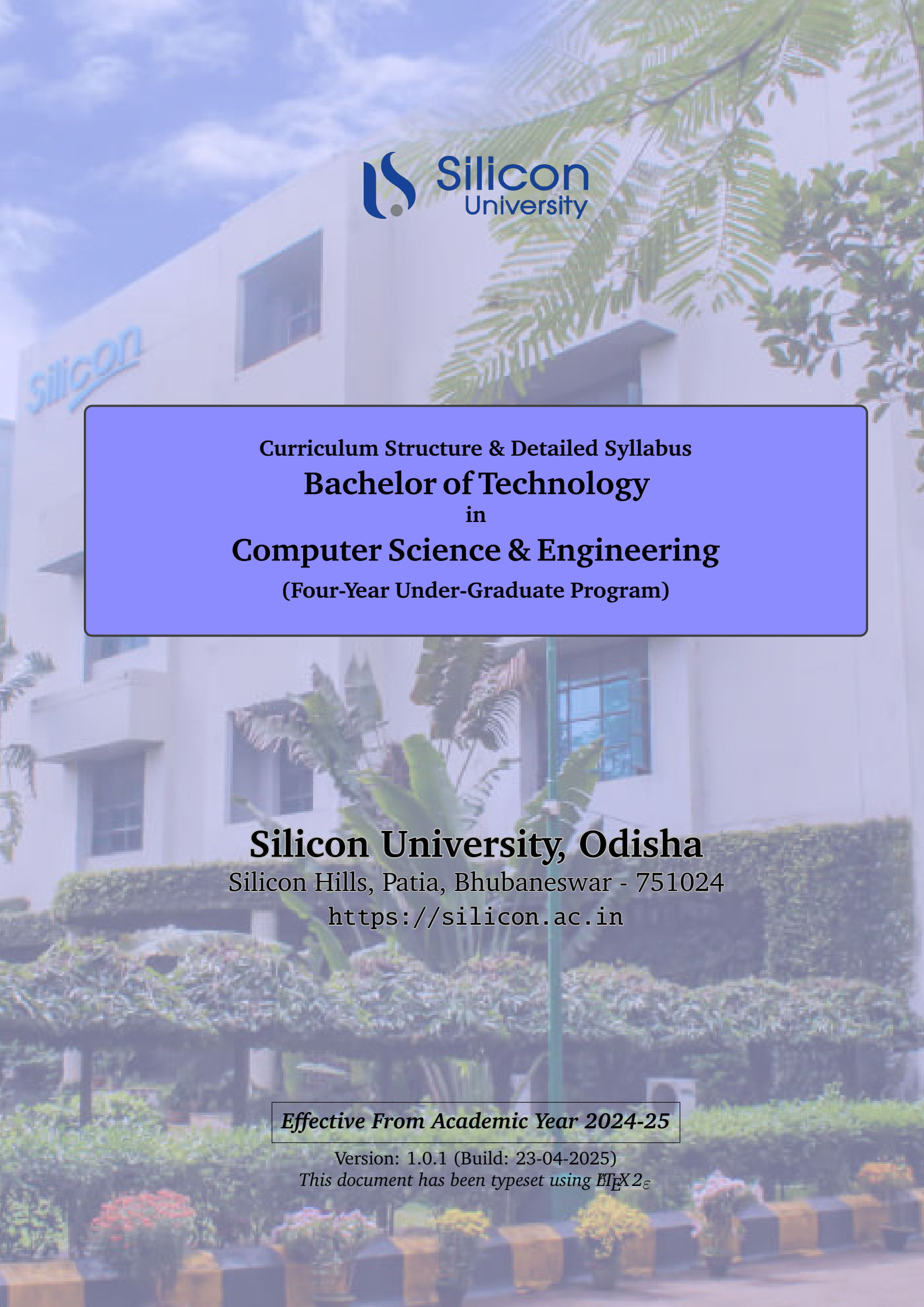

Curriculum Structure & Detailed Syllabus

# Bachelor of Technology

in

# Computer Science & Engineering

(Four-Year Under-Graduate Program)


## Silicon University, Odisha

Silicon Hills, Patia, Bhubaneswar - 751024

https://silicon.ac.in


***Effective From Academic Year 2024-25***


Version: 1.0.1 (Build: 23-04-2025)

*This document has been typeset using LaTeX 2ε*

# Approval History

| ACM# | Date | Resolutions |
|---|---|---|
| SU-1 | 27/04/2024 | The curriculum structure of B. Tech. (CSE) was approved in principle by the Academic Council. |
| SU-2 | 17/08/2024 | The curriculum structure of B. Tech. (CSE) and the 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. (CSE) 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 develop efficient software solutions to problems of varying complexity related to algorithms, system software, multimedia, web applications, data processing, and networking by applying fundamental concepts of computer science.

PSO2. Develop the skills in different computer languages, environments, tools & platforms to become a successful software professional or entrepreneur, develop a zest for innovation & higher studies, and contribute as a responsible citizen with effective communication, strong moral values and professional ethics.

PSO3. Adapt to the evolutionary changes in computing and embrace modern practices of software development to deliver user-friendly expert systems with for business success in the real world to meet the challenges of the future.

## Program Educational Objectives (PEOs)

PEO1. *Fundamental Knowledge & Core Competence*: To apply fundamental knowledge of mathematics, science and engineering required for a successful computer professional and inculcate competent problem solving ability using efficient algorithms.

PEO2. *Proficiency for the Real World*: To foster the skills and creative ability to analyze, design, test and implement cost effective software applications and digital support systems for the changing 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 |

# Contents

# 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.(CSE)

| Semester III | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| PCR | MT2001 | Discrete Mathematics | 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 | CS2002 | Design & Analysis of Algorithms | 3 | 1 | 0 | 3 | 1 | 0 |
| PCR | CS2003 | Operating Systems | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | EC2001 | Digital Electronics | 3 | 0 | 0 | 3 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| UCR | CS2004 | OOP Using Java Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | CS2005 | Design & Analysis of Algorithms Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | EC2002 | Operating Systems Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | CS2006 | Digital Electronics Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| INT | IP2001 | Summer Internship - I | 0 | 0 | 0 | 0 | 0 | 1 |
| | | ***TOTAL*** | **27** | | | **24** | | |

| Semester IV | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| PCR | MT2002 | Optimization Techniques | 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 | CS2008 | Computer Organization & Architecture | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | CS2009 | Database Management Systems | 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 | CS2011 | Database Management Systems Lab | 0 | 0 | 4 | 0 | 0 | 2 |
| PCR | CS2012 | Computer Organization & Architecture Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | CS2013 | Internet & Web Technology Lab | 0 | 0 | 4 | 0 | 0 | 2 |
| | | ***TOTAL*** | **31** | | | **25** | | |
| | | ***TOTAL (with Honours/Minor)*** | **32** | | | **27** | | |

# 3rd Year B.Tech.(CSE)

| Semester V | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| PCR | | Computer Networks | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | | Machine Learning | 3 | 1 | 0 | 3 | 1 | 0 |
| PCR | | Software Engineering | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | | Formal Languages & Automata Theory | 3 | 0 | 0 | 3 | 0 | 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 | | Computer Networks Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | | Machine Learning Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | | Software Engineering Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| SEC | | Soft Skills & Inter-Personal Skills | 0 | 0 | 2 | 0 | 0 | 1 |
| INT | | Summer Internship - II | 0 | 0 | 0 | 0 | 0 | 1 |
| | | ***TOTAL*** | **27** | | | **24** | | |
| | | ***TOTAL (with Honours/Minor)*** | **30** | | | **27** | | |

| Semester VI | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category** | **Code** | **Course Title** | **WCH** L-T-P | | | **Credits** L-T-P | | |
| **THEORY** | | | | | | | | |
| PCR | | Internet of Things | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | | Soft Computing | 3 | 0 | 0 | 3 | 0 | 0 |
| PCR | | Compiler Design | 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 | | Internet of Things Lab | 0 | 0 | 2 | 0 | 0 | 1 |
| PCR | | Soft Computing 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.(CSE)

## (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*** | **201** | **160** |
| | | ***GRAND TOTAL (with Honours/Minor)*** | **221** | **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.(CSE)

## (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*** | **180** | **160** |
| | | ***GRAND TOTAL (with Honours/Minor)*** | **198** | **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.(CSE)

## (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*** | **180** | **160** |
| | | ***GRAND TOTAL (with Honours/Minor)*** | **198** | **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*** | |
| CS2014 | Artificial Intelligence |
| CS2015 | Computer Graphics |
| CS2016 | Advanced Java Programming |
| ***Program Elective - II*** | |
| | Data Mining & Data Warehousing |
| | Cloud Computing |
| | System Programming |
| ***Program Elective - III*** | |
| | Big Data Analytics |
| | Realtime Systems |
| | Distributed Databases |
| ***Program Elective - IV*** | |
| | Natural Language Processing |
| | Wireless Sensor Networks |
| | Mobile Application Development |
| ***Program Elective - V*** | |
| | Data Visualization & Reporting |
| | Mobile Computing |
| | Cryptography & Network Security |
| ***Program Elective - VI*** | |
| | Bioinformatics Algorithms |
| | Embedded Systems |
| | Blockchain Technology |
| ***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 Computer Science & Engineering*** | |
| MT2003 | Statistical Inference |
| | Time Series Analysis |
| | Deep Learning |
| | Generative AI |
| | Nature Inspired Computing |
| ***Minor in "VLSI System Design & Verification"*** | |
| EC2013 | Semiconductor Devices |
| | Digital VLSI Design |
| | IC Fabrication Technology |
| | Digital IC Design & Verification |
| | Analog VLSI Design |
| ***Minor in "Smart Energy Systems"*** | |
| EE2010 | Circuit Theory |
| | Renewable Energy Systems |
| | Basics of Power Systems |
| | Smart Power Systems |
| | Electric & Hybrid Vehicles |
| ***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 | 1 | 1 |
| CO2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 2 | 1 |
| CO3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | | | 1 | 1 | 2 | 1 |
| CO4 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 2 | 1 |

| 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.

