Curriculum Structure & Detailed Syllabus

Bachelor of Technology

in

Electrical & Electronics Engineering

(Four-Year Under-Graduate Program)

Silicon University, Odisha

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https://silicon.ac.in

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Approval History

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

Knowledge and Attitude Profile (WK's)

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

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

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

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

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

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

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

WK7. Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8. Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9. Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Program Outcomes (PO's)

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

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

PO2. **Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).

PO3. **Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).

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

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

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

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

PO8. **Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9. **Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10. **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

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

Program Specific Outcomes (PSOs)

PSO1. Understand, analyze, formulate and solve engineering problems of varying complexity in Electrical and Electronics Engineering by implementing the fundamental principles of electrical machines, power systems, power electronics, control systems and signal processing.

PSO2. Acquire the skills in modern methodologies, tools and 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. Adapt to the emerging developments in electrical sciences, apply modern practices & strategies in project development using hardware & software environments to deliver quality solutions considering green energy challenges of the future.

Program Educational Objectives (PEOs)

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

PEO2. *Proficiency for the Real World*: To foster creative ability and skills required to analyze, design, test, and implement emerging technologies in electronics & power systems with economic considerations, useful in the real world.

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

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

Course Categories & Definitions

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

Contents

Part I

Curriculum Structure

Induction Program

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

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

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

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

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

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

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

Curriculum Structure

1st Year B.Tech. (Common)

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

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

1st Year B.Tech. (Common)

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

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

2nd Year B.Tech.(EEE)

Semester III								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	MT2003	Vector Calculus & Fourier Analysis	3	0	0	3	0	0
UCR	CS2001	OOP Using Java	3	0	0	3	0	0
UCR	MG2001 / BL2001	Management & Economics for Engineers / Biology for Engineers	3	0	0	3	0	0
PCR	EC2016	Analog Electronics	3	0	0	3	0	0
PCR	EE2001	Circuits & Signals	3	1	0	3	1	0
PCR	EE2002	Electromagnetic Theory	3	0	0	3	0	0
PRACTICAL								
UCR	CS2004	OOP Using Java Lab	0	0	2	0	0	1
PCR	EC2017	Analog Electronics Lab	0	0	2	0	0	1
PCR	EE2003	Circuits & Signals Lab	0	0	4	0	0	2
INT	IP2001	Summer Internship - I	0	0	0	0	0	1
		TOTAL	**27**			**24**		

Semester IV								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	MT2004	Complex Analysis & Numerical Methods	3	0	0	3	0	0
UCR	CS2007	Programming in Python	3	0	0	3	0	0
UCR	MG2001 / BL2001	Management & Economics for Engineers / Biology for Engineers	3	0	0	3	0	0
PCR	EC2001	Digital Electronics	3	0	0	3	0	0
PCR	EE2004	Electrical Machines	3	1	0	3	1	0
PEL		Program Elective - I	3	0	0	3	0	0
HNS/MNR		Honours / Minor - I	3	0	0	3	0	0
PRACTICAL								
UCR	CS2010	Programming in Python Lab	0	0	2	0	0	1
PCR	EE2005	Electrical Machines Lab	0	0	4	0	0	2
PCR	EC2002	Digital Electronics Lab	0	0	2	0	0	1
PCR	EE2006	Electrical & Electronics Design Lab	0	0	2	0	0	1
		TOTAL	**29**			**24**		
		TOTAL (with Honours/Minor)	**32**			**27**		

3rd Year B.Tech.(EEE)

Semester V								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR		Control Systems Engineering	3	0	0	3	0	0
PCR		Electrical Power Transmission & Distribution	3	0	0	3	0	0
PCR		Electrical & Electronics Measurement	3	0	0	3	0	0
PCR		Power Electronics	3	1	0	3	1	0
PEL		Program Elective - II	3	0	0	3	0	0
PEL		Program Elective - III	3	0	0	3	0	0
HNS/MNR		Honours / Minor - II	3	0	0	3	0	0
PRACTICAL								
PCR		Control Systems Engineering Lab	0	0	2	0	0	1
PCR		Power Electronics Lab	0	0	2	0	0	1
PCR		Electrical & Electronics Measurement lab	0	0	2	0	0	1
SEC		Soft Skills & Interpersonal Skills	0	0	2	0	0	1
INT		Summer Internship - II	0	0	0	0	0	1
		TOTAL	**27**			**24**		
		TOTAL (with Honours/Minor)	**30**			**27**		

Semester VI								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR		Fundamentals of MPMC	3	0	0	3	0	0
PCR		Power Systems Operation & Control	3	1	0	3	1	0
PCR		Introduction to Digital Signal Processing	3	0	0	3	0	0
PEL		Program Elective - IV	3	0	0	3	0	0
PEL		Program Elective - V	3	0	0	3	0	0
PEL		Program Elective - VI	3	0	0	3	0	0
HNS/MNR		Honours / Minor - III	3	1	0	3	1	0
PRACTICAL								
PCR		Fundamentals of MPMC Lab	0	0	2	0	0	1
PCR		Power Systems Lab	0	0	2	0	0	1
SEC	/	Emerging Technologies Lab / Entrepreneurship & Innovation	0	0	4	0	0	2
SEC		Professional & Technical Writing	0	0	2	0	0	1
VAC		Yoga / NSS / NCC / PES / CPA *	0	0	2	0	0	0
		TOTAL	**31**			**24**		
		TOTAL (with Honours/Minor)	**35**			**28**		

*__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.(EEE)

(Without Practice School Option)

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

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

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

Note:

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

4th Year B.Tech.(EEE)

(With Practice School Option in 7th Semester)

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

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

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

Note:

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

4th Year B.Tech.(EEE)

(With Practice School Option in 8th Semester)

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

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

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

Note:

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

List of Electives

Code	Elective # and Subjects
Program Elective - I	
EC2018	Advanced Electronic Circuits
EE2007	Soft Computing Techniques
EE2008	Renewable Energy Systems
Program Elective - II	
	IoT & Applications
	HVDC Transmission
	Microwave Engineering
Program Elective - III	
	Smart Grid
	Electrical Drives
	Communication Systems Engineering
Program Elective - IV	
	Flexible AC Transmission Systems
	Advanced Power Electronics
	Fiber Optic Communications
Program Elective - V	
	Power System Protection
	Advanced Control Systems
	Introduction to VLSI Design
	Mobile Communication & Networks
Program Elective - VI	
	Power Quality
	High Voltage Engineering
	Digital Image & Video Processing
	PLC & SCADA
Open Elective - I & II (Basket)	
	Applied Linear Algebra
	Stochastic Processes
	Numerical Optimization
	Simulation & Modelling
	Fluid Mechanics
	Power Plant Engineering
	Project Management
	Organizational Behaviour
	Entrepreneurship Development
	Securities Analysis, Investment & Trading
	Circular Economy

