Curriculum Structure & Detailed Syllabus

Bachelor of Technology

in

Electronics & Instrumentation Engineering

(Four-Year Under-Graduate Program)

Silicon University, Odisha

Silicon Hills, Patia, Bhubaneswar - 751024

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Approval History

ACM#	Date	Resolutions
SU-4	19/07/2025	The curriculum structure of B. Tech. (EIE) 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. (EIE) 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, formulate, and solve various complex engineering problems related to sensors, process instrumentation, VLSI, Biomedical and Real-time Embedded Systems by applying fundamental concepts of electronics and instrumentation.

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

PSO3. Appreciate and adapt to emerging technologies in electronics and related domains to design and create efficient systems for process automation in the real world using appropriate sensors, instruments, tools, and platforms to meet the challenges of the future.

Program Educational Objectives (PEOs)

PEO1. *Fundamental Knowledge & Core Competence*: To apply the knowledge of science, mathematics and principles of electronics & instrumentation engineering essential for a successful professional and inculcate competent problem-solving ability.

PEO2. *Proficiency for the Real World*: To inculcate the skills required to analyze, formulate, design, develop, test and optimize efficient and cost-effective electronics and instrumentation systems useful in various real world scenarios.

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
OOC	Open Online Course (on NPTEL / Swayam / Other)
INT	Summer Internship
PSI	Practice School / Industry Internship
PRJ	Project Work
SEC	Skill Enhancement Course
VAC	Value Addition Course

Contents

Part I

Curriculum Structure

Induction Program

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.(EIE)

Semester III						
Category	**Code**	**Course Title**	**WCH (L — T — P)**			**Credit**
THEORY						
PCR	MT2003	Vector Calculus & Fourier Analysis	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	EC2019	Basics of Instrumentation	3	0	0	3
PCR	EE2010	Circuit Theory	3	0	0	3
PCR	EC2004	Analog Electronic Circuits	3	1	0	4
PRACTICAL						
UCR	CS2004	OOP Using Java Lab	0	0	2	1
PCR	EC2023	Basics of Instrumentation Lab	0	0	2	1
PCR	EC2005	Analog Electronic Circuits Lab	0	0	4	2
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	MT2004	Complex Analysis & Numerical Methods	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	EC2020	Transducers & Measurement Systems	3	0	0	3
PCR	EC2007	Digital Electronic Circuits	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	EC2021	Transducers & Measurement Systems Lab	0	0	2	1
PCR	EC2008	Digital Electronic Circuits Lab	0	0	4	2
PCR	EC2022	Simulation & Design Lab	0	0	2	1
		TOTAL	**29**			**24**
		TOTAL (with Honours/Minor)	**32**			**27**

3rd Year B.Tech.(EIE)

Semester V						
Category	**Code**	**Course Title**	**WCH (L — T — P)**			**Credit**
THEORY						
PCR	EC3009	Introduction to Digital Signal Processing	3	0	0	3
PCR	EC3002	Digital VLSI Design	3	1	0	4
PCR	EC3047	Instrumentation Devices & Systems	3	1	0	4
PCR	EC3045	Communication Systems Engineering	3	0	0	3
PEL		Program Elective - I	3	0	0	3
PEL		Program Elective - II	3	0	0	3
HNS/MNR		Honours / Minor - II	3	0	0	3
PRACTICAL						
PCR	EC3048	Introduction to Digital Signal Processing Lab	0	0	2	1
PCR	EC3005	Digital VLSI Design Lab	0	0	2	1
PCR	EC3049	Instrumentation Devices & Systems 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	**28**			**25**
		TOTAL (with Honours/Minor)	**31**			**28**

Semester VI						
Category	**Code**	**Course Title**	**WCH (L — T — P)**			**Credit**
THEORY						
PCR	EC3050	Industrial Automation & Control	3	0	0	3
PCR	EC3009	Microprocessors & Microcontrollers	3	0	0	3
PCR	EE3001	Control Systems Engineering	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	EC3051	Industrial Automation & Control Lab	0	0	2	1
PCR	EC3011	Microprocessors & Microcontrollers Lab	0	0	2	1
SEC	IP3007 / 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.(EIE)

(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	IP4012	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	**200**	**160**
		GRAND TOTAL (with Honours/Minor)	**220**	**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.(EIE)

(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
OOC		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	IP4012	Skill Lab & Project - I	0	0	4	2
		TOTAL	**7**			**8**
		TOTAL (with Honours/Minor)	**15**			**16**

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

Note:

1. Courses offered under each elective are given in “List of Electives” on Page 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.(EIE)