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**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 | 1 | 2 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 3 | 1 | | | | | 2 | 1 | 2 | 1 |
| 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 | 3 |
| CO2 | 3 | 3 | 3 | 2 | | | | | | | 2 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 1 | 2 | | | | | | | 2 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 1 | 2 | | | | | | | 2 | 3 | 2 | 3 |
| 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 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 2 | 2 | | | | | 1 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | | | | | 1 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | | | | | 1 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 2 | | | | | 1 | 3 | 2 | 3 |

| 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 | | | | | | | | | 1 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 1 | | | | | | | | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 1 | | | | | | | | 2 | 2 | 2 |
| CO4 | 2 | 2 | 3 | | | | | | | | | 2 | 2 | 1 |

| 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 | 2 | | | 2 | | 1 | | 1 | 1 | 1 | 1 | | 1 | 1 |
| CO2 | 3 | | | 2 | | 1 | | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| CO3 | 1 | | | 3 | | 2 | | 2 | 1 | 1 | 1 | | 1 | 2 |
| CO4 | 1 | | | 2 | | 2 | | 1 | 1 | 2 | 2 | | 1 | 1 |
| CO5 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| 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 | 3 | 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 | 3 | 2 | 2 |

| 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. |

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| | |
|---|---|
| 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 |
| CO2 | 2 | 2 | 2 | 1 | 2 | | | | 2 | 1 | 1 | | | 1 |
| CO3 | 2 | 2 | 3 | 1 | 2 | | | | 2 | 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 | 3 | 2 | 3 |
| CO2 | 2 | 2 | 3 | 2 | 1 | 1 | | | | | 1 | 3 | 2 | 3 |
| CO3 | 2 | 2 | 3 | 2 | 1 | 1 | | | | | 1 | 3 | 2 | 3 |
| CO4 | 2 | 2 | 2 | 3 | 1 | 1 | | | | | 1 | 3 | 2 | 3 |
| CO5 | 2 | 2 | 3 | 3 | 1 | 1 | | | | | 1 | 3 | 2 | 3 |

| 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 | Discrete Mathematics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | MT2001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to gain mathematical maturity to handle logical & abstract processes, discrete structures including graph which are essential for solving various problems in computer science. |
| **Pre-Requisites** | Knowledge of Sets, basics of number systems, 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** | Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Proof Strategies. | **9 Hours** |
| **Module-2** | Mathematical induction, basics of counting, Pigeonhole principle, Relations and their properties, N-ary Relations & their applications, Representing relations, Closure of relations, Equivalence relations, Partial ordering and Lattice. | **9 Hours** |
| **Module-3** | Introduction to Graphs, Graph terminology, Representation of graphs & graph isomorphism, Connectivity, Euler & Hamilton paths, Planar graph & Graph colouring, Trees, Spanning trees. | **9 Hours** |
| **Module-4** | Generalized permutation and combinations, Recurrence Relations, solving linear Recurrence Relations, Generating functions, Inclusion and Exclusion with applications. | **7 Hours** |
| **Module-5** | Semigroup, Monoid, Groups, Subgroups, Cosets and Lagrange's theorem, Codes and group codes, Rings, Integral Domains & Fields. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. K. H. Rosen, ***Discrete Mathematics and Its Applications***, 6th *Ed.*, Tata McGraw-Hill, 2008.
T2. C. L. Liu, ***Elements of Discrete Mathematics***, 2nd *Ed.*, Tata McGraw-Hill, 2008.

**Reference Books**:

R1. J. P. Tremblay and R. Manohar, ***Discrete Mathematical Structures with Applications to Computer Science***, 1st *Ed.*, McGraw-Hill Education, 2017.
R2. J. R. Mott, A. Kandel, and T. P. Baker, ***Discrete Mathematics for Computer Scientists and Mathematicians***, 2nd *Ed.*, Pearson Education, 2015.

**Online Resources**:

1. https://nptel.ac.in/courses/106104573: by Prof. N. Saxena, IIT Kanpur
2. https://nptel.ac.in/courses/106106183: by Dr. A. Shukla and Prof. S. Iyengar, IIT Ropar
3. https://nptel.ac.in/courses/106108227: by Prof. A. Choudhury, IIIT Bangalore
4. https://nptel.ac.in/courses/106103205: by Prof. B. George and Prof. S. Gopalan, IIT Guwahati
5. https://nptel.ac.in/courses/106106094: by Prof. K. Krithivasan, IIT Madras
6. https://nptel.ac.in/courses/111106086: by Prof. S. Chakraborty, Chennai Mathematical Institute

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

| | |
|---|---|
| CO1 | Apply logic for logical inferences in real life problems. |
| CO2 | Understand and apply the concepts of relation and lattice. |
| CO3 | Apply graph theory to real-life problems of computer science & engineering. |
| CO4 | Apply principle of inclusion & exclusion, generating functions and recurrence relations to solve counting problems. |
| CO5 | Differentiate the discrete algebraic structures and apply them to study group codes. |

**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). |
| 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 | 3 | 3 | 2 | 2 | 2 | | | | | 1 | 1 | 2 | 1 | 1 |
| CO2 | 3 | 2 | 2 | 2 | 1 | | | | | | | 2 | 1 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | | | | | 3 | 1 | 2 | 1 | 1 |
| CO4 | 3 | 2 | 3 | 2 | 2 | | | | | 2 | | 2 | 1 | 1 |
| CO5 | 2 | 2 | 2 | 2 | 2 | | | | | | | 2 | 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 | Design & Analysis of Algorithms | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | CS2002 | | 3-1-0 | 4 | 100 |

| | |
|---|---|
| **Objectives** | The objectives of this course is to introduce the techniques for designing efficient algorithms, apply them to solve problems, and analyze their complexities for application in different domains of computer science. |
| **Pre-Requisites** | Knowledge of Discrete Mathematics and Data Structures is essential. |
| **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, Definition, Characteristics of algorithm, Growth of functions, Asymptotic analysis, Standard asymptotic notations and common functions, Recurrences, Solution of recurrences by iterative, Recursion tree, Substitution and Master method; Algorithm design techniques, Divide and conquer strategy for designing algorithms, Obtaining best, average, and worst-case running time of merge sort, quick sort and randomized quick sort. | **12 Hours** |
| **Module-2** | Heaps, Building a Heap, The heap sort algorithm, Priority Queue with their analysis; Lower bound of sorting algorithms; Dynamic Programming, Elements of dynamic programming, Matrix chain multiplication, Longest Common Subsequence, String matching algorithms (Naive, Rabin-Karp, Knuth Morris-Pratt algorithm). | **10 Hours** |
| **Module-3** | Greedy algorithms, Elements of Greedy strategy, Activity selection problem, Fractional Knapsack problem along with correctness proof, Huffman codes; Backtracking and Branch & Bound techniques (n-Queen, Knapsack, and Travelling Salesman problem); Data structure for disjoint sets, Disjoint set operations, Linked list representation, Path compression, Disjoint set forest. | **12 Hours** |
| **Module-4** | Graph algorithms and their characteristics, Breadth-first and Depth-first search, Minimum spanning trees, Kruskal and Prim's algorithms, Single source shortest path algorithms(Bellman-Ford, Dijkstra), All-pair shortest path algorithm (Floyd-Warshall) with their analysis. | **10 Hours** |
| **Module-5** | Maximum flow problem, Ford-Fulkerson algorithm and its analysis; NP completeness (Polynomial time, Polynomial time verification, NP completeness and reducibility), Cook's Theorem (without proof), Examples of NP complete problems (without proof)- Circuit satisfiability, 3-CNF satisfiability, Clique, Vertex cover, Ham-cycle, TSP (without proof); Approximation algorithm characteristics, Travelling Salesman Problem, Randomized algorithms (Max 3-CNF satisfiability). | **12 Hours** |
| | **Total** | **56 Hours** |

**Text Books**:

T1. T. H.Cormen, C.E.Leiserson, R. L. Rivest, and C. Stein, ***Introduction to Algorithms***, 4th *Ed.*, PHI Learning, 2021.

T2. E. Horowitz, S.Sahni, and S. Rajasekaran, ***Fundamentals of Computer Algorithms***, 2nd *Ed.*, University Press, 2015.

T3. J. Kleinberg and É. Tardos, ***Algorithm Design***, 1st *Ed.*, Pearson Education, 2013.

