MOHAN BABU UNIVERSITY

Sree Sainath Nagar, Tirupati – 517 102

SCHOOL OF ENGINEERING

B.Tech. Electrical and Electronics Engineering

CURRICULUM AND SYLLABUS

(From 2022-23 Admitted Batches)

FULLY FLEXIBLE CHOICE BASED CREDIT SYSTEM (FFCBCS)

MOHAN BABU UNIVERSITY

Vision

To be a globally respected institution with an innovative and entrepreneurial culture that offers transformative education to advance sustainability and societal good.

Mission

- Develop industry-focused professionals with a global perspective
- Offer academic programs that provide transformative learning experience founded on the spirit of curiosity, innovation, and integrity
- Create confluence of research, innovation, and ideation to bring about sustainable and socially relevant enterprises
- Uphold high standards of professional ethics leading to harmonious relationship with environment and society

SCHOOL OF ENGINEERING

Vision

To be the sought-after destination for engineering education recognised for excellence, innovation and the societal relevance and impact of its pursuits.

Mission

- Instil within our students fundamental engineering knowledge, a broad set of skills, and an inquisitive attitude to create innovative solutions to serve industry and community
- Provide an experience par excellence with our state-of-the-art research, innovation, and incubation ecosystem to realise our learners' fullest potential
- Impart continued education and research support to working professionals in engineering fields to enhance their domain expertise in the cutting-edge technologies
- Inculcate among the engineers of tomorrow with a spirit to solve societal challenges

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vision

To become the Nation's premiere center of excellence in electrical engineering through teaching, training, research and innovation by creating competent engineering professionals with values and ethics.

Mission

- Providing state-of-art resources that foster academic excellence through teaching-learning, research, avenues for entrepreneurship, employability and other holistic developmental activities.
- Providing contemporary curriculum with academic flexibilities and learner centric higher order learning in the field of Electrical and Electronics Engineering or multi-disciplinary domains.
- Honing technical and soft skills to bridge the gap between the industry and academia through comprehensive modular training programs.
- Inspiring students for aptitude for research and innovation by exposing them to industry and societal needs to create solutions for contemporary problems.
- Inculcating values and ethics among students for a holistic engineering professional practice.

B.Tech. Electrical and Electronics Engineering

PROGRAM EDUCATIONAL OBJECTIVES

After few years of graduation, the graduates of B.Tech. EEE will:

PEO1. Pursue higher academic programs in the disciplines of electrical engineering, multidisciplinary areas and in management.

PEO2. Become entrepreneurs or be employed as productive and valued engineers in reputed industries.

PEO3. Engage in lifelong learning, career enhancement and adopt to changing professional and foster the societal needs.

PROGRAM OUTCOMES

On successful completion of the Program, the graduates of B.Tech. EEE Program will be able to:

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

On successful completion of the Program, the graduates of B.Tech. EEE program will be able to:

PSO1. Analyze specific engineering problems in the domains of Electrical and Electronics Systems, Measurements, Control Systems, Machines and provide feasible solutions by applying the knowledge of Electrical and Electronics Engineering.

PSO2. Analyze, design and develop, power system networks, Power Electronic circuits, drives and control strategies for sustainable operation of the electrical systems, and practice professional ethics to sustain environment and society.

PSO3. Develop competency to use the techniques, skills, and modern engineering tools necessary for engineering practice and provide sustainable solutions to the societal problems.

B.Tech. Electrical and Electronics Engineering

(Regular – 4 Years)

Basket Wise - Credit Distribution

S. No.	Basket	Credits (Min.- Max.)
1	SCHOOL CORE	50-54
2	PROGRAM CORE	45-61
3	PROGRAM ELECTIVE	24-36
4	SPECIALIZATION ELECTIVE	12-18
5	UNIVERSITY ELECTIVE	9-12
	TOTAL CREDITS	**Min. 160**

B.Tech. Electrical and Electronics Engineering

(Lateral Entry – 3 Years)

Basket Wise - Credit Distribution

S. No.	Basket	Credits (Min.- Max.)
1	SCHOOL CORE	20-34
2	PROGRAM CORE	45-61
3	PROGRAM ELECTIVE	24-36
4	SPECIALIZATION ELECTIVE	12-18
5	UNIVERSITY ELECTIVE	9-12
	TOTAL CREDITS	**Min. 120**

School Core (50-54 Credits) (Regular – 4 Years)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22BS102401	Engineering Chemistry	3	-	2	-	4	-
22ME101401	Basic Civil and Mechanical Engineering	3	-	-	-	3	-
22CS102001	Programming for Problem Solving	3	-	2	-	4	
22AI102401	Data Structures and Algorithms	3	-	2	-	4	Programming for Problem Solving
22ME105401	Engineering Drawing	-	1	2	-	2	-
22AI105001	Design Thinking	-	1	2	-	2	-
22EE111001	Internship	-	-	-	-	2	-
22EE111002	Technology Extension for Societal Problems	-	-	-	4	1	-
22EE108001	Capstone Project	-	-	-	-	10	-
Language Basket (Min. 4 Credits to be earned)							
22LG102401	English for Professionals	2	-	2	-	3	
22LG105402	Soft Skills	-	-	2	-	1	
22LG101403	German Language	2	-	-	-	2	
22LG101404	French Language	2	-	-	-	2	
22LG102402	Empowering Your English	2	-	2		3	-
Mathematics Basket (Min. 9 Credits to be earned)							
22MM101402	Multivariable Calculus and Differential Equations	3	-	-	-	3	-
22MM101404	Transformation Techniques and Linear Algebra	3	-	-	-	3	-
22MM102404	Transformation Techniques and Linear Algebra	3	-	2	-	4	

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22MM101406	Special Functions and Complex Analysis	3	-	-	-	3	Multivariable Calculus and Differential Equations
22MM101405	Numerical Methods, Probability and Statistics	3	-	-	-	3	-
Physics Basket (Min. 4 Credits to be earned)							
22MM102452	Engineering Physics	3	-	2	-	4	
22MM102451	Applied Physics	3	-	2	-	4	
Management Basket (Min. 5 Credits to be earned)							
22CM101402	Principles of Business Economics and Accountancy	3	-	-	-	3	-
22MG101401	Essentials of Leadership	2	-	-	-	2	-
22MG101402	Organizational Behaviour	2	-	-	-	2	-
22MG101403	Project Management	2	-	-	-	2	-
Mandatory Courses (Min. 8 Credits to be earned - Earned Credits will not be considered for CGPA)							
22LG107601	Professional Ethics and Human Values	2	-	-	-	2	-
22CE107601	Environmental Science*	2	-	-	-	2	-
22CE107602	Disaster Mitigation and Management	2	-	-	-	2	-
22CE107603	Rural Technology	2	-	-	-	2	-
22LG107603	Spoken English	-	1	2	-	2	English for Professionals
22LG107602	Essential Life Skills for Holistic Development	2	-	-	-	2	-
22AB107601	NCC/NSS Activities	-	-	-	-	2	-
22MG107601	Innovation, Incubation and Entrepreneurship	2	-	-	-	2	-
22EE107601	Intellectual Property Rights	2	-	-	-	2	-
22EE107602	Fundamentals of Research Methodology	2	-	-	-	2	-

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22AB107602	Yoga	-	-	-	-	2	-

* Compulsory Course

School Core (20-34 Credits) (Lateral Entry – 3 Years)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22BS102401	Engineering Chemistry	3	-	2	-	4	-
22ME101401	Basic Civil and Mechanical Engineering	3	-	-	-	3	-
22CS102001	Programming for Problem Solving	3	-	2	-	4	
22AI102401	Data Structures and Algorithms	3	-	2	-	4	Programming for Problem Solving
22ME105401	Engineering Drawing	-	1	2	-	2	-
22AI105001	Design Thinking	-	1	2	-	2	-
22EE111001	Internship	-	-	-	-	2	-
22EE111002	Technology Extension for Societal Problems	-	-	-	4	1	-
22EE108001	Capstone Project	-	-	-	-	10	-
22LG102401	English for Professionals	2	-	2	-	3	
22LG105402	Soft Skills	-	-	2	-	1	
22LG101403	German Language	2	-	-	-	2	
22LG101404	French Language	2	-	-	-	2	
22MM101402	Multivariable Calculus and Differential Equations	3	-	-	-	3	-
22MM101404	Transformation Techniques and Linear Algebra	3	-	-	-	3	-
22MM102404	Transformation Techniques and Linear Algebra	3	-	2	-	4	
22MM101406	Special Functions and Complex Analysis	3	-	-	-	3	Multivariable Calculus and Differential Equations
22MM101405	Numerical Methods, Probability and Statistics	3	-	-	-	3	-
22MM102452	Engineering Physics	3	-	2	-	4	
22MM102451	Applied Physics	3	-	2	-	4	

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22CM101401	Principles of Business Economics and Accountancy	3	-	-	-	3	-
22MG101401	Essentials of Leadership	2	-	-	-	2	-
22MG101402	Organizational Behaviour	2	-	-	-	2	-
22MG101403	Project Management	2	-	-	-	2	-
22LG107601	Professional Ethics and Human Values	2	-	-	-	2	-
22CE107601	Environmental Science*	2	-	-	-	2	-
22CE107602	Disaster Mitigation and Management	2	-	-	-	2	-
22CE107603	Rural Technology	2	-	-	-	2	-
22LG107603	Spoken English	-	1	2	-	2	English for Professionals
22LG107602	Essential Life Skills for Holistic Development	2	-	-	-	2	-
22AB107601	NCC/NSS Activities	-	-	-	-	2	-
22MG107601	Innovation, Incubation and Entrepreneurship	2	-	-	-	2	-
22EE107601	Intellectual Property Rights	2	-	-	-	2	-
22EE107602	Fundamentals of Research Methodology	2	-	-	-	2	-
22AB107602	Yoga	-	-	-	-	2	-

* Compulsory Course

Program Core (45-61 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EE102001	Electrical Circuits	3	-	2	-	4	-
22EE101002	Electromagnetic Fields	3	-	-	-	3	Multivariable Calculus and Differential Equations
22EE102003	Signals and Networks	3	-	2	-	4	Electrical Circuits; Transformation Techniques and Linear Algebra
22EE101004	Electrical and Electronic Measurements	3	-	-	-	3	Electrical Circuits
22EE102005	Electrical Machines-I	3	-	2	-	4	Electrical Circuits
22EE102006	Electrical Machines-II	3	-	2	-	4	Electrical Machines-I
22EE102007	Control Systems	3	-	2	-	4	Signals and Networks
22EE101008	Transmission and Distribution	3	-	-	-	3	Electromagnetic Fields
22EE102009	Power System Analysis	3	-	2	-	4	Transmission and Distribution
22EE105010	Electrical CAD Lab	-	-	2	-	1	Engineering Drawing
22EE101011	Power Electronics	3	-	-	-	3	Semiconductor Devices and Circuits
22EE102012	Solid State Drives	3	-	2	-	4	Power Electronics
22EC102001	Semiconductor Devices and Circuits	3	-	2	-	4	-
22EC102401	Analog Electronics	3	-	2	-	4	Semiconductor Devices and Circuits
22EC102402	Linear and Digital IC Applications	3	-	2	-	4	Analog Electronics; Digital Design
22EC102010	Digital Design	3	-	2	-	4	-
22EC102013	Interfacing with Microcontrollers	3	-	2	-	4	Digital Design

Program Elective (24 - 36 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EE101019	Generation of Electrical Power	3	-	-	-	3	-
22EE101022	Power System Operation and Control	3	-	-	-	3	Transmission & Distribution
22EE101025	Switchgear and Protection	3	-	-	-	3	Power System Analysis
22EE103014	Design and Estimation of Electrical ystems	3	-	-	4	4	Transmission and Distribution
22EE102017	Energy Audit, Conservation and Management	3	-	2	-	4	–
22EC101401	Sensors and Signal Conditioning	3	-	-	-	3	Electrical and Electronic Measurements
22EC104018	Advanced Microcontrollers	3	-	2	4	5	Interfacing with Microcontrollers
22EC101402	Discrete Time Signal Processing	3	-	-	-	3	Signals and Networks
22EE101029	Electric Vehicles	3	-	-	-	3	Electrical Machines-II; Power Electronics.
22EC101016	Micro Electro Mechanical Systems	3	-	-	-	3	-
22EC103011	VLSI System Design	3	-	-	4	4	Digital Design
22EC104017	Embedded Systems	3	-	2	4	5	Interfacing with Microcontrollers
22EC101012	Computer Organization	3	-	-	-	3	Digital Design
22AI101401	Principles of Operating Systems	3	-	-	-	3	-
22AI104002	Object Oriented Programming Through Java	3	-	2	4	5	Programming for Problem Solving
22CB102005	Internet of Things	3	-	2	-	4	Computer Networks
22CS102005	Database Management Systems	3	-	2	-	4	Data Structures and Algorithms
22CB102001	Computer Networks	3	-	2	-	4	Object Oriented Programming Through Java
22CS102002	Python Programming	3	-	2	-	4	Programming for Problem Solving

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EE101018	Evolutionary and Swarm Computing Techniques	3	-	-	-	3	-
22EE101021	Neural Network and Fuzzy Logic Control Applications	3	-	-	-	3	-
22ME101023	Optimization Techniques	3	-	-	-	3	-
22EE101020	Industrial Drives and Automation	3	-	-	-	3	Solid State Drives
22EE101023	PWM Converters and Applications	3	-	-	-	3	Power Electronics

Specialization Elective (12 - 18 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EE101024	DSP Control for Electric Drives	3	-	-	-	3	Discrete-Time Signal Processing and Power Electronics
22EE101033	Optimal Control and Adaptive Control	3	-	-	-	3	Control Systems
22EE101028	Digital Control System	3	-	-	-	3	Control Systems
22EE101013	Advanced Control Systems	3	-	-	-	3	Control Systems
22EC101134	Industrial Data Communications	3	-	-	-	3	Computer Networks
22EC101026	Digital Image Processing	3	-	-	-	3	-
22EC101019	FPGA Architectures and Applications	3	-	-	-	3	VLSI System Design
22EE102027	Analysis and Design of Power Electronic Converters	3	-	2	-	4	Power Electronics
22EE101034	Power Electronics for Renewable Energy Systems	3	-	-	-	3	Power Electronics
22EE101039	Switched Mode Power Conversion	3	-	-	-	3	Power Electronics
22EE101026	Advanced Electrical Drives and Control	3	-	-	-	3	Solid State Drives
22EE101032	Flexible AC Transmission Systems	3	-	-	-	3	Power Electronics and Power System Analysis.

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EE104035	Power Quality	3	-	2	4	5	Power System Analysis; Power Electronics.
22EE101036	Power System Automation	3	-	-	-	3	Power Systems Operation and control.
22EE101037	Restructured Power Systems	3	-	-	-	3	Power System Analysis
22EC101403	PLC and SCADA	3	-	-		3	Digital Design
22EC101103	Industrial Instrumentation	3	-	-	-	3	Sensors and Signal Conditioning
22EC101105	Biomedical Instrumentation and Measurements	3	-	-	-	3	-
22EC101112	Power Plant Instrumentation	3	-	-	-	3	Industrial Instrumentation
22EE101031	Finite Element Analysis for Electrical Machines	3	-	-	-	3	Electrical Machines-II
22EE101040	Utilization of Electrical Energy	3	-	-	-	3	Electrical Circuits.
22EE101038	Special Electrical Machines	3	-	-	-	3	Electrical Machines–II
22EE103030	Electrical Machine Design	3	-	-	4	4	Electrical Machines-II
22EE101054	Battery Management System	3	-	-	-	3	Electrical Circuits
22EE101070	Fast-Charging Infrastructure for Electric Vehicles	3	-	-	-	3	Power Electronics
22EE102071	AI for Electrified Transportation System	3		2		4	
22EE102072	Robotics And Automation in Electrical Systems	3		2		4	
22EE101073	E-Mobility Business and Policies	3	-	-	-	3	-
22EE101074	Modern Grid using SMART Power Flow Controllers	3	-	-	-	3	Power system Analysis
22EE101075	AI & Machine Learning Techniques for Smart Grids	3	-	-	-	3	Power system Analysis
22EE101076	Machine Learning & Data Science in The Power Generation Industry	3	-	-	-	3	-
22EE101077	Electric Grid Security	3	-	-	-	3	Power System Analysis
22EE101078	AI Techniques for Renewable Energy Systems	3	-	-	-	3	Power System Analysis
22EE101079	Machine Learning in Power System Optimization		-	-	-	3	Power System Analysis
22EE101095	Cyber Physical Systems	3	-	-	-	3	-

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EE102096	IoT for Electrical Systems	3	-	2	-	4	-
22EE102097	Computer Vision for Electrical Systems	3	-	2	-	4	-

University Elective (9-12 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EC101701	AI in Healthcare	3	-	-	-	3	-
22CM101701	Banking and Insurance	3	-	-	-	3	-
22DS101701	Bioinformatics	3	-	-	-	3	-
22BS101036	Biology for Engineers	3	-	-	-	3	-
22LG101701	Business Communication and Career Skills	3	-	-	-	3	-
22CE101701	Civil Engineering and The Society	3	-	-	-	3	-
22SS101701	Constitution of India	3	-	-	-	3	-
22CM101702	Cost Accounting and Financial Management	3	-	-	-	3	-
22CB101701	Cyber Laws and Security	3	-	-	-	3	-
22EE101701	Electrical Safety and Safety Management	3	-	-	-	3	-
22MG101701	Entrepreneurship for Micro, Small and Medium Enterprises	3	-	-	-	3	-
22CE101702	Environmental Pollution and Control	3	-	-	-	3	-
22EC101702	Essentials of VLSI	3	-	-	-	3	-
22CB101702	Introduction to Ethical Hacking	3	-	-	-	3	-
22CB101703	Forensic Science	3	-	-	-	3	-
22SS101702	Gender and Environment	3	-	-	-	3	-
22ME101701	Global Strategy and Technology	3	-	-	-	3	-
22EE101704	Green Technologies	3	-	-	-	3	-
22ME101702	Human Resource Management	3	-	-	-	3	-
22SS101703	Indian Economy	3	-	-	-	3	-
22SS101704	Indian History	3	-	-	-	3	-
22SS101705	Indian Tradition and Culture	3	-	-	-	3	-
22EC101703	Instrumentation in Industries	3	-	-	-	3	-
22EC101704	Introduction to Nanotechnology	3	-	-	-	3	-

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22AI101701	Introduction to Artificial Intelligence	3	-	-	-	3	-
22DS101702	Introduction to Data Science	3	-	-	-	3	-
22AI101702	Introduction to Machine Learning	3	-	-	-	3	-
22CS101701	Introduction to Python Programming	3	-	-	-	3	-
22CB101704	Introduction to Internet of Things	3	-	-	-	3	-
22ME101703	Management Science	3	-	-	-	3	-
22ME101704	Managing Innovation and Entrepreneurship	3	-	-	-	3	-
22ME101705	Material Science	3	-	-	-	3	-
22LG201701	Personality Development	3	-	-	-	3	-
22CE101703	Planning for Sustainable Development	3	-	-	-	3	-
22EC101705	Principles of Communication Engineering	3	-	-	-	3	-
22EE101702	Reliability and Safety Engineering	3	-	-	-	3	-
22CE101704	Remote Sensing, GIS and GPS	3	-	-	-	3	-
22CE101705	Smart Cities	3	-	-	-	3	-
22EC101706	Smart Sensors for Engineering Applications	3	-	-	-	3	-
22EE101703	Sustainable Energy Systems	3	-	-	-	3	-
22CS101702	Web Design Fundamentals	3	-	-	-	3	-
22SS101706	Women Empowerment	3	-	-	-	3	-

Note:

1. If any student has chosen a course or equivalent course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s under University Elective.
2. The student can choose courses from other disciplines offered across the schools of MBU satisfying the pre-requisite other than the above list.

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22BS102401	**ENGINEERING CHEMISTRY**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on water technology, multi functional materials, applications of electrochemistry, instrumental methods of analysis, fuel chemistry and lubricants. This course also provides analytical skills for the quantitative estimation of materials through volumetric and instrumental methods of analysis and addresses the societal, health issues related to quality of water.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Solve problems associated with water, and address the societal, health and safety issues related to quality of water

CO2. Acquire basic knowledge on industrial polymers, composites, and Nano materials used in engineering applications.

CO3. Apply and demonstrate competency in the basic concepts of electrochemical cells and sensors.

CO4. Acquire basic knowledge of instrumental methods and their applications in the analysis of materials.

CO5. Identify the quality of fuels and lubricants for their engineering applications.

CO6. Develops independent working ability, through problem solving and effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	1	-	2	1	-	-	-	-
CO2	3	-	-	-	-	-	2	-	-	-	-	-
CO3	3	-	-	-	1	-	1	-	-	-	-	2
CO4	3	-	-	-	2	-	-	-	-	-	-	1
CO5	3	2	-	-	-	-	1	-	-	-	-	-
CO6	3	3	-	-	1	1	2	-	3	3	-	1
Course Correlation Mapping	**3**	**3**	**-**	**-**	**2**	**1**	**2**	**1**	**3**	**3**	**-**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: WATER TECHNOLOGY ***(09 Periods)***

Introduction, types of water, Impurities in water and their consequences. Hardness of water, units of hardness, disadvantages of hardness, determination of hardness by EDTA method, numerical problems, boiler troubles, softening of water – Internal treatment, External treatment (Ion exchange process, zeolite process), desalination of brackish water by reverse osmosis, specifications of potable water as per WHO and BIS standards. Fluoride in ground water: Effects on human health, defluoridation method – Nalgonda method; merits and demerits of various defluoridation methods.

Module 2: CHEMISTRY OF MULTI FUNCTIONAL MATERIALS ***(09 Periods)***

Engineering plastics: Definition, synthesis, properties and applications of PC, PTFE, and PMMA.

Conducting polymers: Definition, types and applications.

Biodegradable polymers: Definition, classification, mechanism of degradation and applications.

Nano Materials: Introduction, size dependent properties (Colour, magnetic and electrical), method of synthesis – CVD, applications of Nano materials.

Module 3: ELECTROCHEMICAL CELLS, STORAGE DEVICES AND SENSORS ***(09 Periods)***

Electrode potential, Electrochemical cell, EMF of an electrochemical cell.

Batteries: Introduction, types of Batteries-Primary battery-dry cell, secondary battery- Lead-acid batteries, Lithium-ion batteries, Lithium- Polymer batteries, Applications of batteries.

Fuel Cells: Definition, H_2–O_2 fuel cell, solid oxide fuel cell, applications of fuel cells.

Sensors: Introduction, Types of Sensors, electrochemical sensors, applications.

Module 4: INSTRUMENTAL METHODS AND APPLICATIONS ***(08 Periods)***

Introduction to spectroscopy–types of energy present in molecules, types of spectra, UV-Vis spectroscopy – principle, types of electronic transitions, Instrumentation and applications; Infrared spectroscopy – principle, types of vibrational modes, Instrumentation and applications; working principle and applications of SEM, TEM, and XRD.

Module 5: FUELS AND LUBRICANTS ***(10 Periods)***

Fuels: Classification of fuels, calorific value, numerical problems; Liquid fuels, cracking of oils (Thermal and Fixed-bed catalytic cracking), Synthetic petrol: Fischer-Tropsch method and Bergius process. Eco friendly fuels-Types, significances.

Lubricants: Definition, functions of lubricants, mechanism of lubrication, classification of lubricants, properties of lubricants – viscosity and viscosity index, flash and fire point, cloud and pour point, Aniline point, neutralization number and mechanical strength.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXPERIMENTS: (Minimum 10 exercises shall be conducted)

1. Determination of hardness of ground water sample.
2. Determination of alkalinity of Water sample.
3. Estimation of residual chlorine in drinking water.
4. Estimation of Dissolved Oxygen in water by Winkler’s method.
5. Estimation of Fe (II) by Dichrometry.
6. Conductometric titration of strong acid Vs strong base.

7. Estimation of Ferrous ion amount by Potentiometry.
8. Synthesis of nano ZnO using sol-gel process.
9. Determination of Viscosity by Ostwald's viscometer.
10. Determination of strength of acid by using P^H metric method.
11. Determination of Strength of an acid in Pb-Acid battery.
12. Determination of percentage of Iron in Cement sample by colorimetry.

RESOURCES

TEXT BOOKS:

1 P. C. Jain & Monika Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 16th edition, 2013.

2 K.N. Jayaveera, G.V. Subba Reddy and C. Ramachandriah, *Engineering Chemistry*, Mc.Graw Hill Publishers, New Delhi.

3 Engineering Chemistry lab Manual

REFERENCE BOOKS:

1 Peter Atkins, Julio de Paula and James Keelar, Atkins' *Physical Chemistry*, Oxford University Press, 10th edition, 2010.

2 Skoog and West, *Principles of Instrumental Analysis*, Thomson, 6th edition, 2007.

3 K. Mukkanti, *Practical Engineering Chemistry*, BS Publications, 2013.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=ly_FS3LZXEY

2 https://www.youtube.com/watch?v=0_ZcCqqpS2o

3 https://www.youtube.com/watch?v=Tye3dcBOqtY

4 https://www.youtube.com/watch?v=tsvIvQJiTL4

WEB RESOURCES:

1 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4851520/

2 https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Analytical_Sciences_Digital_Library/Active_Learning/Shorter_Activities/Electrochemical_Sensor_Project/01_Introduction_To_Electrochemical_Sensors

3 https://www.arsdcollege.ac.in/wp-content/uploads/2020/04/Document-2.pdf

4 https://www.salon.com/2015/10/14/4_outlandish_things_our_ancestors_used_as_lube_partner/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22ME101401	**BASIC CIVIL AND MECHANICAL ENGINEERING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides an overview of civil engineering such as surveying, civil engineering materials, mechanics of materials, building components and civil engineering infrastructure. This course also provides an overview of basic mechanical engineering concepts like functioning of various prime movers, their prospects, advantages and limitations. It further enlighten about basics of power transmission systems, Additive manufacturing processes and their classifications.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the principles of surveying, materials used in civil engineering and their mechanics.

CO2. Apply the basic principles of civil engineering, techniques and tools for analyzing civil structures and solve related problems.

CO3. Understand the functional aspects of various prime movers used in industrial applications.

CO4. Realize the principle of mechanical power transmission through belts and gear trains.

CO5. Realize the fundamental concepts of Additive Manufacturing (i.e. Rapid Prototyping) and 3-D printing, its advantages and limitations.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	2	-
CO4	2	3	3	-	-	-	-	-	-	-	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	-	**-**	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Surveying and Civil Engineering Materials ***(09 Periods)***

Overview of Civil Engineering: Civil Engineering contributions to the welfare of society, specialized sub disciplines in Civil Engineering.

Surveying: Objectives, classification and principles; Measurements – distances, angles, levels, areas and volumes; contouring; Illustrative examples.

Civil Engineering Materials: Bricks, stones, concrete, steel, glass, timber, composite materials.

Mechanics of Materials: Forces, system of forces, laws of mechanics ,moment of a force, equilibrium, resultant, Internal and External forces, Stress, Strain, Hooke's law and Elasticity.

Module 2: Building Components and Civil Engineering Infrastructure ***(09 Periods)***

Building Components: Sub structure - Types of foundations, Bearing capacity and settlement, Requirement of good foundations.

Superstructure - Civil engineering construction - Brick masonry, Stone masonry, Beams, Columns, Lintels, Roofs, Floors, Stairs, Building bye-laws - bye-laws floor area, carpet area and floor space index, basics of interior design and landscaping.

Civil Engineering Infrastructure - Types of Bridges and Dams, Water supply and Sanitary systems, Rainwater harvesting, Types of Highways and Railways, Ports and Harbors.

Module 3: Internal Combustion Engines, Turbines and Pumps ***(09 Periods)***

Internal Combustion Engines - Classification – Working principle of Petrol and Diesel Engines – Four stroke and two stroke engines – Comparison of four stroke and two stroke engines.

Turbines and Pumps – Classifications of Steam turbines - Impulse turbine, Reaction turbines; Working principle of Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps.

Module 4: Mechanical Power Transmission Systems ***(09 Periods)***

Power Transmission Systems: Belt, rope and chain drives, Gears and Transmission screw

Power transmission by belts: Classification of belts, Length of the Belt (Open and Crossed-Belt Drives), Power Transmitted by Belt Drive, Tension due to Centrifugal Forces, Initial Tension, Maximum Power Transmitted.

Power transmission by Gear train: Gear terminology, Classification of gears, Gear train-Simple Gear Train and Compound Gear Train, Power Transmitted by Simple Gear Train.

Module 5: Additive Manufacturing Processes ***(09 Periods)***

Rapid Prototyping: Introduction, Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping,

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Visit the IC engine lab
2. Visit Machine Tools Lab and Foundry
3. Visit Design lab

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

CASE STUDIES/ ARTICLES:

Contemporary relevant case studies/Articles will be provided by the course instructor at the beginning.

(Note: It's an indicative one. The course instructor may change the activities and shall be reflected in the course handout.)

RESOURCES

TEXT BOOKS:

1. Shanmugam G and Palanichamy MS, *Basic Civil and Mechanical Engineering*, Tata McGraw Hill Publishing Co., New Delhi, 1st Edition 2018.
2. R. Vaishnavi, Prof. M. Prabhakaran & Prof. V. Vijayan, *Basic Civil and Mechanical Engineering*, S.CHAND Publications, 2nd Edition, 2013.

REFERENCE BOOKS:

1. Kalpakjian, Serope, *Manufacturing Engineering and Technology*, Pearson Education, 7th Edition, 2014
2. Mikell P.Groover, "*Automation, Production Systems & CIM*", 3rd Edition, PHI.
3. Rapid prototyping; *Principles and Applications* /Chua C.K., Leong K.F. and LIM C.S/World Scientific Publications.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/116/102/116102012/
2. https://archive.nptel.ac.in/courses/112/103/112103262/
3. https://archive.nptel.ac.in/courses/108/106/108106182/

WEB RESOURCES:

1. https://www.britannica.com/technology/prime-mover-mechanics
2. https://unacademy.com/content/gate/study-material/mechanical-engineering/additive-manufacturing/
3. https://www.tezu.ernet.in/sae/Download/transmission.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22CS102001	PROGRAMMING FOR PROBLEM SOLVING	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on C Programming concepts, Operators and Expressions, Input and Output Functions, Control Structures, Problem Solving Aspects, Arrays and Strings, Functions, Pointers, Structures and Unions and File Handling.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on C programming constructs to develop programs.

CO2. Design algorithms using problem-solving techniques for given problems.

CO3. Apply functions and Arrays to enhance reusability and data manipulation.

CO4. Use pointers to manage the memory effectively.

CO5. Apply Structures, Unions and File handling concepts to develop societal applications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	3	-	-	-	-	-	-	-	-
CO3	3	2	3	-	-	-	-	-	-	-	-	-
CO4	2	2	2	2	3	-	-	-	-	-	-	-
CO5	3	2	2	3	2	3	-	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**3**	**3**	**3**	**-**	**-**	-	**3**	**3**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO C PROGRAMMING ***(09 Periods)***

Basics of C Programming: Introduction, Structure of a C program, Concept of a variable, Data types in C, Program statement, Declaration, Storing the data in memory, Tokens, Operators and expressions, Lvalues and Rvalues, Type conversion in C.

Input and Output: Basic screen and keyboard I/O in C, Non-formatted input and output, formatted input and output functions.

Module 2: CONTROL STATEMENTS AND INTRODUCTION TO PROBLEM SOLVING ***(08 Periods)***

Control Statements: Specifying test condition for selection and iteration, Writing test expression, Conditional execution and selection, Iteration and repetitive execution, goto statement, Special control statements, Nested loops.

Introduction to Problem Solving: Algorithms, Flowcharts, Problem solving aspect, Top-down design, Implementation of algorithms, program verification and efficiency of algorithms.

Module 3: ARRAYS & STRINGS AND FUNCTIONS ***(10 Periods)***

Arrays and Strings: One-dimensional array – Declaration, Initialization, Accessing elements, operations; Multi-dimensional arrays – Declaration, Initialization, Working with 2D arrays; Strings – Declaration, Initialization, Printing strings, String input, Character manipulation, String manipulation; Arrays of strings – Initialization, manipulating string arrays.

Functions: Concept of function, Using functions, Call by value mechanism, working with functions, passing arrays to functions, Scope and extent, Storage classes, Recursion.

Module 4: POINTERS ***(08 Periods)***

Introduction to Pointers: Understanding memory addresses, Address operator (&), Pointer – declaration, Initialization, Indirection operator and dereferencing, Void and Null pointers, Use of pointers, Arrays and pointers, Pointers and strings, Pointer arithmetic, Pointers to pointers, Array of pointers, Pointers to an array, Two-dimensional arrays and pointers, Pointers to functions, Dynamic memory allocation.

Module 5: USER-DEFINED DATA TYPES AND FILES ***(10 Periods)***

User-Defined Data Types: Structures - Declaration, Accessing the members, Initialization, typedef and its use, Arrays of structures, Arrays within structure, Structures and pointers, Structures and functions; Unions, Enumeration types, Bitfields.

***Files**:* Using files in C, Working with text and binary files, Direct File Input and Output, Files of records, Random access to files of records.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. a) Write a C program to perform the arithmetic operations on two integer numbers.

   b) Write a program to evaluate the following expressions by reading the necessary values from the keyboard.

   i. $(ax + b)/(ax - b)$ ii. $2.5 \log x + \cos 32^0 + | x^2 + y^2|$

   iii. $ax^5 + bx^3 + c$ iv. ae^{kt}

2. a) Write a C program to find the roots of a quadratic equation.

   b) In a town, the percentage of men is 52. The percentage of total literacy is 48 and the total percentage of literate men is 35 of the total population. Write a C program to find the total number of illiterate men and women if the population of the town is 7000.

c) The total distance travelled by a vehicle in t seconds is given by the distance $ut+at^2/2$ where u and a are the initial velocity (m/sec.) and acceleration (m/sec^2). Write C program to find the distance travelled at regular intervals of time given the values of u and a. The program should provide the flexibility to the user to select his own time intervals and repeat the calculations for different values of u and a.

3. a) Write a C Program to compute an electricity bill based on the following slab rates.

Consumption units	Rate (in Rupees/unit)
0-100	4.0
101-150	4.6
151-200	5.2
201-300	6.3
Above 300	8.0

(**Hint**: Take current and old meter readings from the user to get consumption units)

b) An insurance company computes the premium amount based on the following;

i. If a person's health is excellent and the person is between 25 and 35 years of age and lives in a city, and is a male then the premium is Rs.4 per thousand and the policy amount cannot exceed Rs.2 lakhs.

ii. If a person satisfies all the above conditions and is female then the premium is Rs.3 per thousand and the policy amount cannot exceed Rs.1 lakh.

iii. If a person's health is poor and the person is between 25 and 35 years of age and lives in a village and is a male then premium is Rs.6 per thousand and the policy cannot exceed Rs. 10000.

iv. In all other cases the person is not insured.

Write a C program to determine whether the person should be insured or not, his/her premium rate and maximum amount for which he/she can be insured.

c) Write a C Program to find the grade for a student using a Switch case. The user needs to enter a subject score (varies from 0 to 100)and then display the grade as described below.

Score	Grade	Score	Grade
> = 90	O	>=50 to < 60	D
>=80 to < 90	A	>=40 to < 50	E
>=70 to < 80	B	< 40	Fail
>=60 to < 70	C		

4. a) A Fibonacci sequence is defined as follows:

The first and second terms in the sequence are 0 and 1. Sub-sequent terms are found by adding the preceding two terms in the sequence. Write a C program to generate the first n terms of the sequence.

b) Write a C program to find the sum of individual digits of a positive integer.

c) Write a C program to read two numbers x and n, and then compute the sum of the geometric progression: $1+x+x^2+x^3+$…………. $+x^n$. Show appropriate error message for $n<0$. (Example: if n is 3 and x is 5, then the sum is: 1+5+25+125)

d) Write a C program to print the following pattern.

```
                1
            1   2   1
        1   2   3   2   1
    1   2   3   4   3   2   1
1   2   3   4   5   4   3   2   1
```

5. a) Write a C program to generate all the prime numbers between 1 and n, where n is a value entered by the user. Define a separate function to generate prime numbers.

   b) Write C program that uses recursive function to find the following. i) Factorial of a given integer ii) GCD of two given integers

6. a) Write a C program to find both the largest and smallest numbers in a list of integers.

   b) Write a C program that uses function to perform the following:
      i) Addition of Two Matrices ii) Multiplication of Two Matrices

7. a) Write a C program to insert a sub-string in to a main string at a given position.

   b) Write a C program to count the lines, words and characters in a given text.

8. a) Write a C program to print the elements of an array in reverse order using pointers.

   b) Write a C program to count the number of vowels and consonants in a string using pointers.

   c) Write a C program to store n elements in an array and print the elements in sorted order using pointers.

9. a) Write a C program that performs the following operations:
      i. Reading a complex number ii. Writing a complex number
      iii. Addition of two complex numbers iv. Multiplication of two complex numbers
      (**Note:** Represent complex number using a structure.)

   b) Define a structure to store employee details include Employee-Number, Employee-Name, Basic-pay, Date-of-Joining. Write a C program for the following.
      i. A function to store 10 employee details.
      ii. A function to implement the following rules while revising the basic pay.
         If Basic-pay<=Rs.5000 then increase it by 15%.
         If Basic-pay> Rs.5000 and <=Rs.25000 then it increase by10%.
         If Basic-pay>Rs.25000 then there is no change in Basic-pay.
      iii. A function to print the details of employees who have completed 20 years of service from the Date-of-Joining.

10 a) Write a C program to reverse the first n characters of a given text file.

   b) Write a C program to merge two files into a new file.

RESOURCES

TEXT BOOKS:

1 Pradip Dey and Manas Ghosh, *Programming in C*, 2nd Edition, Oxford University Press, New Delhi, 2013.

2 R. G. Dromey, *How to Solve it by Computer*, 1st Edition, Pearson Education, 2013.

REFERENCE BOOKS:

1. Byron S Gottfried and Jitender Kumar Chhabra, *Programming with C*, 4th Edition, McGraw Hill Education, 2019.
2. Yashavant Kanetkar, *Let Us C*, 15th Edition, BPB Publications, 2017.
3. E. Balaguru samy, *Programming in C*, 7th Edition, McGraw Hill Education Pvt, Ltd, New Delhi, 2017.
4. Behrouz A. Forouzan and Richard F. Gilberg, *Computer Science: A Structured Programming Approach Using C*, 3rd Edition, Cengage Learning, 2008.

SOFTWARE/TOOLS:

1. Software: Turbo C++/Dev C++

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/106105171/L03.html
2. https://nptel.ac.in/courses/106104128

WEB RESOURCES:

1. Learn C Programming - https://www.programiz.com/c-programming
2. Learn C Programming - https://www.tutorialspoint.com/cprogramming/index.htm
3. C Programming Exercises, Practice, Solution - https://www.w3resource.com/c-programming-exercises/
4. Basic programming exercises and solutions in C - https://codeforwin.org/2015/05/ basic-programming-practice-problems.html
5. C Programming Exercises, Practice, Solution - https://www.w3resource.com/c-programming-exercises/
6. Basic programming exercises and solutions in C - https://codeforwin.org/2015/05/basic-programming-practice-problems.html

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22AI102401	**DATA STRUCTURES AND ALGORITHMS**	3	-	2	-	4

Pre-Requisite 22CS102001-Programming for Problem Solving

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides theoretical and practical knowledge on sorting and searching, Linked list, stacks and queues. It also emphasizes on concepts and techniques of trees, search trees and heaps, multi way trees, graphs and hashing.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the fundamental concepts of data structures, asymptotic notations and Algorithm analysis techniques to measure the performance of an algorithm.

CO2. Analyze performance of sorting and searching algorithms by making use of time and space complexity.

CO3. Design algorithms to solve societal problems by applying contextual knowledge on linked lists.

CO4. Identify suitable data structure to Solve computational problems

CO5. Construct hash tables by using Hash functions and relevant collision resolution technique.

CO6. Work independently or in team to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	1	-	-	-	-	-	-	-
CO3	2	2	3	-	1	1	-	-	-	-	-	-
CO4	3	2	3	-	1	-	-	-	-	-	-	-
CO5	2	2	3	-	1	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**1**	**1**	**-**	**-**	**3**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION, SORTING AND SEARCHING ***(11 Periods)***

Introduction: Introduction to data structures, Introduction to Algorithm, Performance Analysis- Space Complexity, Time Complexity, Asymptotic Notation- Big Oh, Omega, Theta notations, Guidelines for Asymptotic Analysis, Algorithms Analysis: Problems & Solutions.

Sorting: Bubble Sort**,** Insertion sort, Selection Sort, Shell Sort, Radix sort and their performance analysis.

Searching: Linear Search, Binary Search and their performance analysis.

Module 2: LINKED LIST ***(08 Periods)***

Single Linked List, Circular Linked List, Double Linked List, Circular Double Linked List, Applications of Linked List- Sparse Matrix Representation and its performance analysis, Addition of Polynomials and its performance analysis.

Module 3 STACKS AND QUEUES ***(08 Periods)***

Stacks: Introduction, Definition, Implementation of stacks using arrays, Implementation of stacks using linked list, Applications of Stacks.

Queues: Introduction, Definition, Implementation of queues using arrays, Implementation of queues using linked list, Circular Queue, Dequeue, Priority Queue, Applications of Queues.

Module 4 TREES, SEARCH TREES AND HEAPS ***(09 Periods)***

Trees: Basic Terminologies, binary trees, Properties of binary tree, Representation of Binary Tree, Binary tree traversals.

Search Trees: Binary Search Trees, Operations on Binary Search Trees, AVL Trees and Operations on AVL trees

Heap: Heap Trees, Implementation of Heap Trees, Applications of Heap – Heap Sort and Its performance Analysis.

Module 5 MULTI WAY TREES, GRAPHS AND HASHING ***(09 Periods)***

Multiway Trees: M-way search trees, B-trees, Operations on B-trees, B+-trees.

Graphs: Introduction, Basic Terminologies, Representation of Graphs, Breadth First Search and its Complexity Analysis, Depth First Search and its Complexity Analysis.

Hashing: Introduction, Hash Table Structure, Hash Functions, Linear Open Addressing, Chaining and their performance analysis.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Implement following sorting algorithms

   a) Bubble Sort

   b) Insertion sort

   c) Selection sort

2. Store roll numbers of students who attended placement training program in random order in an array.

   a) Write a program to search whether a particular student attended training or not using linear search

   b) Write a program to search whether a particular student attended training or not using binary search

3. **a)** Department of CSE has a readers club named 'Prerana'. Students of all years can be granted membership on request and they can get books. Similarly one may cancel the membership of club. First node is reserved for head of readers club and last node is reserved for in-charge of readers club. The student's information in each node consisting of name of the student and roll no of the student. Develop a program to perform following operations on readers club member�to information using singly linked list.

   i) Add and delete the members as well as head or even in-charge.

   ii) Compute total number of members in readers club

   iii) Display members in readers club

   iv) Display list in reverse order using recursion

   v) Sort the list using name and display it.

   b) A Company has N employees and it maintains each employee data with the following attributes like: emp_id, emp-dept,emp_sal, emp_mobileno. Use a menu driven Program to perform following operations on employee's data using Doubly Linked List (DLL).

   i) Create a DLL of N Employees Data by using end insertion.

   ii) Display the status of DLL and count the number of nodes in it

   iii) Perform Insertion and Deletion at End of DLL

   iv) Perform Insertion and Deletion at Front of DLL

   v) Perform Insertion and Deletion at any user specified position of DLL

   vi) Exit

4. **a)** Implement a menu driven Program for the following operations on stack using arrays.

   i) Push an Element on to Stack

   ii) Pop an Element from Stack

   iii) Demonstrate how Stack can be used to check Palindrome

   iv) Display the elements of a Stack

   v) Exit

   b) Develop a menu driven program to implement queue operations using arrays

5. **a)** Write a program to implement stack using linked list
   b) Write a program to implement queue using linked list

6. **a)** Develop a program to convert an infix expression to postfix expression using stack
   b) Write a program to evaluate given postfix expression using stack
7. Develop a menu driven program to perform the following operations on a binary search tree
   a) Create a binary search tree

   b) Insert an element into a binary search tree

   c) Delete an element from binary search tree

   d) Traverse the binary search tree in In order, Preorder and post order

8. Write a program to perform the following operations on AVL tree

   a) Insert an element into AVL tree

   b) Delete an element from AVL tree

   c) Display the elements of AVL tree in ascending order

9. **a)** Develop a program to implement Breadth first search traversal.

   b) Develop a program to implement Depth first search traversal.

10. Write a program to implement hashing with

    a) Separate Chaining Method

    b) Open Addressing Method

RESOURCES

TEXT BOOKS:

1 Debasis Samanta, *Classic Data Structures*, PHI Learning private limited, 2nd Edition, 2017.
2. Narasimha Karumanchi, *Data Structures and Algorithms made easy*, Career Monk, 5th Edition, 2017.

REFERENCE BOOKS:

1. G A V Pai, *Data Structures and Algorithms: Concepts, Techniques and Applications*, McGraw Hill Education.
2. Satraj Sahani, Data Structures, Algorithms and Applications in Java, Universities Press, 2nd Edition, 2008.
3. Michael T. Goodrich, Roberto Tamassia, *Data Structures and Algorithms in java*, Wiley India, 2nd Edition, 2007.

SOFTWARE/TOOLS:

1. **Software:** JDK 1.8
2. **Operating System:** Windows/ Linux

VIDEO LECTURES:

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/lecture-videos
2. http://nptel.ac.in/courses/106106127/
3. http://www.nptel.ac.in/courses/106102064

WEB RESOURCES:

1. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
2. https://hackr.io/tutorials/learn-data-structures-algorithms

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22ME105401	**ENGINEERING DRAWING**	-	1	2	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on engineering drawing conventions, Importance of engineering drawing, fundamental concepts of sketching, computer aided drafting and different types of projections of geometric entities (both 2D and 3D) through computer aided drafting packages.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the principles of engineering drawing, Methods and CAD tools to draw the Geometries and Curves to communicate in engineering field.

CO2. Understand and draw projections of points (0D) located in four quadrants.

CO3. Visualize, plan and draw projections of lines (1D) and planes (2D) (inclined to both planes of projection).

CO4. Visualize and draw projections of regular solids (3D) (inclined to both planes of projection) and sections of regular solids (front view, top view and true shape).

CO5. Develop lateral surfaces of solids and draw Isometric views of given objects for engineering communication using principles of engineering drawing and CAD tools.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO ENGINEERING GRAPHICS AND DESIGN ***(06 Periods)***

Principles, significance -Conventions in drawing-lettering - BIS conventions-Dimensioning principles and conventional representations.

Exercises:

1. Practice exercise on Basic Lettering and Dimensioning
2. Practice exercise on Conventional representations

Introduction to AutoCAD: Basic drawing and editing commands: line, circle, rectangle, erase, view, undo, redo, snap, object editing, moving, copying, rotating, scaling, mirroring, layers, templates, polylines, trimming, extending, stretching, fillets, arrays, dimensions.

Exercises:

3. Practice exercise using basic drawing commands
4. Practice exercise using editing commands

Module 2: CONICS, PROJECTION OF POINTS ***(06 Periods)***

Conics & Special Curves**:** Conic sections - eccentricity method only

Exercises:

5. Practice exercises on Ellipse, Parabola, Hyperbola
6. Practice exercises on Projection of points

Module 3 PROJECTION OF LINES AND PLANES ***(08 Periods)***

Projection of points in any quadrant, lines inclined to one or both planes, finding true lengths, angle made by line, Projections of regular plane surfaces.

Exercises:

7. Practice exercises on projection of lines inclined to one plane
8. Practice exercises on projection of lines inclined to both planes
9. Practice exercises on Projections of regular plane surfaces

Module 4 PROJECTION OF SOLIDS AND SECTION OF SOLIDS ***(06 Periods)***

Projection of solids: Projection of regular solids inclined to one plane.

Sections of solids: Section planes and sectional view of right regular solids- prism, cylinder, pyramid and cone, True shapes of the sections.

Exercises:

10. Practice exercises on Projections of regular solids
11. Practice exercises on Sections of solids

Module 5 DEVELOPMENT OF SURFACES, ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS ***(10 Periods)***

Development of surfaces: Development of surfaces of right regular solids-prism, cylinder, pyramid, cone and their sectional parts.

Exercises:

12. Practice exercises on Development of surfaces of right regular solids

ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS

Orthographic Projections: Systems of projections, conventions and application to orthographic projections.

Isometric Projections: Principles of isometric projection- Isometric scale; Isometric views: lines, planes, simple solids.

Exercises:

14. Practice exercises on Orthographic Projections
15. Practice exercises on Isometric Projections
16. Practice exercise on Isometric Projection of the 2-storage building.

Total Periods: 36

RESOURCES

TEXT BOOKS:

1. D. M. Kulkarni, A. P. Rastogi, A. K. Sarkar, *Engineering Graphics with AutoCAD*, PHI Learning Private Limited, New Delhi, Revised edition, 2010. 2. 1.. 2.
2. N. D. Bhatt and V. M. Panchal*, Engineering Drawing*, Charotar Publishing House, Gujarat, 51st edition, 2013.

REFERENCE BOOKS/LABORATORY MANUALS:

1. Sham Tickoo, *AutoCAD 2013 for Engineers and Designers*, Dreamtech Press, 2013
2. M. H. Annaiah & Rajashekar Patil, *Computer Aided Engineering Drawing*, New Age International Publishers, 4th edition, 2012.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112105294

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22AI105001	**DESIGN THINKING**	-	1	2	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on design thinking process, evaluation of requirement specification and reflections on design experience. This course also focuses on demonstration of five phases of design thinking such as empathize, define, ideate, prototyping, testing and validation with design thinking tools and frameworks.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Investigate the requirements of a problem by conducting surveys.

CO2. Create meaningful and actionable problem statements for creative problem solving.

CO3. Construct blueprints to visualize user attitudes and behavior for gaining insights of customers.

CO4. Design prototypes of innovative products or services for a customer base.

CO5. Develop relevant products or services by choosing good design and applying empathy tools for experiencing user requirements.

CO6. Work independently and communicate effectively in oral and written forms.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	3	-	2	-	-	-	-	-	-	-	-
CO2	1	-	1	3	-	-	-	-	-	-	-	-
CO3	-	2		3	-	-	-	-	-	-	-	1
CO4	-	2	3	2	-	-	-	-	-	-	-	-
CO5	-	3	-	1	1	-	1	2	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	3	2	-
Course Correlation Mapping	**1**	**3**	**2**	**3**	**1**	**-**	**1**	**2**	**3**	**3**	**2**	**1**

Correlation Levels: 3: High; 2: Medium; 1: Low

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

Introduction to Design Thinking – Design thinking Process, Definition, Importance, Phases of Design Thinking, Canva Tool.

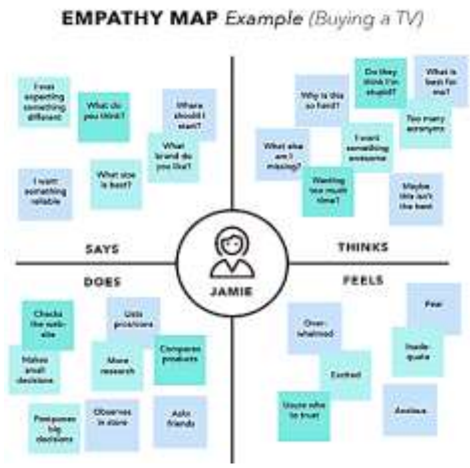
1 Conduct survey and identify the problem by either individual or group and frame a problem statement using AEIOU (Activities, Environment, Interactions, Objects, Users) framework.

2 Identify demographic or focus group for problem statement and create persona and explicitly define the characteristics of persona using Canva tool.

Emphathize - Role of empathy in design thinking, Purpose of Empathy Map, Empathy Tools – Customer Journey Map, Personas, Coggle Tool.

3 Build a Customer Journey Map (CJM-Before-During-After) and identify touch points for any mock scenario or persona created during last experiment and frame 2-3 questions using HMW (How Might We).

4 Create an Empathy Map using Coggle design thinking tool.
Sample Empathy Map:



Ideation - Importance of visualizing and empathizing before ideating, Applying the method**,** Ideation Tools - Story board, Brainstorming, Mind Map, SCAMPER.

5 **Story boarding design ideas:** Consider a mock scenario and create user stories and storyboards to transform information about user needs into design concepts using any story board tool.

6 Create Mind Map for your problem statement using Coggle.
Sample Mind Map:

7 Perform Brain Storming Session with your team and record using the SCAMPER framework and finalize the best three innovative ideas.

Prototyping and Testing – Definition, Prototype examples, Need for Prototyping, Fidelity for prototypes, Process of prototyping, Introduction to Marvel POP Software**,** Testing prototypes with users.

8 Create an application prototype for product recommendation using **Marvel POP Software**.

9 Create a **low-fidelity paper prototype** by sketching out the product design and adding relevant functionality.

10 Test the prototype created in Exercise 9 by interacting with each member of the team, walking them through the design and gathering feedback. Use feedback grid with the following quadrants: what worked, what could be improved, questions, and ideas.

What worked?	**What could be improved?**
Questions	**Ideas**

RESOURCES

REFERENCES:

1. Michael G. Luchs, Scott Swan , Abbie Griffin, *Design Thinking – New Product Essentials from PDMA*, Wiley, 2015.
2. Vijay Kumar, *101 Design Methods: A Structured Approach for Driving Innovation in Your Organization,* 2012.
3. Kathryn McElroy, *Prototyping for Designers: Developing the best Digital and Physical Products*, O'Reilly, 2017.
4. S.Salivahanan, S.Suresh Kumar, D.Praveen Sam, *Introduction to Design Thinking*, Tata McGraw Hill, 1st Edition, 2019.

SOFTWARE/TOOLS:

1. Canva (https://www.canva.com/)
2. Coggle (https://coggle.it/)
3. Marvel POP

VIDEO LECTURES:

1. https://nptel.ac.in/courses/109/104/109104109/
2. https://nptel.ac.in/courses/110106124/
3. https://www.youtube.com/watch?v=q654-kmF3Pc&t=0s
4. https://www.youtube.com/watch?v=TNAdanuvwtc
5. https://www.youtube.com/watch?v=U-hzefHdAMk
6. https://www.youtube.com/watch?v=zbLxs6te5to

WEB RESOURCES:

1 https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process

2 https://www.ibm.com/design/thinking/page/toolkit

3 https://www.interaction-design.org/literature/article/define-and-frame-your-design-challenge-by-creating-your-point-of-view-and-ask-how-might-we

4 https://www.culturepartnership.eu/en/article/ten-tools-for-design-thinking

5 https://www.mindtools.com/pages/article/newCT_02.htm

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE111001	**INTERNSHIP**	-	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Expose students to the industrial environment; Create competent professionals for the industry; sharpen the real time technical / managerial skills required at the job; Gain professional experience and understand engineer�really's responsibilities and ethics; Familiarize with latest equipment, materials and technologies; Gain exposure to technical report writing; Gain exposure to corporate working culture.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze latest equipment, materials and technologies that are used in industry to solve complex engineering problems following relevant standards, codes, policies and regulations.

CO2. Analyze safety, health, societal, environmental, sustainability, economical and managerial factors considered in industry in solving complex engineering problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on practicing engineering.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
CO2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
CO3	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
Course Correlation Mapping	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE111002	**TECHNOLOGY EXTENSION FOR SOCIETAL PROBLEMS**	-	-	-	4	1

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Identification of topic for the socially relevant project; Gaining deep insight about the problem; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the socially relevant project; Articulation of technological support/ recommendations given to the societal problems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Create/Design engineering systems or processes to solve complex societal problems using appropriate tools and techniques following relevant standards, codes, policies, regulations and latest developments.

CO2. Consider environment, sustainability, economics and project management in addressing societal problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on socially relevant project.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
CO2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
CO3	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
Course Correlation Mapping	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE108001	**CAPSTONE PROJECT**	-	-	-	-	10

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Identification of topic for the project work; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the project work; Preparation of thesis and presentation.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. create/design Electrical engineering systems or processes to solve complex electrical engineering and allied problems using appropriate tools and techniques following relevant standards, codes, policies, regulations and latest developments.

CO2. Consider society, health, safety, environment, sustainability, economics and project management in solving complex Electrical and Electronics engineering and allied problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on Electrical and Electronic engineering systems or processes.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
CO2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
CO3	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2
Course Correlation Mapping	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22LG102401	**ENGLISH FOR PROFESSIONALS**	2	-	2	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course deals with listening strategies, reading comprehension, grammar, vocabulary, pronunciation, Written, Verbal and Non-verbal communication, Channels of communication, Barriers to communication, Modes of technology-based communication, and Technical Communication.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the basics of Reading, Writing, Listening, and Speaking skills.

CO2. Analyze the rules of English grammar in speaking and writing.

CO3. Demonstrate knowledge of English pronunciation in speaking.

CO4. Apply the knowledge of reading strategies and vocabulary in communication.

CO5. Apply the strategies of writing in preparing a report.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	-	-	3	-	2
CO2	-	3	2	-	-	-	-	-	-	3	-	2
CO3	3	2	-	-	-	-	-	-	-	3	-	2
CO4	-	-	-	-	3	-	-	-	-	3	-	2
CO5	-	-	-	-	3	-	-	-	-	3	-	2
Course Correlation Mapping	**3**	**2**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: SUPER HEROES – THE SCIENCE BEHIND SUPER HEROES ***(06 Periods)***

Reading for Comprehension, Grammar, Speaking, Listening, Vocabulary, Writing, Verbal and Non-verbal communication.

Module 2: ALIENS – THE CYLINDER OPENS ***(06 Periods)***

Reading for comprehension, Grammar, Vocabulary, Writing, Listening, and Channels of communication.

Module 3: INVENTORS – THE RAMAN EFFECT ***(06 Periods)***

Reading comprehension, Listening, Writing, Grammar, Speaking, Pronunciation, and communication barriers.

Module 4: HEALTH AND NUTRITION – WHAT SHOULD YOU BE EATING ***(06 Periods)***

Reading comprehension, Listening, Speaking, Grammar, Writing, Pronunciation, and Modes of technology-based communication.

Module 5: NEW-AGE ENTREPRENEURS – HOW A CHINESE BILLIONAIRE BUILT HER FORTUNE ***(06 Periods)***

Reading comprehension, Vocabulary, Listening, Grammar, Writing, and Technical Communication

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

PART-A

Any six modules among the following:

1. Conversation starters and role play
2. Reading comprehension
3. Listening comprehension
4. Vocabulary Building (business and job-related vocabulary)
5. Describing people, places, objects, and Events
6. Phonetics - Accent/ Rhythm/ Intonation
7. Tenses
8. Proposal Writing

PART-B

Any four modules among the following:

1. Communicating effectively is important to become successful in any business. Prepare a Case study of successful business personnel regarding communication competence.
2. Prepare a PowerPoint presentation on an orator and analyze the voice dynamics.
3. People face situations to convince or agree with the points they have. The college arranges a 5-day tour program to Goa. Prepare a video on persuasive talk and convince parents to get permission.
4. Write an article on the famous clichés of our time.

5. Prepare a poster on the effects of social media on youth.
6. Give a short talk on the importance of inventors and their role in present socio, political and economic changes.
7. Prepare a collage of entrepreneurs' pictures and their achievements.
8. NASA released recent photos of the universe with the help of the James Webs Space Telescope. Write down the expected impact on the existing theory on planets and the universe.
9. Obesity is the most common problem for people. List out the reasons for the problem and prepare food habits to overcome.
10. Epics of India deals with superheroes of those days. Compare the weapons used in the battles of Mahabharata with modern weapons.
11. Write a report on your recently invented product so that it should be sold as a hot cake in the market.
12. Illustrate the essential rules for good precis writing.

RESOURCES

TEXTBOOK:

N.P. Sudharshana & C.Savitha, "*English for Technical Communication*", Cambridge University Press. 2016.

REFERENCE BOOKS:

1. Kline, J. A. "*Speaking effectively: Achieving excellence in presentations. Upper Saddle River*", NJ: Pearson/Prentice Hall, 2004.
2. Kuiper, "S. *Contemporary business report writing"* (3rd ed.). Cincinnati, OH: Thomson/South, Western, 2007.
3. Locker, K. O. & Kaczmarek, "S. K. *Business communication*": Building critical skills (3rd ed.). New York: McGraw, Hill/Irwin, 2007.
4. Mascull, "*B. Business vocabulary in use: Advanced. Cambridge*": Cambridge University Press, 2004.
5. Matthews, C. B. & Matthews, and M. *Quick steps to winning business presentations: Make the most of your PowerPoint presentations*. New York: McGraw, Hill, 2007.
6. Marsh, C. Strategic writing: *Multimedia writing for public relations, advertising, sales and marketing, and business communication*. Boston: Pearson/Ally and Bacon, 2005.
7. Munter, M. & Russell, L. *Guide to presentations*. (2nd ed.). Upper Saddle River: NJ: Pearson/Prentice Hall, 2008.
8. Reardon, K. K. *The skilled negotiator: Mastering the language of engagement*. San Francisco: Jossey,Bass, 2004.
9. Stiff, J. B. Persuasive *communication* (2nd ed.). New York: Guilford Press. Engagement. San Francisco: Jossey, Bass, 2003.
10. Stiff, J. B. *Persuasive communication* (2nd ed.). New York: Guilford Press, 2003.

VIDEO LECTURES:

1. https://learnenglish.britishcouncil.org/general,english/video,zone/the,day,elizabeth,became,queen
2. https://www.youtube.com/watch?v=CscHc8qSn1A

WEB RESOURCES:

1. https://galgotiacollege.edu/assets/pdfs/study,material/Notes,english.pdf
2. https://lecturenotes.in/subject/183
3. https://www.fluentu.com/blog/english/professional,english/
4. https://learnenglish.britishcouncil.org/business,english

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22LG105402	**SOFT SKILLS**	-	-	2	-	1

Pre-Requisite -

Anti-Requisite -

Co - Requisite -

COURSE DESCRIPTION: This course deals with an understanding of the fundamental soft skills and their practical social and workplace usage. It helps participants to communicate effectively and to carry themselves confidently and in harmony with their surroundings. They also learn how to identify and overcome the barriers in interpersonal relationships, and to employ oral and written communication, teamwork, leadership, problem-solving, and decision-making skills, to gain the best results.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge of career skills by analyzing the strategies of Goal Setting, Thinking Skills, interpersonal skills, and etiquette.

CO2. Analyze various situations by applying Assertive communication and Non-verbal forms in developing Interpersonal Skills.

CO3. Apply appropriate managerial strategies by analyzing the conflicts in various situations.

CO4. Demonstrate various communication styles by analyzing and applying Thinking Skills in diverse teams as an individual and a team member and during Interviews and Group Discussions.

CO5. Analyze and apply appropriate strategies of emotional intelligence and adaptability skills for personal and professional success.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	-	2	-	2	-	-	-	-	2
CO2	3	3	2	-	2	-	2	-	-	2	-	2
CO3	2	2	2	-	3	-	2	-	-	-	-	2
CO4	3	2	2	-	2	-	2	-	3	2	3	2
CO5	2	2	2	-	3	-	3	-	-	2	-	3
Course Correlation Mapping	**3**	**2**	**2**	**-**	**3**	**-**	**2**	**-**	**3**	**2**	**3**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

***Any ten modules are mandatory among the following:**

Module 1: BODY LANGUAGE

Body language basics, Types of Body Language, Facial Expressions and their messages, Eye Contact Insights, Body Posture, Hand gestures, and finger movements

Module 2: ASSERTIVENESS

Communication Styles, Benefits, Asserting yourself, Tips, and Role Play

Module 3: GOALSETTING

Seven Steps of Goal Setting, Self-Motivation, Personal Goal Setting, and Setting Career Goals

Module 4: THINKING SKILLS

Positive Thinking, Creative Thinking, Lateral Thinking, Logical Thinking, and Intuitive Thinking

Module 5: TEAM BUILDING

Learning Activities, Management Essentials, and Team Building Scenarios

Module 6: CONFLICT MANAGEMENT

Ways of Resolving Conflict, Personality Types and Conflict, Conflict Resolution Process, and Team Conflict

Module 7: EMOTIONAL INTELLIGENCE

Definition, understanding emotions, Identifying emotional intelligence, and self-assessment

Module 8: ADAPTABILITY SKILLS

Understanding organizational communication, Identifying adaptability skills, and self-assessment.

Module 9: GROUP DISCUSSIONS

Types of GD, Dos, and Don'ts, Dynamics of GD, Intervention, and Summarization Techniques

Module 10: INTERVIEW SKILLS

Planning, Opening Strategies, Answering Strategies, Teleconferencing, Videoconferencing, Practice questions, and Dress code

Module 11: INTERPERSONAL SKILLS

Starting a Conversation, Responding to a Conversation, Conversation Examples, Body Language, and Role Play

Module 12: ETIQUETTE

Basic Social Etiquette, Telephone Etiquette, Dining Etiquette, Conference Etiquette, and Email Etiquette

RESOURCES

REFERENCES:

1. Manual…
2. Dr. K. Alex, *Soft Skills*, S. Chand & Company LTD, Latest Edition, New Delhi, 2018.
3. R. C. Sharma & Krishna Mohan, *Business Correspondence and Report Writing*, Tata McGraw,Hill Publishing Company Limited, 3rd Edition, New Delhi, 2012.
4. S.P. Dhanavel, *English and Soft Skills*, Orient Black Swan Private Limited, 2010.

SOFTWARE/TOOLS:

1. K-VAN Solutions.
2. Learning to Speak English 8.1, The Learning Company, 4 CDs.
3. English in Mind, Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge.
4. Language in Use 1, 2 & 3.
5. Cambridge Advanced Learner's Dictionary, 3rd Edition.
6. Let’s Talk English, Regional Institute of English South India

VIDEO LECTURES:

1. http://nptel.ac.in/courses/106102064
2. http://nptel.ac.in/courses/106106127/

WEB RESOURCES:

1. http://psydilab.univer.kharkov.ua/resources/ucheba/softskills/Chapter_1_Introduction.PDF
2. https://learning.tcsionhub.in/courses/tcs,ion/introduction,to,soft,skills/
3. https://goo.gl/laEHOY (dealing with complaints)
4. http://www.adm.uwaterloo.ca/infocecs/CRC/manual/resumes.html
5. https://goo.gl/FEMGXS
6. http://www.career.vt.edu/interviewing/TelephoneInterviews.html
7. http://job,search,search.com/interviewing/behavioral_interviews
8. https://www.thebalancecareers.com/what,are,soft,skills,2060852

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22LG101403	**GERMAN LANGUAGE**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Oral communication; Basic grammar; Basic writing; Berufsdeutcsch (Business German)

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate basic knowledge of the German language and verb conjugation.

CO2. Comprehend and apply the knowledge of vocabulary and phrases in day-to-day real-life conversation.

CO3. Apply the various sentence structures by examining the rules of grammar in speaking and writing.

CO4. Analyze the various verb structure of English and German languages effectively in professional writing

CO5. Apply the various verb structure of English and German languages effectively in professional writing.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	2	-	-	-	-
CO2	3	-	-	-	-	-	-	2	-	-	-	-
CO3	3	-	-	-	-	-	-	2	-	-	-	-
CO4	3	-	-	-	-	-	-	2	-	-	-	-
CO5	3	-	-	-	-	-	-	2	-	-	-	-
Course Correlation Mapping	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION ***(06 Periods)***

Introduction - German alphabet, numbers, days in a week, names of months, seasons. Grammar: Nouns –(i)Nominative case and (ii) Nominative personal pronouns, simple sentence, Verb Conjugation 1st and 2nd type, verb Conjugation 3rd type, 'Wh' questions (simple sentences) Nominative (definite and indefinite) Articles

Module 2: CITY AND FOOD ***(06 Periods)***

In the city: naming places and buildings, means of transport, basic directions. Food: drink, groceries and meals. Apartments: rooms, furniture, colours.
Grammar: Nouns-articles negation–(kein and nicht); imperative and the accusative case; Nominative Possessive Pronouns.

Module 3: DAY-TO-DAY CONVERSATIONS ***(06 Periods)***

Everyday life, telling time, making appointments, leisure activities, and celebrations. Different types of professions, Health and the body, holidays and weather, Clothes and Dresses.

Module 4: BASIC GRAMMAR ***(06 Periods)***

Grammar: Possessive articles, Prepositions (am, um, von. bis); Modal verbs, Separable verbs, accusative, past tense of 'to have' and 'to be', imperative sentences, dative case, perfect tense.

Module 5: BASIC WRITING ***(06 Periods)***

Translation from English to German and German to English, Contacts, Writing letters and Email Writing.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Prepare a report on the importance of the German language in India
2. Why is German taught in Indian schools?

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXTBOOKS:

1. Stefanie Dengler, Paul Rusch, Helen Schmitz, Tana Sieber, *Netzwerk Deutsch als Fremdsprache, Arbeitsbuch A1*, Goyal Publishers and Distributors Pvt. Ltd. 2015.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=o4GvYa-3BmY
2. https://www.youtube.com/watch?v=mrF9BizWmgk
3. https://www.youtube.com/watch?v=mojirClzQEs
4. https://www.youtube.com/watch?v=0osSyX0MmCM
5. https://www.youtube.com/watch?v=mMDOtG5ucHA

Web Resources:

1. https://learngerman.dw.com/en/beginners/c-36519789
2. https://storylearning.com/learn/german/german-tips/basic-german-phrases
3. https://study.com/academy/lesson/how-to-write-a-letter-in-german.html

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22LG101404	**FRENCH LANGUAGE**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Oral communication; Basic writing; Basic grammar

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate basic knowledge of the French language.

CO2. Comprehend and apply the knowledge of the alphabet in day-to-day real-life conversation.

CO3. Apply the various styles of greetings in speaking and writing.

CO4. Analyze the various conversations in French languages

CO5. Apply the French words for date and time.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	2	-	-	-	-
CO2	3	-	-	-	-	-	-	2	-	-	-	-
CO3	3	-	-	-	-	-	-	2	-	-	-	-
CO4	3	-	-	-	-	-	-	2	-	-	-	-
CO5	3	-	-	-	-	-	-	2	-	-	-	-
Course Correlation Mapping	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION ***(06Periods)***

Introduction – Introduction, History of the French Language, Extent of the French Language, Reasons To Learn French, Book Organization, Learning French, Advice on Studying French.

Module 2: THE ALPHABET ***(06 Periods)***

Letters, Punctuation, Acute Accent, Grave Accent, Tonic Accent, Stress.

Module 3: GREETINGS ***(06 Periods)***

Greetings, Good-byes, Names, Vous vs. tu, Courtesy, Formal Speech Titles, Asking For One's Name.

Module 4: CONVERSATIONS & NUMBERS ***(06 Periods)***

How are you? Asking How One Is Doing, Cardinal Numbers and Ordinal Numbers.

Module 5: THE DATE & TIME ***(06 Periods)***

Numbers 01-31, Seasons, Days of the week, Months of the Year, Numbers 30-60, Times of Day, Asking for the time.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Prepare a report on the importance of the French language in India
2. Why is French taught in Indian schools?

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXTBOOKS:

1 The current, editable version of this book is available in Wikibooks, the open-content textbooks collection, at http://en.wikibooks.org/wiki/French

VIDEO LECTURES:

1 https://www.bing.com/videos/riverview/relatedvideo?&q=video+lecture+on+THE+ALPHABET+in+french&qpvt=video+lecture+on+THE+ALPHABET+in+french&mid=D123409C16604E0FDE26D123409C16604E0FDE26&&FORM=VRDGAR

2 https://www.youtube.com/watch?v=hd0_GZHHWeE

Web Resources:

1 https://vdocument.in/french-lecture-notespdf.html?page=2

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MM101402	**MULTIVARIABLE CALCULUS AND DIFFERENTIAL EQUATIONS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course contains various topics related to the calculus of the functions of two or more variables and differential equations. In particular, this contains topics like differentiation and integration of the functions of several variables together with their applications. It includes calculus of vector functions with applications. The methods of solving ordinary and partial differential equations are also incorporated for a better exposure.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Determine the extreme values of functions of two variables.

CO2. Evaluate multiple integrals in Cartesian, Polar and Spherical coordinates.

CO3. Demonstrate gradient, directional derivative, divergence, curl and Green's, Gauss, Stoke's theorems.

CO4. Solve higher order linear differential equations related to various engineering fields.

CO5. Identify solution methods for partial differential equations that model physical processes.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	2	1	-	-	-	-	-	-	-
CO2	2	3	-	3	1	-	-	-	-	-	-	
CO3	3	2	-	3	1	-	-	-	-	-		-
CO4	3	2	-	3	1	-	-	-	-	-	-	-
CO5	3	3	-	3	1	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Multivariable Calculus (Differentiation) (07 Periods)
Introduction to function of several variables, Jacobian and its properties, Functional dependence, Maxima and minima of functions of two variables, Lagrange's multiplier method.