List of Tracks for Honours / Minor

Code	Honours / Minor # and Subjects
Honours in Electrical & Electronics Engineering	
EE2009	Design of Electrical Apparatus
	Advanced Electrical Machines
	Electric & Hybrid Vehicles
	Embedded System Design
	Power Distribution Systems
Minor in "VLSI System Design & Verification"	
EC2013	Semiconductor Devices
	Digital VLSI Design
	IC Fabrication Technology
	Digital IC Design & Verification
	Analog VLSI Design
Minor in "Embedded & IoT System Design"	
EC2011	Embedded C Programming
	Sensors & Transducers
	Embedded System Design
	Real Time Embedded Systems
	Industrial IoT
Minor in "Information Technology"	
CS2003	Operating Systems
	Computer Organization & Architecture
	Algorithm Design & Analysis
	Fundamentals of DBMS
	Internet Technology & Applications
Minor in "Artificial Intelligence & Machine Learning"	
CS3013	Data Mining & Data Warehousing
	Artificial Intelligence
	Machine Learning
	Natural Language Processing
	Advanced Machine Learning
Minor in "Business Management"	
MG2002	Marketing Management
	Human Resources Management
	Production and Operation Management
	Financial Management
	Business & Corporate Law

Note:

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

Part II

Detailed Syllabus

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

T1. R. L. Boylestad and L. Nashelsky, ***Electronic Devices and Circuit Theory***, 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	Credits	Marks
UCR	EE1001		3-0-0	3	100

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

P.T.O

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Measures of central tendencies, Elementary probability, Conditional probability, Bayes' Rule (related problems only), Random variable, Binomial & Hypergeometric distribution, Mean and variance.	**8 Hours**
Module-2	The Poisson approximation to Binomial Distribution, Poisson Process, Geometric Distribution & Multinomial Distribution, Continuous random variables, Normal Distribution, Normal Approximation to the Binomial Distribution, Uniform Distribution, Exponential Distribution, Joint Discrete Distribution.	**9 Hours**
Module-3	Populations and Samples, Sampling Distribution of Mean (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	Credits	Marks
UCR	CS1003		3-0-0	3	100

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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	Credits	Marks
UCR	EC1002		0-0-2	1	100

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

T1. R. L. Boylestad and L. Nashelsky, ***Electronic Devices and Circuit Theory***, 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	Credits	Marks
UCR	EE1002		0-0-2	1	100

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Cont'd. . .

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

Cont'd. . .

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

T1. B. H. Deshmukh, ***Electrical Materials and Wiring Practices***, Nirali Prakashan, 2018.
T2. G. Haldar, ***Electronics Course Book: Basic Components, IC boards, SMD, Logic Gates, Transistors, Resistors, Capacitors, Diodes, Audio Circuit and More***, GRPV Arts and Office Supplies, 2024.
T3. R. S. Khandpur, ***Printed Circuit Boards: Design, Fabrication, Assembly and Testing***, 1st *Ed.*, McGraw Hill,2006.

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

Reference Books:

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

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Cont'd. . .

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

Cont'd. . .

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Analog Electronics	L-T-P	Credits	Marks
PCR	EC2016		3-0-0	3	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	Basic knowledge of semiconductor diodes and 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.	**9 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.	**9 Hours**
Module-3	**Compound Configurations**: Darlington pair, Current Mirror, Cascade configuration, CMOS circuit realization. **Frequency Response Analysis**: Frequency Response of BJT, Miller's Effect, Multistage Frequency Effects, Gain-Bandwidth Relation.	**8 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.	**8 Hours**
Module-5	**Feedback Amplifiers**: Introduction to Feedback Amplifiers, Feedback Topologies, Derivation of different parameters (Z_i, Z_o, A_v, A_i), Standard ICs. **Oscillators**: Crystal Oscillators, Standard ICs. **Power Amplifiers**: Introduction to Power Amplifiers, Classification of Power Amplifiers: Class A, Class B, Class C, Push-Pull Amplifiers.	**8 Hours**
	Total	**42 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. 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.allaboutcircuits.com
4. https://www.electronics-tutorials.ws/

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

CO1	Explain biasing methods and small signal models of BJT and their performance estimation.
CO2	Analyze the behavior, characteristics and biasing configurations of JFET and MOSFET.
CO3	Analyze the structural configuration of multi-stage amplifier and its frequency response.
CO4	Study the construction and characteristics of an Op-Amp and design circuits using Op-Amp.
CO5	Design oscillators & negative feedback amplifiers 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).
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	Circuits & Signals	L-T-P	Credits	Marks
PCR	EE2001		3-1-0	4	100

Objectives	The objective of this course is to study circuit configuration & analysis with given specifications or network functions, test and improve the design as required. It also includes study of various signals & systems in time & frequency domains, and investigate the systems' stability & causality.
Pre-Requisites	Knowledge of circuit analysis, Laplace transform, Fourier transform. differential equations, complex numbers, and elementary calculus 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 graph and incidence matrix; Network Theorems: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Maximum power transfer theorem, Millman's theorem; Coupled Circuits: Introduction, Dot convention, Coefficient of coupling, Electrical equivalent of magnetically coupled coils, Series & parallel connection of coupled coils; Resonance: Introduction, Series Resonance, Parallel Resonance, Quality factor, Bandwidth & Selectivity for series & parallel resonant circuits.	**12 Hours**
Module-2	Signals & Systems: Introduction, Classification of Signals, Operation on Continuous-time signals, Classification of Systems, LTI System and its response; Laplace Transform: Definition, Properties, Initial and final value theorem, Inverse Laplace Transform; Application of Laplace Transform to Transient Analysis: Fundamentals of Switching behavior, Response of RL, RC & RLC network with step input, Transient Numericals.	**12 Hours**
Module-3	Two-Port Network Parameters: Introduction to Z, Y, ABCD, and h-parameters, Reciprocity and Symmetry conditions, Interrelation between parameters, Interconnection of networks, parameter calculation; Network Functions: Transfer functions and driving point functions, Concept of poles and zeros, Significance of Poles and Zeros, Hurwitz polynomial and its properties, Positive real functions and their properties.	**12 Hours**
Module-4	Fourier Series: Introduction, Fourier Analysis, Symmetry in Fourier Series, Frequency Spectrum; Fourier Transform: Definition, properties, Circuit analysis with Fourier Series and Fourier Transform, Network Filters: Introduction, Classification, Ideal & Practical Filters, Frequency response curve, Design of Filters.	**10 Hours**
Module-5	Convolution & Correlation of continuous-time and discrete-time signals, Discrete-Time Fourier Transform: Z-Transform and its properties, Inverse Z-transform, Region of Convergence (ROC) and its properties, Z-transform of Standard functions and ROC.	**10 Hours**
	Total	**56 Hours**

