



Curriculum Structure & Detailed Syllabus
Bachelor of Technology
in
Computer Science & Engineering
(Four-Year Under-Graduate Program)

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Approval History

ACM#	Date	Resolutions
SU-4	19/07/2025	The curriculum structure of B. Tech. (CSE) and detailed syllabus of 1st Year has been approved by the Academic Council.
SU-5	07/02/2026	The amendments to the curriculum structure and the detailed syllabus up to 2nd Year of B. Tech. (CSE) as recommended by the Board of Studies 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	Practice / Hands-On / 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
OOO	Open Online Course (on NPTEL / Swayam / Other)
INT	Summer Internship
PSI	Practice School / Industry Internship
PRJ	Project Work
SEC	Skill Enhancement Course
VAC	Value Addition Course

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Part I

Curriculum Structure

Induction Program

In accordance with the guidelines issued by AICTE and NEP-2020, it is essential for newly admitted B.Tech. students to undergo a structured Student Induction Program (SIP). The program is designed to facilitate a smooth transition into higher technical education by enabling students to acclimatize to the institutional environment, develop a sense of belonging, and imbibe academic, ethical, and societal values. The primary objectives of the Student Induction Program are to:

- Help students adjust to the new academic and social environment
- Establish healthy bonding among students, faculty members, and the institution
- Familiarize students with the academic system, institutional culture, and discipline
- Promote communication skills, self-confidence, and teamwork
- Instill human values, professional ethics, and social responsibility
- Encourage holistic development in alignment with NEP-2020

Mandatory Nature of the Program

All students admitted to the B.Tech. programs shall undergo a mandatory Student Induction Program immediately after joining the institute and before the commencement of regular academic classes. As per AICTE guidelines, regular classes shall begin only after the successful completion of the induction program.

Components of the Student Induction Program

The Student Induction Program shall include, but not be limited to, the following components:

1. *Institutional Orientation*

- Rules and regulations of the university
- Examination, evaluation, and academic progression systems
- Departments, branches, and academic structure
- Campus facilities, laboratories, libraries, and learning resources
- Administrative processes and important officials
- Curricular, co-curricular, and extra-curricular activity clubs
- Innovation, research, entrepreneurship, and start-up initiatives

2. *Universal Human Values and Ethics*

- Sessions on human values, professional ethics, and responsible conduct
- Social awareness, civic duties, and environmental consciousness
- Motivation to contribute to societal development and nation building

3. *Physical and Mental Well-being*

- Individual and group physical activities, yoga, sports, or fitness sessions
- Awareness on disciplined and healthy lifestyles

4. *Creative Arts and Cultural Activities*

- Learning, practicing, or exhibiting art forms, music, literature, or other creative expressions
- Activities aimed at nurturing creativity, emotional expression, and cultural appreciation

5. *Interaction and Mentoring*

- Interaction with faculty advisors, mentors, and senior students
- Sessions focused on career planning, emerging technologies, and professional pathways
- Lectures and interactions with eminent academicians, professionals, and industry experts

6. *Community and Social Engagement*

- Social service and community outreach activities
- Visits to important places of the city or nearby areas of social, cultural, or historical significance
- Any other activities deemed necessary by the institute in alignment with AICTE/NEP-2020 objectives

Attendance and Participation

Every newly admitted student must diligently attend and actively participate in all components of the Student Induction Program. Attendance for all activities shall be recorded. Students shall submit a daily report in the prescribed format to the concerned faculty advisor on the following working day.

Assessment and Evaluation

A computer-based multiple-choice test (MCQ) shall be conducted on a suitable date, generally about one week after the completion of the induction program. The evaluation of the Student Induction Program shall be carried out for a total of 100 marks, distributed as follows:

- | | |
|----------------------------|------------|
| 1. Attendance | : 25 marks |
| 2. Daily Reports | : 25 marks |
| 3. Computer-Based MCQ Test | : 50 marks |

A student must secure a minimum of 50 marks in aggregate to successfully complete and pass the Student Induction Program.

In case a student fails to secure the minimum required marks, the student shall be required to undergo the Student Induction Program again in the subsequent academic year along with the newly admitted students, submit daily reports, and appear for the computer-based test to obtain the prescribed passing marks.

Curriculum Structure

1st Year B.Tech. (Common)

Semester I						
Category	Code	Course Title	WCH (L — T — P)			Credit
THEORY						
UCR	MT1001	ODE & Matrix Algebra	3	0	0	3
UCR	CH1003 / PH1002	Engineering Chemistry / Engineering Physics	3	0	0	3
UCR	EC1001 / EE1001	Basic Electronics Engineering / Basic Electrical Engineering	3	0	0	3
UCR	ME1004 / ME1002	Engineering Mechanics / Engineering Thermodynamics	2	0	0	2
UCR	CS1001	Computer Programming	3	0	0	3
UMC	HS0001 / CH0001	Constitution of India & Professional Ethics / Environmental Science & Engineering	3	0	0	0
PRACTICAL						
UCR	EC1002 / EE1002	Basic Electronics Engineering Lab / Basic Electrical Engineering Lab	0	0	2	1
UCR	CS1002	Computer Programming Lab	0	0	4	2
SEC	HS1001	Communicative & Technical English	0	0	4	2
UCR	EE1003 / ME1003	Workbench Practices / Engineering Graphics	0	0	2	1
		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 courses (if any) will be as per the theory courses 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)			Credit
THEORY						
UCR	MT1002	Probability & Statistics	3	0	0	3
UCR	PH1002 / CH1003	Engineering Physics / Engineering Chemistry	3	0	0	3
UCR	EE1001 / EC1001	Basic Electrical Engineering / Basic Electronics Engineering	3	0	0	3
UCR	ME1002 / ME1004	Engineering Thermodynamics / Engineering Mechanics	2	0	0	2
UCR	CS1003	Data Structures & Algorithms	3	0	0	3
UMC	CH0001 / HS0001	Environmental Science & Engineering / Constitution of India & Professional Ethics	3	0	0	0
PRACTICAL						
UCR	EE1002 / EC1002	Basic Electrical Engineering Lab / Basic Electronics Engineering Lab	0	0	2	1
UCR	CS1004	Data Structures & Algorithms Lab	0	0	4	2
SEC	HS1002	Corporate Communication Skills	0	0	4	2
UCR	ME1003 / EE1003	Engineering Graphics / Workbench Practices	0	0	2	1
		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 courses (if any) will be as per the theory courses 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)			Credit
THEORY						
PCR	MT2001	Discrete Mathematics	3	0	0	3
UCR	CS2001	OOP Using Java	3	0	0	3
UCR	MG2001 / BL2001	Management & Economics for Engineers / Biology for Engineers	3	0	0	3
PCR	CS2002	Design & Analysis of Algorithms	3	1	0	4
PCR	CS2003	Operating Systems	3	0	0	3
PCR	EC2001	Digital Electronics	3	0	0	3
PRACTICAL						
UCR	CS2004	OOP Using Java Lab	0	0	2	1
PCR	CS2005	Design & Analysis of Algorithms Lab	0	0	2	1
PCR	CS2006	Operating Systems Lab	0	0	2	1
PCR	EC2002	Digital Electronics Lab	0	0	2	1
INT	IP2001	Summer Internship - I	0	0	0	1
		TOTAL	27			24