Module 2: Multivariable Calculus (Integration) (10 Periods)
Evaluation of Double integrals (Cartesian and Polar coordinates), Change of order of integration (Cartesian form only), Evaluation of triple integrals, Change of variables: Double integration from Cartesian to Polar coordinates, Triple integration from Cartesian to Spherical polar coordinates.

Module 3: Multivariable Calculus (Vector Calculus) (11 Periods)
Vector Differentiation: Scalar and Vector fields: Gradient of a scalar field, Directional derivative, Divergence of a vector field, Solenoidal vector, Curl of a vector field, Irrotational vector, Laplacian operator.
Vector Integration: Line, Surface and Volume integrals, Vector integral theorems: Statement of Green's, Stoke's and Gauss divergence theorems, Verification and evaluation of vector integrals using them.

Module 4: Ordinary Differential Equations (10 Periods)
Second and higher order linear differential equations with constant coefficients: Non-Homogeneous equations with R.H.S terms of the type e^{ax}, $\sin ax$, $\cos ax$, polynomials in x, $e^{ax}V(x)$ and $x^n V(x)$, Method of variation of parameters, Equations reducible to linear differential equations with constant coefficients: Cauchy-Euler and Cauchy-Legendre differential equations.

Module 5: Partial Differential Equations (07 Periods)
Formation of partial differential equations by the elimination of arbitrary constants and arbitrary functions, Lagrange's linear equation, Method of separation of variables.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTAL LEARNING

1. American Airlines requires that the total outside dimensions (length + width + height) of a checked bag not exceed 62 inches. Suppose you want to check a bag whose height is equal to its width. What is the largest volume bag of this shape that you can check on an American Airlines flight?
2. An insulated rod of length l has its ends *A* and *B* maintained at 0^0C and 100^0C respectively until steady state conditions prevail. If *B* is suddenly reduced to 0^0C and maintained at 0^0C, establish an equation to find the temperature at a distance x from *A* at time t under the above conditions.

3 Apply the Gamma function; obtain the mass of an octant of the ellipsoid $\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$ with the density at any point being $\rho = k\,x\,y\,z$.

4 A person weighs 150lb walking exactly one revolution up a circular, spiral staircase of radius x ft. if the person rises 10ft then find the work done by the person. Consider different radii and find the work done by the person in each case.

(Note: It's an indicative one. The course instructor may change the activities and shall be reflected in the course handout.)

RESOURCES

TEXT BOOKS:

1. B. S. Grewal, *Higher Engineering Mathematics*, Khanna publishers, 44th edition, 2017.
2. Erwin kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 10th edition, 2011.

REFERENCE BOOKS:

1. Dennis G. Zill and Warren S. Wright, *Advanced Engineering Mathematics*, Jones and Bartlett, 6th edition, 2011.
2. N.P. Bali and Manish Goyal, "*A Text Book of Engineering Mathematics*", Laxmi Publications, Reprint, 2008.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/111107108
2. https://nptel.ac.in/courses/111106100
3. https://nptel.ac.in/courses/111103021

WEB RESOURCES:

1. http://www.efunda.com/math/math_home/math.cfm
2. http://www.sosmath.com/
3. http://www.mathworld.wolfram.com/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MM101404	**TRANSFORM TECHNIQUES AND LINEAR ALGEBRA**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite 22MM102404-Transformation Techniques and Linear Algebra

Co-Requisite -

COURSE DESCRIPTION: This course focus on basic areas of theory and more advanced Engineering Mathematics topics which provide students with the relevant mathematical tools required in the analysis of problems in Engineering and scientific professions. This course includes Fourier series, Fourier Transforms, Laplace transforms, Inverse Laplace transform, solutions for linear systems, Eigen values and Eigen vectors, Linear transformation.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate Fourier series to study the behaviour of periodic functions and their applications and Fourier transform to connect the frequency and time domain systems.

CO2. Apply the techniques of Laplace transform to solve ordinary differential equations.

CO3. Make use of echelon forms in finding the solution of system of linear equations. Compute Eigen values and Eigen vectors of square matrices.

CO4. Use the fundamental concept of a basis for a subspace to give a precise definition of dimensions and rank, and to solve problems in appropriate situations.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	1	-	-	-	-	-	-	-
CO2	3	3	-	3	1	-	-	-	-	-	-	-
CO3	3	2	-	1	1	-	-	-	-	-	-	-
CO4	3	2	-	3	1	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**2**	**1**	**-**	**-**	**-**	-	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FOURIER SERIES & FOURIER TRANSFORMS **(09 Periods)**

Introduction to Fourier series, Convergence of Fourier series (Dirichlet's conditions), Fourier series in $(-\pi, \pi)$, Half-range Fourier sine and cosine expansions in $(0, \pi)$, Fourier integral theorem (statement only), Fourier sine and cosine integrals; Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier transforms.

Module 2: LAPLACE TRANSFORMS **(09 Periods)**

Definition of Laplace transforms, Existence conditions, Laplace transforms of standard functions, Properties of Laplace transforms (without proofs), Laplace transforms of derivatives, Laplace transforms of integrals, Multiplication by t^n, Division by t, Laplace transforms of periodic functions, Laplace transforms of unit step function and unit impulse function.

Module 3: INVERSE LAPLACE TRANSFORMS **(09 Periods)**

Inverse Laplace transforms by different methods, Convolution theorem (without proof), Inverse Laplace transforms by convolution theorem, Applications of Laplace transforms to ordinary differential equations of first and second order with constant coefficients.

Module 4: LINEAR ALGEBRA -MATRICES **(09 Periods)**

Rank of a matrix: Echelon form, Linear systems of equations: solving system of Homogeneous and Non-Homogeneous equations; Eigen values and Eigen vectors of a matrix and properties (without proofs), Diagonalization of a matrix by orthogonal transformation, Cayley-Hamilton Theorem.

Module 5: LINEAR ALGEBRA- VECTOR SPACES **(09 Periods)**

Vector spaces, Linear dependence and independence of vectors, Basis, Dimension, Linear transformations (maps), Range and Kernel of a linear map, Rank and Nullity, Inverse of a linear transformation, Rank-Nullity theorem (without proof).

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTAL LEARNING

1. A 100-gm mass is suspended from a spring with constant 50 N/m. It is set into motion by raising it 10 cm above its equilibrium position and giving it a velocity of 1 m/s downward. During the subsequent motion a damping force acts on the mass and the magnitude of this force is twice the velocity of the mass. If an impulse force of magnitude 2 N is applied vertically upward to the mass at t = 3 s, find the position of the mass for all time.
2. Develop a differential equation from an LRC circuit connected in series using Kirchoff Voltage law and then solve using Laplace transform. Analyze the result by using any technology.
3. Check that the complex numbers $\mathbb{C} = \left\{x + iy \,/\, i^2 = -1, x, y \in \Re\right\}$, satisfy all of the conditions in the definition of vector space over $\mathbb{R}$. Make sure you state carefully what your rules for vector addition and scalar multiplication.

4 Let Breakfast consists of orange juice, cereal, and eggs with the following nutritional information:

	OJ	Cereal	Eggs
Protein	0%	10%	20%
Vitamin C	20%	15%	0%
Calories	100	120	100

If you must have 30% protein, 30% Vitamin C and 300 calories for your breakfast, How many servings of OJ, Cereal, and Eggs should you have?

(Note: It's an indicative one. The course instructor may change the activities and shall be reflected in the course handout.)

RESOURCES

TEXT BOOKS:

1. B. S. Grewal, *Higher Engineering Mathematics*, Khanna publishers, 44th edition, 2017.
2. David Poole, *Linear Algebra: A Modern Introduction*, Brooks/Cole, 2nd edition, 2005.

REFERENCE BOOKS:

1. Erwin kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 10th edition, 2011.
2. Belkacem Said-Houari, *Linear Algebra,* Springer International publish, 2017.
3. Bernard Kolman and David, R. Hill, Introductory *Linear Algebra- An applied first course*, Pearson Education, 9th Edition, 2011.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/111106111
2. https://nptel.ac.in/courses/111106051

WEB RESOURCES:

1. https://www.coursera.org/learn/matrix-algebra-engineers
2. https://www-users.cse.umn.edu/~mille003/fouriertransform.pdf
3. https://nitkkr.ac.in/docs/12-%20Laplace%20Transforms%20and%20their%20 Applications.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MM102404	**TRANSFORMATION TECHNIQUES AND LINEAR ALGEBRA**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite 22MM101404 – Transformation Techniques and Linear Algebra

Co-Requisite -

COURSE DESCRIPTION: This course focus on basic areas of theory and more advanced Engineering Mathematics topics which provide students with the relevant mathematical tools required in the analysis of problems in Engineering and scientific professions. This course includes Fourier series, Fourier Transforms, Laplace transforms, Inverse Laplace transform, solutions for linear systems, Eigen values and Eigen vectors, Linear transformation.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate Fourier series to study the behaviour of periodic functions and their applications and Fourier transform to connect the frequency and time domain systems.

CO2. Apply the techniques of Laplace transform to solve ordinary differential equations.

CO3. Make use of echelon forms in finding the solution of system of linear equations. Compute Eigen values and Eigen vectors of square matrices.

CO4. Use the fundamental concept of a basis for a subspace to give a precise definition of dimensions and rank, and to solve problems in appropriate situations.

CO5. Work independently or in teams to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	1	-	-	-	-	-	-	-
CO2	3	3	-	3	1	-	-	-	-	-	-	-
CO3	3	2	-	1	1	-	-	-	-	-	-	-
CO4	3	2	-	3	1	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	3	3	-	-
Course Correlation Mapping	**3**	**3**	**-**	**2**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FOURIER SERIES & FOURIER TRANSFORMS ***(09 Periods)***

Introduction to Fourier series, Convergence of Fourier series (Dirichlet's conditions), Fourier series in $(-\pi, \pi)$, Half-range Fourier sine and cosine expansions in $(0, \pi)$, Fourier integral theorem (statement only), Fourier sine and cosine integrals; Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier transforms.

Module 2: LAPLACE TRANSFORMS ***(09 Periods)***

Definition of Laplace transforms, Existence conditions, Laplace transforms of standard functions, Properties of Laplace transforms (without proofs), Laplace transforms of derivatives, Laplace transforms of integrals, Multiplication by t^n , Division by t, Laplace transforms of periodic functions, Laplace transforms of unit step function and unit impulse function.

Module 3 INVERSE LAPLACE TRANSFORMS ***(09 Periods)***

Inverse Laplace transforms by different methods, Convolution theorem (without proof), Inverse Laplace transforms by convolution theorem, Applications of Laplace transforms to ordinary differential equations of first and second order with constant coefficients.

Module 4 LINEAR ALGEBRA -MATRICES ***(09 Periods)***

Rank of a matrix: Echelon form, Linear systems of equations: solving system of Homogeneous and Non-Homogeneous equations; Eigen values and Eigen vectors of a matrix and properties (without proofs), Diagonalization of a matrix by orthogonal transformation, Cayley-Hamilton Theorem.

Module 5 LINEAR ALGEBRA- VECTOR SPACES ***(09 Periods)***

Vector spaces, Linear dependence and independence of vectors, Basis, Dimension, Linear transformations (maps), Range and Kernel of a linear map, Rank and Nullity, Inverse of a linear transformation, Rank-Nullity theorem (without proof).

Total Periods: 45

EXPERIENTAL LEARNING

1. Find the constant, first sine and cosine terms in the Fourier series expansion of the function y=f(x) from the given data through MATLAB.
2. Plot and visualize the first four terms of a Fourier series of a function f(x) in [0, 2l] using MATLAB.
3. Plot and visualize the first four terms of a Fourier series of a function f(x) in [-l, l] using MATLAB.
4. Solve and visualize solutions of the first order differential equations using Laplace transform through MATLAB code.
5. Solve and visualize solutions of the second order differential equations using Laplace transform through MATLAB code.

6. Write a MATLAB program to verify the Cayley-Hamilton theorem for the given square matrix and also to find A^n.
7. Find the Eigen values and Eigen vectors of the non symmetric matrix through MATLAB code.
8. Find the Eigen values and Eigen vectors of the symmetric matrix through MATLAB code.
9. Diagonalize the given square matrix through similarity transformation using MATLAB.
10. Diagonalize the given square matrix through orthogonal transformation using MATLAB

RESOURCES

TEXT BOOKS:

1. B. S. Grewal, *Higher Engineering Mathematics*, Khanna publishers, 44th edition, 2017.
2. David Poole, *Linear Algebra: A Modern Introduction*, Brooks/Cole, 2nd edition, 2005.

REFERENCE BOOKS:

4. Erwin kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th edition, 2011.
5. Belkacem Said-Houari, Linear Algebra, Springer International publish, 2017.
6. Bernard Kolman and David, R. Hill, Introductory Linear Algebra- An applied first course, Pearson Education, 9th Edition, 2011.

VIDEO LECTURES:

4. https://nptel.ac.in/courses/111106111
5. https://nptel.ac.in/courses/111106051

Web Resources:

4. https://www.coursera.org/learn/matrix-algebra-engineers
5. https://www-users.cse.umn.edu/~mille003/fouriertransform.pdf
6. https://nitkkr.ac.in/docs/12-%20Laplace%20Transforms%20and%20their%20Applications.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MM101406	**SPECIAL FUNCTIONS AND COMPLEX ANALYSIS**	3	-	-	-	3

Pre-Requisite 22MM101402-Multivariable Calculus and Differential Equations

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides fundamental knowledge of Beta and Gamma functions, Analyticity of a function. Further, this course focuses on differentiability, evaluation of complex integrals over a contour, Residues, evaluation of real integrals using Residue theorem.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Evaluate integrals by applying Beta and Gamma functions.

CO2. Analyze the analyticity of complex functions and apply Cauchy-Riemann equations & harmonic functions to solve engineering problems.

CO3. Determine the image of given region under the given conformal mapping

CO4. Identify singularities of complex functions and determine the values of integrals using complex variable techniques.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	3	1	-	-	-	-	-	-	-
CO2	3	3	-	3	1	-	-	-	-	-	-	-
CO3	3	3	-	3	1	-	-	-	-	-	-	-
CO4	3	3	-	3	3	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**3**	**2**	**-**	**-**	**-**	-	**-**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1 SPECIAL FUNTCIONS (BETA AND GAMMA FUNCTIONS) ***(07 Periods)***

Beta and Gamma functions and their properties, relation between beta and gamma functions, Evaluation of integrals using beta and gamma functions.

Module 2 ANALYTIC FUNCTIONS ***(10 Periods)***

Analytic Functions: Elementary functions-separation of real and imaginary parts, Differentiation, analyticity, Cauchy-Riemann equations (both Cartesian and polar), harmonic functions, harmonic conjugate-construction of analytic function by Milne Thomson method, potential functions.

Module 3 CONFORMAL MAPPING ***(08 Periods)***

Conformal Mapping: Definition and examples, Translation, Rotation, Inversion, Transformations $w = z^2, e^z$; Bilinear transformations and their properties.

Module 4 COMPLEX INTEGRATION ***(10 Periods)***

Line integrals, Cauchy's integral theorem (without proof)-verification, Cauchy's integral formula (without proof), Generalized integral formula (without proof); Taylor's series, Laurent's series

Module 5 RESIDUE THEOREM ***(10 Periods)***

Zeros of analytic functions, Singularities: Types of singularities, pole of order n.
Residues and evaluation of residue at poles, Cauchy's Residue theorem (without proof), evaluation of integrals using residue theorem, evaluation of real integrals (not having poles on real axis) of the type: i) $\int_0^{2\pi} f(\cos\theta, \sin\theta) d\theta$ ii) $\int_{-\infty}^{\infty} f(x) dx$ iii) $\int_{-\infty}^{\infty} e^{imx} f(x) dx$.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Apply the Gamma function, obtain the mass of an octant of the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ with the density at any point being $\rho = k\,x\,y\,z$.
2. Discuss how to prepare a geographical map (Atlas) of the earth on a piece of paper using complex plane.
3. Two concentric circular cylinders of radii r_1 and r_2 $(r_1 < r_2)$ are kept at potentials ϕ_1 and ϕ_2 respectively. Using complex function $w = a \log z + c_1$, prove that the capacitance per unit length of the capacitor formed by them is $\frac{2\pi\lambda}{\log\left(r_2/r_1\right)}$, where λ is the dielectric constant of the medium.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. B. S. Grewal, *Higher Engineering Mathematics*, Khanna publishers, 44th edition,2017.
2. J. W. Brown and R. V. Churchill, *Complex Variables and Applications,* Mc-Graw Hill, 7th edition, 2004.

REFERENCE BOOKS:

1. T. K. V. Iyengar, B. Krishna Gandhi, S. Ranganatham and M. V. S. S. N. Prasad, *Text book of Engineering Mathematics, Vol-III*, S. Chand & Company, 9th edition, 2013.

2. N. P. Bali and Manish Goyal, *A text book of Engineering Mathematics*, Laxmi Publications, Reprint, 2010.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/111/103/111103070/
2. https://youtube.videoken.com/embed/3Co68ALYRT
3. https://nptel.ac.in/courses/112/108/112108285/
4. https://nptel.ac.in/courses/111/106/111106141/

Web Resources:

1. https://ocw.mit.edu/courses/18-04-complex-variables-with-applications-spring-2018/download/
2. https://www.math.ucdavis.edu/~romik/data/uploads/notes/complex-analysis.pdf
3. https://mathworld.wolfram.com/BetaFunction.html

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MM101405	**NUMERICAL METHODS, PROBABILITY AND STATISTICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course contains various numerical methods to solve algebraic and transcendental equations and differential equations. This course also contains probability distributions and interpretation of hypothesis test for large and small samples.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Determine the approximate root of an equation and apply different methods to compute the value of interpolating polynomial at given point.

CO2. Evaluate integrals making use of quadrature formulae and solve ordinary differential equations numerically.

CO3. Use discrete and continuous distribution models to calculate probabilities for appropriate random variables.

CO4. Demonstrate and apply the basic concepts of inferences concerning means and proportions to the decision making process.

CO5. Interpret hypotheses test for small samples.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	3	2	-	-	-	-	-	-	-
CO2	3	3	-	3	2	-	-	-	-	-	-	-
CO3	3	3	-	3	2	-	-	-	-	-	-	-
CO4	3	3	-	3	2	-	-	-	-	-	-	-
CO5	3	3	-	3	2							
Course Correlation Mapping	**3**	**3**	**-**	**3**	**2**	**-**	**-**	**-**	-	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1 ALGEBRAIC AND TRANSCENDENTAL EQUATONS, INTERPOLATION ***(09 Periods)***

Solution of algebraic and transcendental equations: Bisection method and Newton-Raphson's method. Finite differences, relation between operators, interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Lagrange's formula.

Module 2 NUMERICAL DIFFERENTIATION AND INTEGRATION ***(10 Periods)***

Numerical Differentiation- Newton's forward and backward difference formulae, numerical integration- trapezoidal rule, Simpson's 1/ 3^{rd} and 3/ 8^{th} rules.

Module 3 RANDOM VARIABLE AND DISTRIBUTIONS ***(09 Periods)***

Random variables (discrete and continuous), probability density functions, probability distribution: Binomial - Poisson - normal distribution and their properties (mathematical expectation and variance).

Module 4 TEST OF SIGNIFICANCE FOR LARGE SAMPLES ***(09Periods)***

Formulation of null hypothesis, critical regions, level of significance. Large sample tests: Test for single proportion, difference of proportions, test for single mean and difference of means.

Module 5 TEST OF SIGNIFICANCE FOR SMALL SAMPLES ***(08 Periods)***

Student's t-distribution (single mean, two means and paired t-test), Testing of equality of variances (F-test). Chi-square test for goodness of fit.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Write a Python program to solve algebraic equation by bisection method.
2. Write a Pseudo code on numerical integration using Simpson1/3 method.
3. What is the importance of probability distribution in computer science engineering?
4. If you draw from a normal distribution with known values of parameters, how do you generate draws in a uniform distribution?

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1 B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 44/e, 2019.

2 S.S. Sastry, *Introductory Methods of Numerical Analysis*, Prentice Hall of India, 5^{th} Edition, 2012.

3 Miller and Freund's, *Probability and Statistics for Engineers*, Prentice Hall of India, 8^{th} Edition, 2011.

REFERENCE BOOKS:

1 Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 9^{th} Edition, 2006.

2 T.K.V.Iyenger, Krishna Gandhi and others, *Probability & Statistics*, S.Chand.

3 S. C. Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons Publications, 11^{th} Edition, 2012.

VIDEO LECTURES:

1 https://nptel.ac.in/courses/127106019
2 https://nptel.ac.in/courses/111106112
3 https://nptel.ac.in/courses/111105041
4 https://nptel.ac.in/courses/111106112

Web Resources:

1 https://www.pdfdrive.com/introductory-methods-of-numerical-analysis-by-ss-sastry-d148704487.html
2 https://faculty.ksu.edu.sa/sites/default/files/probability_and_statistics_for_engineering_and_the_sciences.pdf
3 http://brharnetc.edu.in/br/wp-content/uploads/2018/11/21.pdf
4 http://www.mi.sanu.ac.rs/~gvm/Teze/Numerical%20methods%20In%20Computational%20Engineering.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MM102452	**ENGINEERING PHYSICS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a complete discussion about the wave theory of light, propagation of electromagnetic waves on a dielectric medium, and behavior of various semiconducting materials in addition to that dielectric, magnetic, nanomaterials, and superconducting materials. This course also provides hands-on experience on the above concepts.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the concepts of light waves to interpret the concepts of Interference, Diffraction, and Polarization.

CO2. Demonstrate the concepts of electromagnetic wave propagation in optical fibers.

CO3. Understand the basic concepts of semiconductors in the functioning of various optoelectronic devices.

CO4. Demonstrate the basic concepts of dielectric and magnetic properties in the behavior of the various dielectric polarizations and magnetic materials.

CO5. Analyze the concepts of superconductors and nanomaterials to familiarize their applications in emerging fields.

CO6. Work independently and in teams to solve problems with effective communications.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-		1	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-
CO3	3	2	1	-	-	1	-	-	-	-	-	-
CO4	3	2	-	-	-	1	-	-	-	-	-	-
CO5	3	2	-	-	-	-	1	-	-	-	-	-
CO6	3	2	-	-	-	-	-	1	1	1		
Course Correlation Mapping	**3**	**2**	**1**	**-**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: WAVE OPTICS **(09 Periods)**

Interference: Introduction- Interference in thin films (reflected light) - Newton's rings.

Diffraction: Fraunhofer diffraction - Single slit diffraction (qualitative) - Double slit diffraction (qualitative).

Polarization: Polarization by reflection and double refraction - Nicol's prism - Half wave and Quarter wave plate - Engineering applications of interference, diffraction, and polarization.

Module 2: ELECTROMAGNETIC WAVES AND FIBER OPTICS **(09 Periods)**

Electromagnetic Waves: Divergence, Curl of Electric and Magnetic Fields - Maxwell's Equations (qualitative).

Fiber Optics: Introduction to fiber optics - Total Internal Reflection - Critical angle of propagation -Acceptance angle, Acceptance cone - Numerical Aperture - V number (qualitative) - Classification of fibers based on Refractive index profile, modes - Applications of optical fiber - Fiber optic Sensors (temperature, displacement).

Module 3: SEMICONDUCTORS AND OPTOELECTRONIC DEVICES **(10 Periods)**

Semiconductors: Introduction - Intrinsic semiconductors - Density of electrons in intrinsic semiconductor - Intrinsic carrier concentration - Fermi energy - Extrinsic semiconductors - Density of charge carriers in Extrinsic semiconductors (qualitative) - Drift and Diffusion currents - Direct and Indirect band gap semiconductors - Hall effect - pn junction

Optoelectronic devices: Light Emitting Diode (LED) – Photodiode - Semiconductor diode laser.

Module 4: DIELECTRICS AND MAGNETIC MATERIALS **(09 Periods)**

Dielectric Materials: Introduction - Electric polarization - Types of polarizations (qualitative) - Frequency dependence of polarization - Lorentz (internal) field - Dielectric break down - Piezoelectricity - Applications of dielectrics.

Magnetic Materials: Introduction - Origin of magnetic moment - Classification of magnetic materials - Hysteresis loop - Soft and hard magnetic materials - Applications.

Module 5: SUPERCONDUCTORS AND NANOMATERIALS **(08 Periods)**

Superconductors: Introduction – Critical parameters of Superconductors - Meissner effect - Types of Superconductors - BCS Theory - Applications of Superconductors.

Nanomaterials: Basic principles of nanomaterials - Synthesis of nanomaterials by Ball Milling and Pulsed Laser Deposition (PLD) methods - Properties of nanomaterials - Applications of nanomaterials.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXPERIMENTS: (Minimum 10 experiments shall be conducted)

1. Find the thickness of a human hair using the interference technique.
2. Determination of the radius of curvature of the lens (or) wavelength of monochromatic source by forming Newton's ring.
3. Estimate the wavelength of a given laser source by using a diffraction grating.

4. Determination of the numerical aperture of a given optical fiber and hence estimate its acceptance angle.
5. Estimation of the number of charge carriers of a given semiconducting specimen by calculating Hall coefficients using the Hall apparatus.
6. Calculation of forward and reverse resistances of a p-n junction diode by studying I-V characteristic curves.
7. Prediction of the energy gap of a given semiconductor diode by varying the temperatures.
8. Estimation of threshold voltages of different LEDs by plotting I-V curves.
9. Study the characteristics of Photodiode by varying the intensity of light.
10. Estimation of the magnetic field along the axis of a circular coil carrying current using Stewart Gee's method.
11. Determination of wavelength of light by plane diffraction grating using spectrometer by minimum deviation method.
12. Determination of particle size using laser source with help of diffraction technique.

RESOURCES

TEXTBOOKS:

1. M.N. Avadhanulu, P.G.Kshirsagar, and T.V.S Arun Murthy, *A Textbook of Engineering Physics,* S. Chand Publications, 11th edition, 2019.
2. R.K. Gaur and S.L. Gupta, *Engineering Physics*, Dhanpat Rai Publications (P) Ltd, 2015.
3. P.K. Palaniswamy, *Engineering Physics*, Scitech Publications India Private Limited, 2nd edition, 2009.
4. Serway and Jewett, *Physics for Scientists and Engineers with Modern Physics*, 6th Edition, Thomson Brooks, 2007.

REFERENCE BOOKS:

1. K. Thyagarajan*, Engineering Physics*, McGraw-Hill Education (India) Pvt. Ltd, 2016.
2. V. Rajendran, *Engineering Physics*, Tata McGraw Hill Publications Ltd, 7th Edition, New Delhi, 2014.
3. N.K. Verma, *Physics for Engineers*, PHI Pvt. Ltd., 2014.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/122/107/122107035
2. https://nptel.ac.in/courses/117102061
3. https://nptel.ac.in/courses/118104008
4. https://nptel.ac.in/courses/115107095

WEB RESOURCES:

1. http://www.freepdfbook.com/engineering-physics-mcgraw-hill/
2. https://quickstudyhelper.com/textbook-engineering-physics.html
3. https://salmanisaleh.files.wordpress.com/2019/02/physics-for-scientists-7th-ed.pdf
4. https://www.researchgate.net/publication/344758634_Short_Notes_on_Engineering_Physics

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MM102451	APPLIED PHYSICS	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion on optical fibers with structure and classification, ideas for designing acoustically good halls, production and detection of ultrasonic's with suitable industrial applications, studying the different paths of the particles using kinetics and kinematics relations, heat transfer mechanisms in material media, characteristics, and applications of modern Engineering materials.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1. Demonstrate the concepts of electromagnetic wave propagation in optical fibers.

CO2. Apply the basic knowledge of acoustics and ultrasonics to provide solutions for various engineering problems.

CO3. Analyze and solve the problems associated with kinetics and kinematics.

CO4. Acquire basic knowledge in several heat transfer mechanisms and heat conduction through the compound media.

CO5. Understand the characteristics and applications of modern engineering materials.

CO6. Work independently and in teams to solve problems with effective communications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	1	-	-	-	-	-	-	-
CO2	3	2	1	-	-	1	-	-	-	-	-	-
CO3	3	2	-	1	-	-	-	-	-	-	-	-
CO4	3	2	-	1	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	1	-	-	-	-	-	-
CO6	3	2	-	-	-	-	-	1	1	1	-	-
Course Correlation Mapping	**3**	**2**	**1**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	-	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FIBER OPTICS (08Periods)

Introduction- Structure of optical fiber - Total internal reflection - Acceptance angle, acceptance cone - Numerical aperture - Modes of propagation - Classification of optical fibers - V-number (qualitative) - Fabrication of optical fiber by double crucible technique - Applications of optical fibers - Sensors (temperature, displacement, liquid level detector).

Module 2: ACOUSTICS AND ULTRASONICS (09 Periods)

Acoustics: Introduction - Classification of sound - Sound intensity level (decibel) – Reverberation - Reverberation time - Sabine's formula (qualitative) - Absorption coefficient and its determination - Factors affecting acoustics and their remedies - Basic requirements of an acoustically good hall.

Ultrasonics: Introduction to ultrasonic waves - Production of ultrasonic waves by magnetostriction method - Piezoelectric method - Detection of ultrasonics (qualitative) - Industrial applications (ultrasonic welding, ultrasonic soldering, and ultrasonic drilling).

Module 3: KINEMATICS AND KINETICS (10 Periods)

Kinematics of particles: Introduction - Rectilinear motion (displacement-time curve, velocity-time curve, acceleration-time curve) - Curvilinear motion (velocity and angle of projection, equation of trajectory path, horizontal range) - Inclined projection (equation of trajectory, maximum height, time of flight of projectile, horizontal range, angle of projection).

Kinetics: Bodies in rectilinear translation - Kinetics of bodies rotating about a fixed axis – Work, Energy, Power – Work-Energy equation for translation.

Module 4: THERMAL PHYSICS (08 Periods)

Introduction - Modes of heat transfer (conduction, convection, and radiation) - Coefficient of thermal conductivity - Rectilinear flow of heat along a uniform bar - Thermal conductivity of bad conductor (Lee's disc method) - Heat conduction through compound media (materials in series and parallel).

Module 5: MODERN ENGINEERING MATERIALS (10 Periods)

Metallic glasses: Introduction - Preparation of metallic glasses by RF sputtering technique - Properties (structural, thermodynamic, mechanical, electrical, chemical, and optical), Applications of metallic glasses.

Shape memory alloys (SMA): Introduction- Shape memory effect and its types - Characteristics of SMA - Properties of NiTi alloy - Applications of SMA.

Composite materials- Introduction- Types and applications of composite materials.

Total periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXPERIMENTS: (Minimum 10 experiments shall be conducted)

1. Estimate the numerical aperture and acceptance angle of an optical fiber.
2. Determination of the moment of inertia of a bar and acceleration due to gravity by using a compound Pendulum.
3. Find the moment of inertia of a Flywheel.
4. Estimate the moment of inertia of a rectangular body using the Bifilar Pendulum.

5. Determine the frequency of electrically driven tuning fork in transverse and longitudinal modes of vibration using Melde’s Experiment.
6. Determination of coefficient of thermal conductivity of a bad conductor using Lee’s disc apparatus.
7. Verify Newton's Law of Cooling for any two liquids.
8. Estimate the number of charge carriers per unit volume and hall coefficients of a given material using the Hall Effect.
9. Calculate the rigidity Modulus of a material of a wire using Torsional Pendulum
10. Determine the energy gap of material by varying temperatures.
11. Verify the three laws of stretched strings using a sonometer.
12. Estimate the particle size using a monochromatic light source (LASER).

RESOURCES

TEXTBOOKS:

1. M. N. Avadhanulu, P. G. Kshirsagar, T. V. S. Arun Murthy, *A Textbook of Engineering Physics* - S. Chand Publications, 11^{th} edition, 2019.
2. S. S. Bhavikatti and K. G. Rajashekarappa, *Engineering Mechanics*, New Age International Publishers, 2^{nd} edition, 2015.
3. R.K. Gaur and S.L. Gupta, *Engineering Physics*, Dhanpat Rai Publications (P) Ltd, 2015.
4. Serway and Jewett, *Physics for Scientists and Engineers with Modern Physics*, 6^{th} Edition, Thomson Brooks, 2007

REFERENCE BOOKS:

1. B. K. Pandey and S. Chaturvedi, *Engineering Physics*, Cengage Learning, 2012.
2. Brij Lal and N. Subrahmanyam, *Heat and Thermodynamics,* S. Chand and Company Ltd., 1995.
3. William D. CallisterJr., David G. Rethwisch, *Material Science and Engineering*, 9^{th} Edition, Wiley 2013.

VIDEO LECTURES:

1. http://nptel.ac.in/courses/112104212
2. http://nptel.ac.in/courses/105/106/105106053
3. https://nptel.ac.in/courses/115107095
4. https://archive.nptel.ac.in/courses/105/106/105106053/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22CM101401	**PRINCIPLES OF BUSINESS ECONOMICS AND ACCOUNTANCY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Business economics and demand analysis; theory of production and cost analysis; markets and pricing; principles of accounting and capital; final accounts and tally ERP 9.0

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the principles of Business Economics and theories of Demand.

CO2. Apply the theories of Production and Cost to the managerial decision-making of an organization.

CO3. Determine the Price and Output relation in the different Market structures.

CO4. Demonstrate the principles of Accountancy and sources of Capital.

CO5. Analyze the profitability and soundness of an organization.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	1	-	3	-	2
CO2	3	2	-	-	-	-	-	1	-	3	-	2
CO3	3	2	-	-	-	-	-	1	-	3	-	2
CO4	3	2	1	-	-	-	-	1	-	3	-	2
CO5	3	2	1	-	-	-	-	1	-	3	-	2
Course Correlation Mapping	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**-**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: BUSINESS ECONOMICS AND DEMAND ANALYSIS ***(09 Periods)***

Definition - Nature and Scope of Business Economics - Demand: Determinants of demand – Demand function - Law of demand, assumptions, and exceptions - Elasticity of demand – Types of elasticity of demand - Demand forecasting and methods of demand forecasting.

Module 2 THEORY OF PRODUCTION AND COST ANALYSIS ***(09 Periods)***

Production Function: Input-output relationship - Law of Variable proportion- Isoquants and Isocosts

Cost Concepts: Total, Average and Marginal Cost **-** Fixed vs. Variable costs – Opportunity Costs Vs Outlay Costs– Separable Costs Vs Joint Costs, Urgent Costs Vs Postponable Costs- Avoidable Costs Vs Unavoidable Costs

Break Even Analysis (BEA) – Assumptions, Merits and demerits - Determination of Break-Even Point (Simple problems).

Module 3 MARKETS AND PRICING ***(09 Periods)***

Market Structure: Types of Markets - Features of perfect competition - Monopoly and monopolistic competition - Price and Output determination in perfect competition, monopoly and monopolistic Markets.

Pricing: Objectives and policies of pricing – Sealed bid pricing - Marginal cost pricing - Cost plus pricing - Going rate pricing – penetration Pricing –skimming Pricing - Block pricing – Peak load pricing - Cross subsidization.

Module 4 PRINCIPLES OF ACCOUNTING & CAPITAL ***(09 Periods)***

Accountancy: Introduction – Concepts – Conventions – Double Entry Book Keeping – Journal – Ledger - Trial Balance (Simple problems)

Capital: Significance - Types of capital – Sources of Capital.

Module 5 FINAL ACCOUNTS & TALLY ERP 9.0 ***(09 Periods)***

Introduction to Final Accounts - Trading account - Profit and Loss account and Balance Sheet with simple adjustments (Simple problems)

Tally ERP 9.0: Introduction – Create a company – Create ledger – Posting vouchers – Advantages of Tally.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Prepare the Journal Entries by the students with practical examples.
2. Conduct an event about the market structure.
3. Do the problems on Financial Statements with practical examples.
4. Prepare a report regarding the demand and supply of electric vehicles in the Indian market.
5. From the following balances of Mr. Aravind as at 31.12.2016, prepare Trading, Profit and Loss Account for the year ended and Balance Sheet as at that date after making the necessary adjustments.

Debit Balances	Amount (Rs.)	Credit Balances	Amount (Rs.)
Drawing Account	6,000	Capital	80,000
Plant and Machinery	25,000	Sundry Creditors	10,000
Stock (opening)	15,000	Sales	1,20,000
Purchases	82,000	Returns outwards	1,000
Return Inwards	2,000	R.B.D.D.	400
Sundry Debtors	20,600	Discounts	800
Furniture & Fixtures	5,000	Rent of Premises sublet	1,200
Freight and Duty	2,000	Reserve Fund	5,000
Carriage outwards	500		
Rent, Rates & Taxes	4,600		
Printing & Stationery	800		
Trade Expenses	400		
Postage and Telegrams	800		
Insurance charges	700		
Salaries and Wages	21,300		
Cash in Hand	6,200		
Cash at Bank	25,500		
	2,18,400		2,18,400

Adjustments:

- Stock on 31.12.2006 was Rs.14,600.
- Write off Rs.600 as bad debts and provide 5% for R.B.D.D.
- Provide for depreciation on furniture 5% & Plant & Machinery at 20%.
- Insurance prepaid was Rs.100.
- Outstanding salaries Rs. 700
- A fire occurred on 25th December 2006 and stock worth Rs.5,000 was destroyed and the insurance company admitted a claim for Rs. 4500 only.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES:

TEXT BOOKS:

1. H L Ahuja, *Business Economics (Thirteenth edition)*, S Chand Publishing, Jan 2016.
2. S.P. Jain and K.L. Narang, *Financial Accounting*, Kalyani Publishers, Ludhiana, 12th edition, 2018.

REFERENCE BOOKS:

1. Joseph G.Nellis and David Parker, *Principles of Business Economics*, Pearson Education Canada, 2nd edition, 2016.
2. Larry M. Walther, *Financial Accounting*, Create Space Independent Publishing Platform, July 2017.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=xWKfKCnQqAE
2. https://www.youtube.com/watch?v=daYPYHbJ6Xc

WEB RESOURCES:

1. https://leverageedu.com/blog/scope-of-business-economics/
2. https://www.economicsdiscussion.net/break-even-analysis/break-even-point-of-a-firm-meaning-determination-and-types/21785

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MG101401	**ESSENTIALS OF LEADERSHIP**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is designed for learners who desire to improve their leadership, communications, and workplace skills.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Differentiate between leadership and management

CO2. Identify the values common among great leaders.

CO3. Discuss the power of positive expectations and how to apply it as a leader

CO4. Assess what, how, and to whom you should delegate.

CO5. Describe what it means to be an ethical leader.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	1	-	-	-	-	-	-
CO2	1	1	2	1	-	1	-	-	-	-	-	-
CO3	2	-	2	-	1	-	-	-	-	2	-	-
CO4	1	2	-	1	-	-	-	-	-	2	-	-
CO5	1	2	1	-	-	-	-	-	-	2	2	-
Course Correlation Mapping	**2**	**2**	**2**	**1**	**1**	**1**	**-**	**-**	-	**2**	**2**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Introduction ***(06 Periods)***

What is leadership, leadership vs management, leadership and change, Maxwell's 5 levels of leadership, how to move to the next level

Module 2: Leadership Values & Expectations ***(06 Periods)***

14 Leadership Values, what matters most exercise. Expectations, The Pygmalion Effect, impact of positive expectations, setting expectations

Module 3: Delegation ***(06 Periods)***
Definition, why delegate, delegate/empower, why people don't delegate, steps for delegation - the IDEALS model.

Module 4: Ethics ***(06 Periods)***
Definitions, introduction to ethics, ethics vs morals, self-assessment, Good People, Bad Choices examples, how to be an ethical leader, 8 Ethical Actions for Leaders.

Module 5: Commitment ***(06 Periods)***
Introduction, significance of commitment, Universal Laws of Leadership, tips towards being accountable and committed leader.

Total Periods:30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

LIST OF EXPERIMENTS:

1. Collect the case studies related to successful leaders and their traits.
2. Different Case Studies Will be Given to students as per the topic that will be collected and evaluated.
3. The case studies will be collected as Assignments and the same will be evaluated.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Anderson T, *Transforming leadership*, St. Lucie Press, Boca Raton, FL, 2nd ed 1998
2. Babiak, P. & Hare, R.D., *Snakes in suits: when psychopaths go to work*, Regan Books, New York, 2006

REFERENCE BOOKS:

1. Conger J, *Inspiring others: Th e language of leadership,* Academy of Management Executive, 5(1), 31-45, 1991
2. *Leadership Skills*. MTD Training & Ventus Publishing ApS, 2010

VIDEO LECTURES:

1. Marshall Goldsmith: The Essentials Of Leadership (fs.blog)
2. https://onlinecourses.nptel.ac.in/noc23_mg28/preview

Web Resources:

1. cdn2.hubspot.net/hubfs/4654529/Expert landing pages/Peter Cox/Resources/10 Leadership Essentials .pdf
2. 3-leadership-essentials-discovery-event-w.-no.-05.11.12.pdf (imd.org)

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MG101402	**ORGANIZATIONAL BEHAVIOUR**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course enables the students to know the principles in an organization, the system and process of effective controlling in the organization.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Interpret the scope of organizational behavior and its significance.

CO2. Understand the managerial strategies in achieving the organizational goals of an organization

CO3. Demonstrate the impact of motivation and leadership in group dynamics.

CO4. Solve organizational conflicts through negotiation and team building.

CO5. Improve the results – performance outcome through human behavior and organizational behaviour can aid them in their purist of the goals.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	2	-	-	-	2	-	2	-	2	-	2
CO2	1	-	2	1	-	2	-	-	-	-	-	2
CO3	2	-	2	-	1	-	-	-	-	2	-	2
CO4	1	2	-	1	-	-	-	-	-	2	-	2
CO5	1	2	1	-	-	-	-	-	-	2	2	2
Course Correlation Mapping	**2**	**2**	**2**	**3**	**2**	**2**		**2**		**2**	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: **Introduction** ***(06 Periods)***

Nature and scope – Linkages with other social sciences- Individual roles and organizational goals – perspectives of human behavior - Perception– perceptual process

Module 2: Learning ***(06 Periods)***

Learning - Learning Process- Theories- (Pavlov, Skinner and Thorndike) - Personality and Individual Differences - Determinants of Personality - Values, Attitudes and Beliefs.

Module 3: Motivation and Leadership ***(06 Periods)***

Definition and nature of motivation, Theories of Motivation (Maslow, Alderfer) - Leadership – Traits-Styles –Leadership skills– Challenges to leaders.

Module 4: Organizational conflicts ***(06 Periods)***

causes and consequences-conflict and Negotiation Team Building, Conflict Resolution in Groups and problem solving Techniques.

Module 5: Organizational Communication ***(06 Periods)***

Communication, types and process, importance and barriers – Organizational change - change process - resistance to change – Organizational development and OD interventions.

Total Periods:30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

LIST OF EXPERIMENTS:

1. Collect the case studies related to recent topics in OB and other Contemporary OB Practices and Present them as a seminar.
2. Different Case Studies Will be Given to students as per the topic that will be collected and evaluated.
3. The case studies will be collected as Assignments and the same will be evaluated.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Robbins.P. Stephen (2006), Organizational Behaviour, Pearson Education, New Delhi.
2. Luthans Fred (1998), Organizational Behaviour, Tata Mc Graw Hill International Edition, New Delhi
3. K.Aswathappa "Organizational Behaviour-Text, Cases and Games", HimalayaPublishingHouse, New Delhi, 2008.

REFERENCE BOOKS:

1. Steven L Mc Shane, Mary Ann Von Glinow, Radha R Sharma: "Organizational Behaviour",TMH Education, NewDelhi,2008
2. PareekUdai (2007), Understanding Organizational Behaviour, Oxford University Press, New Delhi

3. Jerald Greenberg and Robert.A. Baron, (2009), Organizational Behaviour, PHI learning Private Ltd., New Delhi.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=Sg64udtQ300&list=PL3Y_p3e-Lne2no2K5cNa8y7ti1uqCjZw8
2. https://www.youtube.com/watch?v=pHg3ZfGk5j0

Web Resources:

1. https://www.icmrindia.org
2. https://www.citeob.com/ 5 https://www.ob-guide.com

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MG101403	**PROJECT MANAGEMENT**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: To understand the importance of decision-making while implementing any project and interpret and discuss the results of qualitative and quantitative analysis

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the basic introduction to project management

CO2. Apply the methods of project identification and selection.

CO3. Understand project allocation methods and evaluation.

CO4. Analyse the techniques for project time, review, and cost

CO5. Understand the factors of risk and quality of a project.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	-	-	-	-	-	-	-
CO2	1	1	2	2	-	-	2	-	1	-	-	-
CO3	2	2	1	2	1	-	-	1	-	-	2	-
CO4	3	1	2	2	1	-	-	-	-	-	-	2
CO5	2	2	1	2	1	1	-	-	-	-	-	1
Course Correlation Mapping	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	1	**-**	**2**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Introduction ***(05 Periods)***

Concept of project management, project definition and key features of projects, project life cycle phases, typical project management issues, basic project activities

Module 2: Project Identification and Selection ***(06 Periods)***
Identification and screening (brainstorming, strength and weakness in the system, environmental opportunities and threats), Project evaluation methods- Payback period, Net present value, Internal rate of return and project evaluation under uncertainty.

Module 3: Project Resource Management ***(07 Periods)***
Scheduling resources, resource allocation methods, project crashing and resource leveling, working of systems, design of systems, project work system design, project execution plan, project procedure manual project control system, planning scheduling and monitoring

Module 4: Time and Cost Management ***(05 Periods)***
Time Management-Network diagram, forward and backward pass, critical path, PERT and CPM, AOA and AON methods, tools for project network, Cost management-earned value method

Module 5: Risk and Quality Management ***(07 Periods)***
Risk identification, types of risk, risk checklist, risk management tactics, risk mitigation and contingency planning, risk register, communication management, Quality assurance and quality control, quality audit, methods of enhancing quality

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Refer to any video lecture on project evaluation methods and give a brief seminar using PPT
2. Select any company wherein you will get the details of activities and time and draw the project network diagram and submit a report.
3.

Activity	Predecessor Activity	Normal Time (Weeks)	Crash Time (Weeks)	Normal Cost (Rs.)	Crash Cost (Rs.)
A	-	4	3	8,000	9,000
B	A	5	3	16,000	20,000
C	A	4	3	12,000	13,000
D	B	6	5	34,000	35,000
E	C	6	4	42,000	44,000
F	D	5	4	16,000	16,500
G	E	7	4	66,000	72,000
H	G	4	3	2,000	5,000

Determine a crashing scheme for the above project so that the total project time is reduced by 3 weeks

4. Collect any case study that discusses the process of probability calculation of success of the project and submit a report

(Note: It’s an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. R.Panneerselvam and P.Senthil Kumar (2013), Project Management, PHI Learning Private Limited.
2. Prasanna Chandra (2014), Projects: Planning, Analysis, Selection, Financing, implementation, and Review.

REFERENCE BOOKS:

1. A Guide to the Project Management Body of Knowledge: (PMBOK Guide) by Project Management Institute, 2013.
2. Gopala Krishnan & Rama Murthy, A Text book of Project Management, McMillan India.
3. S. Choudhary (2004), Project Management, Tata McGraw Hill Publication.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc19_mg30/preview
2. https://archive.nptel.ac.in/courses/110/104/110104073/

WEB RESOURCES:

1. https://www.pmi.org/about/learn-about-pmi/what-is-project-management
2. https://www.manage.gov.in/studymaterial/PM.pdf
3. https://imada.sdu.dk/u/jbj/DM85/lec7.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22LG107601	**PROFESSIONAL ETHICS AND HUMAN VALUES**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course deals with personal conviction, and ethics and describes the accepted principles and standards of conduct regarding moral duties and virtues as applied to an organization. Codes of professional ethics guide the stakeholders of an organization about the desirable and undesirable acts related to the profession.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the principles of ethics, professional values, and social responsibility.

CO2. Analyze the problems in the implementation of moral autonomy and use ethical theories in resolving moral dilemmas.

CO3. Develop suitable strategies to resolve problems that arise in practicing professional ethics and Industrial standards.

CO4. Function as a member, consultant, manager, advisor and leader in multi-disciplinary teams.

CO5. Provide solutions to complex problems associated with professional ethics using analysis and interpretation.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	2	2	2	-	-	-
CO2	2	3	2	-	2	2	2	2	2	-	-	-
CO3	2	-	3	-	2	2	2	2	2	-	-	-
CO4	2	-	-	-	-	2	2	2	2	-	3	-
CO5	2	2	3	2	-	3	2	2	2	-	-	-
Course Correlation Mapping	**2**	**3**	**-**	**-**	**2**	**2**	**2**	**2**	**2**	**-**	**3**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: PROFESSIONAL ETHICS (06 Periods)
Scope and aim of ethics, Senses of ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral autonomy-Kohlberg's theory, Gilligan's theory, Consensus, and controversy.

Module 2: PROFESSIONAL IDEALS AND VIRTUES (06 Periods)
Theories on virtues and ideals, Professions, Professionalism, Characteristics, Expectations, Professional responsibility, Integrity, Self-respect, Sense of responsibility, Self-interest, Customs and religion, Self-interest and ethical egoism, Customs and ethical relativism, Religion and divine command ethics, Use of ethical theories, Resolving moral dilemmas and moral leadership.

Module 3: SOCIAL EXPERIMENTATION (06 Periods)
Experimentation, Similarities to standard experiments, Learning from the past and knowledge gained, responsible experimenters, Conscientiousness, Moral autonomy and accountability, The challenger case, Codes of ethics and limitations, Industrial standards and Problems with the law of engineering.

Module 4: RESPONSIBILITIES AND RIGHTS (06 Periods)
Collegiality and loyalty, Respect for authority, Collective bargaining, Confidentiality, Conflict of interests, Occupational crime, Rights of engineers, Professional rights, Whistle-blowing, The BART case, Employee rights, and discrimination.

Module 5: HARMONY WITH PROFESSIONAL ETHICS (06 Periods)
Acceptance of human values; Ethical Human Conduct; Basis for Humanistic Education, Constitution, and Universal Order; Competence in professional ethics; Case studies: Holistic technologies, Management Models and Production Systems; Transition from the present state to Universal Human Order: socially and ecologically responsible engineers, technologists and managers - enriching institutions and organizations.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Demonstrate orally using your experiences of what is naturally acceptable in a relationship – Feeling of respect or disrespect and what is naturally acceptable is to nurture or exploit others.
2. Identify community partners and discuss with a community partner or organization. Prepare a report by identifying and analysing the issues or opportunities.
3. Field experiences may be directed to include a range of time-intensive endeavours that require varying levels of student interaction. Prepare a report on visiting a Juvenile home.
4. Students read a speech in the classroom by former United Nations Secretary-General Kofi Annan on human values.
5. Students are encouraged to bring a daily newspaper to class or to access any news related to the need for human values and note down the points.
6. Bring out the relevance of engineering ethics theory and practice with relevance to current trends.

7. Professional ideals and virtues are important to everyone. Prepare a case study on the professional ideals and virtue of any one of the famous sports personalities from India.
8. Compare the present to the past in engineering experimentations concerning the change in professionalism.
9. Make a study on occupational crime and the role of modern technology in finding solutions.
10. Prepare a case study on how to maintain harmony with different cultural people using professional ethics.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXTBOOKS:

1. Gaur R R, Sangal R & G P Bagaria*, Human Values and Professional Ethics*, Excel Books, New Delhi, 2010.
2 Govindarajan, M., Nata Govindarajan, M., Natarajan, S. and Senthilkumar, V. S., *Engineering Ethics*, Prentice Hall of India, 2004.
3 Mike W. Martin and Roland Schinzinger, *Ethics in Engineering*, Tata McGraw-Hill, 3rd Edition, 2007.

REFERENCE BOOKS:

1. S. Kannan and K. Srilakshmi, *Human Values and Professional Ethics*, Taxmann Allied Services Pvt Ltd., 2009.
2. Edmund G. Seebauer and Robert L. Barry, *Fundamental of Ethics for Scientists and Engineers*, Oxford University Press, 2001.
3. Charles F. Fledderman, *Engineering Ethics*, Pearson Education, 2nd Edition, 2004.
4. R. Subramanaian, *Professional Ethics*, Oxford Higher Education, 2013.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=jfGIq_EiXzI
2. https://www.youtube.com/watch?v=QFHOtH54oUc
3. https://www.youtube.com/watch?v=JJshY11nX14
4. https://www.youtube.com/watch?v=TyP09S0UEzA
5. https://www.youtube.com/watch?v=0QMwjV_ZVtc

WEB RESOURCES:

1. https://siiet.ac.in/wp-content/uploads/2020/09/7.1.10-professional-ethics-manual.pdf
2. https://soaneemrana.org/onewebmedia/Professional%20Ethics%20and%20Human%20Values%20by%20R.S%20NAAGARAZAN.pdf
3. https://india.oup.com/productPage/5591038/7421214/9780199475070

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22CE107601	**ENVIRONMENTAL SCIENCE**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on natural resources, ecosystems, biodiversity, environment pollution and control, social issues and environment, human population and environment.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze natural resources to solve complex environmental problems and natural resource management considering society, environment and sustainability.

CO2. Analyze ecosystems and biodiversity to solve complex environmental problems by following environmental ethics considering society, environment and sustainability besides communicating effectively in graphical form.

CO3. Analyze various types of pollution and their control measures to solve environmental problems through appropriate tools and techniques following latest developments considering society, ethics, environment and sustainability.

CO4. Analyze social issues and its impact on environment, environmental acts to solve complex environmental problems considering society, environment and sustainability besides communicating effectively in graphical form.

CO5. Analyze human population and its impact on environment to solve complex environmental problems through team work and using appropriate tools and techniques considering ethics, society, environment and sustainability.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	1	1	-	-	-	1	-
CO2	3	3	-	2	-	1	1	1	-	1	-	-
CO3	3	3	-	2	1	1	1	1	-	-	-	1
CO4	3	3	-	3	-	1	1	1	-	1	-	-
CO5	3	3	-	2	1	1	1	1	1	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: NATURAL RESOURCES ***(07 Periods)***

Multidisciplinary nature of environment; Natural Resources: Renewable and non-renewable resources; Forest, Water, Mineral, Food and Energy resources -Causes, Effects, Remedies, Case studies; Role of an individual in conservation of natural resource and equitable use of resources for sustainable lifestyles.

Module 2: ECOSYSTEMS AND BIODIVERSITY ***(07 Periods)***

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem - Producers, Consumers, Decomposers; Food chains, Food webs, Ecological pyramids – Types; Characteristic features, Structure and functions of forest ecosystem, Desert ecosystem, Aquatic ecosystem.

Biodiversity: Concept and value of biodiversity, Role of biodiversity in addressing new millennium challenges, Hot spots of biodiversity, Threats to biodiversity, Man-wild life conflicts, Endemic, Endangered and extinct species of India, Conservation of biodiversity – In-situ and ex-situ.

Module 3: ENVIRONMENTAL POLLUTION AND CONTROL ***(06 Periods)***

Causes, Adverse effects and control measures of pollution - Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear pollution, Solid waste management – Urban waste, industrial waste; Latest developments in pollution control, Hazards and disaster management – Floods, Earthquakes, Tsunamis, Case studies.

Module 4: SOCIAL ISSUES AND THE ENVIRONMENT ***(06 Periods)***

Sustainable development, Urban problems related to energy, Environmental ethics –Issues, Solutions; Global warming, Acid rain, Ozone layer depletion, Nuclear accidents and case studies, Wasteland reclamation, Consumerism and waste products, Concept of green technologies, Environment justice: National Green Tribunal and its importance; Environment protection act, Air act, Water act, Wildlife protection act, Forest conservation act, Issues involved in enforcement of environmental legislation, Public environmental awareness.

Module 5: HUMAN POPULATION AND THE ENVIRONMENT ***(04 Periods)***

Population growth, Population characteristics and variation among nations, Population explosion, Family welfare programme, Environment and human health, Human rights, Value education, HIV/AIDS, Women and child welfare, Role of information technology in environment and human health; Case studies - Field Work/Assignment/Seminar on Environmental assets – Water bodies/Forest/Grassland/Hill/Mountain.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Visit a nearby villages and know the status of availability of local resources that can be improved through proper education.
2. Make an awareness program in the villages for the development of natural resources, ecosystems and biodiversity.
3. Prepare a document by visiting a local urban waste dumping yard near to the Tirupati city.

4. Visit a local village and find a barren land and make the land into a useful land by planting plants or providing the soil and fertilizers required to improve the soil.
5. Visit a local zoological park and identify the species variety and variability.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Anubha Kaushik and Kaushik, C.P., *Perspectives in Environmental Studies*, New Age International (P) Ltd. Publications, 6th Edition, 2018.
2. Erach Barucha, *Environmental Studies,* Orient Blackswan, 3rd Edition, 2021.

REFERENCE BOOKS:

1. Cunningham, W. P. and Cunningham, M. A., *Principles of Environmental Science*, Tata McGraw-Hill Publishing Company, New Delhi, 8th Edition, 2016.
2. Benny Joseph, *Environmental Studies*, Tata McGraw-Hill, 2nd Edition, 2009.
3. Anji Reddy, M., *Text Book of Environmental Science and Technology*, BS Publications, Revised Edition, 2014.
4. Rajagopalan, R., *Environmental Studies*, Oxford University Press, 3rd Edition, 2015.

VIDEO LECTURES:

1 http:// nptel.ac.in/courses/109/104/109104047

2 https://www.youtube.com/watch?v=mIPBPG-5dUw

WEB RESOURCES:

1 https://nptel.ac.in/courses/122102006

2 https://www.flame.edu.in/academics/ug/program-structure/major-minor courses/environmental-studies

3 https://www.tutorialspoint.com/environmental_studies/environmental_studies_environment.htm

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22CE107602	**DISASTER MITIGATION AND MANAGEMENT**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on disasters, earthquakes, floods, cyclones, droughts, landslides and disaster management.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the vulnerability of an area to natural and man-made disasters/hazards as per the guidelines to solve complex problems using appropriate techniques ensuring safety, environment and sustainability.

CO2. Propose appropriate mitigation strategies for earthquake and tsunami impacts as per code of practice using suitable techniques ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO3. Analyze the causes and impacts of floods, cyclones and droughts using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO4. Analyze the causes and impacts of landslides using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability.

CO5. Design disaster management strategies to solve pre, during and post disaster problems using appropriate tools and techniques following the relevant guidelines and latest developments ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	2	2	2	2	-	-	-	-
CO2	3	3	3	3	2	2	1	2	-	2	-	-
CO3	3	3	-	2	2	2	2	-	-	2	-	-
CO4	3	3	-	3	2	2	2	-	-	-	-	-
CO5	3	2	3	2	2	2	1	2	-	1	3	2
Course Correlation Mapping	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**-**	**2**	**3**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: DISASTERS ***(06 Periods)***

Types of disasters - Natural disasters; Impact of disasters on environment, infrastructure and development; Concepts of hazards and vulnerability analysis, Hazard Assessment, Guidelines for hazard assessment and vulnerability analysis, Basic principles and elements of disaster mitigation.

Module 2: EARTHQUAKES ***(06 Periods)***

Introduction to earthquake, Intensity scale (MSK–64), Seismic zones and activity in India, Action plan for earthquake disaster preparedness, Elements at risk, Recovery and rehabilitation after earthquake, Concepts of Earthquake resistant design and construction of buildings; Tsunami – Onset, Types and causes, Warning, Elements at risk, Typical effects, Specific preparedness and mitigation strategies, Case studies.

Module 3: FLOODS, CYCLONES AND DROUGHTS ***(07 Periods)***

Floods and Cyclones: Onset, Types, Causes, Warnings, Elements at risk, Typical effects, Indian floods and cyclones, Hazard zones, Potential for reducing hazards, Mitigation strategies and community based mitigation, Case studies.

Droughts: Onset, Types and warning; Causes, Impact, Early warning and response mechanisms, Mitigation strategies, Droughts in India, Case studies.

Module 4: LANDSLIDES ***(06 Periods)***

Onset, Types and warning; Causes, Elements at risk, Indian landslides, Hazards zones, Typical effects, Mitigation strategies and community based mitigation, Case studies.

Module 5: DISASTER MANAGEMENT ***(05 Periods)***

Disaster management organization and methodology, Disaster management cycle, Disaster management in India – Typical cases and Cost–benefit analysis, Disaster management programs implemented by NGOs and Government of India, Usage of GIS and Remote sensing techniques in disaster management, Leadership and Coordination in Disaster management, Emerging trends in disaster management.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Perform hazard assessment and vulnerability analysis for any nearby town/city and prepare a detailed report of possible impacts of various disasters on environment, infrastructure and development.
2. Prepare a detailed report on the causes and effects of Tsunami that was occurred in the year 2004. Also discuss various advancements in Tsunami warning systems.
3. Identify the major causes of urban floods in cities like Chennai, Hyderabad & Mumbai and submit a report along with various mitigation strategies to reduce the impact of floods.
4. Prepare a detailed report on how various man-made activities are directly/indirectly related to the occurrence of landslides that occurred in recent days in India.
5. Visit AP State Disaster Response and Fire Services Department and record about various methods used by them in mitigating disasters and their management.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

3. Sharma V. K., *Disaster Management, Medtech Publishing*, 2nd Edition, 2013.
4. Anand S. Arya, Anup Karanth, and Ankush Agarwal, *Hazards, Disasters and Your Community: A Primer for Parliamentarians*, GOI–UNDP Disaster Risk Management Programme, Government of India, National Disaster Management Division, Ministry of Home Affairs, New Delhi, Version 1.0, 2005

REFERENCE BOOKS:

1. Donald Hyndman and David Hyndman, *Natural Hazards and Disasters*, Cengage Learning, USA, 5th Edition, 2015.
2. *Disaster Management in India,* A Status Report, Ministry of Home Affairs, Govt. of India, May 2011.
3. Rajendra Kumar Bhandari, *Disaster Education and Management: A Joyride for Students, Teachers, and Disaster Managers*, Springer India, 2014.
4. Singh R. B., *Natural Hazards and Disaster Management*, Rawat Publications, 2009.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/105104183
2. https://www.digimat.in/nptel/courses/video/124107010/L01.html

WEB RESOURCES:

1. https://egyankosh.ac.in/handle/123456789/25093
2. https://www.egyankosh.ac.in/handle/123456789/25912
3. https://www.nios.ac.in/media/documents/333courseE/12.pdf
4. https://ndmindia.mha.gov.in/images/public-awareness/Primer%20for%20Parliamentarians.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22CE107603	**RURAL TECHNOLOGY**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on technology for rural development, nonconventional energy, technologies for rural development, community development and it in rural development.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Compare various technologies for rural development by solving rural problems through different schemes by considering ethics, society, environment and sustainability.

CO2. Analyze non-conventional energy sources using appropriate tools and techniques to solve rural energy problems considering society, environment and sustainability besides communicating effectively in graphical form.

CO3. Select appropriate technologies in different areas of rural development to solve rural issues following latest developments considering society, environment and sustainability.

CO4. Relate water conservation, health, safety and rural employment issues for community development to solve rural problems through appropriate technologies considering ethics, society, environment and sustainability.

CO5. Analyze the impact of IT, public and private partnership on rural development to solve complex rural problems using appropriate tools and techniques considering ethics, society, environment and sustainability.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	-	3	2	1	1	1	-	-	-	-
CO2	2	3	-	2	2	1	1	-	-	1	-	-
CO3	2	3	-	2	2	1	1	-	-	-	-	1
CO4	2	3	-	2	2	1	2	1	-	-	-	-
CO5	2	3	-	3	2	1	1	1		-	-	-
Course Correlation Mapping	**2**	**3**	**-**	**3**	**2**	**1**	**2**	**1**	-	**1**	**-**	**1**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO RURAL DEVLOPMENT ***(06 Periods)***

India - Technology and rural development, Pre and post-independence period, Rural India Life, Indian farmer, Role of science and technology in rural development, Rural technology and poverty eradication, Rural business hubs, Technology in improving rural infrastructure, Various organizations related to innovation, Issues of technology transfer - CAPART, NABARD, CSIR, NIF.

Module 2: NON CONVENTIONAL ENERGY ***(06 Periods)***

Definition of energy, Types of alternative sources of energy, Sources of non-conventional energy – Solar energy: Solar pump in agriculture, Solar dryer, Solar cooker, Solar heater; Biogas, Recycling and management, Wastes conservation, Assessment and production of biomass products and their utilization.

Module 3: TECHNOLOGIES FOR RURAL DEVELOPMENT ***(06 Periods)***

Food and agro based technologies, Tissue culture, Nursery, Building and construction technologies, Cultivation and processing of economic plants, Cottage and social industries, Latest developments in rural technologies.

Module 4: COMMUNITY DEVELOPMENT ***(06 Periods)***

Water conservation, Rain water Harvesting, Drinking water Standards and simple treatments used, Environment and Sanitation, Bio fertilizers, Medical and aromatic plants, Employment generating technologies – Apiculture, Pisciculture, Aquaculture.

Module 5: IT IN RURAL DEVELOPMENT ***(06 Periods)***

Role of information technology (IT) in rural areas, Impact of IT in rural development, Need and necessity of technology, Corporate social responsibilities, Private sector participation (Activities in different spheres: Employment, Education, Health, Agriculture and service sectors) and Saansad Adarsh Gram Yojana (SAGY), Village adoption schemes.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Visit a nearby village and know the status of small-scale industries which are implanted and to be established based on the availability of the local resources.
2. Visit a local village and make an awareness program on energy utilization using biomass products.
3. Make a awareness program in the villages for the rural development in terms of home-made products.
4. Construct rain water harvesting structures in nearby villages where water scarcity is more and prepare a document.
5. Develop a small IT application the village area which will be used for the growth of the village.

(Note: It's an indicative one. The course instructor may change the activities and shall be reflected in the course handout.)

RESOURCES

TEXT BOOKS:

1. Virdi, M. S., *Sustainable Rural Technologies*, Daya Publishing House, 2nd Edition 2018.
2. Prabhath, S. V. and P. Ch. Sita Devi, *Technology and Rural India*, Serials Publications, 1st Edition, 2012.

REFERENCE BOOKS:

1. Chakravarthy, R., and Murthy, P. R. S., *Information Technology and Rural Development*, Pacific Book International, 1st Edition, 2012.
2. Shivakanth Singh, *Rural Development Policies and Programmes*, Northern Book Centre, 1st Edition, 2002.
3. Katar Singh, and Anil Shishodia*, Rural Development: Principles, Policies, and Management,* SAGE Publications India Private Limited, 4th Edition, 2016.
4. Vinayak Reddy, A. and Yadagira Charyulu, M., *Rural Development in India: Policies & Initiatives,* New Century Publications, 1st Edition, 2008.

VIDEO LECTURES:

1. http:// nptel.ac.in/courses/109/104/109104047
2. https://www.youtube.com/channel/UCEZxAQu3ZBulN-pYMYO2i_A/videos
3. https://www.youtube.com/watch?v=HnrIB-QmvlQ

WEB RESOURCES:

1. en.wikibooks.org/wiki/Technologies_for_Rural_Development/Complete
2. https://www.oecd-ilibrary.org/sites/ae6bf9cd-en/index.html?itemId=/content/component/ae6bf9cd-en
3. https://crdt.iitd.ac.in/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22LG107603	**SPOKEN ENGLISH**	-	1	2	-	2

Pre-Requisite 22LG102401-English for Professionals

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course deals with the development of fluency and intelligibility in spoken English. Through individual and group activities, students work on improving pronunciation, practicing conversation strategies, and delivering oral presentations.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge of functional English for effective communication.

CO2. Analyze different types of vocabulary for fluency in communication

CO3. Apply correct usage of English grammar in writing and speaking.

CO4. Apply speaking strategies in terms of usage of English with accuracy, appropriacy, and fluency.

CO5. Analyze techniques to use communication skills for effective presentation.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	2	-	3	-	-	-
CO2	2	3	-	-	-	-	2	-	3	-	-	-
CO3	2	-	3	-	3	-	2	-	3	-	-	-
CO4	2	-	-	-	3	-	2	-	3	-	-	-
CO5	2	3	2	-	3	-	2	-	3	-	-	-
Course Correlation Mapping	2	3	-	-	3	-	2	-	3	-	-	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FUNCTIONAL ENGLISH **(06 Periods)**

Concepts of Functional Spoken English, Self Introduction; Listening and Speaking: Do's and Don'ts; Expressions: Ability, Admiration, Agreement, Annoyance, Appreciation, Pleasure, Sarcasm, Satisfaction, Surprise, Approval, Certainty, Doubt, Gratitude, Possibility, Fear, Worry, Condolences; Asking for: Advice, Clarification, Direction, Information, Permission; Making: Predictions, recommendations

Module 2: VOCABULARY BUILDING (06 Periods)
Vocabulary for day-to-day conversations: Vegetables, Groceries, Fruits, Weather, Parts of a Human body, Dresses, Furniture; Relations: Birds, Cries of Animals, Food, Hospitality, Houses, Rooms, Tools, Airport, News Paper, Books, Gems, Corporate Vocabulary, Jobs, Occupations, Diseases; British and American spelling; Slang Words and Technical Jargons.

Module 3 FUNCTIONAL GRAMMAR - I (06 Periods)
English Grammar and the Indian Student, Parts of Speech, Verb forms: Tenses, Voice and Speech.

Module 4 FUNCTIONAL GRAMMAR -II (06Periods)
Universal Auxiliaries: Sentence Structure, WH Questions, framing of Questions with answers; Question Tags, Subject and verb agreement, Spotting Errors.

Module 5 COMMUNICATION SKILLS: (06 Periods)
Polite, Courteous and diplomatic expressions, Good manners and Etiquette, Conversation Techniques, Narrating Stories.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Critically analyse the value of Indian money and its impact on the common man and Prepare a PowerPoint Presentation.
2. Prepare a conversation between you and a sanitary officer regarding sanitary conditions in your locality.
3. The English Language has a rich vocabulary and it increases day by day. Present a seminar on the norms adhered to in adding new words and list out the words added in the last five years with their meaning.
4. Enact roleplays in different situations.
5. Participate in group discussions and debate on present issues
6. A conversation is an exchange of ideas, thoughts, and feelings between two or more persons. Explain it with suitable examples
7. Prepare a schedule and identify various committees to be formed for celebrating the Annual Day of a college and explain team involvement in the celebration.
8. Gather various ideas on discussing with parents the role of higher education and job opportunities.
9. Imagine you see a person wasting water. Write a dialogue objecting to such wastage of natural resources.
10. Since social media offers a wide reach easily, it becomes easier for bullies to spread gossip or issue threats. How do you think Cybercrime is a menace brought about by social media?

(Note: It’s an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXTBOOKS:

1. L. Adinarayana and V. Prakasam, "*Spoken English*", Neelkamal Publications Pvt. Ltd., NewDelhi, 2008.
2. Ram Bhasker Raju, "*The Complete Book on Spoken English*" Goutham Buddha Publications, Hyderabad, 2002.

REFERENCE BOOKS:

1. Sabina Pillai, *Spoken English for my World*, Oxford University Press, New Delhi, 2016.
2. K. R. Lakshminarayanan, *Speak in English*,Scitech Publications, Chennai, 2009.

VIDEO LECTURES:

1. https://www.britishcouncil.in/programmes/english-partnerships/state/skills-projects/AP-English-Skills
2. https://www.fluentu.com/blog/english/websites-to-learn-english/

WEB RESOURCES:

1. https://study.sagepub.in/kakarla_fec
2. https://www.theconfidentteacher.com/2018/04/five-useful-vocabulary-websites/
3. https://ling.sprachwiss.uni-konstanz.de/pages/home/lfg/resources.html
4. https://www.makeuseof.com/tag/improve-communication-skills-7-websites/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22LG107602	ESSENTIAL LIFE SKILLS FOR HOLISTIC DEVELOPMENT	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course deals with different types of thinking skills, self-awareness, coping with stress and emotion, transformational skills, group and team dynamics, and leadership.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Understand different life skills required in personal and professional life.

CO2 Analyse well-defined techniques to cope with emotions and stress.

CO3 Apply appropriate thinking and problem-solving methods to solve problems.

CO4 Function effectively in a team and as an individual.

CO5 Demonstrate the qualities of an effective leader.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	2	-	2
CO2	2	3	-	-	2	-	-	-	-	2	-	2
CO3	2	3	-	-	2	-	-	-	-	2	-	2
CO4	2	2	-	-	2	-	-	-	3	2	-	2
CO5	2	2	-	-	-	-	-	-	-	2	-	3
Course Correlation Mapping	**2**	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**-**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: OVERVIEW OF LIFE SKILLS ***(06 Periods)***

Meaning and significance of life skills, Life skills identified by WHO: Self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem-solving, Effective Communication, interpersonal relationships, coping with stress, coping with emotion.Ethics, Moral & Professional Values: Human Values, Civic Rights, Engineering Ethics, Engineering as

Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE.