P.T.O

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

Reference Books:

R1. A. Chakrabarti, ***Circuit Theory: Analysis and Synthesis***, 7th *Ed.*, Dhanpat Rai & Co., 2013.
R2. S. Ghosh, ***Network Theory: Analysis And Synthesis***, 1st *Ed.*, Prentice Hall of India, 2009.
R3. P. K. Satpathy, P. Kabisatapathy, S. P. Ghosh, and A. K. Chakraborty, ***Network Theory***, 1st *Ed.*, Tata McGraw-Hill, 2009.
R4. J. G. Proakis and D. G. Manolakis, ***Digital Signal Processing: Principles, Algorithms and Applications***, 4th *Ed.*, Prentice Hall India, 2007.
R5. B. P. Lathi, ***Principles of Signal Processing and Linear Systems***, 2nd *Ed.*, Oxford Univ. Press, 2009.
R6. A. N. Kani, ***Signals and Systems***, 2nd *Ed.*, McGraw-Hill Education, 2010.

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://nptel.ac.in/courses/117104074/: by Prof. K. S. Venkatesh, IIT Kanpur
4. https://nptel.ac.in/courses/108105065/: by Prof. T. K. Basu, IIT Kharagpur
5. https://nptel.ac.in/courses/108104100/: by Prof. A. K. Jagannatham, IIT Kanpur
6. https://nptel.ac.in/courses/117101055/: by Prof. V. M. Gadre, IIT Bombay
7. 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	Explain the concepts of network theorems, coupled circuits, and resonant circuits and apply them to solve complex network problems.
CO2	Analyze and classify signals and systems and solve the transient analysis of RLC circuits using Laplace transform.
CO3	Evaluate two-port network parameters and network functions, understanding their applications in electrical network interconnections and stability analysis.
CO4	Analyze sinusoidal & non-sinusoidal signals using the Fourier series & transform and apply them to electric circuit analysis.
CO5	Perform convolution, correlation, and Z-transform analysis of continuous and discrete-time signals to address real-world engineering challenges.

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

Category	Code	Electromagnetic Theory	L-T-P	Credits	Marks
PCR	EE2002		3-0-0	3	100

Objectives	The objective of this course is to study, analyze, synthesize & interpret the application of electric & magnetic fields as functions of time & space using different coordinate systems, and propagation of electromagnetic waves.
Pre-Requisites	Knowledge of physics, mathematics, and fundamentals of engineering sciences 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	Vector Analysis: Scalars, Vectors, Unit vector, Scalar & Vector fields, Co-ordinate systems and transformation, Cartesian co-ordinates, Cylindrical co-ordinates, Spherical co-ordinates and Application; Vector Calculus: Line, Surface and volume integrals, Del operator, Gradient of a scalar, Divergence of a vector and Divergence theorem, Curl of a vector and Stoke's theorem, Laplacian and Applications.	**8 Hours**
Module-2	Electrostatic Fields: Coulomb's Law, Electric field intensity, Electric fields due to point, line, surface and volume charge, Electric flux density, Gauss's Law - Maxwell's equation, Application of Gauss's Law, Electric potential, Potential due to a line, Surface and volume charge; Conservative field, Relationship between E & V - Maxwell's equations, An Electric Dipole, Dipole moment, Expression of E due to an electric Dipole, Energy density in the Electrostatic fields; Conductors: Current and Current density, Continuity equation, Point form of Ohm's law, Resistance of a conductor, Relaxation time; Dielectrics: Polarization, Dielectric strength, Capacitance, Boundary conditions, Poisson's and Laplace's equation, Uniqueness Theorem, General procedures for solving Laplace's equation.	**12 Hours**
Module-3	Magnetostatic Fields: Magnetic field Intensity, Biot-Savart's law & its application, Ampere's Circuital Law & its application, Magnetic scalar & vector potentials, Magnetic Boundary conditions, Application; Force in Magnetic Fields: Force on a moving Point charge, Force between two straight, Long and parallel conductors carrying currents.	**8 Hours**
Module-4	Faraday's Law and Lenz's Law: Statically inducted EMF, Dynamically induced EMF, Displacement current density and displacement current, Physical significance of displacement current; Maxwell's Equations for Static fields, Maxwell's equations for Time varying fields: Maxwell's Equation for Harmonic varying fields; Maxwell's Equation for Good conductors, Maxwell's Equation for Free space; Retarded Potential, Average power density, Poynting vector and Poynting Theorem(Integral & Point forms),Applications.	**8 Hours**

Cont'd. . .

Module-#	Topics	Hours
Module-5	Wave Propagation: Electromagnetic wave, Electromagnetic wave equation in phasor form, Intrinsic impedance, The loss tangent, Uniform plane waves, Uniform plane wave in lossy dielectric, Perfect dielectric, Free space and in Good conductors, Skin depth, Transmission lines, Transmission line equations, Characteristic impedance, Wave form distortion, Distortionless line.	**6 Hours**
	Total	**42 Hours**

Text Books:

T1. S. C. Mahapatra and S. Mahapatra, ***Principles of Electromagnetics***, 2nd *Ed.*, McGraw Hill Education, 2015.
T2. M. N. O. Sadiku and S. V. Kulkarni, ***Principles of Electromagnetic***, 6th *Ed.*, Oxford University Press, 2009.