(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
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	IP4012	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	**179**	**160**
		GRAND TOTAL (with Honours/Minor)	**197**	**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	
EC2010	Solid State Devices
EC2011	Embedded C Programming
EE2007	Soft Computing Techniques
Program Elective - II	
EC3013	IC Fabrication Technology
EC3014	IoT & Applications
EC3052	PLC, SCADA & Distributed Control Systems
Program Elective - III	
EC3054	VLSI System Design & Verification
EC3017	Embedded System Design
EC3018	Introduction to Machine Learning
Program Elective - IV	
EC3020	Analog VLSI Design
EC3021	Real Time Embedded Systems
EC3055	Virtual Instrumentation & DAQ
Program Elective - V	
EC3024	Low Power VLSI Design
EC3025	Smart Sensors for IoT
EC3056	Industrial Instrumentation
Program Elective - VI	
EC3028	Design of Semiconductor Memories
EC3029	Industrial IoT
EC3019	MEMS & Sensor Design
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
Honours in Electronics & Instrumentation Engineering	
EC2018	Advanced Electronic Circuits
EC3057	Mechatronics in Manufacturing
EC3058	Biomedical Instrumentation & Signal Processing
EC4007	Advanced Sensor Technology
EC4008	Analytical Instrumentation
Minor in "Sustainable Energy & E-Mobility"	
EC2024	Power Electronic Devices
EE2008	Renewable Energy Systems
EE3022	Basics of Power Systems
EE3024	Smart Power Systems
EE4002	Electric & Hybrid Vehicles
Minor in "Information Technology"	
CS2003	Operating Systems
CS2008	Computer Organization & Architecture
CS2002	Design & Analysis of Algorithms
CS2009	Database Management Systems
CS4001	Internet Technology & Applications
Minor in "Artificial Intelligence & Machine Learning"	
CS3013	Data Mining & Data Warehousing
CS2014	Artificial Intelligence
CS3002	Machine Learning
CS4003	Human Language Processing
CS4004	Advanced Machine Learning
Minor in "Business Management"	
MG2002	Digital Marketing & SMO
MG3003	Human Resource Information Systems
MG3004	E-Commerce & Supply Chain Management
MG4005	Financial Management
MG4006	Business Strategy
Minor in "Business Analytics"	
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:

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

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Engineering Chemistry	L-T-P	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	2	1	1
CO3	2	2	1	2	1	1	1	1			1	2	1	1
CO4	2	2	2	1	1	1	1	1			1	1	2	2
CO5	2	2	1	1	1	1	1				1	2	1	2

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-Savarat'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. 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 discussionon the First law for cycle, closed system and open system (steady flow energy equation, SFEE), Perpetual Motion Machines, PMM1.	**7 Hours**
Module-3	Introduction to Second Law of Thermodynamics, Kelvin-Planck and Clausius' Statements and their Equivalence, Corollaries, PMM2, Carnot's Principle and Cycle, Entropy, Clausius' Inequality, Principle of Entropy and its application, T-s plot.	**7 Hours**
Module-4	Applications of Thermodynamics, Brief description and working principles of Steam Power Plant, Refrigerators and Heat pump, I.C. Engines (two-stroke and four-stroke, petrol and diesel) and Aircraft Propulsion Engines, Brayton Cycle, Rankine Cycle, Comparison.	**7 Hours**
	Total	**28 Hours**

Text Books:

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

Reference Books:

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

P.T.O

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Computer Programming	L-T-P	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. Kanetker, ***Let Us C***, 16th *Ed.*, BPB Publications, 2018.

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Constitution of India & Professional Ethics	L-T-P	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	2	2	1
CO2	3	3	3	2	2	2					1	2	1	1
CO3	3	3	2	2	2	1					1	2	1	1
CO4	3	3	3	3	2	2					1	2	2	1
CO5	3	3	3	2	2	2					1	2	3	1

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

T1. R. L. Boylestad and L. Nashelsky, ***Electronic Devices and Circuit Theory***, 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									2	2	2
CO2	3	3	2	1								3	3	2
CO3	2	2	2	1							2	3	2	2
CO4	2	2	3								2	3	3	2

Category	Code	Basic Electrical Engineering Lab	L-T-P	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:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

Category	Code	Computer Programming Lab	L-T-P	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. Kanetker, ***Let Us C***, 16th *Ed.*, BPB Publications, 2018.

Reference Books:

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

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Communicative & Technical English	L-T-P	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 Skils***, Oxford University Press, 2011.
R3. T. Panigrahi, ***Communicative Competence***, 1st *Ed.*, Notion Press, 2024.

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

Cont'd. . .