**Reference Books**:

R1. M. T. Goodrich and R. Tamassia, ***Algorithm Design: Foundations, Analysis, and Internet Examples***, 1st *Ed.*, John Wiley & Sons, 2001.
R2. U. Manber, ***Introduction to Algorithms: A Creative Approach***, 1st *Ed.*, Addison-Wesley, 1989.
R3. S. Sridhar, ***Design and Analysis of Algorithms***, 1st *Ed.*, Oxford University Press, 2014.
R4. G. Sharma, ***Design & Analysis of Algorithms***, 4th *Ed.*, Khanna Publishers, 2019.

**Online Resources**:

1. https://nptel.ac.in/courses/106106131: by Prof. M. Mukund, Chennai Mathematical Institute
2. https://nptel.ac.in/courses/106101060: by Prof. Ranade, Diwan, and Viswanathan, IIT Bombay
3. https://nptel.ac.in/courses/106105164: by Prof. S. Mukhopadhyay, IIT Kharagpur
4. https://web.stanford.edu/class/archive/cs/cs161/cs161.1138/
5. https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/

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

| | |
|---|---|
| CO1 | Design algorithms, analyze their running time for best, worst, and average-cases, and understand divide & conquer strategy considering quick sort and merge sort as examples. |
| CO2 | Compare Heapsort with other comparison based sorting algorithms and develop dynamic programming algorithms. |
| CO3 | Apply disjoint-set data structure and various algorithm design techniques such as greedy, backtracking, and branch-and-bound in real life problems. |
| CO4 | Model a given engineering problem using graphs and design the corresponding algorithms to solve the problem. |
| CO5 | Compare various pattern matching algorithms, understand NP-Completeness and the need of approximation & randomized 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). |

*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 | 3 | 2 | 3 | 2 | | | | | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 3 | 2 | | | | | 2 | 3 | | |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | | 1 |
| CO5 | 3 | 3 | 1 | 2 | 2 | 1 | | | | | 2 | 2 | | 2 |

| Category | Code | Operating Systems | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | 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 | Digital Electronics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2001 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to introduce the concepts & techniques associated with digital electronic systems and their design & simulation using HDL. |
| **Pre-Requisites** | Knowledge of Basic Electronics 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** | Number System: Number System (binary, octal, decimal, hexadecimal) and their Conversion, Arithmetic Operation using 1's and 2's complements; Codes: Binary codes and Their application - BCD Code, Excess-3 Code, 2-4-2-1 Code, 8-4-(-2)-(-1) code and Gray code; Logic Gates: Basic Logic Gates, Universal Logic Gates, Function Realization using basic and universal logic gates, Examples of Logic Gate ICs. | **8 Hours** |
| **Module-2** | Combinational Logic Design: Boolean Algebra and Identities, Algebraic Reduction; Sum of Product and Product of Sum forms, Canonical SOP and POS forms, K-Map (Up to 4-variable); Combinational Logic Design: Code Converter, MSI devices like Half and Full Adders, Subtractors, Comparators, Multiplexers, De-Multiplexors, Encoder, Decoder. | **9 Hours** |
| **Module-3** | Sequential Logic Design: Flip flops - S-R, D, JK & T Flip Flops. Master-Slave JK FF, Edge triggered FF, Flip Flop Conversion; Synchronous Counters: (Up counter, Down Counter, Up-Down Counter, Mod-N Counters & Random Sequence Counter); Asynchronous Counter: (Up & Down using positive and negative edge trigger Flip Flop) Mod-N Asynchronous counter. | **9 Hours** |
| **Module-4** | Shift registers: SISO, SIPO, PIPO & PISO, Bi-directional shift register, Ring Counter, Johnson Ring Counter; Finite State Machines: Mealy and Moore models - State Diagram, State Table, FSM Design using Melay based model, FSM Design using Moore based model, Sequence detector (Melay based), Sequence detector (Moore based). | **8 Hours** |
| **Module-5** | Verilog HDL: Introduction to Verilog HDL, different modeling styles in Verilog - Data flow, Behavioral, Gate level and Structural modeling, Data types, Synthesis and simulation, Verilog design codes for combinational and sequential circuits, Verilog test bench for design simulation. | **8 Hours** |
| | **Total** | **42 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. L. K. John and C. H. Roth Jr., ***Digital System Design using VHDL***, 2nd *Ed.*, Cengage Learning, 2012.

P.T.O

**Reference Books**:

R1. D. V. Hall, ***Digital Circuits and Systems***, International Student Edition, McGraw-Hill Education, 1989.
R2. A. A. Kumar, ***Fundamentals of Digital Circuits***, 3rd *Ed.*, PHI Learning, 2014.
R3. R. P. Jain, ***Modern Digital Electronics***, 4th *Ed.*, McGraw-Hill Education, 2009.

**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 | Explain various number systems, codes and Logic gates. |
| CO2 | Design and analyze combinational logic circuits. |
| CO3 | Design and analyze various sequential logic circuits and explain counter design. |
| CO4 | Implement memory array using sequential logic and explain FSM for digital circuit design. |
| CO5 | Simulate and synthesize digital circuits using Verilog HDL and explore open source 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) |

**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 | 3 | | | | | | 2 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 3 | | | | | | 2 | 2 | 2 | 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 | Design & Analysis of Algorithms Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | CS2005 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to design and implement efficient algorithms for a specified application. |
| **Pre-Requisites** | Knowledge of Discrete Mathematics and Data Structures are essential. |
| **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 | Linear & Binary Search. |
| 2 | Conversion of infix to postfix expression using Stack. |
| 3 | Sorting: Selection, Bubble and Insertion Sort. |
| 4 | Sorting: Quick Sort and Merge Sort. |
| 5 | Sorting: Heap Sort. |
| 6 | Matrix Chain Multiplication. |
| 7 | Longest Common Subsequence. |
| 8 | Fractional and 0/1 Knapsack problem. |
| 9 | n-Queen problem. |
| 10 | Graph Traversal using BFS/DFS. |
| 11 | Dijkstra's single source shortest path algorithm. |
| 12 | Warshall's all pair shortest path algorithm. |
| 13 | Kruskal's/Prim's algorithm for Minimum Spanning Tree. |
| 14 | Naïve and Rabin-Karp string matching algorithm. |

**Text Books**:


T1. T. H.Cormen, C.E.Leiserson, R. L.Rivest, and C. Stein, ***Introduction to Algorithms***, 4th *Ed.*, PHI Learning, 2021.

T2. E. Horowitz, S.Sahni, and S.Rajasekaran, ***Fundamentals of Computer Algorithms***, 2nd *Ed.*, University Press, 2015.

T3. J. Kleinberg and É. Tardos, ***Algorithm Design***, 1st *Ed.*, Pearson Education, 2013.


**Reference Books**:


R1. M. T. Goodrich and R. Tamassia, ***Algorithm Design: Foundations, Analysis, and Internet Examples***, 1st *Ed.*, John Wiley & Sons, 2001.

R2. U. Manber, ***Introduction to Algorithms: A Creative Approach***, 1st *Ed.*, Addison-Wesley, 1989.

R3. S. Sridhar, ***Design and Analysis of Algorithms***, 1st *Ed.*, Oxford University Press, 2014.

R4. G. Sharma, ***Design & Analysis of Algorithms***, 4th *Ed.*, Khanna Publishers, 2019.


**Online Resources**:

1. https://nptel.ac.in/courses/106106131: by Prof. M. Mukund, Chennai Mathematical Institute
2. https://nptel.ac.in/courses/106101060: by Prof. Ranade, Diwan, and Viswanathan, IIT Bombay
3. https://nptel.ac.in/courses/106105164: by Prof. S. Mukhopadhyay, IIT Kharagpur

4. https://web.stanford.edu/class/archive/cs/cs161/cs161.1138/
5. https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/

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

| | |
|---|---|
| CO1 | Implement various searching and sorting algorithms and compare their execution time. |
| CO2 | Understand and develop skill to solve problems using divide and conquer strategy. |
| CO3 | Apply greedy, dynamic programming, backtracking and branch and bound paradigms to solve real life problems. |
| CO4 | Formulate engineering problems and solve them using graph algorithms. |
| CO5 | Implement and compare various pattern matching algorithms such as Naïve, Rabin-Karp 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). |
| 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 | 1 | 2 | 2 | 2 | | | | | 2 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 3 | 3 | 2 | 2 | | | | | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | | | | | 3 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | | | | | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 1 | | | | | 2 | 3 | 2 | 2 |

| Category | Code | Digital Electronics Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | EC2002 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of the course is to provide hands-on exposure on logic gates, its implementation using Boolean algebra, designing digital circuits like counters, registers and simulating the 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, with focus on implementation using 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 and Buffer gates, use of Universal (NAND & NOR) Gates. |
| 2 | Gate-level minimization: Two level and multi level implementation of Boolean functions. |
| 3 | Design, implement and test a given design example with: (a) NAND Gates only, (b) NOR Gates only, and (c) Using minimum number of Gates. |
| 4 | Combinational Circuits: Design, assemble and test: adders and subtractors, Code Converters, gray code to binary and 7-segment display. |
| 5 | Study of Multiplexer, Demultiplexer. Implement a function using a multiplexer. |
| 6 | Flip-Flop: assemble, test and investigate operation of SR, D, J-K & T flip-flops. |
| 7 | Shift Registers: Design and investigate the operation of all types of shift registers. |
| 8 | Counters: Design, assemble and test various ripple and synchronous counters. |
| 9 | Verilog/VHDL simulation and implementation of logic gates. |
| 10 | Verilog/VHDL simulation and implementation of different combinational circuits in dataflow and behavioral modeling. |
| 11 | Memory Unit: Investigate behaviour of RAM and its storage capacity – 16 $\times$ 4 RAM: testing, simulating and memory expansion. |
| 12 | Clock-pulse generator: design, implement and test. |
| 13 | Binary Multiplier: design and implement a circuit that multiplies 4-bit unsigned numbers to produce a 8-bit product. |

**Text Books**:

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

**Reference Books**:

R1. A. M. Michelén, ***Digital Electronics Laboratory Manual***, Prentice Hall, 2000.
R2. J. W. Stewart, C. -Y. Wang, ***Digital Electronics Laboratory Experiments*** (Using the Xilinx XC95108 CPLD with Xilinx Foundation: Design and Simulation Software), Prentice Hall, 2001.

