier: design and implement a circuit that multiplies two 4-bit unsigned numbers to produce a 8-bit product. |
| 12 | Design, implement & test two bit magnitude comparator. |
| 13 | Design of a special type of counters (4-bit ring counter & Johnson counter) using JK flip-flops. |
| ***Verilog Simulation & Implementation*** | |
| 14 | Different types of logic gates. |
| 15 | Half adder and half subtractor using different types of modeling. |
| 16 | Full adder and full subtractor using different types of modeling. |
| 17 | Multiplexer circuits using different types of modeling. |
| 18 | Decoder circuits using different types of modeling. |
| 19 | SR-FF, D-FF, JK-FF, T-FF. |
| 20 | 4-bit up counter & 4-bit down counter. |

**Text Books**:

T1. M. M. Mano and M. D. Ciletti, ***Digital Design: With an Introduction to Verilog HDL, VHDL and System Verilog***, 6th *Ed.*, Pearson Education, 2018.
T2. S. Palnitkar, ***Verilog HDL: A Guide to Digital Design and Synthesis***, 2nd *Ed.*, Pretince Hall, 2003.

**Reference Books**:

R1. A. M. Michelén, ***Digital Electronics Laboratory Manual***, Pearson Education, 2000.
R2. J. W. Stewart and C. -Y. Wang, ***Digital Electronics Laboratory Experiments: Using the Xilinx XC95108 CPLD with Xilinx Foundation : Design and Simulation Software***, 2nd *Ed.*, Pearson, 2004.

**Online Resources**:

1. https://www2.mvcc.edu/users/faculty/jfiore/Resources/DigitalElectronics1LaboratoryManual.pdf
2. https://www.elprocus.com/top-digital-electronic-projects-for-electronics-engineering-students/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-111-introductory-digital-systems-laboratory-spring-2006/

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

| | |
|---|---|
| CO1 | Analyze the function of logic gates and implement of Boolean functions. |
| CO2 | Realize universal gates and implement minimized Boolean expressions. |
| CO3 | Design and analyze different combinational circuits. |
| CO4 | Design various asynchronous and Synchronous Sequential Circuits. |
| CO5 | Acquire knowledge about internal circuitry and logic behind any digital system. |
| CO6 | Simulate various digital circuits using VHDL in industry standard tool such as Xilinx. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| PO6 | **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7). |
| 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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**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 3 | 2 | 1 | | | | | | 3 | 1 | |
| CO2 | 2 | 3 | 3 | 3 | 3 | 1 | | | | | | 3 | 1 | |
| CO3 | 2 | 3 | 3 | 3 | 3 | 1 | | | | | 1 | 3 | 1 | |
| CO4 | 2 | 3 | 2 | 3 | 2 | 1 | | | | | 1 | 3 | 1 | |
| CO5 | 2 | 3 | 2 | 3 | 2 | 1 | | | | | 1 | 3 | 1 | |
| CO6 | 2 | 3 | 2 | 3 | 2 | 1 | | | | | 1 | 3 | 1 | |

| Category | Code | Analog Communication Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2009 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this laboratory course is to visualize spectrum of signals, FDM process, modulation schemes, demodulation methods, and simulate through MATLAB & LABVIEW software. |
| **Pre-Requisites** | Knowledge on Basic Electronics, MATLAB, and LABVIEW are required. |
| **Teaching Scheme** | Regular laboratory experiments to be conducted using hardware and software tools under the supervision of the teacher; some experiments shall consist of programming assignments. |

## Evaluation Scheme

| Attendance | Daily Performance | Lab Record | Lab Test / Mini Project | Viva-voce | Total |
|---|---|---|---|---|---|
| 10 | 30 | 15 | 30 | 15 | 100 |

## Detailed Syllabus

| Experiment-# | Assignment/Experiment |
|---|---|
| 1 | Analyze and plot the spectrum of following signals with aid of spectrum analyzer:Sine wave, square wave, triangle wave, saw-tooth wave of frequencies 1 KHz, 10KHz, 50KHz, 100KHz and 1 MHz. |
| 2 | Analyze the process of frequency division multiplexing and frequency division de-multiplexing. |
| 3 | Study and design of AM modulator and demodulator (Full AM, DSBSC, SSBSC). |
| 4 | Study of FM modulation and Demodulation Techniques. |
| 5 | Observe the process of Pulse Amplitude Modulation and Demodulation. |
| 6 | Study of quantization and PCM technique. |
| 7 | Using MATLAB generate a carrier and a modulating signal, Modulate the carrier using AM, Show the waveform in time domain and analyze its frequency spectrum. Repeat the simulation for modulating signal being square, triangular and other forms of waveform. |
| 8 | Using MATLAB generate a carrier and a modulating signal, Modulate the carrier using FM, Show the waveform in time domain and analyze its frequency spectrum. Repeat the simulation for modulating signal being square, triangular and other forms of waveform. |
| 9 | Simulate AM modulation & demodulation system using LabView software. |
| 10 | Simulate FM modulation & demodulation system using LabView software simulate . |
| 11 | Design a receiver to demodulate and receive the signal from AM radio station. |
| 12 | Design a receiver to demodulate and receive the signal from the local FM radio station. |

**Text Books**:

T1. H. Taub, D. L. Schilling, and G. Saha, ***Principles of Communication Systems***, 4th *Ed.*, McGraw-Hill Education, 2013.

T2. R. P. Singh and S. D. Sapre, ***Communication Systems: Analog and Digital***, 3rd *Ed.*, McGraw-Hill Education, 2012.

**Reference Books**:

R1. M. Salehi and J. G. Proakis, ***Communication System Engineering***, 2nd *Ed.*, PHI, 2002.

R2. S. Haykin and M. Moher, ***Communication Systems***, 5th *Ed.*, John Wiley & Sons, 2009.
R3. B. P. Lathi, Z. Ding, and H. M. Gupta, ***Modern Digital and Analog Communication Systems***, 4th *Ed.*, Oxford University Press, 2017.

**Online Resources**:

1. https://nptel.ac.in/courses/117105143: by Prof. G. Das, IIT Kharagpur
2. https://nptel.ac.in/courses/108104091: by Prof A. K. Jagannatham, IIT Kanpur
3. https://nptel.ac.in/courses/117105144: by Prof. S. S. Das, IIT Kharagpur
4. https://nptel.ac.in/courses/117102059: by Prof. S. Prasad, IIT Delhi

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

| | |
|---|---|
| CO1 | Investigate the different types of spectrum and analyze their bandwidth. |
| CO2 | Explain the process of FDM and its advantages in the field of communication. |
| CO3 | Describe different analog modulation and their application in transmission and reception. |
| CO4 | Differentiate pulse modulation with respect to their type of generation. |
| CO5 | Represent different analog modulation signals using various software. |

**Program Outcomes Relevant to the Course**:

| | |
|---|---|
| PO1 | **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4). |
| PO2 | **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**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5). |
| PO4 | **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8). |
| PO5 | **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6). |
| 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) |

**Mapping of COs to POs and PSOs** (1: Low, 2: Medium, 3: High)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 1 | 3 | | | | | | 1 | 2 | | |
| CO2 | 3 | 2 | 2 | 2 | 3 | | | | | | 1 | 3 | | |
| CO3 | 3 | 3 | 3 | 2 | 3 | | | | | | 1 | 3 | | |
| CO4 | 3 | 3 | 3 | 2 | 3 | | | | | | 1 | 3 | | |
| CO5 | 3 | 3 | 2 | 2 | 3 | | | | | | 1 | 3 | | 1 |

Silicon University

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