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

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

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

Category	Code	Workbench Practices	L-T-P	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. Haldar, ***Electronics Course Book: Basic Components, IC boards, SMD, Logic Gates, Transistors, Resistors, Capacitors, Diodes, Audio Circuit and More***, GRPV Arts and Office Supplies, 2024.
T3. R. S. Khandpur, ***Printed Circuit Boards: Design, Fabrication, Assembly and Testing***, 1st *Ed.*, McGraw Hill,2006.

Reference Books:

R1. H. Joshi, ***Residential, Commercial and Industrial Electrical Systems: Protection, Testing and Commissioning, Vol-3***, McGraw-Hill Education, 2008.

R2. S. Monk, ***Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards***, 1st *Ed.*. McGraw-Hill, 2014.
R3. J. Varterisian, ***Fabricating Printed Circuit Boards***, 1st *Ed.*, Newnes, 2002.
R4. A. Kemp, ***The Makerspace Workbench: Tools, Technologies and Techniques for Making***, O'Reilly Media, 2013.

Online Resources:

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

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

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

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

CO1	Understand and apply the concepts of lettering and dimensioning for drafting of machine drawings and building drawings and different 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	2	2	1
CO2	2	2	3	2	1	1					1	2	1	1
CO3	2	2	3	2	1	1					1	2	1	1
CO4	2	2	2	3	1	1					1	2	2	1
CO5	2	2	3	3	1	1					1	2	3	1

Category	Code	Corporate Communication Skills	L-T-P	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:

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

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

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

Program Outcomes Relevant to the Course:

PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

Cont'd. . .

PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

P.T.O

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	OOP Using Java	L-T-P	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	Basics of Instrumentation	L-T-P	Credit	Marks
PCR	EC2019		3-0-0	3	100

Objectives	The objective of this course is to introduce the basic principles & uses of different electrical & electronic measuring instruments including applications of transducers, storage, display and data acquisition systems.
Pre-Requisites	Basic knowledge of intermediate physics, mathematics, basic electrical and electronics engineering 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	Qualities of Measurement: Significance of measurement, Significant figure, Functional elements of generalized measurement systems, Deflection & null type instruments; Static & Dynamic Characteristics: Systematic statistical characteristics, Calibration; Errors in measurement, Concept of calibration and loading effects of series and shunt connected instruments.	**9 Hours**
Module-2	Bridge Circuits: DC and AC Bridges, Errors in bridge circuits, Quality factor (Q) and dissipation factor(D), General equations for Bridge Balance; Application of DC and AC bridges: Resistance measurement, Insulation resistance measurement, Inductance measurement (Maxwell's, Hay's and Anderson bridge) and Capacitance measurement (Wien's, Owens's and Schering Bridge).	**9 Hours**
Module-3	Measuring Instruments: DC Galvanometer, DC Potentiometer, PMMC and MI instruments, Voltmeters, Ammeters, Ohmmeters, Extension of the range of instruments; AC Indicating Instruments: EDM Wattmeter (1-phase & 3-phase), Energy meter; Basics of instrument transformer, Digital CRO, DVM, Digital frequency meter and spectrum analyzer.	**9 Hours**
Module-4	Basic Sensing Elements: Sensors, Transducers, Classification & selection of transducers; Resistive Sensing Elements: Resistive potentiometers, strain gauges, RTD and Thermistor; Inductive Sensing Elements: Principle, inductive displacement sensor, push-pull type, LVDT, RVDT, Hall effect sensors.	**8 Hours**
Module-5	Capacitive Transducers: Variable separation, Area dielectric displacement transducer, Push-pull type capacitive sensor, Pressure, Humidity and Level measurement.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. E. W. Golding and F. C. Widdis, ***Electrical Measurements and Measuring Instruments***, 5th *Ed.*, Reem Publication, 2015.

T2. A. K. Ghosh, ***Introduction to Measurement and Instrumentation***, 3rd *Ed.*, PHI Learning, 2009.

T3. H. S. Kalsi, ***Electronic Instrumentation and Measurements***, 4th *Ed.*, McGraw-Hill Education, 2019.

T4. A. K. Sawhney, ***A Course in Electrical and Electronics Measurements & Instrumentation***, Dhanpat Rai & Co, 2015.

Reference Books:

R1. J. J. Carr, ***Elements of Electronics Instrumentation Measurement***, 3rd *Ed.*, Pearson Education, 2003.
R2. D. A. Bell, ***Electronic Instrumentation and Measurements***, 3rd *Ed.*, Oxford University Press, 2013.
R3. J. P. Bentley, ***Principles of Measurement Systems***, 4th *Ed.*, Pearson Education, 2005.
R4. D. V. S. Murthy, ***Transducers and Instrumentation***, 2nd *Ed.*, PHI Learning, 2008.