**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://de-iitr.vlabs.ac.in/

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

| | |
|---|---|
| CO1 | Analyze the function of logic gates and implementation of Boolean functions. |
| CO2 | Design and analyze different combinational circuits. |
| CO3 | Design various asynchronous and synchronous sequential circuits. |
| CO4 | Acquire knowledge about internal circuitry and logic behind digital systems. |
| CO5 | Simulate various digital circuits using Verilog/VHDL & 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). |
| 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 | 2 | | | | | | 1 | 2 | 2 | |
| CO2 | 2 | 3 | 3 | 2 | 3 | | | | | | 1 | 3 | 3 | |
| CO3 | 2 | 3 | 2 | 3 | 3 | | | | | | 2 | 3 | 2 | 1 |
| CO4 | 2 | 2 | 2 | 3 | 2 | | | | | | 1 | 2 | 3 | 1 |
| CO5 | 2 | 3 | 2 | 3 | 3 | | | | | | 2 | 2 | 2 | 1 |

| Category | Code | Operating Systems Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | CS2006 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this laboratory course is to learn operating system level programming and provide a hands-on exposure on implementation of various algorithms of the operating system. |
| **Pre-Requisites** | Knowledge of programming, data structures, and concepts of operating systems taught in the theory class 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 | Introduction to Linux OS and basic VI editor commands. |
| 2 | Linux File Structure and advance Linux commands like `grep`, `pipe`, `cut`, etc. |
| 3 | Introduction to UNIX Shell Script: Arithmetic Expressions, Relational and Conditional Operators. |
| 4 | UNIX Shell Script: Looping, Switch Cases. |
| 5 | Process Creation, process handing, process signaling through `fork()`, `exec()`. |
| 6 | CPU Scheduling (Non-Pre-emptive) FCFS, SJF, Priority. |
| 7 | CPU Scheduling (Pre-emptive) SRTF, RR, Priority-based preemptive. |
| 8 | Multi-Threaded application using POSIX threads. |
| 9 | Synchronization using Semaphore (Producer- Consumer, Reader-Writer). |
| 10 | Message passing : Pipe and Signals. |
| 11 | Inter-process communication using shared memory. |
| 12 | Deadlock implementation: Banker's Algorithm. |
| 13 | Implementing Page Replacement Algorithms. |
| 14 | Implementing Disk scheduling Algorithms. |

**Text Books**:

T1. V. Mukhi, ***The C Odyssey: UNIX***, 1st *Ed.*, BPB Publications, 1992.
T2. A. Silberschatz, P. B. Galvin, and G. Gagne, ***Operating System Concepts***, 8th *Ed.*, Wiley, 2009.

**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://www.technicalsymposium.com/sharelabcodings_os.html
2. https://www.cse.iitb.ac.in/~mythili/teaching/cs347_autumn2016/index.html

P.T.O

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

| | |
|---|---|
| CO1 | Become conversant with various Linux commands and their specific uses. |
| CO2 | Write, debug, and execute UNIX shell scripts for a given problem. |
| CO3 | Implement various scheduling algorithms used at the operating system level. |
| CO4 | Write programs for creation of child processes and communication among them. |
| CO5 | Develop and implement deadlock avoidance and detection 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). |
| 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 | 3 | 2 | | 1 | | | | | 2 | | | 1 |
| CO2 | 3 | 2 | 3 | 2 | | 1 | | | | | 2 | 2 | | |
| CO3 | 2 | 2 | 3 | 2 | | 1 | | | | | 2 | 2 | | 1 |
| CO4 | 2 | 2 | 2 | 3 | | 1 | | | | | 2 | 2 | | |
| CO5 | 2 | 3 | 3 | 3 | | 1 | | | | | 2 | 2 | | 1 |

| Category | Code | Optimization Techniques | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | MT2002 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to provide a good exposure to linear and non-linear programming with several standard numerical methods, and the right kind of tools to solve large scale optimization problems in engineering. |
| **Pre-Requisites** | Knowledge of calculus of several variables, coordinate geometry of two and 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** | Linear Programming: Graphical Method, Simplex Method, Big-M Method, Alternate Optima, Redundancy & Degeneracy. | **8 Hours** |
| **Module-2** | Simplex Method Algorithm, Dual Problem, Construction of Dual, Duality Theorem (without proof), Dual Simplex method, Post Optimal analysis. | **8 Hours** |
| **Module-3** | Integer Linear Programming: Branch & Bound Method, Gradient of a Function, Matrix differentiation, Multi Variable Unconstrained Optimization and its relationship to Taylor's Series, Convex Function, Convex Programming Problem. | **9 Hours** |
| **Module-4** | Quadratic Programming, Wolfe's method for QPP, Optimality Conditions, Lagrangian & Lagrange Multipliers, KKT Necessary/sufficient optimality conditions, Unconstrained optimization - Line search methods for uni-modal functions, Steepest Descent method, Newton's method. | **9 Hours** |
| **Module-5** | Constrained Optimization: Frank Wolfe's Method, Rosen's Gradient Projection Method, Penalty Function Method. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:


T1. S. Chandra, Jayadeva, and A. Mehera, ***Numerical Optimization with Applications***, 1st *Ed.*, Narosa Publishing House, 2013.

T2. A. Ravindran, D. Phillips, and J. J. Solberg, ***Operations Research: Principle and Practice***, 2nd *Ed.*, Wiley India,2010.


**Reference Books**:


R1. D. G. Luenberger and Y. Ye, ***Linear & Nonlinear Programming***, 3rd *Ed.*, Springer, 2008.

R2. S. S. Rao, ***Engineering Optimization***, 4th *Ed.*, New Age Publishers, 2009.

R3. K. Dev, ***Optimization for Engineering Design***, 2nd *Ed.*, Prentice Hall India, 2012.


**Online Resources**:

1. https://nptel.ac.in/courses/106108056: by Dr. S. K. Shevade, IISc Bangalore
2. https://nptel.ac.in/courses/111105100: by Prof. Goswami and Chakraborty, IIT Kharagpur
3. https://nptel.ac.in/courses/112101298: by Prof. A. A. Kulkarni, IIT Bombay
4. https://nptel.ac.in/courses/106106245: by Prof. P. Biyani, IIT Delhi

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

| | |
|---|---|
| CO1 | Solve linear programming problems using graphical and simplex methods. |
| CO2 | Apply duality concepts solve optimization problems and perform post-optimal analysis. |
| CO3 | Solve integer programming and quadratic programming problems. |
| CO4 | Explain and solve non-linear programming and unconstrained optimization problems. |
| CO5 | Solve constrained optimization problems in engineering using appropriate 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). |
| 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 | 3 | 3 | 2 | 3 | 3 | | | | | 1 | | 2 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | | | | | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 2 | 1 | 1 | 2 | | | | | 1 | | 2 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 3 | | | | | 1 | | 2 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 3 | | | | | 1 | | 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 | Computer Organization & Architecture | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | CS2008 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to familiarize students about hardware design including logic design, basic structure and behaviour of the various functional modules of a modern digital computer and how they interact to provide the processing power to fulfil the needs of the user. |
| **Pre-Requisites** | Knowledge of basic digital electronics and computer fundamentals 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 Structures of Computers**: Computer Architecture vs. Computer Organization, Functional units, Operational concepts, Registers, Bus Structure, Performance Consideration, SPEC rating. | **8 Hours** |
| **Module-2** | **Memory Location & Addresses**: Big-endian and Little-endian representation, Instruction format, Instruction set Architecture, RISC vs. CISC, Addressing modes, Instruction Sequencing, Subroutines. | **8 Hours** |
| **Module-3** | **Binary Arithmetic**: Addition and subtraction of signed numbers, Design of fast adders, Multiplication of positive numbers, Signed operand multiplication, Fast multiplication, Integer division, Representation of floating point numbers. | **8 Hours** |
| **Module-4** | **Memory System**: Basic Concepts, Speed, Size and cost, Cache memory concepts, Cache memory mapping techniques, Performance consideration; Virtual memory concepts, Translation look-aside buffer, Replacement techniques, Secondary Storage. | **10 Hours** |
| **Module-5** | **Basic Processing Units**: Fundamental concepts, Execution cycle, Single-Bus and Multi-Bus Organization, Execution of complete instruction, Hardwired control, Micro programmed control, Accessing I/O devices. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. C. Hamacher, Z. Vranesic, and S. Zaky, ***Computer Organization***, 5th *Ed.*, McGraw-Hill, 2017.
T2. W. Stallings, ***Computer Organization and Architecture***, 9th *Ed.*, Prentice Hall India, 2012.