Module 2: STRESS MANAGEMENT ***(06 Periods)***

Stress Management: Stress, reasons, and effects, identifying stress, stress diaries, the four A's of stress management, techniques,

Approaches: action-oriented, emotion-oriented, acceptance oriented, resilience, Gratitude Training,

Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method, and relaxation techniques.

Module 3 TRANSFORMATIONAL SKILLS ***(06 Periods)***

Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity, Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence.

Module 4 GROUP AND TEAM DYNAMICS ***(06 Periods)***

Introduction to Groups: Composition, formation, Cycle, thinking, Clarifying expectations, Problem Solving, Consensus, Dynamics techniques, Group vs Team, Team Dynamics, and Virtual Teams. Managing team performance and managing conflicts, Intrapreneurship.

Module 5 LEADERSHIP ***(06 Periods)***

Leadership framework, entrepreneurial and moral leadership, vision, cultural dimensions. Growing as a leader, managing diverse stakeholders, crisis management. Types of Leadership, Traits, Styles, VUCA Leadership, Levels of Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Prepare an attitude test and measure the attitudes of your class.
2. Prepare a Case study on the Campus Interview pressure and stress of students using SWOT analysis.
3. Record and prepare videos of various cultural people and make a comment on their accents.
4. Prepare a short film of a leader of your choice and list out the best qualities.
5. Prepare a presentation on the impact of social media on leadership management.
6. 'Knowledge of present technologies helps us to live a harmonious life.'
   Make a video to justify the statement.
7. Identify life skills needed in our day-to-day life and explain their importance.
8. Come up with strategies to become successful in professional life.
9. Find methods and solutions to overcome the self-pity of a person.
10. Identify the persons who are irregular to class. Find out their problems and come up with solutions.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXTBOOK:

1 Dr. K Alex, "*Soft Skills*". S Chand & Company Pvt.Ltd.2013.

2 Monmohan Joshi, "*Soft Skills*". Boolkboon.com, First Edition, 2017.

REFERENCE BOOKS:

1. Barun K. Mitra. "Personality Development & Soft Skills", First Edition; Oxford Publishers. 2011.
2. Kalyana. "Soft Skill for Managers"; First Edition; Wiley Publishing Ltd. 2015.
3. Shalini Verma. "Development of Life Skills and Professional Practice"; First Edition; Sultan Chand (G/L) & Company, 2014.
4. John C. Maxwell. "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc. 2014.
5. Daniel Goleman, "Emotional Intelligence"; Bantam, 2006.
6. Remesh S., Vishnu R.G. "Life Skills for Engineers", Ridhima Publications, First Edition, 2016.
7. Butterfield Jeff. "Soft Skills for Everyone", Cengage Learning India Pvt Ltd; 1 edition, 2011.
8. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India; 6 edition, 2015.
9. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=xM0fajUl7Bg
2. https://www.youtube.com/watch?v=HwLK9dBQn0g
3. https://www.youtube.com/watch?v=sxX5LoojdJw
4. https://www.youtube.com/watch?v=xJBgqW9-lzc
5. https://www.youtube.com/watch?v=QVwTVM1Iv1c

WEB RESOURCES:

1. https://www.clarke.edu/campus-life/health-wellness/counseling/articles-advice/developing-a-positive-attitude/
2. https://www.skillsyouneed.com/ps/personal-swot-analysis.html
3. https://ecampusontario.pressbooks.pub/profcommsontario/chapter/cross-cultural-communication/
4. https://thepeakperformancecenter.com/educational-learning/thinking/#:~:text=There%20are%20several%20core%20thinking,storing%20and%20then%20retrieving%20information.
5. https://www.webmd.com/anxiety-panic/guide/stage-fright-performance-anxiety
6. https://www.ktunotes.in/ktu-syllabus-life-skills/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22MG107601	**INNOVATION, INCUBATION AND ENTREPRENEURSHIP**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: To sensitize students on the prospects, opportunities, and challenges in entrepreneurship and the potential for value creation from prospective idea

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Understand the basics of generating new business ideas

CO2 Explain the concept of design thinking and product innovation.

CO3 Illustrate the roles of digital technology in entrepreneurship.

CO4 Understand the need for startup economics and market conditions

CO5 Evaluate the reasons for successful entrepreneurship.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	-	-	-	-	-	-	-
CO2	1	1	1	-	-	-	-	-	1	-	-	-
CO3	2	2	1	-	-	-	-	1	-	-	2	-
CO4	3	1	1	-	-	-	-	-	-	-	-	1
CO5	2	2	-	-	-	1	-	-	-	-	-	1
Course Correlation Mapping	2	2	1	1	-	1	-	1	1	-	2	1

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Introduction ***(06 Periods)***

Concept & Definition, Taking product or service ideas to creating value: Why should one choose to become an entrepreneur, Entrepreneurial mind-set, Intrapreneurship

Module 2: Product Innovation ***(06 Periods)***

Product innovation process, engineering design process and the concept of frugal engineering for developing innovative affordable products, effective user-interface.

Module 3: Digital Technology Entrepreneurship ***(06 Periods)***

Industry 4.0 landscape and innovations using digital technologies like AI, IOT, AR/VR, Cloud, SAAS, User Applications.

Module 4: Startup Economics & Market considerations ***(06 Periods)***

Economic consideration for starting a venture, Understanding Feasibility analysis, Understanding market, targeting customer and positioning product

Module 5: Successful Business Incubation ***(06 Periods)***

Business model innovation, Business process management , competitive advantages, Business model canvas, Bootstrapping.

Total Periods: 30

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Create and present a prototype of a new product of your choice.
2. Present at least three cases of successful business Ideas in recent times
3. Discuss in the group Entrepreneurship opportunities in terms of Orientation and Develop mentation.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Robert D. Hisrich, *Entrepreneurship*,
2. Kuratko & Hodgetts, *Entrepreneurship- Theory, Process & Practice*, Thompson South-Western Publication

REFERENCE BOOKS:

1. Peter Drucker, *Innovation and Entrepreneurship*, Harper Collins
2. Thomas N. Duening, Robert D. Hisrich and Michael A. Lechter, *Technology Entrepreneurship Taking Innovation to the Marketplace*, Elsevier
3. Prof. Nigel Cross, *Bloomsbury Design Thinking Understanding How Designers Think and Work*, 2019 Edition

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_mg63/preview
2. https://onlinecourses.nptel.ac.in/noc22_de08/preview

Web Resources:

1. nhttps://ciie.iitism.ac.in/files/CIIE-POLICY.pdf
2. https://www.nios.ac.in/media/documents/249_Enterpreneurship/English_pdf/249_Enterpreneurship_Lesson_16.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE107601	INTELLECTUAL PROPERTY RIGHTS	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course is designed to provide comprehensive knowledge to the students regarding the general principles of intellectual property rights, Concepts and Theories, Criticisms of Intellectual Property Rights, and International Regime Relating to IPR. The course provides awareness on how to protect one's unique creation, claim ownership, knowledge of what falls under the purview of someone's rights and what doesn't, and safeguard their creations and gain a competitive edge over their peers.

COURSE OUTCOMES: *After successful completion of the course, students will be able to:*

CO1	Understand the need and the concepts of intellectual property right and avenues for filling intellectual property rights.
CO2	Understand the legislative practices and protocols for the acquisition of trademarks and the judicial consequences for violating laws of trademark protection.
CO3	Understand the legislative practices and protocols for the acquisition of copyrights and the judicial consequences for violating laws of copyright protection.
CO4	Understand the fundamentals of patent laws, legislative practices, and protocols for acquisition of trade secrets and the judicial consequences for violating laws of trade secrets protection.
CO5	Understand the importance of geographical indications and various laws and protocols for protecting geographical indications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	1	-	-	3	-	-	-	2
CO3	3	-	-	-	1	-	-	3	-	-	-	2
CO4	3	-	-	-	1	-	-	3	-	-	-	2
CO5	3	-	-	-	1	-	-	3	-	-	-	2
Course Correlation Mapping	**3**	**-**	**-**	**-**	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (06 Periods)

Introduction and the need for intellectual property rights (IPR); types of intellectual property-Design; International organizations, agencies, and treaties.

Module 2: TRADEMARKS (06 Periods)

Introduction to trademark, Purpose, and function of trademarks, acquisition of trademark rights, protectable matter, selecting and evaluating trademark, trademark registration processes.

Module 3: LAW OF COPYRIGHTS (06 Periods)

Fundamental of copyright law, originality of material, rights of reproduction, rights to perform the work publicly, copyright ownership issues, copyright registration, a notice of copyright, and international copyright law.
Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

Module 4: TRADESECRETS (06 Periods)

Trade secret law, determination of trade secret status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.
Unfair competition: Misappropriation right of publicity, false advertising.

Module 5: GEOGRAPHICAL INDICATIONS (06 Periods)

The Geographical indications law in India, The objectives and features, the registry of geographical indications powers and functions. Types of goods offered. Protection: Agriculture goods, manufactured goods, and natural goods. Registration of indications and the requirements. Prohibition of misleading use of indications of geographical origins, prohibition of dilution of geographical origins.

Total Periods: ***30***

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Should conduct a survey based on the real scenario, where IPR is misused or unethically used and present an article.
2. Prepare an article on the registration processes of IPR practically (copy right/trade mark/ patents).
3. Should study a case of conflict on trademarks/patents and should produce an article mentioning the circumstances and remedial measures.
4. Prepare an article on the latest development in the international intellectual property rights.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Deborah, E. Bouchoux, *Intellectual property: The law of Trademarks, Copyright, Patents, and Trade Secrets,* Cengage learning, 4th Edition, 2013.
2. Prabuddha Ganguli, *Intellectual property right - Unleashing the knowledge economy*, Tata McGraw Hill Publishing Company Ltd.
3. Marsha Aechols; *Geographical Indications for Food Products*, , Wolters, 2008

REFERENCE BOOKS:

1. Neeraj P., & Khusdeep D. Intellectual Property Rights. India, IN: PHI learning Private Limited. 1st Edition 2019.
2. Nithyananda, K V. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited. 2019

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110105139

Web Resources:

1. Subramanian, N., & Sundararaman, M. (2018). *Intellectual Property Rights – An Overview*. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. World Intellectual Property Organization. (2004). *WIPO Intellectual property Handbook*. Retrieved from
 https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf
3. Cell for IPR Promotion and Management (http://cipam.gov.in/)
4. World Intellectual Property Organization (https://www.wipo.int/about-ip/en/)
5. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE107602	FUNDAMENTALS OF RESEARCH METHODOLOGY	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course is developed for the students to understand the underlying concepts of research methodology and a systematic approach for carrying out research in the domain of interest. The course is emphasized on developing skills to recognize and reflect on the strength and limitations of different types of research; data collection methods, and methods of Processing and analyzing data. The course also emphasizes interpreting the findings and research articulating skills.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Understands the underlying concepts of research methodology, types of research and the systematic research process.

CO2 Understand the philosophy of research design, types of research design and develop skills for a good research design.

CO3 Understand the philosophy of formulation of a research problem, methods of data collection, review of literature and formulation of working hypothesis.

CO4 Understand various data processing and analyzing techniques and their significance in the research.

CO5 Develop skills to interpret the findings and research articulating skills along with the ethics of research.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	1	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	2	1	-	-	-	-	-	-
CO4	3	2	-	-	3	1	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	3	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**3**	**1**	**-**	**-**	**3**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO RESEARCH METHODOLOGY (06 Periods)

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research and Scientific Method, Research Process, Criteria of Good Research.

Module 2: RESEARCH DESIGN (06 Periods)

Research design—Basic Principles, Need of research design, Features of good design, Important concepts relating to research design, Different research designs, Basic principles of experimental designs, Developing a research plan.

Module 3: RESEARCH FORMULATION (06 Periods)

Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Data collection – Primary and secondary sources; Critical literature review – Identifying gap areas from literature review, Development of working hypothesis.

Module 4: PROCESSING AND ANALYSIS OF DATA (06 Periods)

Processing Operations, Elements/Types of Analysis, Statistics in Research, Measures of Central Tendency, Measures of Dispersion, Measures of Relationship, Simple Regression Analysis.

Module 5: INTERPRETATION AND REPORT WRITING (06 Periods)

Interpretation: Meaning of interpretation; Techniques of interpretation; Precautions in Interpretation.
Report Writing: Significance, Different Steps, Layout, Types of reports, Mechanics of Writing a Research Report, Precautions in Writing Reports.

Total Periods: *30*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Should conduct a survey based on a hypothesis, analyze the data collected and draw inferences from the data.
2. Should review the literature on the given topic and should identify the scope/gaps in the literature and develop a research hypothesis.
3. Should study a case, formulate the hypothesis and identify an appropriate testing technique for the hypothesis.
4. Study an article and submit a report on the inferences and should interpret the findings of the article.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCE
TEXT BOOKS:

1. C.R. Kothari, *Research Methodology: Methods and Techniques, New Age International Publishers*, 2nd revised edition, New Delhi, 2004.

2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. *An introduction to Research Methodology*, RBSA Publishers.

REFERENCE BOOKS:

1. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.
2. Singh, Yogesh Kumar. *Fundamental of research methodology and statistics*. New Age International, 2006.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/121106007
2. https://onlinecourses.nptel.ac.in/noc22_ge08/preview
3. https://www.youtube.com/watch?v=VK-rnA3-41c

Web Resources:

1. https://www.scribbr.com/category/methodology/
2. https://leverageedu.com/blog/research-design/
3. https://prothesiswriter.com/blog/how-to-formulate-research-problem
4. https://www.formpl.us/blog/hypothesis-testing
5. https://www.datapine.com/blog/data-interpretation-methods-benefits-problems/
6. https://leverageedu.com/blog/report-writing/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE102001	**ELECTRICAL CIRCUITS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite 22EE102402-Fundamentals of Electrical Engineering
22EE102403-Network Analysis
22EE102401-Basic Electrical and Electronics Engineering

Co-Requisite -

COURSE DESCRIPTION: This course is designed to provide a complete overview of electric circuit analysis and hands-on experience for electrical and electronics engineering graduates. The course provides a deep insight about the various concepts such as network reduction techniques, analysis methods of DC and AC circuits, and magnetic circuits. The course has a huge scope in various competitive exams and provides foundations for subsequent electrical and electronics engineering courses.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the electrical circuits by applying the principles of network reduction techniques, mesh and nodal analysis.

CO2. Analyze the single phase circuits to investigate the response and to determine various electrical quantities.

CO3. Analyze various electrical circuits, by applying circuit theorems and determine various electrical quantities.

CO4. Analyze 3-phase circuits, to determine various electrical quantities and assert the relation between the circuit variables.

CO5. Analyze magnetic circuits, coupled circuits by applying the principles of electromagnetism and determine various parameters.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**1**	-	**3**	**3**	-	-	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FUNDAMENTALS OF ELECTRIC CIRCUITS (12 Periods)

Classification of network elements; Voltage-Current relations for passive elements; Network reduction techniques-series, parallel, series-parallel circuits, current and voltage division rules; source transformation, wye-to-delta and delta-to-wye transformations; nodal analysis and super node concept, mesh analysis and super mesh concept with dependent and independent sources.

Module 2: ANALYSIS OF SINGLE PHASE AC CIRCUITS (10 Periods)

Peak factor and form factor for different wave forms; Analysis of single phase AC circuits: impedance and admittance, impedance triangle; Power triangle; Sinusoidal response of R, L and C elements with different combinations; Resonance, bandwidth and quality factor for series and parallel networks.

Module 3: CIRCUIT THEOREMS (09 Periods)

Superposition, Thevenin's, Norton's, Maximum power transfer, Millmann's, Telligen's, Compensation theorem and Reciprocity theorems for DC & AC Excitations (without proof); Concept of dual and duality.

Module 4: POLY-PHASE CIRCUITS (07 Periods)

Advantages of poly-phase system; Analysis of three phase balanced and unbalanced systems; Measurement of active and reactive power in balanced and unbalanced systems-single wattmeter and two wattmeter methods.

Module 5: MAGNETIC AND COUPLED CIRCUITS (07 Periods)

Coupled circuits-self and mutual inductance, coefficient of coupling, DOT convention; series and parallel connection of coupled coils, equivalent circuits of coupled coils. Magnetic Circuits – Series and Parallel; Analogy between electrical and magnetic circuits.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

Pre-Lab: *Demonstration of bread board connections, component identification, Meters for measurement of electrical quantities, Types of sources available, function generator, CROs.*

1. Verification of Mesh and Nodal Analysis.
2. Measurement of power and power factor in a single phase ac series inductive circuit and improvement of power factor using capacitor.
3. Development of Locus diagram for RL and RC circuits.
4. Design a resonant circuit to select or reject the specified range of frequencies.

5. Verification of Superposition theorem.

6. Verification of Thevinan's and Nortorn's theorem.

7. Verification of Maximum power transfer theorem for DC and AC excitations.

8. Verification of Reciprocity theorem for DC and AC excitations.

9. Measurement of active and reactive power in a three phase load using two wattmeter method and determination of load power factor.

10. Measurement of reactive power using single wattmeter in a three phase load.

11. Determination of coefficient of coupling in a coupled circuit.

12. Determination of equivalent inductance for aiding and opposing fluxes.

RESOURCES

TEXT BOOKS:

1. Charles K. Alexander, Mathew N O Sadiku, *Fundamentals of Electric Circuits*, 5th edition, McGraw Hill Education (India) Private Limited, New Delhi, 2013.
2. A. Sudhakar, Shyammohan S Palli, *Circuits and Networks Analysis and Synthesis*, 5th edition, McGraw Hill Education (India) Private Limited, New Delhi, 2015

REFERENCE BOOKS:

1. J.A.Edminister, M.D.Nahvi, *Theory and Problems of Electric Circuits*, 4th edition, Schaum's outline series, McGraw Hill, New Delhi, 2004.
2. W H Hayt, J E Kemmerly, S M Durbin, *Engineering Circuit Analysis*, 6th edition, McGraw Hill, New Delhi, 2008.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/117106108/
2. https://nptel.ac.in/courses/108105159

WEB RESOURCES:

1. https://www.electrical4u.com/electric-circuit-or-electrical-network/
2. https://www.electronicshub.org/dc-circuits-basics/
3. https://www.engineeringenotes.com/electrical-engineering/circuits/single-phase-ac-circuit-with-diagram-electrical-engineering/27590
4. https://electrical-engineering-portal.com/resources/knowledge/theorems-and-laws
5. https://circuitglobe.com/what-is-a-polyphase-system.html
6. https://khitguntur.ac.in/shmat/NA%20Unit-III%20Coupled%20Circuits.pdf

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE101002	**ELECTROMAGNETIC FIELDS**	3	-	-	-	3

Pre-Requisite 22MM101402-Multivariable Calculus and Differential Equations

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with Static electric fields; Gauss's law and its applications; Potential and Potential Gradient; steady magnetic fields; Ampere's circuital law and its applications; Force in magnetic fields; behavior of various materials in electric and magnetic fields; Inductance and capacitance calculations; Maxwell's equations for time variant and time invariant fields.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the static electric field and determine electric field for various charge configurations by applying the laws of electrostatics.

CO2. Analyze the static magnetic field and determine magnetic field due to various current carrying elements by applying the laws of magnetostatics.

CO3. Analyze the static magnetic field and determine the force due to various current carrying elements by applying the laws of magnetostatics.

CO4. Analyze the time varying magnetic fields by applying the laws of electromagnetics.

CO5. Analyze the time varying electric fields by applying the laws of electromagnetics.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	2	1	1	1	-	-	-	-	-	3	-	2
CO2	3	3	-	2	1	1	1	-	-	-	-	-	3	-	2
CO3	3	3	-	2	1	1	1	-	-	-	-	-	3	-	2
CO4	3	3	-	2	1	1	1	-	-	-	-	-	3	-	2
CO5	3	3	-	2	1	1	1	-	-	-	-	-	3	-	2
Course Correlation Mapping	**3**	**3**	**-**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: ELECTROSTATICS - I (12 Periods)

Introduction to electrostatic fields, coulomb's law in vector form, electric field intensity (EFI), EFI due to various charge distributions, electric flux density, Gauss's law, application of Gauss's law - symmetrical charge distributions, differential volume element, Maxwell's first equation in point and integral form. Energy expended in moving a point charge in an electric field, electric potential, potential for different charge distributions, potential gradient, Maxwell's second equation in point and integral form.

Module 2: ELECTROSTATICS - II (10 Periods)

Electric Dipole, dipole moment, Potential and EFI due to an electric dipole. Current density, conduction and convection current density, Ohm's law in point form, current continuity equation, conductors and dielectric materials, properties, boundary conditions between conductor and dielectric material, two perfect dielectric materials, law of refraction, capacitance, capacitance of a parallel plate capacitor (with and without composite dielectric), energy density in electrostatic field.

Module 3: MAGNETOSTATICS (09 Periods)

Introduction to Magnetic fields, relation between magnetic flux density and magnetic Field Intensity (MFI), Biot-Savart's law, MFI due to various current carrying elements, Ampere's Circuital law, Maxwell's third equation in point and integral form, applications of Ampere's Circuital law - infinite line current, infinite sheet of current, solenoid and toroid. Maxwell's fourth equation in point and integral form. Scalar magnetic potential and vector magnetic potential.

Module 4: FORCE IN MAGNETIC FIELDS (08 Periods)

Force due to magnetic fields, Lorentz force equation, force on a straight and long current carrying conductor in a magnetic field, force between two straight long and parallel current carrying conductors. Torque on a current loop placed in a magnetic field, magnetic boundary conditions between different magnetic materials. Self-inductance of a solenoid, toroid and co-axial cable, energy density in magnetic field.

Module 5: TIME VARYING FIELDS (06 Periods)

Introduction to time varying fields, Faraday's laws of electromagnetic induction, statically and dynamically induced EMF, concept of displacement current, modifications of Maxwell's equations for time varying fields, Poynting theorem.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. The student should report the effect of electric and magnetic fields on humans and on other biological species.
2. The student should enlist the equipment working on the principle of the electromagnetic field and should report the functionality of the component.

3. Should develop simulation modals to analyze the field around different types of electrodes.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. William H. Hayt and John A. Buck, *Engineering Electromagnetics,* 8th Edition, McGraw Hill Education (India) Pvt. Ltd. 2014.
2. Matthew N.O. Sadiku, *Principles of Electromagnetics,* 4th Edition, Oxford University Press, New Delhi, 2007.

REFERENCE BOOKS:

1. Joseph A. Edminister, *Theory and Problems of Electromagnetics*, Schaum's Outline Series, Tata McGraw Hill Inc., New Delhi, 2009.

WEB RESOURCES:

1. https://nptel.ac.in/courses/108/106/108106073/
2. https://nptel.ac.in/courses/108/104/108104087/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE102003	**SIGNALS AND NETWORKS**	3	-	2	-	4

Pre-Requisite 22EE102001-Electrical Circuits

22MM101404–Transformation Techniques and Linear Algebra

Anti-Requisite 22EC101005-Signals and Systems.

Co-Requisite -

COURSE DESCRIPTION: This course is designed to provide a complete overview of Signals and their applications to various electrical circuits and various aspects of networks. The course also emphasized the spectral analysis of continuous signals using Laplace and Fourier transforms and the spectral analysis of discrete signals using z-transforms. The course also deals with the transients in electrical circuits and the analysis of two-port networks.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Perform various operations on signals, investigate system characteristics and evaluate their features.

CO2. Analyze spectral characteristics of signals applied to the circuits using Fourier series and Fourier Transformation techniques.

CO3. Analyze spectral characteristics of signals applied to the circuits using Fourier, Laplace and z-Transforms.

CO4. Analyze transient behavior of DC & AC circuits by using differential equations and Laplace transform methods.

CO5. Analyze network parameters of an isolated and interconnected two-port network.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

	Program Outcomes												**Program Specific Outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	2	1	-	-	-	-	-	-	3	-	2
CO2	3	3	-	1	2	1	-	-	-	-	-	-	3	-	2
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	2
CO4	3	3	-	1	-	2	-	-	-	-	-	-	3	-	2
CO5	3	3	3	1	-	2	-	-	-	-	-	-	3	-	2
CO6	-	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**1**	**3**	**1**	**1**	-	**3**	**3**	-	-	**3**	-	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DISCRETE AND CONTINUOUS TIME SIGNALS AND SYSTEMS (11 Periods)

Continuous and discrete signals: Test signals — Unit step, ramp, parabolic, unit impulse and exponential signals; Basic operation on signals — Time and Amplitude scaling; Classification of Signals — Periodic and aperiodic signals, Odd and even components, Energy and power signals.

Systems—Linear and Non-linear, Static and dynamic systems, Time variant and invariant, Causal and non-causal systems.

Module 2: TRANSFORMATION OF SIGNALS: Fourier transforms (08 Periods)

Fourier series: Review of Fourier series, Trigonometric Fourier Series, properties of Fourier series (Without proof), Fourier series of common signals — amplitude and phase spectrum, Circuit Applications — Average value, RMS Values, average power and response.

Fourier transforms — Definition, properties of Fourier transforms (Without proof); Fourier transform of periodic signals; Inverse Fourier transform. Applications — Circuit analysis and Parseval's theorem.

Module 3: TRANSFORMATION OF SIGNALS: Laplace and z-Transforms (10 Periods)

Laplace transforms: Review of Laplace transform, Laplace transform of periodic signals, properties of the Laplace transform(Without proof) — initial and final value theorems (without proof) and convolution, Region of convergence; Applications — Circuit analysis.

Z-Transforms: z-Transform, Region of convergence for the z-Transform, inverse z-Transform; Properties of the z-Transform — Initial and final value theorem (without proof) and convolution; Application: z-Transform solution of linear difference equations.

Module 4: TRANSIENT ANALYSIS (08 Periods)

DC Transients: Initial conditions; Transient response of RL, RC and RLC circuits.

AC Transients: Transient response of RL, RC and RLC circuits; solution methods using differential equation and Laplace transforms.

Module 5: TWO-PORT NETWORKS (07 Periods)

Network Functions — Driving point and transfer functions; Network parameters — Impedance, Admittance, Transmission and Hybrid parameters. Symmetry and reciprocity property in two-port networks; Interrelationships of different parameters; Inter-connection of two-port networks.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

Pre-lab: *Demonstrate the fundamentals and programming in MATLAB environment and modelling using the SIMULINK toolbox.*

1. Generation of continuous and discrete time signals.
2. Basic operations on continuous and discrete time signals — Time scaling and amplitude scaling.
3. Systems and their properties — Linearity, causality, and stability.
4. Response of LTI systems for different excitations.
5. Analysis of spectral characteristics of signals — Amplitude and Phase spectrum.
6. Determination of Fourier and Laplace transforms and their inverse transformations.
7. Determination of z-transform of a given sequence.
8. Transient response of RL circuit and design of timer circuit.
9. Transient response of RC circuit and design of timer circuit.
10. Transient response of RLC circuit and applications.
11. Determination of two-port network parameters in an isolated network — Z, Y, ABCD, and h-Parameters.
12. Determination of two-port network parameters in an interconnected network — Series-Series, Parallel-Parallel, and cascaded interconnections.

RESOURCES

TEXT BOOKS:

1. Lathi & Bhagwandas Pannalal, *Principles of Linear Systems and Signals,* Oxford University Press, 2nd Edition, 2009.
2. Charles K. Alexander & Matthew N. O. Sadiku, *Fundamentals of Electric Circuits,* McGraw-Hill education Private Limited, New Delhi, 5th Edition, 2013.

REFERENCE BOOKS:

1. Matthew N Sadiku, and Warsame Hassan Ali, *Signals and Systems: A Primer with MATLAB,* CRC Press, 2016.
2. A Chakrabarthi, *Network Analysis and Synthesis,* Dhanpat Rai & Co., New Delhi, 2nd revised Edition, 2016.

Software:

1. MATLAB/SIMULINK

VIDEO LECTURES:

3. https://onlinecourses.nptel.ac.in/noc21_ee28/preview
4. https://nptel.ac.in/courses/117106108/
5. https://nptel.ac.in/courses/108105159

WEB RESOURCES:

1. https://www.electrical4u.com/electric-circuit-or-electrical-network/
2. https://www.electronicshub.org/dc-circuits-basics/
3. https://www.engineeringenotes.com/electrical-engineering/circuits/single-phase-ac-circuit-with-diagram-electrical-engineering/27590
4. https://electrical-engineering-portal.com/resources/knowledge/theorems-and-laws
5. https://circuitglobe.com/what-is-a-polyphase-system.html
6. https://khitguntur.ac.in/shmat/NA%20Unit-III%20Coupled%20Circuits.pdf

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE101004	ELECTRICAL AND ELECTRONIC MEASUREMENTS	3	-	-	-	3

Pre-Requisite 22EE102001-Electrical circuits

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with the various concept of electrical and electronic measurements such as the measurement of electrical quantities; construction, working, design, and applications of various electrical measuring instruments; Performance evaluation of various electrical measuring instruments.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the constructional and operating principles of various measuring instruments, static and dynamic characteristics, error analysis, and design an appropriate shunt and multiplier for the extension of instrument range.

CO2. Analyze various errors, while measuring the electrical quantities due to the interconnection of power, energy, and power factor measuring instruments, and assess the error compensation techniques.

CO3. Analyze the standard producers and calibration methods, while measuring the electrical quantities due to the interconnection of instrument transformers and potentiometers.

CO4. Analyze the phasor of various electrical bridges used for measuring, to estimate various electrical quantities.

CO5. Analyze the patterns of various monitoring instruments to determine the phase and frequency of various electrical signals

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	-	-	2	-	2
CO2	3	3	-	1	2	1	-	-	-	-	-	-	1	1	2
CO3	3	3	-	1	2	1	-	2	-	-	-	-	1	1	1
CO4	3	2	-	1	2	-	-	-	-	-	-	-	2	-	3
CO5	3	2	-	-	2	1	-	-	-	-	-	-	1	-	1
Course Correlation Mapping	**3**	**3**	**1**	**1**	**2**	**1**	-	**2**	-	-	-	-	**1**	**1**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: MEASUREMENT OF VOLTAGE AND CURRENT (12 Periods)

Significance of measurements, methods of measurements, classification of instruments, static and dynamic characteristics (elementary treatment only), error analysis, operating forces, PMMC, MI instruments — Construction, working, errors, compensations, advantages and disadvantages, extensions.

Module 2: MEASUREMENT OF POWER, ENERGY AND POWER FACTOR (08 Periods)

Wattmeter: EDM type wattmeter — construction, working, errors and compensations and LPF wattmeter.
Energy Meter: construction, working, driving and braking torques, errors and compensations, three-element energy meter.
Power factor meter: EDM type single phase and three phase meters.

Module 3: INSTRUMENT TRANSFORMERS AND POTENTIOMETERS (09 Periods)

Current and Potential transformers — construction, working, measurement of power using instrument transformers.
DC Crompton's potentiometer — principle, operation, standardization and applications.
AC Potentiometers: Polar type — Principle, operation, standardization and applications.

Module 4: DC AND AC BRIDGES (08 Periods)

Measurement of resistance: Wheatstone bridge, Kelvin's double bridge and loss of charge method.
Measurement of inductance: Maxwell's inductance-capacitance, Anderson's bridges.
Measurement of capacitance & frequency: Schering Bridge and Wien's bridge.

Module 5: ELECTRONIC MEASUREMENTS (08 Periods)

Cathode ray oscilloscope: Block diagram of cathode ray tube, measurement of phase and frequency by Lissajous patterns.
Electronic instruments: Digital voltmeters—ramp type only, Digital energy meter, Digital storage oscilloscope, Digital frequency meter, Digital multi-meters, Q meter and its applications, Digital Energy meter.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Prepare a technical report on a smart meter and explain the different smart meters used in daily life.
2. Prepare a technical report on the safety practices to be followed while making live measurements for the observer and also equipment.

3. Identify the latest IEEE standards used in the calibration of electrical measuring instruments and make a report on the relevant standard and latest procedure.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. A.K. Sawhney, A course on Electrical and Electronics Measurements & Instrumentation, DhanpatRai and Co. Publishers, 19th edition, 2015.
2. J.B. Gupta, A course on Electrical and Electronics Measurements & Instrumentation, S.K. Kataria publishers, 14th edition, 2014.

REFERENCE BOOKS:

1. H. S. Kalsi, Electronic Instrumentation, Tata MC Graw Hill Company, 3rd edition, 2010.
2. E.W. Golding and F.C. Widdis, Electrical Measurements and measuring Instruments, Reem Publications, 5th Edition, 2011.

VIDEO LECTURES:

1. https://youtu.be/L9wHaLyv94Q
2. https://youtu.be/D8Lc_YjCQFU
3. https://youtu.be/duKQaMQk-rw
4. https://youtu.be/juTW4DAq01c

WEB RESOURCES:

1 https://nptel.ac.in/courses/108/105/108105153/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE102005	**ELECTRICAL MACHINES-I**	3	-	2	-	4

Pre-Requisite 22EE102001-Electrical Circuits

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion and hands-on experience on construction, operation, types, performance characteristics and applications of DC machines and transformers.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyse the DC generator to evaluate various operating parameters and develop constructional features for sustainability.

CO2. Analyse the operational characteristics of various DC generators to assess measures for sustainability.

CO3. Analyse the performance characteristics of various types of DC motors to develop accessories and assess the suitability for industrial applications.

CO4. Analyse the equivalent circuits of single-phase transformers with various configurations to determine their performance and assess sustainability for various load conditions.

CO5. Analyse the three phase and three winding transformers with various configurations to determine their performance and assess sustainability for various load conditions.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	1	1	2	-	-	-	-	-	2	-	2
CO2	2	2	-	2	1	2	2	-	-	-	-	-	2	-	2
CO3	3	3	1	2	-	2	2	-	-	-	-	-	2	-	2
CO4	2	3	-	3	-	2	2	-	-	-	-	-	2	-	2
CO5	2	3	-	3	-	2	2	-	-	-	-	-	2	-	2
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**1**	**3**	**1**	**2**	**2**	-	**3**	**3**	-	-	**2**	-	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DC GENERATORS **(09 Periods)**

Principle of operation and constructional details of DC generator. Armature windings — lap and wave, simplex and multiplex, single layer and multi-layer, equalizer rings and dummy coils. EMF equation and methods of excitation. Losses — constant, variable and minimization of losses. Calculation of efficiency — condition for maximum efficiency.

Module 2: ARMATURE REACTION, COMMUTATION AND CHARACTERISTICS **(09 Periods)**

Armature reaction — cross magnetizing and de-magnetizing AT/pole; compensating winding. Commutation — reactance voltage and methods of improving commutation. Build-up of EMF in a self-excited DC generator; causes for failure of self-excitation and remedial measures. Internal and external characteristics of DC generators and applications.

Module 3: DC MOTORS **(09 Periods)**

Principle of operation of DC motor; Back EMF & its significance; speed and torque equation. Characteristics and applications of shunt, series and compound motors. Speed control of DC shunt and series motor. Electric braking; Starters for DC Motors (2-, 3- and 4-point) and their design.

Module 4: SINGLE PHASE TRANSFORMERS **(10 Periods)**

Introduction — classification of transformers, cooling methods, ideal and practical transformers; operation on no-load and on-load, phasor diagrams; losses, equivalent circuit, efficiency and regulation; Effects of variation of frequency and supply voltage on iron losses. All-day efficiency. Auto transformers — equivalent circuit, comparison with two winding transformers.

Module 5: THREE-PHASE TRANSFORMERS **(08 Periods)**

Three-phase transformers — construction and connections — Y/Y, Y/Δ, Δ/Y, Δ/Δ, open-Δ and Scott connections. Three winding transformers — tertiary windings; determination of Zp, Zs and Zt; OFF-load and ON-load tap changing.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Draw OCC of DC shunt generator.
2. Performance evaluation by load test on DC shunt generator.
3. Performance evaluation by brake test on DC Shunt and Compound Motors.
4. Speed control of DC shunt motor.
5. Perform Swinburne’s test on DC Shunt motor.
6. Perform Hopkinson's test on two identical DC shunt machines.

7. Perform electric braking of DC motor.
8. Perform OC and SC tests on 1-Phase transformer.
9. Separation of core losses in a 1-Phase transformer.
10. Perform Sumpner's test.
11. Perform parallel operation of 1-Phase transformers.
12. Perform Scott connection on transformers.

RESOURCES

TEXT BOOKS:

1. JB Gupta, *Theory and performance of Electrical Machines*(DC machines, Poly phase Circuits & AC machines) in SI Units, S.K. Kataria & Sons, New Delhi, 15th Edition, 2015.

2. R.K. Rajput, *Electrical Machines* in S.I. Units, Laxmi Publications (P) Ltd, 6th Edition, New Delhi, 2017.

REFERENCE BOOKS:

1. P.S. Bimbhra, *Electrical Machinery*, Khanna Publishers, 7th Edition, Delhi, 2011.
2. B.L. Theraja and A.K. Theraja, *A Text Book of Electrical Technology(in S. I. Units)*, Vol.2, S. Chand & Company Ltd, Multicolour illustrative Edition, New Delhi, 2014.

VIDEO LECTURES:

1. http://www.nptelvideos.in/2012/11/electrical-machines-i.html
2. https://freevideolectures.com/course/3085/electrical-machines-i
3. https://www.youtube.com/playlist?list=PL9RcWoqXmzaJpnkjoNleyFNgGk9-znOji

WEB RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102146/
2. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Sadhya/experimentlist.html

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE102006	**ELECTRICAL MACHINES-II**	3	-	2	-	4

Pre-Requisite 22EE102005-Electrical Machines-I

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on construction, types, operation and applications of induction machines and synchronous machines; parallel operation of synchronous generators; Performance evaluation of induction machines and synchronous machines.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. analyze the performance of induction motor to evaluate the operating parameters and to asses feasible control strategies.

CO2. analyze the starting and speed control methods of induction motor and performance of induction generator to evaluate the operating parameters and to asses feasible control strategies.

CO3. analyze the performance of synchronous generator to evaluate the operating parameters and to assess measures for sustainability.

CO4. analyze the synchronized operation of alternators and the effect of influencing factors on synchronization, and to determine feasible operating state for sustainability.

CO5. analyze the performance of synchronous motor to evaluate the operating parameters, and to determine sustainable and feasible operating states for various loadings.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	2	2	1	-	-	-	-	-	2	3	2
CO2	3	3	-	2	2	2	1	-	-	-	-	-	2	3	2
CO3	3	3	-	3	--	1	2	-	-	-	-	-	2	3	1
CO4	2	3	-	3	1	1	2	-	-	-	-	-	2	3	3
CO5	2	3	-	3	1	2	2	-	-	-	-	-	1	3	2
CO6	-	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	-	**3**	**2**	**2**	**2**	-	**3**	**3**	-	-	**2**	**3**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: THREE PHASE INDUCTION MOTORS (09 Periods)

Production of rotating magnetic field in 3-phase Induction motor, slip, rotor EMF and rotor frequency, rotor reactance, rotor current and power factor at standstill and running conditions; ratio of full-load torque and maximum torque, ratio of starting torque and maximum torque; losses in 3-phase induction motor, relation between rotor power input, rotor copper loss and mechanical power developed; Induction motor as a generalized transformer. Double-cage and deep bar rotors.

Module 2: STARTING AND SPEED CONTROL METHODS (09 Periods)

Methods of starting — starting current and torque calculations for direct online, primary resistors, auto transformer and star-delta starters; Crawling and Cogging; Speed control — change of frequency, voltage and stator poles, rotor rheostat control, cascade connection and injection of EMF into rotor circuit; Induction generator — principle of operation and its applications.

Module 3: SYNCHRONOUS GENERATORS (10 Periods)

Armature windings — integral slot and fractional slot, distributed and concentrated, short pitch and full pitch, winding factors; EMF equation, harmonics in generated EMF and suppression of harmonics. Armature reaction and its effect for various operating power factors. — Phasor diagrams; Power flow equations in synchronous generator; Salient pole alternators —two-reaction theory, phasor diagrams and voltage regulation.

Module 4: PARALLEL OPERATION OF SYNCHRONOUS GENERATORS (08 Periods)

Conditions for parallel operation; methods of synchronization; Synchronizing current, power and torque, rigidity factor; Effect of change of excitation and mechanical power input on parallel operation of two alternators, load sharing between two alternators; Synchronous machines on infinite bus bars; Short Circuit Ratio (SCR) and its significance; Time period of rotor oscillations.

Module 5: THREE PHASE SYNCHRONOUS MOTORS (07 Periods)

Principle of operation; starting methods —auxiliary motor, damper winding, synchronous-induction motor. Phasor diagrams; Variation of armature current and power factor with excitation; synchronous condenser; Power flow equations in synchronous motor; Circle diagram —excitation and power circles; Hunting and its suppression.

Total Periods: ***45***

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Brake test on three phase induction motor.
2. Separation of no-load losses of three phase induction motor.
3. Speed control of induction motor.
4. No load and blocked rotor test on three phase induction motor.
5. Predetermination of voltage regulation of a three phase alternator by E.M.F and M.M.F. methods.
6. Predetermination of voltage regulation of three phase alternator by Z.P.F. and A.S.A methods.
7. Determination of efficiency of a three phase alternator.
8. Perform slip test on a salient pole synchronous machine.
9. Draw V and inverted V curves of a three phase synchronous motor.
10. Determination of equivalent circuit parameters of single phase induction motor.
11. Performance evaluation of universal motor.
12. Perform parallel operation of 3-phase alternators.

RESOURCES

TEXT BOOKS:

1. P.S. Bimbhra, *Electrical Machinery*, 7th Edition, Khanna Publishers, New Delhi, 2011.
2. JB Gupta, *Theory and performance of Electrical Machines (DC machines, Poly phase circuits & AC machines) in SI Units*, 15th Edition, S.K. Kataria & Sons, New Delhi, 2015

REFERENCE BOOKS:

1. A.E. Fitzgerald, C. Kingsley and S. Umans, *Electric Machinery*, 6th Edition, McGraw-Hill, New Delhi, 2008.
2. B.L. Theraja and A.K. Theraja, *A Text Book of Electrical Technology in S. I. Units*, Vol.2, S. Chand Company Ltd, Multicolour Edition, New Delhi, 2014.

VIDEO LECTURES:

1. https://em-coep.vlabs.ac.in/

WEB RESOURCES:

1. http://www.vlab.co.in/broad-area-electrical-engineering

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE102007	**CONTROL SYSTEMS**	3	-	2	-	4

Pre-Requisite 22EE102003-Signals and Networks

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on Concepts of control systems, transfer function of various physical systems, time response analysis, frequency response analysis, controller design, and state space analysis.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. develop the mathematical model for various physical systems to determine the transfer function by applying fundamental principles.
CO2. analyze the time response of first and second-order systems to evaluate steady-state errors.
CO3. analyze the stability of a system in the time domain and investigate the stability of the given system using the root locus technique.
CO4. analyze the stability of a system in the frequency domain and design a compensator for a system to meet the desired specifications using the Bode plot technique.
CO5. apply the state space method to model the system to investigate controllability and observability.
CO6. Work independently or in teams to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	1	-	-	-	-	-	-	-	2	1	2
CO2	3	3	-	1	-	-	-	-	-	-	-	-	2	1	2
CO3	3	3	3	1	1	-	-	-	-	-	-	-	2	2	2
CO4	3	3	3	1	1	-	1	-	-	-	-	-	1	2	2
CO5	3	3	-	-	1	-	-	-	-	-	-	-	2	1	2
CO6	-	-	-	-	-	-	-	-	3	3	-	-	2	-	2
Course Correlation Mapping	**3**	**3**	**3**	**1**	**1**	-	**1**	-	**3**	**3**	-	-	**2**	**1**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: MATHEMATICAL MODELING OF SYSTEMS **(09 Periods)**

Introduction to control systems — Classification of open loop and closed loop control systems with examples; Modelling of physical systems — Transfer function of mechanical systems, electrical systems, Armature control and field control of DC motor – electrical analogy of mechanical systems; Block diagram reduction, Signal flow graph.

Module 2: TIME RESPONSE ANALYSIS **(09 Periods)**

Standard test signals; Time response of first and second order systems — Time-domain specifications, steady state error — static and dynamic error constants; Effects of Proportional, Integral and Derivative controllers.

Module 3: STABILITY ANALYSIS **(09 Periods)**

Introduction to stability, Stability in terms of location of roots, Routh-Hurwitz stability criterion – Relative stability; Root locus — rules to construct root loci, effect of adding pole and zero on root loci.

Module 4: FREQUENCY RESPONSE ANALYSIS **(09 Periods)**

Frequency domain specifications, Bode plot, Polar plot and Nyquist Stability Criterion Correlation between time and frequency response; Design of Lag and Lead Compensators using bode plot.

Module 5: STATE SPACE ANALYSIS **(09 Periods)**

Concept of state, state variable, state model; Transfer function to state space and state space to transfer function representation; Modelling of physical system in state space; State transition matrix and its properties – solution of state equations – diagonalization of state matrix; Controllability and observability using Kalman's test.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXPERIMENTS: (Minimum 10 exercises shall be conducted)

1. Transfer function of DC Motor to investigate speed torque characteristics.
2. Transfer function of AC Servo Motor to investigate speed torque characteristics..
3. Time response of first and Second-order Systems with the unit step as input.
4. Investigating the system response by the addition of poles and zeroes for a transfer function.
5. Effect of P, PD, PI, PID Controller on Second order system.

6. Investigate the stability of a system using root locus
7. Design of Lag and Lead Compensators using root locus
8. Stability analysis with Bode Plot for given open loop system.
9. Design a Lag and Lead Compensators using bode plot.
10. Stability analysis for the given system using Nyquist Stability Criteria
11. State space model for classical transfer function and vice versa.
12. Design of Classical and State Space Controller.

RESOURCES

TEXT BOOKS:

1. A. Anandkumar, *Control Systems*, PHI learning Pvt Ltd., 2ndedition, 2014.
2. Katsuhiko Ogata, *Modern Control Engineering*, Pearson Education Publishers, 5thedition, 2010.

REFERENCE BOOKS:

1. Nagrath I.J. and Gopal M, *Control Systems Engineering*, New Age International Publications, 5thedition, 2010.
2. Richard C. Dorf and Robert H. Bishop, *Modern Control Systems*, Prentice Hall, 12th edition, 2010.
3. Benjamin C.Kuo and FaridGolnaraghi, *Automatic Control Systems*, John Wiley & Sons Publications, 8th edition, 2002.
4. Nagoorkani, *Control Systems*, RBA Publications, 2nd edition, 2006.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=vVFDm__CdQw&list=PLA74601484F6994D8
2. https://www.youtube.com/watch?v=u6kYU3qcR3c&list=PLA74601484F6994D8&index=2
3. https://www.youtube.com/watch?v=vPQvS9XxlNk&list=PLA74601484F6994D8&index=31
4. https://www.youtube.com/watch?v=FXbKYT1G6Xs&list=PLA74601484F6994D8&index=35

WEB RESOURCES:

1 NPTEL_CONTROL SYSTEMS: https://nptel.ac.in/courses/107/106/107106081/

2 EDX_INTRODUCTION TO CONTROL SYSTEMS: https://www.edx.org/course/introduction-to-control-system-design-a-first-look

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE101008	**TRANSMISSION AND DISTRIBUTION**	3	-	-	-	3

Pre-Requisite 22EE101002-Electromagnetic Fields

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on the parameters of overhead transmission lines and underground cables, Insulators. This course also provides analytical skills for the quantitative estimation of transmission lines, traveling wave phenomenon, sag and corona, distribution systems classification, analysis and planning.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the overhead lines and underground cables to evaluate various parameters and their characteristics for different configurations.

CO2. Analyze the performance of transmission lines and investigate the behavior of traveling waves for different configurations of transmission lines.

CO3. Analyze the mechanical and electrical aspects of overhead transmission lines and realize measures for sustainability.

CO4. Analyze various distribution systems, to determine their performance characteristics under various scenarios.

CO5. Realize various aspects of the substation, and analyze the primary and secondary feeders systems of the substation to configure the feeder layout in a service area.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	1	-	1	2	2
CO2	3	3	2	2	2	-	-	-	-	-	-	-	1	2	2
CO3	3	3	-	2	1	2	1	-	-	-	-	-	1	2	2
CO4	3	3	-	2	-	1	-	-	-	-	-	-	1	2	2
CO5	3	3	1	1	-	1	1	-	-	-	-	-	1	2	2
Course Correlation Mapping	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**--**	**--**	**--**	**1**	**--**	**1**	**2**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: OVERHEAD TRANSMISSION LINE AND UNDERGROUND CABLES ***(11 Periods)***

Overhead Transmission Lines: Overhead line and underground cables and its types, Parameters- resistance, inductance and capacitance calculations in single and three phase transmission lines, single and double circuits, symmetrical and unsymmetrical spacing, concepts of GMR and GMD-Effect of earth on capacitance.

Underground Cables: Construction, types of insulating materials, classification of cables, laying of cables, insulation resistance, capacitance of single and 3-core belted cables, grading of cables - capacitance and inter sheath grading.

Module 2: ANALYSIS OF TRANSMISSION LINES ***(11 Periods)***

Modeling and Analysis of Transmission lines: Classification - short line, medium line and long line; equivalent circuits – end condenser, Nominal-T, Nominal-π models, rigorous method; ABCD constants, voltage regulation and efficiency of transmission lines.

Travelling waves on transmission lines: Travelling waves – open end line, short circuited line, Line terminated through a resistor, line connected to a cable, Line connected to a T-junction.

Module 3: MECHANICAL ASPECTS OF OVER HEAD LINE AND CORONA ***(08 Periods)***

Insulators— Line supports, overhead line insulators, types of insulators, string efficiency and methods for improvement.

Sag in overhead line: Sag and tension calculations with equal and unequal heights of towers, effect of wind and ice on sag, stringing chart.

Corona: Corona phenomenon - factors affecting corona, critical voltages and power loss, advantages and disadvantages.

Module 4: DISTRIBUTION SYSTEMS ***(07 Periods)***

Classification and Characteristics—residential, commercial, agricultural and industrial loads.

Voltage drop calculations in DC distributors– radial DC distributor fed at one end, at both the ends (equal/unequal voltages) and ring main distributor.

Voltage drop calculations in AC distributors– power factors referred to receiving end voltage and respective load voltages.

Module 5: SUBSTATIONS ***(08 Periods)***

Classification of substations — Indoor and outdoor, gas and air insulated substations; Substation layout, different bus bar schemes, location of substations and benefits through optimal location — rating of distribution substations, service area with 'n' primary feeders; Considerations of distribution feeder voltage levels: Radial and loop types of primary feeders and secondary feeders – Feeder loading – Basic design practice of the secondary distribution system.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Prepare a technical report on the present scenario of power system transmission system adopted in the country.
2. Prepare an article on the impact of various transmission and distribution schemes on the environment and should recommend measures to sustain the environment.
3. Review any IEEE article on power transmission and distribution, and prepare a report on the inferences of the article.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Wadhwa, C. L. *Electrical power systems*. 7thEdition, New Age International Private limited, 2017.
2. Turan Gonen, *Electric Power Distribution System Engineering,* 3rdEdition CRC Press, Taylors and Francis Group, 2014.

REFERENCE BOOKS:

1. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt Ltd, New Delhi, 2002.
2. U.A.Bakshi and M.V.Bakshi, *Transmission and Distribution of Electrical Power*, Fourth revised Edition, Technical Publications, 2009.
3. J.B.Gupta, *A Course in Electrical Power*, 11th Edition, S.K.Kataria & sons, New Delhi 2013.
4. V.K.Mehta, Rohit Mehta, *Principles of Power System,* revised Edition, S.Chand & Company Ltd, 2013.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=_-Cg34oz-MQ
2. https://www.youtube.com/watch?v=uy9lZCdkQIM&list=PLD4ED2FAF3C155625
3. https://www.youtube.com/watch?v=lr1jgbR5ca8&list=PLD4ED2FAF3C155625&index=10
4. https://www.youtube.com/watch?v=OsgIo5z-0EA&list=PLD4ED2FAF3C155625&index=12

WEB RESOURCES:

1 Travelling Wave: https://www.eeeguide.com/travelling-waves-on-transmission-lines/

2 Travelling Waves Lecture: https://nptel.ac.in/courses/108/102/108102119/

3 Power System: https://nptel.ac.in/courses/108/105/108105104/

4 https://edisontechcenter.org/Transmission.html

5 http://www.minnelectrans.com/transmission-system.html

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE102009	**POWER SYSTEM ANALYSIS**	3	-	2	-	4

Pre-Requisite 22EE101008-Transmission and Distribution

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on per unit analysis, formulation of network matrices. This course also provides analytical skills for the quantitative estimation on computing power flow using various iterative techniques, symmetrical components and sequence networks, various balanced and unbalanced faults, and stability analysis of power system.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the concepts of per-unit system to represent the power system network, and algorithms to model the power system network in terms of bus matrices.

CO2. Analyze the power system network to investigate the power flow in various lines of a power system network using numerical methods.

CO3. Analyze the power system networks to determine the balanced fault for various faults in a power system and prefer the current limiter reactors to sustain circuit breakers.

CO4. Analyze the power system networks to determine the symmetrical components and unbalanced fault level for various faults in a power system.

CO5. Investigate stability of a power system network under various operating conditions using conventional and numerical methods to sustain stability.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	3	1	-	-	-	-	-	-	-	2	3
CO2	3	3	-	1	2	2	-	-	-	-	-	-	-	2	3
CO3	3	3	-	1	2	2	1	-	-	-	-	-	-	3	3
CO4	3	3	-	1	2	2	1	-	-	-	-	-	-	2	3
CO5	3	3	-	1	3	2	1	-	-	-	-	-	-	2	3
CO6	-	-	-	-	-	-	-	-	3	3	2	-	3	3	3
Course Correlation Mapping	**3**	**3**	-	**1**	**3**	**2**	**1**	-	**3**	**3**	**2**	-	**3**	**2**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: PER UNIT REPRESENTATION AND NETWORK MATRICES (08 Periods)

Per unit — advantages, change of base, per unit equivalent reactance representation of power system networks; Construction of Y-bus using inspection methods; Formation of Z_{Bus} using Z_{Bus} building algorithm — Modification of Z_{Bus} due to change in network impedance (without mutual coupling).

Module 2: POWERFLOW STUDIES (12 Periods)

Necessary and importance of power flow; Static load flow equations — Formulation of power flow problem— Iterative solution using Gauss-Seidel, Newton-Raphson method (polar coordinates only), Decoupled method and Fast Decoupled methods (with and without PV and for a maximum 3 bus system only); Algorithm; Comparison of different load flow methods.

Module 3: BALANCED FAULT ANALYSIS (06 Periods)

Three phase short circuit on unloaded synchronous generator; Effect of Load Current or Pre-fault Current — analysis using Thevenin's theorem and bus impedance matrix; Short circuit capacity; Current limiting reactors.

Module 4: UNBALANCED FAULT ANALYSIS (09 Periods)

Symmetrical component theory — Sequence voltages, currents, impedances; Sequence representation of power system components — Sequence networks; Importance of short circuit analysis; Unsymmetrical faults—LG, LL, LLG on an un-loaded generator and power system networks.

Module 5: POWER SYSTEM STABILITY (10 Periods)

Basic concepts, definitions and classification; Steady state stability — power limit and transfer reactance; Swing equation; Equal area criterion, Applications — Determination of critical clearing angle and time; Solution of swing equation — Point-by-point method; Methods to improve transient and steady state stability.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXPERIMENTS: (Minimum 10 exercises shall be conducted)

1. Load forecasting using statistical methods
2. Analyze the load cycle of a typical residential/industrial load and suggest strategies to minimize the peak load demand the tariff based on peak demand.
3. Solving economic load dispatch problem with transmission losses.
4. Simulation of AVR and load frequency control with and without integral controller.
5. Develop bus admittance matrix of a transmission network.
6. Develop bus impedance matrix of a transmission network.

7. Analyze Load flows for a given transmission network.
8. Symmetrical fault analysis using bus impedance matrix.
9. Analysis of rotor dynamics using swing equation.
10. Simulation of power quality problems (Sag/Swell, interruption, transients, harmonics, flickers).
11. Simulation of FACTS controllers (TCR and TCSC).
12. Simulation of single phase grid connected PV system.

RESOURCES

TEXT BOOKS:

1 Wadhwa, C. L. *Electrical power systems*. 7th Edition, New Age International Private limited, 2017.

2 Hadi Saadat, *Power System Analysis*, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st Reprint, 2010.

REFERENCE BOOKS:

1 John J. Grainger and William D. Stevenson, Jr., *Power System Analysis*, McGraw-Hill, 2003.

2 T.K.Nagsarkar and M.S.Sukhija, *Power System Analysis*, Oxford University Press, New Delhi, 2007.

3 K. Uma Rao, *Computer Techniques and Models in Power Systems*, I.K. International Publishing House Pvt. Ltd., 2010.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=fBm1dr_gRBk&list=PL36A60B630E8C7B56

2 https://www.youtube.com/watch?v=BYtY61hOiaw&list=PL36A60B630E8C7B56&index=2

3 https://www.youtube.com/watch?v=MYGT1_9mwpg&list=PL36A60B630E8C7B56&index=16

4 https://www.youtube.com/watch?v=HcMh7ahJxfo&list=PL36A60B630E8C7B56&index=25

WEB RESOURCES:

1 https://nptel.ac.in/courses/108107112/

2 https://nptel.ac.in/courses/117105140/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE105010	**ELECTRICAL CAD LAB**	-	-	2	-	1

Pre-Requisite 22ME105401-Engineering Drawing

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides hands-on experience in drafting standards for electrical engineering applications; Drafting residential electrical layouts and electrical sub-station. This course also provides analytical skills to create and modify electrical drawings such as wiring diagrams for residential and commercial buildings that provide visual representation describing electrical systems or circuits, electrical control systems, and Pre-programmed tasks.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate preliminary design aspects of electrical design using CAD.

CO2. Develop preliminary and detailed single-line diagrams of complete electrical load distribution in a residential building.

CO3. Develop wiring layouts for lighting, power, and Air conditioning applications in residential accommodations.

CO4. Develop a typical electrical layout of industrial blueprints and control appliances for industrial applications.

CO5. Develops independent working ability, through problem-solving and effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	-	3	3	3	3	-	-	1	-	-	2	3
CO2	3	3	3	-	3	3	3	3	-	-	-	-	-	2	3
CO3	3	3	3	-	3	3	3	3	-	-	-	-	-	2	3
CO4	3	3	3	-	3	3	3	3	-	-	-	-	-	2	3
CO5	-	-	-	-	-	-	-	-	3	3	-	-	-	2	3
Course Correlation Mapping	**3**	**3**	**3**	-	**3**	**3**	**3**	**3**	**3**	**3**	**1**	-	-	**2**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

EXPERIENTIAL LEARNING

LIST OF EXPERIMENTS: (Minimum 10 exercises shall be conducted)

1. Introduction to computer-aided drafting and practice(Review of AutoCAD – basics) with drawing editor, UCS icon, setting limits of a drawing, setting unit of a drawing, toolbar, etc.
2. Typical 2D residential floor plan (single) providing all amenities.
3. Computation of preliminary electrical designing for the provision of lighting and power loads for a residential accommodation.
4. Exercise on three-phase load balancing for provisions of lighting and heating, ventilation, and AC loads for a residential accommodation.
5. Typical SLD of a house wiring schematic circuit with cable specifications.
6. Typical SLD of a commercial building with floor plan and cable specifications.
7. Typical SLD of an industrial workshop with floor plan and cable specifications.
8. Single line diagram of a typical HV& EHV electrical substation with all components.
9. Design of a DC lap or Wave winding for a DC machine with CAD software.
10. Design of a three-phase AC concentric (MUSH or LAP) winding of an AC machine with CAD software.
11. Design of a DOL Starter and Star Delta Starter using CAD software.
12. Draw the layout of an 11kV/400V distribution substation using CAD software.
13. Design of electrical power infrastructure for a typical residential complex
14. Schematic diagram of a motor control centre.

RESOURCES

TEXT BOOKS:

1. https://law.resource.org/pub/in/bis/S03/is.sp.7.1.2005.pdf
2. K.Gaurav Verma and Matt Weber, AUTOCAD Electrical 2016 Black Book, CADCAMCAE works, USA, 2015 (http://1.droppdf.com/files/YooGv/autocad-electrical-2016-black-book-by-gaurav-verma-2015.pdf)

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=zTo8QL7A-wg
2. https://www.youtube.com/watch?v=6VXybp4g4vU
3. https://www.youtube.com/watch?v=fCJtarn6Jvg
4. https://www.youtube.com/watch?v=B0x-OHR-1Pk

WEB RESOURCES:

1 https://eees.in/computer-aided-drafting-cad-lab-manual/

2 https://www.studocu.com/in/document/riphah-international-university/electrical-engineering/cad-lab-manuel-12/8308317

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE101011	**POWER ELECTRONICS**	3	-	-	-	3

Pre-Requisite 22EC102001-Semiconductor Devices and Circuits

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Power electronics is a field of electrical engineering that focuses on the design and control of electronic circuits for the efficient conversion and control of electrical power. This course covers topics such as power semiconductor devices, power converters, and their control techniques.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the switching operations/characteristics of uncontrolled, semi-controlled, and fully controlled power semiconductor devices.

CO2. Analyze AC-DC converter's circuit operation and evaluate their output parameters for R & RL loads with different firing pulses.

CO3. Analyze commutation circuits, buck and boost operations of DC-DC converters circuit for different duty cycles.

CO4. Analyze AC-AC and dual converters circuit operation and evaluate their output parameters for R & RL loads with different firing pulses.

CO5. Analyze the conduction modes and PWM techniques of DC-AC converters circuit by single-phase or three-phase topologies.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	3	-	3	3	-	-	-	-	-	-	-	-	3	3
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	1	1
CO4	3	3	-	3	3	-	-	-	-	-	-	-	-	3	3
CO5	3	3	-	1	1	-	-	-	-	-	-	-	-	2	1
Course Correlation Mapping	**3**	**3**	-	**3**	**3**	-	-	-	-	-	-	-	-	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: POWER SEMICONDUCTOR DEVICES (11 Periods)

Introduction to power electronics, Power diode—switching characteristics. Power transistors — power BJT, power MOSFET, IGBT, and their characteristics; Thyristor — basic theory and operation, static and dynamic characteristics; two transistor analogy, turn-on methods, UJT firing circuits, series, and parallel operation; protection against dv/dt and di/dt, design of snubber circuit.

Module 2: PHASE CONTROLLED RECTIFIERS (11 Periods)

Single phase-controlled rectifiers — half wave-controlled rectifier, bridge connections semi and fully controlled rectifiers with R and RL loads, derivation of average load voltage and current, effect of the freewheeling diode; Effect of source inductance; Three phase-controlled rectifiers — half and fully controlled rectifiers-midpoint connection with R load, Bridge connections with R and RL loads, derivation of average load voltage and current.

Module 3: COMMUTATION CIRCUITS AND CHOPPERS (07 Periods)

Thyristor forced commutation circuits; Chopper — step-down and step-up operation, control strategies, derivation of load voltage with R load. Load commutated chopper.

Module 4: DUAL CONVERTERS & AC VOLTAGE CONTROLLERS (07 Periods)

Dual converters — circulating and non-circulating current modes of operation of single-phase and three-phase dual converters with R-Load; Single-phase AC voltage controllers — two SCRs in anti-parallel with R and RL loads, derivation of RMS load voltage and load current; Cyclo-converters — single phase midpoint and bridge type (step-up and step-down operations) with R and RL loads.

Module 5: INVERTERS (09 Periods)

Single phase inverters — basic operation, voltage source inverters, current source inverter, and basic series & parallel inverters. Voltage control by pulse width modulation techniques — single pulse, multiple pulse, and sinusoidal PWM techniques; Three phase bridge Inverters — 1800 and 1200 conduction modes of operation.

Total Periods: ***45***

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. A rectifier is used in the Auto-Rickshaw application to convert the input AC power (230 V) to DC. The rectified DC voltage has an rms value of 320 V (i.e., √2 * 230). A buck converter is used to lower this voltage to 60 V. Furthermore, the 60 V is decreased to 48 V, which is the battery's rating and is utilized to charge the battery. The bidirectional converter, which now acts as a boost converter, drives the 48 V battery to the 60 V. Develop a block diagram,

circuit diagram, and mathematical expressions for an appropriate Auto-Rickshaw electric vehicle.

2. Develop a photovoltaic standalone system with a boost converter used in rural applications such as PV water pumping, solar lighting, and battery charging. When implementing all applications, consider about all of the design parameters and power quality standards.

3. Design an 8-hour backup power inverter and battery based on the components used as 2 PCs, 2 fans, 4 LED lights, and 1 LED television.

4. Prepare a technical report on On-board and off-board chargers, fast chargers, and opportunity chargers in electric vehicle applications.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Dr. P. S. Bimbhra, Power Electronics, Khanna Publishers, 6th Edition, Delhi, 2018.
2. M. D. Singh & K. B. Kanchandhani, Power Electronics, Tata McGraw - Hill Publishing Company, 2013.

REFERENCE BOOKS:

1. Mohan, Undeland, Robbins, Power Electronics: Converters, Applications and Design, 3rd Edition, Wiley, 2007.
2. Muhammad H. Rashid, Power Electronics – Devices, Circuits and Applications, 4th Edition, Pearson, 2017.

ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102145/
2. https://nptel.ac.in/courses/108/101/108101126/
3. https://nptel.ac.in/courses/108/101/108101038/
4. https://nptel.ac.in/courses/108/107/108107128/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EE102012	**SOLID STATE DRIVES**	3	-	2	-	4

Pre-Requisite 22EE101011-Power Electronics.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course introduces solid-state drives and their applications in electric motor control systems. Topics include power electronic devices, such as IGBTs and MOSFETs, pulse width modulation (PWM) techniques, controlled rectifiers, choppers, voltage source inverters (VSIs), current source inverters (CSIs), and motor control algorithms. The course also covers drive performance analysis and design considerations for different types of loads.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Evaluate the characteristics and operational aspects of drives operating in different modes.

CO2. Analyze the operational aspects of various controlled rectifiers fed DC drives operating in different sustainable modes of operation.

CO3. Analyze the operational aspects of various controlled chopper fed DC drives operating in different sustainable modes of operation.

CO4. Analyze the operational aspects of various asynchronous motor drives operating in different sustainable modes of operation.

CO5. Analyze the operational aspects of synchronous motor and stepper motor drives operating in different sustainable modes of operation.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	-	-	-	-	-	-	-	-	-	2	1
CO2	3	3	-	1	1	1	1	-	-	-	-	-	-	2	2
CO3	3	3	-	1	1	1	1	-	-	-	-	-	-	2	2
CO4	3	3	2	1	1	1	1	-	-	-	-	-	-	2	2
CO5	3	3	2	1	1	1	1	-	-	-	-	-	-	2	2
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**1**	**1**	**1**	-	**3**	**3**	-	-	-	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO ELECTRIC DRIVES (10 Periods)

Electrical drives — block diagram, advantages of electric drive, parts of electric drives, choice of electrical drives, the status of DC and AC drives. Dynamics of electrical drives — fundamental torque equations, speed-torque conventions, and multi-quadrant operation; Equivalent values of drive parameters — loads with rotational and translational motion; Load torques — components, nature and classification. Concept of steady-state stability. Electric braking methods — regenerative, dynamic and plugging. Modes of operation of electrical drives — steady state, acceleration including starting and deceleration including stopping. Speed control and drive classifications, closed-loop control of drives — current limit control, torque control, speed control and position control (Block diagram only).

Module 2: SINGLE-PHASE AND THREE PHASE CONVERTER FED DC DRIVES (10 Periods)

Control of DC separately excited motor by single-phase and three-phase half and full bridged converters — voltage and current waveforms for continuous and discontinuous conduction, speed-torque expressions and characteristics. Single phase half-controlled rectifier fed DC series motor — voltage and current waveforms for continuous and discontinuous conduction, speed-torque expressions and characteristics. Multi-quadrant operation of DC separately excited DC motor fed from fully controlled rectifier — mechanical reversible switch in armature, dual converter and field current reversal.

Module 3: DC CHOPPER FED DRIVES (07 Periods)

Control of DC separately excited motor by one, two and four quadrant choppers — voltage and current waveforms for continuous conduction (motoring, regenerative and dynamic braking), speed-torque expressions and characteristics. Chopper control of DC series motor — operation, speed-torque expressions and characteristics. Closed loop chopper control of separately excited DC motor (Block diagram only).

Module 4: INDUCTION MOTOR DRIVES (11 Periods)

Three phase induction motors — Introduction, Stator variable voltage control — speed-torque characteristics, AC voltage controllers and efficiency of induction motor under voltage control. Stator variable voltage and variable frequency control — slip speed control, torque-power limitations and modes of operation. Voltage Source Inverters (VSIs) and Current Source Inverters (CSIs) fed induction motor and closed loop operation of induction motor drives (Block diagram only). Comparison of VSI and CSI fed drives. Static rotor resistance control, slip power recovery schemes — static scherbius and kramer drive, speed-torque characteristics.

Module 5: SYNCHRONOUS AND STEPPER MOTOR DRIVES (07 Periods)

Synchronous Motor Drives: Separate control and self-control of synchronous motors — operations of self-controlled synchronous motors by VSI and CSI. Load commutated CSI fed Synchronous motor — operation and speed torque characteristics. Closed loop control operation of synchronous motor drives (Block diagram only).

Stepper Motor Drives: Variable reluctance and permanent magnet operation — features of stepper motor — torques Vs stepping rate characteristics and drive circuits.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES: (Minimum 10 exercises shall be conducted)

1. Analysis of single and three-phase half and fully-controlled bridge converters for various loads.
2. Analysis of single-phase AC voltage controller and cyclo-converter for various loads.
3. Single phase half and fully controlled bridge converter with R and RL loads.
4. Single-phase dual converter with R and RL loads.
5. Single-phase AC voltage controller with R and RL Loads.
6. Single phase cyclo-converter with R and RL loads.
7. Speed control of separately excited DC motor using the single-phase full converter.
8. Four quadrant chopper fed DC drive.
9. Speed control of single-phase induction motor using IGBT-based PWM inverter.
10. Speed control of single-phase induction motor using cyclo-converter.
11. Analysis of choppers and inverters for various loads using PWM/sliding mode controller.
12. Speed control of separately excited DC motor using single-phase full converter.

RESOURCES

SOFTWARE/TOOLS:

1. Matlab- R2023a (Version 9.14)
2. PSIM and PSPICE

TEXT BOOKS:

1. Gopal K. Dubey, Fundamentals of Electric Drives, Narosa Publications, Alpha Science International Ltd, 2nd Edition, 2002.
2. Krishnan, Ramu. Electric motor drives: modeling, analysis, and control, 1st Edition, Pearson, 2015.

REFERENCE BOOKS:

1. Gopal K. Dubey, Power Semiconductor Controlled Drives, Prentice-Hall International, 1989.
2. P. C. Sen, Principles of Electrical Machines and Power Electronics, Wiley, 3rd Edition, 2013.

ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108/104/108104140/
2. https://nptel.ac.in/courses/108/102/108102046/
3. https://swayam.gov.in/nd1_noc19_ee65/preview

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EC102001	**SEMICONDUCTOR DEVICES AND CIRCUITS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands on experience on semiconductor devices like transistors, MOSFETs and their applications like amplifiers and oscillators.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the operation of various semiconductor diodes.

CO2. Analyze the applications of semiconductor diodes.

CO3. Analyze various configurations and biasing techniques for BJT and FET.

CO4. Design various Oscillators for desired specifications.

CO5. Work independently and in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	1	-	-	-	-	3	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	3	1	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**1**	3	**3**	**-**	**-**	**3**	-	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: SEMICONDUCTOR DIODES ***(08 Periods)***

Introduction, Semiconductor diodes, ideal versus practical diodes, resistance levels, Diode equivalent circuits, transition and diffusion capacitance, reverse recovery time, diode specification sheet, zener diode, Light Emitting diode, Tunnel diode, schottky diode, varicap diode.

Module 2: DIODE CIRCUITS ***(10 Periods)***
Introduction, Series Diode configuration, Parallel and series-parallel configurations, Half-wave & Full wave rectifier, Clippers, Clampers, Zener Diode as voltage regulator, Problems.

Module 3: BIPOLAR JUNCTION TRANSISTOR ***(10 Periods)***
Introduction, Transistor construction, Operation, Common-base configuration, Transistor as an amplifier, Common-Emitter configuration, Common collector configuration, Operating point, Fixed biased configuration, Emitter-bias configuration, Voltage divider bias configuration, Collector feedback configuration, compensation Techniques, Problems.