Semester IV						
Category	Code	Course Title	WCH (L — T — P)			Credit
THEORY						
PCR	MT2002	Optimization Techniques	3	0	0	3
UCR	CS2007	Programming in Python	3	0	0	3
UCR	MG2001 / BL2001	Management & Economics for Engineers / Biology for Engineers	3	0	0	3
PCR	CS2008	Computer Organization & Architecture	3	0	0	3
PCR	CS2009	Database Management Systems	3	1	0	4
PEL		Program Elective - I	3	0	0	3
HNS/MNR		Honours / Minor - I	3	0	0	3
PRACTICAL						
UCR	CS2010	Programming in Python Lab	0	0	2	1
PCR	CS2013	Computer Organization & Architecture Lab	0	0	2	1
PCR	CS2011	Database Management Systems Lab	0	0	4	2
PCR	CS2012	Internet & Web Technology Lab	0	0	4	2
		TOTAL	31			25
		TOTAL (with Honours/Minor)	34			28

3rd Year B.Tech.(CSE)

Semester V						
Category	Code	Course Title	WCH (L — T — P)			Credit
THEORY						
PCR	CS3001	Computer Networks	3	0	0	3
PCR	CS3002	Machine Learning	3	1	0	4
PCR	CS3003	Software Engineering	3	0	0	3
PCR	CS3004	Formal Languages & Automata Theory	3	0	0	3
PEL		Program Elective - II	3	0	0	3
PEL		Program Elective - III	3	0	0	3
HNS/MNR		Honours / Minor - II	3	0	0	3
PRACTICAL						
PCR	CS3005	Computer Networks Lab	0	0	2	1
PCR	CS3006	Machine Learning Lab	0	0	2	1
PCR	CS3003	Software Engineering Lab	0	0	2	1
SEC	HS3001	Soft Skills for Professionals	0	0	2	1
INT	IP3003	Summer Internship - II	0	0	0	1
		TOTAL	27			24
		TOTAL (with Honours/Minor)	30			27

Semester VI						
Category	Code	Course Title	WCH (L — T — P)			Credit
THEORY						
PCR	CS3008	Internet of Things	3	0	0	3
PCR	CS3009	Soft Computing	3	0	0	3
PCR	CS3010	Compiler Design	3	0	0	3
PEL		Program Elective - IV	3	0	0	3
PEL		Program Elective - V	3	0	0	3
PEL		Program Elective - VI	3	0	0	3
HNS/MNR		Honours / Minor - III	3	0	1	4
PRACTICAL						
PCR	CS3011	Internet of Things Lab	0	0	2	1
PCR	CS3012	Soft Computing Lab	0	0	2	1
SEC	IP3001 / IP3002	Emerging Technologies Lab / Entrepreneurship & Innovation	0	0	4	2
SEC	HS3002	Technical & Research Writing	0	0	2	1
VAC	VA0001	Yoga / NSS / NCC / PES / CPA *	0	0	2	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)			Credit
THEORY						
OEL		Open Elective - I	3	0	0	3
OOC		MOOC - I	0	0	0	3
HNS/MNR		Honours / Minor - IV	3	0	1	4
HNS/MNR		Honours / Minor - V	3	0	1	4
PRACTICAL						
PRJ	IP4007	Skill Lab & Project - I	0	0	4	2
INT	IP4005	Summer Internship - III	0	0	0	1
		TOTAL	7			9
		TOTAL (with Honours/Minor)	15			17

Semester VIII						
Category	Code	Course Title	WCH (L — T — P)			Credit
THEORY						
OEL		Open Elective - II	3	0	0	3
OOC		MOOC - II	0	0	0	3
PRACTICAL						
UCR	IP4008	Presentation Skills & Technical Seminar	0	0	2	1
PRJ	IP4009	Project - II	0	0	16	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 11.
2. Courses for Honours and Minor are given in “List of Tracks for Honours and Minor” on Page 12.
3. A 4-Credit Honours / Minor course may have L-T-P of 3-1-0 if the course does not require any practice or hands-on component. Refer to the detailed syllabus of the course for the allocated L-T-P.
4. MOOC - Massive Open Online Course (on NPTEL / Swayam / Other).
5. 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.