Online Resources:

1. https://nptel.ac.in/courses/108105153: by Prof. A. Chatterjee, IIT Kharagpur
2. https://nptel.ac.in/courses/108105062: by Prof. Mukhopadhyay and Sen, IIT Kharagpur
3. https://nptel.ac.in/courses/108105064: by Prof. A. Barua, IIT Kharagpur
4. https://nptel.ac.in/courses/108108147: by Prof. H. J. Pandya, IISc Bangalore.

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

CO1	Explain the characteristics, errors, and calibration concepts of different measuring instruments.
CO2	Evaluate the values of R, L, and C using suitable bridges and their applications.
CO3	Analyze the construction, characteristics, and working principles of various measuring instruments.
CO4	Explain the construction, characteristics, and working principles of different sensing elements used in different measuring instruments.
CO5	Explore the concepts of capacitive transducers and their applications in modern industrial instrumentation.

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

Cont'd. . .

PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

Category	Code	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 robus and concurrent programs using exception handling and multi-threading.
CO4	Design programs using I/O operations, String classes and collection framework.
CO5	Design GUI applications using Swing and database connectivity.

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

R1. L. K. Maheshwari and M. M. S. Anand, ***Laboratory Experiments and PSPICE Simulations in Analog Electronics***, PHI Learning, 2006.
R2. L. K. Maheshwari and M. M. S. Anand, ***Laboratory Manual for Introductory Electronics Experiments***, John Wiley & Sons, 1980.
R3. K. A. Navas, ***Electronics Lab Manual, Vol-2***, 6th *Ed.*, PHI Learning, 2018.

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Basics of Instrumentation Lab	L-T-P	Credit	Marks
PCR	EC2023		0-0-2	1	100

Objectives	The objective of this laboratory course is to practically understand the concepts of static characteristics, dynamic characteristics, error analysis tools, principles, testing & calibration of different measuring instruments.
Pre-Requisites	Basic knowledge of different electrical and magnetic circuits. Topics taught in Basics of Instrumentation 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 in the pre-lab session.

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 static and dynamic characteristics of a Measuring Instrument.
2	Statistical analysis of errors in measurement (using standard dataset).
3	Measurement of Low Resistance using Kelvin's Double Bridge.
4	Design & testing of Sinusoidal Oscillator.
5	Measurement of Self Inductance using Anderson's Bridge.
6	Calibration of capacitance sensor using Schering Bridge.
7	Measurement of frequency using Wien's Bridge.
8	Measurement of R, L, and C using Q-meter (bandwidth of a resonance circuit and Q-meter).
9	Study and testing of energy meter and clamp meter.
10	Study of Lissajous pattern and measurement of unknown frequency.
11	Temperature measurement by RTD and Thermistor.
12	Measurement of force using strain gauge.
13	Displacement measurement using LVDT.
14	Level measurement using capacitive transducer & its calibration.

Text Books:

T1. A. K. Sawhney, ***A Course in Electrical and Electronics Measurements & Instrumentation***, Dhanpat Rai & Co, 2015.
T2. A. K. Ghosh, ***Introduction to Measurement and Instrumentation***, 4th *Ed.*, PHI Learning, 2009.

Reference Books:

R1. D. A. Bell, ***Electronic Instrumentation and Measurements***, 3rd *Ed.*, Oxford University Press, 2013.
R2. D. V. S. Murthy, ***Transducers and Instrumentation***, 2nd *Ed.*, PHI Learning, 2008.
R3. E. W. Golding and F. C. Widdis, ***Electrical Measurements and Measuring Instruments***, 5th *Ed.*, Reem Publication, 2015.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/108105153: by Prof. A. Chatterjee
2. https://nptel.ac.in/courses/108105062: by Prof. Mukhopadhyay and Sen, IIT Kharagpur
3. https://nptel.ac.in/courses/108105064: by Prof. A. Barua, IIT Kharagpur
4. https://nptel.ac.in/courses/108108147: by Prof. H. J. Pandya, IISc Bangalore

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

CO1	Investigate performance characteristics and evaluate errors of a measuring instrument.
CO2	Accurately measure various electrical parameters using appropriate instruments.
CO3	Measure physical parameters using relevant sensors and measuring instruments.
CO4	Perform analysis on time domain signals to measure unknown parameters.
CO5	Investigate the response of measuring 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).
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	1	1
CO2	3	3	3	2							2	3	1	2
CO3	2	2	3	3							3	3	3	2
CO4	3	3	2	3							3	3	1	1
CO5	3	3	2	3							3	3	2	3