Module 4: FIELD-EFFECT TRANSISTORS ***(10 Periods)***
JFET -construction, operation and characteristics, MOSFET - Device Structure and Physical Operation, Current-Voltage Characteristics, The MOSFET as an Amplifier and as a Switch, Biasing in MOS Amplifier Circuits, Small-Signal Operation and Models, The Depletion-Type MOSFET.

Module 5: OSCILLATORS ***(07 Periods)***
Introduction, Feedback Oscillators, Oscillation with RC Feedback Circuits, Wien Bridge Oscillator, Phase Shift Oscillator, Oscillation with LC Feedback Circuits, crystal oscillator.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Verification of switching action of a PN junction diode with V-I characteristics.
2. Rectify the AC signal and then to find out Ripple factor and percentage of Regulation in Half wave/Full wave rectifier with and without Capacitor filter.
3. Verify input and output characteristics of transistor in common base and common emitter configurations.
4. Study and draw the Drain and Transfer Characteristics of a JFET.
5. Design and analyze any biasing circuit using BJT.
6. Study the characteristics of an emitter follower circuit.
7. Design RC integrator and differentiator and determine their response to the square input.
8. Develop clipper circuit to clip positive and negative portions of the input waveform with two reference voltages.
9. Develop clamping circuits to clamp different positive and negative dc levels of the input signal.
10. Design and Verification of RC and LC Oscillators.
11. Study and experimental verification of MOSFET Transfer characteristics (with depletion and enhancement mode)

RESOURCES

TEXT BOOKS:

1. Millman & Halkias, *"Integrated Electronics",* McGraw Hill Publications, 1992.
2. Boylestad & Nashlesky, *"Electronic Devices & Circuit Theory"*, PHI, 10th Edition.
3. Albert Malvino& David J. Bates, *"Electronic Principles",* Tata McGraw Hill, 7th Edition 2007.

REFERENCE BOOKS:

1. Sedra, Smith, *'Microelectronic Circuits',* Oxford University Press, 5th Edition, 2004.
2. David A.Bell, *"Electronic Devices and Circuits",* Prentice Hall of India Private Limited, New Delhi, 2007.
3. Paul Horowitz and Winfield Hill, *'The art of electronics',* Cambridge university press, 3rd Edition, 2011.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/108108112
2. https://www.coursera.org/specializations/semiconductor-devices

WEB RESOURCES:

1. www.electronic_circuits.com
2. www.circuitstoday.com

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EC102401	**ANALOG ELECTRONICS**	3	-	2	-	4

Pre-Requisite 22EC102001-Semiconductor Devices and Circuits

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course Demonstrates Single Stage Amplifiers; Multi Stage amplifiers; Frequency Response; Negative Feedback Amplifiers; Oscillators; Multi vibrators; Large Signal Amplifiers.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze multistage amplifiers to determine the Gain, Bandwidth, Input and Output Impedances.

CO2. Analyze the concept of feedback to improve the stability of amplifiers and generate sustained oscillations.

CO3. Realize different classes of Power Amplifiers to improve efficiency

CO4. Design filters to find the frequency response for different applications.

CO5. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	-	1	-	1	-	-	2	-	-	-	3	-	-
CO2	2	3	1	2	-	-	-	-	2	-	-	-	3	-	-
CO3	3	2	-	-	-	1	-	-	2	-	-	-	3	-	-
CO4	1	2	3	1	-	-	-	-	2	-	-	-	3	-	-
CO5	-	-	-	-	-	-	-	-	2	2	-	-	3	-	-
Course Correlation Mapping	**2**	**2**	**1**	**1**	-	**1**	-	-	**2**	**1**	-	-	**3**	-	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: BJT AMPLIFIERS ***(11 Periods)***

Classification of Amplifiers, Distortion in amplifiers, Analysis of Single Stage Common Emitter Amplifier- Frequency Response, Different coupling schemes used in multistage amplifiers, Effect of coupling and bypass capacitors on frequency response, Multistage Frequency Effects, Analysis of Two stage RC Coupled amplifier, Cascade amplifier, Darlington pair, Bootstrapped Darlington circuit, Hybrid- Pi (п)- Common Emitter model.

Module 2: NEGATIVE FEEDBACK AMPLIFIERS ***(09 Periods)***

Classification of Amplifiers, Concepts of feedback – Classification of feedback amplifiers – General characteristics of negative feedback amplifiers – Effect of Feedback on Amplifier characteristics, Method of analysis of Feedback amplifier, Voltage series Feedback, Voltage shunt feedback, Current series feedback and Current shunt Feedback configurations.

Module 3: OSCILLATORS ***(08Periods)***

Conditions for oscillations, Classification, RC phase shift oscillator using BJT and FET, Wien bridge oscillator using BJT, Generalized analysis of LC oscillators, Hartley and Colpitts Oscillators, Crystal Oscillator, Frequency stability.

Module 4: LARGE SIGNAL AMPLIFIERS ***(08 Periods)***

Classification, Series fed Class A Power Amplifier- Power conversion Efficiency, Transformer Coupled class A power Amplifier, Push Pull and Complimentary Symmetry Class B power amplifier, Class AB operation, Principle of operation of class –C Amplifier, Transistor Power Dissipation, Heat Sinks.

Module 5: ACTIVE FILTERS ***(09 Periods)***

Analog Filters: Introduction, RC Active Filters- first order and second order all pass, Low pass & high pass, Band pass and Band reject using Op-Amp.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

Part-A: Simulation of the following circuits using simulation software

1. Two stage RC Coupled Amplifier
2. Cascade Amplifier
3. Voltage Series feedback amplifier
4. R C Phase Shift Oscillator
5. Class A Power Amplifier (Transformer less)
6. Class B Complementary Symmetry Amplifier

Part-B: Implementation of the following circuits through hardware

7. Darlington Amplifier
8. Current shunt Feedback Amplifier
9. Hartley and Colpitts Oscillator
10. Design of First order and Second Order Low Pass Filter
11. Design of First order and Second Order High Pass Filter

RESOURCES

TEXT BOOKS:

1. Jacob Millman, Christos C. Halkias and Satyabrata Jit, Integrated Electronics, McGraw-Hill Education, 3rd Edition, 2010.
2. Ramakanth A. Gayakwad, Op-Amps & Linear ICs, PHI, 3rd Edition, 1998.

REFERENCE BOOKS:

1. Adel S.Sedra, Kenneth C.Smith, Micro Electronics Circuits Theory and applications,OXFORD international student Edition, 5thEdition, 2009.
2. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuits Theory,Pearson Education, 10thEdition, 2009.
3. D. Roy Chowdhury, Linear Integrated Circuits, New Age International (p) Ltd, 4thEdition, 2011.
4. S Poornachandra Rao and B Sasikala ”Handbook of Experiments in Electronics andCommunication Engineering” ; Vikas Publishing House Pvt. Ltd, 1st Edition, 2003
5. Adel S. Sedra, Kenneth C. Smith ,Micro Electronic Circuits Theory and applications,OXFORD international student Edition 5thEdition, 2009.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=7jaa1rlW7Ak&list=PLBlnK6fEyqRiw-GZRqfnlVIBz9dxrqHJS
2. https://www.youtube.com/watch?v=XG3cVoUh7wc&list= PLs5_Rtf2P2r674CTMNJ3odeHk9Wtb-WWl

Web Resources:

1. https://archive.nptel.ac.in/courses/108/105/108105158/
2. https://nptel.ac.in/courses/108102095

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EC102402	**LINEAR AND DIGITAL IC APPLICATIONS**	3	-	2	-	4

Pre-Requisite 22EC102401-Analog Electronics
22EC102010-Digital Design

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed Linear & Non-Linear Applications of Op-Amp; IC 555 timer and phase locked loops; Application of PLL; filters; A-D & D-A Converters; CMOS and Bipolar Logic Interfacing; HDL with combinational and sequential logic design.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Design different applications of op-amp, timer circuits and analyze PLL for specified applications.

CO2. Design active filters using op-amp for audio processing applications.

CO3. Analyze different analog to digital and digital to analog converters for data acquisition system.

CO4. Analyze Verilog HDL capabilities to model and synthesize combinational and sequential circuits.

CO5. Work independently and in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	1	-	-	-	-	-	-	-	-	3	-	-
CO2	1	2	3	1	1	-	-	-	-	-	-	-	3	-	-
CO3	1	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO4	1	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	-	-	-	-	3	2	-	-	-	3	-	-
Course Correlation Mapping	**1**	**2**	**2**	**1**	**1**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**3**	-	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: OP-AMP APPLICATIONS, IC555 TIMERS & PLL ***(11 Periods)***

Review of operational Amplifiers, Instrumentation amplifier, Log and Antilog amplifiers, RC phase shift oscillator.
Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications. PLL - Introduction, block schematic, principles and description of individual blocks, Voltage Controlled Oscillator (IC 566).

Module 2: FILTERS &D-A AND A-D CONVERTERS ***(09 Periods)***

Filters: First - order and second order LPF, HPF Butterworth Filters.
D-A Converter: Weighted resistor DAC, R-2R Ladder DAC.
A-D Converters: Flash type, Successive Approximation type and Dual slope ADC.

Module 3: Verilog HARDWARE DESCRIPTION LANGUAGE ***(08 Periods)***

Introduction, Language Elements, operators, Expressions, Modeling-gate level modeling, data flow modeling, behavioral modeling, structural modeling..

Module 4: COMBINATIONAL LOGIC DESIGN APPLICATIONS ***(08 Periods)***

74x999 Adder and Subtractor, 74X138 3-to-8 Decoder,74x148 Priority Encoder,74x1518X1 Multiplexer, 74x181 Arithmetic and Logic Unit,74x280 9-Bit Parity Generator, 74x854-bit Comparator, Barrel Shifter using 74x151 multiplexer, Simple Floating-Point Encoder, Dual priority Encoder, modeling of circuits by using Verilog HDL.

Module 5: SEQUENTIAL LOGIC DESIGN APPLICATIONS ***(09 Periods)***

Flip-Flops- JK-74LS109 and D-74LS74. Counters - 74x163 binary counter, Modulo-11 &193 counters with a counting sequence, Modulo-8 Binary counter, Excess 3 decimal Counter using 74X163,74x169 up/down counter, Self-Correcting Ring & JohnsonCounter,3-bit LFSR Counter.74x194 universal shift register, Modeling of circuits using Verilog HDL.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

PART: A (Minimum Five exercises to be to be implemented using hardware)

1. Design and Simulate RC Phase shift oscillator circuit using Op-Amp 741.
2. Design and Simulate an Instrumentation Amplifier using Op-Amp 741 with required gain.
3. Design and Simulate applications of 555 timer (Monostable/Astable Multivibrator)with given duty cycle and frequency.
4. Design and Simulate an Active first and second order LPF/HPF filter for a given cut off frequency using Op-amp 741.

5. Design and Simulate D-A converter (R-2R ladder) using Op-amp 741 with requiredvoltage levels.
6. Design and verify an Active first and second order LPF/HPF filter for a given cut offfrequency using Op-amp 741.
7. Design and verify applications of 555 timer (Monostable/Astable Multivibrator) withgiven duty cycle and frequency.

PART B:(Minimum FIVE exercises to be implemented using Verilog HDL)

8. Arithmetic and Logic Unit using IC 74x181
9. Barrel Shifter using 74x151 multiplexer
10. Floating Point Encoder
11. Dual Priority Encoder
12. Self-Correcting Ring Counter
13. Universal Shift Register using IC 74x194
14. 3-bit Linear Feedback Shift Register

RESOURCES

TEXT BOOKS:

1. D. Roy Chowdhury, Linear Integrated Circuits, New Age International (p) Ltd, 4^{th}Edition, 2011.
2. John F. Wakerly, Digital Design Principles & Practices, Pearson Education Asia, 4^{th}Edition, 2008.

REFERENCE BOOKS:

1. Ramakanth A. Gayakwad, Op-Amps & Linear ICs, PHI, 3rd Edition, 1998
2. John F. Wakerly, Digital Design Principles & Practices, Pearson Education Asia, 4^{th}Edition, 2008.
3. J. Bhaskar, A Verilog HDL Primer, BS Publications, 2nd Edition, 2001.

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/108108111/L01.html
2. https://www.digimat.in/nptel/courses/video/108108114/L01.html

Web Resources:

1. https://freevideolectures.com/course/2915/linear-integrated-circuits

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EC102010	**DIGITAL DESIGN**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite 22CS101001-Digital Logic Design

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands on experience on Number systems, Boolean algebra, Minimization of Boolean functions, Analysis and synthesis of digital circuits; Asynchronous Sequential Logic & Programmable Memories.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Design logical circuits by analyzing various Boolean functions and simplification methods to perform desired logical operations using logical gates.

CO2. Design combinational logical circuits for performing various arithmetic operations and data encoding and decoding in various data lines.

CO3. Analyze various sequential circuits for realizing counters and registers using flip-flops

CO4. Design Asynchronous sequential logic and programmable memories for societal needs.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	3	1	-	1	1	-	-	-	-	-	3	-	-
CO3	3	2	3	1	-	1	1	-	-	-	-	-	3	-	-
CO4	3	2	3	1	-	1	1	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**3**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium;1: Low

COURSE CONTENT

Module 1: NUMBER SYSTEMS AND BOOLEAN ALGEBRA ***(10 Periods)***

Digital systems, Binary Numbers, Number base conversions, Complements of numbers, Binary codes, Error detection and correction codes. Boolean Algebra-Basic definition, Basic theorems and properties, Boolean Functions, Canonical & Standard forms, logic operations & Logic gates.

Module 2: GATE LEVEL MINIMIZATION ***(08 Periods)***

The map method, four variable, Five variable K-map, POS & SOP Simplification, Don't care conditions, NAND & NOR Implementation, Tabular Method- Simplification of Boolean function.

Module 3 COMBINATIONAL LOGIC CIRCUIT DESIGN ***(09 Periods)***

Combinational circuits, Adders, Subtractors, Binary Adder-Subtractor, Decimal Adder, carry look-a–head adder, Binary Multiplier, Magnitude comparator, Decoder, Encoders, Priority Encoder, Multiplexers.

Module 4 SEQUENTIAL LOGIC CIRCUIT DESIGN ***(10 Periods)***

Sequential Circuits, Latches, Flip-Flops-SR, D, JK & T, Introduction to Registers-Universal Shift Registers, State table and state diagrams, State Reduction & Assignment, Sequence Detector, Design of counters-Modulo-n, Johnson, Ring, Up/Down.

Module 5 ASYNCHRONOUS SEQUENTIAL LOGIC & PROGRAMMABLE MEMORIES ***(08 Periods)***

Analysis of Clocked sequential circuits, State Reduction & Assignment- partition technique, merger chart & merger table, Hazards

Programmable Memories: ROM, PLA, PAL.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

(Minimum **Ten** Experiments are to be conducted)

1. Minimization of logic circuits using K-Map.
2. Design of half adder & subtractor and full adder & subtractor.
3. Design of 4 bit
    a. binary adder and
    b. binary adder-subtractor
4. Design of 3 bit Magnitude comparator.
5. Design of BCD Adder
6. Design of 3 to 8 decoder & 8 to 3 encoder for an engineering application.
7. Design of 16 to 1 multiplexer using two 8 to 1 multiplexer.
8. Design of BCD to seven segment decoder.
9. Design SR, JK, T and D Flip-flops using logic gates.
10. Design of Universal Shift Register circuit.

11. Design and implementation of 3-bit synchronous up/down counter.
12. Design a ring counter using flip flops.

RESOURCES

TEXT BOOKS:

1. M. Morris Mano, Digital Design, Pearson education, 5th Edition, 2013.
2. Charles H. Roth, Fundamentals of Logic Design, Thomson Publications, 5th Edition, 2004.

REFERENCE BOOKS:

1. A. Anand Kumar, *Switching Theory and Logic Design*, PHI Learning Private Limited, 3rd edition, India, 2017
2. ZviKohavi and NirahK.Jha, Switching theory and Finite Automata Theory, Tata McGraw-Hill, 2nd Edition, 1978.

SOFTWARE/TOOLS:

Digital Schematic tool (DSCH2)

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_ee75/preview
2. https://onlinecourses.nptel.ac.in/noc20_cs63/preview

Web Resources:

1. https://www.digitalelectronicsdeeds.com/
2. https://www.tutorialspoint.com/digital_circuits/digital_circuits_useful_resources.htm

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EC102013	**INTERFACING WITH MICROCONTROLLERS**	3	-	2	-	4

Pre-Requisite 22EC102010-Digital Design

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: 8051 Microcontroller - Architecture, programming, interrupts and applications

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. Analyze various components of a computer system and criterion for choosing a microcontroller for realizing a prototype.

CO2. Analyze Architectural features and Instruction Set of 8051 for control applications.

CO3. Develop Programs at Assembly level using various on Chip resources for realizing Medium Scale Applications.

CO4. Design microcomputer-based systems with the knowledge of Interfaces and Peripherals with 8051 to solve various engineering problems.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	2	3	-	-	1	-	-	-	-	-	-	3	-	-
CO4	3	2	3	1	-	1	-	1	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**1**		**1**		**1**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO MICROCONTROLLERS ***(09 Periods)***

Major components of a computer system, Role of CPU, Major Components & Purpose, Microprocessors Vs Microcontrollers, Concept of Embedded Systems, Criterion for considering a Microcontroller.

Module 2: ARCHITECTURE OF 8051 ***(09 Periods)***

Compare various members of 8051 Family, 8051 Architecture, Register Organization – General & Special purpose, Pin out details, Extended mode (External Memory Interfacing), Timing details, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.

Module 3: PROGRAMMING 8051 AT ASSEMBLY LEVEL ***(09 Periods)***

Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.

Module 4: PROGRAMMING ON-CHIP RESOURCES AT ASSEMBLY LEVEL ***(09 Periods)***

8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode-2 on a port pin. 8051 Serial Communication-Basics of Serial Data Communication, RS-232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.

Module 5: 8051 INTERFACING ***(09 Periods)***

8255 Introduction, Interfacing 8051 to: LED, 7 –Segment display, LCD, Keyboard, ADC, DAC, Sensor Interfacing, Relay, DC Motor, Stepper Motor.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Arithmetic operations using internal and external memory.
2. Programs using special instructions like SWAP, bit/byte, set/ reset etc.
3. Bank Switching & Branch operations.
4. Timer Programming.
5. Serial communication programming

(Note: It’s an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay, "*The 8051 Microcontroller and Embedded Systems-using assembly and C*," PHI, 2006/ Pearson 2008

REFERENCE BOOKS:

1. Kenneth J. Ayala, "*The 8051 Microcontroller-Architecture, Programming & Applications*", 3rd Edition, Cengage learning, June 2004.

VIDEO LECTURES:

1. Lecture 1 Introduction - YouTube
2. Introduction to 8051 Microcontroller | Part 1 | Bharat Acharya Education - YouTube
3. Lecture 3 Introduction (Contd.) - YouTube
4. Lecture 26 : 8051 Microcontroller(Contd.) - YouTube
5. Lecture 39 : 8051 Programming Examples (Contd.) - YouTube

WEB RESOURCES:

1. 8051 Microcontroller Mini Projects - Matlab Projects | Matlab Project | Best IEEE Matlab Projects
2. 8051 Microcontroller Projects List from Microtronics (projectsof8051.com)
3. Microcontrollers - 8051 Architecture (tutorialspoint.com)
4. 8051 MicroController - javatpoint

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101019	**GENERATION OF ELECTRICAL POWER**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course is an introductory course in the field of electric power systems. The course is emphasized on the various conventional base load generation plants such as hydro, thermal and nuclear power plants, and peak load power plants such as pumped storage, gas fired and diesel power plants. The course also emphasis on the economics of power generation, tariffs and power factor improvement aspects.

COURSE OUTCOMES: *After successful completion of the course, students will be able to:*

CO1. Understand the operational aspects of hydro, thermal power plants and their impacts on environment.

CO2. Understand the operational aspects of Nuclear power plants and their impacts on environment.

CO3. Understand the operational aspects of peak load power plants and their impacts on environment.

CO4. Understand the concepts of cogeneration and aspects of power factor and improvement of power factor for sustainable operation.

CO5. Understand the economics of power generation and determine the various factors of power generation and various methods of tariffs.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	1	2	-	-	-	-	-	-	3	-
CO2	3	-	-	-	-	1	2	-	-	-	-	-	-	3	-
CO3	3	-	-	-	-	1	2	-	-	-	-	-	-	3	-
CO4	3	2	1	1	1	1	2	-	-	-	3	-	1	3	2
CO5	3	2	-	1	1	1	2	-	-	-	3	-	1	3	2
Course Correlation Mapping	**3**	**2**	**1**	**1**	**1**	**1**	**2**	-	-	-	**3**	-	**3**	**3**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: HYDRO POWER AND THERMAL POWER GENERATION (10 Periods)

Energy sources and their availability in India; Concept of grid—typical layout of power system.
Hydro power plant: Selection of site for hydroelectric power station, layout and classification of hydroelectric power station, available hydro power and mass curve.
Steam power plant: Layout of steam power plant -fuel handling, combustion equipment for steam boilers, fluidized bed combustion, ash handling, dust collectors, boilers, condenser, chimney and cooling towers.
Environmental impacts: effects of hydro-electric projects; GHG emission and its effects on environment.

Module 2: NUCLEAR POWER GENERATION (06 Periods)

Nuclear power stations: Nuclear fission, chain reaction, site selection, layout of nuclear power station, nuclear reactors classification, components, PWR, BWR and breeder reactor; Safety of nuclear power reactor.
Environmental impacts: Atmospheric pollution, disposal of nuclear waste.

Module 3: PEAK LOAD POWER PLANTS (08 Periods)

Hydro power plant: Concept of pumped storage plants, Operation; Introduction to the concept of distributed generation.
Diesel engine power plant: Introduction, applications, site selection, classification of internal combustion engines, essential components and operation of diesel power plant.
Gas turbine power plant: Gas turbines, site selection, simple gas turbine plant, energy cycle, layout and essential components of gas turbine power plant.
Environmental impacts: Atmospheric pollution.

Module 4: COGENERATION AND POWER FACTOR CORRECTION (11 Periods)

Cogeneration- Electricity generating systems, Economic benefits, Environmental benefits. Operation modes of cogeneration systems, Factors to consider, project risks, cogeneration usage in different places, Practical aspects of installing a cogeneration plant.
Power factor correction: Causes of low power factor, methods of improving power factor - power capacitors, series and shunt capacitors for power factor correction. Most economical power factor.

Module 5: ECONOMIC ASPECTS OF POWER GENERATION AND TARIFF (10 Periods)

Introduction, terms and definitions - connected load, maximum demand, load factor, demand factor, diversity factor, plant capacity factor, utilization factor, Plant use factor, loss factor, coincidence factor and contribution factor. Relation between loss factor and load factor. Tariffs -simple, flat rate, block rate, maximum demand, two-part, three-part and power factor tariffs.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Prepare a technical report on the present scenario of generation and current status of power demand in the country.
2. Prepare an article on the impact of conventional generation on environment and should recommend measures to sustain the environment.

3. Visit an industry/organization to review the scope for cogeneration and prepare a technical report to assess the possibilities of cogeneration in the industry.
4. Visit an industry/agricultural sector and should review the power consumption and should prepare the technical report to assess the possibilities for reduction of tariff.

(Note: It's an indicative one. The course instructor may change the activities and shall be reflected in the course handout.)

RESOURCES

TEXT BOOKS:

1. R. K. Rajput, *A textbook of power system engineering*, Laxmi publications (P) Ltd, 2016.
2. C.L. Wadhwa, *Generation Distribution and Utilisation of Electrical Energy*, New Age, International publishers, 3rd edition, 2015.

REFERENCE BOOKS:

1. D P Kothari, K C Singal and Rakesh Ranjan, '*Renewable Energy Sources and Emerging Technologies*' 2nd Edition, 2012.
2. *S.Rao, Dr.B.B.Parulekar, Energy Technology,* third edition, Khanna publications, 2013.
3. V.K.Mehta and Rohith Mehta, *Principles of Power Systems*, S Chand & Company Ltd, New Delhi, 4th Multi-color illustrative edition, 2006.
4. Tagare, Digambar M. *Electricity power generation: the changing dimensions*. John Wiley & Sons, 2011.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/121106014
2. https://www.youtube.com/watch?v=AXcb3TBLETY

WEB RESOURCES:

1. https://www.eia.gov/energyexplained/electricity/how-electricity-is-generated.php
2. https://www.endesa.com/en/discover-energy/energy-and-more/how-electricity-is-generated
3. https://pb.edu.pl/oficyna-wydawnicza/wp-content/uploads/sites/4/2018/12/Buildings-2020-part2-rozdz7.pdf
4. https://www.electrical-technology.com/2019/05/power-factor-correction.html
5. https://www.e-education.psu.edu/ebf483/node/517

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101022	**POWER SYSTEM OPERATION AND CONTROL**	3	-	-	-	3

Pre-Requisite 22EE101008-Transmission and Distribution

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with the fundamentals aspects of planning and operation of power systems such as: Load forecasting; Optimal operation of generators in thermal power station; Optimal scheduling of hydrothermal system; Unit commitment; Modeling of Power system components; Reactive power and Voltage control; and Load frequency control.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Estimate the load profile using statistical methods for planning and scheduling of thermal plants in power system.

CO2. Determine the optimal schedule of hydro-thermal plants for sustainable operation of the plant.

CO3. Solve the unit-commitment problem using dynamic programming to allocate the load among the committed generators.

CO4. Model the power system components appropriate for automatic generation control of Power system.

CO5. Assess the load frequency dynamics in single area and two-area system, and design a suitable controller to control the LFC dynamics

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	--	--	2	1	1	--	--	--	1	--	1	3	2
CO2	3	3	--	2	2	2	1	--	--	--	1	--	--	3	2
CO3	3	3	--	3	3	1	--	--	--	--	1	--	--	3	2
CO4	3	3	1	2	2	1	2	1	--	--	--	--	--	3	2
CO5	3	3	1	2	2	1	1	--	--	--	--	--	--	3	2
Course Correlation Mapping	**3**	**3**	**1**	**2**	**2**	**1**	**1**	**1**	**--**	**--**	**1**	**--**	**1**	**3**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: PLANNING AND ECONOMIC OPERATION OF THERMAL POWER SYSTEM (12 Periods)

Planning: Load curves, Load curve parameters – Connected load, Maximum Demand, Average Load, Load Factor, Demand Factor, Diversity Factor; Load forecasting: Simple regression – Linear and quadratic.

Economic Operation of thermal plants: Characteristics of thermal plants, cost function: fuel cost and incremental fuel cost; Optimum allocation with and without transmission losses, loss coefficients, general transmission line loss formula.

Module 2: HYDROTHERMAL SCHEDULING (08 Periods)

Introduction, classification of hydro plants, scheduling of hydro plants - long-term, short-term, scheduling energy. Hydrothermal scheduling - problem formulation, objective function, operational constraints. Short term scheduling - Lagrange function, penalty factor; iteration method

Module 3: UNIT COMMITMENT (08 Periods)

Introduction, Constraints in unit commitment—Start-up and shutdown costs, up time and downtime, and reserves; Unit commitment solution methods - priority list method, dynamic Programming method (maximum of three plants for three operating hours only); Unit commitment Vs Economic dispatch.

Module 4: MODELLING OF POWER SYSTEM COMPONENTS FOR AGC (07 Periods)

Load Frequency Problem; LFC Model - speed governor, turbine, generator-load model; Components and block diagram representation of IEEE type-1 excitation system; AVR model.

Module 5: LOAD FREQUENCY CONTROL IN POWER SYSTEM (10 Periods)

Load frequency control of single area system: Necessity of keeping frequency constant; Steady state response - uncontrolled and controlled case, dynamic response.

Load frequency control of two area system: Concept of control area, Block diagram representation, Steady state response - uncontrolled and controlled case, dynamic response, tie-line bias control.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Develop the MATLAB Program to determine the Load forecasting using statistical methods.
2. Develop an AVR model for a generator and simulate the same to understand the dynamics with and without a controller.
3. Develop an LFC model for a generator and simulate the same to understand the dynamics with and without a controller.
4. Visit any generation plant and observe the load and generation balancing in the plant and prepare a technical report on the observations made.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1 K. Uma Rao, *Power system operation and control*, Wiley India Pvt. Ltd, 1st Edition, 2013.

2 C. L. Wadhwa, Electrical Power Systems, New age International, New Delhi, 5th Edition, 2009.

REFERENCE BOOKS:

1 Siva nagaraju, S. Power system operation and control. Pearson Education India, 2009.

2 A. Chakravarthi and S. Halder, Power System Analysis Operation and Control, Prentice Hall India, 3rd Edition, 2006

VIDEO LECTURES:

1 https://nptel.ac.in/courses/108/104/108104052/

2 https://www.digimat.in/nptel/courses/video/108105104/L53.html

WEB RESOURCES:

1 a) https://engineerscommunity.com/t/load-curve-questions-and-answers/6581

b)https://www.jntua.ac.in/gate-online-classes/registration/downloads/material/a159041324364.pdf

c) https://www.iitp.ac.in/~siva/2021/ee381/Economic_Load_Dispatch.pdf

2 a) http://www.gvpcew.ac.in/Material%203%20Units/4%20EEE%20PSOC%20Unit%202.pdf

b) https://home.engineering.iastate.edu/~jdm/ee553/HydroThermal.pdf

3 a) https://www.brainkart.com/article/Unit-Commitment---Introduction_12469/

4 a) https://www.brainkart.com/article/Speed-Governing-Mechanism-and-Modelling_12444/

b) https://link.springer.com/chapter/10.1007/978-1-4615-5633-6_2

5 a)https://www.seu.edu.bd/seujse/downloads/vol_10_no_2_dec_2016/05_Vol10No2Dec2016.pdf

b)https://www.jntua.ac.in/gate-online-classes/registration/downloads/material/a159041328312. Pdf

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101025	**SWITCHGEAR AND PROTECTION**	3	-	-	-	3

Pre-Requisite 22EE102009-Power System Analysis

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on protection schemes, circuit breakers, electromagnetic, static, and microprocessor-based relays, Protection schemes for various components under various operating conditions, and various grounding schemes.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the conceptual knowledge of various circuit breakers for the secured operation of power system networks.

CO2. Apply the conceptual knowledge of relays for sensing various faults and invoke preventive action for the protection of power system networks.

CO3. Analyze various abnormalities in power system equipment and develop an appropriate protection strategy for the protection of generators, transformers and bus bars.

CO4. Analyze various protection schemes for the protection of transmission lines and feeders.

CO5. Apply various neutral grounding methods and determine the system parameters for protection in the power system.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	3	2	-	-	-	-	-	1	3	2
CO2	3	2	-	1	1	3	2	-	-	-	-	-	-	3	2
CO3	3	2	3	1	-	3	2	-	-	-	-	-	-	3	2
CO4	3	2	-	1	-	3	2	-	-	-	-	-	-	3	2
CO5	3	2	-	2	-	3	2	-	-	-	-	-	-	3	2
Course Correlation Mapping	**3**	**2**	**3**	**1**	**1**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**1**	**3**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: CIRCUIT BREAKER (09 Periods)

Circuit breakers — elementary principles of arc interruption, recovery voltage, restriking voltage, RRV, average and maximum RRRV; current chopping and resistance switching; Construction and principle of operation — minimum oil circuit breaker, air blast circuit breaker, vacuum circuit breaker, and SF_6 circuit breaker; Isolator.

Module 2: RELAYS (11 Periods)

Electromagnetic relays: Types of relays, construction, operation of induction type relays, differential relays and biased differential relays. Universal torque equation — Characteristics of various relays, characteristics of over current, directional and distance relays.

Static relays: Advantages and disadvantages, block diagram of a basic static relay; definite time, inverse and inverse definite minimum time (IDMT). Comparators — amplitude and phase comparators.

Microprocessor-based relays: Advantages and disadvantages, block diagram with flow charts — distance relays and over current relays — definite, inverse &IDMT.

Module 3: PROTECTION OF GENERATORS AND TRANSFORMERS (08 Periods)

Protection of generators: Rotor protection; Stator protection — restricted earth fault protection and internal fault protection; Other faults — unbalanced loading, overloading protection, over-speed protection, over-voltage protection, failure of prime mover, loss of excitation; calculation of percentage winding unprotected.

Transformer protection: Percentage differential protection, design of CT's ratio.

Protection of bus bars: Differential protection.

Module 4: PROTECTION OF FEEDERS AND TRANSMISSION LINES (10 Periods)

Protection of transmission lines: Protection through directional and distance relays (R-X); Three-zone distance protection using distance relays; Carrier current protection using over current relays.
Protection of feeders: Protection of radial and ring main feeders using over current relays.
Protection against over-voltages: Causes of over voltages in power systems, protection against lightning over voltages — surge diverters and absorbers, Insulation coordination, basic impulse insulation level(BIIL)

Module 5: NEUTRAL GROUNDING (07 Periods)

Grounded and ungrounded systems. Effects of ungrounded neutral on system performance. Methods of neutral grounding — solid, resistance, reactance, arc suppression coil (Peterson coil), grounding practices.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Visit any industrial/agricultural sector and identify the common faults they are encountering and suggest a suitable remedial method for mitigating the issue.
2. Prepare an article on the impact of various power quality problems on the protection equipment and recommend measures to sustain the operation of protection equipment.
3. Visit an industry/organization to review the protection scheme adopted and prepare a technical report to assess the possibilities of protection schemes in the industry.
4. Review a relevant IEEE journal on protection, and prepare a report on the inferences of the article.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Sunil S. Rao, *Switchgear Protection and Power Systems (Theory, practice and Solved Problems)*, 13th Edition, Khanna Publishers, New Delhi, 2013.
2. Badri Ram, D. N. Viswakarma, *Power System Protection and Switchgear*, 2ndEdition, McGraw Hill education (India) Private Limited, New Delhi, 2011.

REFERENCE BOOKS:

1. C. L. Wadhwa, *Electrical Power systems*, 7thEdition, New Age International (P) Limited, Publishers, New Delhi, 2017.
2. T. S. Madhava Rao, *Power System Protection: Static Relays with Microprocessor Applications*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2ndEdition, 2004.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=_-Cg34oz-MQ
2. https://www.youtube.com/watch?v=LPQiajWeijY&list=PLBVJZMfxcrJn3p03lxsOP_ivHXzFLysYE

WEB RESOURCES:

1 https://nptel.ac.in/courses/108/101/108101039/

2 https://lsin.panasonic.com/blog/understand-importance-switchgear-protection-devices/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE103014	DESIGN AND ESTIMATION OF ELECTRICAL SYSTEMS	3	-	-	4	4

Pre-Requisite 22EE101008-Transmission and Distribution

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Design and estimation of residential & commercial buildings, overhead transmission & distribution lines, and industrial buildings; Light sources, principals of light & design, types of lamps; electric heating, welding, and their applications.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Design and estimate the requirements of electrical wiring in residential & commercial buildings adhering to Indian electricity rules and standards.

CO2. Design and estimate the requirements of overhead transmission and distribution lines adhering to Indian electricity rules and standards.

CO3. Design and estimate the requirements of electrical wiring for industrial buildings adhering to Indian electricity rules and standards.

CO4. Design the lighting system for various industrial and domestic applications following the design procedures and laws of illumination.

CO5. Understand various methods of heating and welding processes and their applications.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	-	1	-	-	2	-	-	2	1	-	2	3
CO2	3	3	3	-	1	-	-	2	-	-	2	1	-	2	3
CO3	3	3	3	-	1	-	-	2	-	-	2	1	-	2	3
CO4	3	3	3	-	-	-	-	1	-	-	2	1	-	2	3
CO5	3	1	-	-	-	-	-	-	-	-	2	2	-	2	3
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	2	3
Course Correlation Mapping	**3**	**3**	**3**	**-**	**1**	**-**	**-**	2	**3**	**3**	2	1	-	**2**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DESIGN AND ESTIMATION OF RESIDENTIAL AND COMMERCIAL BUILDINGS (11 Periods)

Introduction to residential wiring system, systems of distribution of electric energy, methods of wiring, systems of wiring, choice of wiring, rating of wires and cables, load calculations and selection of size of conductor. Estimation & costing for residential and commercial buildings. Indian Electricity Act and major applicable Indian Electricity (I.E) rules.

Module 2: DESIGN AND ESTIMATION OF OVERHEAD TRANSMISSION & DISTRIBUTION LINES (09 Periods)

Introduction, components of overhead lines, conductor materials, determination of size of conductor for overhead transmission line, conductors' configuration, spacing and clearances, span lengths. Preparation of detailed estimates and costing of overhead transmission and distribution lines.

Module 3: DESIGN AND ESTIMATION OF INDUSTRIAL NETWORK INSTALLATIONS (09 Periods)

Introduction and classification of industrial buildings, design process, Industries with lessthan or equal to 1MVA and above 1MVA load, selection of distribution architecture, selection of transformer substations, selection of drives, selection of switch gears.

Module 4: PRINCIPLES OF LIGHT AND DESIGN (10 Periods)

Light sources, colour characteristics, terms used in illumination, laws of illumination, polar curves, photometry - integrating sphere. Types of lamps, LED lights, photometric analysis, lighting calculations, average lumen method, light loss factor, quality of lighting, design procedures, arrangement of fixtures, factory lighting, street lighting and flood lighting.

Module 5: ELECTRIC HEATING AND ELECTRIC WELDING (06 Periods)

Electric heating: Design of heating element, advantages, methods and applications - resistance, induction and dielectric heating.
Electric welding: Classification, resistance and arc welding, electric welding, comparison between AC and DC welding.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

PROJECT-BASED LEARNING: The following activities are indicative only; the detailed project-based activities will be provided in the course handout.

1. The student shall take a typical house load in real-time and should design a wiring system to meet the required specifications.
2. The student shall take a typical industrial or commercial load in real-time and should design a wiring system to meet the required specifications.
3. The student shall take a typical indoor/outdoor system and should design an appropriate illumination system to meet the required specifications.

RESOURCES

TEXT BOOKS:

1. J.B. Gupta, A Course in Electrical Installation Estimating and Costing, Reprint Edition, S.K. Kataria and Sons, 2013.
2. M. K. Giridharan, Electrical Systems Design, 3rd Edition, I K International Publishing House Pvt. Ltd, 2015.

REFERENCE BOOKS:

1. Hemant Joshi, Residential - Commercial and Industrial Electrical Systems: Network and Installation (Volume 1), 21st Edition, McGraw Hill Education, 2007.
2. Hemant Joshi, Residential - Commercial and Industrial Electrical Systems: Network and Installation (Volume 2), 21st Edition, McGraw Hill Education, 2007.
3. J.B. Gupta, Utilization of Electric Power and Electric Traction, 10th Edition, S.K. Kataria and Sons, 2013.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=AQffdGvDNcA&list=PL_6_U09jayh3eylqB7OHU-FMgi6FLO-XZ
2. https://www.youtube.com/watch?v=ufg1Z9Q4frA&list=PLFhcZ8mFno-Y4uQd8U_AVRU0c9u2dBZJH

WEB RESOURCES:

1 https://bis.gov.in/index.php/standards/technical-department/national-building- code/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE102017	ENERGY AUDIT, CONSERVATION AND MANAGEMENT	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides an orientation and hands-on experience on principles of energy audit, management, and conservation practices, Energy efficient motors, lighting schemes, Energy measuring instruments, and analytical skills for the quantitative estimation of energy economics. This course also provides a procedure to asses and addresses the various societal issues related to energy management and provides feasible energy conservation techniques.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the relevant rules, regulations and procedures to carry the energy audit in industries.

CO2. Apply and realize the relevant practices to carry effective energy conservation practices for various societal problems.

CO3. Analyze the performance of energy-efficient motors and propose an appropriate illumination system by applying the protocols of energy auditing.

CO4. Apply appropriate energy auditing instruments for energy auditing in industries and assess the economic benefits of auditing.

CO5. Apply the demand-side management techniques and relevant standards for the organization of energy conservation awareness programs.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	-	-	2	2	1	1	-	-	-	1	1	2	3
CO2	3	1	-	-	2	2	2	1	-	-	1	-	-	2	3
CO3	3	1	2	-	1	2	1	1	-	-	1	2	-	2	3
CO4	3	2	-	2	2	2	1	-	-	2	1	2	-	2	3
CO5	3	1	-	-	2	1	3	1	-	-	1	-	-	2	3
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	2	3
Course Correlation Mapping	**3**	**1**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**1**	**2**	**1**	**2**	**3**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: ENERGY AUDIT AND MANAGEMENT PRINCIPLES (10 Periods)

Energy audit — definitions, concept, types of audit, energy index-cost index, pie charts, Sankey diagrams, load profiles, energy audit in industries, energy saving potential, energy audit of process industry, thermal power station, building energy audit, case study. IE rules and regulations for energy audit.

Energy management — Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, and reporting.

Module 2: ENERGY CONSERVATION PRINCIPLES (08 Periods)

Energy scenario in India and world. Rules for efficient energy conservation; technologies for energy conservation. Principles of energy conservation, current energy consumption in India, roles and responsibilities of energy managers in industries.

Module 3: ENERGY EFFICIENT MOTORS AND LIGHTING (09 Periods)

Energy efficient motors - factors affecting efficiency, loss distribution, constructional details, characteristics, variable speed, variable duty cycle systems, motor energy audit.

Lighting - Good lighting system design and practice, lighting control, lighting energy audit.

Module 4: ENERGY INSTRUMENTS AND ECONOMIC ANALYSIS (09 Periods)

Energy Instruments— Infrared thermometer, data loggers, thermo-couples, pyrometers, Lux meters, tongue testers, power quality analyzer, and PLC and PIC applications. Energy Economic Analysis— The time value of money concept. Cash flow models, payback analysis, depreciation, taxes and tax credit - numerical problems.

Module 5: DEMAND SIDE MANAGEMENT (09 Periods)

Introduction to DSM, concept of DSM, benefits of DSM, different techniques of DSM – time of day pricing, multi-utility power exchange model, and time of day models for planning, load management, load priority technique. Management and organization of energy conservation awareness programs.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXPERIMENTS: (Minimum 08 exercises shall be conducted)

1. Demonstration of various auditing instruments for measuring electrical and non-electrical quantities for auditing purpose.
2. Measurement of active, reactive power, energy and power factor for auditing purpose.
3. Energy conservation of Electric motor drive for under variable speed conditions.
4. Determine the energy consumption of incandescent/ fluorescent/CFL/LED lamps and evaluate net energy savings.
5. Evaluate energy conservation in a ceiling fan/BLDC fan with and without an electronic regulator.
6. Determine the energy conservation in an induction motor operating in star and delta mode of operation.
7. Conserve the energy of a three-phase induction motor by employing the switched capacitor for improvement of power factor. Also, estimate the energy and economic savings by improving the power factor for a given class of consumer.

8. Assess power quality problems using power quality analyzer and suggest a suitable conservative measures to mitigate
9. Analyze star labeled electrical apparatus and compare the data sheet of various star ratings.
10. Estimate the economic benefits of improving load factor for a domestic consumer.
11. Audit the energy of a commercial consumer and suggest an appropriate energy conservation practice to reduce energy bill.

RESOURCES

REFERENCE BOOKS:

1. W.R. Murphy & G. Mckay Butter worth, *Energy management*, Butter worth-Heinemann publications, 2nd Edition, 2016.
2. Albert Thumann, William J. Younger, *Handbook of energy audits*, Taylor & Francis Ltd, 7th Edition, 2008.
3. Umesh Rathore, *Energy management*, S.K. Kataria & Sons, 2nd Edition, 2014.
4. W.C.Turner, Stevedoty, *Energy management hand boo*k, CRC press, 6th Edition, 2006.
5. D.P. Sen, K.R. Padiyar, Indrane Sen, M.A. Pai, *Recent Advances in Control and Management of Energy Systems*, Interline Publisher, Bangalore, 1993.
6. Ashok V. Desai, Wiley Eastern, *Energy Demand - Analysis, Management and Conservation Hand book on energy auditing - TERI (Tata Energy Research Institute)*, 2005.
7. Craig B. Smith, Kelly E. Parmenter, *Energy management principles Applications*, benefits, Savings, Elsevier Inc(Pergamon Press), 1st Edition, 2016.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=M1zijCmeXJg
2. https://www.youtube.com/watch?v=FTpMWXMBSyM
3. https://www.youtube.com/watch?v=_T1Au_P5bnQ
4. https://www.youtube.com/watch?v=ENLzwTVjxms
5. https://www.youtube.com/watch?v=7hDyLuFJ0c8
6. https://www.youtube.com/watch?v=lkNIuFkzxBk

WEB RESOURCES:

1 https://drive.google.com/file/d/1rKbsgRMKS1a9SxfDKMnOjucmQDcgIS-e/view
2 https://drive.google.com/file/d/1PEhQ_ZMAzDVhnBdUWdrak5O88S29Mjbi/view
3 https://drive.google.com/file/d/1rH9ibpXqelVMBxreRLlH9DgKgpfPu6FH/view
4 https://drive.google.com/file/d/1cGk0iedOyuEpdmPbvrjFQT6sqU1zoeZz/view
5 https://beeindia.gov.in/sites/default/files/1Ch3.pd
6 https://beeindia.gov.in/content/energy-auditors
7 https://beeindia.gov.in/news-events/energy-conservation-building-code-rules-2018
8 https://nayaenergy.com/difference-between-energy-audit-and-energy-management/

PROGAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101401	**SENSORS AND SIGNAL CONDITIONING**	3	-	-	-	3

Pre-Requisite 22EE101004-Electrical and Electronic Measurements

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on working principle of resistive, inductive, capacitive, self-generating, Digital and other sensors, signal conditioning circuits.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply Resistive sensors to measure physical parameters based on principle and characteristics.

CO2. Apply Inductive and Capacitive sensors to measure physical parameters based on principle and characteristics.

CO3. Apply Self generating sensors to measure physical parameters based on principle of operation.

CO4. Apply Digital Sensors to measure physical parameters based on principle of operation.

CO5. Design Signal Conditioning Circuit for various sensors based on application.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	3	2	-	-	-	-	-	-	-	-	-
CO5	1	2	3	-	2	1	-	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	-	**3**	**2**	-	-	-	-	-	-	-	-	-

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: RESISTIVE SENSORS ***(09 Periods)***

Principle of transducers, classification, Factors influencing the choice of transducers. Potentiometers, Metal and semiconductor strain gauges — principle of operation, gauge factor, gauge sensitivity; Resistance temperature detectors.

Module 2: CAPACITIVE AND INDUCTIVE SENSORS ***(09 Periods)***

Capacitive sensors — Variation in overlapping area, variation in dielectric constant, variation in distance between the plates of variable and differential capacitor.
Inductive sensors — Variable reluctance sensors, Linear variable differential transformers, Synchro's, Resolvers, Hall effect sensors.

Module 3: SELF-GENERATING SENSORS ***(09 Periods)***

Thermoelectric sensors — Thermoelectric effects, Thermocouple laws, common thermocouples.
Piezoelectric sensors — Piezoelectric effect, deformation modes, equivalent circuit, materials.

Module 4: DIGITAL AND OTHER SENSORS ***(09 Periods)***

Digital transducers: Tachometer encoder, incremental encoder, absolute encoder. Semiconductor sensors — principle of operation and techniques; Fiber optic sensors, Ultrasonic sensors, Basics of SMART sensors.

Module 5: SIGNAL CONDITIONING ***(09 Periods)***

Block diagram of signal conditioning, balance and deflection measurement in Wheatstone bridge, Carrier amplifier, chopper amplifier, low drift amplifier and charge amplifier, Instrumentation amplifier.

Total: 45 Periods

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Design resistance to voltage converter using NI Multisim software considering the following specifications:
   a) The change in resistance from 100Ω to 139Ω must be converted in (0 to 5) volts.
   b) Resistance to voltage converter can be designed using operational amplifiers as inverter, differential amplifier at four stages.
   c) Resistance to voltage converter can also be designed using with wheat stone bridge circuit with sensor resistance representing 139Ω and standard resistance representing 100Ω.
   d) Wheat stone bridge can be designed with single sensor for positive and negative voltages.
   e) Wheat stone bridge can be designed with two sensors for improving sensitivity.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Ramon Pallas-Areny and John G. Webster, *Sensors and Signal Conditioning*, John Wiley & Sons, Inc., 2nd edition, 2001.
2. A.K.Sawhney, *A Course in Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai & Co., 19th edition, 2015.

REFERENCE BOOKS:

1. D. V. S Murty, Transducers and Instrumentation, PHI Learning Private Limited, 2nd edition, 2010
2. D. Patranabis, Sensors and Transducers, PHI Learning Private Limited, 2nd edition, 2003.
3. John P. Bentley, Principles of Measurement Systems, Pearson Education, 4th edition, 2005.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/108/108/108108147/
2. https://www.coursera.org/learn/sensors-circuit-interface#syllabus

WEB RESOURCES:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/108105064/lec1.pdf
2. https://www.ibiblio.org/kuphaldt/socratic/sinst/book/liii.pdf.

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC104018	**ADVANCED MICROCONTROLLERS**	3	-	2	4	5

Pre-Requisite 22EC102013-Interfacing with Microcontrollers

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is designed to provide an overview on system design using industry standard Peripheral Interface Controller. The course provides a deep insight about its architecture, Programming at assembly and high levels, various resources -operation and their applications demanding interfacing to external peripherals to solve various engineering problems efficiently.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze Architectural features of PIC family of Microcontrollers for control applications.

CO2. Analyze PIC18 Architecture and Instruction Set to develop computing applications.

CO3. Develop Programs for PIC18 using ports, timers and associated on Chip resources for Specified Applications.

CO4. Design microcomputer based systems with the knowledge of Interfaces and Peripherals of PIC18 to Solve various engineering problems.

CO5. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	2	3	-	-	1	-	-	-	-	-	-	-	3	-
CO4	3	2	3	1	-	1	-	1	-	-	-	-	-	3	-
CO5	3	2	3	-	-	1	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**3**	**3**	**1**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: PIC ARCHITECTURE ***(09 Periods)***

Architecture of PIC18, Register Organization, Memory Organization - ROM space & RAM.

Module 2: PIC PROGRAMMING ***(09 Periods)***

Data formats & Directives, Instruction Set: Arithmetic, Logic, branching, Bit wise, bank switching, Simple PIC Programs.

Module 3: PORTS, TIMERS AND PROGRAMMING ***(09 Periods)***

Pin description of PIC18F452, Basic Port Structure, I/O port programming; Macros and modules, Structure of Timer 0 & its Programming using Assembly and C, Counter programming, Structure of timers 1, 2 and 3 & their Programming.

Module 4: PIC-SERIAL PORTS AND INTERRUPTS ***(09 Periods)***

Basics of communication – Serial/Parallel, RS232 & PIC18 connection to RS232, Serial Port Structure & programming; PIC18 interrupts, Programming timer interrupts, Programming serial interrupts

Module 5: PIC INTERFACING ***(09 Periods)***

7 segment LED and LCD interfacing, keyboard interfacing, interfacing ADC, DAC, Interfacing DC motor, stepper motor, PWM using CCP.

Total Periods: **45**

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

Programs using PIC Microcontroller

1. Arithmetic operations.
2. Logical & Branch operations
3. Bit manipulation operations.
4. Macros & Modular programming.
5. Time Delay programs.

Interfacing with PIC microcontrollers

6. Interface switches, LEDs, 7-segment display.
7. Interfacing of PIC18 with Keyboard and LCD.
8. Interfacing of PIC18 with DAC.
9. Interfacing using serial communication & DC Motor
10. Interfacing Stepper Motors

PROJECT BASED LEARNING:

1. Digital Dice Roller with PIC.
2. Create a Command Line Interface over UART
3. Log Weather data
4. Automated water Dispenser.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny causey, PIC Microcontroller and Embedded SSystems: Using C and PIC18, Pearson Education, 2015.

REFERENCE BOOKS:

2. Ramesh S. Gaonkar, *Fundamentals of Microcontrollers and Applications in Embedded Systems (With PIC18 Microcontroller Family),* Penram International, 2010.

VIDEO LECTURES:

1. https://skills.microchip.com/introduction-to-the-8-bit-pic-mcu-timer0
2. https://nptel.ac.in/courses/117104072

Web Resources:

1. http://crystal.uta.edu/~zaruba/CSE3442/
2. https://owd.tcnj.edu/~hernande/ELC343/
3. http://www.ciebookstore.com/Content/Images/uploaded/PIC18-Study-Guide-CIE.pdf

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101402	**DISCRETE TIME SIGNAL PROCESSING**	3	-	-	-	3

Pre-Requisite 22EE102003-Signals and Networks

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Continuous and discrete signals and sequences; systems**;** DFT and FFT algorithms for the analysis of discrete sequences; design and realization of Digital IIR and FIR filters.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. Analyze discrete-time systems using suitable transforms.

CO2. Apply Discrete and Fast Fourier Transforms to analyze the response of linear systems.

CO3. Design IIR and FIR digital filters by applying transformation and windowing Techniques.

CO4. Realize IIR and FIR digital filters using various structures.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	1	-	-	-	-	-	-	-	-	3	-
CO2	3	2	-	2	3	-	-	-	-	-	-	-	-	3	-
CO3	3	2	3	2	2	-	-	-	-	-	-	-	-	3	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	3	**3**	**-**	**-**	**-**	**3**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FREQUENCY ANALYSIS OF DISCRETE TIME SIGNALS ***(06 Periods)***

Fourier series for DT periodic signal and power density spectrum, the Fourier transform of DT aperiodic signals, convergence of the Fourier transform and energy density spectrum, Solution for difference equations of digital filters using Z-transforms.

Module 2: DISCRETE AND FAST FOURIER TRANSFORMS ***(07 Periods)***

Discrete Fourier Transforms (DFT): Properties of DFT, linear filtering methods based on DFT, frequency analysis of signals using DFT.

Fast Fourier transforms (FFT): Radix-2 Decimation in time (DIT) and Decimation in frequency (DIF) FFT algorithms.

Module 3: IIR FILTER DESIGN ***(06 Periods)***

Design of IIR digital filters from analog filters-IIR filter design by approximation of derivatives, impulse invariance and bilinear transformation. Characteristics of commonly used analog filters, Frequency transformations.

Module 4: FIR FILTER DESIGN ***(06 Periods)***

Symmetric and anti-symmetric FIR filters, Design of linear phase FIR digital filters using windows- Barlett, Blackman, Hamming and Hanning. Frequency sampling technique.

Module 5: REALIZATION OF DISCRETE-TIME SYSTEMS ***(05 Periods)***

Structural realization of IIR Systems-direct, cascade and parallel form structures.

Structural realization of FIR Systems-direct, cascade-form structures and Lattice structures.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Voice biometric speaker recognition
2. Identification of Musical Instruments
3. Speaker recognition system based on MFCC
4. Disease detection based on ECG
5. Implementation of 5-Band Audio Equalizer in Matlab

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. J. G. Proakis and D.G. Manolakis, "*Digital Signal Processing: Principles, Algorithms and Applications,*" Prentice Hall, Fourth Edition, 2007.
2. B.Venkataramani, M. Bhaskar, "*Digital Signal Processors – Architecture, Programming and Applications,*" TATA McGraw Hill, Second Edition, 2010.

REFERENCE BOOKS:

1. Alan. V. Oppenheim, Ronald.W. Schafer and John.R. Buck, *"Discrete-Time Signal Processing,"* Pearson Education, Second Edition, 2006.
2. Emmanuel C. Ifeachor& Barrie. W. Jervis, "*Digital Signal Processing*," Pearson Education / Prentice Hall, Second Edition, 2002.

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/117102060/L01.html
2. https://archive.nptel.ac.in/courses/108/105/108105055/
3. https://www.coursera.org/specializations/digital-signal-processing
4. https://www.coursera.org/learn/dsp1

Web Resources:

1. https://www.tutorialspoint.com/digital_signal_processing/digital_signal_processing_useful_resources.htm

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101029	**ELECTRIC VEHICLES**	3	-	-	-	3

Pre-Requisite: 22EE102006-Electrical Machines-II

22EE101011-Power Electronics

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with Transportation vehicles and their impact in society; Concepts, configurations, principles, types, and operation of Electric Vehicles (EV); Power Electronic converters in EVs; Different motor drives & energy storage technologies in EVs.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the principle of operation of electric, hybrid-electric vehicles and various emerging technological challenges while confronting the issues during transportation.

CO2. Analyze the performance characteristics of various power converters operating in different modes, and assess a suitable converter and its control strategies for the sustainability of electric vehicles.

CO3. Analyze various propulsion motor drives operating in different modes for sustainability and determine the performance/operational parameters of an electric vehicle.

CO4. Analyze various battery energy storage systems and assess their adaptability for the sustainable performance of electric vehicles.

CO5. understand the various types of magnetic gears for electric vehicles and apply them for the sustainable mobility of vehicles.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	1	-	-	-	-	-	-	-	1	1
CO2	3	3	-	-	2	2	1	-	-	-	-	-	1	3	2
CO3	3	3	-	-	2	2	1	-	-	-	-	-	1	3	2
CO4	3	3	-	-	2	2	1	-	-	-	-	-	1	3	2
CO5	3	2	-	-	1	1	1	-	-	-	-	-	1	1	1
Course Correlation Mapping	**3**	**3**	-	-	**2**	**2**	**1**	-	-	-	-	-	**1**	**2**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO EVS AND HEVS (08 Periods)

Environmental impact and history of modern transportation, history of transportation electrification, Electric Vehicles (EVs) — introduction, configurations and traction motor characteristics; Hybrid Electric Vehicles (HEVs) — concept and architectures; series and parallel HEVs — configuration, operation, advantages and disadvantages; HEVs — interdisciplinary nature, challenges and key technologies.

Module 2: POWER CONVERTERS IN EVS (10 Periods)

Introduction, isolated DC-DC converter — advantages, forward converter, CCM currents in forward converter, CCM voltages in forward converter and sizing the transformer. Isolated full-bridge converter, operation, CCM currents in full-bridge converter and CCM voltages in the full-bridge converter. Resonant power conversion — LCLC series-parallel resonant converter, desirable converter characteristics for inductive charging and fly-back converter. Bi-directional battery chargers and contactless charging.

Module 3: ELECTRIC PROPULSION SYSTEMS (09 Periods)

Stator-PM versus rotor-PM, system configurations, doubly salient PM motor drives, flux-reversal PM motor drives, flux-switching PM motor drives, hybrid-excited PM motor drives, flux-mnemonic PM motor drives, magnet less flux switching motor drives and design criteria for EVs.

Module 4: ENERGY STORAGE TECHNOLOGIES (09 Periods)

Battery — basic theory and characterization, battery technologies, types — lead acid batteries, nickel-based batteries and lithium-based batteries. Ultra-capacitors — features, basic principles, performance, battery modeling based on electric equivalent circuit, modeling of ultra-capacitors, battery charging control and flywheel energy storage system. Fuel cells — modeling and block diagrams of hybrid fuel cell energy storage systems.

Module 5: MAGNETIC GEAR FOR EV TRANSMISSION SYSTEMS (09 Periods)

Introduction, system configurations, types, Magnetic Gear (MG) machines — principle, modelling, control and design criteria for MG motor drives. Magnetic Gear Electric Variable Transmission (MG EVT) systems — multiport magnetic gears, magnetic planetary-geared EVT system, magnetic concentric-geared EVT system and applications.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Modelling of PMDC motor based electric vehicle
2. Modelling of DC motor based electric vehicle
3. Modelling of induction motor motor based electric vehicle
4. Modelling of linear induction motor based electric vehicle

5. Modelling of PMSM based electric vehicle
6. Modelling of control scheme for v/f control for induction motor based electric vehicle

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. K. T. Chau, *Electric Vehicle Machines and Drives, Design, Analysis and Application,* Wiley, 2015.
2. John G. Hayes*, Electric Powertrain*, Wiley, 2018.

REFERENCE BOOKS:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals,* 2nd Edition, CRC Press, 2011.
2. Jack Erjavec, *Hybrid, Electric & Fuel-Cell Vehicles*, 2nd Edition, Delmar Cengage learning, 2013.
3. Mehrdad Ehsani, Yimin Gao and Ali Emadi, Modern Electric, *Hybrid Electric and Fuel Cell Vehicles*, 2nd Edition, CRC Press, 2015.

Software:

1. **MATLAB/SIMULINK**

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=2uPRvM-v-jk
2. https://www.youtube.com/watch?v=ZSJtYHsDfa4
3. https://www.youtube.com/watch?v=kzEnYHPHPRg

WEB RESOURCES:

1. https://www.iea.org/reports/electric-vehicles
2. https://e-amrit.niti.gov.in/types-of-electric-vehicles
3. https://www.fueleconomy.gov/feg/evtech.shtml
4. https://www.twi-global.com/technical-knowledge/faqs/what-is-an-ev
5. https://auto.economictimes.indiatimes.com/tag/electric+vehicles
6. https://afdc.energy.gov/vehicles/electric.html

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101016	**MICRO ELECTRO MECHANICAL SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Overview of Micro Electro Mechanical Systems (MEMS), working principles of microsensors and microactuators, materials, microfabrication processes, MEMS accelerometers, packaging of Microsystems and applications over different fields.

COURSE OUTCOMES: On successful completion of the courses, the students will be able to:

CO1. Analyze MEMS Components like microsensors and microactuators.

CO2. Use standard micro fabrication techniques and device packaging methods in manufacturing MEMS devices.

CO3. Understand types of MEMS accelerometers

CO4. Analyze efficient and cost-effective MEMS devices for societal applications.

CO-PO-PSO Mapping Table

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	3	3	2	1	-	-	-	-	-	-	-	3	-	-
CO3	2	3	1	-	2	2	-	-	-	-	-	-	3	-	-
CO4	3	2	1	1	1	2	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Correlation Level: 3-High ; 2-Medium ; 1-Low

COURSE CONTENT

MODULE-I: INTRODUCTION TO MEMS AND MICROSYSTEMS ***(09 Periods)***

Introduction to MEMS, Energy domains and transducers, sensors and actuators, Microsystems versus MEMS, miniaturization, MEMS materials.

MODULE-II: MICROSENSORS & ACTUATORS ***(09 Periods)***

Microsensors: Classification of physical sensors, Integrated, Intelligent, or Smart sensors, Sensor Principles and Examples: Thermal sensors, Pressure, Flow, Inertial, Gyro sensors, Bio Sensors.

Microactuators: Electromagnetic and Thermal microactuation, Mechanical design of microactuators, Microactuator examples, microvalves, micropumps, micromotors.

MODULE-III: MEMS ACCELEROMETERS ***(09 Periods)***

Micro accelerometers for MEMS, Temperature and Damping analysis, Piezoelective accelerometer, Piezoresistive accelerometer, Piezocapacitive accelerometer technology.

MODULE-IV: **MEMS FABRICATION AND PACKAGING** ***(10 Periods)***

Review of Fabrication process-Photolithography, ion implantation, diffusion, oxidation, chemical vapor deposition, physical vapor deposition, deposition by Epitaxy, Czochralski process.

Micromachining technology of MEMS, Microstereolithography; Introduction to microsystem packaging, objectives and general considerations in packaging design, three levels of microsystem packaging.

MODULE-V: MEMS APPLICATIONS ***(09 Periods)***

Applications of MEMS in the automotive industry, avionics and space applications and commercial applications, RF MEMS, optical MEMS, Introduction to Bio MEMS and microfluidics.

Total: 45 Periods

EXPERIENTIAL LEARNING

1. Demonstration of working principle of
    a. accelerometers for airbag sensors,
    b. microphones,
    c. projection display chips,
    d. blood and tire pressure sensors,
    e. optical switches,
    f. analytical components such as lab-on-chip, biosensors
    g. Pressure sensors.
    h. Humidity sensors.
    i. Temperature sensors.
2. Demonstration of the significance of gold, copper, aluminum and titanium in MEMS.

(Note: It’s an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOK(S):

1. G.K.Ananthasuresh, K.J.Vinoy, *Micro and Smart Systems*, Wiley India, 1st edition, 2010 Education (India) Pvt. Ltd., 2002.

REFERENCE BOOKS:

1. Tai-Ran Hsu, *MEMS & Microsystems, Design and Manufacture*, McGraw Hil
2. Nitaigour Premchand Mahalik, *MEMS*, McGraw Hill Education (India) Pvt. Ltd., eighth reprint, 2013.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc22_ee36/preview
2. https://nptel.ac.in/courses/112108092
3. https://onlinecourses.nptel.ac.in/noc21_ee32/preview
4. https://archive.nptel.ac.in/courses/108/108/108108113/
5. https://archive.nptel.ac.in/courses/117/105/117105082/
6. https://www.coursera.org/learn/sensor-manufacturing-process-control

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC103011	**VLSI SYSTEM DESIGN**	3	-	-	4	4

Pre-Requisite 22EC102010-Digital Design.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Logic Families; CMOS Technology; Stick Diagrams and Layouts; Subsystem design; Programmable Interconnect structures; Memories.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze logic families, steady state and dynamic characteristics of CMOS, to improve performance characteristics of digital ICs.

CO2. Analyze electrical properties of MOS circuits for VLSI/ULSI chip fabrication.

CO3. Develop stick diagrams and layouts of CMOS circuits for miniaturization by analyzing gate delays and scaling effects.

CO4. Design subsystems for High speed digital electronics to compensate tradeoff among area, speed and power requirements

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	2	3	2	-	-	-	2	-	-	-	-	3	-	-
CO4	3	2	3	2	-	1	1	2	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**2**	**-**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DIGITAL LOGIC FAMILIES ***(08 Periods)***

Introduction to logic families, RTL, DTL, Transistor-Transistor logic, Emitter Coupled Logic, I^2L, CMOS logic, CMOS steady state and dynamic electrical behavior.

Module 2: FABRICATION AND ELECTRICAL PROPERTIES OF MOS ***(10 Periods)***

Fabrication Process for NMOS and CMOS technology, Basic Electrical Properties of MOS: I_{ds} – V_{ds} relationships, Second order effects of MOSFETs-Latch up, Hot carrier Effects, channel length modulation, Threshold Voltage V_T, g_m, g_{ds} and ω_0; Pass Transistor, NMOS inverter, Pull up to pull down ratio for an NMOS inverter, CMOS Inverter.

Module 3 CMOS CIRCUIT DESIGN PROCESS ***(10 Periods)***

VLSI design flow, MOS layers, stick diagrams, NMOS design style, CMOS design style, lambda based design rules, layouts for inverters, sheet resistance, capacitances of layers, Gate delays, Delay estimation, Scaling, Limitations of Scaling.

Module 4 SUB SYSTEM DESIGN - I ***(08 Periods)***

Adders – Transmission based Adder, Carry look-ahead adder, Manchester carry chain adder, Carry Skip Adder, Carry Select Adder; Barrel Shifter, Multipliers – Array Multiplier, Booth Multiplier; ALUs.

Module 5 SUB SYSTEM DESIGN - II ***(09 Periods)***

Counters- Synchronous and Asynchronous Counter; High Density Memory Elements - Design Approach, FPGAs, Programmable Interconnect structures - Fusible links, Antifuse via link, UV Erasable, Electrically Erasable; CPLDs, Cell based Design Methodology.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

PROJECT BASED LEARNING:

Projects relevant to the contents of the course will be provided by the course instructor at the beginning.

1. FPGA Implementation of Matrix Vector Multiplication Using Xilinx System generation.
2. Image and Video Processing applications using Xilinx System generation.
3. Chip design for Turbo Encoder module for In vehicle system.

(Note: It’s an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Kamran Eshraghian, Douglas A. Pucknell and sholeh Eshraghian, Essentials of VLSI Circuits and Systems, PHI, 2005.
2. Morris Mano, Digital Design, Prentice Hall, 3rd Edition, 2003

REFERENCE BOOKS:

1. John F.Wakerly, Digital Design Principles & Practices, Pearson Education Asia, 4th Edition, 2008.
2. John M. Rabaey, Digital Integrated Circuits: A Design Perspective, PHI, 2nd Edition,

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=9SnR3M3CIm4
2. https://www.digimat.in/nptel/courses/video/108107129/L01.html
3. https://www.youtube.com/watch?v=Y8FvvzcocT4

Web Resources:

1. https://www.tutorialspoint.com/vlsi_design/vlsi_design_useful_resources.htm
2. https://ocw.mit.edu/courses/6-374-analysis-and-design-of-digital-integrated-circuits-fall-2003/pages/lecture-notes/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC104017	**EMBEDDED SYSTEMS**	3	-	2	4	5

Pre-Requisite 22EC102013-Interfacing with Microcontrollers

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This Course describes on MSP430 Architecture; Instruction Set; Programming; On-Chip Resources; Communication with peripherals; Embedded system design approaches

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze MSP430 Architecture, Instruction Set, addressing modes to develop programs for various control applications using Assembly and Embedded C

CO2. Solve Problems by analyzing MSP430 On Chip Resources such as Timer, Clock System, Low Power Modes/techniques and Interrupt Structure.

CO3. Realize Mixed Signal Processing and Networking Applications, by analyzing onChip Resources such as Comparator, ADC, Temperature Sensor, PWM and Communication Peripherals

CO4. Analyze Language, IDE Support, Processor IC & Design Technologies, and System Modeling Techniques to capture behavior of Embedded Prototype using suitable model

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	-	-	-	-	-	-	-	-	2	1	-
CO2	3	3	2	3	2	2	-	-	-	-	-	-	2	2	-
CO3	3	3	3	2	2	2	-	2	-	-	-	-	1	2	2
CO4	3	2	3	2	2	2	-	2	-	-	-	-	1	1	1
Course Correlation Mapping	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: ARCHITECTURE OF MSP430 ***(09 Periods)***

Embedded Systems – Introduction, MSP430 - Anatomy of microcontroller, Memory, Software, Pin out (MSP430G2553), Functional Block diagram, Memory, CPU, and Memory mapped input and output, Clock generator; Exceptions- Interrupts and Resets.

Module 2: PROGRAMMING MSP430 ***(09 Periods)***

Development Environment, Aspects of C for Embedded Systems, Assembly Language, Register Organization, Addressing Modes, Constant Generator and Emulated Instructions, Instruction Set, Example programs- Light LEDs, Read input from a switch; Automatic Control-Flashing light by delay, use of subroutines and Functions; Basic Clock System, Interrupts and Low Power Modes

Module 3: TIMERS AND MIXED SIGNAL SYSTEMS ***(09 Periods)***

Timers - Watchdog Timer, RTC, Timer_A, Measurement in capture mode, PWM generation; Mixed Signal Systems- Comparator_A, ADC10 SAADC –Architecture, operation- Single Conversion, Temperature Sensor on ADC10, DTC in ADC10; ADC12 – Comparison with ADC10.

Module 4: COMMUNICATION PERIPHERALS & PROTOCOLS ***(09 Periods)***

MSP430 Communication Interfaces- USART, USCI, USI; Communication Protocols- SPI, Inter-integrated Circuit Bus, USB, CAN.

Module 5: EMBEDDED SYSTEM DESIGN ***(09 Periods)***

Processor Technology, IC Technology, Design Technology, Tradeoffs. Model VS. Language, System Modelling – Data Flow Model, FSM, FSMD, HCFSM, PSM, Concurrent Process Model & implementation.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Introduction to MSP430 launch pad and Programming Environment
2. Practice on usage of Instruction Set
3. Read input from switch and Automatic control/flash LED (software delay).
4. Interrupts programming example using GPIO.
5. Configure watchdog timer in watchdog & interval mode.
6. Configure timer block for signal generation (with given frequency).
7. Read Temperature of MSP430 with the help of ADC.
8. Test various Power Down modes in MSP430.
9. Generation of Pulse Width Modulation.

10. Use Comparator to compare the signal threshold level.
11. Speed Control of DC Motor.
12. Master slave communication between MSPs using SPI.
13. Networking MSPs using Wi-Fi

PROJECT BASED LEARNING:

1. Create an Morse Code Machine
2. Create a project to control an Analog Guage machine using MSP430G2553.
3. Design an Wi-Fi Controller door lock using MSP430 and mobile phone.
4. Design an RGB mood lamp using MSP430 for low power Control.
5. Control your robot using an Android app to perform various tasks in difficult environmental conditions

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. John H. Davies, MSP430 Microcontroller Basics, Newnes Publications, 1stEdition, 2008.
2. Santanu Chattopadyay, Embedded System Design, PHI, 2010.
3. Frank Vahid, Tony D. Givargis, Embedded System Design – A Unified Hardware/Software Introduction, John Wiley, January 2006

REFERENCE BOOKS:

1. Chris Nagy, Embedded Systems Design using the TI MSP30 Series, Newness Publications, October 2003.
2. Jorgeon Staunstrup, Wayne Wolf, Hardware/Software Co-design Principles and Practice, Springer 2009.
3. Patrick R Schizont, A Practical Introduction to Hardware/Software Co-design, Springer publications, January 2010

VIDEO LECTURES:

1. https://www.udemy.com/course/bootlaoder-design-with-msp430/
2. https://in.coursera.org/learn/introduction-embedded-systems
3. https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee98/

Web Resources:

1. https://www.ti.com/microcontrollers-mcus-processors/msp430-microcontrollers/overview.html
2. https://www.olimex.com/Products/MSP430/Starter/MSP430-EASYWEB-2/resources/MSP430-Internet-Connectivity.pdf
3. https://link.springer.com/book/10.1007/978-3-031-79828-3
4. https://www.udemy.com/course/mcu_msp430/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101012	**COMPUTER ORGANIZATION**	3	-	-	-	3

Pre-Requisite 22EC102010-Digital Design

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course describes Basic structure and operation of a digital computer; Organization and functional principles of the arithmetic and logic unit, control unit, memory unit and I/O unit; Concepts of pipelining and parallel processing techniques; Multicore computers.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze computer arithmetic algorithms for fixed-point and floating-point binary operations.