Reference Books:

R1. E. C. Jordan and K. G. Balmin, ***Electromagnetic Waves and Radiating Systems***, 2nd *Ed.*, Pearson Education, 2009.
R2. B. N. Basu, ***Engineering Electromagnetic Essential***, 1st *Ed.*, Orient Blackswan, 2015.

Online Resources:

1. https://nptel.ac.in/courses/108104087: by Prof. P. Kumar, IIT Kanpur
2. https://nptel.ac.in/courses/108102119: by Prof. S. Aditya, IIT Delhi
3. https://nptel.ac.in/courses/115104088: by Prof. M. K. Harbola, IIT Kanpur
4. https://nptel.ac.in/courses/108106073: by Prof. H. Ramachandran, IIT Madras

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

CO1	Explain various co-ordinate systems and solve problems involving vector calculus.
CO2	Describe electrostatic fields, their characteristics and associated parameters.
CO3	Visualize magneto-static fields, their characteristics and associated parameters.
CO4	Analyze and apply Maxwell's equations to various electromagnetic fields.
CO5	Interpret the propagation of EM waves through different mediums.

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).

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Analog Electronics Lab	L-T-P	Credits	Marks
PCR	EC2017		0-0-2	1	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	Knowledge of basic electronics and analytical reasoning is required.
Teaching Scheme	Regular laboratory experiments to be conducted under supervision of the teacher with focus on implementation using hardware and 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/MOSFET bias circuit and compare the results.
3	Design and simulate BJT common-emitter circuit and compare DC and AC performance.
4	Design and simulate JFET/MOSFET common-source circuit and compare DC and AC performance.
5	Determining the frequency response of a common-emitter amplifier: low frequency, high frequency and mid frequency response and compare with simulated results.
6	Differential amplifier circuits: DC bias & AC operation with & without current source.
7	Study of Darlington connection and current mirror circuits.
8	OP-Amp Frequency Response and Compensation.
9	Application of Op-Amp as differentiator, integrator, square wave generator.
10	Obtain the band width of FET/BJT using Square wave testing of an amplifier.
11	RC phase shift oscillator/Wien-Bridge Oscillator using Op-Amp/Crystal Oscillator.
12	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/

P.T.O

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	3	3	3						1	3	3	2

Category	Code	Circuits & Signals Lab	L-T-P	Credits	Marks
PCR	EE2003		0-0-4	2	100

Objectives	The objective of this laboratory course is to provide practical knowledge of network theory and recording the experimental data effectively. It also includes studying various signals & systems in time & frequency domains using software tools.
Pre-Requisites	Knowledge of circuit analysis, Laplace transform, Fourier transform, differential equations, complex numbers and elementary calculus are required.
Teaching Scheme	Regular laboratory experiments to be conducted using hardware and software tools under the supervision of the teacher. Demonstration along with required safety measures will be explained for each experiment.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1, 2	Verification of network Theorems in DC & AC networks.
3, 4	Study of resonance in R-L-C series and parallel circuit excited by single-phase AC circuit.
5, 6	Determination of different parameters of a two-port network.
7, 8	Frequency response of 1st order active filters
9	Determination of self-inductance, mutual inductance, and coupling coefficient of a magnetic coupled circuit.
10	Transient analysis in the DC network for RL, RC, and RLC circuits.
11	Introduction to MATLAB Programming and Simulink.
12, 13	Generation of standard signals (impulse, step, ramp, and sinusoidal signal) in continuous and discrete domains using MATLAB.
14	Operations on signals (shifting, scaling, reversal) both in time and amplitude for continuous and discrete signals using MATLAB.
15	Linear convolution of signals (with and without using the inbuilt conv function in MATLAB).
16	Computation of autocorrelation of a signal, and cross-correlation of two signals using MATLAB.
17	Spectral analysis of a non-sinusoidal waveform.
18, 19	Modeling and analysis of DC and AC transients for R-L, R-C, and R-L-C circuits (with damping conditions) using MATLAB simulations.
20	Evaluate the Z-transform of standard functions using MATLAB.

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

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. J. G. Proakis and D. G. Manolakis, ***Digital Signal Processing: Principles, Algorithms and Applications***, 4th *Ed.*, Prentice Hall India, 2007.
R4. B. P. Lathi, ***Principles of Signal Processing and Linear Systems***, 2nd *Ed.*, Oxford Univ. Press, 2009.

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://nptel.ac.in/courses/108104100/: by Prof. A. K. Jagannatham, IIT Kanpur
4. https://nptel.ac.in/courses/117101055/: by Prof. V. M. Gadre, IIT Bombay
5. 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	Verify fundamental network theorems and analyze resonance in AC and DC circuits.
CO2	Analyze two-port network parameters and demonstrate electrical network characteristics.
CO3	Evaluate the frequency response of active filters for signal conditioning applications.
CO4	Generate and analyze standard signals and perform various operations using software tools.
CO5	Model and simulate DC & AC transients for R-L, R-C, and R-L-C circuits using software 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	3	2	2	2		2					2	1	1	2
CO2	2	3	2	2	2	3					3	1	1	1
CO3	2	2	3	2		2					1	2	1	2
CO4	3	2		3	3	2					1	2	1	2
CO5	2	2	2	3	3	1					1	2	1	2

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

P.T.O

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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	Digital Electronics	L-T-P	Credits	Marks
PCR	EC2001		3-0-0	3	100

Objectives	The objective of this course is to introduce the concepts & techniques associated with digital electronic systems and their design & simulation using HDL.
Pre-Requisites	Knowledge of Basic Electronics and fundamentals of Number Systems is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

T2. L. K. John and C. H. Roth Jr., ***Digital System Design using VHDL***, 2nd *Ed.*, Cengage Learning, 2012.

P.T.O

Reference Books:

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

Online Resources:

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

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

CO1	Explain various number systems, codes and Logic gates.
CO2	Design and analyze combinational logic circuits.
CO3	Design and analyze various sequential logic circuits and explain counter design.
CO4	Implement memory array using sequential logic and explain FSM for digital circuit design.
CO5	Simulate and synthesize digital circuits using Verilog HDL and explore open source tools.