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Programming in Python	L-T-P	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. 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	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	Transducers & Measurement Systems	L-T-P	Credit	Marks
PCR	EC2020		3-0-0	3	100

Objectives	The objective of this course is to study the characteristics of different types of measurement systems and industrial applications of various transducers & sensors for design & construction of precise measuring instruments.
Pre-Requisites	Basic knowledge of physics, mathematics, electrical and electronics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

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

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Dynamic Characteristics: Transfer functions of typical sensing elements, Step & frequency response of first & second-order elements, Dynamic errors, Dynamic compensation; Temperature Measurement: Thermal expansion methods - Bimetallic, Liquid in glass, Thermocouples (Laws, Characteristics, Installation), RTDs (3-wire & 4-wire type), Thermistor, IC type Temperation Sensor, Thermal Radiation Pyrometer (narrowband & broadband), Optical pyrometer.	**9 Hours**
Module-2	Force Measurement: Bourdon tube, bellows, diaphragm, load cell; Torque Measurement: Torsion Bar; Pressure Measurement: Manometers, Mc-Leodgauge, Thermal conductivity, and Ionization gauge; Flow Measurement: Variable Head (Orifice, Venturi, Pitot static), Variable area (Rotameter), Turbine flow meter, Electromagnetic flow meter, Ultrasonic flow meter, Doppler velocity meter.	**9 Hours**
Module-3	Translational & Rotational Velocity Measurement: Moving coil moving magnet pickups, Eddy current magnetic & photoelectric pulse counting; Seismic Measurement: Seismic displacement, velocity & acceleration pickups. Miscellaneous Sensors: Optical sensors, Principle, intensity and phase-modulated sensors, FBG sensor.	**8 Hours**
Module-4	Acceleration Measurement: Piezoelectric transducers - Basic principle, Equivalent circuit, Frequency response, Charge amplifier; Accelerometers: Basic principle & frequency response, MEMS Accelerometer; Miscellaneous Measurements: Level measurements using floats; pH and Liquid Conductivity Measurement: Basic principles, Viscosity Measurement, Chemical Sensors: ISFET, Electro-chemical.	**8 Hours**
Module-5	Signal Conditioning Elements: Deflection bridges - design of resistive & reactive bridges, push-pull configuration for improvement of linearity & sensitivity; Application of Operational Amplifiers: Instrumentation amplifier, Isolation amplifier, Analog filters, Charge amplifier design, AC carrier systems, Phase-sensitive demodulators and its applications.	**8 Hours**
	Total	**42 Hours**

P.T.O

Text Books:

T1. J. P. Bentley, ***Principles of Measurement Systems***, 4th *Ed.*, Pearson Education, 2005.
T2. A. K. Ghosh, ***Introduction to Measurement and Instrumentation***, 3rd *Ed.*, PHI Learning, 2009.

Reference Books:

R1. D. Patranabis, ***Sensors and Transducers***, 2nd *Ed.*, PHI Learning, 2013.
R2. D. V. S. Murthy, ***Transducers and Instrumentation***, 2nd *Ed.*, PHI Learning, 2008.
R3. E. O. Doeblin, ***Measurement Systems - Applications and Design***, 6th *Ed.*, McGraw Hill, 2007.
R4. C. Rangan, G. Sarma, and V. S. V. Mani, ***Instrumentation : Devices and Systems***, 2nd *Ed.*, McGraw Hill, 2017.
R5. B. G. Liptak, ***Instrument Engineers' Hand Book (Process Measurement & Analysis)***, 4th *Ed.*, CRC Press, 2006.

Online Resources:

1. https://nptel.ac.in/courses/108/105/108105088/: by Prof. S. Mukhopadhyay, IIT Kharagpur
2. https://nptel.ac.in/courses/108/105/108105062/: by Prof. Mukhopadhyay and Sen, IIT Kharagpur
3. https://nptel.ac.in/courses/108/105/108105064/: by Prof. A. Barua, IIT Kharagpur
4. https://nptel.ac.in/courses/108/108/108108147/: By Prof. H. J. Pandya, IISc Bangalore

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

CO1	Explain various measuring instruments and use temperature sensors in industrial applications.
CO2	Articulate the principles and uses of different force, torque, pressure sensors, and flow meters.
CO3	Utilize the concepts of velocity measurement and specialized optical sensors.
CO4	Determine special measuring principles of different physical parameters using various sensors.
CO5	Analyze the design of signal conditioning circuits and evaluate their performance.