CO2. Analyze the architecture, organization and functions of the components of a digital computer.

CO3. Design digital circuits for the given functional description of micro-operations and memory elements.

CO4. Investigate the performance of memory systems, I/O systems, pipelined processors and multiprocessors to evaluate the cost-performance trade-offs.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	1	2	3	-	-	-	-	-	-	-	-	-	3	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	-	-	**-**	**-**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: AMPLITUDE MODULATION & DEMODULATION ***(09 Periods)***

Computer Arithmetic: Fixed point representation, Floating point representation, Addition and subtraction, Binary multiplication algorithms (Booth Algorithm).

Register Transfer and Micro operations: Register transfer, Bus and memory transfers, Arithmetic micro operations, Logic micro operations, Shift micro operations, Arithmetic logic shift unit.

Module 2: BASIC COMPUTER ORGANIZATION AND DESIGN ***(08 Periods)***

Instruction codes, Computer registers, Computer instructions, Instruction formats, Addressing modes, Timing and control, Instruction cycle, Input-Output and Interrupt.

Module 3: MICRO PROGRAMMED CONTROL AND INPUT-OUTPUT ORGANIZATION ***(10 Periods)***

Micro Programmed Control: Control memory, Address sequencing, Design of control unit, Hardwired control, Micro programmed control.

Input-Output Organization: Peripheral devices, Input-Output interface, Modes of transfer, Priority interrupt – Daisy chaining priority, Parallel priority interrupt, Priority encoder; Direct Memory Access, Input-Output Processor – CPU-IOP communication.

Module 4: THE MEMORY SYSTEM ***(09 Periods)***

Semiconductor RAM memories – Internal organization, Static memories, Dynamic RAMs, Synchronous and Asynchronous DRAMs, Structure of larger memories; Read-only memories, Cache memories – Mapping functions.

Module 5: PIPELINE AND VECTOR PROCESSING, MULTIPROCESSORS, MULTICORE COMPUTERS ***(09 Periods)***

Pipeline and Vector Processing: Parallel processing, Pipelining, Instruction pipeline, Vector processing, Array processors.

Multiprocessors: Characteristics of multiprocessors, Interconnection structures,

Inter- processor arbitration.

Multicore Computers: Hardware performance issues, Software performance issues,

Multicore organization, Intel Core i7-990X.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Describe the register reference instructions.
2. Draw a timing diagram assuming that SC is cleared to '0' at the time T4 if control signal D4 is active D4 T4:SC←0, D4 is activated with the positive clock transmission associated with T1.
3. a) Explain how registers are connected to common bus in the computer with a neat diagram.
   b) List various types of computer instructions and give examples to each category.
4. Explain about address sequencing in micro programmed control unit with an example.
5. Explain types of interrupts with examples.
6. Write a note on Direct Memory Access (DMA).
7. Explain about CPU-IOP communication.

8. Distinguish between parallel processing and pipelining processing.
9. Discuss about the Register transfer with symbols and examples.
10. Design a 4-bit arithmetic logic shift unit.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. M. Morris Mano, Rajib Mall, *Computer System Architecture*, Revised 3rd Edition, Pearson Education, 2017.
2. CarlHamacher, ZvonkoVranesic, SafwatZaky,Naraig Manjikian, *Computer Organization and Embedded Systems*, 6th Edition, McGraw Hill, 2012.

REFERENCE BOOKS:

1. William Stallings, *Computer Organization and Architecture: Designing forPerformance*, 11th Edition, Pearson Education, 2018.
2. Andrew S. Tanenbaum, Todd Austin, *Structured Computer Organization*, 6th Edition, Pearson, 2016.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106105163/
2. Bilkent Online Courses, Bilkent University, Lectures by William Sawyer, https://www.youtube.com/watch?v=CDO28Esqmcg
3. Lecture -1 Introduction to Computer Architecture - YouTube
4. NPTEL: NOC: Computer Architecture and Organization (Computer Science and Engineering) (digimat.in)

Web Resources:

1. https://www.geeksforgeeks.org/last-minute-notes-computer-organization/
2. https://www.javatpoint.com/computer-organization-and-architecture-tutorial

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22AI101401	**PRINCIPLES OF OPERATING SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Operating Systems Operations; Process Scheduling; Process Synchronization, Deadlocks; Paging and Segmentation, Disk Scheduling; File Concepts, I/O Interface; Concepts of Protection and Security.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze performance of CPU scheduling algorithms.

CO2. Design solutions for process synchronization problems by using semaphores and monitors.

CO3. Devise solutions for deadlocks using deadlock handling mechanisms.

CO4. Solve memory management problems using page replacement and disk scheduling algorithms.

CO5. Identify efficient file allocation methods for optimal disk utilization & analyse services of I/O subsystems and mechanisms of security & protection.

CO6. Analyze the different concepts of Operating Systems using Case Studies.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	-	-	-	-	-	-	-
CO2	2	2	3	-	2	-	-	-	-	-	-	-
CO3	2	2	3	-	2	-	-	-	-	-	-	-
CO4	2	2	3	-	2	-	-	-	-	-	-	-
CO5	3	3	-	3	-	-	-	-	-	-	-	-
CO6	3	3	-	-	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium;1: Low

COURSE CONTENT

Module 1 INTRODUCTION TO OPERATING SYSTEM AND PROCESS MANAGEMENT ***(08 Periods)***

Introduction: Definition, Operating System Structure and Services, System Calls.
Process Management: Process Scheduling, Process Control Block, Inter Process Communication, Threads, Multithreading Models, CPU Scheduling Criteria, Scheduling Algorithms, Multiprocessor Scheduling.

Module 2 PROCESS SYNCHRONIZATION AND DEADLOCKS ***(10 Periods)***

Process Synchronization: Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Synchronization Problems, Monitors.
Deadlocks: System Model, Deadlock characterization, Methods for handling deadlocks, Prevention, Detection, Avoidance, Recovery from deadlock.

Module 3 MEMORY MANAGEMENT AND SECONDARY STORAGE ***(10 Periods)***

Memory Management: Swapping, Contiguous Allocation, Paging, Segmentation, Segmentation with Paging.
Virtual Memory: Demand Paging, Page Replacement Algorithms, Copy-on-Write, Thrashing.
Secondary Storage Structure: Overview of Mass Storage Structure, Disk Structure, Disk Scheduling, Disk Management.

Module 4 FILE AND I/O SYSTEMS ***(08 Periods)***

File System: File concept, Access Methods, Directory Structure, File System Structure, i-node, File System Implementation, Directory Implementation, Allocation Methods.

Module 5 CASE STUDIES ***(09 Periods)***

The Linux System-History, Kernel Modules, Process Management, Input and Output, Inter-process Communication.
Windows 7- System Components, Networking, Programmer Interface, Terminal Services and Fast User

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Demonstrate File Permissions.
2. Design Banker's Algorithm for Deadlock Avoidance. Find the safe sequence. If Maximum request of any one process is changed, detect whether a deadlock has occurred or not. Consider the number of resources are three and Jobs are five.

(It's an indicative one. The Course Instructor may change the activities and the same shall be reflected in Course Handout)

RESOURCES

TEXT BOOKS:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, Wiley India Edition, 9th Edition, 2016.

REFERENCE BOOKS:

1. William Stallings, Operating Systems, Internals and Design Principles, Pearson Education, 7th Edition, 2013.
2. Andrew S. Tanenbaum, Modern Operating Systems, PHI, 3rd Edition, 2009.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_cs72/preview
2. https://www.udemy.com/course/operating-systems-from-scratch-part1/

WEB RESOURCES:

1. operating-systems · GitHub Topics · GitHub
2. Operating System Introduction (w3schools.in)
3. What is Operating System (OS)? Definition and Functions – javat point
4. Operating System Tutorial - Geeks for Geeks

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22AI104002	**OBJECT ORIENTED PROGRAMMING THROUGH JAVA**	3	-	2	4	5

Pre-Requisite 22CS102001-Programming for Problem Solving

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is emphasized on the fundamentals structure design with classes including development, testing, implementation and documentation. This course also focuses on understanding and practical mastery of object oriented concepts such as classes, objects, data abstraction, methods, method overloading, inheritance and polymorphism. By end of the course, students will acquire the basic knowledge and skills necessary to implement object-oriented programming techniques in software development using Java.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply object oriented programming constructs to solve computational problems.

CO2. Use Exception handling and multithreading mechanisms to create efficient software applications.

CO3. Create Web based applications using collections frameworks to solve real world problems.

CO4. Design and develop GUI using applets and swings for internet and system based applications.

CO5. Work independently or in team to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO2	3	3	3	-	-	-	2	-	-	-	-	2	3	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	2	-	3	-	-	-
CO4	2	3	3	-	-	-	-	2	-	-	-	-	3	-	-	-
CO5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-
Course Correlation Mapping	**1**	**3**	**2**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**-**	**-**	

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: OOPS Fundamentals *(09 Periods)*

Introduction: History of Java, Byte code, JVM, Java buzzwords, OOP principles, Data types, Variables, Scope and life time of variables, Operators, Control statements, Type conversion and casting, Arrays.

Concepts Of Classes And Objects: Introducing methods, Method overloading, Constructors, Constructor overloading, Usage of static with data and method, Access control, this key word, Garbage collection, String class, StringTokenizer.

Module 2: Inheritance, Interface and Packages *(09 Periods)*

Inheritance basics, Types of inheritance, Member access rules, Usage of super key word, Method overriding, Usage of final, Abstract classes, Interfaces - differences between abstract classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces; Packages - defining, creating and accessing a package, importing packages, access control in packages.

Module 3 Exception Handling and Multithreading *(10 Periods)*

Exception Handling: Concepts of exception handling, Types of exceptions, Usage of try, catch, throw, throws and finally keywords, Built-in exceptions, Creating user defined exception;

Multithreading: Concepts of multithreading, Differences between process and thread, Thread life cycle, Creating multiple threads using Thread class and Runnable interface, Synchronization, Thread priorities, Inter thread communication.

Module 4 Collection Framework *(08 Periods)*

Collection Framework: Collections Overview, Collection Interfaces - List, Set, Map, List - ArrayList, Linked List, Vector, Set - HashSet, TreeSet, Map - HashTable, HashMap, Accessing a collection via an Iterator, comparator, comparable.

Module 5 GUI Programming *(09 Periods)*

GUI Programming With Applets: Applets - Applet Class, Applet skeleton, Simple Applet; Delegation event model - Events, Event sources, Event Listeners, Event classes, handling mouse and keyboard events.

Exploring Swing Controls: JLabel and Image Icon, JText Field, JButton, JCheckBox, JRadioButton, JTabbed Pane, JList, JCombo Box.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

OOPS Fundamentals

1. a) Develop a Java application for generating Electricity bill.
Create a class with the following members: Consumer no., consumer name, previous month reading, current month reading, type of EB connection (i.e domestic or commercial). Compute the bill amount using the following tariff. If the type of the EB connection is domestic, calculate the amount to be paid as follows:
    - First 100 units - Rs. 1 per unit
    - 101-200 units - Rs. 2.50 per unit
    - 201 -500 units - Rs. 4 per unit
    - >501 units - Rs. 6 per unit

   If the type of the EB connection is commercial, calculate the amount to be paid as follows:
    - First 100 units - Rs. 2 per unit
    - 101-200 units - Rs. 4.50 per unit
    - 201 -500 units - Rs. 6 per unit
    - > 501 units - Rs. 7 per unit

   b) Design a class to represent a Student details include the Student ID, Name of the Student, Branch, year, location and college. Assign initial values using Constructor. Calculate average of marks of 6 subjects and calculate attendance percentage.

2. a) Create a class Student which has data members as name, branch, roll no, age, sex, marks in five subjects. Display the name of the student and his percentage who has more than 70%.Use array of objects.

   b) Write a program to perform addition of two complex numbers using constructor overloading. The first constructor which takes no argument is used to create objects which are not initialized, second which takes one argument is used to initialize real and imaginary parts to equal values and third which takes two argument is used to initialized real and imaginary to two different values.

Inheritance

3 a) Create a base class basic_info with data members name, roll no, sex and two member functions getdata and display. Derive a class physical_fit from basic_info which has data members height and weight and member functions getdata and display. Display all the information using object of derived class.

   b) Create class first with data members book no, book name and member function getdata and putdata. Create a class second with data members author name, publisher and members getdata and showdata. Derive a class third from first and second with data member no of pages and year of publication. Display all these information using array of objects of third class.

4 A High School application has two classes: The Person superclass (Name, age, Gender) and the Student subclass (RegNo, Dept, CGPA).Using inheritance, create two new classes, Teacher and College Student. Teacher will be like Person but will have additional properties such as salary (the amount the teacher earns) and subject (e.g., “Computer Science”, “Chemistry”, “English”, “Other”). The College Student class will extend the Student class by adding a year (current level in college) and major (e.g., “Electrical Engineering”, “Communications”, “Undeclared”). Create objects and test the functionality of all the methods.

5 Develop a java application for generating pay slip on different category of employees using the concept of inheritance.

Exception Handling and Multithreading

6 Consider two integers x and y as input and compute the value of x/y. Implement a class which raise an exception if x and y are not signed integers or if y is zero.

7 a) Write a java program that implements a multi-thread application that has three threads. First thread generates random integer every 1 second and if the value is even, second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of cube of the number

b) Write a program that creates three threads. First thread displays "Good Morning" every one second, the second thread displays "Hello" every two seconds and the third thread displays "Welcome" every three seconds.

Collection Framework

8 Write a Java program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +, -,*, % operations. Add a text field to display the result. Handle any possible exceptions like divide by zero.

GUI Programming

9 a) Write a java program that simulates a traffic light. The program lets the user select one of three lights: Red, Yellow or Green with radio buttons. On selecting a button an appropriate message with "STOP" or "READY" or "GO" should appear above the buttons in selected color. Initially, there is no message shown.

b) Write an Applet that computes the payment of a loan on the amount of the loan, the interest rate and the number of months. It takes one parameter from the browser. Monthly; if true, the interest rate is per month, otherwise the interest rate is annual.

c) Write a java programs to find factorial of a number. User is allowed to enter a number into the text field whose factorial is to be determined. On pressing the button the value of the text field is firstly converted into integer and then processed to find its factorial. The result will get displayed in another text field. (Hint: use swings).

PROJECT BASED LEARNING:

Faculty shall provide Projects relevant to the contents of the course.

Sample Projects:

1. CALENDER APPLICATION
   Develop a calendar application that uses many windows properties to make it colorful, for example, to indicate the vacation, it uses the red foreground color. The calendar can be used for two purposes. First to see the date and month as usual calendars and second to find out the day corresponding to given date. Some of the salient features of the project are
   1. It uses various windows properties to make the program colorful although it has lack of graphics.
   2. It entirely uses java code which is written in simple manner with lots of comments and important notes can be added.
   3. The date with such notes appears different than others with red background color
   4. The months can be navigated using arrow keys.

2. TICKET RESERVATION SYSTEM

Develop Ticket reservation system to manage details of seats, passenger, trains, Bookings and stations. The features required to be implemented are as follows

1. Provides searching facility based on factors such as seats, trains, booking and stations
2. Manage the information of passengers
3. Shows the information of the seats and trains
4. Provide filter on train, booking, time and station
5. Information Management of booking
6. Export excel report for trains, passengers and station
7. Export pdf for booking details

RESOURCES

TEXT BOOKS:

1. Herbert Schildt, "Java the complete reference", 11th edition, McGraw Hill, Education, 2018.
2. C. Thomas Wu, "An Introduction to Object-Oriented Programming with Java 5th edition", McGraw-Hill Higher Education 2010.

REFERENCE BOOKS:

1. J. Nino and F.A. Hosch, "An Introduction to programming and OOPS design using Java", 3rd edition, John Wiley & sons, 2008.
2. P. Radha Krishna, "Object Oriented Programming through Java", 1st edition, Universities Press, 2007.

SOFTWARE/TOOLS:

1. Software: Eclipse / Net beans / JDK 1.7
2. Java compatible web browser

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106105191
2. https://www.udemy.com/course/java-tutorial/

WEB RESOURCES:

1. https://www.tutorialspoint.com/java/java_tutorial.pdf
2. https://www.guru99.com/java-tutorial.html

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CB102005	**INTERNET OF THINGS**	3	-	2	-	4

Pre-Requisite 22CB102001-Computer Networks

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Internet of Things Components; Domain Applications; Communication models; Sensors; Connectivity; Prototyping; Hardware; Design Methodology; Development platforms; Data Analytics for IoT; IoT Security..

COURSE OUTCOMES: *After successful completion of the course, students will be able to*:

CO1. Understand IoT Architectures , communication technologies and various applications of IoT

CO2. Demonstrate knowledge on IoT-related protocols and Smart Objects

CO3. Understand hardware platforms and cloud services related to IoT

CO4. Build IoT applications using Arduino and Raspberry Pi

CO5. Understand data analytics concepts and security issues in the context of IoT

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-
CO3	3	2	3	-	-	-	-	-	-	-	-	-	3	2	2
CO4	3	2	3	2	3	-	-	-	-	-	-	-	3	2	2
CO5	3	2	2	3	-	-	-	-	-	-	-	-	3	2	2
Course Correlation Mapping	**3**	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION & DOMAIN APPLICATIONS ***(09 Periods)***

Introduction to Internet of Things:
Definition, Conceptual Framework, Architectural View, Technology behind IoT, Communication Technologies, Data Enrichment, Data consolidation and Device management at Gateway.
IoT and M2M: M2M, Difference between IoT and M2M, SDN and NFV for IoT.
Domain Specific IoTs: Home automation, Cities, Environment, Health and Life Style.

Module 2: SENSORS & CONNECTIVITY ***(09 Periods)***

Sensor Technology, Actuators, RFID Technology, Internet Connectivity, Internet-Based Communications, IP Addressing in the IoT, Medium Access Control, Application Layer Protocols.

Module 3: PROTOTYPING & HARDWARE ***(08 Periods)***

Embedded Computing Basics, Embedded platforms for prototyping, Things always connected to the Internet/Cloud, Amazon Web Services for IoT.

Module 4: DESIGN METHODOLOGY & CASE STUDIES ***(10 Periods)***

Design Methodology: Purpose and Requirements specifications, Process Specifications, Domain Model Specification, Information Model Specification, Service Specification, IoT Level Specifications, Functional View Specification, Operational View Specification, Device and Component integration, Application development.
Case Studies Illustrating IoT Design: Home Automation, Cities.

Module 5: DATA ANALYTICS FOR IOT& IoT Security ***(09 Periods)***

Data Analytics for IoT: Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis.
IoT Security: Vulnerabilities, Security Requirements and Threat analysis, Security Tomography and Layered Attacker Model, Identity Management and Establishment, Access Control and Secure Message Communication, Security Models, Profiles and Protocols for IoT

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1 (a) Design and Simulate LED 7-Segment Display interfacing with Arduino.
(b) Design and Simulate Servo motor interfacing with Arduino.

2 (a) Design and Simulate ultrasonic sensor and LCD interfacing with Arduino.
Design and Simulate Flame Sensor interfacing with Arduino.

3 Design and Implement to capture Gas Sensor and send sensor data to cloud from your NodeMCU device using Arduino IDE.

4 Design and Implementation of Humidity and Temperature Monitoring Using Arduino and upload data to cloud using MQTT.

5 Design and Implementation of an IoT ECG (Electrocardiogram) System to record hearts electrical activity.

6 Design and Simulate controlling an LED 7-Segment Display with Raspberry Pi.

7 Design and implementation of Raspberry Pi Home Security System with Camera and PIR Sensor with Email Notifications.

8 Design and Implement to upload Light sensor (TSL) data to cloud through Raspberry Pi.

9 Design and Implementation of Motion Detector with NodeMCU and BLYNK

10 Design and Implementation of Fire notification IoT system with BLYNK

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, *Internet of Things – A hands-on approach*, University Press, 2015.
2. Raj Kamal, *Internet of Things- Architecture and Design Principles*, McGraw Hill, 2017.

REFERENCE BOOKS:

1. Adrian McEwen and Hakim Cassimally, *Designing the Internet of Things*, Wiley Publishing, 2013.
2. Charles Bell, *Beginning Sensor Networks with Arduino and Raspberry Pi*, Apress, 2013.
3. Marco Schwartz, *Internet of Things with the Arduino Yun*, Packt Publishing, 2014.
4. Matt Richardson, Shawn Wallace, *Getting Started with Raspberry Pi*, Maker Media, Inc, 2012.

SOFTWARE/TOOLS:

- Arduino IDE

VIDEO LECTURES:

1. https://www.digikey.com/en/maker/projects/how-to-interface-a-seven-segment-display-with-an-arduino/9c05f147618c4fe3b8bb79acce5c60e3
2. https://www.engineersgarage.com/interfacing-servo-motor-with-arduino-mega-2560/

WEB RESOURCES:

1. https://www.geeksforgeeks.org/top-applications-of-iot-in-the-world1.
2. https://www.javatpoint.com/internet-of-things-applications

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CS102005	**DATABASE MANAGEMENT SYSTEMS**	3	-	2	-	4

Pre-Requisite 22AI102401-Data Structures and Algorithms

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Introduction to database systems; Database design; Relational model; Relational algebra; SQL queries; Constraints and triggers; PL/SQL; Schema refinement and normal forms; Transaction management; Concurrency control; Overview of storage and indexing.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the concepts of ER-modeling and normalization to design viable data models for a given problem.

CO2. Formulate relational database schemas, apply suitable integrity constraints, for querying databases.

CO3. Use SQL to store, query, and manipulate data in relational databases.

CO4. Develop PL/SQL blocks to centralize database applications for maintainability and reusability.

CO5. Analyze transaction processing, concurrency control and storage methods for database management.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	-	-	-	-	-	-	-	-	-	3	-	3
CO2	3	3	-	-	-	-	2	-	-	-	-	-	3	-	3
CO3	3	3	3	-	-	-	-	-	-	-	2	-	3	-	3
CO4	2	3	3	-	-	-	-	2	-	-	-	-	3	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	-	**-**	**2**	**-**	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium;1: Low

COURSE CONTENT

Module 1: Introduction To Database Systems And Database Design ***(09 Periods)***

Introduction to Database Systems: Database system applications, Purpose of database systems, View of data - Data abstraction, Instances and schemas, Data models; Database languages - Data Definition Language, Data Manipulation Language; Database architecture, Database users and administrators.

Introduction to Database design: Database design and ER diagrams, Entities, attributes and entity sets, Relationships and relationship sets, Additional features of ER model, Conceptual Design with ER model.

Module 2: Relational Model, Relational Algebra and Tuple calculus ***(08 Periods)***

Relational Model: Creating and modifying relations, Integrity constraints over relations, Enforcing integrity constraints, Querying relational data, Logical database design, Introduction to views, Destroying/altering tables and views.

Relational Algebra and Tuple calculus: Preliminaries, Relational Algebra operators and tuple calculus.

Module 3 SQL AND PL/SQL ***(09 Periods)***

SQL: Form of basic SQL query, Nested queries, Aggregate operators, Null values, Complex integrity constraints in SQL, Triggers and active databases.

PL/SQL: Generic PL/SQL block, PL/SQL data types, Control structure, Procedures and functions, Cursors, Database triggers.

Module 4 Schema Refinement And Transactions ***(10 Periods)***

Schema Refinement: Problems caused by redundancy, Decompositions, Problems related to decomposition, Functional dependencies, Reasoning about FDs, First normal form, Second normal form, Third normal form, Boyce-Codd normal form, Multivalued dependencies, Fourth normal form, Join dependencies, Fifth normal form.

Transactions: Transaction concept, Transaction atomicity and durability, Concurrent Executions – Serializability, Recoverability, Implementation of isolation, Testing for serializability.

Module 5 Concurrency Control, Storage And Indexing ***(09 Periods)***

Concurrency Control: Lock Based Protocols, Timestamp Based Protocols, Validation Based Protocols, Multiple Granularity, Deadlock Handling.

Storage and Indexing: Data on external storage, File organizations and indexing – Clustered indexes, Primary and secondary indexes; Index data structures – Hash based indexing, Tree based indexing; B and B+ Trees, Comparison of file organizations.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

Week 1: Design and analyze an ER Model for the following use case.
The Library Management System database keeps track of readers with the following considerations –

- The system keeps track of the staff with a single point authentication system comprising login Id and password.
- Staff maintains the book catalog with its ISBN, Book title, price(in INR), category(novel, general, story), edition, author Number and details.
- A publisher has publisher Id, Year when the book was published, and name of the book.
- Readers are registered with their user_id, email, name (first name, last name), Phone no (multiple entries allowed), communication address. The staff keeps track of readers.

Choose appropriate Entities and attributes and relationships and draw the complete ER diagram.
Week 2: a)Implement Data Definition Language commands -Create, Alter, Drop, Truncate, and Rename.
b) Implement Data Manipulation Language commands - Insert, Select, Update, and Delete.
c)Implement Single Row functions - Character, Numeric and Date functions.

Week 3: Implement various types of integrity constraints - NOT NULL constraint, DEFAULT constraint, UNIQUE constraint, PRIMARY key, FOREIGN key, CHECK constraint.

Week 4: a) Implement group functions with different operators such as aggregate operators, group by, having and order by.
b) Implement nested and correlated nested queries using set operators and set comparison operators.

Week 5: a) Creation of views, synonyms, sequence, indexes and save point.
b) Implement various types of joins - outer join and inner join.

Basic PL/SQL:
Week 6: Construct PL/SQL block for the following.
a) To determine whether a number is palindrome
b) To determine whether a number is an Armstrong number
c) To find greatest of three numbers
d) To display Fibonacci series

Control Structures:
Week 7: a) Write a program in PL/SQL to update the salary of a specific employee by 20% if the salary less than 30000/- and 10% when the salary in between 30000/- and 60000/- and 5% when the salary is above 60000/- and display the salary with a suitable message.
b) Write a PL/SQL program to display the description of the grade against a student's grade using CASE statement.

Exception Handling:
Week 8: a) Develop a PL/SQL program that displays the name and address of a student whose ID is given. If there is no student with the given student ID in the database, the program should raise a run-time exception NO_DATA_FOUND, which should be captured in the EXCEPTION block.
b) Construct the user-defined exceptions to get the salary of an employee and check it with the job's salary range. If the salary is below the range, raise an exception BELOW_SALARY_RANGE. If the salary is above the range, raise the exception ABOVE_SALARY_RANGE.
Functions:

Week 9: a) Write a function that accepts two numbers A and B and performs the following operations.
o Addition
o Subtraction
o Multiplication
o Division

b) Write a PL/SQL block that reverses the given number.

Procedures:
Week 10: a) Write a procedure that accepts two numbers and displays their sum.
b) Write procedures to demonstrate IN, IN OUT and OUT parameters.

Cursors:
Week 11: a) Write a block in PL/SQL to create a Cursor that displays the employee name and number of jobs he or she has done in the past.
b) Write a program in PL/SQL to create a cursor to display the name and salary of each employee in the EMPLOYEES table whose salary is less than that specified by a passed-in parameter value.

Triggers:
Week 12: Develop a suitable employee database application by considering appropriate attributes. a) Whenever the inserted or updated salary is more than 10 lacs per month a trigger should be fired.
b) Whenever, the inserted or updated salary is less than 5000 per month a trigger should be activated.

RESOURCES

TEXT BOOKS:

1. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw Hill, 3rd Edition, 2014.
2. Abraham Silberschatz, Henry. F. Korth, S. Sudarshan, Database System Concepts, McGraw Hill, 7th edition, 2019.

REFERENCE BOOKS:

1. Ivan Bayross, SQL, PL/SQL: The Programming Language of Oracle, BPB publications, 4th Edition, 2017.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson, 2015.

SOFTWARE/TOOLS:

1. Oracle SQL plus

Web Resources:

1. https://swayam.gov.in/nd1_noc19_cs46/preview
2. https://www.classcentral.com/course/swayam-introduction-to-database-systems- 17660

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CB102001	**COMPUTER NETWORKS**	3	-	2	-	4

Pre-Requisite	22AI104002-Object Oriented Programming Through Java
Anti-Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: This course provides a detailed discussion on Introduction to computer networks; Protocols of physical layer, data link layer, medium access control sub layer, network layer, transport layer, application layer.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. Analyze the types of network topologies, layers and protocols.

CO2. Evaluate sub netting and routing algorithms for finding optimal paths in networks.

CO3. Solve problems related to flow control, error control and congestion control in data transmission.

CO4. Assess the impact of wired and wireless networks in the context of network protocols Like DNS, SMTP, HTTP, and FTP.

CO5. Apply ethical principles and standards for developing network-based solutions.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	2	3	-	-	-	-	-	-	-	3	3	3	2
CO2	3	3	3	2	2	-	-	-	-	-	-	-	3	3	3	2
CO3	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	2
CO4	3	2	2	2	2	-	-	-	-	-	-	-	3	3	3	2
CO5	3	2	2	-	-	-	-	3	-	-	-	-	3	3	-	-
Course Correlation Mapping	**3**	**3**	-	**3**	**-**	-	-	3	-	-	-	-	3	3	3	2

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT:

Module 1: INTRODUCTION AND PHYSICAL LAYER ***(09 Periods)***

Network hardware, Network software, Reference models - OSI, TCP/IP; Example networks – Internet; Wireless LANs - 802.11.

Physical Layer - Guided transmission media, Wireless transmission, Switching - Circuit switching, Packet switching.

Module 2: DATA LINK LAYER AND MEDIUM ACCESS CONTROL SUBLAYER ***(09 Periods)***

Data Link Layer: Data link layer design issues, Error detection and correction - CRC, Hamming codes; Elementary data link protocols, Sliding window protocols.

Medium Access Control Sub layer: ALOHA, Carrier sense multiple access protocols, Collision free protocols, Ethernet, Data link layer switching - Repeaters, Hubs, Bridges, Switches, Routers, Gateways.

Module 3: NETWORK LAYER ***(09 Periods)***

Network layer design issues, Routing algorithms - Shortest path algorithm, Flooding, Distance vector routing, Link state routing, Hierarchical routing, Broadcast routing, Multicast routing, Any cast routing; Congestion control algorithms, Network layer in the internet - The IP version 4 protocol, IP addresses, IP version 6, Internet control protocols, OSPF, BGP.

Module 4: TRANSPORT LAYER ***(09 Periods)***

UDP – Segment header, Remote procedure call, Real-time transport protocols; TCP – service model, Protocol, Segment header, Connection establishment, Connection release, Sliding window, Timer management, Congestion control.

Module 5: APPLICATION LAYER ***(09 Periods)***

Domain Name System (DNS) - Name space, Domain resource records, Name servers; Electronic mail - Architecture and services, User agent, Message formats, Message transfer, Final delivery; The World Wide Web - Architectural overview, HTTP, FTP.

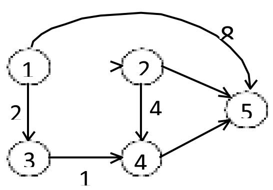
Total Periods: 45

Topics for self-study are provided in the lesson plan.

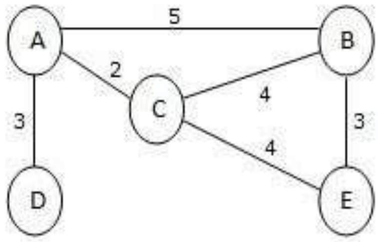
EXPERIENCED LEARNING:

LIST OF EXERCISES:

1. Implement the following data link layer framing methods.
   - i) Character count
   - ii) Character stuffing
   - iii) Bit stuffing
2. Implement the frame sorting technique used in buffers.
3. Design and develop a program to compute checksum for the given frame 1101011011 using CRC-12, CRC-16, and CRC-CCIP. Display the actual bit string transmitted. Suppose any bit is inverted during transmission. Show that this error is detected at the receiver's end.
4. Implement Dijkstra's algorithm to compute the shortest path for the given graph.



5. Develop a program to obtain routing table for each node using Distance Vector Routing Algorithm by considering the given subnet with weights indicating delay between Nodes.



6. Write a program to simulate flow-based routing.
7. Write a program to simulate random early detection congestion control algorithm.
8. Using TCP/IP sockets, write a client-server program to open a file available in the server.
9. Write a program for congestion control using leaky bucket algorithm.
10. Write a program for the Mail Client
    i) POP Client: Gives the server name, user name and password retrieve the mails and allow manipulation of mail box using POP commands.
    ii) SMTP Client: Gives the server name, send email to the recipient using SMTP commands.
11. Write a program for HTTP server to implement the commands - GET, POST, HEAD and DELETE. The server must handle multiple clients.

<u>Exercises on Packet Tracer Simulator Tool:</u>

12. a) Study of basic network commands and network configuration commands.
    i) ping ii) nslookup iii) netstat iv) ifconfig

    b) Create a network topology and configure a network topology with four PCs, two switches, and two routers.

REFERENCE BOOKS:

1. Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks*, Pearson, 5th Edition, 2015.
2. A. Jesin, *Packet Tracer Network Simulator*, Packt Publishing, 2014.

Software/Tools used:

1. C/Python/Java
2. Network simulator tool - Packet Tracer
3. Virtual Labs (Computer Networks Lab – http://vlabs.iitb.ac.in/vlabs-dev/labs_local/ computer-networks/ labs/explist.php)

TEXT BOOK:

1. Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks*, Pearson, 5th Edition, 2015.

REFERENCE BOOKS:

1. Behrouz A. Forouzan, *Data Communications and Networking*, McGraw Hill, 5th Edition, 2013.
2. James F. Kurose and Keith W. Ross, *Computer Networking: A Top-Down Approach*, Pearson, 7th Edition, 2017.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_cs18/preview
2. https://www.coursera.org/learn/tcpip

WEB RESOURCES:

- https://www.itprc.com/packet-tracers/
- https://www.nsnam.org/docs/tutorial/html/
- http://www.tcpipguide.com/free/t_OSIReferenceModelLayers.htm
- https://www.cisco.com/c/en/us/solutions/small-business/resourcecenter/networking/networking-basics.html
- https://memberfiles.freewebs.com/00/88/103568800/documents/Data.And.Computer.Communications.

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CS102002	**PYTHON PROGRAMMING**	3	-	2	-	4

Pre-Requisite 22CS102001-Programming for Problem Solving

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on Basics of Python programming, Control structures, Sequences, Sets, Dictionaries, Regular expressions, Functions, File handling, Object-oriented programming, Exception handling.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on Python constructs, sequences, sets and dictionaries to solve basic computational problems.

CO2. Apply the concepts of regular expressions for searching patterns in strings.

CO3. Develop and use Python modules to provide solutions to problems.

CO4. Apply the knowledge of file operations in Python for file processing.

CO5. Design applications using object-oriented programming features – encapsulation, inheritance, polymorphism and exception handling.

CO6. Work independently to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	3	-	-	-	-	-	-	-	3	-	-	-
CO2	3	2	-	-	3	-	-	-	-	-	-	-	3	-	-	-
CO3	3	3	3	3	3	-	-	-	-	-	-	-	3	-	-	-
CO4	3	2	2	2	3	-	-	-	-	-	-	-	3	-	-	-
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	-	-	-
CO6	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO PYTHON PROGRAMMING ***(07 Periods)***

Introduction to Python, Tokens, Variables, Literals, Identifiers, Keywords, Special symbols, Operators, Fundamental datatypes, Expressions, Type conversions, Handling Input and output in Python.

Module 2: CONTROL STRUCTURES ***(08 Periods)***

Selection Statements: if statement, if-else statement, if-elif-else statement, nested-if statement.
Iterative Statements: while loop, for loop, break statement, continue statement, pass and else statements used with loops.

Module 3: SEQUENCES, SETS, DICTIONARIES AND REGULAR EXPRESSIONS ***(11 Periods)***

Sequences: Lists and operations – Creating, Inserting elements, Updating elements, Deleting elements, Searching and sorting, List comprehensions, Nested lists; Tuples – Creating, Searching and sorting, Nested tuples; Strings – Initializing a string and string operations, String handling methods, String formatting.
Sets: Set creation, Set operations.
Dictionaries: Operations on dictionaries, Dictionary methods, Sorting elements using lambdas.
Regular Expressions: Regular expressions, Sequence characters in regular expressions, Quantifiers in regular expressions, Special characters in regular expressions.

Module 4: FUNCTIONS AND FILE HANDLING ***(09 Periods)***

Functions: Need for functions, Function definition, Function call, Variable scope and lifetime, Return statement, Positional arguments, Keyword arguments, Default arguments and variable length arguments, Recursive functions, Lambda functions, Generators.
File Handling: Types of files, Opening and closing files, Reading and writing data.

Module 5: OBJECT ORIENTED PROGRAMMING AND EXCEPTION HANDLING ***(10 Periods)***

Object Oriented Programming: Introduction to object-oriented programming, Classes and objects, Inheritance and polymorphism, Abstract Classes and interfaces.
Exception Handling: Errors in a python program, Exceptions, Exception handling, Types of exceptions, Except block, Assert statement, User defined exceptions.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1) Design a python script to the perform the various computations for the amount payable by the customer for Challenger Computers Store. A customer buying two numbers of SSD device, one SSD device cost is Rs. 3575/-. The stores offer 15% of the total cost. The customer has to pay 9% CGST, and 9% SGST. Prepare the Net Amount to be payable by the customer.

2) Design a python script to compute and generate the electricity bill as per the following slab rates. Collect the meter reading inputs, such as current unit and previous unit.

Consumption Units	Rate (in Rupees/Unit)
0-200	3.0
201-250	4.5
251-300	5.2
301-400	6.5
Above 400	7.0

3) Design a python script to display the sum of numbers divisible by 4. The code must allow the user to accept a number and add it to the sum if it is divisible by 4. It should repeatedly accepting numbers as long as the user wants to provide an input using an appropriate iterative statement and should display the final sum.

4) Food Corner home delivers vegetarian and non-vegetarian combos to its customer based on order. A vegetarian combo costs Rs.120 per plate and a non-vegetarian combo costs Rs.150 per plate. Their non-veg combo is really famous that they get more orders for their non-vegetarian combo than the vegetarian combo.
Apart from the cost per plate of food, customers are also charged for home delivery based on the distance in kms from the restaurant to the delivery point. The delivery charges are as mentioned below:

Distance in kms	Delivery charge in Rs per km
For first 3kms	0
For next 3kms	3
For the remaining	6

Given the type of food, quantity (no. of plates) and the distance in kms from the restaurant to the delivery point, write a python program to calculate the final bill amount to be paid by a customer. The below information must be used to check the validity of the data provided by the customer.

- Type of food must be 'V' for vegetarian and 'N' for non-vegetarian.
- Distance in kms must be greater than 0.
- Quantity ordered should be minimum 1.
- If any of the input is invalid, bill amount should be considered as -1.

5) a) A list has the AP City Names [Tirupati, Kurnool, Kadapa]. Design a python script and perform the operations like, add 3 more AP City names Chittoor, Nellore, Guntur, insert Hyderabad in 3rd position, delete any two city names, update all city names as in Uppercase. Displays the list data, whenever an operation completes.

b) Design a python script for given an integer tuple, for each element in the tuple, check whether there exists a smaller element on the next immediate position of the tuple. If it exists print the smaller element. If there is no smaller element on the immediate next to the element then print -1.
Example: Input: 4 2 1 5 3 Output: 2 1 -1 3 -1

6) a) Sets n1 has the data {1, 3, 5, 7, 9}, n2 has the data {9, 5, 6, 8},
wd1=set(["Mon", "Tue", "Wed", "Thu", "Fri", "Sat", "Sun"]),
wd2=set(["Mon", "Tue", "Wed"]).
Design a python script to perform intersection, difference, and symmetric difference operations on the sets n1 and n2, and to perform superset, and subset operations on the sets wd1, and wd2.

b) The dictionary city_pin has the data {'Tirupati': 517101, 'Hyderabad': 500002, 'Chittoor': 517001,'Nellore': 524001}. Design a python script using lambda function to sort the dictionary on city name and produce the output and sort the dictionary on pincode and produce the output.

c) The string has the data, Wel_str = "Welcome to AI ML DS". Design a python script to search the pattern “AI” using regular expression search and display the three location numbers of the pattern. First shows the pattern starts location, second shows the pattern end location, and the last shows pattern span locations.

7) a) Design a python script for the mathematical puzzle, Towers of Hanoi. The puzzle has three rods and n disks. To move the entire stack to another rod, obeying the three rules (i) Only one disk can be moved at a time, (ii) Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e., a disk can only be moved if it is the uppermost disk on a stack, (iii) No disk may be placed on top of a smaller disk.

b) Design a python script to display the numbers that do not appear in the Fibonacci series of n numbers where n is given by the user. (If n is 8 then up to 8 Fibonacci numbers has to be printed Ex: 1 1 2 3 5 8 13 21 and in this series missing numbers should be traced and printed, Ex: missing numbers are: 4 6 7 9 10 11 12 14 15 16 17 18 19.

8) a) Design a function Learner_Age_Days with two formal parameters name, age and it computes Learner’s age in days, then displays learners name and age in days.

(i) Design a driver code to call the function using positional arguments, keyword arguments

(ii) Apply the necessary changes in Learner_Age_Days function, and design a driver code to call the function using default arguments.

b) Design a python script using lambda and filter functions to construct an odd numbers list from numbers 1 to 10, and construct a negative numbers list from range of numbers -7 to 7 and to find the biggest number from a numbers list.

9) a) Design a python script to create a new file Collect_Literals_Phython.txt, collect the data from the keyboard about the contents of collection literals list, tuple, sets, dictionaries details, then write all the data into that file, and then close that file. Afterwards Open the Collect_Literals_Phython.txt file in read mode, read the entire contents of the file Collect_Literals_Phython.txt, then display all the contents of that file in monitor.

b) The file feat_python1.txt has the contents of features of the Python programming language. Design a python script to open that file feat_python1.txt in read mode, open the new file in feat_python2.txt in write mode, then read entire contents of the file feat_python1.txt, then copy all the contents of that file into the new file feat_python2.txt

10) a) Construct a Python script to implement the below requirements. Create a base class Basic_Info with data members name, rollno, gender and two member functions getdata() and display(). Derive a class Physical_Fit from Basic_Info which has data members height and weight and member functions getdata() and display(). Display all the information using object of derived class.

b) Design a Python script to implement the below specifications, compute, and produce required output. Define a class REPORT with the following specification

Private members

Admno	:	4-digit admission number
Name	:	20 characters
Marks	:	A list of 5 floating point values
Average	:	average marks obtained

GETAVG() a function to compute the average obtained in five subjects.

Public members

READINFO() function to accept values for Adno, Name, Marks. Invoke the function GETAVG ().

DISPLAYINFO() function to display all data members of report on the screen. You should give function definitions. Write driver code to demonstrate all the functions.

11) a) The below scenarios will create Logical Error/Exception, and it will forcibly stop the execution in middle of the program. Design a Python Script the to handle these operations exceptions effectively, and avoid to stop the script execution in the middle.

i. The variable num has the data 100, the value of num dividing by the value 0.
ii. To importing a library file matheqn, this library file not available in Python.
iii. A num_List has the values[10,20,30].To print the fifth value of num_List[5]
iv. A dictionary has the data, Dict_Univ = {'1':"MBU", '2':"Tirupathi", '3':"CSE"}. to print the fifth key value Dict_Univ[5]

b) Design a python script to collect the 10 students Python course mark. Check that entered mark is negative, then throw a user defined exception called Negative, otherwise store into the mark in the List Python_mark[].

RESOURCES

TEXT BOOKS:

1. R. Nageswara Rao, *Core Python Programming*, 3rd Edition, Dreamtech Press, 2021.
2. Paul J. Deitel, Harvey Deitel, Python for Programmers with Big Data and Artificial Intelligence Case Studies, Pearson, 2019.

REFERENCE BOOKS:

1. Charles Dierbach, *Introduction to Computer Science using Python: A Computational Problem Solving Focus*, Wiley India, 2016.
2. Christian Hil, Learning Scientific Programming with Python, 2nd Edition, Cambridge University Press, 2020.

SOFTWARE/TOOLS:

1. Python 3.10
2. Jupyter Notebook/JupyterLab/IDLE/Google CoLab

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc19_cs41/preview
2. https://www.coursera.org/specializations/python
3. https://www.coursera.org/learn/python-for-applied-data-science-ai
4. https://www.youtube.com/watch?v=WGJJIrtnfpk
5. https://www.youtube.com/watch?v=_uQrJ0TkZlc
6. https://www.udemy.com/topic/python/
7. https://freevideolectures.com/course/2512/python-programming

WEB RESOURCES:

1. https://www.w3schools.com/python/
2. https://www.programiz.com/python-programming
3. https://www.geeksforgeeks.org/python-programming-language/
4. https://www.javatpoint.com/python-lists
5. https://www.learnpython.org/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101018	**EVOLUTIONARY AND SWARM COMPUTING TECHNIQUES**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course provides an overview on the derivative-free optimization methods and their implementation aspects to solve complex engineering problems. The course introduces the major types of evolutionary algorithms and a class of stochastic, population-based algorithms inspired by population dynamics capable of solving complex optimization problems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Model the objective functions for a complex engineering problem and optimize them using a derivative-free evolutionary genetic algorithm.

CO2. Model the objective functions for a complex engineering problem and optimize them using a derivative-free differential evolution algorithm.

CO3. Model the objective functions for a complex engineering problem and optimize them using a derivative-free Particle Swarm algorithm.

CO4. Model the objective functions for a complex engineering problem and optimize them using a derivative-free Ant Colony algorithm.

CO5. Model the objective functions for a complex engineering problem and optimize them using a derivative-free Artificial Immune algorithm.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	1	3	2	1	-	-	-	-	1	1	1	3
CO2	3	-	-	1	3	2	1	-	-	-	-	1	1	1	3
CO3	3	-	-	1	3	2	1	-	-	-	-	1	1	1	3
CO4	3	-	-	1	3	2	1	-	-	-	-	1	1	1	3
CO5	3	-	-	1	3	2	1	-	-	-	-	1	1	1	3
Course Correlation Mapping	**3**	**-**	**-**	**1**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**3**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: GENETIC ALGORITHM (10 Periods)

Basic concepts, Search space, working principle, flow chart. Encoding: binary, real coded; Decoding, fitness function, Selection: Roulette-wheel, Tournament, and Rank. Elitism, Crossover: single-pint, two-point, multi-point, uniform, matrix and cross-over rate, Mutation: mutation, mutation rate, Replacement and Stop Criteria.

Module 2: DIFFERENTIAL EVOLUTION (08 Periods)

Differential Evolution, Evolution Strategies; Classic Differential Evolution: Evolution Mechanism, Initialization, Differential Mutation, Crossover, Selection, Termination Conditions; DE variants.

Module 3: PARTICLE SWARM OPTIMIZATION (10 Periods)

Particle swarm Optimization: basic principle, algorithm, flowchart. Variations of PSO: weighted, repulsive, stretched, comprehensive learning, combined effect PSO, and clonal PSO.

Module 4: ANT COLONY OPTIMIZATION (08 Periods)

Ant colony optimization: Ant foraging behavior, combinatorial optimization, Routing in the communication network, traveling salesman problem, graph portioning, nest building.

Module 5: ARTIFICIAL IMMUNE SYSTEM (09 Periods)

Artificial Immune System: overview, central and peripheral immune systems, immune network: clonal selection and its mathematical modeling, beyond clonal selection, danger theory, negative selection. Applications: function optimization, adaptive system identification, channel equalization and financial forecasting.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Model a standard benchmarking mathematical function using an evolutionary genetic algorithm and find the optimal solution to the problem.
2. Model a standard benchmarking mathematical function using a differential evolution algorithm and find the optimal solution to the problem.
3. Model a standard benchmarking mathematical function using a particle swarm algorithm and find the optimal solution to the problem.
4. Model a standard benchmarking mathematical function using an ant colony optimization algorithm and find the optimal solution to the problem.
5. Model a standard benchmarking mathematical function using an Artificial Immune System algorithm and find the optimal solution to the problem.

(Note: It’s an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. D. E. Goldberg, *Genetic Algorithms in search, Optimization and machine learning*, Addison-Wesley Professional 1 edition
2. E. Bonabeau, M. Dorigo and G. Theraulaz,, *Swarm Intelligence : From natural to Artificial Systems*, OUP USA

REFERENCE BOOKS:

1. R. C. Eberhart, Y. Sai and J. Kennedy, *Swarm Intelligence*, Morgan Kaufmann 1st edition
2. K. M. Passino, *Biomimicry for optimization, control and automation*, Springer 2005 edition

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/103/112103301/
2. https://www.youtube.com/watch?v=vg1FTkWHNSg&list=PLL61h44ln0J0Pbs2EPR71wn-8wvwxHI9z
3. https://www.youtube.com/watch?v=uwXFnzWaCY0
4. https://www.youtube.com/watch?v=u7bQomllcJw

WEB RESOURCES:

1. https://en.wikipedia.org/wiki/Differential_evolution
2. https://www.sciencedirect.com/science/article/pii/S111001682100613X

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101021	NEURAL NETWORK AND FUZZY LOGIC CONTROL APPLICATIONS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite 22EE103062-Soft computing techniques for Automotive Applications

Co-Requisite -

COURSE DESCRIPTION: The course deals with the various concepts of soft computing techniques such as Architectures of artificial neural networks: feed forward and feedback networks, Learning strategies: Supervised, Un-supervised and reinforced; Fuzzy set theory; Fuzzy systems design; applications of neural networks and fuzzy systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Develop architecture of a neural network, its training/learning algorithms and apply them to solve various real world problems.

CO2. Demonstrate the concepts of feed forward and re-current neural networks and apply to solve the real time problems.

CO3. Demonstrate the concepts of Associative Memory and Adaptive Resonance Theory into forecasting problems to find the optimal solution.

CO4. Develop a rule base fuzzy system and apply the control strategy to control various real world appliances.

CO5. Design of fuzzy systems for Speed control of a DC motor

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	2	1	-	-	-	-	2	-	-	2
CO2	3	2	1	1	3	2	1	-	-	-	-	2	-	-	2
CO3	2	2	1	2	3	2	1	-	-	-	-	2	-	-	2
CO4	3	2	1	1	3	2	1	-	-	-	-	2	-	-	2
CO5	3	2	1	1	3	2	1	-	-	-	-	2	2	2	2
Course Correlation Mapping	**3**	**2**	**1**	**1**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS (09 Periods)

Biological neural network, architectures of artificial neural networks; McCulloch-Pitts Neuron Model, activation functions, learning strategies- supervised, un supervised, reinforced; learning rules; single layer perceptron network, linear separability with AND & XOR examples; Back propagation neural network- architecture, training algorithm; Kohonen self-organizing maps-competitive process, training algorithm.

Module 2: FEED FORWARD AND FEEDBACK NETWORKS (09 Periods)

Backpropagation Neural Network: Generalized Delta Learning Rule, Error Back Propagation Training, Learning Factors: Initial Weights, Steepness of the Activation Function, Leaning Constant, Momentum Method, Necessary Number of Hidden Neurons.

Kohenen Self-Organizing Map: Competitive process, Cooperation process, Adaptive process. Learning Vector Quantization, Neurodynamic Model: Additive model, Continuous-time Hopfield Model.

Hybrid neural network: Counter propagation Network: Architecture, Training algorithm.

Module 3: ASSOCIATIVE MEMORIES AND ART (09 Periods)

Basic Concepts, Bidirectional Associative Memory: Memory Architecture, Association Encoding and Decoding, Stability Considerations. Discrete-time Hopfield model as a content-addressable memory, Adaptive Resonance Theory: Architecture of ART1, Training algorithm of ART1.

Applications: Forecasting and Process identification.

Module 4: CLASSICAL AND FUZZY SETS (10Periods)

Introduction: Historical perspective, Utility of Fuzzy systems, Limitations of Fuzzy systems. Classical sets: Operations, Properties. Fuzzy sets: Operations, Properties. Crisp relations: Cardinality, Operations, Properties, Cartesian product, composition. Fuzzy relations: Cardinality, Operations, Properties, Fuzzy Cartesian product, composition. Linguistic hedges, Membership functions: Features, Methods of membership value assignments – Intuition, Inference, Rank ordering, Neural networks, Inductive reasoning.

Module 5: FUZZY LOGIC SYSTEMS (08 Periods)

Fuzzification, Rule-based system, Fuzzy inference system, Defuzzification methods: Max membership principle, Centroid, Center of sums. Fuzzy logic controller: Block diagram, Design procedure.

Applications: A typical washing machine or and automatic air conditioning system.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Develop a Neural network model for Load forecasting problems.
2. Develop the rule base for the speed control of the DC motor.
3. Develop a fuzzy logic controller to control the dynamics of LFC/AVR using a simulation tool and validate the improvement of the performance of the system.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. S.N. Sivanandam, S.N.Deepa, *Principles of Soft computing*, Wiley India private Ltd., 2nd edition, 2013.
2. Timothy J.Ross, *Fuzzy Logic with Engineering Applications*, John Wiley and sons, 2017.

REFERENCE BOOKS:

1. Jacek M. Zurada, *Introduction to Artificial Neural Networks*, Jaico Publishing House.
2. Fakhreddine O. karray, Clarence De Silva, *Soft computing and Intelligent systems Design, Theory, tools and applications*, *Pearson Education Limited*, 2009.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=9ZhwKv_bUx8
2. https://www.coursera.org/lecture/nlp-sequence-models/backpropagation-through-time-bc7ED
3. https://www.youtube.com/watch?v=ep3hLUDM7uA
4. https://www.youtube.com/watch?v=8dpYjgRskgQ

WEB RESOURCES:

1. https://www.aitude.com/supervised-vs-unsupervised-vs-reinforcement/
2. https://www.quora.com/How-is-RNN-related-to-deep-learning
3. https://intellipaat.com/blog/supervised-learning-vs-unsupervised-learning-vs-reinforcement-learning/
4. https://www.quora.com/Is-reinforcement-learning-the-combination-of-unsupervised-learning-and-supervised-learning

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101023	OPTIMIZATION TECHNIQUES	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to optimization; classical optimization techniques; classification of optimization problems; linear programming; Transshipment and Travelling salesman problem; non-linear programming; un-constrained non-linear programming; constrained non-linear programming; dynamic programming; Genetic Algorithm; Ant Colony Optimization.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1. Model and solve unconstrained optimization problems.

CO2. Apply LP Techniques and Conduct Sensitivity analysis for real life Problems

CO3. Apply Non-Linear Programming techniques for real life problems

CO4. AnalyzevariouscomplexproblemsbyusingDynamicprogrammingapproaches

CO5. Model and solve complex problems using evolutionary algorithms to optimize the parameters

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	1	1	1	1	-	-	1	-	-	-	3
CO2	3	2	1	-	1	-	-	-	-	-	1	-	-	-	3
CO3	3	3	1	1	1	-	-	-	-	-	1	-	-	-	3
CO4	3	2	1	1	1	1	-	-	-	-	1	-	-	-	3
CO5	3	3	3	1	1	1	-	-	-	-	2	-	-	-	3
Course Correlation Mapping	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSECONTENT

Module 1: CLASSICAL OPTIMIZATION TECHNIQUES (09 Periods)

Introduction, Engineering applications of optimization, Statement of an optimization problem, Design vector, Design constraints, Constraint surface, Objective function, Classification of Optimization problems,
Single variable optimization, Multi variable optimization without constraints, Multivariable optimization with equality constraints-Lagrange multipliers method; Multi variable optimization with inequality constraint-Kuhn Tucker conditions.

Module 2: LINEAR PROGRAMMING (09 Periods)

Introduction, Formulation, Primal Simplex method, Dual simplex method, Sensitivity Analysis, Goal programming

Module 3: NON LINEAR PROGRAMMING (09 Periods)

One dimensional minimization method, classification-Fibonacci method, quadratic interpolation method; classification of unconstrained minimization methods - Powell's method, steepest descent method (Cauchy's method); classification of constrained optimization
Techniques – interior and exterior penalty function methods.

Module 4: DYNAMIC PROGRAMMING (09 Periods)

Multi stage decision processes, Concept of sub optimization and Principle of optimality, -Calculus method, Tabular method; Linear Programming problem by dynamic programming approach, Applications-reliability problem, shortest path problem, and capital budgeting problem.

Module 5: EVALUATIONARY OPTIMIZTION ALGORITHMS (09 Periods)

Introduction to Evolutionary optimization, genetic algorithm-Mathematical Modeling of Genetic algorithm, Ant Colony Optimization, particle swarm Optimization and differential evolution techniques.

Total Periods:45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Linear Programming:
A manufacturing company wants to optimize their production process to reduce costs while meeting the demand for their products. They use linear programming to find the optimal combination of production levels for each product, taking into account the costs of raw materials, labor, and other factors.
2. Non-Linear Programming:
A tech company wants to optimize the design of a new product by minimizing its weight while maximizing its strength. They use non-linear programming techniques to find the optimal shape and dimensions of the product, taking into account the properties of the materials used.

3. Dynamic Programming:
A transportation company wants to optimize their delivery routes to reduce travel time and fuel costs. They use dynamic programming to find the shortest path for each delivery, considering traffic conditions, road closures, and other factors.
4. Evolutionary Optimization:
A financial institution wants to optimize their investment portfolio to maximize returns while minimizing risk. They use evolutionary optimization techniques like genetic algorithms and particle swarm optimization to find the optimal combination of investments, considering market trends, risk factors, and other variables.
5. Optimization in Healthcare:
A hospital wants to optimize their patient scheduling system to reduce wait times and improve patient satisfaction. They use optimization techniques like linear programming and simulation to find the optimal scheduling algorithms, considering patient flow, staff availability, and other factors.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXTBOOKS:

1. Singiresu S Rao, Engineering Optimization: Theory and Practice, New Age International, 3rd Edition, 2013.
2. A. Ravindran, K. M. Ragsdell, G. V. Reklaitis, Engineering Optimization: Methods and applications, Wiley India Pvt. Ltd.,2nd Edition 2006.

REFERENCE BOOKS:

1. C Mohan and Kusum Deep, Optimization Techniques, New Age International Publishers,1st Edition, 2010.
2. Hamdy A. Taha, Introduction to Operations Research, PHI, 10th edition, 2017.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=eo2tOPV3AoE
2. https://archive.nptel.ac.in/courses/111/107/111107104/
3. https://www.youtube.com/watch?v=3Bh_viwz6_0

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101020	**INDUSTRIAL DRIVES AND AUTOMATION**	3	-	-	-	3

Pre-Requisite 22EE102012-Solid state drives

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course explore the various DC, AC, and special machine drives for industrial applications and provides orientation on various open-loop and closed-loop control schemes for drives, and also emphasis on implementation of the basic controllers using PLC**.**

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the concept of Industrial Automation and exposure to its components.

CO2. Analyze the various converters used in the DC drive with appropriate control.

CO3. Apply various scalar and vector control methodologies for induction motor drive and synchronous motor drive with relevant control techniques

CO4. Identify and use the various special machines in industrial applications and its control.

CO5. Understand the basics of PLC and be able to use PLC programming to control drives.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	1	2	2	1	-	-	-	-	-	2	3
CO2	3	2	-	-	-	2	2	-	-	-	-	-	-	2	3
CO3	3	3	-	-	1	3	1	-	-	-	-	2	-	2	3
CO4	3	2	2	-	2	2	1	-	-	-	-	1	-	2	3
CO5	3	2	2	-	2	2	1	-	-	-	-	-	-	2	3
Course Correlation Mapping	**3**	**2**	**2**	**-**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**2**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION **(09 Periods)**

Introduction to Electric Drives – Need of electric drives, basic parts, present scenario of electric drives, Mechanical Dynamics in an Electric Drive –concepts of Industrial Automation and exposure on its components. Identify the Scope.

Module 2: INDUSTRIAL AUTOMATION **(09 Periods)**

Introduction to Industrial Automation and Control, Architecture of Industrial Automation Systems, Introduction to sensors and measurement systems, Temperature measurement, Pressure and Force measurements, Displacement and speed measurement, Flow measurement techniques.

Module 3: PROCESS CONTROL **(10 Periods)**

Introduction to Process Control. P-- I -- D Control, Controller Tuning- Implementation of PID Controllers-Networking of Sensors, Actuators and Controllers

Module 4: SPECIAL MACHINE DRIVES AND INTRODUCTION TO PLC **(07 Periods)**

Permanent magnet synchronous motor - Field oriented control - Direct torque control – Sensor-less control. Brushless Direct current (BLDC) machine control strategies, Voltage Source Inverter fed BLDC-Torque ripple minimization – Application. PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC.

Module 5: PLC BASED CONTROL **(10 Periods)**

PLC programming methodologies: ladder diagram, STL, functional block diagram, creating ladder diagram from process control descriptions, introduction to IEC61131 international standard for PLC. Bit logic instructions, ladder diagram examples, interlocking, latching, inter dependency and logical functions, PLC Timer & Counter functions, Control components, sensors, actuators and valves, PID configuration, various network topologies and communication protocols like Profibus, Foundation field bus, Devicenet, HART.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Visit any nearby industry, observe the industrial drives used in the plant and prepare a technical report on the drive studied.
2. Visit any nearby industry, enquire about the problems the industry is facing with the drive or avenues for the improvement in the performance, and suggest/develop a solution strategy to the problem
3. Develop a PLC-based program to control the sensors or actuators or a valve.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. G.K.Dubey, Fundamentals of Electrical drives, Alpha Science International Ltd; 200.
2. Richard Shell, Handbook of Industrial Automation, CRC Press, 2000.

REFERENCE BOOKS:

1. John Webb: Programmable Logic Controllers principles & Applications, PHI, 2009.
2. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia, 2012.
3. R. Krishnan, „Permanent Magnet Synchronous and Brushless DC Motor Drives", Taylor and Francis, 2010

VIDEO LECTURES:

1. https://youtu.be/1AT1yuQ9awM
2. https://youtu.be/ExRVJGN2NnY
3. https://youtu.be/fbXVt0VL5Rs
4. https://youtu.be/1JPxilLeXpk
5. https://archive.nptel.ac.in/courses/108/105/108105063/

WEB RESOURCES:

1 https://youtu.be/3pVUWQFUE3Y

2 https://youtu.be/rF0yV80mb5I

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101023	**PWM CONVERTERS AND APPLICATIONS**	3	-	-	-	3

Pre-Requisite 22EE101011-Power Electronics

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion on overview of PWM converters, working of PWM techniques, performance analysis of different PWM techniques and PWM for multilevel inverter and applications.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the operation of different PWM converters and need of PWM techniques for feasible operation.

CO2. Analyze the operation of various carrier based and space vector PWM techniques.

CO3. Analyze the performance analysis of line current ripple and DC link current for various PWM techniques.

CO4. Analyze the performance analysis of torque ripple and inverter's loss for various PWM techniques.

CO5. Analyses the operation of PWM for multilevel inverters.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	2	2	2	2	-	-	-	-	-	2	2	2
CO2	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
CO3	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
CO4	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
CO5	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
Course Correlation Mapping	**3**	**3**	**-**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: OVERVIEW OF PWM CONVERTERS (08 Periods)

Review of power electronic converters for DC-AC and AC-DC power conversion, Purpose of pulse-width modulation, Review of Fourier series, fundamental and harmonic voltages; machine model for harmonic voltages; undesirable effects of harmonic voltages- line current distortion, increased losses, pulsating torque in motor drives; control of fundamental voltage; mitigation of harmonics and their adverse effects.

Module 2: PWM TECHNIQUES (10 Periods)

Pulse-width modulation (PWM) at low switching frequency: square wave operation of voltage source inverter, PWM with a few switching angles per quarter cycle, equal voltage contours and selective harmonic elimination.

Triangle-comparison based PWM: Average pole voltages, sinusoidal modulation, third harmonic injection, continuous PWM, bus-clamping or discontinuous PWM.

Module 3: PERFORMANCE ANALYSIS OF LINE CURRENT RIPPLE AND DC LINK CURRENT (09 Periods)

Analysis of line current ripple: Synchronously revolving reference frame; error between reference voltage and applied voltage; integral of voltage error; evaluation of line current ripple.

Analysis of DC link current: Relation between line-side currents and DC link current; DC link current and inverter state; rms DC current ripple over a carrier cycle.

Module 4: PERFORMANCE ANALYSIS OF TORQUE RIPPLE AND INVERTER'S LOSS (09 Periods)

Analysis of torque ripple: Evaluation of harmonic torques and rms torque ripple.

Analysis for inverter's loss: Simplifying assumptions in evaluation of inverter loss, dependence of inverter loss on line power factor, influence of PWM techniques on switching loss.

Module 5: PWM FOR MULTILEVEL INVERTER AND APPLICATIONS (09 Periods)

Introduction to multilevel inverters, extensions of sine-triangle PWM to multilevel inverters, voltage space vectors, and space vector based PWM.

Applications: Active power filtering, Reactive power compensation, Constant Volt Per hertz drives, PWM Rectifier.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Simulation of various MLIs for various carrier based PWM techniques.
2. Design of hybrid PWM technique for minimizing the current ripple.
3. Case study of the fundamental and sideband harmonics of output voltage with PWM with different carrier ratio.
4. Seminar on comparison of conventional sine PWM and third harmonic injected PWM.
5. Technical talk on various applications of PWM techniques.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. D. G. Holmes, T. A. Lipo, 'Pulse Width Modulation for Power Converters: Principles and Practice', John Wiley and Sons., 2003.
2. Euzeli Cipriano dos Santos Jr. and Edison Roberto Cabral Da Silva "Advanced Power Electronics Converters - PWM Converters Processing AC Voltages", Willey – IEEE Press, 2014.

REFERENCE BOOKS:

1. Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2006.
2. NPTEL Lecture series by Prof. G. Narayanan, Department of Electrical Engineering, IISC Bangalore on the web-course.

VIDEO LECTURES:

1. http://www.digimat.in/nptel/courses/video/108108035/
2. http://nptel.ac.in/courses/108108077/

WEB RESOURCES:

1. https://www.semikron.com/service-support/semisel-simulation.html
2. http://www.satishkashyap.com/2014/01/video-lectures-on-pulse-width.html
3. https://www.biomechatronics.ca/teaching/ape/notes/Lecture_7.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101024	**DSP CONTROL FOR ELECTRIC DRIVES**	3	-	-	-	3

Pre-Requisite 22EC101402-Discrete-Time Signal Processing
22EE101011-Power Electronics

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed overview on DSP-based implementation of DC-DC buck-boost converters, stepper motors, permanent magnet brushless DC machines, DSP-based control of permanent magnet synchronous machines, DSP-based control of switched reluctance motor drives.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyse the Continuous Conduction Mode, Discontinuous Conduction Mode of Buck-Boost Converter using the concepts of DSP

CO2. Analyze the operational aspects of the stepper motor and Stepper Motor Control System Using the LF2407 DSP

CO3. Analyze the operation and control aspects of a permanent magnet brushless DC motor Using the LF2407 DSP

CO4. Analyze the operation and control aspects of the permanent magnet synchronous motor Using the LF2407 DSP

CO5. Analyze the open and closed-loop operational characteristics of the Reluctance motor and assess its performance under various scenarios

CO-PO Mapping Table:

<table>
<tr><th rowspan="2">Course Outcomes</th><th colspan="12">Program Outcomes</th><th colspan="3">Program Specific Outcomes</th></tr>
<tr><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th><th>PO7</th><th>PO8</th><th>PO9</th><th>PO10</th><th>PO11</th><th>PO12</th><th>PSO1</th><th>PSO2</th><th>PSO3</th></tr>
<tr><td>CO1</td><td>3</td><td>3</td><td>-</td><td>1-</td><td>3</td><td>2</td><td>1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td>CO2</td><td>3</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td><td>1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td><td>3</td></tr>
<tr><td>CO3</td><td>3</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td><td>1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>--</td><td>-</td><td>3</td><td>3</td></tr>
<tr><td>CO4</td><td>3</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td><td>1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>--</td><td>-</td><td>3</td><td>3</td></tr>
<tr><td>CO5</td><td>3</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td><td>1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td><td>3</td></tr>
<tr><td>Course Correlation Mapping</td><td>3</td><td>2</td><td>-</td><td>1</td><td>3</td><td>2</td><td>1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>3</td><td>3</td></tr>
</table>

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DSP-BASED IMPLEMENTATION OF DC-DC BUCK-BOOST CONVERTERS **(09 Periods)**

Introduction, Converter Structure, Continuous Conduction Mode, Discontinuous Conduction Mode, Connecting the DSP to the Buck-Boost Converter, Controlling the Buck-Boost Converter

Module 2: DSP-BASED CONTROL OF STEPPER MOTORS **(09 Periods)**

Introduction, The Principle of Hybrid Stepper Motor, The Basic Operation, The Stepper Motor Drive System, The Implementation of the Stepper Motor Control System Using the LF2407 DSP, The Subroutine of Speed Control Module.

Module 3: DSP-BASED CONTROL OF PERMANENT MAGNET BRUSHLESS DC MACHINES **(09 Periods)**

Introduction, Principles of the BLDC Motor, Torque Generation, BLDC Motor Control System, Implementation of the BLDC Motor Control System Using the LF2407.

Module 4: DSP-BASED CONTROL OF PERMANENT MAGNET SYNCHRONOUS MACHINES **(08 Periods)**

Introduction, The Principle of the PMSM, PMSM Control System, Implementation of the PMSM System Using the LF2407.

Module 5: DSP-BASED CONTROL OF SWITCHED RELUCTANCE MOTOR DRIVES **(10 Periods)**

Introduction, Fundamentals of Operation, Fundamentals of Control in SRM Drives Open Loop Control Strategy for Torque, Closed Loop Torque Control of the SRM Drive Closed Loop Speed Control of the SRM Drive

Total Periods: 45

Topics for self-study are provided in the lesson plan

EXPERIENTIAL LEARNING:

1. The students shall study various control systems to analyze the performance of brushless DC Motor synchronous motor and reluctance motor.
2. Should visit a nearby industry and should understand the characteristics of various motors and controlling methods using Digital signal processing
3. Develop a Mathematical/simulation model/Program/Prototype to validate the operation/performance of various motors.
4. Participate in a technical quiz/competitive exam.

(Note: It’s an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Hamid A. Toliyat, Steven G. Campbell, DSP based electromechanical motion control, CRC Press Special Indian Edition, 2012.

REFERENCE BOOKS:

1. Slobodan N. Vukosavić, Digital Control of Electrical Drives, Springer.

VIDEO LECTURES:

1. https://youtu.be/tc521JDEcRY
2. https://youtu.be/LB6VOXSq1Kg

WEB RESOURCES:

1. https://www.analog.com/en/analog-dialogue/articles/dsp-based-control-for-ac-machines.html
2. https://www.motioncontroltips.com/digital-signal-processors-dsps-motion-control/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101033	OPTIMAL CONTROL AND ADAPTIVE CONTROL	3	-	-	-	3

Pre-Requisite 22EE102007-Control Systems

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed overview of optimal control problems, calculus of variation, linear quadratic control problems, dynamic programming, and adaptive control systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the concept of different types of optimal control for solving control systems problems.

CO2. Apply the concept of the calculus of variation and the principle of optimality for solving control systems problems

CO3. Apply the concept of the Linear Quadratic method for solving control systems problems

CO4. Apply the concept of adaptive control technique for solving control systems problems

CO5. Apply the concept of Self-Tuning Regulators and Model Reference Adaptive Systems for solving control systems problems

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	1	2	1	1	1	-	-	1	-	2	-	3
CO2	3	2	-	1	2	1	1	-	-	-	1	-	2	-	3
CO3	3	2	1	1	2	1	1	-	-	-	1	-	2	-	3
CO4	3	2	-	1	2	1	1	-	-	-	1	-	2	-	3
CO5	3	2	-	1	2	1	1	-	-	-	1	-	2	-	3
Course Correlation Mapping	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**2**	**-**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO OPTIMAL CONTROL PROBLEMS: (09 Periods)

Statement of optimal control problem - Problem formulation and types of optimal control - Selection of performance measures, General Model of feedback control systems, Transient performance analysis, Tracking performance analysis, Disturbance rejection analysis, Cost functions and norms, Mathematical preliminary to optimal control

Module 2: CALCULUS OF VARIATION AND HAMILTON FORMULATION: (09 Periods)

Fundamental concepts – Extremum functionals involving single and several independent functions – Piecewise smooth extremals -Variation of functionals with fixed and free terminal time constrained extrema Pontryagin's minimum principle - State inequality constraints- The Weierstrass Erdmann corner conditions- Solution of Bolza problem. Partial differential equation for cost function-HamiltonJacobi equation - Principle of optimality, solution of Hamilton Jacobi equation - Matrix Riccati equation - Optimal control law.