4th Year B.Tech.(CSE)
(With Practice School Option in 7th Semester)

Semester VII						
Category	Code	Course Title	WCH (L — T — P)			Credit
PRACTICAL						
PSI	IP4006	Practice School / Industry Internship	0	0	0	15
INT	IP4005	Summer Internship - III	0	0	0	1
		TOTAL	0			16

Semester VIII						
Category	Code	Course Title	WCH (L — T — P)			Credit
THEORY						
OEL		Open Elective - II	3	0	0	3
OOO		MOOC - II	0	0	0	3
HNS/MNR		Honours / Minor - IV	3	0	1	4
HNS/MNR		Honours / Minor - V	3	0	1	4
PRACTICAL						
PRJ	IP4007	Skill Lab & Project - I	0	0	4	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 11.
2. Courses for Honours and Minor are given in “List of Tracks for Honours and Minor” on Page 12.
3. A 4-Credit Honours / Minor course may have L-T-P of 3-1-0 if the course does not require any practice or hands-on component. Refer to the detailed syllabus of the course for the allocated L-T-P.
4. MOOC - Massive Open Online Course (on NPTEL / Swayam / Other).
5. 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.

4th Year B.Tech.(CSE)
(With Practice School Option in 8th Semester)

Semester VII						
Category	Code	Course Title	WCH (L — T — P)			Credit
THEORY						
OEL		Open Elective - I	3	0	0	3
OOOC		MOOC - I	0	0	0	3
HNS/MNR		Honours / Minor - IV	3	0	1	4
HNS/MNR		Honours / Minor - V	3	0	1	4
PRACTICAL						
PRJ	IP4007	Skill Lab & Project - I	0	0	4	2
INT	IP4005	Summer Internship - III	0	0	0	1
		TOTAL	7			9
		TOTAL (with Honours/Minor)	15			17

Semester VIII						
Category	Code	Course Title	WCH (L — T — P)			Credit
PRACTICAL						
PSI	IP4006	Practice School / Industry Internship	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 11.
2. Courses for Honours and Minor are given in “List of Tracks for Honours and Minor” on Page 12.
3. A 4-Credit Honours / Minor course may have L-T-P of 3-1-0 if the course does not require any practice or hands-on component. Refer to the detailed syllabus of the course for the allocated L-T-P.
4. MOOC - Massive Open Online Course (on NPTEL / Swayam / Other).
5. 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.

List of Electives

Code	Elective # and Subjects
Program Elective - I	
CS2014	Artificial Intelligence
CS2015	Computer Graphics
CS2016	Advanced Java Programming
Program Elective - II	
CS3013	Data Mining & Data Warehousing
CS3014	Cloud Computing
CS3015	System Programming
Program Elective - III	
CS3016	Big Data Analytics
CS3017	Realtime Systems
CS3018	Distributed Databases
Program Elective - IV	
CS3019	Natural Language Processing
CS3020	Wireless Sensor Networks
CS3021	Mobile Application Development
Program Elective - V	
CS3022	Data Visualization & Reporting
CS3023	Mobile Computing
CS3024	Cryptography & Network Security
Program Elective - VI	
CS3025	Bioinformatics Algorithms
CS3026	Embedded Systems
CS3027	Blockchain Technology
Open Elective - I & II (Basket)	
MT4001	Applied Linear Algebra
MT4002	Stochastic Processes
MT4003	Numerical Optimization
MT4004	Simulation & Modelling
ME4001	Fluid Mechanics
EE4001	Power Plant Engineering
ME4002	Project Management
HS4001	Organizational Behaviour
HS4002	Entrepreneurship Development
MG4001	Securities Analysis, Investment & Trading
MG4002	Circular Economy

List of Tracks for Honours / Minor

Code	Honours / Minor # and Subjects
<i>Honours in Computer Science & Engineering</i>	
MT2007	Statistical Inference
MT3001	Time Series Analysis
CS3029	Deep Learning
CS4005	Generative AI
CS4006	Nature Inspired Computing
<i>Minor in “VLSI System Design & Verification”</i>	
EC2013	Semiconductor Devices
EC3032	CMOS VLSI Design
EC3033	VLSI Fabrication Technology
EC4001	VLSI Chip Design & Verification
EC4002	Analog Integrated Circuit Design
<i>Minor in “Smart Energy Systems”</i>	
EE2010	Circuit Theory
EE2008	Renewable Energy Systems
EE3022	Basics of Power Systems
EE3024	Smart Power Systems
EE4002	Electric & Hybrid Vehicles
<i>Minor in “Embedded & IoT System Design”</i>	
EC2011	Embedded C Programming
EC3034	Sensors & Transducers
EC3035	Embedded Systems & Microcontrollers
EC4003	Realtime Embedded System Design
EC4004	Industrial Internet of Things
<i>Minor in “Business Management”</i>	
MG2002	Digital Marketing & SMO
MG3003	Human Resource Information Systems
MG3004	E-Commerce & Supply Chain Management
MG4005	Financial Management
MG4006	Business Strategy
<i>Minor in “Business Analytics”</i>	
MG2005	Fundamentals of Business Analytics
MG3001	Data Analytics with Python
MG3002	Business Statistics & Predictive Modelling
MG4003	Business Intelligence & Visualization
MG4004	Business Analytics using Power of AI

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	Credit	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:

- <https://nptel.ac.in/courses/111105035>: by Prof. P. D. Srivastava, IIT Kharagpur
- <https://nptel.ac.in/courses/122104017>: by Prof. S. K. Ray, IIT Kanpur
- <https://nptel.ac.in/courses/122102009>: by Prof. S. R. K. Iyengar, IIT Delhi
- <https://nptel.ac.in/courses/111107063>: by Dr. S. Gakkhar, IIT Roorkee
- <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	Credit	Marks
UCR	CH1003		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.	8 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	Electrochemical Devices: Battery Technology — Fundamentals of primary & secondary cells, Rechargeable batteries – Lead acid storage battery, Lithium ion battery, Fuel cells – Principles, Applications, Solar Cells – Principles & applications; Potentiostat – Introduction, Instrumentation and working principle, Voltammetry, Cyclic voltammetry (principle, role of scan rate, potential range and current response), Analysis of cyclic voltammograms - peak currents, redox potentials, and reversibility, Applications of potentiostat.	10 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.
- T4. Willard, Merritt, Dean, and Settle, *Instrumental Methods of Analysis*, 7th Ed., CBS Publishers, 2004.