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

P.T.O

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

P.T.O

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

Reference Books:

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

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

Category	Code	Advanced Electronic Circuits	L-T-P	Credit	Marks
HNS	EC2018		3-0-0	3	100

Objectives	The objective of this course is to learn the advanced electronic circuits such as filters, multivibrators, timers, etc., and their applications in the real world.
Pre-Requisites	Fundamental knowledge of basic electronics and analog electronics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

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

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Active Filters**: Active filters and their frequency response, First- and second-order low-pass and high-pass Butterworth filters, Filter design, Frequency scaling, Band-pass and band-reject filters (wide and narrow), All-pass filters; **Oscillators**: principles, types, Quadrature and voltage-controlled oscillator, Sawtooth wave generator; **Comparators**: Basic comparator, Zero-crossing detector, Schmitt trigger, Comparator characteristics, Limitations of op-amp as comparators.	**9 Hours**
Module-2	**Multivibrator**: Bi-stable (fixed bias and self-bias) multivibrator, Loading, Commutating capacitors, Triggering the binary (symmetrical and asymmetrical through unilateral device), Schmitt trigger circuit (emitter-coupled bi-stable MV), Mono-stable multivibrator (collector- and emitter-coupled), Gate width and waveforms, Triggering of the monostable MV, Astable multivibrator (collector- and emitter-coupled).	**9 Hours**
Module-3	**Wide-band Amplifiers**: The Hybrid-π, High-frequency, small-signal common-emitter model, RC-coupled amplifier, Frequency response of a transistor stage, Short-circuit current gain, Current gain with resistive load, Transistor amplifier response taking source impedance into account, Transient response of a transistor stage; **Negative Resistance Switching Devices**: Voltage-controllable negative resistance devices, Tunnel diode operation and characteristics, Monostable, astable, bi-stable operations using tunnel diode, Voltage-controlled negative resistance switching circuits.	**8 Hours**
Module-4	**Voltage & Current Time Base Generators**: Time-base generators, General features of a time-base signal, Methods of generating a voltage time-base waveform, Exponential sweep circuit, Miller and bootstrap time-base generators - basic principles, Transistor Miller and transistor bootstrap time-base generators, Current time-base generators, A simple current sweep, Linearity correction through adjustment of driving waveform, Transistor current time-base generator.	**8 Hours**
Module-5	**Specialized IC Applications**: IC 555 timer as monostable and astable multivibrator, Applications, Phase locked loop – Operating principle of PLL, Phase detectors, Exclusive-OR and monolithic phase detectors, Instrumentation amplifier and its applications.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. J. Millman and H. Toub, ***Pulse, Digital and Switching Waveforms***, 3rd *Ed.*, McGraw Hill, 2017.
T2. R. A. Gayakwad, ***Op-Amps and Linear Integrated Circuits***, 4th *Ed.*, Pearson Education, 2015.

Reference Books:

R1. A. A. Kumar, ***Pulse and Digital Circuits***, 2nd *Ed.*, PHI Learning, 2008.
R2. K. V. Rao, K. R. Sudha, and G. M. Rao, ***Pulse and Digital Circuits***, 1st *Ed.*, Pearson Education, 2011.

Online Resources:

1. https://nptel.ac.in/courses/108102095: by Prof. S.C. Dutta Roy, IIT Delhi
2. https://nptel.ac.in/courses/117107094: by Dr. P. Agarwal, IIT Roorkee
3. https://nptel.ac.in/courses/117108038: by Prof. M. K. Gunasekaran, IISc Bangalore
4. https://www.elprocus.com/types-active-filters-and-applications/

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

CO1	Explain the concepts of active filters, oscillators, comparators, and signal generators with uses.
CO2	Differentiate and analyze astable, monostable and bistable multivibrator circuits.
CO3	Design multivibrator and microwave circuits using wideband amplifiers and NDR devices.
CO4	Design and implement voltage and current time-base generators for engineering applications.
CO5	Implement specialized ICs like timers, PLLs, and instrumentation amplifiers for 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).
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

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Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Cont'd. . .