Module 3: LINEAR QUADRATIC CONTROL PROBLEMS: (09 Periods)

Optimal control by Liapunov method - Parameter optimization –Quadratic performance index - Optimal control of systems – Matrix Riccati equation and solution methods of State regulator and discrete systems - Choice of weighting matrices – Linear Quadratic Guassian control – Kalman filter – H2 and H∞ Control and Optimal estimation

Module 4: DYNAMIC PROGRAMMING AND INTRODUCTION TO ADAPTIVE CONTROL: (08 Periods)

Principle of optimality - Recurrence relation of dynamic programming for optimal control problem - Combinational procedure for solving optimal control problem.

Development of adaptive control problem-The role of Index performance (IP) in adaptive systems- Development of IP measurement process model

Module 5: SELF TUNING REGULATORS (STR) AND MODEL REFERENCE ADAPTIVE SYSTEMS (MRAS) (10 Periods)

Introduction - Pole placement design-Indirect Self-tuning regulators- Continuous time Self-Tuners - Direct self-tuning regulators – Linear quadratic self - Tuning regulators - Adaptive predictive control. The MIT rule – Determination of Adaptation Gain – Design of MRAS using Liapunov theory – BIBO Stability – Applications to Adaptive control- Model-Free Adaptive Control.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. The students shall implement the concepts of adaptive control statergy to a model and should optimize its performance.
2. The students shall implement the concepts of Linear quadratic control problem to a model and should optimize its performance.

3. The students shall develop self-tuning regulators in adaptive control
4. Review an IEEE article given, and prepare a report on the inferences of the article.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Optimal control theory-An Introduction by Donald E.Krik- Prentice Hall Networks series, 2008.
2. Karl J Astrom and Bjorn Wittenmark, "Adaptive Control", Pearson education Inc., New Delhi, Second Edition, 2008.
3. D S Naidu "Optimal Control Systems", CRC Press 2002.

REFERENCE BOOKS:

1. A.P. Sage-Optimum Systems Control, Prentice Hall.
2. Yoan D. Landu - Adaptive Control - Model Reference Approach, Marcel Dekker.
3. HSU and Meyer - Modern Control. Principles and Applications, McGraw Hill.

VIDEO LECTURES:

1. https://youtu.be/6rUdAOCNXAU
2. https://youtu.be/kDtcg6U49kY
3. https://youtu.be/kDtcg6U49kY
4. https://youtu.be/GBBXZXmb8UE

WEB RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee24/preview

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101028	**DIGITAL CONTROL SYSTEM**	3	-	-	-	3

Pre-Requisite 22EE102007-Control Systems

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on signal processing, Z transforms, controllability and observability, lag and lead compensators and stability analysis of digital control systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the concepts of digital control systems and assemble various components associated with it and relate them to an analog type.

CO2. Understand the theory of z–transformations and its application for the mathematical analysis of digital control systems.

CO3. Represent the discrete–time systems in state–space model and evaluation of the state transition matrix, the design of state feedback control by "the pole placement method.", and design of state observers.

CO4. Examine the stability of the system using the frequency domain.

CO5. Design of discrete–time control systems by conventional methods.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	1	-	-	-	-	-	-	-	2	-	3
CO2	3	-	-	-	2	-	-	-	-	-	-	-	2	-	3
CO3	3	-	-	-	2	-	1	-	-	-	-	2	3	-	3
CO4	3	-	-	2	2	-	1	-	-	-	-	1	3	-	3
CO5	3	2	3	-	-	-	1	-	-	-	-	-	3	-	3
Course Correlation Mapping	**3**	**3**	**3**	**2**	**2**	-	**1**	-	-	-	-	**2**	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION AND SIGNAL PROCESSING (09 Periods)

Introduction to analog and digital control systems – Advantages of digital systems – Typical examples – Continuous and Discrete Time Signals – Sample and hold devices – Sampling theorem and data reconstruction – Frequency domain characteristics of zero order hold..

Module 2: Z–TRANSFORMATIONS (09 Periods)

z–Transforms – Theorems – Finding inverse z–transforms – Formulation of difference equations and solving – Block diagram representation – Pulse transfer functions and finding open loop and closed loop responses..

Module 3: STATE SPACE ANALYSIS AND THE CONCEPTS OF CONTROLLABILITY AND OBSERVABILITY (09 Periods)

space representation of discrete time systems – Solving Discrete Time state space equations – State transition matrix and its properties – Discretization of continuous time state equations – Concepts of controllability and observability – Tests(without proof).

Module 4: STABILITY ANALYSIS (08 Periods)

Mapping between the s–Plane and the z–Plane – Primary strips and Complementary strips – Stability criterion – Modified Routh's stability criterion and Jury's stability test.

Module 5: DESIGN OF DISCRETE–TIME CONTROL SYSTEMS BY CONVENTIONAL METHODS (10 Periods)

Transient and steady state specifications – Design using frequency response in the w–plane for lag and lead compensators – Root locus technique in the z–plane.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING: The following activities are indicative only; the detailed experiential learning activities will be provided in the course handout.

1. The students shall prepare a technical report on the advantages of digital control systems by realizing any practical digital control system
2. The students shall develop a state space model in discrete time systems and determine the stability of the system
3. The students shall design lag and lead compensators to meet the given specification.
4. Review a relevant IEEE article given, and prepare a report on the inferences of the article.
5. Participate in a technical quiz/competitive exam.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Discrete–Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition.
2. Digital Control and State Variable Methods by M.Gopal, TMH, 4^{th} Edition.

REFERENCE BOOKS:

1. A. Nagoorkani, Advanced Control Theory, 3^{rd} Edition, CBS Publishers and Distributors Pvt Ltd, March 2020.
2. Digital Control Systems, Kuo, Oxford University Press, 2^{nd} Edition, 2003

VIDEO LECTURES:

1. https://youtu.be/V_dzSAfu3D8
2. https://youtu.be/0B-Vouc_a0I
3. https://youtu.be/a_GXpxDMjB0
4. https://youtu.be/-CDSwABqvVY

WEB RESOURCES:

1. https://nptel.ac.in/courses/108103008
2. https://people.inf.ethz.ch/fcellier/Lect/DC/Lect_dc_index.html

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101013	**ADVANCED CONTROL SYSTEMS**	3	-	-	-	3

Pre-Requisite 22EE102007-Control Systems

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with the advanced concepts of control systems such as State space analysis; design of compensators and controllers; describing function for non-linear systems, phase-plane analysis; Lyapunov's stability analysis.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Design state feedback controller and observer by applying knowledge on controllability and observability.

CO2. Design the compensators and controllers to enhance the performance of the system using root locus technique.

CO3. Understand various non-linearities in control systems and realize their describing functions.

CO4. Analyze the non-linear control system stability using describing the function and phase-plane analysis.

CO5. Investigate the stability of non-linear systems by applying the principles of Liapunov.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1	2	-	-	-	-	-	2	-	3
CO2	3	3	3	2	1	1	2	-	-	-	-	-	2	-	3
CO3	3	1	-	-	--	-	1	-	-	-	-	-	3	-	3
CO4	3	2	-	2	2	-	-	-	-	-	-	-	3	-	3
CO5	3	3	-	2	-	-	1	-	-	-	-	-	3	-	3
Course Correlation Mapping	**3**	**3**	**3**	**2**	**1**	**1**	**2**	-	-	-	-	-	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: STATE SPACE ANALYSIS AND STATE FEEDBACK CONTROL (12 Periods)

Review of state space analysis, Canonical forms —controllable canonical form, observable canonical form and Jordan canonical form; Test for controllability and observability for continuous time invariant systems and principle of duality; Design of state feedback control through pole placement technique — direct substitution method and Ackermann's formula. full-order observer and reduced-order observer.

Module 2: COMPENSATORS AND CONTROLLERS (10 Periods)

Introduction to preliminary design considerations, Lag, lead and lag-lead compensator; Compensator design based on root locus. Types of controllers, tuning rules for PID controller, design of PI, PD and PID controllers using frequency domain and root locus techniques.

Module 3: NON-LINEAR SYSTEMS (09 Periods)

Introduction to non-linear systems, common non-linearities in control systems; study of nonlinear systems — describing function method, derivation of describing function for saturation, ideal relay, relay with dead-zone, backlash, stability analysis with describing function.

Module 4: PHASE PLANE ANALYSIS (07 Periods)

Concept of phase plane analysis — singular-points, concept of limit cycle construction of phase trajectory by analytical method, isocline and delta methods.

Module 5: LYAPUNOV STABILITY (07 Periods)

Introduction — Stability in the sense of Lyapunov; Lyapunov's stability and Lypanov's instability theorems; Lyapunov function for linear system, Lyapunov function for non-linear systems — Krasooviski's and variable gradient methods.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. The students shall develop various canonical forms of a given system in state space and should analyze the controllability and observability of the system.
2. The students shall design a state feedback controller through pole placement technique in the discrete domain.
3. The students shall design and develop a controller or compensator to meet the given specifications in both frequency and time domain analysis
4. Develop a Mathematical/simulation model/Program/Prototype to validate the operation/performance of a given electrical electronics system.
5. Participate in the technical talk on the topic given

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Pearson, 2010.

2. M. Gopal, Control Systems Principles and Design, 4th Edition, McGraw Hill Education (India) Private Limited, NewDelhi, 11th reprint 2016.

REFERENCE BOOKS:

1. A. Nagoorkani, Advanced Control Theory, 3rd Edition, CBS Publishers and Distributors Pvt Ltd, March 2020.

2. I.J Nagarth, M.Gopal, Control systems Engineering, 6th Edition, New Age International Publishers, September 2018.

VIDEO LECTURES:

1. https://youtu.be/LczXeE-MaKI
2. https://youtu.be/3fYViOgv0NA

WEB RESOURCES:

1. http://www.nptelvideos.in/2012/11/advanced-control-system-design_27.html
2. https://swayam.gov.in/nd1_noc19_de04/preview

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101134	**INDUSTRIAL DATA COMMUNICATIONS**	3	-	-	-	3

Pre-Requisite 22CB102001-Computer Networks.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course is designed to provide comprehensive knowledge to the students regarding the Data networks, inter-networking and serial communications, HART and Field buses, MODBUS, PROFIBUS, Communication protocol, industrial Ethernet and wireless communication.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on fundamentals of industrial data communication.

CO2. Analyze interfacing standards EIA-232 and EIA-485.

CO3. Select a communication protocol for particular application.

CO4. Demonstrate knowledge on foundation field bus.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	2	2	-	-	3	-	-	-	-	-	-	-	-	3	-
CO4	3		-	-	-	-	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INDUSTRIAL DATA COMMUNICATION METHODOLOGY ***(09 Periods)***

Modern instrumentation and control systems, Open systems interconnection (OSI) model, Protocols, Standards Common problems and solutions, General comments on troubleshooting, a specific methodology, Grounding/shielding and noise, Sources of electrical noise, Electrical coupling of noise, Shielding, Cable ducting or raceways, Cable spacing, earthing and grounding requirements, Suppression techniques, Filtering.

Module 2: EIA-232 & EIA-485 INTERFACE STANDARD ***(09 Periods)***

EIA-232 interface standard: the major elements of EIA-232, Half-duplex operation of the EIA-232 interface, EIA/TIA-232 revisions, Limitations of EIA-232, trouble shooting: Introduction, Typical approach, Test equipment, Typical EIA-232 problems.EIA-485 interface standard, Trouble shooting. Introduction: EIA-485 vs EIA-422, EIA-485 installation, Noise problems, Test equipment.

Module 3: HART PROTOCOL & AS-INTERFACE (AS-I) ***(07 Periods)***

Introduction to HART and smart instrumentation, HART protocol: Physical layer, Data link layer, Application layer, troubleshooting. Introduction to AS-interface, Layer 1 – the physical layer, Layer 2 – the data link layer, Operating characteristics, Troubleshooting: Introduction, Tools of the trade.

Module 4: PROFIBUS PA/DP/FMS PROTOCOL ***(11 Periods)***

Introduction, ProfiBus protocol stack: Physical layer (layer 1), Data link layer (layer 2), Application layer, Fieldbus message specification (FMS), Lower layer interface (LLI), Fieldbus management layer (FMA 7), The ProfiBus communication model, Relationship between application process and communication, Communication objects, Performance, System operation: Configuration, Data transfer between DPM1 and the DP-slaves, Synchronization and freeze modes, Safety and protection of stations, Mixed operation of FMS and DP stations, Troubleshooting: Introduction, Troubleshooting tools.

Module 5: FOUNDATION FIELDBUS ***(09 Periods)***

Introduction to Foundation Fieldbus, The physical layer and wiring rules, The data link layer, The application layer, The user layer, Error detection and diagnostics, High-speed Ethernet (HSE), Good wiring and installation practice with Fieldbus: Termination preparation, Installation of the complete system, Troubleshooting: Introduction, Power problems, Communication problems, Foundation Fieldbus test equipment.

Total: 45 Periods

EXPERIENTIAL LEARNING

1. Design and implement a communication network for a manufacturing facility that consists of multiple machines and devices. What considerations would you take into account, such as data transfer speed, reliability and security?
2. Set up a real-time monitoring system for a production line using industrial data communication protocols. How would you ensure that the system can handle high-volume data transmission and provide accurate and timely information?

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

TEXT BOOKS:

1. Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, *Practical Industrial Data Networks Design, Installation and Troubleshooting*' Newnes Publication, Elsevier 1st Edition, 2004.

REFERENCE BOOKS:

1. Sunit Kumar Sen, *Fieldbus and Networking in Process Automation*, CRC Press.,1st Edition, 2014.
2. Andrew S. Tanenbaum, David J. Wetherall, *Computer Networks*, Prentice Hall of India Pvt. Ltd., 5th Edition. 2011.
3. Theodore S Rappaport, *Wireless Communication: Principles and Practice*, Prentice Hall of India 2nd Edition, 2001.
4. William Stallings, *Wireless Communication & Networks*, Prentice Hall of India, 2nd Edition, 2005.

VIDEO LECTURES:

1 https://nptel.ac.in/courses/106105082

2. https://www.udemy.com/course/industrial-communication-by-siemens-s7-1200plc-real-hardware/

WEB RESOURCES:

1. http://gtu-info.com/Subject/171703/IDC/Industrial_Data_Communication/Syllabus
2. https://www.gtu.ac.in/syllabus/NEW_Diploma/Sem6/3361704.pdf
3. https://rmd.ac.in/dept/eie/notes/7/IDN/syllabus.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101026	**DIGITAL IMAGE PROCESSING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Image processing becomes a very important aspect in various industries ranging from process industry to medical field. This course will introduce various image processing techniques, algorithms and their applications.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply various transformations on images by analyzing basic operations on
.

CO2. Understanding of image enhancement in both spatial and frequency domains

CO3. Apply restoration techniques based on noise models and degradation function to restore the images, pertaining to health and societal applications.

CO4. Use appropriate image compression and segmentation techniques on the images.

CO5. Understand the basics of morphological operations.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	-	2	3	-	-	-	-	-	-	-	-	-	3
CO2	1	3	-	2	-	-	-	-	-	-	-	-	-	-	3
CO3	1	2	-	2	3	-	-	-	-	-	-	-	-	-	3
CO4	1	2	-	2	3	-	-	-	-	-	-	-	-	-	3
CO5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	
Course Correlation Mapping	**2**	**2**	**-**	**2**	**3**	**-**	-	-	-	-	-	-	-	-	3

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FUNDAMENTALS OF IMAGE PROCESSING ***(09 Periods)***

Fundamental steps in Image Processing, Image sampling & quantization, some basic relationships between pixels, Mathematical tools for image processing.

Image Transforms: Unitary transforms, 2D-DFT, Hadamard transform, Walsh transform, DCT, properties of transforms.

Module 2: IMAGE ENHANCEMENT ***(11 Periods)***

Spatial Domain methods: Basic Intensity transformation functions, Histogram processing, Fundamentals of Spatial Filtering, Smoothing spatial filters, Sharpening spatial filters.

Frequency Domain methods: Basics of filtering in frequency domain, Correspondence between filtering in the spatial and frequency domains, Image smoothing using frequency domain filters, Image sharpening using frequency domain filters, Homomorphic filtering.

Module 3: IMAGE RESTORATION and RECONSTRUCTION ***(09 Periods)***

Image degradation/Restoration model, Noise models, Restoration in the presence of Noise only-spatial filtering - mean, order- statistic and adaptive filters. Estimating the degradation function, Inverse filtering, Weiner filtering, Constrained least squares filtering.

Module 4: IMAGE COMPRESSION AND SEGEMENTATION ***(11 Periods)***

Image Compression: Fundamentals of redundancies, Compression models, Huffman coding, Arithmetic coding, JPEG Compression standard.

Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation.

Module 5: MORPHOLOGICAL IMAGE PROCESSING ***(05 Periods)***

Dilation and erosion, Opening and closing, Some basic morphological algorithms.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Introduction to Image Processing Toolbox
2. To read, write, view images, conversion between different formats and
3. Manipulations on images (addition, subtraction, division, logical).
4. Computation of Mean, Standard Deviation, Correlation coefficient of the given Image.
5. Image enhancement techniques on 8-bit image:
   (a) Brightness improvement (b) Brightness reduction (c) Thresholding (d) Negative of an image (e) Log transformation (f) Power Law transformation

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson Education,4th Edition, 2018.
2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital Image Processing, Tata McGraw Hill Education, Second Edition, 2020.

REFERENCE BOOKS:

1. Anil K. Jain, Fundamentals of Digital Image processing, Prentice Hall, 2007.
2. Pratt W.K, Digital Image Processing‖, 3rd ed., John Wiley & Sons, 2007
3. Vipula Singh, Digital Image Processing with MATLAB & LabVIEW, Elsevier, 2019.
4. Chris Solomon, Toby Breckon, "Fundamentals of Digital Image Processing a Practical Approach with Examples in Matlab", John Wiley & Sons.
5. https://in.mathworks.com/help/images/deep-learning.html

VIDEO LECTURES:

1. https://www.youtube.com/@digitalimageprocessing3396/playlists
2. https://www.youtube.com/@Ekeeda/playlists
3. https://www.youtube.com/playlist?list=PL3rE2jS8zxAykFjinlf6EsucLv5EA03_m

Web Resources:

https://in.mathworks.com/videos/image-processing-made-easy-81718.html

1. https://in.mathworks.com/videos/introduction-to-matlab-with-image-processing-toolbox-90409.html?s_tid=srchtitle_image%20processing%20tool%20box_2
2. https://in.mathworks.com/videos/edge-detection-with-matlab-119353.html?s_tid=srchtitle_image%20processing%20tool%20box_4

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101019	**FPGA ARCHITECTURES AND APPLICATIONS**	3	-	-	-	3

Pre-Requisite 22EC103011-VLSI System Design

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on evolution of programmable devices, design with PLDs, FPGA-organization, programming, Xilinx-XC2000, XC3000, XC4000 architectures, programming technologies, anti-fuse programmed FPGAs, design applications.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Implement Boolean functions using programmable logic devices to develop a digital system.

CO2. Analyze FPGA's and its programmable technologies to assess the impact of digital functions in the development of digital system.

CO3. Analyze Xilinx & Actel based FPGA architectures, place and route designs for high speed digital Circuits.

CO4. Develop various sub systems using FPGA for specified applications.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	1	-	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO4	3	2	3	-	-	1	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DESIGNING OF PROGRAMMABLE LOGIC DEVICES: ***(10 Periods)***

Introduction, Simple Programmable Logic Devices – Read Only Memories, Programmable Logic Arrays, Programmable Array Logic, Sequential Programmable Logic Devices (22CEV10), Implementation of a serial Adder with Accumulation.

Module 2: FIELD PROGRAMMABLE GATE ARRAYS ***(10 Periods)***

Finishings: Introduction to FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, and Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, Applications of FPGAs.

Module 3 SRAM PROGRAMMABLE FPGAS ***(08 Periods)***

Introduction, Programming Technology, Device Architecture, the Xilinx XC2000, XC3000 and XC4000 Architectures

Module 4 ANTI-FUSE PROGRAMMED FPGAS ***(09 Periods)***

Introduction, Programming Technology, Device Architecture, The Actel ACT1, ACT2 and ACT3 Architectures.

Module 5 DESIGN APPLICATIONS ***(08 Periods)***

General Design Issues, A Fast Video Controller, A Position Tracker for a Robot Manipulator, A Fast DMA Controller, Designing Counters with ACT devices.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

RESOURCES

TEXT BOOKS:

1. Stephen M. Trimberger, Field Programmable Gate Array Technology, Springer International Edition,Eighth Indian Reprint 2015.
   Robert Lafore, Data Structures & Algorithms in Java, 2nd Edition, Pearson, 2007.
2. Charles H. Roth Jr, LizyKurian John, Digital Systems Design using VHDL, 3rd edition, Cengage Learning,2017.

REFERENCE BOOKS:

1. John V. Oldfield, Richard C. Dorf, Field Programmable Gate Arrays, Wiley India,2008.
2. Pak K. Chan/Samiha Mourad, Wayne Wolf, Digital Design Using Field Programmable Gate Arrays, Pearson Low Price Edition,2009.

VIDEO LECTURES:

1. Architecture All Access: Modern FPGA Architecture - Bing video
2. EEVblog #496 - What Is An FPGA? - Bing video
3. Introduction to FPGA Part 10 - Metastability and Clock Domain Crossing | Digi-Key Electronics - Bing video

Web Resources:

1. FPGA Design for Embedded Systems | Coursera
2. FPGA Design Resources | Microchip Technology
3. Programming an FPGA: An Introduction to How It Works (xilinx.com)
4. Embedded design with FPGAs: Hardware resources - Embedded.com

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE102027	**ANALYSIS AND DESIGN OF POWER ELECTRONIC CONVERTERS**	3	-	2	-	4

Pre-Requisite 22EE101011-Power Electronics.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with the analysis and design of power electronic converters, the design, analysis, and control of various types of power electronic converters. The course covers power electronic devices, converter topologies, modulation techniques, and control strategies for applications in renewable energy systems, electric vehicles, and industrial drives.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the operational principle of switching phenomenon/characteristics of various special power switching devices.

CO2. Analyze the operational characteristics of various transistor and thyristor gate driver circuits.

CO3. Analyze various multi-pulse converters operating in different modes and determine their operational parameters.

CO4. Design various switching regulators and analyze their performance in different modes of operation.

CO5. Analyze the performance and application of advanced PWM techniques in inverter configurations.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	-	-	-	-	-	-	-	-	-	2	1
CO2	3	3	-	1	1	1	1	-	-	-	-	-	-	2	2
CO3	3	3	-	1	1	1	1	-	-	-	-	-	-	2	2
CO4	3	3	2	1	1	1	1	-	-	-	-	-	-	2	2
CO5	3	3	--	1	1	1	1	-	-	-	-	-	-	2	2
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**-**	**3**	**3**	**-**	**-**	**-**	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: ADVANCED POWER SEMICONDUCTOR DEVICES (10 Periods)

Thyristors: GTOs—Construction, operation, steady state characteristics and switching characteristics; Construction and operation of BCTs, FET — CTHs, ETOs, IGCTs, MCTs, SITHs, ASCR, RCT, SCS, and light-activated thyristor; Comparison of various thyristors; Transistors: Construction and operation of COOLMOS and SITs.

Module 2: GATE & BASE DRIVE CIRCUITS (10 Periods)

MOSFET and BJT gate drive circuits; Isolation of gate and base drives — pulse transformer, optocouplers; Thyristor firing circuits — R, RC firing circuits, photo-SCR isolator, pulse transformer isolation for inverter gate bias circuits and thyristor converter gating circuits; Gate drive ICs — MOSFETs and IGBTs; Drive ICs for converters — MOS Gated Driver.

Module 3: ANALYSIS OF MULTIPULSE CONVERTERS (09 Periods)

Operation of 3-, 6-, and 12-pulse converters; Performance analysis of 3-, 6-, and 12-pulse converters — Low Order Harmonics (LOH), Total Harmonic Distortion (THD), Power Factor, Ripple Factor, Form Factor, Distortion Factor.

Module 4: SWITCHING REGULATORS (08 Periods)

Design and analysis of buck, boost, buck-boost, Cuk, and SEPIC Converters. Resonant Converters — Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS) converters — M and L Type.

Module 5: ADVANCED PWM TECHNIQUES (08 Periods)

Modified Sinusoidal Pulse Width Modulation; Phase Displacement Control; Trapezoidal Modulation Technique; Staircase Modulation; Stepped Modulation; Harmonic Injection Modulation; Delta Modulation; Selective Harmonics Elimination (SHE) Technique, Space Vector PWM.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

Minimum 10 exercises shall be conducted.

1. Pulse triggering circuit of SCR for half wave and full wave rectifier.
2. Performance analysis of three-phase AC voltage controller with R load.
3. Performance analysis of a flyback, cuk, and sepic DC-DC converter.
4. Performance analysis of resonant converter.

5. Performance analysis of selective harmonics elimination PWM techniques.
6. Performance analysis of space vector pulse width modulation for three-level converters.
7. Performance analysis of series and parallel inverter.
8. Performance analysis of five Level H-Bridge cascaded multilevel inverter.
9. Performance analysis of three-level neutral point clamped multilevel inverter
10. Performance analysis of five-level flying capacitor multilevel inverter.
11. Generation of Gating pulse using Arduino/Micro Controller/PIC microcontroller for a DC-DC converter
12. Generation of Gating pulse using Arduino/Micro Controller/PIC microcontroller for a single-phase voltage source inverter.

RESOURCES

SOFTWARE/TOOLS:

1. Matlab- R2023a (Version 9.14)
2. PSIM and PSPICE

TEXT BOOKS:

1. Muhammad H. Rashid, Power Electronics – Devices, Circuits and Applications, 4th Edition, Pearson, 2017.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, Power Electronics: Converters, Applications and Design, Wiley, 3rd Edition, 2007.

REFERENCE BOOKS:

1. P C Sen, Modern Power Electronics, Wheeler publishing Co, 1st Edition, New Delhi, 1998.
2. Bimal K Bose, Modern Power Electronics and Drives, Pearson Education, 2nd Edition, 2003.

ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108/107/108107128/
2. https://nptel.ac.in/courses/108/105/108105066/
3. https://nptel.ac.in/courses/108/102/108102145/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101034	**POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS**	3	-	-	-	3

Pre-Requisite 22EE101011-Power Electronics.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed orientation on solar energy conversion System, types of Photovoltaic Systems, wind energy conversion systems, types ofwind energy conversion systems and hybrid systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the operation of various power converters for solar photovoltaic system

CO2. Analyze the operation of various solar PV system.

CO3. Analyze the operation of various power converters for wind energy conversion system.

CO4. Analyze the operation of various electrical machines and review their suitability for wind energy conversion system.

CO5. Analyse the operation of various hybrid energy systems.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
CO2	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
CO3	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
CO4	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
CO5	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
Course Correlation Mapping	**3**	**3**	**-**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: POWER CONVERTERS FOR SOLAR APPLICATIONS (09 Periods)

Introduction to solar photovoltaic system; I-V and P-V characteristics; Block diagram of solar photo voltaic system. Principle of operation — line commutated converters (inversion-mode). Selection of inverter. Multilevel inverters and its classification. Battery sizing and array sizing.

Module 2: PHOTOVOLTAIC SYSTEMS (11 Periods)

PV Systems — Stand-alone PV system: Charge controllers — series and shunt charge regulators. Maximum power point tracking algorithm. Solar pumping application.

Grid Connected PV Systems: Inverter types — line, self-commutated inverters, PV inverter with high frequency transformer and grid-tied inverter characteristics. Grid connection issues.

Module 3: ELECTRICAL MACHINES FOR WIND APPLICATIONS (08 Periods)

Introduction to wind energy system, Components of Wind Energy Conversion System (WECS), classification of WECS, performance of induction generators for WECS.

Electrical Machines — Principle of operation and analysis of induction generator, permanent magnet synchronous generator, squirrel cage and doubly fed induction generators

Module 4: POWER CONVERTERS FOR WIND APPLICATIONS (09 Periods)

Power converters: Three phase AC voltage controllers, AC-DC-AC converters — uncontrolled rectifiers, PWM inverters, grid interactive inverters, matrix converters. Stand alone operation of fixed and variable speed WECS. Grid connection issues. Grid integrated PMSG and SCIG based WECS.

Module 5: HYBRID ENERGY SYSTEMS (08 Periods)

Need for hybrid energy systems, issues in designing the hybrid energy systems. PV - Diesel hybrid system: Types – series, parallel and switched hybrid energy systems. Stand-alone PV and wind hybrid energy system, hybrid wind and diesel energy systems.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Simulation of various power electronics converters
2. Design of battery for solar PV applications
3. Case study of various solar PV and wind energy systems
4. Seminar on real time hybrid energy systems
5. Technical talk on various grid integration of RE sources

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Rashid .M. H, Power electronics Hand book, Academic press, 2017
2. Mukund R Patel, Wind and Solar Power Systems, CRC Press, 2005.

REFERENCE BOOKS:

1. J K Kaldellis, Stand-alone and Hybrid Wind Energy Systems, Woodhead Publishing, 1st Edition 2010
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 2002

VIDEO LECTURES:

1. https://nptel.ac.in/courses/108108078/
2. https://swayam.gov.in/nd1_noc19_ee37/preview
3. https://nptel.ac.in/courses/121/106/121106014/
4. https://nptel.ac.in/courses/103107157/

WEB RESOURCES:

1. https://www.alternative-energy-tutorials.com/wind-energy/wind-turbine-generator.html
2. https://www.solarfeeds.com/mag/types-of-wind-turbine-generators-and-their-functions/
3. https://ece.ncsu.edu/seminar/advance-power-electronic-converters-renewable-energy-systems/
4. https://www.iberdrola.com/innovation/hybrid-energy

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101039	**SWITCHED MODE POWER CONVERSION**	3	-	-	-	3

Pre-Requisite 22EE101011-Power Electronics

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion on single-switch isolated Converters, isolated bridge converters, dynamic analysis of DC-DC converters, controller design and resonant converters.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the knowledge of single switch mode DC–DC Converters and analyze with different modes of operation.

CO2. Demonstrate the knowledge of bridge type Converters and analyze with different modes of operation.

CO3. Analyse the dynamic analysis of various DC-DC converters.

CO4. Design a suitable controller to achieve the desired response of a system.

CO5. Analyse the operation of various resonant converters with different modes of operation.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	2	2	2	-	-	-	-	-	3	2	3
CO2	3	3	-	2	2	2	2	-	-	-	-	-	3	2	3
CO3	3	3	-	2	2	2	2	-	-	-	-	-	3	2	3
CO4	3	3	3	2	1	2	2	-	-	-	-	-	3	3	2
CO5	3	3	-	2	3	2	2	-	-	-	-	-	3	2	3
Course Correlation Mapping	**3**	**3**	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**3**	**2**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: SINGLE-SWITCH ISOLATED CONVERTERS (09 Periods)

Requirement for isolation in the switch-mode converters, transformer connection, Forward and flyback converters, power circuit and steady-state analysis. Push-Pull Converters-Power circuit and steady-state analysis, utilization of magnetic circuits in single switch and push-pull topologies.

Module 2: ISOLATED BRIDGE CONVERTERS (11 Periods)

Half bridge and full-bridge converters, Power circuit and steady state analysis, utilization of magnetic circuits and comparison with existing topologies.

Module 3: DYNAMIC ANALYSIS OF DC-DC CONVERTERS (08 Periods)

Formulation of dynamic equation of buck and boost converters, averaged circuit models, linearization technique, small-signal model and converter transfer functions.

Module 4: CONTROLLER DESIGN (09 Periods)

Review of frequency-domain analysis of linear time-invariant systems, concept of bode plot, phase and gain margins, bandwidth, controller specifications, proportional (P), proportional plus integral (PI), proportional plus integral plus integral controller (PID), selection of controller parameters.

Module 5: RESONANT CONVERTERS (08 Periods)

Classification of Resonant converters-Basic resonant circuits- Series resonant circuit-parallel resonant circuits- Resonant switches. Concept of Zero voltage switching, principle of operation, analysis of M-type and L-type Buck or boost Converters. Concept of Zero current switching, principle of operation, analysis of M-type and L-type Buck or boost Converters.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Simulation of various power electronics converters.
2. Design and dynamic analysis of DC-DC converters.
3. Case study of various controllers to improve the system response.
4. Seminar on real time applications of various DC-DC converters
5. Technical talk on various resonant converters.

(Note: It’s an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education, 4th Edition, 2014.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, Power Electronics: Converters, Applications and Design, Wiley, 3rd Edition, 2007.

REFERENCE BOOKS:

1. M. D. Singh & K. B. Kanchandhani, Power Electronics, Tata McGraw – Hill Publishing Company, New Delhi, 3rd Edition, 2008
2. Dr. P. S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi, 4th Edition, 2012.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/108/108/108108036/
2. https://nptel.ac.in/courses/108105066
3. http://www.infocobuild.com/education/audio-video-courses/electronics/SwitchedModePowerConversion-IISc-Bangalore/lecture-33.html

WEB RESOURCES:

1. https://ee.iisc.ac.in/wp-content/uploads/2023/01/SMPC_VRamnarayanan.pdf
2. https://www.studocu.com/in/document/indian-institute-of-science/electrical-engineering/smpcbook-vr-lecture-notes-1-20/6978153
3. https://en.wikipedia.org/wiki/Switched-mode_power_supply
4. https://dokumen.tips/documents/course-material-on-switched-mode-power-2017-04-11course-material-on-switched-mode.html

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101026	**ADVANCED ELECTRICAL DRIVES AND CONTROL**	3	-	-	-	3

Pre-Requisite 22EE102012-Solid State Drives

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Advanced Electrical Drives and Control is a course that covers the theoretical and practical aspects of electric drives and control systems used in modern industrial applications. Topics include power electronics, motor control techniques, motion control, and energy-efficient operation. The course provides an in-depth understanding of advanced control techniques for efficient and reliable operation of electric drives.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the basic operational requirements of electrical drives.

CO2. Analyze the operational instructions of DSP controllers to electric drives.

CO3. Analyze the operational characteristics of PWM inverters to electric drives.

CO4. Analyze the operational aspects of space vector modulation to electric drives.

CO5. Analyze the operational aspects of neural networks and fuzzy controllers to electric drives.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	--	1	--	--	--	--	--	--	--	--	--	2	1
CO2	3	3	2	1	1	1	1	--	--	--	--	--	--	2	2
CO3	3	3	2	1	1	1	1	--	--	--	--	--	--	2	2
CO4	3	3	2	1	1	1	1	--	--	--	--	--	--	2	2
CO5	3	3	2	1	1	1	1	--	--	--	--	--	--	2	2
Course Correlation Mapping	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**2**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Introduction (09 Periods)

Need for advanced controls — Principle factor affecting the choice of drive — Parameter identification techniques for electric motors — Electromagnetic compatibility of electric drives — Different options for an adjustable speed electric drive — Simulation of electrical drives — Advanced control strategies for electrical drives — DSP based control of electric drives.

Module 2: DSP Controllers and Instruction Set (09 Periods)

TMS 320 family overview — 320 C24X Series of DSP controllers — Architecture overview — C24X CPU internal bus structure — Memory — Central processing unit — Memory and I/O spaces — Overview of Memory and I/O spaces — Program control — Address modes – System configuration and interrupts — Clocks and low power modes — Digital input / output (I/O).

Instruction set: Assembly language instructions — Instruction set summary — Instruction description — Accumulator, arithmetic and logic instructions — Auxiliary register and data page pointer instructions — TREG, PREG, and Multiply instructions — Branch instructions — Control instructions — I/O and memory instructions.

Module 3 PWM Inverter Control (09 Periods)

Inverter — Operation principle — Inverter switching — Unipolar — Bipolar — Inverter deadtime — Inverter modulation — Different types — Sine triangle — Analysis of Sine triangle modulation — Trapezoidal modulation — Third harmonic Modulation — Analysis of Third Harmonic Modulation — Output filter requirement for different PWM techniques.

Module 4 Space Vector Modulation (09 Periods)

Concept of a Space Vector — dq Components for Three-phase sine wave source/level — dq Components for Voltage Source Inverter (VSI) operated in Square Wave Mode — Synchronously rotating reference frame — Space Vector Modulation (SVM) — Principle — SVM compared to regular sampled PWM Phase Lag reference for SVM — Naturally sampled SVM — Analytical solution for SVM — Harmonic losses for SVM — Placement of Zero Space Vector — Discontinuous Modulation — Phase Lag reference for discontinuous PWM.

Module 5 Neural Network and Fuzzy Controllers (09 Periods)

Current and Speed control of Induction Motor — Current control algorithm — Sensorless motion control strategy — Induction Motor Controller using VHDL design. Fuzzy Logic Control of a Synchronous Generator — System representation — VHDL Modeling — FPGA implementation.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Investigate the scope of artificial intelligence (AI) techniques such as fuzzy logic and neural networks in motor drive control. Develop a simulation model in MATLAB/Simulink and analyze the system's performance under different control scenarios.

2. Design a control system for a multi-motor drive system using a distributed control approach. Implement the system on a hardware prototype and test its performance in the laboratory.

3. Develop a control algorithm for a brushless DC motor (BLDC) drive and implement it on a microcontroller. Test the system's response to different input signals and disturbances and compare the results with simulation predictions.

4. Develop a model of an induction motor drive using MATLAB/Simulink and simulate its operation under different loading conditions. Investigate the effects of changing parameters such as rotor resistance, stator voltage, and frequency.

5. Develop a MATLAB/Simulink simulation model for a three-phase induction motor drive using space vector pulse width modulation (SVPWM) technique. Analyze the performance of the drive under various load conditions.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Bimal K. Bose, Power Electronics and Variable Frequency Drives – Technology and Applications, IEEE Press, 1997.
2. Grafame Holmes. D and Thomas A. Lipo, Pulse Width Modulation for Power Converters – Principles and Practice, IEEE Press, 2003.

REFERENCE BOOKS:

1. Peter Vas, Vector Control of AC Machines, Oxford University Press, 1990.
2. Hamid A. Toliyat and Steven G.Campbell, DSP based Electromechanical Motion Control, CRC Press 2003.

ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108104011
2. https://archive.nptel.ac.in/courses/108/104/108104140/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101032	**FLEXIBLE AC TRANSMISSION SYSTEMS**	**3**	**-**	**-**	**-**	**3**

Pre-Requisite 22EE102009-Power System Analysis
22EE101011-Power Electronics.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Need for flexible AC transmission systems; objectives of shunt and series compensations, phase angle regulators; FACTS controllers: shunt, series and combined; coordination of various FACTS controllers.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the power flow aspects in AC transmission system and realize the need of compensation and philosophy of FACTS controllers.

CO2. Realize the principle of static shunt compensation techniques and apply an appropriate shunt controller for sustainable operation of AC transmission system.

CO3. Realize the principle of static series compensation techniques and apply an appropriate series controller for sustainable operation of AC transmission system.

CO4. Realize the philosophy of various power flow controllers operating in various modes to control the active and reactive power and foster sustainable operation of AC transmission system.

CO5. Realize the principle of multiple FACTS controllers in AC transmission system and techniques to coordinate them for sustainable operation.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	2	-	-	-	-	-	-	1	2	3
CO2	3	2	-	1	2	2	2	-	-	-	-	-	1	2	3
CO3	3	2	-	1	2	2	2	-	-	-	-	-	1	2	3
CO4	3	2	-	1	2	2	2	-	-	-	-	-	1	2	3
CO5	3	2	-	--	2	2	2	-	-	-	-	-	2	2	2
Course Correlation Mapping	**3**	**2**	-	**1**	**2**	**2**	**2**	-	-	-	-	-	1	1	3

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO AC TRANSMISSION SYSTEMS ***(07 Periods)***

Overview of interconnected power system. Power flow in AC systems – Expression for real and reactive power flow between two nodes of a power system, controllable parameters. Power flow in parallel and meshed system. Overview of compensated transmission lines – shunt and series compensation. Conventional controllers for real and reactive power flows – merits and demerits. FACTS – benefits, types of FACTS controllers.

Module 2: STATIC SHUNT COMPENSATION ***(10 Periods)***

Expression for real and reactive power flow with mid-point voltage regulation. Variable impedance type static VAR generators - V-I characteristics and control schemes of TCR, TSR, TSC. QD-QO characteristic and control scheme of TSC-TCR. Switching converter type VAR generators – V-I characteristics and control schemes of STATCOM. Hybrid VAR generators – V-I characteristics of SVC and STATCOM, regulation of V-I slope. Applications of static shunt compensators – Voltage regulation, improvement in transient stability, prevention of voltage instability, power oscillation damping. Comparison of static shunt compensators.

Module 3: STATIC SERIES COMPENSATION ***(10 Periods)***

Expression for real and reactive power flow with series line compensation. Variable impedance type series compensators: V-I characteristics and control schemes of GCSC, TSSC, TCSC-modes of operation. Sub-synchronous resonance. Switching converter type series compensator – V-I characteristics, internal and external control schemes of SSSC. Applications of static series compensators – improvement in transient stability, power oscillation damping. Comparison of static series compensators.

Module 4: STATIC PHASE ANGLE REGULATORS AND COMBINED COMPENSATORS ***(10 Periods)***

Power flow control by phase angle regulators - Concept of voltage and phase angle regulation. Operation and control of TCVR and TCPAR. Switching converter type phase angle regulators. Objectives of TCPAR - improvement of transient stability, power oscillation damping. UPFC – Principle, expression for real and reactive power between two nodes of UPFC, independent real and reactive power flow control using UPFC, control schemes of UPFC - operating principle and characteristics of IPFC.

Module 5: CO-ORDINATION OF FACTS CONTROLLERS ***(08 Periods)***

FACTS controller interactions – interaction between multiple SVC's – interaction between multiple TCSC's – SVC-TCSC interaction – Coordination of multiple controllers using linear control techniques. Comparative evaluation of different FACTS controllers: performance comparison and cost comparison, Control coordination using Genetic Algorithm, Future direction of FACTS technology.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. The students shall understand various significance IEEE standards, position and sizing of the various FACTs Controllers in power system networks.
2. The students must visit to nearby Power/Process/Production industry to know about various types of power factor improvement techniques and reactive power compensation schemes to be followed for economic savings.

3. The students must follow the standard practices for operating/switching /maintenance/commissioning process of the FACTs Controllers in any commercial industry and society.
4. Should collect the literature and information on various types of FACTs Controllers present across the globe and its significance on electrical grids.
5. Should collect various power grid connected of FACTs Controllers and their controller models for evaluations of network reliability.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

TEXT BOOKS:

1. Narain G. Hingorani, Laszi Gyugyi, *"Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems",* Wiley-IEEE Press, 1999.
2. R. Mohan Mathur and Rajiv k. Varma, "*Thyristor based FACTS Controllers for Electrical Transmission Systems",* Wiley-IEEE Press, 2002.

REFERENCE BOOKS:

1. Xiao-Ping, Rehtanz, Christian, Pal, Bikash, "*Flexible AC Transmission Systems: Modeling and Control",* Springer Power Systems Series, 2006.
2. T.J.E. Miller, *Reactive Power Control in Electric Systems,* Wiley, 1982

VIDEO LECTURES:

1. https://nptel.ac.in/courses/108107114
2. https://digimat.in/nptel/courses/video/108107114/L01.html
3. https://dituniversity.digimat.in/nptel/courses/video/108107114/L08.html
4. http://www.nitttrc.edu.in/nptel/courses/video/108107114/L07.html

WEB RESOURCES:

1. https://www.elprocus.com/flexible-ac-transmission-system-need-definition-types/
2. https://www.electrical4u.com/facts-on-facts-theory-and-applications/
3. https://www.sciencedirect.com/topics/engineering/flexible-ac-transmission-systems
4. https://www.site.uottawa.ca/~rhabash/ELG4125FACTS.pdf
5. https://www.gegridsolutions.com/facts.htm

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE104035	POWER QUALITY	3	-	2	4	5

Pre-Requisite 22EE102009-Power System Analysis
22EE101011-Power Electronics.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Power Quality concepts; harmonics and power quality standards and monitoring; power quality enhancement using custom power devices; power quality issues in distributed generation.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the conceptual knowledge of power quality and it's standards to analyze, monitor and mitigate various power quality issues.

CO2. Apply the knowledge of filters to mitigate harmonic distortion due to industrial and commercial loads.

CO3. Apply the conceptual knowledge on various power quality instruments to select and use appropriate equipment for monitoring and measurement of power quality.

CO4. Apply the conceptual knowledge of various custom power devices to enhance power quality for specific applications.

CO5. Demonstrate the conceptual knowledge of distributed generation to analyze the power quality issues in power systems.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	1	-	2	3	-	-	-	-	-	2	1
CO2	3	3	3	-	2	-	2	-	-	-	-	-	-	2	2
CO3	3	2	1	-	2	-	1	-	-	-	-	-	-	2	2
CO4	3	3	2	-	2	-	1	-	-	-	-	-	-	2	2
CO5	3	2	2	-	-	-	1	-	-	-	-	-	-	2	2
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	2	2
Course Correlation Mapping	3	2	2	--	2	--	1	3	3	3	--	--	--	2	2

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: FUNDAMENTALS OF POWER QUALITY **(10 Periods)**

Introduction, Definition of Power Quality, Classification of Power Quality Issues, Power Quality Standards, Categories and Characteristics of Electromagnetic Phenomena in Power Systems: Impulsive and Oscillatory Transients, Interruption, Sag, Swell, Sustained Interruption, Under Voltage, Over Voltage, Outage. Sources and causes of different Power Quality Disturbances.

Module 2: HARMONICS & APPLIED HARMONICS **(10 Periods)**

Harmonic Distortion, Voltage Vs Current Distortion, Harmonics Vs Transients, Power System Qualities under Non-Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads. Applied Harmonics: Effects of Harmonics, Harmonic Distortion Evaluations, Principles of controlling harmonics, devices for Controlling Harmonic Distortion.

Module 3: POWER QUALITY MONITORING **(08 Periods)**

Power quality benchmarking, monitoring considerations, choosing monitoring locations, permanent power quality monitoring equipment, historical perspective of power quality measuring instruments, power quality measurement equipment-types of instruments, assessment of power quality measurement data, power quality monitoring standards.

Module 4: POWER QUALITY ENHANCEMENT USING CUSTOM POWER DEVICES **(09 Periods)**

Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL) -Solid State Breaker (SSB) -Solid State Transfer Switch (SSTS). Compensating Type: Dynamic Voltage Restorer, Distribution STATCOM and Unified Power Quality Conditioner – operation, realization, and control of DVR, DSTATCOM, and UPQC – load compensation.

Module 5: POWER QUALITY ISSUES IN DISTRIBUTED GENERATION **(08 Periods)**

DG Technologies, Perspectives on DG benefits- Interface to the Utility System - power quality issues affected by DG - Operating Conflicts: Utility fault-clearing, Reclosing, Interference with relaying, Voltage regulation issues, Islanding - siting DG.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXPERIMENTS: (Minimum 10 exercises shall be conducted)

1. Study the power quality characteristics as per IEEE/IEC standards.
2. Analyze harmonics in inrush currents drawn by the transformer.
3. Analyze harmonics due to capacitor switching transients.

4. Analyze power quality due to interruptions and flickering.
5. Analyze harmonics in various inverter configurations.
6. Analyze power quality due to voltage swell and sag.
7. Harmonic analysis and Single tuned filter design to mitigate harmonics.
8. Estimation of Harmonics caused by Industrial drives in a power system network.
9. Determination of Power quality issues while grid integration.
10. Design a DVR to mitigate voltage sag.
11. Measurement Harmonics in industrial drive using PQ analyzer.
12. Measurement of various power quality issues in a power system network using PQ analyzer.

RESOURCES

TEXT BOOKS:

1. Roger C. Dugan, Mark E. Mc. Granaghan, Surya Santosoh and H. Wayne Beaty, *Electrical Power Systems Quality,* 2nd edition, TATA McGraw Hill, 2010.
2. ArindamGhosh, Gerard Ledwich, *Power Quality Enhancement Using Custom Power Devices*, Springer, 2002.

REFERENCE BOOKS:

1. Math H J Bollen, *Understanding Power Quality Problems*, IEEE Press, 1998.
2. C. Sankaran,*Power quality*, CRC Press, 2002.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=19eIVIVBrfE&list=PLp6ek2hDcoNBczPs_OoWYh4Siixdm20wQ
2. https://www.youtube.com/watch?v=z_E8uvhTrwY&list=PLLy_2iUCG87BPAd2561uroIhkb1zoywH6
3. https://www.youtube.com/watch?v=DiHIREIkwqs&list=PLy0RL0cwiTufq1TbbQe333f_faQeL24Bk
4. https://www.youtube.com/watch?v=z_E8uvhTrwY

WEB RESOURCES:

1. https://nptel.ac.in/courses/108106025
2. https://nptel.ac.in/courses/108106025
3. https://nptel.ac.in/courses/108102179/
4. https://nptel.ac.in/courses/108107157

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101036	**POWER SYSTEM AUTOMATION**	3	-	-	-	3

Pre-Requisite 22EE101022-Power Systems Operation and control

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Power system control and deregulation; Power system automation, Substation and distribution automation; Energy control canters.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the various modes of power system operation and interpret various market models of deregulated power system.

CO2. Understand the power system automation procedures, communication systems, and norms for data acquisition for automation.

CO3. Understand the role and responsibility of a substation automation architectures and their technical issues for automation

CO4. Understand the role and responsibility of transmission control center in monitoring and maintaining the security of the transmission network following the relevant standards.

CO5. Understand the role and responsibility of distribution control centre to automate the distribution system using distributed management system following the relevant standards.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	1	-	-	-	-	2	-	1	2	3
CO2	3	-	-	-	-	1	-	-	-	-	2	-	1	2	3
CO3	3	-	-	-	2	1	1	2	-	-	-	-	1	2	3
CO4	3	-	-	-	2	1	1	1	-	-	-	-	1	2	3
CO5	3	-	-	-	2	1	1	1	-	-	-	-	2	2	2
Course Correlation Mapping	3	-	-	-	2	1	1	1	-	-	2	-	1	1	3

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: POWER SYSTEM CONTROL AND DEREGULATION ***(09 Periods)***
Introduction — Operation of power systems and modes, Organization and operator activities, Investment factor and control centre experiences. Deregulation — need for deregulation and Advantages of deregulation in power system; Restructuring Models — PoolCo. Model, Bilateral Model and Hybrid Model; Independent system operator (ISO) — Role of ISO; Congestion Management.

Module 2: POWER SYSTEM AUTOMATION ***(09 Periods)***
Evolution of automation systems; SCADA in Power system; Building blocks of SCADA system; Remote terminal unit; Intelligent electronic devices; Data concentrators and merging units; SCADA communication systems; Master station; Human-machine interface; Classification of SCADA systems.

Module 3: SUBSTATION AUTOMATION ***(09 Periods)***
Substation automation, conventional automation; new smart devices for substation automation; new integrated digital substation; technical issues new digital simulation; Substation automation architectures; substation automation applications functions; Benefits of data warehousing.

Module 4: ENERGY CONTROL CENTERS ***(09 Periods)***
Introduction — Energy control centers; EMS framework; Data acquisition and communication; Generation operation and management; Transmission operations and management: Real time Study-mode Simulations; Post-event analysis and energy scheduling and accounting; Dispatcher training simulator; Smart transmission.

Module 5: DISTRIBUTION AUTOMATION ***(09 Periods)***
Introduction to Distribution automation — Customer, feeder and substation automation; Subsystems in a distribution control center; Distributed Management System (DMS) framework integration with subsystems; advanced real-time DMS applications; Advanced analytical DMS applications; DMS coordination with other systems.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. The students shall understand the various IEEE technical and commercial standards for automation of software and hardware applications in grids that are followed in the globe for establishments of new technologies.
2. The students to visit a nearby an automation industry/smart substations to know about various types of sensors used in the power system automation. The role of data collection for development of advanced technologies required for better performance.
3. Should understand the Virtualized Learning Platform for Substation Automation and Industrial Control Cyber security practices followed during the switching operations /protection schemes/maintenance process/commissioning procedures.
4. Should collect the information about various types of Energy Management Systems and their Exhaustive Parametric, Comprehensive Analysis of Existing Trends, Significance, Opportunities, and Challenges.
5. Should collect various types of frame works for Distributed Management System and their cyber security requirements for Distribution automation.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

TEXT BOOKS:

1. M Shahidehpour, Muwaffaq Alomoush, *Restructured electrical power systems operation, trading and volatility,* CRC Press, 1st Edition, 2001.
2. Mini S Thomas and John D Mc Donald, *Power System SCADA and Smart Grids,* CRC Press, 1st Edition 2015.

REFERENCE BOOKS:

1. Torsten cegrell, *Power systems control Technology,* Prentice Hall, 1st Edition, 1986.
2. James Northcote-Green and Robert Wilson, *Control and Automation of Electrical Power Distribution Systems,* CRC Press, 1st Edition, 2013.
3. Edmund Handschin, *Real time control of Electric Power System,* Elsevier Publishing Company, 1st Edition, 1972.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/108106022/8.
2. https://nptel.ac.in/courses/108/101/108101005/
3. https://www.google.com/search?sca_esv=558584954&q=POWER+SYSTEM+AUTOMATION&tbm=vid&source=lnms&sa=X&ved=2ahUKEwjv5ryi5uuAAxVKU94KHSpuDkAQ0pQJegQICxAB&biw=1536&bih=707&dpr=1.25#fpstate=ive&vld=cid:7fa8f0b9,vid:AGSW0KqnzwQ

WEB RESOURCES:

1. https://www.eit.edu.au/cms/courses/industrial-automation-instrumentationprocess-control/professional-certificate/in-iec-61850-based-substation-automation.
2. https://www.automationit.com/blog/8-automated-power-systems
3. https://scadahacker.com/library/Documents/ICS_Basics/InTech%20-%20Power%20System%20and%20Substation%20Automation.pdf
4. https://www.jcboseust.ac.in/electrical/images/notes/unit6_scada_system.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101037	**RESTRUCTURED POWER SYSTEMS**	3	-	-	-	3

Pre-Requisite 22EE102009-Power System Analysis

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on features of restructured power systems, market models, information and transmission services, electricity pricing and forecasting, and ancillary services management.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the conceptual knowledge of deregulation for various market models, electricity pricing, and forecasting methods in a competitive market.

CO2. Apply the conceptual knowledge of deregulation for various market models, electricity pricing, and forecasting methods in restricted power systems.

CO3. Analyze market models to provide power exchange, and regulate congestion in tie-lines of deregulated power systems.

CO4. Analyze market models to develop various forecasting methods for pricing, planning and operation of deregulated power systems.

CO5. Apply the conceptual knowledge of deregulation for various ancillary service management in the competitive market.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	2	-	-	-	-	-	-	-	2	3
CO2	3	2	-	-	-	2	-	-	-	-	-	-	-	2	3
CO3	3	2	--	-	-	2	-	-	-	-	2	-	-	2	3
CO4	3	2	3	-	3	2	-	-	-	-	-	-	-	2	3
CO5	3	-	-	-	-	2	-	-	-	-	-	-	-	2	3
Course Correlation Mapping	**3**	**2**	**3**	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: OVERVIEW OF KEY ISSUES IN ELECTRIC UTILITIES (08 Periods)

Introduction: Deregulation, need for deregulation, Advantages of deregulation in power system. Restructuring Models: PoolCo Model, Bilateral Model, Hybrid Model: independent system operator (ISO), Role of ISO. Power exchange, market operations, market power, standard cost, transmission pricing, congestion pricing and management of congestion.

Module 2: MARKET MODELS IN RESTRICTED POWER SYSTEMS (08 Periods)

Introduction: Market models based on contractual arrangements: Monopoly model, Single buyer model, Wholesale competition model, Retail competition model. Comparison of various market models. Market architecture: Day-ahead and Hour-Ahead Markets, Block forwards Market, Transmission Congestion Contracts (TCCs), and Ancillary service market.

Module 3: OASIS: OPEN ACCESS SAME-TIME INFORMATION SYSTEM (09 Periods)

Structure of OASIS: Functionality and Architecture of OASIS, information requirement of OASIS, Transfer Capability on OASIS: Definitions, Transfer Capability Issues, ATC Calculation, TTC Calculation, TRM Calculation, CBM Calculation. Transmission Services, Methodologies to Calculate ATC.

Module 4: ELECTRICITY PRICING - VOLATILITY, RISK, AND FORECASTING (10 Periods)

Electricity pricing: introduction, electricity price volatility, electricity price indexes. Challenges to Electricity Pricing: Pricing Models, Reliable Forward Curves. Construction of Forward Price Curves: Time frame for Price Curves, Types of Forward Price Curves: Short-term Price Forecasting, Factors Impacting Electricity Price, Forecasting Methods, Analyzing Forecasting Errors.

Module 5: ANCILLARY SERVICES MANAGEMENT (10 Periods)

Introduction: Types of ancillary services, Classification of ancillary services, Load-generation balancing related services: Frequency regulation, Load following, Spinning reserve services. Voltage control and reactive power support services: Generators, Synchronous condensers, Capacitors and inductors, SVCs, STATCOMs- Black start capability service.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Develop a market model to reduce the cost for generation, transmission and distribution.
2. Study the functioning if power exchange in India and prepare a technical report on the operational aspects for the day of observation.
3. Develop a forecasting model to predict the price of electricity in a competitive marker.
4. Develop a model to manage ancillary services in a competitive environment.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Kankan Bhattacharya, Math H.J. Buller, Jalap E. Daladier, *Operation of Restructured PowerSystem*, Kluwer Academic Publisher, 2001.
2. Mohammad Shahidehpour, and MuwaffaqAlomoush, - *Restructured Electrical Power Systems – Operation, Trading and Volatility,* Marcel Dekker, Inc. 2001.

REFERENCE BOOKS:

1. Loi Lei Lai, *Power system Restructuring and Deregulation*, John Wiley & Sons Ltd., England, 2001.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=aM9CrGHFlg4
2. https://www.youtube.com/watch?v=OxWXRGs_Gec
3. https://www.youtube.com/watch?v=l9I2jWEnyEA

WEB RESOURCES:

1. https://nptel.ac.in/courses/108101005/2
2. https://posoco.in/

SPECILAIZAION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101403	**PLC and SCADA**	3	-	-	-	3

Pre-Requisite 22EC102010-Digital Design

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on PLC ladder diagrams, programming on PLC, timers, counters and sequences used in PLC, Display Conventions and Navigation, Remote Terminal Units, Master Terminal Units, SCADA Works Station Application Programmes.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Develop ladder diagrams for various industrial operations and societal applications.

CO2. Develop ladder diagrams for various industrial operations using PLC Timer and Counter functions.

CO3. Develop ladder diagrams for various industrial operations and societal applications using Intermediate and Data handling functions.

CO4. Demonstrate knowledge on various elements of SCADA Software.

CO5. Analyse the industrial process by using various displays in SCADA software and provide appropriate solutions.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	-	3	3	3	-	-	-	-	-	3	-	-
CO2	3	3	3	-	3	3	3	-	-	-	-	-	3	-	-
CO3	3	3	3	-	3	3	3	-	-	-	-	-	3	-	-
CO4	3	-	-	-	3	2	2	-	-	-	-	-	3	-	-
CO5	3	-	-	-	3		2	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: PLC BASICS AND PROGRAMMING ***(10 Periods)***

Introduction, PLC system, CPU, I/O modules and interfacing, power supplies, Programming equipment, Programming formats, Construction of PLC ladder diagrams, Devices connected to I/O modules. Input instructions, Outputs, Operational procedures.

Module 2: LADDER DIAGRAMS, REGISTERS AND TIMER FUNCTIONS ***(10 Periods)***

Digital logic gates, Boolean algebra PLC programming, Fail-Safe Circuits, characteristics of Registers, module addressing, holding registers, Input Registers, Output Registers. Timer function & Counter function .

Module 3: INTERMEDIATE AND DATA HANDLING FUNCTION ***(09 Periods)***

Intermediate functions: Arithmetic functions, Number comparison functions, Number conversion functions. Skip, Master control relay, Jump functions, Sequencer functions and applications, Controlling of two-axis & three axis Robots with PLC, Matrix functions.

Module 4: The Elements of SCADA Software ***(10 Periods)***

SCADA System Architecture - Field Devices and Signals, Programmable Process Controller, Communication Network, Central Control Facilities, Display Conventions and Navigation. Remote Terminal Units-Discrete control, analog control, Monitor discrete signals, monitor analog signals, Master terminal Units.

Module 5: SCADA WORKS STATION APPLICATION PROGRAMME ***(06 Periods)***

Identifying the process areas, configuring HMI applications. Process Graphic Displays-Current Process Operations, Equipment Control Displays, Alarm and Event Summaries, Trends and Historical Reports, Maintenance Displays. Configuration of I/O Server, System graphic displays Sample Application: Water Treatment Plant SCADA System.

Total: 45 Periods

EXPERIENTIAL LEARNING

1. Programme a PLC for DC Motor speed control.
2. Programming a PLC for Bottle filling system.

(Note: It’s an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. John W. Webb & Ronald A. Reiss, *Programmable Logic Controllers Principles and Applications*, 5th edition, PHI, 2009.
2. Stuart G. Mc. Crady, *Designing SCADA Application Software A Practical Approach*, 1st Elsevier, 2013.

REFERENCE BOOKS:

1. Frank D. Petruzella, *Programmable Logic Controller*, 3rd edition, Tata McGraw-Hill Edition 2010.
2. Stuart A. Boyer, *Supervisory Control and Data Acquisition*, 3rd edition, ISA 2004.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me67/preview
2. https://www.udemy.com/course/plc-programming-from-scratch/

WEB RESOURCES:

1. https://openautomationsoftware.com/use-cases/allen-bradley-wpf-scada/
2. https://new.siemens.com/global/en/products/automation/industry-software/automation-software/scada.html
3. https://ab.rockwellautomation.com/Programmable-Controllers

SPECILAIZAION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101103	**INDUSTRIAL INSTRUMENTATION**	3	-	-	-	3

Pre-Requisite 22EC101401-Sensors and Signal Conditioning

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on Measurement of humidity, Viscosity, Density, Pressure, Level and Flow parameters; Signal Conditioning & Safety Instruments.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply suitable densitometer, viscometer and hygrometer for measurement of density, viscosity and humidity for a specific application.

CO2. Select an appropriate pressure transducer for an industrial requirement.

CO3. Select an appropriate level transducer for measurement of level for a specific application.

CO4. Select an appropriate flow transducer for an industrial requirement.

CO5. Design signal conditioning circuit for temperature, pressure and level transducers.

CO6. Demonstrate the safety instruments, requirements for safety and standards.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO2	2	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO3	2	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO4	2	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DENSITY, VISCOSITY & HUMIDITY MEASUREMENT *(11 Periods)*

Density Measurement: Introduction, pressure head type, displace type, float type, buoyancy effect densitometer method, hot-wire gas bridge type, vibration type, radioactive method.

Viscosity Measurement: Introduction, friction tube viscometer, saybolt's viscometer, rotameter viscometer, searle's rotating cylinder, cone and plate viscometer. Consistency meter – rotating vane type and oscillating type.

Humidity Measurement: Psychrometer, hygrometer & types, dew point device. Analysis and selection of density, viscosity and humidity sensors.

Module 2: PRESSURE MEASUREMENT *(08 Periods)*

Introduction: Dead weight gauges, manometer and its types, elastic transducers – Bourdon tube, diaphragm, bellows, electrical types, resistive, inductive and capacitive, force balance & vibrating cylinder.

High pressure measurement: Very high pressure transducer (Bulk modulus Gage).

Low Pressure (Vacuum) measurement: McLeod Gage, Knudsen Gage, Momentum transfer gage, Thermal conductivity gage, Ionization gage, Sound level meter, Microphone. Analysis and selection of pressure sensors.

Module 3: LEVEL MEASUREMENT *(07 Periods)*

Introduction, Gauge Glass technique, Float Types – Float–and– tape method, Float–and–shaft method, Magnetic float types. Displacer types, Hydrostatic types – Air-Purge type,

Bubbler type. Thermal effect types, Electrical types – Resistance switch type, Inductive and Capacitance type. Ultrasonic methods, bellow element type level transmitters, Fibre - optic type, Analysis and selection of level sensors.

Module 4: FLOW MEASUREMENT *(10 Periods)*

Introduction, Head types – Orifice, Venturi, Flow Nozzle, Dahl Tube, Pitot tube, Area Flow meter - Rotameter & types, Mass flow meters – Turbine Mass flow meter, Coriolis flow meter, Gyroscopic flow meter, Liquid bridge mass flow meter, Calorimetric flow meter. Positive Displacement type flow meters - Nutating Disc, Rotary Vane, Lobed Impeller, Reciprocating Piston type, Fluted Rotor. Electrical type flow meter – Turbo magnetic flow meter, Electromagnetic flow meter, Ultrasonic flow meter, Hotwire anemometer type, Vertex Shedding type. Analysis and selection of Flow sensors.

Module 5: SAFETY INSTRUMENTS *(09 Periods)*

Proximity Sensors, Limit switches, ***Electrical & Intrinsic Safety:*** NEMA types, Fuses & Circuit breakers. ***Explosion hazards & intrinsic safety*** – Protection methods, Purging, pressurization, ventilation.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Design and verification of converters using op-amps in Multisim.
   a) I to V
   b) V to I
2. Design and verification of resistance measurement, conversion in Multsim using
   a) Op-Amp
   b) Wheatstone bridge for improving sensitivity, compensation and linearity.
3. Design and verification of level measurement using Simulation software.
4. Design and verification of Speed measurement using Simulation software.
5. Design and verification of temperature measurement using Simulation software.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. D. Patranabis, Principles of Industrial Instrumentation, TMH, 3rd Edition, 2010.
2. A. K. Sawhney, A Course in Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai and Sons, 19th edition, 2011.

REFERENCE BOOKS:

1. Bela G Liptak, *Instrument Engineers' Handbook: Process Measurement and Analysis*, CRC Press - Butterworth Heinemann, 4^{th} Edition, 2003.
2. Ramon Pallás Areny, John G. Webster, *Sensors and Signal Conditioning*, John Wiley and Sons, 2^{nd} Edition, 2000.
3. Ernest Doebelin, Dhanesh Manik, *Measurement Systems*, McGraw-Hill International, 6^{th} Edition, 2011.

SOFTWARE/TOOLS:

1. NI Labview 2018
2. NI Circuit Design Suite – Multisim 2019
3. NI myRIO
4. NI ELVIS

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/103105130/L46.html
2. https://www.youtube.com/watch?v=gByrUkZUnKo
3. https://www.youtube.com/watch?v=sHmjE21Fp9w

Web Resources:

1. https://nptel.ac.in/courses/108105064/
2. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/108105064/lec1.pdf
3. https://www.ibiblio.org/kuphaldt/socratic/sinst/book/liii.pdf
4. https://www.ni.com/pdf/manuals/320999e.pdf
5. https://ieeexplore.ieee.org/document/8960023/
6. http://www.ni.com/pdf/manuals/376047c.pdf
7. http://www.ni.com/pdf/manuals/374629c.pdf
8. http://www.ni.com/pdf/manuals/373363f.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101105	**BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course deals with the concepts of Physiology of Cardiovascular, Nervous and Respiratory System; Generation and propagation of bioelectrical signals; Therapeutic and Imaging equipment.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Demonstrate knowledge on Bioelectric Potentials and various electrodes for measuring Potentials.

CO2 Analyze ECG signals and measure various cardiovascular parameters.

CO3 Analyze EEG and EMG signals and measure various parameters in neuro muscular and respiratory systems.

CO4 Demonstrate the working of various therapeutic instruments.

CO5 Demonstrate the working of imaging instruments used for diagnosis by following ethical values.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	2	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	2	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	3	-	-	-	-	-	-	3	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**	**-**	**3**	**2**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: BIO- POTENTIAL SIGNALS AND ELECTRODES ***(09 Periods)***

Bio-signals and their characteristics, Organization of cell, Nernst equation of membrane, Resting and Action potentials. Bio-amplifiers, characteristics of medical instruments, problems encountered with measurements from living systems. Bio-potential electrodes – Body surface recording electrodes, Internal electrodes, micro electrodes. Bio-chemical transducers – reference electrode, the pH electrodes, Blood gas electrodes

Module 2: CARDIOVASCULAR INSTRUMENTATION ***(09 Periods)***

Heart and cardiovascular system Heart electrical activity, blood pressure and heart sounds. Cardiovascular measurements electro cardiography – electrocardiogram, ECG Amplifier, Electrodes and leads, ECG recorder principles. Types of ECG recorders. Principles of blood pressure and blood flow measurement.

Module 3: NEUROLOGICAL INSTRUMENTATION ***(09 Periods)***

Neuronal communication, electro encephalogram (EEG), EEG Measurements EEG electrode-placement system, interpretation of EEG, EEG system Block diagram, preamplifiers and amplifiers. EMG block diagram and Stimulators.

Module 4: EQUIPMENT FOR CRITICAL CARE ***(09 Periods)***

Therapeutic equipment – Pacemaker, Defibrillator, Shortwave diathermy, Hemodialysis machine. Respiratory Instrumentation – Mechanism of respiration, Spirometry, Pneumotachograph, Ventilators.

Module 5: MEDICAL IMAGING SYSTEM ***(09 Periods)***

Ultrasonic Imaging: Doppler principle, Modes of Display: A-Mode, B-Mode and Echocardiography. Computed Tomography: Block diagram of CT scanner, Applications of Computed Tomography. MRI Imaging System, Cine angiogram, Endoscope.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Measure the of Blood pressure of a patient.
2. Analysis of ECG for different lead configurations.
3. Analysis of EEG Signals.
4. Analysis of EMG Signals.
5. Design of Instrumentation Amplifier for bioelectrical Signals.
6. Study the Real time EPR System.
7. Test the electrical safety of biomedical equipment.
8. Record the heart sounds using phonocardiogram
9. Design an electronic circuit for synchronous pacemaker.
10. Measure blood oxygen saturation using pulse oximeter.

(Note: It’s an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Leslie Cromwell, Fred. J. Weibell and Erich. A. Pfeiffer, *Biomedical Instrumentation and Measurements*, 2^{nd} Edition, PHI, 2003.
2. R.S. Khandpur, *Hand Book of Biomedical Instrumentation*, Tata McGraw Hill, 2^{nd} Edition, 2002.

REFERENCE BOOKS:

1. John G.Webster, *Medical Instrumentation Application and Design*, 3^{rd} Edition, Wiley India Pvt. Ltd., 2004.
2. M. Arumugam, *Biomedical Instrumentation*, Anuradha Publications.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc22_bt56/preview
2. https://onlinecourses.nptel.ac.in/noc21_ee105/preview

Web Resources:

1. https://www.nibib.nih.gov›science-education›students-resource
2. https://www.who.int›medical_devices›support
3. http://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering
4. https://www.labster.com/simulations?institution=university-college

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101112	**POWER PLANT INSTRUMENTATION**	3	-	-	-	3

Pre-Requisite 22EC101103-Industrial Instrumentation

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on different methods of power generation; Instrumentation and control in water and air-fuel circuit; Turbine monitoring and control; Power plant maintenance.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on different power generation methods.

CO2. Analyze the various parameters like temperature, pressure, level measured in power plant.

CO3. Apply different control schemes in water circuit and air fuel circuits.

CO4. Select suitable instruments to measure and control various parameters of turbine.

CO5. Demonstrate knowledge on safety and maintenance of instruments.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	3	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	-	-	-

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: AN OVERVIEW OF POWER GENERATION ***(09 Periods)***

Methods of power generation: Hydro, Nuclear, Solar, Wind, Thermal, Tidal, Geothermal, classification of instruments in a power plant, Objectives of instrumentation and control, Cogeneration.

Module 2: INSTRUMENTATION IN WATER CIRCUIT AND AIR-FUEL CIRCUIT ***(10 Periods)***

Measurements in water circuit: Water circuit, Water flow measurement, Differential pressure transmitter, Steam flow measurement, Water and Steam pressure measurements, Water and steam temperature measurements, Drum water level measurement in power plant.

Measurements in Air-fuel circuit: Air-fuel circuit- fuels, Combustion air, Flue gases, Waste gases, Measurement of Flow/Quantity, Pressure, Temperature, level in power plant.