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. <https://nptel.ac.in/courses/105104102/>
2. <https://nptel.ac.in/courses/113104082/>
3. <https://nptel.ac.in/courses/104106122/>
4. <https://nptel.ac.in/courses/103102015/>

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	Understand different technologies for storing energy and the working principles of electrochemical devices & their industrial applications.
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.
PO11	Life-Long Learning: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

P.T.O

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	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	Credit	Marks
UCR	PH1002		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 which are necessary to understand the working of instruments & technologies, and solving various engineering problems.
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: Wave and wave equation, Superposition of waves, Huygen's principle, Concept of Interference and Diffraction, Polarization, Types of polarization, Brewster's law, Malus's Law, Nicol Prism, Wave plate and types, Applications of polarization.	9 Hours
Module-2	Electrostatics and Magnetostatics: Introduction to Gauss's law, Faraday's law, Ampere's Circuital law and Biot-Savart's law, Application of the laws to derive the constituent relations of the fundamental passive elements: Resistor, Capacitor and Inductor.	8 Hours
Module-3	Electromagnetic Waves: Gradient of scalar field, Divergence and curl of vector field, Displacement current and modified Ampere's circuital law, Maxwell's electromagnetic equations, Wave equations in free space, dielectric and conducting medium, Poynting's theorem.	8 Hours
Module-4	Basics of Quantum Physics: Need of Quantum Physics, Particle nature of radiation, Planck's Quantum Theory, Photoelectric effect, Compton's effect, Pair production, Matter waves, Heisenberg's uncertainty principle, Schrödinger's wave equation, Particle in a box.	9 Hours
Module-5	Laser and Fiber Optics: Radiation-matter interaction, Stimulated emission, Population inversion, Types of Laser – Solid State Laser and Gas Laser, Optical Fiber – Structure and Principle, Types of optical fiber, Numerical aperture, Applications of laser and 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.

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.

P.T.O

Online Resources:

1. <https://nptel.ac.in/courses/122101002>: by Prof. D. K. Ghosh, IIT Bombay
2. <https://nptel.ac.in/courses/122107035>: by Prof. G. D. Verma et. al., IIT Roorkee
3. <https://nptel.ac.in/courses/115101107>: by Prof. Ramadevi, IIT Bombay
4. <https://ocw.mit.edu/courses/physics/>

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

CO1	Analyze & apply waves and polarized light in different fields and engineering applications.
CO2	Understand basic laws in electromagnetism and apply them to solve problems involving electromagnetic fields and their interaction with circuit analysis.
CO3	Develop and apply Maxwell's equations to understand the properties of electromagnetic waves.
CO4	Analyze wave particle duality to understand radiation-matter interaction 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 domains of engineering.

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	3						1	3	2	2
CO2	3	3	3	3	2						2	3	1	2
CO3	3	2	3	3	2						2	3	2	2
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	Credit	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*, 11th 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	Credit	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	Credit	Marks
UCR	ME1004		2-0-0	2	100

Objectives	The objective of this course is to provide knowledge of statics with focus on force equilibrium, free body diagrams, concepts of mass moment of inertia, and elementary idea of kinematics of a particle and forces in nature including curvilinear motion, which are required for solving various engineering problems.
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, Basic principles of Equivalent Force system, Equations of equilibrium, Free body diagram, Moment of forces and its application; Description and applications of friction.	7 Hours
Module-2	Virtual Work & Moment of Inertia: Virtual Work, Centroid and Center of Gravity, Centroid of simple and composite sections; Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Area moment of inertia of standard and composite sections, Mass moment inertia of circular plate, Elementary concepts of stresses, and Stress-Strain behaviour.	7 Hours
Module-3	Kinematics of Particles: Rectilinear motion, Curvilinear motion; Use of cartesian & polar coordinate systems, Relative and constrained motion, Space curvilinear motion, Extension to cylindrical & spherical coordinate systems.	7 Hours
Module-4	Dynamics of a Particle & Forces in Nature: Newton's laws in describing particle motion, D'Alembert's Principle; Work and Energy, Impulse, Momentum and Angular Momentum; Solving Newton's equations of motion in polar coordinates; Kepler's Laws and satellite motion.	7 Hours
Total		28 Hours

Text Books:

- T1. S. Timoshenko, D. H. Young, S. Pati, and J. V. Rao, *Engineering Mechanics*, 5th Ed., McGraw-Hill Education, 2013.
- T2. M. K. Harbola, *Engineering Mechanics*, 2nd Ed., Cengage Learning, 2018.
- T3. J. L. Meriam and L. G. Kraige, *Engineering Mechanics: Statics*, 8th Ed., Wiley India, 2014.

Reference Books:

- R1. F. Beer, E. Johnston, D. Mazurek, P. Cornwell, and B. Self, *Vector Mechanics for Engineers: Statics and Dynamics*, 10th Ed., McGraw Hill, 2019.
- R2. G. H. Ryder, *Strength of Materials*, 3rd Ed., Macmillan Press, 1969.
- R3. D. Kleppner and R. Kolenkow, *An Introduction to Mechanics*, 1st Ed., McGraw Hill, 2017.