**Reference Books**:

R1. M. M. Mano, ***Computer System Architecture***, 3rd *Ed.*, Pearson Education, 2007.
R2. B. Govindarajalu, ***Computer Architecture and Organization***, 5th *Ed.*, Tata McGraw-Hill, 2004.
R3. N. P. Carter, ***Schaum's Outline of Computer Architecture***, McGraw-Hill Education, 2002.

**Online Resources**:

1. https://nptel.ac.in/courses/106106166: by Prof. V. Kamakoti, IIT Madras
2. https://nptel.ac.in/courses/106104073: by Prof. B. Raman, IIT Kanpur
3. https://nptel.ac.in/courses/106103180: by Prof. J. K. Deka and Prof. A. Sarkar, IIT Guwahati
4. https://ocw.mit.edu/courses/6-823-computer-system-architecture-fall-2005/

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

| | |
|---|---|
| CO1 | Explain the architectural concepts of a digital computer, identify various functional units and describe their functionality. |
| CO2 | Understand various instruction formats, represent instructions in different formats, and solve problems using different addressing modes. |
| CO3 | Explore circuit arrangements for binary arithmetic, perform diverse arithmetic operations using various techniques, and work with floating-point representations and operations. |
| CO4 | Explain the working principle of Main memory, Cache memory and Virtual memory and solve numerical problems based on memory management. |
| CO5 | Describe the working mechanism of the control unit and compare the performance of hardwired and software approaches. |

**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 | 3 | 2 | 2 | 2 | | | | | | 1 | 2 | | 3 |
| CO2 | 3 | 3 | 2 | 2 | 3 | | | | | | 1 | 2 | 1 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | | | | | | 2 | 2 | 1 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | | | | | | 2 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 2 | 2 | | | | | | 1 | 1 | | 1 |

| Category | Code | Database Management Systems | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | CS2009 | | 3-1-0 | 4 | 100 |

| | |
|---|---|
| **Objectives** | The objective of the course is to understand the aspects of design, implementation, and operation of relational database systems, transaction processing, concurrency control, recovery, and some advanced database concepts. |
| **Pre-Requisites** | Basic knowledge of data structures and algorithms 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 and definitions, three-schema architecture, data independence, Concept of data models, types of data models, database languages, integrity, database users, Entity-Relationship model, Constraints & Keys, Extended Entity Relationship model, Relational model, Mapping of E-R model to relational schema, System structure of DBMS, Codd's 12 Rules. | **12 Hours** |
| **Module-2** | **Query Languages**: Relational Algebra, basic operations, join operations, grouping & aggregation, Relational Calculus; Query processing and optimization: Evaluation of relational algebra expressions, Heuristic-based Query optimization. | **11 Hours** |
| **Module-3** | **Database Design**: Functional dependencies, Armstrong axioms, Attribute closure, Equivalence sets of FD, Minimal cover; Normalization: Dependency & attribute preservation, lossless join; Normal Forms: 1NF, 2NF, 3NF, BCNF, Testing for lossless design, Multi-Valued Dependency (MVD), 4NF and 5NF. | **11 Hours** |
| **Module-4** | **Transaction Processing**: Basic concepts, ACID Properties, Serializability, Concurrency Control Schemes – lock-based & timestamp-based protocols, Deadlock handling, deadlock prevention, detection and recovery; Database Recovery: types of database failures, Recovery techniques - log-based recovery, checkpoints, shadow paging. | **12 Hours** |
| **Module-5** | **Storage Strategies**: Storage Architecture, File and Record Organization, Types of Indexes, B-Tree, B+ Tree, Index Files, Hashing, Data Dictionary; Distributed databases: Homogeneous vs. heterogeneous, Fragmentation & replication, Data transparency; Introduction to NoSQL: Properties, Columnar families, different NoSQL systems. | **10 Hours** |
| | **Total** | **56 Hours** |

**Text Books**:


T1. A. Silberschatz, H. F. Korth, and S. Sudarshan, ***Database System Concepts***, 6th *Ed.*, McGraw-Hill Education, 2013.
T2. R. Elmasri and S. B. Navathe, ***Fundamentals of Database Systems***, 7th *Ed.*, Pearson Education, 2016.
T3. P. J. Sadalage and M. Fowler, ***NoSQL Distilled***, 1st *Ed.*, Pearson Education, 2012.


**Reference Books**:


R1. R. Ramakrishnan and J. Gekhre, ***Database Management Systems***, 3rd *Ed.*, McGraw-Hill, 2003.
R2. R. P. Mahapatra and G. Verma, ***Database Management Systems***, 1st *Ed.*, Khanna Publishing, 2013.

R3. C. J. Date, ***Introduction to Database Systems***, 8th *Ed.*, Pearson Education, 2003.

**Online Resources**:

1. https://nptel.ac.in/courses/106104135/: by Dr. A. Bhattacharya, IIT Kanpur
2. https://nptel.ac.in/courses/106105175/: by Prof. P. P. Das et. al., IIT Kharagpur
3. https://cs145-fa18.github.io/: by Prof. S. Shivakumar
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-830-database-systems-fall-2010/lecture-notes/
5. https://docs.oracle.com/database/121/SQLRF/toc.htm

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

| | |
|---|---|
| CO1 | Understand the components of DBMS and create E-R model for real world applications. |
| CO2 | Construct queries using relational algebra and explain query processing & optimization. |
| CO3 | Design relational databases and normalize the designs using different normalization techniques. |
| CO4 | Resolve concurrency control issues and recover from database failures. |
| CO5 | Visualize storage structures, indexing techniques and explore distributed & NoSQL databases. |

**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 | 2 | 1 | | 2 | | | | | 1 | 2 | | 1 |
| CO2 | 3 | 3 | 3 | 2 | 1 | 1 | | | | | 1 | 2 | | 1 |
| CO3 | 3 | 3 | 3 | 2 | 1 | 2 | | | | | 2 | 2 | | 2 |
| CO4 | 2 | 3 | 3 | 2 | 1 | 1 | | | | | 1 | 1 | | 1 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 1 | | | | | 2 | 2 | | 2 |

| Category | Code | Artificial Intelligence | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PEL | CS2014 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of the course is to provide a strong foundation of fundamental concepts and goals, methods & techniques of Artificial Intelligence (AI) to build intelligent systems with perception, reasoning, and learning abilities. |
| **Pre-Requisites** | Knowledge of basic mathematics, algorithms & 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**: Definitions of AI, Four approaches to AI, Turing Test, Foundations of AI, Intelligent Agents: Definition, Agent function & programs, Rationality, Environment types, PEAS description, Structure of Agents; Types of Agent Programs, Problem Solving: Solving Problems by Searching - Problem-Solving Agents, Example Problems, State space search, Searching for Solutions, Uninformed Search Strategies: Breadth First, Depth First, Depth Limited, Iterative Deepening DFS, Uniform Cost, Bi-directional Searches. | **9 Hours** |
| **Module-2** | **Informed Search & Exploration**: Introduction, Evaluation & Heuristic functions, Informed Search Strategies: Greedy Best First Search, A* Search, Example Problems, Local Search Algorithms: Hill Climbing Search & Simulated Annealing, Example Problems, Constraint Satisfaction Problems: Introduction & types of CSPs, Backtracking Search for CSPs, Adversarial Search: Introduction, Game playing, Minimax & Alpha-Beta Pruning; Knowledge & Reasoning: Knowledge-Based Agents, Wumpus World problem. | **9 Hours** |
| **Module-3** | **Knowledge & Reasoning**: Logic, Propositional Logic, First-Order Logic: Syntax and Semantics of First Order Logic, Using First-Order Logic, Inference in First-Order Logic: Propositional vs. First-Order Logic, Resolution, Forward & Backward Chaining, Knowledge Representation: Ontological Engineering, Categories and Objects, Semantic Nets, Frames. | **8 Hours** |
| **Module-4** | **Planning**: The Planning Problem, Planning with State-Space Search, Example Problems, Partial Order Planning, Planning Graphs, Hierarchical Planning, Uncertain Knowledge & Reasoning: Acting under Uncertainty, Bayes Rule & it's use; Probabilistic Reasoning: Representing Knowledge in an Uncertain Domain, Semantics of Bayesian Networks. | **8 Hours** |
| **Module-5** | **Learning**: Introduction, Learning Agent, Paradigms of learning, Learning from Observations, Inductive Learning, Information Gain approach, Learning Decision Trees; Statistical Learning, Instance Based Learning, Neural Networks: Introduction, Perceptron, Reinforcement Learning, Expert Systems: Introduction & architecture. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. S. Russell and P. Norvig, ***Artificial Intelligence - A Modern Approach***, 3rd *Ed.*, Pearson Education, 2016.

T2. D. W. Patterson, ***Introduction to Artificial Intelligence & Expert Systems***, 1st *Ed.*, Pearson Education, 2015.

**Reference Books**:

R1. E. Rich, K. Knight, and S. B. Nair, ***Artificial Intelligence***, 3rd *Ed.*, McGraw Hill Education, 2009.
R2. G. F. Luger, ***Artificial Intelligence: Structures and Strategies for Complex Problem Solving***, 6th *Ed.*, Pearson Education, 2008.
R3. M. Negnevitsky, ***Artificial Intelligence: A Guide to Intelligent Systems***, 3rd *Ed.*, Addison Wesley, 2.
R4. N. J. Nilson, ***Principles of Artificial Intelligence***, Narosa Publishing, 2002.