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Electrical Machines	L-T-P	Credits	Marks
PCR	EE2004		3-1-0	4	100

Objectives	The objective of this course is to study constructional features, working principles, operation, performance and various other aspects of DC & AC electrical machines, transformers, synchronous and induction machines etc.
Pre-Requisites	Knowledge of Basic Electrical Engineering, Physics and knowledge of Basic Mathematics such as Calculus, 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	**DC Machines**: Constructional features, Armature windings, Armature reaction, Commutation; DC Generator – Expression for EMF induced, Voltage build-up process, OCC, Critical resistance and critical speed, Load characteristics; DC Motor – Back Emf, Torque developed, Characteristic curves; Starting and speed Control of DC Shunt and Series motors, Losses, Efficiency and Power Flow diagram of a DC Machine.	**12 Hours**
Module-2	**Synchronous Machines**: Synchronous Generator – Constructional details, Types of rotors, Winding factors, Emf equation, Synchronous reactance, Armature reaction, Phasor diagrams of non-salient pole synchronous generator connected to infinite bus, Synchronizing and parallel operation, Synchronizing torque, Change of excitation and mechanical input, Voltage regulation (EMF & MMF method), Steady state power-angle characteristics, Two reaction theory, Phasor diagram for salient pole machines, Reluctance power and power angle characteristics, Slip test; Synchronous Motor – Principle of operation, Torque equation, V and Inverted V curves, Power input and power developed equations, starting methods, Hunting.	**12 Hours**
Module-3	**Transformers**: Single-Phase Transformers – Emf equation, Phasor Diagrams at No-Load and Load Conditions of an Ideal transformer and Practical transformer, Equivalent Circuit, Per Unit Calculation and its importance, Voltage regulation, Losses, Efficiency and All-Day efficiency, Open Circuit and Short Circuit Test, Polarity Test, Parallel operation of transformers; Auto Transformer – Constructional and Operational features, Conversion of a two-winding transformer into auto-transformer; Three Phase Transformers – Connections, Vector Groups, Open Delta (V-Connection), Scott Connection (T-Connection).	**12 Hours**

Cont'd. . .

Module-#	Topics	Hours
Module-4	**Induction Motor**: Three-Phase Induction Motor – Principle of operation, Slip, Equivalent circuit, Torque-Slip characteristics, Condition for maximum torque, Losses and efficiency, No-load and blocked rotor tests, Cogging and crawling, Induction generators; Starting method and Speed Control of Three Phase Induction Motor – Types of Starters, DOL, Rotor resistance, Autotransformer and Star-delta starters; Speed Control methods - Voltage control, Frequency control and pole changing, Cascaded connection.	**11 Hours**
Module-5	**Single-Phase Induction Motors**: Constructional details, Double field revolving theory and operation, Equivalent circuit, No-load and blocked rotor test, starting methods of single-phase induction motors, Capacitor Start & Capacitor run Induction motor. **Special Machines**: Shaded pole induction motor, AC series motor, Stepper motors, BLDC motor. **Practical Transformers**: Components of a practical transformer, Power and distribution transformer, Cooling methods of transformers, Buchholtz's relay, Tap changing transformers and its application.	**9 Hours**
	Total	**56 Hours**

Text Books:

T1. A. E. Fitzgerald, C. Kingsley Jr., and S. D. Umans, ***Electric Machinery***, 6th *Ed.*, McGraw-Hill, 2017.
T2. S. J. Chapman, ***Electric Machinery and Fundamentals***, 4th *Ed.*, McGraw-Hill, 2017.

Reference Books:

R1. P. S. Bimbhra, ***Electrical Machinery***, 7th *Ed.*, Khanna Publishers, 2011.
R2. D. P. Kothari and I. J. Nagrath, ***Electric Machines***, 5th *Ed.*, McGraw-Hill Education, 2017.
R3. P. K. Mukherjee and S. Chakravorti, ***Electrical Machines***, Dhanpat Rai Publications, 2011.
R4. B. S. Guru and H. R. Hiziroglu, ***Electric Machinery and Transformers***, 3rd *Ed.*, Oxford Univ. Press, 2012.
R5. B. L. Theraja and A. K. Theraja, ***A Textbook of Electrical Technology (Vol.2) - AC and DC Machines***, 23rd *Revised Ed.*, S Chand & Co, 2005.

Online Resources:

1. https://nptel.ac.in/courses/108105017: by Prof. D. Kastha, IIT Kharagpur
2. https://nptel.ac.in/courses/108105131: by Prof. T. K. Bhattacharya, IIT Kharagpur
3. https://nptel.ac.in/courses/108106072: by Prof. Vasudevan, Rao, and Rao, IIT Madras
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/

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

CO1	Analyze the construction and operation of DC machines and evaluate their performance through key operating characteristics.
CO2	Explain the principles of various transformers and analyze their circuit parameters & operating performances.
CO3	Explain the construction, operation, starting methods, speed control techniques, and performance evaluation of 3-phase induction machines.
CO4	Explain the construction and performance of different types of synchronous generators and motors and plot their characteristic curves.
CO5	Explore single-phase induction motors, special types of machines and the practical transformer.

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Advanced Electronic Circuits	L-T-P	Credits	Marks
PEL	EC2018		3-0-0	3	100

Objectives	The objective of this course is to study advanced electronic circuits like filters, multivibrators, timers, trigger, sweep generators etc., and their applications.
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 order and Second Order Low-pass/High Pass Butterworth filter: Filter Design, Frequency Scaling, Band-pass and Band-reject filters (wide & narrow), All-Pass filter; Oscillators: Principles, Types, Quadrature and Voltage Controlled Oscillator, Saw tooth wave generator; Comparators: Basic comparator, zero-crossing detector, Schmitt trigger, Comparator characteristics, Limitations of Op-Amp as comparators, Voltage limiters.	**9 Hours**
Module-2	Bistable (Fixed Bias and Self Bias) Multivibrator, Loading, Commutating capacitors, Triggering the binary (symmetrical and unsymmetrical through unilateral device), Schmitt Trigger Circuit (Emitter-coupled Bi-stable MV), Monostable Multivibrator (collector coupled and emitter coupled), Gate Width and Waveforms, Triggering of the Monostable MV, Astable Multivibrator (collector coupled 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, Bistable operations using tunnel diode, Voltage controlled Negative Resistance Switching circuits.	**8 Hours**
Module-4	Voltage and 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 timebase generators - Basic principles, Transistor miller time-base generator, Transistor bootstrap time-base generator, 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 phase detector, Monolithic phase detector, 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://nptel.ac.in/courses/117105138: by Prof. A. Bhattacharya, IIT Kharagpur
5. 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 active filters, oscillators, comparators and signal generators with their applications.
CO2	Distinguish between different types of multivibrators (astable, monostable and bistable).
CO3	Design memory circuits, multivibrators, and microwave circuits using wide band amplifiers and negative resistance switching devices.
CO4	Design different types of voltage and current time-base generators for various applications.
CO5	Use instrumentation amplifier in electronic communication circuits and realize specialized chip design for monostable and astable 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)