Online Resources:

1. <https://nptel.ac.in/courses/122104015/>: by Prof. M. Harbola, IIT Kanpur.
2. <https://nptel.ac.in/courses/112106286/>: by Prof. K. Ramesh, IIT Madras

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

CO1	Apply the principles of mechanics to solve problems in statics.
CO2	Compute virtual work, area & mass moment of inertia, and explain stress-strain behaviour.
CO3	Use appropriate coordinate systems to explain and analyze motion of particles.
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).
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	3	3	2	2	1				2	3	2			
CO2	3	3	3	3	2				2	3	2			
CO3	2	2	2	2	3	1	1	1	2	3	2	3	3	
CO4	1	2	2	1	2	1	1	1	3	3	2	2	2	1

Category	Code	Engineering Thermodynamics	L-T-P	Credit	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 discussion on 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	Credit	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. Kanetkar, *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	Credit	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	Credit	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	Credit	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 (σ known), Sampling Distribution of Mean (σ 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	Credit	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)

P.T.O

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	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	Credit	Marks
UCR	EC1002		0-0-2	1	100

Objectives	The objective of this practical course is 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**, 11th Ed., Pearson Education.
 T2. A. S. Sedra and K. C. Smith, **Microelectronic Circuits**, 7th 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	Credit	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:

- <https://nptel.ac.in/courses/108/105/108105053/>: by Prof. G. D. Roy, Prof. N. K. De, and Prof. T. K. Bhattacharya, IIT Kharagpur
- <https://nptel.ac.in/courses/108/108/108108076/>: By Prof. L. Umanand, IISc Bangalore
- <https://www.electrical4u.com/>
- 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	Credit	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. Kanetkar, **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	Credit	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 Skills*, Oxford University Press, 2011.
 R3. T. Panigrahi, *Communicative Competence*, 1st Ed., Notion Press, 2024.

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO6	The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO7	Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual & Collaborative Team Work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

Cont'd. . .

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

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

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

Category	Code	Workbench Practices	L-T-P	Credit	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 a Desktop Computer System and recognize its parts.
3	Study of cables, wires, switches, fuses, MCB, fuse carriers in an electrical network.
4	Study of earthing and electrical safety, demonstration of the precautionary steps adopted 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 electronics & electrical components (such as Resistor, Capacitor, Inductor, Potentiometer, Diode, Transistor, Sensors, ICs, etc.) for circuit design.
9 - 10	Design PCB for the simulated design using KiCAD.
11	Assemble PCB with components using the assembling tools (such as Soldering iron, Desoldering pump, Pliers, Cutters, Wire strippers, Crimping tool, Micro-soldering, Hot air soldering and desoldering station etc.)
12	Testing and characterization of the assembled PCB using standard testing instruments: Multimeter, Digital Storage Oscilloscope (DSO), and Function generator etc.

Text Books:

- T1. B. H. Deshmukh, *Electrical Materials and Wiring Practices*, Nirali Prakashan, 2018.
- T2. G. Halder, *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/Electrician_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/108108157/>
8. <https://nptel.ac.in/courses/122106025/>
9. <https://nptel.ac.in/courses/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 identify the components.
CO3	Identify and utilize common electrical components with proper safety mechanisms.
CO4	Design house wiring and measure energy consumption using digital meters.
CO5	Assemble PCB with basic electronics components, and use various measuring & testing tools.
CO6	Use KiCAD for creating schematic diagrams and translating it into PCB layout.

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.

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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	1	1	1	1		1			1	1	1	1	
CO2	1				3		2		2		1			
CO3	2	1	2	1	2	1		1	1	1	1			
CO4	2	3	3	1	1	1		1	2	2	2			
CO5	2	2	3	2	1			2			1	2	1	
CO6	1	2	3	2	2			2			1	1	2	1

Category	Code	Engineering Graphics	L-T-P	Credit	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 CAD software, its GUI, toolbars and commands, shortcut keys.
9	2D drawing using basic tools, Draw & Modify menu commands of the CAD software.
10	Orthographic projection drawings of various models using CAD software.
11	Isometric drawing & 3D modeling in CAD, different solid editing options.
12	3D modeling of simple & compound models, and machine components using CAD.
13	Introduction to 3D printing.

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:

- <http://nptel.ac.in/courses/112103019>
- <https://nptel.ac.in/courses/112/102/112102101/>
- <https://freevidelectures.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 drawing concepts.
CO2	Recognize and interpret orthographic projections of points, lines, planes, and solids, and visualize real-world objects from isometric, solid, and sectional views.
CO3	Draw 2D engineering drawings using various draw and modify tools of CAD Software.
CO4	Design various 3D models by using CAD Software.
CO5	Describe the modern manufacturing methods like 3D printing.

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	2		1
CO4	2	2	3	1	2				2	1	1	2		1
CO5	1	1	1	1	1				2	1	1	1		1

Category	Code	Data Structures & Algorithms Lab	L-T-P	Credit	Marks
UCR	CS1003		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	Credit	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:

- <https://archive.nptel.ac.in/courses/109/105/109105144/>: by Prof. S. Singh, IIT Kharagpur
- <https://archive.nptel.ac.in/courses/109/106/109106129/>: by Dr. Ay. I. Viswamohan, IIT Madras
- <https://archive.nptel.ac.in/courses/109/104/109104030/>: by Dr. T. Ravichandran, IIT Kanpur
- <https://www.ef.com/wwen/english-resources/>
- https://owl.purdue.edu/owl/purdue_owl.html
- <https://www.usingenglish.com/>
- <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.

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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	Credit	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:

- <https://nptel.ac.in/courses/106104573>: by Prof. N. Saxena, IIT Kanpur
- <https://nptel.ac.in/courses/106106183>: by Dr. A. Shukla and Prof. S. Iyengar, IIT Ropar
- <https://nptel.ac.in/courses/106108227>: by Prof. A. Choudhury, IIIT Bangalore
- <https://nptel.ac.in/courses/106103205>: by Prof. B. George and Prof. S. Gopalan, IIT Guwahati
- <https://nptel.ac.in/courses/106106094>: by Prof. K. Krithivasan, IIT Madras
- <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	Credit	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	Credit	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	Credit	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	Credit	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)
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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	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	Credit	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, 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*, 10th Ed., Wiley, 2018.
 T2. M. Milenković, *Operating Systems: Concepts and Design*, 2nd Ed., Tata McGraw-Hill, 2010.