**Online Resources**:

1. https://nptel.ac.in/courses/106102220/: by Prof. Mausam, IIT Delhi
2. https://nptel.ac.in/courses/106106140/: by Prof. D. Khemani, IIT Madras
3. https://nptel.ac.in/courses/106105079/: by Prof. P. Dasgupta, IIT Kharagpur
4. https://nptel.ac.in/courses/106105077/: by Prof. A. Basu and Prof. S. Sarkar, IIT Kharagpur

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

| | |
|---|---|
| CO1 | Explore agents, environments, and search goal state using uninformed techniques. |
| CO2 | Apply search techniques for game playing and solving constraint satisfaction problems. |
| CO3 | Interpret logic, inference rules for decision making, and represent knowledge by semantic nets. |
| CO4 | Apply planning and reasoning to handle uncertainty in real life problems. |
| CO5 | Use learning to solve complex real-life problems and design expert systems. |

**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 | 3 | 2 | | | | | | | 3 | 1 | | 2 |
| CO2 | 2 | 3 | 3 | 2 | | | | | | | 2 | 2 | 1 | 2 |
| CO3 | 3 | 3 | 3 | 2 | | | | | | | 2 | 2 | 1 | 2 |
| CO4 | 3 | 3 | 2 | 2 | | 1 | | | | | 2 | 2 | 1 | 2 |
| CO5 | 3 | 3 | 2 | 2 | | 2 | | | | | 3 | 2 | 1 | 2 |

| Category | Code | Computer Graphics | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PEL | CS2015 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study computer modeling of 2D & 3-D objects and efficiently generating photo-realistic renderings on color raster graphics devices. |
| **Pre-Requisites** | Knowledge of coordinate geometry and matrix operations is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as 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 of computer graphics, Basic terminologies in graphics, Lookup table, Plotters, Printers, Digitizers, Light pens, Active & passive graphics devices, Raster & random scan displays, CRT basics, Video basics. | **8 Hours** |
| **Module-2** | Output Primitives - Points, Lines, Circles and Ellipses as primitives, Scan conversion algorithms for primitives, Fill area primitives including scan-line polygon filling, Inside-outside test, Boundary and flood-fill, Character generation, Line attributes, Area-fill attributes, Character attributers. | **10 Hours** |
| **Module-3** | 2D and 3D Transformations (translation, rotation, scaling), Matrix representation, Homogeneous coordinates, Composite transformations, Reflection and shearing, Viewing pipeline and coordinates system, Window-to-viewport transformation, Clipping including point clipping, Line clipping (Cohen-Sutherland, Liang-Barsky), Polygon clipping. | **8 Hours** |
| **Module-4** | 3D display methods, Polygon surfaces, Tables, Equations, Meshes, Curved lines and surfaces, Quadric surfaces, Spline representation, Cubic spline interpolation methods, Bezier curves and surfaces, B-spline curves and surfaces, General (parallel and perspective) projection transformations, Fractal geometry. | **8 Hours** |
| **Module-5** | Visible surface detection concepts, Back-face detection, Depth buffer method, Illumination, Light sources, Illumination methods (ambient, diffuse reflection, specular reflection), Color models - properties of light, XYZ, RGB, YIQ and CMY color models, Animation (introduction only). | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. D. Hearn and P. Baker, ***Computer Graphics – C Version***, 2nd *Ed.*, Pearson Education, 2004.
T2. F. S. Hill, ***Computer Graphics using OpenGL***, 2nd *Ed.*, Pearson Education, 2003.

**Reference Books**:

R1. J. F. Huges, A. V. Dam, M. McGuire, D. F. Sklar, J. D. Foley, S. K. Feiner, and K. Akeley, ***Computer Graphics: Principles and Practice***, 3rd *Ed.*, Addison-Wesley Professional, 2013.
R2. D. Hearn, M. P. Baker and W. Caritthers, ***Computer Graphics with OpenGL***, 4th *Ed.*, Prentice Hall India, 2010.
R3. S. Harrington, ***Computer Graphics - A Programming Approach***, 2nd *Ed.*, Tata McGraw-Hill, 2004.

**Online Resources**:

1. http://nptel.ac.in/courses/106102065/: by Prof. P. K Kalra, IIT Delhi
2. https://nptel.ac.in/courses/106/106/106106090/: by Prof. S. Das, IIT Madras

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

| | |
|---|---|
| CO1 | Describe the basics of computer graphics and its applications. |
| CO2 | Explore the standard line, circle, and area filling algorithms. |
| CO3 | Design various transformation models in 2D and 3D spaces. |
| CO4 | Apply the design principles to generate curves and mapping using projection. |
| CO5 | Explore hidden lines and surface detection techniques with color models. |

**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 | 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 | Advanced Java Programming | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PEL | CS2016 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of the course is to learn advanced features of the Java programming language, various frameworks in J2EE for rapid development, and apply these to develop enterprise applications. |
| **Pre-Requisites** | Knowledge of object oriented programming using Java is required. |
| **Teaching Scheme** | Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on 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** | J2EE Environment: Overview of J2EE and J2SE, J2EE Architecture; JDBC: The Concept of JDBC, JDBC Driver Types, JDBC Packages, Database Connection, CRUD Operations using JDBC, Transaction Processing, Metadata; Web Applications and Programming: Web application architecture, Client, Server (Apache Tomcat/WebLogic), HTML5, CSS3; Client Side Programming: JavaScript, JQuery; Introduction to XML/JSON. | **8 Hours** |
| **Module-2** | Servlets: Introduction, Servlet Architecture, Environment Setup, Life Cycle, Form Data processing, Client HTTP Request, Server HTTP Response, HTTP Status Codes, Exception Handling; Advanced Features of Servlets: Handling Cookies, Session Tracking, URL rewriting, Database access, File uploading, Date handling, Page redirection, Sending email, Packaging, Debugging, Internationalization. | **8 Hours** |
| **Module-3** | Java Server Pages (JSP): Advantages of JSP over Servlet, Lifecycle of a JSP page, JSP API, Scriptlet tag, Implicit objects, Directives, Exception handling, Action tags, Expression Language (EL); Advanced Features of JSP: Session Tracking, MVC, JSTL, Custom Tags, CRUD operations; JSP Sample Code: Pagination, Registration Form, File Uploading. | **9 Hours** |
| **Module-4** | Maven: Introduction to Maven, Dependencies and Dependency Management, POM Structure; Spring Core: Introduction to Spring Framework, Inversion of Control and Dependency Injection, Configuring Beans in Spring, Autowiring, and Component Scanning. | **8 Hours** |
| **Module-5** | Spring MVC: Introduction to Spring MVC Framework, MVC Design Pattern, Configuring Spring MVC with XML and Java Configuration, Spring MVC Annotations, Form Handling and Data Binding; Spring JDBC Template: Introduction, Quires, Parameterized Queries and Named Parameter JDBC Template, CRUD Operations. | **9 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. J. Keogh, ***J2EE: The Complete Reference***, 11th *Ed.*, McGraw Hill, 2017.
T2. Kogent Learning Solutions, ***Java Server Programming: Java EE 7 (J2EE 1.7) Black Book***, 1st *Ed.*, DreamTech, 2014.

**Reference Books**:

R1. DT Editorial Services, ***J2EE 1.7 Projects Black Book***, 1st *Ed.*, DreamTech, 2015.
R2. Kogent Learning Solutions, ***Web Technologies: HTML, Javascript, PHP, Java, JSP, XML and Ajax, Black Book***, 2nd *Ed.*, DreamTech, 2009.
R3. C. Walls, ***Spring in Action***, 6th *Ed.*, Manning, 2022.

**Online Resources**:

1. https://docs.spring.io/spring-framework/reference/: Spring Reference
2. https://www.baeldung.com/spring-jdbc-jdbctemplate: by Eugen Paraschiv
3. https://www.javatpoint.com/spring-tutorial/: Spring Tutorials
4. https://www.javatpoint.com/spring-JdbcTemplate-tutorial/: JDBC Tutorials

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

| | |
|---|---|
| CO1 | Explain concepts of J2EE and fundamentals of web application development. |
| CO2 | Design & develop web applications using Servlet technologies. |
| CO3 | Design & develop web applications using JSP technologies. |
| CO4 | Understand dependency, dependency managers and set up J2EE applications. |
| CO5 | Create enterprise J2EE applications using Spring MVC and Spring JDBC. |