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

Reference Books:

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

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Renewable Energy Systems	L-T-P	Credits	Marks
PEL	EE2008		3-0-0	3	100

Objectives	The objective of this course is to study various renewable energy sources, their generation technologies, storage methods, and efficient utilization, along with their environmental impacts.
Pre-Requisites	Basic knowledge of semiconductor physics, fluid dynamics, and electrical engineering concepts is required. Familiarity with energy systems, power generation, and environmental science is recommended.
Teaching Scheme	Regular classroom lectures with use of ICT as needed, sessions are planned to be interactive with focus on real world 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	Introduction: Conventional & non-conventional energy sources, their impact, availability, variability, Indian and world scenario; Basic concept: Solar, Wind, Biomass, Wave, Tidal, Geothermal energy systems and Hydroelectric Energy; Solar Energy: Solar processes, Composition of solar radiation; Extra-terrestrial & terrestrial radiation, Angles - Azimuth, Zenith, Hour; Irradiance, Solar constant; Solar Thermal Systems & Applications: Solar collectors, Types & performance characteristics, Water heating systems (active & passive), Space heating & cooling systems, Solar Cooker, Solar thermal power plant.	**8 Hours**
Module-2	Solar Photovoltaic System: Operating principle, Photovoltaic cell concepts, Cell, Module, Array, Losses in solar cell, Effects of partial & complete shadowing, Series and parallel connections, Cell mismatching, PV voltage-current characteristics, Equivalent circuit, Maximum power point tracking; Applications: battery charging, Pumping, Lighting.	**9 Hours**
Module-3	Biomass Power: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Types of biogas digester, Wood gasifier, Pyrolysis, Applications: Biogas, Wood stoves, Biodiesel, Combustion engine, Urban waste to energy conversion, Biomass-based power generation.	**9 Hours**
Module-4	Wind Energy: Wind energy, Variability, Conversion principle; Wind power density, Efficiency limit, Types of converters, Aerodynamics of rotors, Power∼Speed and Torque∼Speed characteristics, Wind turbine control systems; Conversion to Electrical Power: Induction and synchronous generators, Grid connected & self-excited induction generator operation, Constant voltage & constant frequency generation with power electronic control, Single & double output systems, Reactive power compensation, Characteristics of wind power plant, Concepts of DFIG.	**9 Hours**

Cont'd. . .

Module-#	Topics	Hours
Module-5	Energy Storage Systems: Batteries, Ultracapacitors, SMES; Fuel Cell: Fuel Cell Basics, History of fuel cell technology, Open circuit voltage, Nernst equation analysis, Causes for voltage loss, Types of fuel cell and their efficiency, Electric Vehicles (EVs) and Backup Power & Uninterruptible Power Supply (UPS); Introduction to Hybrid Energy Systems: PV-Wind, PV-Fuel Cell, PV-Diesel, Introduction to Green Hydrogen Technology.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. B. H. Khan, ***Non-Conventional Energy Resources***, 3rd *Ed.*, McGraw Hill Education, 2017.
T2. S. N. Bhadr, D. Kastha, and S. Banerjee, ***Wind Electrical Systems***, 7th *Ed.*, Oxford University Press, 2005.
T3. G. Boyel, ***Renewable Energy - Power for a Sustainable Future***, 3rd *Ed.*, Oxford University Press, 2012.

Reference Books:

R1. S. A. Abbasi and N. Abbasi, ***Renewable Energy Sources and Their Environmental Impact***, 1st *Ed.*, PHI Learning, 2004.
R2. S. H. Saeed and D. K. Sharma, ***Non-Conventional Energy Resources***, 4th *Ed.*, S. K. Kataria & Sons, 2019.
R3. S. Peake, ***Renewable Energy : Power for a Sustainable Future***, 4th *Ed.*, Oxford University Press, 2018.
R4. C. S. Solanki, ***Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers***, 1st *Ed.*, PHI Learning, 2013.

Online Resources:

1. https://nptel.ac.in/courses/103107157: by Prof. B. Mondal, IIT Roorkee
2. https://nptel.ac.in/courses/108105058: by Prof. S. Banerjee, IIT Kharagpur
3. https://nptel.ac.in/courses/121106014: by Dr. P. Haridoss, IIT Madras

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

CO1	Generalize solar thermal systems and identify alternate energy sources & their characteristics.
CO2	Analyse and design a solar photovoltaic system for specified applications.
CO3	Evaluate the effectiveness of biomass energy conversion in waste management.
CO4	Design wind energy systems and analyze their operational characteristics.
CO5	Investigate the operation of fuel cells and the working of different energy storage 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).

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

Category	Code	Design of Electrical Apparatus	L-T-P	Credits	Marks
HNS	EE2009		3-0-0	3	100

Objectives	The objective of this course is to study advanced topics in various electrical machines and transformers, and applications of computers to design them.
Pre-Requisites	Knowledge of DC and AC machines 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	Design of Field System and Armature: Major considerations in Electrical Machine Design, Materials for Electrical apparatus, Design of Magnetic circuits, Magnetising current, Flux leakage, Leakage in Armature, Design of lap winding and wave winding.	**8 Hours**
Module-2	Design of DC Machines: Construction, Output Equations, Main Dimensions – Choice of specific loadings, Selection of number of poles, Design of Armature, Design of commutator and brushes, design of field, Computer program: Design of Armature main dimensions.	**8 Hours**
Module-3	Design of Transformers: Construction, KVA output for single and three phase transformers, Overall dimensions, design of yoke, core and winding for core and shell type transformers, Estimation of No-load current, Temperature rise in Transformers, Design of Tank and cooling tubes of Transformers. Computer program: Complete Design of single-phase core transformers.	**8 Hours**
Module-4	Design of Induction Motors: Construction, Output equation of Induction motor, Main dimensions, choice of specific loadings, Design of squirrel cage rotor and wound rotor, Magnetic leakage calculations, Operating characteristics: Magnetizing current, Short circuit current, Circle diagram, Computer program: Design of slip-ring rotor.	**10 Hours**
Module-5	Design of Synchronous Machines: Output equations, choice of specific loadings, Design of salient pole machines, Short circuit ratio, Armature design, Estimation of air gap length, Design of rotor, Design of damper winding, Determination of full load field MMF, Design of field winding, Design of turbo alternators, Computer program: Design of Stator main dimensions, Brushless DC Machines.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. A. K. Sawhney, ***A Course in Electrical Machine Design***, 5th *Ed.*, Dhanpat Rai & Sons, 1984.