Module-#	Topics	Hours
Module-5	**Secondary Storage Structure**: Overview of mass storage structure, Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, LOOK, CLOOK, Swap-space management, RAID structure; File System: Concept, Access methods, Directory structure, Directory implementation, Allocation methods, Free space management, 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	Data Mining & Data Warehousing	L-T-P	Credit	Marks
MNR	CS3013		3-0-0	3	100

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

Evaluation Scheme

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

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Data Warehousing**: Concepts and applications, Difference between operational database and data warehouses, OLTP and OLAP systems, 3-tier architecture, ETL Process, Data Marts, Data staging area, Metadata.	**8 Hours**
Module-2	**Data Mining**: Concepts and applications, KDD process, Data Objects and attributes types, Basic Statistical Descriptions of Data – Central tendency - variation, spread, standard deviation and Boxplot, Data similarity; Data Pre-processing – Data cleaning, binning, integration, reduction and transformation; Correlation Analysis – Pearson's coefficient, Chi-Square and Covariance.	**10 Hours**
Module-3	**Mining Frequent Patterns**: Introduction, Market Basket Analysis, Association rule mining, Support, Confidence, Lift, Frequent Item-sets, Closed Item-sets, Maximal Item-set and generation, Apriori and FP-Growth algorithms, Evaluation of association patterns, Association and Correlation analysis.	**8 Hours**
Module-4	**Classification**: Concepts and applications, Decision Tree Induction, Information Gain, Bayes Theorem, Naïve Bayesian Classifier, K Nearest Neighbor; Classification evaluation techniques (Confusion matrix – Precision, Recall & F-Measure), Handling the class imbalance problem (Oversampling, Undersampling, Threshold moving and Ensemble techniques).	**8 Hours**
Module-5	**Clustering**: Concepts and applications, Partition-based Clustering – K-Means and K-Medoid algorithms, Hierarchical clustering – Agglomerative and Divisive methods, Density-based Clustering – DBSCAN, Graph-based clustering, Clustering evaluation techniques (Silhouette Coefficient and Dunn's Index).	**8 Hours**
	Total	**42 Hours**

Text Books:

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

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

P.T.O

Reference Books:

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

Online Resources:

1. https://nptel.ac.in/courses/106105174/: by Prof. P. Mitra, IIT Kharagpur
2. https://nptel.ac.in/courses/110107092: by Prof. G. Dixit, IIT Roorkee
3. http://infolab.stanford.edu/~ullman/mining/2003.html: notes by Stanford University
4. https://www.cse.iitb.ac.in/~krithi/courses/631/anand.ppt: by Prof. A. Deshpande, IIT Bombay

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

CO1	Describe the concepts and applications of Data Warehouse and its components.
CO2	Explain the concepts of Data Mining and its applications.
CO3	Construct frequent patterns and association rules by discovering correlations among data.
CO4	Compare key classification algorithms and apply them to real life problems in multiple domains.
CO5	Apply different clustering algorithms for solving real life problems in various domains.

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	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:

1. https://nptel.ac.in/courses/110105091: by S. Das, IIT Kharagpur
2. https://nptel.ac.in/courses/110107081: by IIT Roorkee
3. https://nptel.ac.in/courses/110105085: by IIT Kharagpur
4. https://nptel.ac.in/courses/110106120: by IIT Madras
5. https://nptel.ac.in/courses/110106144: by IIT Bombay
6. https://academy.hubspot.com/courses
7. 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).

Cont'd. . .

PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
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	Digital Electronic Circuits Lab	L-T-P	Credit	Marks
PCR	EC2008		0-0-4	2	100

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

P.T.O

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

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

Category	Code	Transducers & Measurement Systems Lab	L-T-P	Credit	Marks
PCR	EC2021		0-0-2	1	100

Objectives	The objective of this laboratory course is to get practical exposure to transducers and measurement systems for accurately measuring temperature, weight, position/displacement, pressure, flow, level, etc.
Pre-Requisites	Basic knowledge of physics, mathematics, electrical and electronics is required. Topics taught in TMS 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 in the pre-lab session.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Analyze the response of the vibration sensor.
2	Temperature sensing using semiconductor type temperature sensor.
3	Weight measurement using strain gauge Load cell.
4	Implementation of LVDT and its signal conditioning for position/displacement measurement.
5	Pressure measurement using Bourdon tube and diaphragm type sensor.
6	Temperature measurement using a thermocouple.
7	Flow measurement using turbine-type flow sensor.
8	Time duration measurement using DAQ system and LabView.
9	Speed measurement using optical and variable reluctance type transducers.
10	Design of active 2nd order low pass filter.
11	Design of a piezoelectric accelerometer with charge amplifier configuration
12	Design of Instrumentation amplifiers.
13	Design of Phase sensitive detector.
14	Analyze the characteristics of Fiber Bragg Grating (FBG) sensor.

Text Books:

T1. J. P. Bentley, ***Principles of Measurement Systems***, 4th *Ed.*, Pearson Education, 2005.
T2. A. K. Ghosh, ***Introduction to Measurement and Instrumentation***, 3rd *Ed.*, PHI Learning, 2009.