**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 | 2 | 3 | | | | | | 3 | 1 | | 2 |
| CO2 | 3 | 3 | 3 | 2 | 3 | | | | | | 2 | 2 | 1 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 3 | | | | | | 2 | 2 | 1 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | | | | | | 3 | 2 | 1 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | | | | | | 3 | 2 | 1 | 2 |

| Category | Code | Statistical Inference | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| HNS | MT2003 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is inculcate statistical thinking in designing data collection, derive insights from visualizing data, obtain supporting evidence for data-based decisions, and construct models for predicting & inferring future trends from statistical properties of data. |
| **Pre-Requisites** | Basic knowledge of probability & statistics 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** | Distributions Derived from the Normal Distribution: $\chi^2$, $t$, and $F$ distribution, Sample mean and sample variance; Survey Sampling: Population parameters, Sample random sampling - Expectation and variance of sample mean, Estimation of population variance, Normal approximation to the sampling distribution of $\bar{X}$, Estimation of a ratio. | **9 Hours** |
| **Module-2** | Estimation of Parameters & Fitting of Probability Distributions: Fitting the Poisson distribution, Parameter estimation (method of moments, maximum likelihood); Large sample theory for maximum likelihood estimates, Confidence intervals from maximum likelihood estimates, Bayesian approach to parameter estimation, Large sample normal approximation to the posterior, Computational aspects, Efficiency and the Camer-Rao lower bound, Negative binomial distribution, Sufficiency (Factorization & Rao-Blackwell theorem). | **9 Hours** |
| **Module-3** | Testing Hypotheses & Assessing Goodness of Fit: The Neyman-Person paradigm - Specification of the significance level, Concept of a $p$-value, Null hypothesis, Uniformly most powerful tests, Duality of confidence intervals & hypothesis tests, Generalized likelihood ratio test, Likelihood ratio tests for multinomial distribution, Probability plots, Tests for normality; Summarizing Data: Comparison of location estimates, Estimating variability by bootstrap, Measures of dispersion, Boxplots, Scatter plots, Relationship. | **8 Hours** |
| **Module-4** | Comparing Two Samples: Comparing two independent samples – Methods based on the normal distribution, power, A nonparametric method - the Mann Whitney test, Bayesian approach, Comparing paired samples - Methods based on the normal distribution, Signed rank test, Case studies; Analysis of Variance: One-way layout - Normal theory, $F$ test, Problem of multiple comparisons, Kruskal Wallis test. | **8 Hours** |
| **Module-5** | Analysis of Categorical Data: Fisher's exact test, $\chi^2$ test of homogeneity & independence, matched pairs designs, odds ratios; Simple Linear Regression: Statistical properties of the estimated slope & intercept, Accessing the fit, Correlation & regression. | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:

T1. J. A. Rice, ***Mathematical Statistics and Data Analytics***, 3rd *Ed.*, Cengage Learning, 2006.

**Reference Books**:

R1. L. Wasserman, ***All of Statistics : A Concise Course in Statistical Inference***, 1st *Ed.*, Springer, 2004.
R2. B. Efron and T. Hastie, ***Computer Age Statistical Inference : Algorithms, Evidence, and Data Science***, 1st *Ed.*, Cambridge University Press, 2016.

**Online Resources**:

1. https://nptel.ac.in/courses/111105090: by Prof. S. Kumar, IIT Kharagpur
2. https://nptel.ac.in/courses/111102160: by Prof. S. Dhharmaraja, IIT Delhi
3. https://nptel.ac.in/courses/111105043: by Prof. S. Kumar, IIT Kharagpur
4. https://nptel.ac.in/courses/111102112: by Prof. N. Chaterjee, IIT Delhi

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

| | |
|---|---|
| CO1 | Explain sampling distributions like $\chi^2$, $t$, and $F$ distribution and apply to real life problems. |
| CO2 | Estimate the parameters and fitting of probability distributions. |
| CO3 | Tests a hypothesis, assess the goodness of fit and make a decision using $p$-value. |
| CO4 | Draw conclusion using two sample studies and analysis of variance. |
| CO5 | Analyze categorical data and formulate linear regression model for the given 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). |
| 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 | 3 | 3 | 2 | 2 | 3 | | | | | 1 | | 3 | 1 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 3 | | | | | 2 | | 3 | 1 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | | | | | 3 | 1 | 3 | 1 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | | | | | 3 | 2 | 3 | 1 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | | | | | 3 | 3 | 3 | 1 | 3 |

| Category | Code | Semiconductor Devices | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| MNR | EC2013 | | 3-0-0 | 3 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study the characteristics of different semiconductor devices used in modern electronic equipment and explore the nano scale CMOS structures and materials for applications in advanced technology nodes. |
| **Pre-Requisites** | Knowledge of physics and semiconductor devices 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** | MOSFET: ITRS roadmap for semiconductors, Different groups of MOSFETs, Gate length scaling, Short channel effects, Scattering mechanisms, Hot carrier effect, Buried channel device, Gate oxide scaling and Gate leakage currents in MOSFETs. | **9 Hours** |
| **Module-2** | Advanced Materials for MOSFETs: High-K materials, Gate stack & Channel stack technology, Reverse short channel effect and HALO doping, FDSOI technology. | **9 Hours** |
| **Module-3** | Hetero structure FETs: Hetero junction MOSFETs, Strain engineering for higher mobility (Strained-Si/Strained-SiGe), Staggered hetero junction MOSFETs, Tunnel FETs. | **8 Hours** |
| **Module-4** | Nanoscale Devices: Multiple Gate MOS Structures – Double Gate MOSFET, FinFET, Surrounding Gate MOSFET, HEMTs – AlGaN/GaN HEMT structure and operation. | **8 Hours** |
| **Module-5** | Applications of MOSFETs: RF performance and linearity analysis of MOSFETs for high frequency applications, MOSFET application as bio-sensor, optoelectronic devices (LEDs, LASERs, Photo diodes, Solar cells). | **8 Hours** |
| | **Total** | **42 Hours** |

**Text Books**:


T1. D. A. Neamen, ***Semiconductor Physics and Devices***, 4th *Ed.*, McGraw-Hill, 2012.
T2. S. M. Sze and K. N. Kwok, ***Physics of Semiconductor Devices***, 3rd *Ed.*, Wiley & Sons, 2006.


**Reference Books**:


R1. G. Streetman and S. K. Banerjee, ***Solid State Electronic Devices***, 7th *Ed.*, Pearson, 2014.
R2. C. C. Hu, ***Modern Semiconductor Devices for Integrated Circuits***, 1st *Ed.*, Pearson, 2010.
R3. R. S. Muller, T. I. Kamins and M. Chan, ***Device Electronics for Integrated Circuits***, 3rd *Ed.*, Wiley & Sons, 2003.
R4. C. K. Maiti, S. Chattopadhyay and L. K. Bera, ***Strained-Si Heterostructure Field Effect Devices***, 1st *Ed.*, CRC Press, 2007.


**Online Resources**:

1. https://nptel.ac.in/courses/108108122: by Prof. D. N. Nath, IISc Bangalore
2. https://nptel.ac.in/courses/117108047: by Dr. N. Bhat, et al., IISc Bangalore
3. https://nptel.ac.in/courses/108107129: by Prof. S. Dasgupta, IIT Roorkee
4. https://nptel.ac.in/courses/117107149: by Prof. V. S. Poonia, IIT Roorkee

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

| | |
|---|---|
| CO1 | Illustrate the limit at ions of down scaling the size of MOS transistor. |
| CO2 | Explore the use of advanced materials in the MOS structure and their benefits. |
| CO3 | Analyze the advantages of Hetero Junction MOSFET structures. |
| CO4 | Summarize the advantages of nano scale MOS structures and HEMTs. |
| CO5 | Explain the applications of MOSFETs in different 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). |
| 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. |
| 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 | 2 | 2 | 1 | 2 | | 1 | | | 1 | 2 | | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 2 | | 2 | | | 2 | 2 | 1 | 2 |
| CO3 | 3 | 1 | 3 | 1 | 1 | 1 | | 2 | | | 1 | 1 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | | 2 | | | 2 | 2 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 2 | | 2 | | | 2 | 3 | 2 | 2 |

| Category | Code | Circuit Theory | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| MNR | 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 | 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 | Database Management Systems Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | CS2011 | | 0-0-4 | 2 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to provide a formal foundation in database design, query, and data manipulation, and impart hand-on practice to the students to groom them into well-informed database application developers. |
| **Pre-Requisites** | Knowledge of theory of databases and programming skills is 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 | Introduction to Oracle databases, simple queries for data retrieval. |
| 2,3 | Data retrieval based on conditions and sorting the query results. |
| 4 | Using single-row functions in SQL queries for data retrieval. |
| 5 | Applying grouping and aggregation functions. |
| 6 | Writing complex queries using sub-queries. |
| 7 | Create, alter, and manipulate design of tables. |
| 8,9 | Data manipulation using various DML statements. |
| 10 | Imposing various constraints on tables for maintaining data integrity. |
| 11,12 | Retrieve data from multiple tables using various types of Join operations. |
| 13 | Create, alter, and manage Views from single & multiple base tables. |
| 14 | Create and use other data base objects like sequence, indexes, and synonyms. |
| 15 | Controlling user access to database using DCL queries: Grant, Revoke. |
| 16 | Perform Set operations on tables: Union, Union All, Intersect, Minus. |
| 17 | Write SQL queries by using co-related sub-queries. |
| 18 | Introduction to PL/SQL, identifiers, literals, and keywords. |
| 19 | Write PL/SQL block by using conditional statements and expressions. |
| 20 | Using different types of Loops in a PL/SQL block. |
| 21 | Implement Exception Handling in a PL/SQL block. |
| 22 | Write PL/SQL block by using numeric, string, and other miscellaneous data types. |
| 23 | Introduction to data retrieval using Cursors by providing elementary idea. |
| 24,25 | Introduction to Stored procedures, Write PL/SQL block using procedures. |
| 26 | Develop functions with in/out parameters and using them in a PL/SQL block. |
| 27, 28 | Oracle Triggers – introduction, syntax, types and use. |

**Text Books**:

T1. K. Loney, ***Oracle Database 11g : The Complete Reference***, 1st *Ed.*, McGraw-Hill, 2009.
T2. I. Bayross, ***Teach Yourself SQL/PL SQL Using Oracle 8i and 9i with SQLJ***, 1st *Ed.*, BPB Publications, 2003.