T2. M. V. Deshpande, ***Design and Testing of Electrical Machines***, 3rd *Ed.*, PHI learning, 2011.

T3. S. K. Sen, ***Principles of Electrical Machine Designs with Computer Programs***, 2nd *Ed.*, Oxford & IBH, 2009.

Reference Books:

R1. A. Shanmugasundaram, G. Gangadharan, and R. Palani, ***Electrical Machine Design Data Book***, 1st *Ed.*, New Age International, 2007.

R2. B. Singh, ***Electrical Machine Design***, 1st *Ed.*, Vikas Publishing House, 1981.
R3. V. Rajini and V. S. Nagarajan, ***Electrical Machine Design***, 1st *Ed.*, Pearson Education, 2018.
R4. K. M. Vishnumurthy, ***Computer Aided Design of Electrical Machines***, 1st *Ed.*, BSP Books, 2015.

Online Resources:

1. https://nptel.ac.in/courses/108105017: by Prof. S. Maiti, IIT Kharagpur
2. https://nptel.ac.in/courses/108105131: by Prof. T. K. Bhattacharya, IIT Kharagpur
3. https://nptel.ac.in/courses/108102372: by Prof. B. Singh, IIT Delhi

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

CO1	Design and construct the armature & field system of rotating machines.
CO2	Design and analyze the performance of DC machines.
CO3	Explore the design principles of transformers and their analysis.
CO4	Design and analyze of various types of induction machines.
CO5	Model synchronous machines and evaluate their performance 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).
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	1	1	1					1	2	2	1
CO2	3	3	2	1	1	1					1	2	2	1
CO3	3	3	2	1	2	1					1	2	2	1
CO4	3	3	2	1	2	1					1	2	2	1
CO5	3	3	2	1	2	1					1	2	2	1

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Cont'd. . .

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

Cont'd. . .

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

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Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

Objectives	The objective of this course is to study the characteristics of different semiconductor devices used in modern electronic equipment and explore the nano scale CMOS structures and materials for applications in advanced technology nodes.
Pre-Requisites	Knowledge of physics and semiconductor devices is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with problem solving activities.

Evaluation Scheme

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

Detailed Syllabus

Module-#	Topics	Hours
Module-1	MOSFET: ITRS roadmap for semiconductors, Different groups of MOSFETs, Gate length scaling, Short channel effects, Scattering mechanisms, Hot carrier effect, Buried channel device, Gate oxide scaling and Gate leakage currents in MOSFETs.	**9 Hours**
Module-2	Advanced Materials for MOSFETs: High-K materials, Gate stack & Channel stack technology, Reverse short channel effect and HALO doping, FDSOI technology.	**9 Hours**
Module-3	Hetero structure FETs: Hetero junction MOSFETs, Strain engineering for higher mobility (Strained-Si/Strained-SiGe), Staggered hetero junction MOSFETs, Tunnel FETs.	**8 Hours**
Module-4	Nanoscale Devices: Multiple Gate MOS Structures – Double Gate MOSFET, FinFET, Surrounding Gate MOSFET, HEMTs – AlGaN/GaN HEMT structure and operation.	**8 Hours**
Module-5	Applications of MOSFETs: RF performance and linearity analysis of MOSFETs for high frequency applications, MOSFET application as bio-sensor, optoelectronic devices (LEDs, LASERs, Photo diodes, Solar cells).	**8 Hours**
	Total	**42 Hours**

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

Category	Code	Embedded C Programming	L-T-P	Credits	Marks
MNR	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	Marketing Management	L-T-P	Credits	Marks
MNR	MG2002		3-0-0	3	100

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

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

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

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

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

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

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

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

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

Reference Books:

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

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

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

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

Online Resources:

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

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

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

Program Outcomes Relevant to the Course:

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems (WK1 to WK4).
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems (WK2 and WK6).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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

Category	Code	Electrical Machines Lab	L-T-P	Credits	Marks
PCR	EE2005		0-0-4	2	100

Objectives	The objective of this laboratory course is to provide practical exposure to different electrical machines and help understand & verify the concepts of electrical machines, calculate different parameters like speed regulation, voltage regulation, efficiency & losses and their effect on performance. The laboratory experiments shall go hand-in-hand with the topics taught in the theory class.
Pre-Requisites	Knowledge of Basic Electrical Engineering, Physics and knowledge of Basic Mathematics such as Calculus, ordinary differential equations is required.
Teaching Scheme	Regular laboratory experiments to be conducted under supervision of the faculty with demonstration and simulation-based verification of the experiments.

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	Speed control of DC Shunt motor by armature voltage & flux control method and its realization through software.
2	Determination of critical resistance and critical speed from No-load test of DC Separately Excited generator.
3	Determination of efficiency of a DC Shunt Motor by brake test and Swinburne's test.
4	Plotting of External & Internal characteristics of DC shunt generator from load test.
5	Determination of efficiency and voltage regulation by Open Circuit and Short Circuit test on 1-ϕ Transformer.
6	Study of Scott connection of two 1-ϕ Transformers.
7	Back to Back test on two 1-ϕ Transformers.
8	Study of various vector groups of 3-ϕ Transformer.
9	Study of 3-ϕ induction generator.
10	Speed control of 3-ϕ induction motor using variable frequency (V/F) control method.
11	Determination of efficiency, plotting of torque-slip characteristics of 3-ϕ slip ring induction motor by electrical loading.
12	Determination of parameters of a 3-ϕ squirrel cage induction motor from No-load & Blocked rotor test.
13	Determination of the parameters of a 1-ϕ capacitor start induction run motor from No-load & Blocked rotor test.
14	Determination of the voltage regulation of an alternator by synchronous impedance and MMF method.
15	Determination of the voltage regulation of an alternator by ZPF Method.
16	Measurement of direct and quadrature axis reactance of salient pole synchronous machine and calculation of voltage regulation.
17	Study of parallel operation of two alternators.
18	Determine the power angle characteristics of an alternator & simulation by software.