Module 3 CONTROLS IN WATER CIRCUIT AND AIR-FUEL CIRCUIT ***(10 Periods)***

Controls in water circuit: Boiler drum level- single element drum level control, Superheated steam temperature control- waterside steam temperature control, Cascade steam temperature control, Feed forward-plus-feedback steam temperature control, Fire side steam temperature control, Steam pressure control.

Controls in Air-fuel circuit: Combustion control, Furnace draft control.

Module 4 TURBINE MONITORING AND CONTROL ***(08 Periods)***

Principal parts of steam turbine, Turbine measurements- Process parameters, Mechanical parameters, Electrical parameters, Turbine control system- safety control systems, process control systems, Lubrication system, Controls in lubrication system, Turbo alternator cooling system.

Module 5 POWER PLANT MAINTENANCE AND SAFETY ***(08 Periods)***

Maintenance of measuring instruments- Types of maintenance, Maintenance costs, Life cyclecosts, Intrinsic and electrical safety- Intrinsic safety of instruments, Electrical safety, Explosion hazards and intrinsic safety, Interlocks for boiler operation- safety interlocks, start-up and shut down interlocks.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Develop a closed loop set to monitor pressure and level of water in the boiler using cascade controller
2. Build a feedback set up to monitor temperature of water in the boiler using suitable controller.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. K. Krishnaswamy, M. Ponni Bala, *Power Plant Instrumentation*, PHI, 2010.

REFERENCE BOOKS:

1. Patranabis*, Principles of Industrial Instrumentation*, Mcgraw Hill, 2nd Edition, 2001
2. A.R.Mallick, *Practical boiler operation engineering and power plant*, Denett & Co., 2nd Edition, 2010.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc20_me10/preview
2. https://nptel.ac.in/courses/112/107/112107291/

Web Resources:

1. https://www.iare.ac.in/sites/default/files/IARE_PPCI_LN_0.pdf
2. https://somemmec.files.wordpress.com/2015/10/thermal-plant-control-instrumentation-i.pdf
3. https://www.sustainable-carbon.org/wp-ntent/uploads/dlm_uploads/reports/powergeneration/instrumentation-and-control-in-coal-fired-power-plant-ccc-56.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101031	**FINITE ELEMENT ANALYSIS FOR ELECTRICAL MACHINES**	3	-	-	-	3

Pre-Requisite 22EE102006-Electrical Machines-II

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with the fundamental types and steps on finite element methods, finite element analysis on single-phase transformers and synchronous generators, electromagnetic analysis, thermal analysis, and vibration analysis

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on various types of finite element methods and its procedure on electrical machines

CO2. Analyze the performance of single-phase transformer and synchronous generator under no load and loaded conditions using finite elements.

CO3. Analyze the electromagnetics analysis on permanent magnet motors and induction motors under different stages.

CO4. Analyze the thermal behavior of electrical motors and also the impact of the cooling system on the motor performance.

CO5. Analyze the performance of electric motors by applying the concepts of vibration and noise

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	2	2	1	3	-	-	-	-	-	2	-	3
CO2	3	2	-	2	2	1	3	-	-	-	-	-	2	-	3
CO3	3	2	-	1	2	1	2	-	-	-	-	-	3	-	3
CO4	3	2	-	1	2	1	3	-	-	-	-	-	2	-	3
CO5	3	2	1	1	2	1	3	-	-	-	-	-	2	-	3
Course Correlation Mapping	**3**	**2**	**1**	**1**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION **(09 Periods)**

Field Problems with Boundary Conditions, Classical Method for the Field Problem Solution, Galerkin's Method, Rayleigh-Ritz's Method, The Finite Element Method, Simple Descriptions of Electromagnetic Fields, Reduction of the Field Problem to a Two-Dimensional Problem, Boundary Conditions— Dirichlet's Condition, Neumann's Condition, Periodic Condition. Computation of the Solved Structure.

Module 2: FINITE ELEMENT ANALYSIS ON ELECTRICAL MACHINES (09 Periods)
The Single-Phase Transformer – Introduction, Equivalent Electric Circuit of the Transformer, Computation of the No-Load Inductances, Determination of the Leakage Inductances.
Synchronous Generators – Introduction, Computation of the No-Load Characteristic, Computation of the Direct-Axis Inductance, Computation of the Quadrature Axis Inductance, Self- and Mutual Inductances, Computation of Ld and Lq with Any Current, Computation of the Machine Characteristics

Module 3: FEA OF ELECTROMAGNETICS IN ELECTRICAL MACHINES (09 Periods)
Single phase linear PM motors— preprocessor stage, postprocessor stage. Rotatory PMSMs— BLDC motor preprocessor stage, BLDC motor analysis post processor stage. Three phase induction machines— Ideal no-load, rotor bar skin effect.

Module 4: THERMAL PROBLEMS IN ELECTRICAL MACHINES (09 Periods)
Introduction, heat extraction through conduction, heat extraction through convection, heat extraction through radiation, thermal network based on lumped parameters, thermal analysis using finite element method, thermal analysis using computational fluid dynamics, thermal parameters determination, losses in brushless permanent magnet machines, cooling systems.

Module 5: VIBRATION AND NOISE ANALYSIS IN ELECTRICAL MACHINES (09 Periods)
Sources of noise, procedures for investigating noise and vibration, calculation of natural frequencies, Nodal force density, Decomposition of radial force density, features of harmonics for radial force density surface, Acoustic analysis, Estimation of damping ratio, source identification and vibration reduction, Numerical methods for acoustic analysis, computation process of acoustic noise.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Design a 250 W, 600 RPM, internal permanent magnet motor for electric vehicle applications by using motoranalysis software.
2. Design a 2 kW, 3000 RPM brushless DC motor for electric vehicle applications by using motoranalysis software.
3. Design a 48 V, 36 A PMSM motor for drone applications by motoranalysis software.
4. Design a 48 V, 36 A BLDC motor for drone applications by FEMM software.
5. Simulate the thermal analysis on 60 V, 2 kW, 3000 RPM PMBLDC motor using FEA packages.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Nicola Bianchi, *Electrical Machine Analysis Using Finite Elements*, CRC Press, 2005.
2. Ali Emadi, *Switched Reluctance Motor Drives*, CRC press, 2019.

REFERENCE BOOKS:

1. Jacek F. Gieras, Chong Wang, Joseph Cho Lai, *Noise of polyphase electric motors*, CRC/Taylor & Francis, 2006
2. S. J. Salon, *Finite Element Analysis of Electrical Machines*, Springer New York, NY, 1995.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=YE0R8jHi9HI&list=PLOzRYVm0a65evnes6W1TFYThU8-4hfqwc&index=4
2. https://www.youtube.com/watch?v=fyNunbunel8&list=PLSGws_74K018SmggufD-pbzG3thPIpF94&index=4

WEB RESOURCES:

1. https://drive.google.com/file/d/1wiyJuqohQMM8lPlCGI2hVKD1cLqO6cTP/view
2. http://www.aedie.org/eeej/webrevista/articulos/librosONLINE/EFRBP2006FULL.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101040	UTILIZATION OF ELECTRICAL ENERGY	3	-	-	-	3

Pre-Requisite 22EE102001-Electrical Circuits.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with different types and characteristics of electric drives; types of electric heating and welding; Fundamentals and various methods of Illumination; electric traction; electrolysis, Extraction, and refining of metals.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply the appropriate electric drives for various industrial applications.

CO2. Understand the different types of heating and welding techniques.

CO3. Design an illumination system for the proper lighting system.

CO4. Understand the basic principle and different braking techniques of electric traction.

CO5. Understand the basic principle and applications of the electrolytic process.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	2	-	-	-	-	-	-	2	-	3
CO2	2	-	-	-	-	2	-	-	-	-	-	-	2	-	3
CO3	3	3	2	-	-	2	1	-	-	-	1	--	3	-	3
CO4	2	2	-	-	-	2	-	-	-	-	-	-	2	-	3
CO5	2	2	-	-	-	1	-	-	-	-	-	-	2	-	3
Course Correlation Mapping	**3**	**2**	**2**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: ELECTRIC DRIVES **(06 Periods)**

Type of electric drives – rating and choice of motor - starting and running characteristics - particular applications of electric drives - types of industrial loads - Continuous - intermittent and variable loads.

Module 2: ELECTRIC HEATING & WELDING **(08 Periods)**

Introduction: Advantages and methods of electric heating - resistance heating - induction heating and dielectric heating.

Electric welding: Classification- resistance and arc welding - electric welding equipment - comparison between AC and DC Welding.

Module 3: ILLUMINATION **(12 Periods)**

Introduction - terms used in illumination - laws of illumination - sources of light. Discharge lamps – mercury vapor and sodium vapor lamps – comparison between tungsten filament lamps and fluorescent tubes – compact fluorescent lamp – LED -Basic principles of light control - Types and design of good lighting system and practice - flood lighting.

Module 4: ELECTRIC TRACTION **(10 Periods)**

Traction systems: System of electric traction and track electrification - Review of existing electric traction systems in India - Special features of traction motor - Speed-time curves for different services - methods of electric braking - plugging - rheostatic braking - regenerative braking.

Module 5: ELECTROLYTIC PROCESS **(9 Periods)**

Introduction - Basic principles - Faradays laws of electrolysis - Energy efficiency – Electrodeposition-Factors governing deposition Processes - Deposition of Alloys - Extraction and refining of metals.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Explore different motor types, their suitability for specific applications and also evaluate the selection criteria for motors based on load requirements, efficiency, cost, and other factors
2. Explore real-world applications of electric drives, such as conveyors, pumps, fans, compressors, cranes, & robots etc., and analyze the benefits of using electric drives in terms of energy efficiency, reliability, and maintenance.
3. Review the protocols and procedures for safe installation, operation, and maintenance of electric heating systems.
4. Analyze the cost savings, environmental benefits, and maintenance requirements associated with energy-efficient lighting. Also assess the impact of lighting control on energy savings, user comfort, and convenience.
5. Explore techniques for improving energy efficiency in electric traction systems.

(Note: It’s an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. C.L Wadhwa, Generation Distribution and Utilization of Electrical Energy, New age International Publishers,
2. J. B. Gupta, Utilization of Electrical Power and Electric Traction, S. K. Kataria and sons, 2002

REFERENCE BOOKS:

1. N. V. Suryanarayana, Utilization of Electrical Power including Electric drives and Electric traction, New Age International (P) Limited, Publishers, 1996.
2. Alan. V. Oppenheim, Ronald. W. Schafer, John R Buck, Discrete Time Signal Processing, Prentice Hall, 2ndedition, 2006. E. Openshaw Taylor, Utilization of Electric Energy, Orient Longman,1971.

VIDEO LECTURES:

1. https://www.NPTEL video lectures.
2. https://www.opto-e.com/basics/led-pulsing-and-strobing

WEB RESOURCES:

1. https://biet.ac.in/pdfs/EEE-UEE.pdf
2. https://vardhaman.org/wp-content/uploads/2021/03/Utilization-of-Electrical-Energy.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101038	**SPECIAL ELECTRICAL MACHINES**	3	-	-	-	3

Pre-Requisite 22EE102006-Electrical Machines-II

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course deals with the functional, Construction, Working, Types, control operation, characteristics, and applications of Stepper Motors, Switched Reluctance Motors, Synchronous Reluctance Motors, Permanent Magnet Motors and Linear Induction Motors.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the open and closed-loop operational characteristics of the stepper motor and assess its performance under various scenarios.

CO2. Analyze the operational aspects of switched reluctance motors to assess the performance and design the constructional features for sustainability.

CO3. Analyze the operational aspects of the synchronous reluctance motor to assess its performance, sustainability, and applications.

CO4. Analyze the sensorless and sensor based operation and control aspects of permanent magnet brushless DC motor and assess the performance under diverse scenarios.

CO5. Analyze the operational and control aspects of linear induction motor and assess their performance for special applications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	3	2	1	3	-	-	-	-	-	2	-	3
CO2	3	3	3	2	1	2	3	-	-	-	-	-	2	-	3
CO3	3	2	-	1	1	2	2	-	-	-	-	-	3	-	3
CO4	3	3	-	2	3	2	1	-	-	-	-	-	2	-	3
CO5	3	3	-	1	1	2	3	-	-	-	-	-	2	-	3
Course Correlation Mapping	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: STEPPER MOTORS **(08 Periods)**

Types of construction and working principle of stepping motor. Various configurations for switching the phase windings, torque equation, and characteristics. Open loop and closed loop control of stepper motor, applications.

Module 2: SWITCHED RELUCTANCE MOTORS **(08 Periods)**

Construction details, principle of operation, design of stator and rotor pole arcs – torque equation and characteristics, power converter for switched reluctance motor, control of switched reluctance motor, rotor position sensing mechanism,

Module 3: SYNCHRONOUS RELUCTANCE MOTORS **(09 Periods)**

Constructional features, Types – Axial and Radial flux motors. Principle of operation, torque-speed characteristics, Phasor diagram and torque equation, Characteristics, control of SyRM, advantages and applications

Module 4: PERMANENT MAGNET MOTORS **(10 Periods)**

Permanent magnet materials–hysteresis loop, analysis of magnetic circuits.

Permanent Magnet DC Motors (PMDCM): Constructional details, principle of operation, types of BLDC motor, sensor less and sensor based control of BLDC motors, Torque/speed characteristics and Applications.

Permanent Magnet AC Motors (PMACM): Principle of operation - Ideal PMSM– EMF and Torque – Synchronous Reactance – Sine wave motor with practical windings - Torque/speed characteristics – Applications.

Module 5: AC SERIES AND LINEAR MOTORS **(10 Periods)**

AC Series Motors: Construction, principle, characteristics and applications.

Linear Induction Motor(LIM): Construction, principle of operation– single sided and double-sided LIM, thrust equations and performance equations based on current sheet concept, equivalent circuit of LIM, applications.

Linear Synchronous Motor (LSM): Construction, types, principle of operation, thrust equation, control and applications.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Design an appropriate pole arc's for 250 W, 10/12 switched reluctance motor by considering the feasible triangle method.
2. Visit a nearby industry and study any special electrical machine and prepare a technical report on the machine studied
3. Prepare a technical report on the motors used in the appliances such as printer, electrical vehicles and robotic arms.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. K. Venkata Ratnam, *Special Electrical Machines*, University press, New Delhi, 2009.
2. E.G. Janardhanan, *Special Electrical Machines*, PHI learning private limited, 2014.

REFERENCE BOOKS:

1. Takashi Kenjo, *Stepping Motors, and their Microprocessor controls*, Clarendon press, Oxford, 1984.
2. T. Kenjo and S. Nagamori, *Permanent-Magnet and Brushless DC Motors*, Clarendon press, Oxford, 1984.
3. T.J.E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drives*, Clarendon press, Oxford 1989.
4. R. Krishnan, *Switched Reluctance Motor Drives – Modeling, Simulation, analysis, Design and Applications*, CRC press, Special Indian Edition, 2015.
5. JB Gupta, *Theory and Performance of Electrical Machines (DC Machines, Polyphase circuits and ACMachines) in SI Units*, 15th Edition, S.K.Kataria & Sons, New Delhi, 2015.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=eyqwLiowZiU
2. https://www.youtube.com/watch?v=31hUDWjzLjY
3. https://www.youtube.com/watch?v=q7532zkg0jI
4. https://www.youtube.com/watch?v=Ru9PE_J9WsM
5. https://www.youtube.com/watch?v=_MbrIe5oxKY

WEB RESOURCES:

1. https://archive.nptel.ac.in/courses/108/102/108102156/
2. https://www.brainkart.com/subject/Special-Electrical-Machines_185/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE103030	**ELECTRICAL MACHINE DESIGN**	3	-	-	4	4

Pre-Requisite	22EE102006-Electrical Machines-II
Anti-Requisite	-
Co-Requisite	-

COURSE DESCRIPTION: The course deals with the fundamentals and design aspects of electrical machine design; The Design of transformers, DC machines, Induction machines, and alternators.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the specific electrical and magnetic loadings on various machines and determine the thermal aspects.

CO2. Design the armature and field systems of DC motor and validate the performance of designed machine.

CO3. Design the core, yoke, windings and cooling systems of a static device and determine its operational parameters.

CO4. Design the stator and various types of rotors for induction motor to validate the given specifications.

CO5. Design the stator and various types of rotors for synchronous machines to validate the given specifications.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	1	1	-	1	-	-	-	-	2	-	3
CO2	3	2	3	2	1	1	-	-	-	-	-	-	2	-	3
CO3	3	2	3	2	1	1	-	-	-	-	-	-	3	-	3
CO4	3	2	3	2	1	1	-	-	-	-	-	-	2	-	3
CO5	3	2	3	2	1	1	-	-	-	-	-	-	2	-	3
Course Correlation Mapping	**3**	**2**	**3**	**2**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**3**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION **(09 Periods)**

Major considerations in electrical machine design, classification of design problems, electrical engineering materials, space factor, and choice of specific electrical and magnetic loadings. Thermal considerations, heat flow, temperature rise, rating of machines and standard specifications.

Module 2: DC MACHINES **(10 Periods)**

Output equation, main dimensions, magnetic circuit calculations, Carter's coefficient, net length of iron, real & apparent flux densities, selection of the number of poles, design of armature, design of commutator and brushes, Design of interposes, performance prediction using design values.

Module 3: TRANSFORMERS **(09 Periods)**

Output equations, main dimensions for single and three-phase transformers, Design of cores, window space factor, overall dimensions, Design of windings, estimation of no-load current, temperature rise in transformers, design of the tank, methods of cooling of transformers.

Module 4: INDUCTION MOTORS **(09 Periods)**

Output equation, choice of loadings, main dimensions, length of the air gap, stator core and windings, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor. Dispersion coefficient.

Module 5: SYNCHRONOUS MACHINES **(08 Periods)**

Output equation, choice of loadings, design of salient pole machines, short circuit ratio (SCR), estimation of the length of air gap using SCR, armature design, armature parameters, design of the rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo-alternators.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING:

1. Present a technical report on acoustic based localization of partial discharge inside oil-filled transformers.
2. Design a motor component for the given specifications.
3. Analyze the temperature Rise and Fluid Flow of High-Power-Density and High-Voltage Induction Motor in the Starting Process.
4. Review a relevant IEEE journal on design aspects of machines, and prepare a report on the latest developments and inferences of the article.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1 A.K. Sawhney, A. Chakrabarthi , *A Course in Electrical Machine Design*, 6th Edition,Dhanpat Rai & Co, Delhi, 2016.

2 M.V.Deshpande, *Design and Testing of ElectricalMachines*, PHI learning Pvt. Ltd, New Delhi, 3rdEdition, May 2010.

REFERENCE BOOKS:

1 R.K. Agarwal, *Principles of Electrical Machine Design,* 5th Edition, S.K.Kataria & Sons, New Delhi, 2014

2 V.N.Mittle, Arvind Mittal, *Design of Electrical Machines,* 5th Edition, Standard publications, New Delhi, 2013

3 A.Nagoor Kani, A simplified text Electrical Machine Design, 2nd Edition, RBA Publications, Chennai, 2009.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=UUUkWT1Go2Y&list=PLR3pRvvCj_Y_jcg_Ia6ARvzefov05c7vf&index=5

2 https://www.youtube.com/watch?v=MrOMsgBPOwE&list=PLR3pRvvCj_Y_jcg_Ia6ARvzefov05c7vf&index=33

3 https://www.youtube.com/watch?v=VjmIS7n8go&list=PLR3pRvvCj_Y_jcg_Ia6ARvzefov05c7vf&index=21

WEB RESOURCES:

1 https://www.brainkart.com/subject/Design-of-Electrical-Machines_194/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101054	**BATTERY MANAGEMENT SYSTEM**	3				3

Pre-Requisite 22EE102001-Electrical Circuits

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Batteries, its parameters, modeling and charging requirements. Battery management algorithms for batteries.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Interpret the role of battery management system.

CO2. Identify the requirements of Battery Management System.

CO3. Interpret the concept associated with battery charging / discharging process.

CO4. Calculate the various parameters of battery and battery pack.

CO5. Design the model of battery pack.

CO-PO-PSO Mapping Table:

Course Outcome	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	-	-	-	-	-	-	-	-	-	1	3		
CO2	3	3	-	-	-	-	-	-	-	-	-	1	3		
CO3	3	3	-	-	-	-	-	-	-	-	-	1	3		
CO4	3	3	2	-	1	-	-	-	-	-	-	1	3		
CO5	3	3	3	-	-	-	-	-	-	-	-	-	3		1
Course Correlation Level	3	3	-	-	-	-	-	-	-	-	-	1	3	--	1

Correlation Levels: 3: High; 2: Medium;1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO BATTERY MANAGEMENT SYSTEM (09 Periods)

Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.

Module 2: BATTERY MANAGEMENT SYSTEM REQUIREMENT (11 Periods)

Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of-charge estimation, Cell total energy and cell total power.

Module 3: BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION, CELL BALANCING (09 Periods)

Battery state of charge estimation (SOC): Voltage-based methods to estimate SOC, Model-based state estimation. Battery Health Estimation: Lithium-ion aging- Negative electrode, Positive electrode. Cell Balancing: Causes of imbalance, Circuits for balancing.

Module 4: MODELLING AND SIMULATION (10 Periods)

Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modeling approach, Physics-based modeling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs.

Module 5: DESIGN OF BATTERY BMS (06 Periods)

Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

LIST OF EXERCISES:

Pre-lab: *Demonstrate the fundamentals of* Simscape™

1. To model a lead-acid battery cell using the Simscape™
2. Observe the charging and discharging process, and plot graph of charging/load current, SOC, temperature, DOC, and terminal voltage.
3. To analyse the effect of temperature on the performance of a Lithium-Ion battery model
4. To simulate and plot the result of temperature, SOC, current, and terminal voltage for the HV Battery Charge/Discharge using realistic DC-link current profile, which originates from a dynamic driving cycle
5. To study Lithium Battery Cell - One RC-Branch Equivalent Circuit and it's simulation
6. To simulate Ni-MH Battery Model with the DC machine and show the charging and discharging process using DC machine.
7. To simulate Lithium-Ion (LiFePO4) Battery and analyse the effect of DOD and discharge rate on battery ageing considering 1000 h simulation time

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.

REFERENCE BOOKS:

1. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
2. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010.
3. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=cS5tkvbC4ts

2 https://www.youtube.com/watch?v=DSoHQupqC30

3 https://www.youtube.com/watch?v=k1N2LyXtK-k

WEB RESOURCES:

1. Coursera: Introduction to battery management system.
2. NPTEL: NOC:Electrochemical Energy Storage, IIT Kharagpur

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101070	FAST-CHARGING INFRASTRUCTURE FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES	3	-	-	-	3

Pre-Requisite 22EE101011-Power Electronics

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is designed to provide a complete overview of charging infrastructure used in electric and hybrid vehicles. The course provides a deep insight about the various components involved in an electric vehicle charging system, different types of electric vehicle chargers, along with the applicable standards governing their design and operation. The course has a huge scope in electrical vehicle industries.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the various components of Electric vehicle charging system.

CO2. Analyze the various charging modes used in Electric vehicles.

CO3. Analyze and comprehend the different types of Electric vehicle chargers and their standards.

CO4. Analyze and interpret the various communication protocols and recent trends in Electric vehicle charging

CO5. Analyze and interpret the various Public charging infrastructure and Major Challenges.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**1**	-	**-**	**-**	-	-	**3**	-	**3**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO EV CHARGING (07 Periods)

Electric Vehicle Charging; Charging Modes; Electric Vehicle Supply Equipment (EVSE): Types, Components of EV Battery Chargers; Challenges in Electric Vehicle Charging.

Module 2: CHARGER SIZING AND STANDARDS (10 Periods)

Electric Vehicle Charging; Charging Modes; Electric Vehicle Supply Equipment (EVSE): Types, Components of EV Battery Chargers; Challenges in Electric Vehicle Charging.

Module 3: EV CHARGER COMMUNICATIONS PROTOCOLS (10 Periods)

Open Charge Point Protocol (OCPP); Open System Interconnection Layer Model (OSI); Adapted PWM Signal based Low-level Communication; PLC based High level Communication; CAN Communication; Billing and Authentication

Module 4: PUBLIC CHARGING INFRASTRUCTURE (10 Periods)

Location, Planning and Implementation of Public Charging Stations; Components; Selection and Sizing - HT/LT Equipment & Cables; Protection; Safety Standards: Policy and Regulatory Aspects; EV Charging Station and their Business Models; Economic Aspects; Major Challenges.

Module 5: FUTURE FRONTIERS IN EV CHARGING (08 Periods)

Bulk Charging; Battery Swapping; Wireless Charging; EVs as Distributed Storage Resources: Grid to Vehicle (G2V) and Vehicle to Grid (V2G), V2X Concept, Integration of Charging Station with Renewable Sources and its Impact on the Grid

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

RESOURCES

TEXT BOOKS:

1. Iqbal Husain, "*Electric and Hybrid Vehicles: Design Fundamentals*", 3rd Edition, CRC Press, 2021.
2. Code of Practice for Electric Vehicle Charging Equipment Installation, 4th Edition, IET, 2020.

REFERENCE BOOKS:

1. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid
2. Electric Vehicles", 1st Edition, Springer, 2013.
3. Tom Denton, "Automotive Electrical and Electronic Systems", 5th Edition, Routledge, 2018.

4. Wolfhard Lawrenz, “CAN System Engineering: From Theory to Practical Applications”, Springer, 2nd Edition, 2013. Weblink:

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/108/106/108106182/
2. https://archive.nptel.ac.in/courses/108/106/108106170/

WEB RESOURCES:

1. https://www.udemy.com/course/charging-infrastructure-for-electric-vehicles/
2. https://ieeexplore.ieee.org/document/9326080
3. https://ieeexplore.ieee.org/document/10289005
4. https://ieeexplore.ieee.org/document/9703969
5. https://ieeexplore.ieee.org/document/9161499

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE102071	AI FOR ELECTRIFIED TRANSPORTATION SYSTEM	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course covers advanced AI techniques and their applications in motor drives, battery health estimation, and energy management systems. Topics include fuzzy control, genetic algorithms, neural networks, and reinforcement learning for BLDC motor controllers. It also addresses neural network modeling for lithium-ion battery state of health (SOH) estimation and performance degradation prediction for PEMFCs using transfer learning-based CNNs. Students will explore optimal fuzzy energy management, adaptive fuzzy EMS, and hybrid energy management strategies, incorporating Q-learning and deep deterministic policy gradient (DDPG) algorithms for real-time energy management and optimization.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand and apply AI techniques for designing and optimizing BLDC motor controllers.

CO2. Develop and implement neural network models for accurate estimation of lithium-ion battery state of health (SOH).

CO3. Design and optimize energy management systems using fuzzy logic and neural network-based driving pattern recognition.

CO4. Implement hybrid energy management strategies using Q-learning for efficient energy control in hybrid electric vehicles (HEVs).

CO5. Apply improved DDPG strategies for optimizing energy management in hybrid systems, addressing real-time challenges and limitations.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**1**	**2**	**1**	**-**	-	**3**	**3**	-	-	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: ARTIFICIAL INTELLIGENCE TECHNIQUES (09 Periods)

Basics of Artificial Intelligence, Advantages, Closed-Loop Model of BLDC Motor Drive— P-I Controller & I-P Controller, Fuzzy Control, Auto-Tuning Type Fuzzy PID Controller, Genetic Algorithm, Artificial Neural Network-Based Controller, BLDC Motor Speed Controller With ANN-Based PID Controller, Neural network, Support vector regression, Reinforcement learning.

Module 2: NEURAL NETWORK MODELING FOR SOH OF LITHIUM-ION BATTERY (09 Periods)

Introduction— Battery SOH estimation, PEMFC performance degradation prediction. Transfer learning based CNN for SOH estimation— architecture, model constructing, Transfer learning method, process of the CNN-based SOH estimation, NSGAe-II-eESN for performance degradation prediction of PEMFC— ESN model, NSGA-II for ESN optimization, process.

Module 3: OPTIMAL FUZZY ENERGY MANAGEMENT (09 Periods)

Introduction, Optimal NN driving pattern recognition, Adaptive fuzzy EMS with driving pattern recognition, Resources and limitations, NSGA- III based on similarity and diversity selection, Fuzzy EMS based on NSGA-III-SD, Robust NSGA-III-SD optimal fuzzy EMS.

Module 4: LEARNING-BASED HYBRID ENERGY MANAGEMENT (09 Periods)

Introduction, Fuzzy energy management system using Q-learning - Framework, EMS based on traditional Q-learning, Improved Q-learning-based algorithm; Q-learning-based EMS with deterministic rule for HEV-energy control, Algorithm design, Real-time energy management, Troubleshooting and limitation.

Module 5: HYBRID ENERGY MANAGEMENT STRATEGY (09 Periods)

Introduction, Improved DDPG strategy based on LSH -- Method description, Method procedure, Materials and resources, Optimization and troubleshooting, Limitations. Algorithm comparison.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

LIST OF EXPERIMENTS :

1. Modelling of batteries and fuel cell for electric vehicle
2. Modelling of electric vehicle
3. Modelling and performance estimation of PMSM assists two wheelers
4. Modelling and performance estimation of PMSM assists four wheelers
5. Extraction of hydrogen through electrolysis.
6. Modelling and performance estimation of fuel cell assists electric vehicle
7. Modelling and performance estimation of hybrid vehicle
8. AI for motor control in electric vehicle
9. AI for fuel cell fed electric drives
10. AI for battery management system

RESOURCES

TEXT BOOKS:

1 Authors: Jili Tao, Ridong Zhang, Longhua M, *Application Of Artificial Intelligence In Hybrid Electric Vehicle Energy Management,* Elsevier, 2024.

2 Chitra A., P. Sanjeevikumar, Jens Bo Holm-Nielsen, S. Himavathi, *Artificial Intelligent Techniques for Electric and Hybrid Electric Vehicles*, Wiley, 2020

REFERENCE BOOKS:

1 Aparna Kumari, Sudeep Tanwar, *Artificial Intelligence-Empowered Modern Electric Vehicles in Smart Grid Systems*, Elsevier Science, 2024.

2 Bruno Scrosati, Jürgen Garche, Werner Tillmetz, *Advances in Battery Technologies for Electric Vehicles,* Elsevier Science, 2015.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=pKeVMlkFpRc&list=PLwdnzlV3ogoXaceHrrFVZCJKbm_laSHcH

2 https://www.youtube.com/watch?v=R9UK41vOIRo&list=PLn8PRpmsu08pYXwR-qihN6abrK3Io97NN

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE102072	**ROBOTICS AND AUTOMATION IN ELECTRICAL SYSTEMS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides an extensive overview of robotics and automation with a focus on electrical systems. It covers the history, types, and components of robotic systems, as well as their applications in the electrical domain. Students will delve into the kinematics and dynamics of robots, understand the integration of sensors and actuators, and explore various control systems. Practical applications and case studies will illustrate the use of robotics in industrial and power systems, preparing students for advanced studies and professional work in automation and robotics.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the history, types, and components of robotic systems and their applications in electrical systems.

CO2. Analyze the kinematics and dynamics of robotic systems, including workspace and trajectory planning.

CO3. Integrate various types of sensors and actuators into robotic systems and implement feedback control mechanisms.

CO4. Implement and evaluate control systems for robotic manipulators, including advanced control techniques.

CO5. Apply knowledge of autonomous mobile robots and industrial automation through case studies and real-world examples.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	1	2	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO3	3	3	1	3	1	1	-	-	-	-	-	-	3	-	-
CO4	3	3	1	2	2	-	-	-	-	-	-	-	3	-	-
CO5	3	3	1	2	2	-	-	-	-	-	-	-	3	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**-**	-	3	**3**	-	-	**3**	-	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO ROBOTICS AND AUTOMATION (12 Periods)

History of Robotics - Evolution of Automation - Types of Robots - Components of Robotic Systems - Robotic Mechanisms - Applications in Electrical Systems - Advantages of Robotics - Challenges in Implementation

Module 2: KINEMATICS AND DYNAMICS OF ROBOTS (10 Periods)

Basics of Robot Kinematics - Forward Kinematics - Inverse Kinematics - Dynamics of Robotic Systems - Workspace Analysis - Trajectory Planning - Joint Space Trajectories - Cartesian Space Trajectories

Module 3: SENSORS AND ACTUATORS (09 Periods)

Overview of Sensors - Types of Sensors (Proximity, Vision, Force) - Actuators (DC Motors, Servo Motors, Stepper Motors) - Sensor Integration - Feedback Mechanisms - Sensor Calibration - Signal Processing for Sensors - Role of Actuators in Robotics

Module 4: CONTROL SYSTEMS FOR ROBOTICS (07 Periods)

Introduction to Control Systems - PID Control - State Space Representation - Control of Robot Manipulators - Motion Planning and Control - Advanced Control Techniques (Adaptive, Robust Control) - Non-linear Control Systems - Implementation of Control Algorithms

Module 5: APPLICATIONS AND CASE STUDIES (07 Periods)

Autonomous Mobile Robots - Robotics in Industrial Automation - Robotics in Medical Applications - Robotics in Power Systems - Case Studies in Automation - Emerging Technologies in Robotics - Future Trends in Robotics - Ethical and Social Implications of Robotics

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Analyze the implementation of robotic automation in a car manufacturing plant, focusing on efficiency improvements and cost reductions.
2. Investigate the use of collaborative robots in small and medium-sized enterprises (SMEs) for enhancing productivity and worker safety.
3. Conduct a simulation study on the kinematic analysis of a 6-DOF robotic arm, including forward and inverse kinematics.
4. Develop a dynamic model of a SCARA robot and perform analysis to understand its motion characteristics and stability.

5. Implement a vision-based robotic system for object detection and sorting, evaluating the accuracy and speed of the system.
6. Experiment with different types of actuators (e.g., DC motors, servo motors) to compare their performance in terms of speed, torque, and control precision.
7. Design and implement a PID controller for a robotic arm and analyze its performance in terms of response time and stability.
8. Explore and implement an adaptive control algorithm for a mobile robot, evaluating its effectiveness in different environmental conditions.
9. Develop and test an autonomous mobile robot for indoor navigation, focusing on path planning and obstacle avoidance.
10. Analyze the deployment of industrial robots in a logistics warehouse, focusing on the improvements in throughput and accuracy of order fulfillment.

RESOURCES

Text BOOKS:

1. John J. Craig , *Introduction to Robotics: Mechanics and Control* , Pearson, 3rd Edition, 2005.

2. Kevin M. Lynch and Frank C. Park , *Modern Robotics: Mechanics, Planning, and Control*, Cambridge University Press, 1st Edition, 2017.

Reference BOOKS:

1. Peter, Corke. "*Robotics, vision and control: fundamental algorithms in MATLAB*." Springer, Firse Edition, (2008).
2. Bruno Siciliano, *Springer Handbook of Robotics*, Srringer, First edition, first edition 2011

VIDEO LECTURES:

1. Introduction to Robotics - NPTEL Course
https://nptel.ac.in/courses/112103174
2. Robotics and Control: Theory and Practice - MIT OpenCourseWare
https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/lecture-notes/
3. Control Systems - NPTEL Course
https://nptel.ac.in/courses/108106098

WEB RESOURCES:

1. Basics of Robotics https://www.robotics.org/blog-article.cfm/Basics-of-Robotics/47
2. Kinematics and Dynamics in Robotics https://www.learnrobotics.org/blog/robot-kinematics-dynamics/
3. Sensors and Actuators https://www.allaboutcircuits.com/textbook/robotics-control-systems/chpt-8/sensors-and-actuators/
4. Control Systems for Robots - Control Tutorials for MATLAB and Simulink
http://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=ControlRobotics
5. Applications of Robotics https://www.roboticstomorrow.com/story/2020/06/robotics-in-manufacturing-and-its-impact-on-business/15267/
6. Case Studies in Robotics https://www.roboticsbusinessreview.com/category/case-studies/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101073	**E-MOBILITY BUSINESS AND POLICIES**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understands the market scenario, Indian and global scenarios, policies and regulations.

CO2. Understanding the models used in public transportation system.

CO3. Familiarize the concept of shared mobility services, advantages and monitory benefits.

CO4. Understands the policies and Incentives to promote electric mobility and sharing of vehicles.

CO5. Introduce to the infrastructure requirements for electric vehicle charging and develop policies for electric vehicle charging.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	3	-	-	-	-	2	-	1
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	-	-	-	3	-	-	-	-	-	-	-	2	2	-
CO4	3	-	-	-	-	2	-	-	-	-	-	-	2	2	-
CO5	3	-	1	-	3	-	-	3	-	-	-	-	2	2	1
Course Correlation Mapping	3	-	1	-	3	2	-	3	-	-	-	-	2	2	1

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Indian and Global Scenario (09 Periods)

Technology Scenario - Market Scenario - Policies and Regulations - Payback and commercial model - Polices in India – opportunities; Specification & Classification of Vehicles; Regulations overview (EEC, ECE, FMVSS, AIS, CMVR) - Type approval Scheme.

Module 2: Public Transport in India (09 Periods)

Introduction to India's passenger mobility sector- Current State of India's Public Transport System, Public Transport: Efficiently and Affordably Mobilizing Cities, Opportunities To Maintain And Ideally Increase The Utilization Of Public Transport In India, Expanding India's Definition Of Public Transport Through Data And New Business Models.

Module 3: E Mobility (09 Periods)

India's Path Forward In Public Transport, Sharing and Mobility Services: Unlocking Economic Electrification- the business case for shared, electric mobility services, Examples of Shared Mobility Services Active In Today's Global Marketplace

Module 4: Mobility Policies (09 Periods)

Ride-Hailing Services: Pooled Ride-Hailing Services: Vehicle Sharing: Peer-To-Peer Vehicle Sharing: Fixed-Route Commuter Services: Incentives to promote electric mobility and sharing: Parking and pick-up benefits: Road toll and road tax discount or exemption: Licensing and registration benefits.

Module 5: Mobility Standards (09 Periods)

Considerations and Implications For India's EV Charging Infrastructure Deployment Standards: EV standards-IEEE, IEC and SAE, Basics of EV charging, EV charging standards and infrastructure, Smart Parks, V2G, G2V, V2B, V2H, renewable energy integration to EV charging infrastructure.

Total Periods: ***45***

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Present a technical report on the current scenario of the electrical vehicles used in Indian and global transport system
2. Perform a case study on the payback period and financial benefits of a commercial and domestic electrical vehicle for a life span of the vehicles.
3. Present a technical report on the technical hitches and benefits in charging infrastructure and suggest feasible methods to improve the utility of the batteries of EV.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1 Emadi, A. (Ed.), Miller, J., Ehsani, M. *Vehicular Electric Power Systems*. Boca Raton: CRC Press, (2003).

2 Iqbal Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2010.

REFERENCE BOOKS:

1 Larminie, James, and John Lowry. *Electric Vehicle Technology Explained*. John Wiley and Sons, 2012.

2 Tariq Muneer and Irene Illescas García, *1 -The automobile, In Electric Vehicles: Prospects and Challenges*, Elsevier, 2017

VIDEO LECTURES:

1 https://elearn.nptel.ac.in/shop/iit-workshops/completed/https-elearn-nptel-ac-in-shop-iit-workshops-ongoing-cpoem-cohort-4/?v=c86ee0d9d7ed

2 https://www.shiksha.com/online-courses/electric-vehicles-and-mobility-course-courl4086

WEB RESOURCES:

1 https://byjus.com/free-ias-prep/national-e-mobility-programme/

2 https://www.aicte-india.org/sites/default/files/Model_Curriculum/fINAL%20-%20NEP%202020%20Model%20Syllabus%20for%20Open%20Electives%20in%20Electric%20Vehicles.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101074	**MODERN GRID USING SMART POWER FLOW CONTROLLERS**	3	-	-	-	3
Pre-Requisite	22EE102009-Power system Analysis					
Anti-Requisite	-					
Co-Requisite	-					

COURSE DESCRIPTION: This course is designed to provide a complete overview of smart power flow controllers (SPFCs) to optimize and manage electrical power distribution in real-time. The course provides an extending far down significance about the various concepts of SMART power flow controllers, Power angle regulators, Transformer based Power flow controllers, Sen Transformers for enhancing the efficiency, reliability, and resilience of power grid. The course has a enormous scope in the modern power industry.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Gain knowledge on origin of power flow control using the SMART Power flow Controllers in the real time.

CO2. Asses the Power Flow Controllers in the power grid applications.

CO3. Asses the Power Flow Regulators in the power grid applications.

CO4. Analyses the various control strategies used in the Power Flow Regulators for grid stability.

CO5. Develop the control techniques for Sen transformer in maintain the power grid resiliency.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**1**	-	**3**	**3**	-	-	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low;

COURSE CONTENT

Module 1: INTRODUCTION TO SMART CONTROLLERS (09 Periods)

Need and necessity of Power Flow Controller, concept of Traditional Power Flow Control Modern Power Flow Control Concepts, Cost of a Solution, Independent Active and Reactive PFCs, SMART Power Flow Controller (SPFC), Example of an SPFC.

Module 2: POWER FLOW CONTROL CONCEPTS (09 Periods)

Concept of Power Flow Control, Power Flow Control Equations for a Natural or Uncompensated Line, Power Flow Equations for a Compensated Line, Shunt and Series Compensation concept, Comparison Between Shunt-Compensating Reactance and Series-Compensating Reactance, Implementation of Power Flow Control Concepts.

Module 3: POWER FLOW REGULATORS (09 Periods)

Generalized Power Flow Controller, Sen Transformer, Multiline Sen Transformer (MST), PAR (sym), PAR (asym), RR, IR, Calculation of RPI, LI, and APR for a PAR (sym), a PAR (asym), a RR, and an IR in a Lossy Line

Module 4: TRANSFORMER-BASED POWER FLOW CONTROLLERS (09 Periods)

Voltage-Regulating Transformer (VRT), Voltage Regulating Transformer (Shunt-Series Configuration), Two-Winding Transformer, Phase Angle Regulator (PAR), PAR (Asymmetric), PAR (Symmetric), improvement of transient stability.

Module 5: SEN TRANSFORMER (09 Periods)

Overview of Sen Transformer, Existing Solutions, Voltage Regulation, Phase Angle Regulation, Desired Solution, ST as a New Voltage Regulator, Control of ST, block diagram concepts of Impedance, Resistance, Reactance Emulation, Block diagram of Closed loop and open Loop Control of ST, Generalized Sen Transformer, Flexible Operation of the ST.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Identification of various simulation tools to simulate the Smart Power flow controllers
2. Experimental set up documentation on Sen transformer
3. Computer simulations related to Sen transformer for power grid.
4. Computer simulations related to VRT

5. Computer simulations related to Multiline Sen Transformer
6. Computer simulations related to Phase Angle Regulator.
7. Computer simulations related to Concept of Power Flow Control

RESOURCES

TEXT BOOKS:

1 Kalyan K. Sen, Mey Ling Sen, *Power Flow Control Solutions for a Modern Grid using SMART Power Flow Controllers,* John Wiley & Sons, 1st edition, New Jersey, 2021.

2 Kalyan K. Sen, Mey Ling Sen, *Introduction to FACTS Controllers: Theory, Modeling, and Applications*, Wiley-IEEE Press, 1st edition, 2009.

REFERENCE BOOKS:

1 Suman Bhowmick, *Flexible AC Transmission Systems (FACTS)Newton Power-flow Modeling of Voltage-sourced Converter Based Controllers*, CRC Press Taylor & Francis Group, 1st edition, New York, 2018

2 Joe H. Chow, Juan J. Sanchez-Gasca, *Power System Modeling, Computation, and Control*, Wiley IEEE press, **1st edition** , 2020.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=I_Ov9Rt1c7w

2 https://www.youtube.com/watch?v=8C6wzlGvafo

3 https://www.youtube.com/watch?v=rLKZqoDZ07o&list=PLm_MSClsnwm8tbZEWgV7RCNpdxR-nr31p&index=1

4 https://www.youtube.com/watch?v=8C6wzlGvafo&list=PLm_MSClsnwm8tbZEWgV7RCNpdxR-nr31p&index=2

5 https://www.youtube.com/watch?v=7fwS7hzDOZ8&list=PLm_MSClsnwm8tbZEWgV7RCNpdxR-nr31p&index=3

6 https://www.youtube.com/watch?v=9Ks_fxL8fak

7 https://www.youtube.com/watch?v=AjT7QTw5km4

8 https://www.youtube.com/watch?app=desktop&v=Fo78vONL_-A

WEB RESOURCES:

1 https://www.powersystems.technology/community-hub/technical-articles/the-sen-transformer-technology-digital-article.html

2 https://ieeexplore.ieee.org/document/7656857

3 https://www.mdpi.com/1996-1073/11/4/918

4 https://ieeexplore.ieee.org/document/6474988

5 https://www.cmu.edu/ceic/assets/docs/seminar-files/2013-2014/heidelcmuseminarpresentation09262013.pdf

6 https://acadpubl.eu/jsi/2017-116-13-22/articles/21/67.pdf

7 https://uwaterloo.ca/scholar/sites/ca.scholar/files/ccanizar/files/tamimi_model_hybrid_power_flow.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101075	**AI & MACHINE LEARNING TECHNIQUES FOR SMART GRIDS**	3	-	-	-	3
Pre-Requisite	22EE102009-Power System Analysis					
Anti-Requisite	-					
Co-Requisite	-					

COURSE DESCRIPTION: This course is designed to provide a complete overview of AI & machine learning techniques for smart grids to optimize performance of the power system network in real-time. The course also provides the significance of AI & machine learning techniques in power system, smart grid technologies: challenges and solutions, optimal placement of PMUs for smart power systems, optimal placement of DG and capacitor banks for resilience of power grid. The course has an enormous scope in the modern power industry.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1.	Gain knowledge on optimization techniques.
CO2.	Gain knowledge on evolutionary optimization techniques.
CO3.	Analyses the various measuring units and issues and related to Smart grids.
CO4.	Asses the optimal placement of PMUs using AI & machine learning techniques in the power grid applications.
CO5.	Asses the optimal placement DG and capacitor banks using AI & machine learning techniques in the power grid applications.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**1**	-	**3**	**3**	-	-	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO OPTIMIZATION TECHNIQUES (09 Periods)

Introduction, Conventional Optimization Techniques: Linear Programming, Quadratic Programming, Integer Programming, Dynamic Programming Artificial Intelligence Techniques: Artificial Neural Network, Fuzzy Logic techniques, Expert Systems. Modern Optimization Methods.

Module 2: INTRODUCTION TO EVOLUTIONARY OPTIMIZATION TECHNIQUES (09 Periods)

Introduction, EvolutionaryOptimizationTechniques: Genetic Algorithm, Differential Evolution Algorithm, Particle Swarm Optimization Technique, Seeker Optimization Algorithm Ant Colony Optimization, Algorithm Description of Real Ants, Technique, Seeker Optimization Algorithm, Ant Colony Optimization Algorithm.

Module 3: SMART GRID TECHNOLOGIES: CHALLENGES AND SOLUTIONS (09 Periods)

Introduction, Smart Grid (SG), Smart Metering, Phasor Measurement Units, Observability Analysis, Capacitor Banks, Distributed Generations.

Module 4: OPTIMAL PLACEMENT OF PMUS FOR SMART POWER SYSTEMS (09 Periods)

Introduction, Rules of Observability Based on PMUs, Problem Formulation, Formulation of Optimal PMU Placement Problem, Optimal Solution Using Proposed Multistage Method, Applications to test systems.

Module 5: OPTIMAL PLACEMENT OF DG AND CAPACITOR BANKS (09 Periods)

CAPACITOR BANKS: Introduction, Problem Formulation, Objective function, Sensitivity Analysis and Loss Sensitivity Indices, Optimal Capacitor Placement Using ACO Algorithm Applications to test system.

DG: Introduction, Problem Formulation, Objective Functions, Multi-objective Function, System Constraints, Two Loss Sensitivity Indices, DG Placement Using ACO Algorithm Applications to test system.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Identification of various simulation tools to simulate the various issues on ai & machine learning techniques for smart grids

2. Literature review on Machine Learning and Power System Planning: Opportunities and Challenges

3. Literature review and simulation of Machine Learning Methods in Energy Engineering.

4. Literature Review of the Application of Machine Learning/Deep Learning to Control Problems of Power Systems

5. Computer simulations related to automatic generation control using Evaluation algorithms.

6. Computer simulations related to economic load dispatch problem using Evaluation algorithms.

7. Computer simulations related to State estimation using Evaluation algorithms.

RESOURCES

TEXT BOOKS:

1. Adel Ali Abou El-Ela, Mohamed T.Mouwafi, Adel A.Elbaset, *Modern Optimization Techniques for Smart Grids,* Springer Nature , Switzerland, 2023.

2. Morteza Nazari-Heris, Somayeh Asadi, Behnam Mohammadi-Ivatloo, Moloud Abdar, *Application of Machine Learning and Deep Learning Methods to Power System Problems*, Springer Nature Switzerland, 2022.

REFERENCE BOOKS:

1. Surender Reddy Salkuti, Papia Ray, *Next Generation Smart Grids: Modeling, Control and Optimization*, Springer Nature, Singapore Pvt Ltd, 2022

2. Aranya Chakrabortty, Marija D. Ilic*, Control and Optimization Methods for Electric Smart Grids*, Springer Science Business Media, New York,2012.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=A2DV_kZNkXw
2. https://www.youtube.com/watch?v=-BrZPsElQt0
3. https://www.youtube.com/watch?v=91YsojHzCGY
4. https://www.youtube.com/watch?v=u8KbBzacyJQ
5. https://www.youtube.com/watch?v=u5OuuHPbz1I

WEB RESOURCES:

1. https://www.researchgate.net/publication/356144897_Artificial_Intelligence_
   Techniques in_Smart_Grid_A_Survey
2. https://www.mdpi.com/2624-6511/4/2/29

3. https://www.e3s-conferences.org/articles/e3sconf/pdf/2023/24/e3sconf_icseret2023_02005.pdf
4. https://onlinelibrary.wiley.com/doi/abs/10.1002/9781119786306.ch11
5. https://iopscience.iop.org/article/10.1088/1755-1315/510/2/022012/pdf
6. https://link.springer.com/book/10.1007/978-981-99-0799-1

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101076	**MACHINE LEARNING & DATA SCIENCE IN THE POWER GENERATION INDUSTRY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is designed to provide a complete overview of machine learning and data science in the power generation industry. The course provides a deep insight about the various concepts such as machine learning, data science, statistics, project management. The course has a scope in advanced technological studies

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the machine learning models for various applications.

CO2. Understand the data science, statistics and time series models.

CO3. Analyze the project management for a machine learning

CO4. Understand the power generation industry through machine learning.

CO5. Analyze the variables for power plant efficiency.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**1**	-	-	**-**	-	-	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: MACHINE LEARNING (12 Periods)

Basic ideas of machine learning; Bias-variance-complexity trade-off; Model types —Deep neural network, Recurrent neural network or long short-term memory network, Support vector machine, Random forest or decision trees, Self-organizing maps, Bayesian network and ontology; Training and assessing a model; Role of domain knowledge; Optimization using a model; Practical advices.

Module 2: DATA SCIENCE, STATISTICS, AND TIME SERIES (10 Periods)

Measurement, uncertainty, and record keeping—Uncertainty, Record keeping; Correlation and timescales; The idea of a model; First principles models; The straight line; Representation and significance; Outlier detection; Residuals and statistical distributions; Feature engineering; Principal component analysis; Practical advices.

Module 3: PROJECT MANAGEMENT FOR A MACHINE LEARNING (09 Periods)

Classical project management in power; Agile—The mindset; Scrum—The framework, Roles of Scrum, Events, Artifacts, Values, How it works; Project execution—From pilot to product, Pilot setup, Product owner, Development team, Scrum master, Stakeholders; Management of change and culture; Scaling—From pilot to product, Take advantage of a platform, Establish a team and involve the assets, Keep developing, Involve UX expertise.

Module 4: INTRODUCTION TO MACHINE LEARNING IN THE POWER GENERATION INDUSTRY (07 Periods)

Forecasting; Predictive maintenance; Integration into the grid; Modeling physical relationships; Optimization and advanced process control; Consumer aspects; Other applications.

Module 5: VARIABLE IDENTIFICATION FOR POWER PLANT EFFICIENCY (07 Periods)

Power plant efficiency; The value of efficiency; Variable sensitivity; Measurability, predictability, and controllability; Process modeling and optimization.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

RESOURCES

TEXT BOOKS:

1. Patrick Bangert, *Machine Learning And data science In the power Generation Industry-Best Practices, Tools and Case Studies,* Elsevier, United States 2021.
2. A. Sudhakar, Shyammohan S Palli, *Circuits and Networks Analysis and Synthesis*, 5th edition, McGraw Hill Education (India) Private Limited, New Delhi, 2015

REFERENCE BOOKS:

1. J.A.Edminister, M.D.Nahvi, *Theory and Problems of Electric Circuits*, 4th edition, Schaum's outline series, McGraw Hill, New Delhi, 2004.
2. W H Hayt, J E Kemmerly, S M Durbin, *Engineering Circuit Analysis*, 6th edition, McGraw Hill, New Delhi, 2008.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/117106108/
2. https://nptel.ac.in/courses/108105159

WEB RESOURCES:

1. https://www.electrical4u.com/electric-circuit-or-electrical-network/
2. https://www.electronicshub.org/dc-circuits-basics/
3. https://www.engineeringenotes.com/electrical-engineering/circuits/single-phase-ac-circuit-with-diagram-electrical-engineering/27590
4. https://electrical-engineering-portal.com/resources/knowledge/theorems-and-laws
5. https://circuitglobe.com/what-is-a-polyphase-system.html
6. https://khitguntur.ac.in/shmat/NA%20Unit-III%20Coupled%20Circuits.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101077	**ELECTRIC GRID SECURITY**	3	-	-	-	3

Pre-Requisite 22EE102009-Power System Analysis

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is designed to provide a complete overview of electric grid security and its significance in the real word. The course provides a deep insight about the various concepts such as Introduction to Grid Security, Types of Physical Attacks in power grid, Cyber-Attacks, Analysis of Various Vulnerability Assessments, Attack Detection and Prevention and Metrics for electricity sectors. The course has a huge scope in the modern power industry.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Gain knowledge on various concepts of electric grid security and their security initiatives followed in the real time.

CO2. Analyze the various physical attacks and cyber-attacks that occur in the power grid.

CO3. Analyze the various cyber-attack effects, vulnerability assessment practices and their control procedures for maintain the gird security.

CO4. develop strategies for bad data identification and their prevention schemes to be followed in maintain the grid security.

CO5. understand the challenges in maintain the grid resiliency and the, standards to be followed during the cyber arracks.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**1**	-	**3**	**3**	-	-	**3**	-	**3**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO GRID SECURITY (09 Periods)

Basic review of power grids and its operations, study of electric grids as a cyber-physical system, key smart grid security challenges (physical and cyber), different cyber-attack events and their analysis (Ukrainian attack, STUXNET), current security initiatives.

Module 2: TYPES OF ATTACK (09 Periods)

Cyber-attacks definition, their types, Strategic attack, template attack, location attack, modelling of attack (Time delay attack, denial of service attack).

Module 3: VULNERABILITY ASSESSMENT (09 Periods)

Vulnerability assessment of different types of cyber-attack, case study in PMU, automatic generation control, economic load dispatch problems

Module 4: ATTACK DETECTION AND PREVENTION (09 Periods)

State estimation methods, Observer-based different faulty data detection methods and AI-based schemes.

Module 5: METRICS FOR ELECTRICITY SECTORS (09 Periods)

Study of different metrics and protocols to evaluate and benchmark resilience, framework recommendations and technology evaluations

Total Periods: ***45***

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Identification of various simulation tools to simulate the cyberattacks and their remedy's
2. Computer simulations related to modelling of the cyberattacks
3. Computer simulations related to detection methods of electric systems.
4. Computer simulations related to PMU
5. Computer simulations related to automatic generation control
6. Computer simulations related to economic load dispatch problem.
7. Computer simulations related to State estimation

RESOURCES

TEXT BOOKS:

1. Borlase Stuart, *Smart Grid: Infrastructure, Technology and Solutions*, 1st edition, CRC Press.
2. Al-Shaer, Ehab, Rahman and Mohammad Ashiqur, *Security and Resiliency Analytics for Smart Grids*, Springer International, 1st edition, 2016.

REFERENCE BOOKS:

1. *Resilience Framework, Methods, and Metrics for the Electricity Sector* (TR83), IEEE PES report..
2. Abur A. and Exposito A. G., *Power System State Estimation: Theory and Implementation,* Marcel and Dekker Ink, 2004.

VIDEO LECTURES:

1. https://ocw.tudelft.nl/course-lectures/6-2-1-cyber-security-in-smart-grids/
2. https://ocw.tudelft.nl/course-lectures/6-3-1-why-cyber-risk-management/
3. https://ocw.tudelft.nl/course-lectures/6-3-2-what-is-cyber-risk-management/

WEB RESOURCES:

1. https://www.dragos.com/industries/electric-grid-cybersecurity/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8473297/
3. https://crsreports.congress.gov/product/pdf/IN/IN12074
4. https://blog.sintef.com/sintefenergy/gridsmartgrids/cybersecurity-in-the-electricity-grid/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101078	**AI TECHNIQUES FOR RENEWABLE ENERGY SYSTEMS**	3	-	-	-	3

Pre-Requisite 22EE102009-Power System Analysis

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is designed to provide a complete overview of artificial intelligence for renewable energy sources. The course provides a deep insight about the various concepts such as application of artificial intelligence on renewable energy management, hybrid renewable energy systems and machine learning for renewable energy. The course has a scope in advanced technological studies on Artificial intelligence for renewable energy systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the artificial intelligence

CO2. Analyze the role of artificial intelligence in renewable energy management.

CO3. Apply artificial intelligence for various renewable energy applications.

CO4. Understand the hybrid renewable energy systems.

CO5. Apply artificial intelligence and machine learning methods for renewable energy.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**1**	-	**-**	**-**	-	-	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: ARTIFICIAL INTELLIGENCE (10 Periods)

Introduction, Historical Perspectives of Artificial Intelligence, Applications of AI, Applications of AI in Wind Renewable Energy Systems, Modeling and Simulation Studies of AI in Wind Renewable Energy, Applications of AI in Solar Renewable Energy Systems, Modeling and Simulation of Solar Renewable Energy Systems, Current Trends and Future Prospects of AI.

Module 2: ROLE OF AI IN RENEWABLE ENERGY MANAGEMENT (12 Periods)

Introduction – Supremacy of Renewable Energy, Stumbling Block to Renewable Energy, Issues and Challenges Faced by the Renewable Power Sector, Classification of Artificial Intelligence Applications; Artificial Intelligence Applications for Renewable Energy System-- Applications for Energy Forecast, Artificial Intelligence Applications for Energy Tracking and Optimization of Energy Consumption, Artificial Intelligence-Based Technologies to Assist Other Parts of the Renewable Life Cycle.

Module 3: AI-BASED RENEWABLE ENERGY WITH EMERGING APPLICATIONS (09 Periods)

Introduction, Renewable Energy and its types–Solar Energy, Wind Energy, Hydroelectric Power, Biomass Energy, Geothermal Energy, Ocean, Solar Power, Geothermal Heat Pumps, Hydrogen; AI Applications in Renewable Energy–Energy Forecasting, Energy Efficiency, Energy Accessibility; Challenges in Renewable Energy–Availability of Power, Issue in Power Quality, Resource Location, Information Barrier, Cost Issue.

Module 4: A COMPREHENSIVE OVERVIEW OF HYBRID RENEWABLE ENERGY SYSTEMS (07 Periods)

Introduction, HRESs– Issues Regarding HRESs, Pros and Cons of HRESs; Configuration of HRES – Choice of Common Bus Type, Choice of Converters, Integration Scheme; Stability Issues and Maintenance– Stability Issues, Maintenance of HRES; Optimization Techniques for HRES– Traditional Optimization Techniques, AI-Based Optimization Techniques; Simulation software; Challenges and future trends.

Module 5: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING METHODS FOR RENEWABLE ENERGY (07 Periods)

Introduction, Renewable Energy Definition, Challenges of Renewable Sources, Solutions to Challenges, Artificial Intelligence Techniques in the Field of Renewable Energy, Solar Energy Analysis Using ML-- Solar Energy Analysis Using EDA, Predictive Analysis for Solar Energy.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

RESOURCES

TEXT BOOKS:

1. Suman Lata Tripathi Mithilesh Kumar Dubey Vinay Rishiwal Sanjeevikumar Padmanaban, *Introduction to AI Techniques for Renewable Energy Systems*, 1st edition, CRC Press an imprint of Taylor & Francis Group, LLC, Florida, 2021.

2. Ajay Kumar Vyas, S. Balamurugan, Kamal Kant Hiran, Harsh S. Dhiman, *Artificial Intelligence For Renewable Energy Systems*, 1st edition, Scrivener Publishing LLC, John Wiley & Sons, Inc, USA, 2022.

REFERENCE BOOKS:

1. Neeraj Priyadarshi, Sanjeevkumar Padmanaban, Kamal Kant Hiran, Jens Bo Holm-Nielson, Ramesh C. Bansal, *Artificial Intelligence and Internet of Things for Renewable Energy Systems,* Frontiers in Computational Intelligence, De Gruyter, Vol.12, 2022.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=RCqalbRYN1o
2. https://www.youtube.com/watch?v=pghjLyAmc5g&t=11s
3. https://www.youtube.com/watch?v=91YsojHzCGY

WEB RESOURCES:

1. https://ratedpower.com/blog/artificial-intelligence-renewable-energy/
2. https://ieeexplore.ieee.org/document/9584587
3. https://www.sciencedirect.com/science/article/pii/S2352484722022818
4. https://www.fdmgroup.com/news-insights/ai-in-energy-sector/
5. https://www.mdpi.com/1996-1073/16/24/8057
6. https://ieeexplore.ieee.org/document/8074546

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101079	**MACHINE LEARNING IN POWER SYSTEM OPTIMIZATION**	3	-	-	-	3

Pre-Requisite 22EE102009-Power System Analysis

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course explores the intersection of machine learning (ML) techniques and power system optimization. It aims to equip students with the necessary knowledge and skills to apply ML methods to solve optimization problems in power systems, including power flow, load dispatch, unit commitment, load forecasting.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Learn the principles and techniques of machine learning and its relevance in optimization.

CO2. Understand various techniques of machine learning, associated learning techniques and association rules

CO3. Understand the principle concepts of Artificial Neural Network, their modelling and testing.

CO4. Apply ML techniques to solve optimization of load flow, economic load dispatch problems in power systems.

CO5. Apply ML techniques to solve load forecasting, power plant monitoring and fault identification problems in power systems.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-
CO2	3	1	-	-	1	-	-	-	-	-	-	-	3	3	-
CO3	3	1	-	-	2	-	-	-	-	-	-	-	3	3	-
CO4	3	1	-	-	3	3	-	-	-	-	1	1	3	3	2
CO5	3	1	-	-	3	3	-	-	-	-	1	1	3	3	2
Course Correlation Mapping	3	1	-	-	2	3	-	-	-	-	1	1	3	3	2

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Introduction (08 Periods)

Introduction to Machine learning, History and early works, techniques, comparison and relation to artificial intelligence, optimization and statistics.

Module 2: Machine Learning techniques (10 Periods)

Theoretical aspects of ML, different types of Machine Learning algorithms such as Linear regression, Logistic regression, K - Nearest Neighbor, Artificial Neural Networks, Random Forest, and Support Vector Machine, learning approaches: Supervised learning, unsupervised learning, semi supervised learning, reinforcement learning, self- .

Module 3: Artificial Neural Networks (09 Periods)

Artificial Neural Network, Basic Concept, early NN Architectures, Characteristics, Neural Network architectures, Single layer feed forward Network, Multi layer feed forward network, recurrent networks, Non linear activation operators, learning methods like Back propagation, LM etc., training and testing of ANN.

Module 4: Applications of machine learning in power systems I (09 Periods)

Optimal Power Flow Problem Formulation, Optimal Real Power Dispatch with Network Limit Constraints, Neural Network Application to Optimal Power Flow, Economic load dispatch and Unit commitment problems.

Module 5: Applications of machine learning in power systems II (09 Periods)

Operation and control for solving problems of load forecasting, renewable energy forecasting, power plant monitoring and fault identification.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Develop a suitable machine learning model to optimize the power flow in a given network with possible constraints.
2. Develop a suitable machine learning model to optimize the generation of power plants to meet the load demanded.
3. Develop a suitable machine learning model to schedule the generators for optimal operation.

4. Develop a suitable machine learning model for forecasting the load in conventional and deregulated power systems.

5. Develop a suitable machine learning model for forecasting the energy from the renewable energy sources.

6. Develop a suitable machine learning model for identifying faults in a power system network.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. NP Padhy , Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005.

2. Ongsakul, Weerakorn, and Vo Ngoc Dieu. *Artificial intelligence in power system optimization*. Crc Press, 2016.

REFERENCE BOOKS:

1. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman; The Elements of Statistical Learning, 2nd edition 2009.

2. Warwick, Kevin, Arthur Ekwue, and Raj Aggarwal, eds. *Artificial intelligence techniques in power systems*. No. 22. Iet, 1997.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106106139

2. https://www.coursera.org/learn/machine-learning-duke

WEB RESOURCES:

1. https://www.youtube.com/watch?v=evkjow9j3Bg

2. https://www.osti.gov/servlets/purl/1821445

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101095	**CYBER PHYSICAL SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Cyber-Physical Systems (CPS) represent the convergence of computational algorithms and physical components. This course offers an in-depth exploration of CPS, focusing on the integration of hardware and software to monitor and control physical processes. Students will gain theoretical knowledge and practical skills in modeling, simulation, control, networking, and implementation of CPS across various domains such as smart grids, healthcare, automotive systems, and industrial automation.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Define Cyber-Physical Systems and explain their significance, components, and real-world applications.

CO2. Develop and simulate mathematical models of CPS using tools like MATLAB/Simulink and Modelica.

CO3. Design and implement control systems using feedback mechanisms and optimization techniques to improve CPS performance

CO4. Implement and analyze networking protocols and real-time communication strategies, addressing security and privacy challenges in CPS.

CO5. Integrate and test hardware and software components in CPS, applying knowledge to advanced applications such as autonomous systems and smart cities.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	1	1	-	-	-	-	-	-	3	-	3
CO2	3	-	3	1	3	1	-	-	-	-	-	-	3	-	3
CO3	2	1	3	3	3	1	1	-	-	-	-	-	3	-	3
CO4	3	1	-	3	1	3	3	-	-	-	-	-	3	-	3
CO5	3	1	3	1	3	2	-	-	-	-	3	-	3	-	3
Course Correlation Mapping	3	2	3	2	2	2	2	-	-	-	3	-	3	-	3

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO CYBER-PHYSICAL SYSTEMS (09 Periods)

Overview of CPS: Definition, significance, and applications; Integration of computation, networking, and physical processes; Case Studies: Examples from smart grids, healthcare, automotive systems, and industrial automation

Module 2: MODELING AND SIMULATION (09 Periods)

Modelling Techniques: Mathematical models, state machines, hybrid systems; Simulation Tools: MATLAB/Simulink, Modelica; Application: Modelling and simulating simple CPS scenarios.

Module 3: CONTROL AND OPTIMIZATION (09 Periods)

Control Systems: Feedback control, PID controllers, state estimation; Optimization Methods: Linear programming, dynamic programming, heuristic approaches; Implementation: Applying control and optimization techniques to CPS.

Module 4: COMMUNICATION AND NETWORKING (09 Periods)

Networking: Network protocols, communication standards, wireless communication; Real-time Communication: Time-sensitive networking, quality of service; Security and Privacy: Cybersecurity challenges in CPS, encryption, and secure communication

Module 5: IMPLEMENTATION AND APPLICATIONS (09 Periods)

Hardware and Software Platforms: Embedded systems, sensors, actuators, real-time operating systems; Integration and Testing: System integration, testing methodologies, verification, and validation; Advanced Applications: Autonomous systems, smart cities, IoT integration.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

Case studies from the following and identify key CPS elements in each.

1. Smart grids
2. Healthcare
3. Automotive systems
4. Industrial automation

RESOURCES

TEXT BOOKS:

1. Gaddadevara Matt Siddesh, Hossain Shahriar and Nilanjan Dey, *Cyber-Physical Systems: A Computational Perspective,* CRC Press, October 2020

2. Jonathan W. Valvano, *Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers*, Volume 1, ISBN: 978-1477508992

REFERENCE BOOKS:

1. James F. Kurose and Keith W. Ross, *Computer Networking: A Top-Down Approach.* Pearson Publishers, March 2016.

2. Gene F. Franklin, J. Da Powell, Abbas Emami-Naeini. *Feedback Control of Dynamic Systems*, Pearson publisher, February 2014.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=vVeyePVg8cI

2. https://hits.digimat.in/nptel/courses/video/106105241/L01.html

WEB RESOURCES:

1. https://www.nist.gov/ctl/smart-connected-systems-division/iot-devices-and-infrastructures-group

2. https://modelica.org/language/

3. https://in.mathworks.com/?s_tid=gn_logo

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE102096	**IoT for ELECTRICAL SYSTEMS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides an extensive overview of the Internet of Things (IoT) with a focus on electrical systems. It covers the evolution, components, and technologies involved in IoT. The course also includes practical aspects such as programming IoT devices and managing IoT systems. Through real-world case studies, students will understand the deployment and management of IoT in electrical and other systems, preparing them for advanced studies and professional work in IoT and electrical systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the evolution of IoT, enabling technologies, and various IoT architectures including oneM2M and IoT World Forum (IoTWF) standards.

CO2. Identify and describe the functional blocks of an IoT ecosystem, including sensors, actuators, smart objects, and communication modules.

CO3. Analyze different IoT protocols such as IPv6, 6LoWPAN, MQTT, and CoAP, and understand the role of RFID, wireless sensor networks, big data analytics, and cloud computing in IoT.

CO4. Develop a comprehensive understanding of IoT design methodologies, architectures, platforms, and system implementation, and apply this knowledge to practical IoT scenarios.

CO5. Manage and integrate various functional blocks of an IoT system, including sensors, actuators, middleware, and cloud computing, and apply these concepts to real-world IoT applications.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	1	2	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO3	3	3	1	3	1	1	-	-	-	-	-	-	3	-	-
CO4	3	3	1	2	2	-	-	-	-	-	-	-	3	-	-
CO5	3	3	1	2	2	-	-	-	-	-	-	-	3	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**-**	-	3	**3**	-	-	**3**	-	-

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO IOT (12 Periods)

Evolution of IoT - Historical development of IoT - Key milestones in IoT evolution - Impact of IoT on various industries - **Enabling Technologies** - Sensors and Actuators - Communication Technologies - Data Analytics and Cloud Computing - **IoT Architectures** - oneM2M Architecture - IoT World Forum (IoTWF) Standard - Simplified IoT Architecture - **Core IoT Functional Stack** - Device Layer - Network Layer - Application Layer - **Fog, Edge, and Cloud in IoT** - Role of Fog Computing - Benefits of Edge Computing - Cloud Computing Integration.

Module 2: COMPONENTS IN IOT (10 Periods)

Functional Blocks of an IoT Ecosystem - Sensing and Actuation - Data Communication - Data Processing - **Sensors, Actuators, and Smart Objects** - Types of Sensors - Types of Actuators - Smart Objects in IoT - **Control Units** - Microcontrollers - Microprocessors - FPGA in IoT - **Communication Modules** - Bluetooth Technology - Zigbee Technology - Wi-Fi Technology - **GPS and GSM Modules** - Role of GPS in IoT - GSM for Cellular Connectivity - Integration of GPS and GSM Modules.

Module 3: IOT PROTOCOLS AND TECHNOLOGIES (09 Periods)

IoT Protocols - IPv6 for IoT - 6LoWPAN Protocol - MQTT Protocol - **RFID Technology** - Basics of RFID - Applications of RFID in IoT - RFID System Components - **Wireless Sensor Networks** - Architecture of WSNs - Protocols for WSNs - Applications of WSNs - **Big Data Analytics in IoT** - Role of Big Data in IoT - Tools for Big Data Analytics - Use Cases - **Cloud Computing for IoT** - Cloud Service Models - IoT and Cloud Integration - Cloud Platforms for IoT.

Module 4: IOT PLATFORMS DESIGN (07 Periods)

Design Methodology - Phases of IoT Design - Tools and Techniques - Case Studies - **IoT Architecture** - Layered Architecture - Protocol Stack - Security Considerations - **IoT Platforms** - Open-Source Platforms - Proprietary Platforms - Comparative Analysis - **IoT System Implementation** - Development Life Cycle - Deployment Strategies - Case Studies - **IoT Applications** - Smart Home Systems - Industrial IoT - Healthcare Applications.