Reference Books:

R1. D. Patranabis, ***Sensors and Transducers***, 2nd *Ed.*, PHI Learning, 2013.
R2. D. V. S. Murthy, ***Transducers and Instrumentation***, 2nd *Ed.*, PHI Learning, 2008.
R3. E. O. Doeblin, ***Measurement Systems - Applications and Design***, 6th *Ed.*, McGraw Hill, 2007.

Online Resources:

1. https://nptel.ac.in/courses/108105088: by Prof. S. Mukhopadhyay, IIT Kharagpur
2. https://nptel.ac.in/courses/108105062: by Prof. Mukhopadhyay and Sen, IIT Kharagpur
3. https://nptel.ac.in/courses/108105064: by Prof. A. Barua, IIT Kharagpur
4. https://nptel.ac.in/courses/108108147: By Prof. H. J. Pandya, IISc Bangalore

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

CO1	Analyze the characteristics of RTD and Thermistor.
CO2	Measure temperature, weight and position using different sensors.
CO3	Explain the techniques to measure flow, level and speed using various types of sensors.
CO4	Conceptualize and design different types of active filters.
CO5	Design instrumentation amplifiers and phase sensitive detectors.

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

Category	Code	Simulation & Design Lab	L-T-P	Credit	Marks
PCR	EC2022		0-0-2	1	100

Objectives	The objective of this laboratory course is to provide hands-on experience in simulating, designing, and analyzing systems using advanced tools. Students will gain practical insights into signal processing, data acquisition, hardware interfacing, and the integration of software with physical systems.
Pre-Requisites	Knowledge of programming, analog & digital electronics, sensors, and transducers is required to conduct the experiments.
Teaching Scheme	Regular laboratory experiments conducted under supervision of the teacher. Demonstration will be given for each experiment in the pre-lab session.

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 MATLAB: Basic commands, plotting, and simulating simple mathematical models.
2	Design and simulation of RC, RL and RLC circuits in time and frequency domains.
3	Simulation and analysis of transient and steady-state responses of electrical systems.
4	Introduction to LabVIEW: Creating simple virtual instruments (VIs) for data acquisition and analysis.
5	Simulate the step response of a first-order system using LabVIEW.
6	Arduino Basics: Setting up the IDE, blinking LEDs, and interfacing simple input/output devices.
7	Temperature measurement using an LM35 sensor with Arduino and displaying data on the serial monitor.
8	Interfacing an ultrasonic sensor with Arduino for distance measurement.
9	Pulse Width Modulation (PWM) generation and motor speed control using Arduino.
10	Interfacing an LDR (Light Dependent Resistor) with Arduino for light intensity measurement.
11	Build a virtual oscilloscope for signal visualization using LabVIEW.
12	Measure voltage from a sensor or potentiometer and display it in LabVIEW.
13	Signal processing: Filtering and FFT analysis of sensor signals using LabVIEW.
14	Mini Project: Design and implementation of a simple system integrating Arduino, sensors, and LabVIEW.

Text Books:

T1. G. Johnson, ***LabVIEW Graphical Programming***, 4th *Ed.*, McGraw Hill, 2006.
T2. A. K. Sawhney, ***A Course in Electrical and Electronics Measurements & Instrumentation***, Dhanpat Rai & Co, 2015.
T3. M. Schwartz, ***Internet of Things with Arduino Cookbook***, Packt Publishing, 2016.

P.T.O

Reference Books:

R1. R. Pratap, ***Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers***, South Asia Edition, Oxford University Press, 2010.
R2. D. V. S. Murthy, ***Transducers and Instrumentation***, 2nd *Ed.*, PHI Learning, 2008.
R3. G. W. Johnson and R. Jeninngs, ***LabVIEW Graphical Programming***, 4th *Ed.*, McGraw-Hill Education, 2019.

Online Resources:

1. https://nptel.ac.in/courses/108107115: by Prof. Yogesh Vijay Hote, IIT Roorkee.
2. https://nptel.ac.in/courses/103106118: by Prof. Dr. Niket S.Kaisare, IIT Madras.
3. https://nptel.ac.in/courses/108105376: by Prof. Banibrata Mukherjee, IIT Kharagpur.
4. https://nptel.ac.in/courses/106106210: by Prof. Janakiraman Viraraghavan, IIT Madras.

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

CO1	Simulate mathematical models, analyze circuits and evaluate responses of systems.
CO2	Design and create virtual instruments for data acquisition, signal processing, and visualization.
CO3	Interface various sensors for data acquisition and control using Arduino programming.
CO4	Apply signal processing techniques to interpret sensor outputs effectively.
CO5	Design, simulate, and prototype integrated systems to solve real-world problems.

Program Outcomes Relevant to the Course:

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

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

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

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