Reference Books:

- R1. A. S. Tanenbaum, *Modern Operating Systems*, 5th Ed., PHI, 2022.
 R2. P. B. Prasad, *Operating Systems and System Programming*, 3rd Ed., Scitech Publications, 2018.

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).
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).

Cont'd. . .

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	Credit	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 Mealy based model, FSM Design using Moore based model, Sequence detector (Mealy 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.

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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	Credit	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 robust 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	Credit	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	Credit	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 – 16×4 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*, 5th 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	Credit	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 <code>grep</code> , <code>pipe</code> , <code>cut</code> , 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 <code>fork()</code> , <code>exec()</code> .
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, 2013.
 T2. A. Silberschatz, P. B. Galvin, and G. Gagne, *Operating System Concepts*, 10th Ed., Wiley, 2018.

Reference Books:

- R1. A. S. Tanenbaum, *Modern Operating Systems*, 5th Ed., PHI Learning, 2022.
 R2. P. B. Prasad, *Operating Systems and System Programming*, 3rd Ed., Scitech Publications, 2018.

Online Resources:

- https://www.technicalsposium.com/sharelabcodings_os.html
- https://www.cse.iitb.ac.in/~mythili/teaching/cs347_autumn2016/index.html

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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	Credit	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	Credit	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*, 3rd Ed., DreamTech Press, 2021.
- T2. V. Gutttag, *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*, 3rd Ed., O'Reilly Media, 2023.
- R2. A. Downey, *Think Python: How to Think Like a Computer Scientist*, 3rd Ed., O'Reilly Media, 2024.
- 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*, 4th Ed., Franklin, Beedle & Associates, 2024.

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)

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	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	Credit	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 architecture of a digital computer and the functions of its basic units.
CO2	Interpret instruction formats and apply addressing modes to solve basic problems.
CO3	Perform binary arithmetic operations using techniques for fixed & floating-point arithmetic.
CO4	Analyze memory hierarchy, explain cache & virtual memory mapping & replacement techniques.
CO5	Explain control unit and compare between hardwired & microprogrammed control techniques.

Program Outcomes Relevant to the Course:

PO1	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO11	Life-Long Learning: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

Category	Code	Database Management Systems	L-T-P	Credit	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	Credit	Marks
PEL	CS2014		3-0-0	3	100

Objectives	The objective of this course is to provide a strong foundation to AI approaches to build intelligent systems with perception, logic, 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; Intelligent Agents: Agent function & programs, Rationality, Environment types, PEAS description, Structure of Agents, Types of Agent Programs, Problems solving by Searching - Example Problems, State space search; Uninformed Search Strategies: BFS, DFS, Depth Limited, Iterative Deepening DFS, Uniform Cost, Bi-directional Searches.	9 Hours
Module-2	Search Algorithms & Reasoning: Introduction, Evaluation and Heuristic functions, Greedy Best First Search, A* Search, Example Problems; Local Search Algorithms: Hill Climbing Search and Simulated Annealing; Constraint Satisfaction Problems: Introduction & types of CSPs, Backtracking Search for CSPs; Adversarial Search: Introduction, Game playing, Minimax and α - β Pruning; Knowledge & Reasoning: KB-based Agents, The Wumpus World problem.	9 Hours
Module-3	Logic & Reasoning: Logic, Propositional Logic, First-Order Logic (FOPL): Syntax & Semantics of FOPL, Inference in FOPL Forward and 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, Partial Order Planning, Planning Graphs, Hierarchical Planning; Uncertain Knowledge: Acting under Uncertainty, Bayes Rule & its use; Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, Semantics of Bayesian Networks.	8 Hours
Module-5	Learning & Expert Systems: Introduction to Learning, Learning Agent, Paradigms of learning, Learning from Observations, Inductive Learning, Information Gain, Learning Decision Trees; Statistical Learning, Instance Based Learning, Neural Networks: Introduction, Perceptron, Introduction to Reinforcement Learning; Introduction to Expert Systems: Definition, Architecture, Applications.	8 Hours
Total		42 Hours

Text Books:

- T1. S. Russell and P. Norvig, *Artificial Intelligence - A Modern Approach*, 4th Ed., Pearson Education, 2020.
- 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, 2017.
 R2. M. Negnevitsky, *Artificial Intelligence: A Guide to Intelligent Systems*, 3rd Ed., Addison Wesley, 2011.
 R3. G. F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, 6th Ed., Pearson Education, 2008.

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	Apply 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	Credit	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. Hughes, 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. Carithers, *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/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	Credit	Marks
PEL	CS2016		3-0-0	3	100

Objectives	The objective of the course is to learn advanced features of the Java programming language and various frameworks in JavaEE for rapid development, and to apply these for developing 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	JavaEE Environment: Overview of JavaEE and JavaSE, JavaEE Architecture; JDBC: Concept, Driver Types, Packages, Database Connection, CRUD Operations, 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, Queries, 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	Credit	Marks
HNS	MT2007		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: χ^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, χ^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. Dharmaraja, 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. Chatterjee, IIT Delhi

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

CO1	Explain sampling distributions like χ^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	Credit	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 – AlGaIn/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:

- <https://nptel.ac.in/courses/108108122>: by Prof. D. N. Nath, IISc Bangalore
- <https://nptel.ac.in/courses/117108047>: by Dr. N. Bhat, et al., IISc Bangalore
- <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	Embedded C Programming	L-T-P	Credit	Marks
ERR	EC2011		3-0-0	3	100

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO11	Life-Long Learning: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

Category	Code	Circuit Theory	L-T-P	Credit	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. Kabisatpathy, 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	Digital Marketing & SMO	L-T-P	Credit	Marks
MNR	MG2002		3-0-0	3	100

Objectives	The objective of this course is to provide students with foundational knowledge and practical skills in digital marketing tools, platforms and analytics, enabling them to design, execute and evaluate effective data-driven marketing campaigns across digital channels.
Pre-Requisites	Basic understanding of marketing, computer fundamentals and familiarity with the internet, websites and social media platforms is required.
Teaching Scheme	Regular classroom lectures with the use of ICT tools as and when required; sessions are planned to be interactive with emphasis on real-world case studies, demonstrations and exposure to digital marketing tools.