Cont'd. . .

Experiment-#	Assignment/Experiment
19	Performance analysis of a universal motor by direct loading.
20	Study the characteristics of a synchronous motor.

Text Books:

T1. A. E. Fitzgerald, C. Kingsley Jr., and S. D. Umans, ***Electric Machinery***, 6th *Ed.*, McGraw-Hill Education, 2017.
T2. S. J. Chapman, ***Electric Machinery and Fundamentals***, 4th *Ed.*, McGraw-Hill, 2017.

Reference Books:

R1. P. S. Bimbhra, ***Electrical Machinery***, 7th *Ed.*, Khanna Publishers, 2011.
R2. D. P. Kothari and I. J. Nagrath, ***Electric Machines***, 5th *Ed.*, McGraw-Hill Education, 2017.
R3. P. K. Mukherjee and S. Chakravorti, ***Electrical Machines***, Dhanpat Rai Publications, 2011.
R4. B. S. Guru and H. R. Hiziroglu, ***Electric Machinery and Transformers***, 3rd *Ed.*, Oxford University Press,, 2012.
R5. B. L. Theraja and A. K. Theraja, ***A Textbook of Electrical Technology (Vol.2) - AC and DC Machines***, 23rd *Revised Ed.*, S Chand & Co, 2005.

Online Resources:

1. https://nptel.ac.in/courses/108105017: by Prof. D. Kastha, IIT Kharagpur
2. https://nptel.ac.in/courses/108105131: by Prof. T. K. Bhattacharya, IIT Kharagpur
3. https://nptel.ac.in/courses/108106072: by Prof. Vasudevan, Rao, and Rao, IIT Madras
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/

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

CO1	Perform various tests conducted on DC machines.
CO2	Evaluate the performance parameters of transformers.
CO3	Assess the performance of 1-ϕ and 3-ϕ induction motors in specific applications.
CO4	Determine voltage regulation of synchronous generators and compare the results.
CO5	Simulate the performance characteristics of electrical machines and interpret the 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).

Cont'd. . .

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

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

Objectives	The objective of the course is to provide hands-on exposure on logic gates, its implementation using Boolean algebra, designing digital circuits like counters, registers and simulating the digital systems using HDL.
Pre-Requisites	Knowledge of Basic Electronics is required.
Teaching Scheme	Regular laboratory experiments to be conducted under supervision of the faculty with use of ICT as and when required, with focus on implementation using hardware & software tools.

Evaluation Scheme

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

Detailed Syllabus

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

Text Books:

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

Reference Books:

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

Online Resources:

1. https://www2.mvcc.edu/users/faculty/jfiore/Resources/DigitalElectronics1LaboratoryManual.pdf
2. https://www.elprocus.com/top-digital-electronic-projects-for-electronics-engineering-students/
3. https://de-iitr.vlabs.ac.in/

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

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

Program Outcomes Relevant to the Course:

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

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

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

Category	Code	Electrical & Electronics Design Lab	L-T-P	Credits	Marks
PCR	EE2006		0-0-2	1	100

Objectives	The objective of this course is to expose the students to different electrical and electronic components and give hands-on practice about the fundamental design procedure and their operations to make the students understand and verify the concept of various electrical & electronic devices.
Pre-Requisites	Knowledge of basic electrical, basic electronics, and circuit theory is required.
Teaching Scheme	Regular laboratory experiments using modeling and simulation platforms and hardware devices will be conducted under the 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	Design and development of a 5V regulated power supply.
2	Design of AC-DC converter using transistors and diodes.
3	Design of latching and interlocking configuration control circuit using contactors.
4	Design of zero-crossing detector using op-amp circuits.
5	Design of Digital to Analog Converter(DAC) using R-2R ladder arrangement.
6	Design of microcontroller Interface circuit for temperature, distance, and voltage.
7	Design of speed control system for universal motor using TRIAC circuit.
8	Modeling & simulation of 1-ϕ induction motors and study of the torque-speed characteristics.
9	Modelling a stand-alone photovoltaic energy system and study of the IV and PV characteristics.
10	Evaluation & study of two-port network parameters.
11	V- curve & inverted V-curve of synchronous motor.
12	Study of torque-speed characteristic of a 3-ϕ induction motor with variable rotor resistance method.

Text Books:

T1. A. Pressman, K. Billings, and T. Morey, ***Switching Power Supply Design***, 3rd *Ed.*, McGraw-Hill Professional, 2009.

T2. S. B. Katariya, ***Industrial Automation Solutions for PLC, SCADA, Drive and Field Instruments***, 1st *Ed.*, Notion Press, 2020.

T3. M. Bhattacharyya, ***Electrical Machines: Modelling and Analysis***, 1st *Ed.*, PHI Learning, 2016.

T4. S. Kumar, M. R. Das, R. Kushalkar, N. Venkat, C. G. Kannan, and M. Moudgalya, ***Microcontroller Programming with Arduino and Python***, 1st *Ed.*, SPD Publishers, 2024.

Reference Books:

R1. A. S. Sedra and K. C. Smith, ***Microelectronic Circuits: Theory and Applications (International Version)***, 6th *Ed.*, Oxford University Press, 2013.

R2. A. Malvino and D. J. Bates, ***Electronic Principles***, 7th Edition, McGraw-Hill, 2017.

R3. D. V. Hall, ***Digital Circuits and Systems***, International Student Edition, McGraw-Hill Education, 1989.
R4. D. Gajski, ***Embedded System Design: Modeling, Synthesis and Verification***, Springer, 2009.

Online Resources:

1. https://nptel.ac.in/courses/106105159: by Prof. A. Basu, IIT Kharagpur
2. http://www.allaboutcircuits.com
3. https://www.electronics-tutorials.ws

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

CO1	Explain and design common electrical and electronic control circuits.
CO2	Design and fabricate zero crossing detector and DAC.
CO3	Design and fabricate different interfacing circuits.
CO4	Understand the basic characteristics of photovoltaic modules and filter circuits.
CO5	Model different electrical machines and observe the 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).
PO6	**The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual & Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO11	**Life-Long Learning**: Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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

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