**Reference Books**:

R1. S. Feuerstein, ***Oracle PL/SQL Programming***, 6th *Ed.*, O'Reilly, 2014.
R2. M. Mclaughlin, ***Oracle Database 11g PL/SQL Programming***, 6th *Ed.*, McGraw-Hill Education, 2014.
R3. A. Silberschatz, H. F. Korth, and S. Sudarshan, ***Database System Concepts***, 6th *Ed.*, McGraw-Hill Education, 2013.

**Online Resources**:

1. https://nptel.ac.in/courses/106106095: By Prof. P. S. Kumar, IIT Madras
2. https://docs.oracle.com/cd/B28359_01/appdev.111/b28370.pdf
3. https://www.javatpoint.com/oracle-tutorial

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

| | |
|---|---|
| CO1 | Construct SQL queries and retrieve data using single/multi-row functions, and sub-queries. |
| CO2 | Design relational tables with integrity constraints, operate on table using DDL/DML statements. |
| CO3 | Create other database objects like views, sequences and indices. |
| CO4 | Write PL/SQL programs including control structures, loops, and exception handing. |
| CO5 | Implement the techniques using Procedures, Functions, and Parameters in PL/SQL. |

**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). |
| 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 | | | | | | 2 | 2 | | 1 |
| CO2 | | 2 | | 2 | 2 | | | | | | 2 | 2 | | 1 |
| CO3 | | | 2 | 2 | 2 | | | | | | 1 | 2 | | 1 |
| CO4 | | 2 | | 2 | 2 | | | | | | 2 | 3 | | 2 |
| CO5 | | 2 | | 2 | 2 | | | | | | 2 | 3 | | 2 |

| Category | Code | Internet & Web Technology Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | CS2012 | | 0-0-4 | 2 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to provide hands-on exposure on developing static & dynamic web pages using client-side and server-side scripting with database connectivity and deployment of web applications. |
| **Pre-Requisites** | Knowledge on programming, databases, internet and browsers is 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 | Study of Web Browsers, Browser Settings, Security features, Cookies, Temporary files. |
| 2 | HTML - Basics, headings, text, image, hyperlinks, bookmarks. |
| 3 | HTML - MIME types, lists, tables. |
| 4 | Creating Web Forms and use of HTTP GET & POST Methods. |
| 5 | Embedding audio and video, image map and HTML5 schematic tags. |
| 6 | Cascading Style Sheets - Introduction, types and selectors. |
| 7 | Use of CSS Box Model and Layout Techniques. |
| 8 | Responsive Web Design with Media Queries. |
| 9 | JavaScript - Client side scripting, JavaScript DOM. |
| 10 | JavaScript - Using Elements of DOM, Accessing Form Elements. |
| 11 | Client Side Form Validation using JavaScript. |
| 12 | DHTML- Using JavaScript to change HTML content and CSS styles dynamically. |
| 13 | XML - Introduction to Extensible Markup Language, DTD and XSD. |
| 14 | JSP Basics and Introduction to Server-Side Scripting. |
| 15 | JSP Scripting Elements, directives and Implicit Objects. |
| 16 | FORM data handling and Server Side Validation. |
| 17 | Database connection using MySQL. |
| 18 | Session Management and Authentication Mechanisms. |
| 19 | JSP Code Reusability and Error Page. |
| 20 | JSP Standard Tag Library (JSTL) and Custom Tags. |
| 21 | Project Assignment (requirements, test scenarios & implementation criteria). |
| 22-27 | Development of assigned projects using various web technologies taught. |
| 28 | Demonstration of working project and presentation. |

**Text Books**:

T1. T. A. Powell, ***The Complete Reference HTML and CSS***, 5th *Ed.*, McGraw-Hill, 2017.
T2. T. A. Powell and F. Schneider, ***JavaScript the Complete Reference***, 3rd *Ed.*, McGraw-Hill, 2001.
T3. P. Hanna, ***JSP 2.0 - The Complete Reference***, 1st *Ed.*, McGraw-Hill, 2017.

**Reference Books**:

R1. Kogent Learning Solutions, ***Web Technologies: Black Book***, 1st *Ed.*, Dreamtech Press, 2009.
R2. DT Editorial Services, ***HTML 5 Black Book***, 2nd *Ed.*, Dreamtech Press, 2016.

**Online Resources**:

1. https://nptel.ac.in/courses/106/105/106105084/: Prof. I. Sengupta, IIT Kharagpur
2. https://www.w3schools.com: HTML & CSS with working examples
3. https://www.tutorialspoint.com/javascript/index.htm
4. https://www.javatpoint.com/jsp-tutorial
5. https://www.geeksforgeeks.org/introduction-to-jsp/

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

| | |
|---|---|
| CO1 | Explain the working of Browsers and Internet protocols. |
| CO2 | Develop web pages using HTML and CSS. |
| CO3 | Develop interactive Web pages using Java script and XML. |
| CO4 | Use Web server software and Server side scripts to develop & deploy websites. |
| CO5 | Create and host full fledged interactive web application, using various web technologies. |

**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 | 3 | 2 | 2 | 3 | | | | | | 2 | 2 | 2 | 3 |
| CO2 | 2 | 3 | 2 | 2 | 3 | | | | | | 2 | 2 | 2 | 3 |
| CO3 | 2 | 3 | 3 | 2 | 3 | | | | | | 2 | 2 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 2 | 3 | | | | | | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 2 | 3 | | | | | | 3 | 3 | 2 | 2 |

| Category | Code | Computer Organization & Architecture Lab | L-T-P | Credits | Marks |
|---|---|---|---|---|---|
| PCR | CS2013 | | 0-0-2 | 1 | 100 |

| | |
|---|---|
| **Objectives** | The objective of this course is to study various computer components, develop assembly language programming skills, and understand memory management operations through simulations. |
| **Pre-Requisites** | Knowledge of computer basics and programming logic is required. |
| **Teaching Scheme** | Regular Laboratory classes with the use of ICT whenever required through demonstration of various computer system components and simulation of some of the concepts using Assembly Language and SciLab/MATLAB. |

## 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 | Study of Computer Components. |
| 2 | Study of different types of Motherboards. |
| 3 | Assembling and disassembling of a system. |
| 4 | Introduction to 8085 Simulator and basic Assembly language programming. |
| 5 | Assembly language programming in 8085 simulator using conditional statements. |
| 6 | Assembly language programming in 8085 simulator using loop. |
| 7 | Introduction to SciLab/MATLAB. |
| 8 | Functions and Control Structures in SciLab/MATLAB. |
| 9 | Script files and Functions in SciLab/MATLAB. |
| 10 | Implementation of basic logic gates and design of Adders. |
| 11 | Simulation of Booth Algorithm and Integer division. |
| 12 | Simulation of Page Replacement Algorithms like FIFO, LRU and Optimal. |
| 13 | Simulation of Direct mapping, Associative mapping and Set-associative mapping. |

**Text Books**:


T1. N. K. Srinath, ***8085 Microprocessor: Programming and Interfacing***, 1st *Indian Ed.*, PHI Learning, 2005.

T2. K. U. Kumar and B. S. Umashankar, ***The 8085 Microprocessor: Architecture, Programming and Interfacing***, 1st *Ed.*, Pearson Education, 2008.

T3. T. Sheth, ***SciLab : A Practical Introduction to Programming and Problem Solving***, 1st *Ed.*, Create Space Independent Publishing Platform, 2016.


**Reference Books**:


R1. S. Nagar, ***Introduction to Scilab For Engineers and Scientists***, 1st *Ed.*, Apress, 2017.

R2. G. Roopali, ***Programming with Assembly Language***, Lulu Press, 2019.

R3. R. Pratap, ***Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers***, 1st *Ed.*, Oxford University Press, 2010.


**Online Resources**:

1. https://www.scilab.org/tutorials
2. https://www.scilab.org/sites/default/files/Scilab_beginners_0.pdf

3. https://www.cse.iitb.ac.in/~cs626-449/scilab.pdf
4. https://www.javatpoint.com/programming-in-8085

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

| | |
|---|---|
| CO1 | Identify the components, disassemble and assemble a modern digital computer. |
| CO2 | Write assembly language programs to comprehend instruction execution on the 8085 simulator. |
| CO3 | Analyze and develop programs in SciLab/MATLAB with control structures and functions. |
| CO4 | Implement different logic gates for various binary arithmetic operations using SciLab/MATLAB. |
| CO5 | Implement and analyze different cache memory mapping techniques and replacement policies. |

**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 | 2 | 1 | 2 | 1 | | | | | | 1 | 1 | | 2 |
| CO2 | 3 | 3 | 2 | 3 | 3 | | | | | | 2 | 1 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 3 | 2 | | | | | | 2 | 1 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 3 | | | | | | 1 | 1 | 1 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 2 | 2 | 2 |

Silicon University

**Department of Computer Science & Engineering**
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