Evaluation Scheme

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

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Digital Marketing: Fundamentals of Marketing Concepts and Principles, Key Marketing Terminology, Role of Marketing in the Digital Age, Digital Marketing Channels and Platforms, Role of Data in Digital Marketing; Introduction to Google Ads, Setting Up Google Ads Campaigns, Keyword Research and Selection, Ad Copywriting Best Practices, Ad Formats and Extensions, Bid Management and Budgeting, Quality Score Optimization, Performance Measurement and Reporting.	8 Hours
Module-2	Content Creation & Email Marketing: Content Creation Tools and Platforms, Visual Content Creation (Graphics, Images, Videos), Content Marketing Strategy Development, Content Distribution and Promotion, Content Calendar Planning, Measuring Content Marketing Effectiveness; Email Marketing - Introduction, Email Marketing Platforms, Designing Effective Email Campaigns, Automation Workflows and Drip Campaigns, Email Marketing Analytics and Tracking.	7 Hours
Module-3	Marketing on Social Media: Advertising on Facebook and Instagram, Ad Campaign Objectives, Ad Creatives and Visuals, Ad Placements and Audience Targeting, Facebook Pixel and Conversion Tracking; Video Advertising on YouTube, Video Ad Creation and Optimization, Targeting Options and Metrics; Advertising Formats on Twitter, Campaign Measurement and Reporting.	8 Hours
Module-4	SEO & SMO Management: SEO Fundamentals and Principles, Keyword Research and Analysis, On-Page SEO Optimization, Off-Page SEO Including Link Building and Backlinks, Technical SEO and Site Audit, SEO Tools and Platforms such as SEMrush and Ahrefs; Setting Up Organizational Pages on Social Platforms, Content Calendar Creation, Use of Social Media Management Tools such as Buffer and Hootsuite, Social Media Analysis and Management.	8 Hours

Cont'd...

Module-#	Topics	Hours
Module-5	B2B & Marketing Analytics: B2B Digital Marketing on LinkedIn, LinkedIn Advertising Formats, Targeting Options, Sponsored Content and InMail, Lead Generation Campaigns, Campaign Optimization; Influencer Marketing Strategy, Influencer Identification and Collaboration, Measuring Influencer Marketing ROI, Influencer Marketing Platforms and Tools; Web Analytics Fundamentals, Analytics Setup and Usage, Conversion Rate Optimization Principles, Website Traffic and User Behavior Analysis.	11 Hours
Total		42 Hours

Text Books:

- T1. S. Gupta, *Digital Marketing*, 3rd Ed., McGraw-Hill, 2022.
 T2. D. Chaffey and F. Ellis-Chadwick, *Digital Marketing: Strategies, Implementation and Practice*, 6th Ed., Pearson Education, 2015.
 T3. T. L. Tuten and M. R. Solomon, *Social Media Marketing*, 3rd Ed., Sage Publications, 2017.

Reference Books:

- R1. D. Chaffey and P. R. Smith, *Digital Marketing Excellence: Planning, Optimizing and Integrating Online Marketing*, 5th Ed., Routledge Publication, 2017.
 R2. E. Enge, S. Spencer, J. C. Stricchiola, and R. Fishkin, *The Art of SEO: Mastering Search Engine Optimization*, 3rd Ed., O'Reilly Media, 2015.
 R3. S. S. Chauhan, P. Bhatia, and V. Prakash, *Digital and Social Media Marketing*, 1st Ed., Mahe Publications, 2023.
 R4. M. O. Opresnik, S. Hollensen, and P. Kotler, *Social Media Marketing: A Practitioner Approach*, Indian Edition, Vikas Publishing, 2022.

Online Resources:

- <https://nptel.ac.in/courses/110105091>: by S. Das, IIT Kharagpur
- <https://nptel.ac.in/courses/110107081>: by IIT Roorkee
- <https://nptel.ac.in/courses/110105085>: by IIT Kharagpur
- <https://nptel.ac.in/courses/110106120>: by IIT Madras
- <https://nptel.ac.in/courses/110106144>: by IIT Bombay
- <https://academy.hubspot.com/courses>
- <https://skillshop.withgoogle.com/>

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

CO1	Explain digital marketing fundamentals and design basic Google Ads with performance analysis.
CO2	Create content and email marketing campaigns using tools, automation and analytics.
CO3	Design and analyze social and video advertising campaigns across major digital platforms.
CO4	Apply SEO techniques and manage social media using industry tools and performance metrics.
CO5	Implement B2B, influencer and analytics strategies to optimize digital marketing outcomes.

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

Category	Code	Fundamentals of Business Analytics	L-T-P	Credit	Marks
MNR	MG2005		3-0-0	3	100

Objectives	The objective of this course is to introduce the fundamental concepts of business analytics with preliminary tools & techniques used for discovering important knowledge and use them for achieving business goals.
Pre-Requisites	Basic knowledge of mathematics, probability & statistics, and intermediate level of competence in spreadsheet applications is required.
Teaching Scheme	Regular classroom lectures, power point presentations with use of ICT as required, with examples, real-life case studies, assignments and projects.

Evaluation Scheme

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

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction: Business Intelligence and Business Analytics, Its importance & need for businesses, Business process flow, Business challenges, Decision making under uncertainty, Data driven decision making; Types of analytics: Descriptive, Diagnostic, Predictive, Prescriptive.	6 Hours
Module-2	Business Statistics: Data types, Descriptive and Inferential statistics, Sampling techniques, Measure of central tendencies, Measure of dispersion, Hypothesis Testing, Chi Square test, Regression and Correlation.	8 Hours
Module-3	Basic Analysis: Tools and functionalities of spread- sheets, Data recording rules, Formatting, Conditional formatting, Data protection, Working with multiple sheets & files, Hyperlinking, Cell reference, Sort, Filter, Find and replace, Data cleaning, Applying spreadsheet functions.	8 Hours
Module-4	Advanced Analysis: Data calculation and manipulation functions (Text, Unique, Sort, Transpose, Filter etc.), Data extraction Functions (Nested Ifs, If And, If Or, Xlookup, Vlookup, Index etc.), Pivot table and charts; Automation using Macros, Basics of power query, Business reporting and visual analytics, Slicers, Advanced functions on cloud-based spreadsheets (Importhtml, Importdata, Importrange, Query, Finance).	8 Hours
Module-5	Business Analytics using AI: AI tools for data insight, Business verticals, Sales and Marketing analytics, Finance analytics, Human resources analytics, Supply chain analytics.	7 Hours
Total		42 Hours

Text Books:

- T1. V. Chavda, *Fundamentals of Business Analytics*, 1st Ed., Himalaya Publishing House, 2024.
- T2. U. D. Kumar, *Business Analytics: The Science of Data-Driven Decision Making*, 2nd Ed., Wiley Publication, 2017.

Reference Books:

- R1. J. R. Evans, *Business Analytics*, 3rd Ed., Pearson Education, 2011.
- R2. S. Gupta and A. Jathar, *Marketing Analytics*, 1st Ed., Wiley Publication, 2021.
- R3. R. Bhattacharya and A. M. Bhattacharyya, *Supply Chain Analytics*, 1st Ed., Sage Publications, 2022.

Online Resources:

1. <https://nptel.ac.in/courses/110105089>: by Prof. R. P. Pradhan, IIT Kharagpur
2. <https://nptel.ac.in/courses/110106050>: by Dr. S. Vaidhyasubramaniam, IIT Madras

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

CO1	Appreciate business processes, concepts of business intelligence and analytics.
CO2	Apply statistical methods for descriptive, inferential, predictive and diagnostic analytics.
CO3	Leverage spreadsheet tools for data entry, cleaning, analysis & visualization through dashboards.
CO4	Apply advanced tools for data extraction, pivoting, automation and visual analytics.
CO5	Employ AI-driven analytics across commercial functions to guide key managerial decisions.

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

Category	Code	Programming in Python Lab	L-T-P	Credit	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*, 3rd Ed., DreamTech Press, 2021.
- 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*, 3rd Ed., O'Reilly Media, 2023.
- R2. A. Downey, *Think Python: How to Think Like a Computer Scientist*, 3rd Ed., O'Reilly Media, 2024.
- 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*, 4th Ed., Franklin, Beedle & Associates, 2024.

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	Credit	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 relational databases and structured query language.
2	Basic DML commands: Simple Select queries for data retrieval.
3	Advanced SELECT queries: Using WHERE, ORDER BY and DISTINCT.
4	Functions in SQL: Single-row & Multi-row functions for data retrieval.
5	Aggregate functions: Queries using GROUP BY and HAVING clauses.
6, 7	Nested Queries and Subqueries: Scalar and Correlated subqueries.
8	DDL commands: CREATE, ALTER and manipulate design of tables.
9, 10	DML commands: INSERT, UPDATE & DELETE on the created table.
11	Constraints: Primary key, foreign key, unique, check and not null constraints on tables.
12, 13	JOIN: Retrieve data from multiple tables using various types of JOIN operations.
14	Views: CREATE, ALTER & Manage Views from single & multiple tables.
15	Indexes: Creating and managing indexes for performance optimization.
16	Sequences: Using sequences in relational databases.
17	DCL queries: Using GRANT and REVOKE for permissions on tables.
18	Set operations: UNION, INTERSECT and EXCEPT queries.
19	Introduction to PL/SQL: Identifiers, Literals and Keywords.
20, 21	PL/SQL loops and conditional statements.
22	Exception handling in PL/SQL blocks.
23	PL/SQL block by using numeric, string & other miscellaneous datatypes.
24, 25	Cursors: Use of implicit & explicit cursors in PL/SQL.
26	Stored Procedures: Write PL/SQL block using procedures.
27, 28	Triggers: Creating BEFORE & AFTER row-level triggers.

Text Books:

- T1. S. Saxena, *Essential PostgreSQL*, 1st Ed., BPB Publications, 2025.
- T2. M. S. Hussain, *PostgreSQL 15 Cookbook*, 1st Ed., BPB Publications, 2024.
- T3. R. Obe and L. Hsu, *PostgreSQL: Up and Running*, 3rd Ed., Shroff/O'Reilly, 2017.

Reference Books:

- R1. S. Valeja and D. Gonzalez, *PostgreSQL for Jobseekers*, 1st Ed., BPB Publications, 2023.
 R2. L. Ferrari and E. Pirozzi, *Learn PostgreSQL*, 2nd Ed., Packt Publishing, 2023.
 R3. H. -J. Schönig, *Mastering PostgreSQL 12*, 3rd Ed., Packt Publishing, 2019.

Online Resources:

1. <https://nptel.ac.in/courses/106106095>: By Prof. P. S. Kumar, IIT Madras
2. <https://nptel.ac.in/courses/106105175>: by Prof. P. P. Das and others, IIT Kharagpur
3. <https://www.postgresql.org/docs/online-resources/>

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

CO1	Write SQL queries to retrieve & manipulate data with single & multi-row functions.
CO2	Create relational database with integrity constraints and query data from multiple tables.
CO3	Create views, sequences and indexes to optimize database performance.
CO4	Develop PL/SQL programs for problem-solving and simplifying complex queries.
CO5	Construct PL/SQL programs with cursors and triggers to ensure data integrity.

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

Category	Code	Internet & Web Technology Lab	L-T-P	Credit	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	Credit	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



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