Module 5: IOT APPLICATIONS (07 Periods)

Smart Home - Automation Technologies - Energy Management - Security Systems - **Smart Grid** - Energy Distribution - Monitoring and Control - Smart Meters - **Industrial IoT** - Predictive Maintenance - Process Automation - Asset Tracking - **Smart Healthcare** - Remote Monitoring - Wearable Devices - Health Data Analytics - **Smart Agriculture** - Precision Farming - Livestock Monitoring - Environmental Monitoring.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Analyze the impact of IoT-enabled sensors in smart homes, focusing on energy efficiency and automation of daily tasks.
2. Investigate the role of IoT in healthcare by designing a wearable device that monitors vital signs and sends data to the cloud for analysis.
3. Conduct a study on the implementation of IoT protocols (such as MQTT and CoAP) in a smart agriculture system, evaluating the effectiveness of data transmission and communication.
4. Develop a prototype IoT system for industrial predictive maintenance, integrating sensors and actuators to monitor machine health and predict failures.
5. Implement a smart grid system using IoT technologies, focusing on energy distribution, real-time monitoring, and control mechanisms.
6. Experiment with different wireless communication modules (Bluetooth, Zigbee, Wi-Fi) in an IoT ecosystem to compare their performance in terms of range, power consumption, and data transfer rates.
7. Design and simulate an IoT-based environmental monitoring system that measures air quality, temperature, and humidity, and transmits data to a central server for analysis.
8. Develop an IoT-based home security system with sensors and actuators, analyzing its effectiveness in detecting and responding to security breaches.
9. Explore the use of big data analytics in IoT by creating a cloud-based platform that collects and analyzes data from various IoT devices to provide actionable insights.
10. Implement an edge computing solution for an IoT application, evaluating the performance improvements in terms of latency, bandwidth usage, and data processing efficiency.

RESOURCES

Text BOOKS:

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things. Cisco Press, 1st Edition, 2017.
2. Arshdeep Bahga, Vijay Madisetti. Internet of Things – A Hands-on Approach. VPT, 1st Edition, 2014.

VIDEO LECTURES:

1. Introduction to Internet of Things - NPTEL Course https://nptel.ac.in/courses/106105166
2. Internet of Things - Georgia Tech on Coursera https://www.coursera.org/learn/iot
3. Introduction to IoT and Embedded Systems - University of California, Irvine on Coursera https://www.coursera.org/learn/iot
4. IoT Programming and Big Data - University of California, San Diego on edX https://www.edx.org/course/iot-programming-and-big-data

5. IoT (Internet of Things) Wireless & Cloud Computing Emerging Technologies - Udemy https://www.udemy.com/course/iot-wireless-cloud-computing/

WEB RESOURCES:

1. Introduction to IoT - IoT Agenda https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT
2. IoT Components and Architectures - IoT World Today https://www.iotworldtoday.com/
3. IoT Protocols - IoT For All https://www.iotforall.com/iot-protocols-guide
4. Basics of Sensors and Actuators - All About Circuits https://www.allaboutcircuits.com/textbook/robotics-control-systems/chpt-8/sensors-and-actuators/
5. Understanding IoT Platforms - IoT Analytics https://iot-analytics.com/understanding-iot-platforms/
6. Big Data Analytics in IoT - Towards Data Science https://towardsdatascience.com/big-data-analytics-in-iot-technology-8a1e0865787e
7. Cloud Computing and IoT - TechTarget https://searchcloudcomputing.techtarget.com/definition/cloud-computing

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE102097	**COMPUTER VISION FOR ELECTRICAL SYSTEMS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a comprehensive overview of computer vision with a focus on applications in electrical systems. It covers the fundamentals of image formation, geometric transformations, and image processing techniques. Students will learn about feature detection and matching, image segmentation methods, and machine learning applications in computer vision. The course includes practical examples and case studies to illustrate the integration of computer vision in electrical systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the fundamentals of computer vision, including image formation, geometric primitives, and transformations.

CO2. Apply image processing techniques such as point operators, linear filtering, and histogram equalization to analyze and enhance images.

CO3. Identify and implement feature detection and matching techniques, including edge detection, Hough transforms, and feature tracking.

CO4. Develop and apply image segmentation methods such as region growing, clustering, and graph cuts to segment images effectively.

CO5. Utilize machine learning techniques, including supervised and unsupervised learning, as well as deep learning, to solve vision-related tasks in electrical systems.

CO6. Work independently or in teams to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	1	2	1	-	-	-	-	-	-	3	-	3
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	3
CO3	3	3	-	1	3	1	1	-	-	-	-	-	3	-	3
CO4	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO5	3	3	-	1	2	2	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**2**	**1**	**1**	-	**3**	**3**	-	-	**3**	-	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO COMPUTER VISION (12 Periods)

Introduction - Overview of Computer Vision - Human and Computer Vision - Applications in Electrical Systems - **Image Formation** - Geometric Primitives - 2D and 3D Transformations - Lens Distortions - **Geometric Primitives and Transformations** - 2D Transformations - 3D Transformations - 3D Rotations - **3D to 2D Projections** - Projection Models - Camera Calibration - **Lens Distortions** - Radial Distortion - Tangential Distortion - Correction Techniques.

Module 2: IMAGE PROCESSING AND ANALYSIS (10 Periods)

Point Operators - Pixel Transforms - Color Transforms - Compositing and Matting - **Histogram Equalization** - Application in Tonal Adjustment - **Linear Filtering** - Separable Filtering - Band-Pass and Steerable Filters - **More Neighborhood Operators** - Non-linear Filtering - Morphology - Distance Transforms - **Connected Components** - Labeling Algorithms - Application in Image Segmentation.

Module 3: FEATURE DETECTION AND MATCHING (09 Periods)

Points and Patches - Feature Detectors - Feature Descriptors - Feature Matching - **Edges** - Edge Detection - Edge Linking - **Lines** - Successive Approximation - Hough Transforms - **Vanishing Points** - Application in Rectangle Detection - **Feature Tracking** - Techniques and Applications - Performance-Driven Animation.

Module 4: IMAGE SEGMENTATION (07 Periods)

Fundamentals - Point, Line, and Edge Detection - Thresholding - **Segmentation by Region Growing** - Region Splitting and Merging - **Region Segmentation Using Clustering** - Super pixels - **Region Segmentation Using Graph Cuts** - Application in Electrical Systems - **Segmentation Using Morphological Watersheds** - The Use of Motion in Segmentation.

Module 5: MACHINE LEARNING FOR VISION (07 Periods)

Supervised Learning - Introduction to Supervised Learning - Classification Algorithms - **Regression Algorithms** - Evaluation Metrics for Supervised Learning - **Application in Vision Tasks** - Practical Use Cases in Electrical Systems - **Unsupervised Learning** - Clustering Algorithms - Dimensionality Reduction Techniques - **Evaluation Metrics for Unsupervised Learning** - Application in Vision Tasks - **Deep Learning** - Fundamentals of Deep Learning - Neural Networks Architecture - **Training and Optimization Techniques** - Evaluation Metrics for Deep Learning Models - Application in Vision Tasks.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Analyze the implementation of computer vision algorithms in an automated quality inspection system for electrical components, focusing on defect detection and classification.
2. Investigate the use of image processing techniques to enhance the visibility of electrical circuit diagrams scanned from paper documents.
3. Conduct a study on the effectiveness of various edge detection methods in identifying the boundaries of objects in thermal images used for electrical fault detection.
4. Develop a feature detection and matching system to track the movement of electrical equipment in a smart factory setting, and evaluate its accuracy and robustness.
5. Implement an image segmentation algorithm to distinguish between different types of electrical components in a cluttered environment, and assess its performance.
6. Experiment with different machine learning models to classify electrical meter readings from images, comparing their accuracy and computational efficiency.
7. Design and implement a vision-based system for real-time monitoring of power lines, focusing on identifying potential hazards such as vegetation overgrowth and structural damage.
8. Explore the application of deep learning techniques to predict maintenance needs of electrical machinery based on visual inspection data, and evaluate its predictive power.
9. Develop a 3D reconstruction algorithm using stereo vision to create a detailed model of an electrical substation, and analyze its accuracy and completeness.
10. Implement a convolutional neural network (CNN) for detecting and recognizing various symbols in electrical schematics, and test its performance on a diverse dataset.

RESOURCES

Text BOOKS:

3. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 1st Edition, September 3, 2010, ISBN: 978-1848829343.

4. Simon J.D. Prince, *Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 1st Edition, June 18, 2012, ISBN: 978-1107011793.

VIDEO LECTURES:

1. Introduction to Computer Vision - NPTEL Course https://nptel.ac.in/courses/106105216
2. Computer Vision - MIT OpenCourseWare https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-869-advances-in-computer-vision-fall-2014/
3. Image Processing and Computer Vision - Coursera https://www.coursera.org/learn/image-processing
4. Convolutional Neural Networks for Visual Recognition - Stanford Online http://cs231n.stanford.edu/

5. Visual Perception for Self-Driving Cars - Coursera https://www.coursera.org/learn/visual-perception-self-driving-cars

WEB RESOURCES:

1. Basics of Computer Vision - Computer Vision Online https://www.computervisiononline.com/
2. Image Processing Algorithms - OpenCV Documentation https://docs.opencv.org/master/index.html
3. Feature Detection and Matching - Learn OpenCV https://www.learnopencv.com/
4. Image Segmentation Techniques - Towards Data Science https://towardsdatascience.com/image-segmentation-techniques-2021a75b7927
5. Machine Learning for Computer Vision - GitHub Resources https://github.com/topics/computer-vision

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101701	**AI IN HEALTHCARE**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Concepts of Artificial Intelligence (AI) in Healthcare; The Present State and Future of AI in Healthcare Specialties; The Role of Major Corporations in AI in Healthcare; Applications of AI in Healthcare.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Understand the fundamental concepts of AI in Healthcare sector.

CO2 Analyse the present state and future of AI in Healthcare specialties for different scenarios.

CO3 Apply design concepts and metrics for AI in Healthcare.

CO4 Demonstrate basic concepts and terminologies of future applications of Healthcare in AI.

CO5 Develop AI applications through AI techniques for healthcare

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	-	-	-	-
CO2	2	3	-	2	-	2	2	-	-	-	-	-
CO3	2	-	2	2	-	-	-	-	-	-	-	-
CO4	2	-	-	-	2	2	-	-	-	-	-	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-
Course Correlation Mapping	**2**	**-**	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO ARTIFICIAL INTELLIGENCE IN HEALTHCARE ***(08 Periods)***

Introduction to AI in Healthcare, Benefits & Risks, AI in the health sector, AI versus human intelligence, The future of AI in health sector, AI & Neural networks.

Module 2: THE PRESENT STATE & FUTURE OF AI IN HEALTHCARE SPECIALTIES ***(10 Periods)***

Artificial Intelligence in: preventive healthcare, Radiology, Pathology, Surgery, Anesthesiology, Psychiatry, Cardiology, Pharmacy, Dermatology, Dentistry, Orthopedics, Ophthalmology.

Module 3: THE ROLE OF MAJOR CORPORATIONS IN AI IN HEALTHCARE ***(08 Periods)***

IBM Watson, The role of Google & Deep mind in AI in Healthcare, Baidu, Facebook & AI in Healthcare, Microsoft & AI in Healthcare.

Module 4: FUTURE OF HEALTHCARE IN AI ***(10 Periods)***

Evidence-based medicine, personalized medicine, Connected medicine, Virtual Assistants, Remote Monitoring, Medication Adherence, Accessible Diagnostic Tests, Smart Implantables, Digital Health and Therapeutics, Incentivized Wellness, Block chain, Robots, Robot-Assisted Surgery, Exoskeletons, Inpatient Care, Companions, Drones, Smart Places, Smart Homes, Smart Hospitals.

Module 5: APPLICATIONS OF AI IN HEALTHCARE ***(09 Periods)***

Case Study 1: AI for Imaging of Diabetic Foot Concerns and Prioritization of Referral for Improvements in Morbidity and Mortality.

Case Study 2: Outcomes of a Digitally Delivered, Low-Carbohydrate, Type 2 Diabetes Self-Management.

Case Study 3: Delivering A Scalable and Engaging Digital Therapy.

Case Study 4: Improving Course Outcomes for Junior Doctors through the Novel Use of Augmented and Virtual Reality for Epilepsy.

Case Study 5: Big Data, Big Impact, Big Ethics: Diagnosing Disease Risk from Patient Data.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Analyze how the artificial intelligence is used to predict the disease result and Prognosis Assessment of a patient.
2. How does drug discovery happen and how does AI is helping in drug discovery and Labs.
3. Justify that artificial intelligence provide engineering solutions for early detection and Diagnosis of diseases.
4. Demonstrate the prediction of bladder volume of a patient.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Dr. Parag Mahajan, *Artificial Intelligence in Healthcare*, MedManthra Publications, First Edition 2019.
2. Arjun Panesar, *Machine Learning and AI for Healthcare Big Data for Improved Health*, Apress Publications, 2019.

REFERENCE BOOKS:

1. Michael Matheny, Sonoo Thadaney Israni, Mahnoor Ahmed, and Danielle Whicher, *Artificial Intelligence in Health Care: The Hope, the Hype, the Promise, the Peril*, National Academy of Medicine Publication, First Edition 2019.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=-aHBwTQQyNU
2. https://intellipaat.com/blog/artificial-intelligence-in-healthcare/

Web Resources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6616181/
2. https://www.ibm.com/topics/artificial-intelligence-healthcare
3. https://builtin.com/artificial-intelligence/artificial-intelligence-healthcare

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CM101701	**BANKING AND INSURANCE**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Introduction to Banking; Bank-Customer Relationship; Electronic Payment System and Business Models; Introduction to Risk and Insurance; Insurance Overview.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Demonstrate the importance of Banking and functions of the Reserve Bank of India and its role in the country's sustainable development.

CO2 Demonstrate the role, relationships, and operations between Banker and Customer.

CO3 Demonstrate the Online Banking system, various types of Electronic Payments, and Business models.

CO4 Demonstrate the concept of risk and principles, functions, and, types of Insurance companies.

CO5 Understand the principles of insurance and its functions.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	2	-	-	-	1
CO2	3	-	-	-	-	-	-	2	-	-	-	1
CO3	3	-	-	-	-	-	-	2	-	-	-	1
CO4	3	-	-	-	-	-	-	2	-	-	1	1
CO5	3	-	-	-	-	-	-	2	-	-	1	1
Course Correlation Mapping	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**1**	**1**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO BANKING ***(09 Periods)***

Meaning - Importance of banking- Functions of banking - Reserve Bank of India: Functions – Role of RBI in sustainable development.

Module 2: BANK-CUSTOMER RELATIONSHIP **(09 Periods)**

Debtor-creditor relationship, deposit products or services, payment, and collection of cheques. Accounts – Types of accounts, the procedure for opening and closing an account - Loans and Advances- principles of lending.

Module 3 ELECTRONIC PAYMENT SYSTEM&BUSINESS MODELS **(09 Periods)**

Introduction to Online Banking - types of e-payment system, e-cash, NEFT, RTGS, Credit cards, Electronic Wallet and Debit cards. **Business models**- B2B, B2C, C2C, and B2G.

Module 4 INTRODUCTION TO RISK AND INSURANCE **(09 Periods)**

Insurance: Definition, Insurance as risk mitigation mechanism, elements of insurance. Concept of risk, risk *Vs* uncertainty.

Module 5 INSURANCE OVERVIEW ***(09 Periods)***

Principles of insurance - insurance types - LIC & GIC – insurance functions, IRDA - Insurance Players in India.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Make a PowerPoint presentation on the banking system in India.
2. Submit a report on the working of insurance companies.
3. Prepare a report on the functions of RBI & IRDA in India.
4. Submit a report on electronic banking facilities provided by Indian banks.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. RanganadhaChary, A.V. and Paul, R.R., *Banking and Financial system*, Kalyani Publisher, New Delhi, 3rdedition, 2016.

2. Sharma, R.K., Shashi K. Gupta and Jagwant Singh, *Banking and Insurance*, Kalyani Publishers, New Delhi, 17th edition, 2014

REFERENCES BOOKS:

1. *Indian Institute of Banking & Finance, Digital Banking*, Taxman Publications Pvt. Ltd., 2016 edition, 2016.
2. Jyotsna Sethi and Nishwan Bhatia, *Elements of Banking and Insurance*, PHI Learning Pvt. Ltd., 2nd edition, 2012.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=a1_p8zhbAfE
2. https://www.youtube.com/watch?v=bxNw9VB5Y_0

WEB RESOURCES:

1. https://unacademy.com/content/railway-exam/study material/economics/importance-of-banking-sector-in-the-country/
2. https://www.geeksforgeeks.org/ life-insurance-meaning-elements-and-types-of-life-insurance-policies/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22DS101701	**BIOINFORMATICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course focus on Biological Data Acquisition, Databases, Data Processing, Methods of Analysis, Applications of Bio-informatics.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1	Understand basic biological data acquisition in bioinformatics.
CO2	Identify the proper databases for the information search by choosing the biological databases and also submission and retrieval of data from databases.
CO3	Analyze the results of bioinformatics data using text and sequence-based searching techniques.
CO4	Analyze the secondary and tertiary structures of proteins by applying different alignment programs
CO5	Design biological databases by using contextual knowledge on bioinformatics.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-	-
CO5	3	2	3	3	3	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: BIOLOGICAL DATA ACQUISITION *(09 Periods)*

Biological information, Retrieval methods for DNA sequence, protein sequence and protein structure information

Module 2: DATABASES *(09 Periods)*

Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary and secondary sequence databases, protein sequence and structure databases.

Module 3: DATA PROCESSING ***(09 Periods)***

Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches: Local and global. Distance metrics. Similarity and homology. Scoring matrices, PAM and BLOSUM

Module 4: METHODS OF ANALYSIS ***(09 Periods)***

Dynamic programming algorithms, Needleman-Wunsch and Smith-waterman.Heuristic Methods of sequence alignment, FASTA and BLAST; Multiple Sequence Alignment and software tools for pair wise and multiple sequence alignment, CLUSTAL program, Prediction of Tertiary structure of proteins.

Module 5: APPLICATIONS ***(09 Periods)***

Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis, Genomics, Proteomics, Genome analysis – Genome annotation, DNA Microarray, computer aided drug design (CADD).

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Calculate the dynamic programming matrix and one or more optimal alignment(s) for the sequences GAATTC and GATTA, scoring +2 for a match, −1 for a mismatch and with a linear gap penalty of d = 2.
2. Determine whether the RNA string GGACCACCAGG should be folded into two substructures.
3. Discuss how to carry out the multiple sequence alignment of the following three sequences: TTTTAAAA, AAAACCCC, CCCCTTTT.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Lesk, A. K., *Introduction to Bioinformatics*, Oxford University Press, 4th Edition, 2013
2. Dan Gusfield, *Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology*, Cambridge University Press, 1997.

REFERENCE BOOKS:

1. Baldi, P. and Brunak, S., *Bioinformatics: The Machine Learning Approach*, MIT Press, 2nd Edition, 2001.
2. Mount, D.W., *Bioinformatics Sequence and Genome Analysis*, Cold Spring Harbor Laboratory Press, 2nd Edition, 2004.
3. Tindall, J., *Beginning Perl for Bioinformatics: An introduction to Perl for Biologists*, O'Reilly Media, 1st Edition, 2001.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=liNblw4x50E
2. https://www.youtube.com/watch?v=eZfyWdHnzR0

WEB RESOURCES:

1. https://www.britannica.com/science/bioinformatics
2. https://www.ebi.ac.uk/training/online/courses/bioinformatics-terrified/what-bioinformatics/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22BS101036	**BIOLOGY FOR ENGINEERS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Introduction to living organisms, Proteins, Nucleic acids and enzymes, Genetics and Molecular biology, Recombinant DNA technology, Human physiology and applied biology.

COURSE OUTCOMES: After successful completion of the course, students will be able to

CO1 Identify difference between cells, Cellular components and their functions.

CO2 Understand Proteins, Nucleic acids structure and function and also Mechanism of enzyme action.

CO3 Identify Central dogma of Molecular biology and processes of Molecular Biology.

CO4 Understand Recombinant DNA technology and its importance in creating new Animals and Plants.

CO5 Understand basics and Mechanism of different Physiological process including nerve function and applications of biological sciences.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	-	-	-	-	-	-	-	-	-	-

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: LIVING ORGANISMS ***(09 Periods)***

Comparison of biological organisms with manmade systems, Classification of living organisms, Cellular basis of life, differences between prokaryotes and eukaryotes, classification on the basis of carbon and energy sources, molecular taxonomy

Module 2: PROTEINS, NUCLEIC ACIDS AND ENZYMES ***(10 periods)***
Biomolecules, structure, function and Classification of proteins, structure, function and Classification of and Nucleic acids, Enzymes, Enzyme nomenclature, Classification of Enzymes and Mechanism of Enzyme action, Industrial applications of enzymes, Fermentation and its industrial applications

Module 3 GENETICS AND MOLECULAR BIOLOGY ***(11 Periods)***
Mendel's laws, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation.

Module 4 RECOMBINANT DNA TECHNOLOGY ***(08 Periods)***
Recombinant DNA Technology: recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips.

Module 5 HUMAN PHYSIOLOGY AND APPLIED BIOLOGY ***(07 Periods)***
Fundamentals of Human physiology, neurons, synaptic and neuromuscular junctions, Introduction to EEG, DNA fingerprinting, DNA Micro array and Genomics.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Identify the Cell and Cellular organelle spotters and write the functions of spotters identified
2. Prepare a table of Enzymes and their importance.
3. Assignments on Central dogma of Molecular biology
4. Identify different organs in the organ system diagrams.
5. Assignments on photosynthesis.
6. Quiz related to organ system and functions.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Rajiv Singal, Gaurav Agarwal, *Biology for Engineers*, CBS, 2019.
2. S. Sing and T. Allen, *Biology for Engineers*, Vayu Education of India, 2014.

REFERENCE BOOKS:

1. B. Alberts, A. Johnson et al., *The molecular biology of the cell*, Garland Science, 6th edition, 2014.
2. A. T. Johnson, *Biology for Engineers*, CRC press, 2011.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=N0Y386SVGN8
2. https://www.youtube.com/watch?v=1Pzk-UqilW4
3. https://www.youtube.com/watch?v=208pMhKoQeo

Web Resources:

1. Structure and function of Proteins: https://nptel.ac.in/courses/104102016/16
2. Enzyme catalysis: https://nptel.ac.in/courses/103103026/module3/lec35/4.html
3. Biochips: https://nptel.ac.in/courses/112104029/3

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22LG101701	BUSINESS COMMUNICATION AND CAREER SKILLS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Nature and Scope of Communication, Corporate Communication, Writing Business Messages & Documents, Careers & Résumés, and Interviews.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge of professional communication by analyzing and applying the styles and strategies of business communication in Communication Networks, Interpersonal, and Informal communication.

CO2. Analyze the limitations of communication by applying and demonstrating corporate and cross-cultural communication strategies effectively in a business context and Crisis Management situations.

CO3. Apply appropriate strategies and techniques in writing business messages, business letters, and résumé for effective professional communication and career building.

CO4. Demonstrate appropriate communication techniques and answering strategies by analyzing the expectations during presentations and interviews.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	2	-	-	-	-	3	-	-
CO2	1	2	-	-	2	-	-	-	-	3	1	-
CO3	1	-	-	-	2	-	-	-	-	3	-	-
CO4	1	2	-	-	2	-	-	-	-	3	-	-
Course Correlation Mapping	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**1**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: NATURE AND SCOPE OF COMMUNICATION ***(09 Periods)***

Introduction – Communication Basics – Functions of Communication – Communication Networks – Interpersonal Communication – Informal Communication – Communication Barriers – Roles of a Manager.

Module 2: CORPORATE COMMUNICATION ***(09 Periods)***

Introduction – Corporate Communication – Cross-Cultural Communication; Concept & Styles – Corporate Communication Strategy – Corporate Citizenship – Crisis Communication: Case Study.

Module 3: WRITING BUSINESS MESSAGES & DOCUMENTS ***(09 Periods)***

Introduction – Importance of Written Business Communication – Types of Business Messages – Five Main Stages of Writing Business Messages – Business Letter Writing – Kinds of Business Letters – Common Components of Business Letters – Strategies for Writing the Body of a Letter.

Module 4: CAREERS AND RÉSUMÉS ***(09 Periods)***

Introduction – Career Building – Résumé Formats: Traditional, Electronic and Video Résumé – Sending Résumés – Follow-up Letters – Business Presentations and Speeches: Planning – Structuring – Organizing – Delivery.

Module 5: INTERVIEWS ***(09 Periods)***

Introduction – General Preparation for an Interview – Success in an Interview – Important Non-verbal Aspects – Types of Interviews – Styles of Interviewing – Types of Interviewing –Online Recruitment Process.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. People often get confused in identifying or using English vocabulary on most occasions. Prepare a list of confusing words and find methods to overcome the difficulties in using those words to uplift the career of professionals.
2. Organizations and institutions use modern technology in communicating with their colleagues, clients, and stakeholders. Make a PowerPoint presentation on the modern communication system of any organization and its role in the success of the organization and its career.
3. As a student in the modern technological world, organizing or attending webinars is inevitable. Analyze the pros and cons of video conferencing by organizing webinars and preparing a report.
4. Form a team and act as a team leader. Prepare a performance appraisal report of the team using visual aids to support the presentation.
5. Make a detailed study on social networking and its impact on modern business and Career.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Meenakshi Raman, Prakash Singh, *Business Communication*, Oxford University Press, New Delhi, 2nd edition, 2012.
2. Neera Jain, Sharma Mukherji, *Effective Business Communication*, Tata Mc Graw–Hill

REFERENCE BOOKS:

1. Courtland L. Bovee et al., *Business Communication Today*, Pearson, New Delhi, 2011.
2. Krizan, *Effective Business Communication*, Cengage Learning, New Delhi, 2010.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110105052
2. https://edurev.in/courses/14522_Business-Communication-The-Ultimate-Guide

Web Resources:

1. http://www.career.vt.edu/interviewing/TelephoneInterviews.html
2. http://job-search-search.com/interviewing/behavioral_interviews
3. https://goo.gl/laEHOY (dealing with complaints)
4. http://www.adm.uwaterloo.ca/infocecs/CRC/manual/resumes.html
5. https://goo.gl/FEMGXS
6. http://www.resumania.com/arcindex.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CE101701	**CIVIL ENGINEERING AND THE SOCIETY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on introduction to civil engineering, aesthetics of historic and modern civil engineering structures, unpredictable nature and the civil engineering; civil engineering solutions for the problems of traffic, pollution, water and waste management; building sustainable smart cities.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze principles of civil engineering to basic civil engineering problems following ethics and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

CO2. Analyze aesthetics of historic and modern civil engineering structures to solve complex civil engineering problems using tools and techniques by following ethics and latest trends considering society, environment and sustainability besides communicating effectively in graphical form.

CO3. Analyze unpredictable nature and the role of civil engineering to solve complex civil engineering problems using tools and techniques by following ethics and considering society, environment and sustainability besides communicating effectively in graphical form.

CO4. Analyze civil engineering solutions for the problems of traffic, pollution, water and waste management to solve complex problems using appropriate tools and techniques following relevant standards considering society, health, safety, environment, economics and management besides communicating effectively in graphical form.

CO5. Analyze the building principles of sustainable smart cities to solve complex problems using appropriate tools and techniques following relevant standards considering society, health, safety, environment, economics and management besides communicating effectively in graphical form.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	2	3	2	-	1	-	1
CO2	3	3	-	1	2	2	2	2	-	1	-	1
CO3	3	3	-	1	2	2	2	2	-	1	-	-
CO4	3	3	-	1	2	2	2	2	-	1	2	-
CO5	3	3	-	1	2	2	2	2	-	1	2	-
Course Correlation Mapping	**3**	**3**	**-**	**1**	**2**	**2**	**2**	**2**	-	**1**	**2**	**1**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO CIVIL ENGINEERING ***(07 Periods)***

Philosophy of civil engineering, Disciplines of civil engineering, Evolution of construction and civil engineering in the world; Civil engineer - Duties and responsibilities, Role of Civil engineer in the society; Civil engineering materials and their applications, Latest advancements in civil engineering.

Module 2: AESTHETICS OF HISTORIC AND MODERN CIVIL ENGINEERING STRUCTURES ***(09 Periods)***

Aesthetics in civil engineering structures; Aesthetic principles and techniques - Analysis of materials, textures and colors in aesthetic design, Integration of aesthetics with structural engineering principles; Historic civil engineering structures - Case studies of iconic historic structures (e.g. Colosseum, Taj Mahal, Eiffel Tower); Modern civil engineering structures - Exploration of contemporary iconic structures (e.g. Burj Khalifa, Sydney Opera House, Golden Gate Bridge); Integration of aesthetics and functionality - Ethical considerations in balancing aesthetics, functionality and sustainability; Future trends in aesthetic engineering.

Module 3 UNPREDICTABLE NATURE AND THE CIVIL ENGINEERING ***(09 Periods)***

Unpredictable nature, Examples of unpredictable natural disasters - Earthquakes, Floods, Landslides, Hurricanes, Tsunamis, Impacts of unpredictable natural events on infrastructure; Role of civil engineering; Resilience in civil engineering - Strategies for building resilient structures, Risk assessment and analysis, Incorporating safety factors, Using robust construction materials, Implementing redundancy and backup systems, Sustainable design practices; Case studies of successful resilient designs.

Module 4 CIVIL ENGINEERING SOLUTIONS FOR THE PROBLEMS OF TRAFFIC, POLLUTION, WATER AND WASTE MANAGEMENT ***(11 Periods)***

Introduction to urban challenges and sustainable development; Traffic management solutions - Causes and impacts of traffic congestion, Intelligent transportation systems; Pollution control and environmental engineering, Sources and types of urban pollution, Air quality monitoring and control strategies, Water pollution control, Noise pollution management, Sustainable construction practices to reduce pollution; Water resource management, Water demand and supply management in urban areas, Rainwater harvesting techniques, Water conservation and wastewater treatment technologies; Waste management strategies, Solid waste generation and disposal challenges, Waste-to-energy conversion technologies, Case studies of successful waste management initiatives; Integration and synergies among Solutions, Multi-disciplinary approach for holistic solutions.

Module 5 BUILDING SUSTAINABLE SMART CITIES ***(09 Periods)***

Smart city; Elements of smart city infrastructure – Buildings, Mobility, Energy, Water, Waste management, Health and digital layers; Need for an integrated approach; Role of science, technology and innovation in the implementation of smart infrastructure; Smart infrastructure design principles and policies; Case studies: Gujarat International Finance Tech-City in India.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Group discussion on compatibility of modern construction materials compared to that of traditional civil engineering materials
2. Poster presentation on historic and modern civil engineering structures.
3. Submit a case study report on Life Cycle Analysis (LCA) of any one of the historic civil engineering structure.
4. Submit a case study report on the theme of severity of the natural disasters on the Civil engineering structures.
5. Debate on challenges, limitations and solutions for design and implementation of smart city.

(Note: It’s an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1 David Muir Wood., *Civil Engineering: A Very Short Introduction*, Oxford University Press, 1st Edition, 2012.
2 Roger Scruton, *The Aesthetics of Architecture*, Princeton University Press, 2nd Edition, 2013.

REFERENCE BOOKS:

1 Anubha Kaushik and C. P. Kaushik, *Perspectives in Environmental Studies*, New Age International (P) Ltd Publications, 6th Edition, 2018.
2 Sang Lee (Editor), *Aesthetics of Sustainable Architecture*, 010 publishers, 1st Edition, 2013.
3 Marc Kushner, *The Future of Architecture in 100 Buildings*, Simon and Schuster, 1st Edition, 2015.
4 Nicholas J. Garber and Lester A. Hoel, *Traffic and Highway Engineering*, Nelson Engineering, 1st Edition, 2008.
5 Stephen M. Wheeler and Timothy Beatley, *Sustainable Urban Development*, Reader Routledge Urban Reader Series, 3rd Edition, 2014.
6 Larry W. Mays, *Water Resources Engineering*, Wiley India Private Limited, 3rd Edition, 2011.
7 Hans Straub, *A History of Civil Engineering: An Outline from Ancient to Modern Times*, The MIT Press, 4th Edition, 1964.
8 Brian Vanden Brink, *Iconic: Perspectives on the Man-Made World*, Down East Books, Illustrated Edition, 2012.

VIDEO LECTURES:

1 https://archive.nptel.ac.in/courses/123/105/123105001/
2 https://onlinecourses.nptel.ac.in/noc22_ce42/preview
3 https://onlinecourses.nptel.ac.in/noc19_ce31/preview
4 https://onlinecourses.nptel.ac.in/noc20_ce07/preview

WEB RESOURCES:

1 https://bregroup.com/insights/aesthetics-in-architecture-how-beauty-and-design-are-inspiring-each-other/
2 https://keckwood.com/news-updates/how-civil-engineers-help-during-disaster-recovery/#:~:text=Civil%20engineers%20provide%20humanitarian%20and,shortages%20to%20hard%2Dhit%20communities
3 https://smartcities.gov.in/
4 https://www.twi-global.com/technical-knowledge/faqs/what-is-civil-engineering
5 https://www.ice.org.uk/engineering-resources/knowledge-resources/water-and-waste-water-management

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22SS101701	**CONSTITUTION OF INDIA**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides and in-depth knowledge about Constitution of India's Preamble and its Philosophy; Union Legislature; Federalism in India; Judiciary and Public Services; Nation Building. The students can gain first-hand information and knowledge about these dynamics and accordingly act based on these sources in their professional and routine activities.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1: Demonstrate knowledge in the Parliamentary proceedings, Election Commission, Public Services and Foreign Policy of India.

CO2: Apply the reasoning informed by the various aspects of the Constitution and its provisions to assess societal issues and the consequent responsibilities relevant to the professional engineering practice.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	3	2	-	-	-	-	-
CO2	2	-	-	-	-	3	-	3	-	-	-	-
Course Correlation Mapping	**2**	**-**	**-**	**-**	**-**	**3**	**2**	**3**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: PREAMBLE AND ITS PHILOSOPHY ***(09 Periods)***

Introduction to Indian Constitution; Evolution of Indian Constitution; preamble and its philosophy

Module 2: UNION LEGISLATURE ***(09 Periods)***

The Parliament, Parliamentary Structure, Process of Legislation; President of India – Powers and Functions; Prime Minister and Council of Ministers; Constitution Amendment Procedure.

Module 3: FEDERALISM IN INDIA ***(09 Periods)***

Centre-State Administrative Relationship; Governors – Powers and Functions; State Legislature - Composition and powers; Chief Ministers - Powers and Functions; The Election Commission – Powers and Functions.

Module 4: JUDICIARY AND PUBLIC SERVICES ***(09 Periods)***

The Union Judiciary - Supreme Court and High Court; Fundamental Rights and Duties All India Services - Central Civil Services -State Services - Local Services.

Module 5: INTERNATIONAL PARTICIPATION ***(09 Periods)***

Foreign Policy of India; International Institutions Influence: UNO, WTO, WHO, SAARC, International Summits: BRICS, NSS, UNEP – India's Role in International Negotiations; Environmentalism in India.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Review newspapers and submit a report on critical analysis of Indian Civil Servants exercise of powers, in the awake of constitutionally assigned authority.
2. Visit your village Panchayat office or Municipality office and generate a report on your observations about maintained Constitutional symbolism.
3. Watch few videos on recent Indian Independence Day and Republic Day celebrations as marked in New Delhi and present a detailed report, by considering the following aspects:
    a) Comparatively analyze the speeches of the President of India and Prime Minister of India as delivered on these two occasions.
    b) Compare these two events relevance in terms of Indian Armed Forces presence.
    c) Observe, compare and analyse 'flag code' relevance as marked in these two events.
4. Watch a few videos on recent 'proceedings' of any state Legislative Assembly session and submit a detailed report.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Briji Kishore Sharma, *Introduction to the Constitution of India*, Prentice Hall of India, 2005

REFERENCE BOOKS:

1. Mahendra Pal Singh,V. N. Shukla's, *Constitution of India*, Eastern Book Company, 2011.
2. Pandey J. N., *Constitutional Law of India*, Central Law Agency, 1998

VIDEO LECTURES:

1. Doctrine of Basic Structure: https://www.youtube.com/watch?v=cvUf9ZeEe8Y
2. Significance of the Constitution: https://www.youtube.com/watch?v=vr1Dc_-ZKbQ

Web Resources:

1. The Constitution of India: https://www.youtube.com/watch?v=of2SoO8i8mM
2. Protection of Constitutional Democracy: https://www.youtube.com/watch?v=smJ99cdPrns

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CM101702	COST ACCOUNTING AND FINANCIAL MANAGEMENT	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Cost accounting; cost sheet & preparation of cost sheet; standard costing & variance analysis; financial management & ratio analysis; introduction to investment**.**

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Demonstrate the concepts of Cost Accounting and Management Accounting and the elements of costing.

CO2 Determine the Cost of Production for pricing decisions.

CO3 Apply the Standard Costing and Variance techniques for the control of the cost of production

CO4 Analyze the Profitability and financial condition of an organization using Ratios.

CO5 Apply Capital Budgeting techniques for making investment decisions in an organization.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	2	-	-	1	-	-	-	-
CO2	3	-	-	-	2	-	-	1	-	-	1	-
CO3	3	-	-	-	2	-	-	1	-	-	1	-
CO4	3	-	-	-	2	-	-	1	-	-	1	-
CO5	3	-	-	-	2	-	-	1	-	-	-	-
Course Correlation Mapping	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**1**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: COST ACCOUNTING ***(09 Periods)***

Meaning of Cost and Cost Accounting, Objectives, Scope, Advantages, and Disadvantages – Cost Accounting *Vs* Management Accounting – Elements of Costing – Installation of costing system – Material Control, Labor Control, Overhead Control.

Module 2: COST SHEET & PREPARATION OF COST SHEET **(09 Periods)**

Analysis of Cost – Preparation of cost sheet, estimate, tender, and quotation (Simple problems) – Importance of Costing while pricing the products

Module 3 STANDARD COSTING & VARIANCE ANALYSIS **(09 Periods)**

Introduction to Standard Costing & Variances – Variance Analysis: Material variances, Labor variances (Simple Problems).

Module 4 FINANCIAL MANAGEMENT & RATIO ANALYSIS **(09 Periods)**

Meaning, Objectives - Nature and Scope, Importance of FM – Ratio Analysis**:** Types of Ratios: Solvency Ratios, Liquidity Ratios, Turnover Ratios, and Profitability Ratios - Financial Statement Analysis through Ratios (Simple Problems).

Module 5 INTRODUCTION TO INVESTMENT ***(09 Periods)***

Investment - Meaning and Definition- concept of risk and returns - Capital budgeting techniques – Security Analysis and Portfolio Management (Basic concepts).

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Prepare a report on the role of cost accountants in the growth of a company.
2. To visit the manufacturing unit to observe how they used various techniques for analyzing the financial health of a company.
3. Prepare a report on factors influencing the form of business organization.
4. Prepare the cost sheet with practical examples of any two manufacturing companies.

(Note: It’s an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. S.P. Jain and K.L. Narang: *Cost Accounting*, Kalyani Publishers, Ludhiana, 10th edition, 2016.
2. I.M. Pandey, *Financial Management*, Vikas Publishing House Pvt. Ltd., 14th edition, 2016.

REFERENCE BOOKS:

1. The Institute of Company Secretaries of India, *Cost and Management Study Material*, New Delhi.
2. CA Saravana Prasath, *Cost Accounting and Financial management*, Wolters Kluwer India Pvt. Ltd., New Delhi, 2018.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=ESqO8sFgQa0&list=PLLhSIFfDZcUVE2kzOhEubO9rkvUOAgZbz

2 https://www.youtube.com/watch?v=tzasFmP1CpAhttps://www.youtube.com/watch?v=tzasFmP1CpA

WEB RESOURCES:

1 https://www.tutorialspoint.com/accounting_basics/management_versus_cost_accounting.htm

2 https://www.netsuite.com/portal/resource/articles/financial-management/financial-management.shtml

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CB101701	**CYBER LAWS AND SECURITY**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Cyber Crimes and Indian IT Act; Cyber Offenses; Tools and Methods used in Cyber Crime; Phishing ad Identity Theft; Indian and Global Perspective on Cyber Crimes and Cyber Security; Organizational Implications on Cyber Security; IPR Issues; Cyber
Crime and Terrorism; Cyber Crime Illustrations

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge in Cyber security, Cybercrimes and its related laws in Indian and Global Act.

CO2. Analyze the legal perspectives and laws related to cybercrimes in Indian context.

CO3. Apply security and privacy methods in development of modern applications and in organizations to protect people and to prevent cybercrimes.

CO4. Solve Cyber security issues using privacy policies and Use antivirus tools to minimize the impact of cyber threats.

CO5. Apply security standards for the implementation of Cyber Security and laws.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	-	-	-	-	-	-	-	-
CO4	3	2	3	-	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO CYBER CRIMES AND OFFENSES ***(09 Periods)***

Cyber Crimes: Introduction, Definition, Origin, Cybercrime and information security, Cyber criminals, Classifications of cybercrimes, The legal perspectives and Indian perspective, Cybercrime and Indian ITA 2000, Global perspective on cybercrimes.

Cyber Offenses: Introduction, Criminals planning on attacks, Social engineering, Cyber stalking, Cyber cafe and crimes, Botnets.

Module 2: TOOLS AND METHODS USED IN CYBER CRIME AND PHISHING AND IDENTITY THEFT ***(09 Periods)***

Introduction, Proxy servers and Anonymizers, Phishing, Password cracking, Key loggers and Spywares, Virus, Worms and Ransomware, Trojan horses and Backdoors, Steganography, DoS and DDoS attacks.

Phishing and Identity Theft: Introduction, Phishing, Identity Theft (ID Theft).

Module 3 CYBER CRIMES AND CYBER SECURITY-LEGAL PERSPECTIVES ***(08 Periods)***

Introduction, Cyber laws in Indian context, The Indian IT act, Challenges to Indian law and Cybercrime scenario in India, Consequences of not addressing the weakness in IT act, Digital signatures and the Indian IT Act, Cyber Crime and Punishment, Cyber law, Technology and Students in India scenario.

Module 4 CYBER SECURITY-ORGANIZATIONAL IMPLICATIONS ***(10 Periods)***

Introduction, Web threats for organizations – evils and perils, Security and privacy implications from cloud computing, Social Media Marketing-Security risks and Perils for organizations, Social computing and associated challenges for organizations, Protecting people's privacy in organization, Organizational guidelines for internet usage, Safe computing and Usage policy, Incident handling and Best practices.

Module 5 CYBER CRIME AND TERRORISMAND ILLUSTRATIONS ***(09 Periods)***

Cyber Crime & Terrorism: Introduction, Intellectual property in the cyber space, The ethical dimension of cybercrimes, The psychology, Mindset and skills of hackers and cyber criminals, Sociology of cyber criminals, Information warfare.

Cyber Crime Illustrations: Indian banks lose millions of rupees, Justice vs. Justice, Parliament attack, The Indian case of online gambling, Bank and credit card related frauds, Purchasing goods and services scam, Nigerian 419 scam.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. The Cyber Security Risks on Social Media – Learn from Case Studies: https://www.rswebsols.com/tutorials/internet/cyber-security-risks-social-media
2. SIX automates key cybersecurity tasks to actively protect itself against social media threats: https://www.hootsuite.com/resources/six-group-case-study
3. Important Cyber Law Case Studies : https://www.cyberralegalservices.com/detail-casestudies.php

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Nina Gobole, SunitBelapure, *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*, Wiley India, 2011.

REFERENCE BOOKS:

1. Prashant Mali, *Cyber Law and Cyber Crimes*, Snow White Publications Pvt. Ltd., 2013.
2. Alfred Basta and et al, *Cyber Security and Cyber Laws*, Cengage Learning India 2018

VIDEO LECTURES:

1. Learn Cyber Security | Cyber Security Training: https://www.youtube.com/watch?v=PlHnamdwGmw
2. Cyber Security For Beginners: https://www.youtube.com/watch?v=4RE4d23tDFw

WEB RESOURCES:

1. https://study.com/academy/course/computer-science-110-introduction-to-cybersecurity.html
2. https://www.pandasecurity.com/en/mediacenter/panda-security/types-of-cybercrime/
3. https://mediasmarts.ca/digital-media-literacy/digital-issues/cyber-security/cyber-security-spam-scams-frauds-identity-theft

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101701	**ELECTRICAL SAFETY AND SAFETY MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

The course deals with the various aspects of potential risk due to electrical shock; safety precautions to be followed while working in hazardous zones; safe practices while handling various electrical equipment and during maintenance; and relevant electrical safety standards and Indian rules and acts.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the Indian electricity rules, regulations and various standards to be maintained for the safety of life and equipment.

CO2. Understand the potential effects of electrical shock and safety measures to protect against such risk.

CO3. Understand the safety aspects and safe practices to be followed while installing residential, commercial, and agricultural appliances.

CO4. Identify various hazardous working zones and take necessary precautionary measures while working in such areas.

CO5. Follow safety measures during installation, testing and commissioning, and maintenance of electrical equipment/plant.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	1	3	1	3	-	-	-	1
CO2	3	-	-	-	1	2	2	-	-	-	-	1
CO3	3	-	-	-	1	2	2	-	-	-	-	1
CO4	3	-	-	-	2	3	2	2	-	-	-	1
CO5	3	-	-	-	-	3	2	2	-	-	-	1
Course Correlation Mapping	**3**	-	-	-	**1**	**3**	**2**	**3**	-	-	-	**1**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INDIAN ELECTRICITY RULES AND ACTS, AND THEIR SIGNIFICANCE ***(10 Periods)***

OSHA standards of electrical safety, Basic electrical safety rules as per OSHA; Objectives and scope of IE acts and IE rules, Ground clearance and Section Clearances, Clearance in transmission and distribution lines, Significance of Equipment Earthing, Earthing of equipment bodies, structures and non-current carrying metallic parts, Earthing of system neutral; Rules regarding first aid and firefighting facility, Electrical safety general requirements as per IE rules.

Module 2: INTRODUCTION TO ELECTRICAL SAFETY AND SAFETY MANAGEMENT ***(10 Periods)***

Electric Safety: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current and voltage, Protection against electrical hazards and types, Effect of current on the human body, Principles of electrical safety and approach to prevent accidents.

Electric shocks and its prevention: Primary and secondary electrical shocks, possibilities of getting an electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, Safety precautions in LV installations and electric plant.

Module 3: ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL, AND AGRICULTURAL INSTALLATIONS ***(08 Periods)***

Introduction—Wiring and fitting; Domestic appliances—water tap giving a shock, shock from wet wall, fan firing shock; Multi-storied building, Temporary installations, Agricultural pump installation; Do's and Don'ts for safety in the use of domestic electrical appliances; Principles of safety management in electrical plants, safety auditing, and economic aspects.

Module 4: ELECTRICAL SAFETY IN HAZARDOUS AREAS ***(07 Periods)***

Hazardous zones—class 0, 1 and 2; Sparks, flashovers and corona discharge in electrical plants; equipment for hazardous locations; scope for live line work, principles of live line maintenance, special tools for live line maintenance, safety instructions for working on HV lines/apparatus.

Module 5: SAFETY DURING INSTALLATION TESTING AND MAINTENANCE ***(10 Periods)***

Safety during installations: Preliminary preparations, preconditions for the start of installation work and safe sequence, safety aspects during installations of Transformers and Rotating machines.

Safety during testing: Purpose of commissioning checks and tests, equipment tests, high voltage energization tests, performance and acceptance tests, and safety aspects during commissioning.

Safety during maintenance: Operators' safety, Types of safety maintenance, Safety procedures, safety precautions during maintenance, and planning of maintenance.

Total Periods: *45*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Study and submit a report on various electrical safety standards followed in abroad countries.
2. Visit a nearby industry and submit a report on various safety measures followed in the industry.
3. Study and submit a report on standard practices followed during the maintenance/commissioning of the electrical apparatus in any industry.
4. Collect information about various safety/alert sign boards and the relative measures for a particular situation.
5. Should practice preliminary first aid assistance such as Cardiopulmonary resuscitation (CPR) and shall demonstrate.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Rao, Prof. H.L. Saluja, *Electrical Safety, Fire Safety Engineering and Safety Management*, Khanna Publishers. New Delhi, 2nd Edition, 2018 Reprint.

REFERENCE BOOKS:

1. Cadick, John, Mary Capelli-Schellpfeffer, and Dennis K. Neitzel, *Electrical safety Handbook,* McGraw-Hill Education, 2012.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=g-ofq7i_u48

WEB RESOURCES:

1. https://cercind.gov.in/Act-with-amendment.pdf
2. https://www.edapp.com/blog/electrical-safety-training-topics/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22MG101701	ENTREPRENEURSHIP FOR MICRO, SMALL AND MEDIUM ENTERPRISES	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: To understand the setting up and management of MSMEs and initiatives of Government and other institutions support for growth and development of MSMEs

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the basic of SME and challenges of MSMEs

CO2. Explain the opportunities to Set-Up SSI/SME Units and role of rural & women entrepreneurship.

CO3. Illustrate roles of various institutions supporting MSMEs.

CO4. Understand Management of MSME, NPA & sickness units

CO5. Evaluate role of Government in Promoting Entrepreneurship

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	-	-	-	-	-	-	-
CO2	1	1	2	-	-		2		1			-
CO3	2	2	1	-	-	-	-	1	-	-	2	
CO4	3	1	2	-	-	-	-	-	-	-	-	2
CO5	2	2	1	-	-	1	-	-	-	-	-	1
Course Correlation Mapping	2	2	2	2	1	1	2	1	1	-	2	2

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Introduction2 ***(07 Periods)***

Concept & Definition, Role of Business in the modern Indian Economy SMEs in India, Employment and export opportunities in MSMEs. Issues and challenges of MSMEs

Module 2: MSME Setting ***(09 Periods)***

Identifying the Business opportunity, Business opportunities in various sectors, formalities for setting up an enterprise - Location of Enterprise – steps in setting up an enterprise – Environmental aspects in setting up, Incentives and subsidies.

Module 3: MSMEs Supporting Institutions ***(09 Periods)***
Forms of Financial support, Long term and Short term financial support, Sources of Financial support, Development Financial Institutions, Investment Institutions, Central level institutions, State level institutions, Other agencies, Commercial Bank – Appraisal of Bank for loans

Module 4: Management of MSME ***(10 Periods)***
Management of Product Line; Communication with clients – Credit Monitoring System - Management of NPAs - Restructuring, Revival and Rehabilitation of MSME, Problems of entrepreneurs – sickness in SMI – Reasons and remedies –– Evaluating entrepreneurial performance

Module 5: Entrepreneurship Promotion ***(10 Periods)***
MSME policy in India, Agencies for Policy Formulation and Implementation: District Industries Centers (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB)

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Present a case study on MSMEs Business Strategies.
2. Collect the data about nearby MSMEs and Present their structures in a PPT
3. Discuss in the group MSMEs opportunities in terms of Orientation and Develop mentation.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Vasant Desai, *Small Scale Industries and Entrepreneurship*, Himalaya Publishing House, 2003..
2. Poornima M Charanthimath, *Entrepreneurship Development Small Business Enterprises*, Pearson, 2006.

REFERENCE BOOKS:

1. Suman Kalyan Chaudhury, *Micro Small and Medium Enterprises in India Hardcover*, Raj Publications, 2013.
2. Aneet Monika Agarwal, *Small and medium enterprises in transitional economies, challenges and opportunities*, DEEP and DEEP Publications
3. Paul Burns & Jim Dew Hunt, *Small Business Entrepreneurship*, Palgrave Macmillan publishers, 2010.

VIDEO LECTURES:

1. https://sdgs.un.org/topics/capacity-development/msmes
2. https://blog.tatanexarc.com/msme/msme-schemes-in-india-for-new-entrepreneurs-and-start-ups/

Web Resources:

1. ncert.nic.in/textbook/pdf/kebs109.pdf
2. https://www.jetir.org/papers/JETIR1805251.pdf

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CE101702	**ENVIRONMENTAL POLLUTION AND CONTROL**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on fundamentals of air pollution, dispersion of pollutants, effects and control of air pollution, water pollution, soil pollution and control, and municipal solid waste management.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Analyze air and noise pollution using appropriate tools and techniques to solve complex environmental issues following relevant standards considering society, environment and sustainability besides communicating effectively in graphical form.

CO2 Analyze air and noise pollution control measures using appropriate tools and techniques to solve complex environmental issues following relevant standards and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

CO3 Analyze water pollution and its control measures using appropriate tools and techniques to solve complex environmental issues following relevant standards and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

CO4 Analyze soil pollution and its control measures using appropriate tools and techniques to solve complex environmental issues following relevant standards and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

CO5 Analyze solid waste and its management measures using appropriate tools and techniques to solve solid waste disposal issues following relevant standards and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	2	2	3	3	2	-	1	-	-
CO2	2	3	-	2	2	3	3	2	-	1	-	1
CO3	2	3	-	2	2	3	3	2	-	1	-	1
CO4	2	3	-	2	2	3	3	2	-	1	-	1
CO5	2	3	-	2	2	3	3	2	-	1	1	1
Course Correlation Mapping	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**-**	**1**	**1**	**1**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: AIR AND NOISE POLLUTION ***(08 Periods)***

Air Pollution: Scope, Significance, Classification, Sources – Line, Area, Stationary, Mobile; Effects of air pollutants on man, material and vegetation; Global effects of air pollution; Air pollution meteorology - Lapse rate, Inversion, Plume pattern; Dispersion of air pollutants - Dispersion models and applications; Ambient air quality standards.

Noise Pollution: Sound pressure, Power and intensity, Impacts of noise, permissible limits of noise pollution, measurement of noise, Noise standards.

Module 2: AIR AND NOISE POLLUTION CONTROL ***(10 Periods)***

Self-cleansing properties of the environment, Dilution method, Control at source, Process changes and equipment modifications, Control of particulates – Types of equipment, Design and operation - Settling chambers, Centrifugal separators, Bag house filters, Wet scrubbers, Electrostatic precipitators; Control of gaseous pollutants – Adsorption, Absorption, Condensation, Combustion; Control of air pollution from automobiles, Control of noise pollution, Case studies, Latest developments in the air and noise pollution control.

Module 3: WATER POLLUTION AND CONTROL ***(10 Periods)***

Water pollution – Sources, Causes, Effects; Surface and groundwater quality – Physical, Chemical, Biological; Drinking water quality standards, Water purification – Processes, Engineered systems – Aeration, Solids separation, Settling operations, Coagulation, Softening, Filtration, Disinfection; Wastewater – Sources, Causes, Effects, Treatment process and disposal – Primary, Secondary, Tertiary; Case studies, Latest developments in the water pollution control.

Module 4: SOIL POLLUTION AND CONTROL ***(08 Periods)***

Soil pollutants, Sources of soil pollution, Causes, Effects and control of soil pollution, Diseases caused by soil pollution, Methods to minimize soil pollution, Effective measures to control soil pollution, Soil quality standards, Case studies, Latest developments in the soil pollution control.

Module 5: MUNICIPAL SOLID WASTE MANAGEMENT ***(09 Periods)***

Municipal solid waste – Types, Composition and characteristics; Methods of collection and transportation; Methods of disposal – Open dumping, Sanitary landfill, Composting and Incineration; Utilization - 6R Concept, Recovery and recycling and Energy Recovery; Latest developments in solid waste management.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Explain plume patterns due to air pollution and meteorology effects and draw a neat sketch of plume pattern from any chimney that you have observed in recent times.

2. Compare the different air pollution control equipment used in India and draw a neat sketch line diagram of equipment you have seen in any of your industrial visit.

3. Submit a study report on Coagulation, Flocculation, Sedimentation, Filtration and Disinfection in your own words after watching a YouTube video on water treatment.

4. Enumerate the effective measures to control soil pollution with any two case studies.

5. Submit a report on case studies on the use of 6Rs concept of Municipal Solid Waste Management.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Peavy, H. S, Rowe, D. R., and Tchobanoglous, G., *Environmental Engineering*, McGraw Hill Inc., 1985.
2. C. S. Rao, *Environmental Pollution Control Engineering*, New Age International Pvt. Ltd., 2nd Edition, 2007.
3. Ibrahim A. Mirsa, *Soil Pollution: Origin, Monitoring & Remediation*, Springer, UK, 2nd Edition, 2008.

REFERENCE BOOKS:

1. M. N. Rao and H. V. N. Rao, *Air Pollution,* Tata McGraw–Hill Education Pvt. Ltd., 19th Edition, 2010.
2. Daniel Vallero, *Fundamentals of Air Pollution,* Academic Press (Elsevier), 5th Edition, 2014.
3. S. M. Khopkar, *Environmental Pollution Monitoring and Control,* New Age International Pvt. Ltd., 2nd Edition, 2007.
4. V. M. Domkundwar, *Environmental Engineering*, DhanpatRai & Co. Pvt. Ltd., New Delhi, 2014.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/123/105/123105001/
2. https://archive.nptel.ac.in/courses/105/107/105107213/
3. https://archive.nptel.ac.in/courses/103/107/103107084/

WEB RESOURCES:

1. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202005012116016435Ranvijay-Pratap-Singh-Environmental-Pollution.pdf
2. https://www.deshbandhucollege.ac.in/pdf/resources/1585622878_HIST_(HONS.)_II_Env-Pollution.pdf
3. https://www.jica.go.jp/jica-ri/IFIC_and_JBICI-Studies/english/publications/reports/study/topical/health/pdf/health_08.pdf
4. https://www.iitr.ac.in/wfw/web_ua_water_for_welfare/education/proceeding_of_short-term_training/diploma/Environmental_Sciences_May_24-28_2007/Lecture_notes/Env_Pollution-rb.pdf
5. https://anits.edu.in/online_tutorials/es/Unit%203.pdf

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101702	**ESSENTIALS OF VLSI**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course contains the topics that make student realize the need for Testing. The various types of testing along with Fault Modeling. Test methods for evaluation and test generation algorithms, Delay Tests, IDDQ Tests for testing the circuits , Ad-Hoc DFT Methods, Scan Based Designs, Built-In Self Test.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the importance of Testing, fault models and related theorems.

CO2. Analyze various test methods as applicable to digital circuits.

CO3. Appraise the various combinational and sequential circuit test generation algorithms for functional verification of digital circuits

CO4. Assess delay test algorithms and IDDQ test algorithms for at-speed testing of CMOS Integrated Circuits.

CO5. Recognize the concepts and architectures for Built-In Self Test to satisfy industry specifications.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3					-	-	-	-	-	-	-
CO2	3	3	2	2	2	-	-	-	-	-	-	
CO3	3	3	2	2	2	-	-	-	-	-		-
CO4	3	3	2	2	2	-	2	3	-	-	-	-
CO5	3	-	-	-	-	-	-	3	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**2**	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO VLSI ***(09 Periods)***

Levels of Abstraction, VLSI Design Flow, MOS Transistor - Characteristics, I_{DS} – V_{DS} Relation, NMOS and CMOS Logic – Logic Gates Design, NMOS and CMOS Fabrication Process.

Module 2: CMOS CIRCUIT DESIGN PROCESS ***(10 Periods)***

MOS Layers, Stick Diagrams, NMOS and CMOS Design Styles, Lambda based Design Rules, NMOS and CMOS Layouts for Inverter and Universal Gates, Sheet Resistance, Capacitance and Delay Calculations, Effects of Scaling.

Module 3: SUBSYSTEM DESIGN ***(11 Periods)***

Adders – Manchester Carry Chain Adder, Carry Look Ahead Adder, Carry Select Adder, Carry Skip adder, Barrel Shifter, Multiplier – Array Multiplier, Booth Multiplier.

Module 4: PROGRAMMABLE HARDWARE ***(06 Periods)***

Design Styles, Programmable Interconnects, Field Programmable Gate Arrays, Complex Programmable Logic Devices, Cell based Design Methodology.

Module 5: DESIGN FOR TESTABILITY ***(09 Periods)***

Ad-Hoc DFT Methods, Full Scan Design, Partial Scan Design, Random Logic BIST – Test-per-Clock and Test-per-Scan BIST Systems; Boundary Scan Standard – TAP Controller and Port.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Develop and Illustrate D – algorithm for Sequential Circuits.
2. Illustrate the applicability of existing testing algorithms for circuits with multiple stuck-at-faults.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Michael L. Bushnell, Vishwani D. Agrawal*, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits,* Kluwer Academic Pulishers, Springer US, New York, 2006.

REFERENCE BOOKS:

1. Miron Abramovici, Melvin A. Breur, Arthur D.Friedman, *Digital Systems Testing and Testable Design*, Wiley, Jaico Publishing House, 1st Edition, 2001.
2. Alfred L. Crouch, *Design for Test for Digital ICs & Embedded Core Systems*, Pearson Education, 1st Reprint Edition, 2007.
3. Robert J.Feugate, Jr., Steven M.Mclntyre, *Introduction to VLSI Testing*, Prentice Hall, 1st Illustrated Edition, 1998.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/117105137
2. https://nptel.ac.in/courses/117103125
3. https://nptel.ac.in/courses/106103016
4. https://archive.nptel.ac.in/courses/106/103/106103116/

Web Resources:

1. https://www.electronics-tutorial.net/vlsi-design-for-testability/IC-Testing.html
2. https://alexromanov.github.io/2022/08/14/what-is-testability/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CB101702	**INTRODUCTION TO ETHICAL HACKING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on ethical hacking overview, role of security and penetration testers, foot printing, reconnaissance and scanning networks, enumeration and vulnerability analysis, system hacking, network protection systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand and recognize role of security and penetration testers to protect the system from malware attacks.

CO2. Apply the foot printing tools to find the vulnerabilities in the system.

CO3. Analyze vulnerabilities to find the system security loopholes or flaws in networked systems within a given range of IP

CO4. Apply the web attackers tools to assess the website's security

CO5. Identify the possible incidents and threats, alert administrators, and prevent potential attacks using IDS

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION ***(10 Periods)***

Ethical Hacking Overview, Role of Security and Penetration Testers .Penetration, Testing Methodologies, Laws of the Land, Overview of TCP/IP, The Application Layer, The Transport Layer, The Internet Layer, IP Addressing, Network and Computer Attacks, Malware, Protecting Against Malware Attacks, Intruder Attacks, Addressing Physical Security.

Module 2: FOOT PRINTING, RECONNAISSANCE AND SCANNING NETWORKS ***(09 Periods)***

Foot printing Concepts, Foot printing through Search Engines, Web Services, Social Networking Sites, Website, Email, Competitive Intelligence, Foot printing through Social Engineering, Foot printing Tools, Network Scanning Concepts, Port-Scanning Tools, Scanning Techniques, Scanning Beyond IDS and Firewall

Module 3: ENUMERATION AND VULNERABILITY ANALYSIS ***(09 Periods)***

Enumeration Concepts, NetBIOS Enumeration, SNMP, LDAP, NTP, SMTP and DNS Enumeration, Vulnerability Assessment Concepts, Desktop and Server OS Vulnerabilities, Windows OS Vulnerabilities, Tools for Identifying Vulnerabilities in Windows, Linux OS Vulnerabilities, Vulnerabilities of Embedded Oss.

Module 4: SYSTEM HACKING ***(10 Periods)***

Hacking Web Servers, Web Application Components, Vulnerabilities, Tools for Web Attackers and Security Testers Hacking Wireless Networks, Components of a Wireless Network, Wardriving, Wireless Hacking, Tools of the Trade.

Module 5: NETWORK PROTECTION SYSTEMS ***(07 Periods)***

Access Control Lists, Cisco Adaptive Security Appliance Firewall, Configuration and Risk Analysis Tools for Firewalls and Routers, Intrusion Detection and Prevention Systems, Network, Based and Host-Based IDSs and IPSs, Web Filtering, Security Incident Response Teams, Honeypots.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. List out various ways used to Protect Yourself from Hackers.
2. Demonstrate how do White Hackers work?
3. Demonstrate The bug bounty program.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Michael T. Simpson, Kent Backman, and James E. Corley, *Hands-On Ethical Hacking and Network Defense, Course Technology*, Delmar Cengage Learning, 2010.
2. Patrick Engebretson, *The Basics of Hacking and Penetration Testing*, SYNGRESS, Elsevier, 2013.

REFERENCE BOOKS:

1. Dafydd Stuttard and Marcus Pinto, *The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws*, Wiley, 2nd Edition, 2011.
2. Justin Seitz, *Black Hat Python: Python Programming for Hackers and Pentesters*, 2nd Edition, 2014.

VIDEO LECTURES:

1. https://www.coursera.org/learn/ethical-hacking-essentials-ehe
2. https://www.udacity.com/course/ethical-hacker-nanodegree--nd350

WEB RESOURCES:

1. https://github.com/PacktPublishing/Python-Ethical-Hacking
2. https://www.youtube.com/watch?v=x3IwvPvDpKE

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CB101703	**FORENSIC SCIENCE**	3	-		-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Concepts of Forensic Science, Tools and Techniques in Forensic Science, Forensic Photography, Crime Scene Management, Crime Scene Management Laws and Forensic Science.

COURSE OUTCOMES: *After successful completion of the course, students will be able to*:

CO1 Understand the basic concepts of Forensic science.

CO2 Apply various tools and techniques in forensic science for crime investigation.

CO3 Understand Forensic Photography fundamentals.

CO4 Perform Crime scene investigation, scene reconstruction and prepare reports.

CO5 Understand Legal aspects of Forensic Science.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	2	2	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	2	2	-	-	-	-	-	-	-
CO5	3	3	2	2	2	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION ***(09 Periods)***

Introduction, Need, Scope, Concepts and Significance of Forensic Science, History and Development of Forensic Science, Laws and Basic principles of Forensic Science, Branches of forensic science, Organizational set-up of a Forensic Science Laboratory. Investigative strategies. Expert testimony and eye-witness report.

Module 2: TOOLS AND TECHNIQUES IN FORENSIC SCIENCE ***(09 Periods)***

Basic principles of microscopy, spectroscopy, chromatography, Electrophoresis, Enzyme_Linked Immunosorbent Assay (ELISA), Radio Immuno Assay (RIA). Measuring and optical instruments. Research methodologies; Formation of research design on a specific problem. Central tendency and Dispersion. Test of significance. Analysis of variance, Correlation and Regression.

Module 3: FORENSIC PHOTOGRAPHY ***(8 Periods)***

Basic principles of Photography, Techniques of black & white and color photography, cameras, lenses, shutters, depth of field, film; exposing, development and printing techniques; Different kinds of developers and fixers; UV, IR, fluorescence illumination guided photography; Modern development in photography- digital photography, working and basic principles of digital photography; Surveillance photography. Videography and Crime Scene & laboratory photography.

Module 4: CRIME SCENE MANAGEMENT ***(11 Periods)***

Crime scene investigations, protecting and isolating the crime scene; Documentation, sketching, field notes and photography. Searching, handling and collection, preservation and transportation of physical evidences, Chain of custody and Reconstruction of scene of crime. Report writing.

Module 5: LAW AND FORENSIC SCIENCE ***(8 Periods)***

Legal aspects of Forensic Science: Forensic Science in the Criminal Justice System, The Criminal Investigation Process, Production of Evidence: The Subpoena, The Rules of Evidence, Authentication of Evidence: The Chain of Custody, The Admissibility of Evidence, Laboratory Reports, Examples of Analysis and Reports, Expert Testimony, Getting into Court, Testifying, Being a Witness and an Expert, Considerations for Testimony.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENCIAL LEARNING

1. Study of Computer Forensics and different tools used for forensic investigation
2. **Identify and list the steps for hiding and extract any text file behind an image file/ Audio file using Command Prompt**

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Houck M.M and Siegel J.A, *Fundamentals of Forensic Science*, Elsevier, 2nd edition, 2010.
2. Sharma B.R, *Forensic Science in Criminal Investigation and Trials*, Universal Publishing Co., New Delhi, 2003.

REFERENCE BOOKS:

1. Nanda B.B and Tewari, R.K, *Forensic Science in India- A vision for the Twenty First Century*, Select Publisher, New Delhi, 2001.
2. James, S.H and Nordby, J.J, *Forensic Science- An Introduction to Scientific and Investigative Techniques*, CRC Press, USA, 2003.
3. Saferstein, Criminalistics, *An Introduction of Forensic Science*, Prentice Hall Inc, USA,2007.
4. Barry, A.J. Fisher, *Techniques of Crime Scene Investigation*, CRC Press, NewYork, 7th edition, 2003.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106106178
2. https://www.youtube.com/watch?v=X5fo1H7bc0g

WEB RESOURCES:

1. https://www.nist.gov/forensic-science

2. https://www.coursera.org/learn/forensic-science

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22SS101702	**GENDER AND ENVIRONMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Gender and the environment relationship, Gendered Roles in the Family & Community, Gender and sustainable development, Gender in environmental justice, Gender & Environmental Security.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Apply the knowledge of gender & environmental connections by analyzing key issues and topics within global environmental politics in environmental decision-making.

CO2 Demonstrate knowledge of the concepts of gender and sustainable development through debates and policy documents.

CO3 Analyze the concept of environmental security and justice by identifying the sources of insecurity.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	3	3	-	-	-	-	-
CO2	3	-	-	-	-	2	3	1	-	2	-	-
CO3	3	1	-	-	-	3	3	-	-	-	-	2
Course Correlation Mapping	**3**	**1**	**-**	**-**	**-**	**3**	**3**	**1**	**-**	**2**	**-**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: GENDER AND ENVIRONMENT RELATIONSHIP ***(09 Periods)***
Introduction – Gender and Environment – Development of gender roles – Society, gender & environment – Understanding environmental politics – Gender-environment connections–Eco-feminism – Cultural eco-feminism – Social eco-feminism – Feminist political ecology

Module 2: GENDERED ROLES IN THE FAMILY & COMMUNITY ***(09 Periods)***
Organization of the household – Domestic division of labour – Food: growing, harvesting, shopping, preparing, and cooking
Gender & Power – Planning – Politics – NGO – Gendering of environmental protest – Environmental decision-making

Module 3: GENDER AND SUSTAINABLE DEVELOPMENT ***(09 Periods)***
Concept of sustainability & its achievement – Concept of sustainable development – Ecological Modernization – Gender & sustainability debates – Gender & sustainable development debates - Gender in policy documents – Gender, poverty & equity in sustainable development

Module 4: GENDER IN ENVIRONMENTAL JUSTICE ***(09 Periods)***
Normative Concerns (Fairness, Inequality & Justice) –Making sense of Environmental justice – Ecological debt, Transnational harm, & human rights – Ecological justice – Gender &Environmental Justice – Gender, Vulnerability & risk – Women in environmental justice movements – Knowledge & participation – Gender, sustainability & justice as guiding concepts.

Module 5: GENDER AND ENVIRONMENTAL SECURITY ***(09 Periods)***
Connections between security & the environment – **Gender, environment & security:** Sustainability as security – poverty & insecurity – Insecurity as injustice – Competing ways of thinking security – Reflecting on sources of insecurity – **Case Study** – Food Security -**Case Study** – The impacts of natural disasters

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Prepare a poster presentation on the impact of globalization on family structure and society.
2. Prepare a presentation on the family setup of different countries and their peculiar customs.
3. Prepare poster presentation on "Ancient hominin walked like a human but climbed like an ape."
4. Find out the problems of present society and being part of future generations how you may help to strengthen environmental security.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Nicole Detraz, *Gender and the Environment,* Polity Press, Cambridge, UK. 2017
2. Susan Buckingham- Hatfield, *Gender and Environment*, Routledge, London. 2000

REFERENCE BOOKS:

1. Promillakapur ed., *Empowering Indian Women*, Publication Division, Government of India, New Delhi. 2000.
2. Ronnie Vernooy, Ed., *Social and Gender Analysis Natural Resource Management: Learning Studies and Lessons from Asia,* Sage, New Delhi. 2006
3. Swarup Hemlata and Rajput, Pam, *Gender Dimensions of Environmental and Development Debate: The Indian Experience,* In Sturat S. Nagel, (ed). *India's Development and Public Policy*. Ashgate, Burlington. 2000

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101701	**GLOBAL STRATEGY AND TECHNOLOGY**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION:
Introduction to strategic management; Strategic management process; Principles of good strategy; Globalization strategies; Research and Development strategies; Technology Management and Transfer; Elements of Transfer Process; Corporate Governance in the Indian scenario.

COURSE OUTCOMES:
After successful completion of the course, students will be able to:

CO1 Demonstrate the knowledge on strategic management, its approaches, and tools through ethical decision making.

CO2 Analyse the globalization challenges for scrupulous selection of globalization strategies.

CO3 Apply the R&D strategies and trends to enhance the technological breakthroughs for new products and applications.

CO4 Demonstrate the knowledge on technology management and transfer that strengthen the economy and accelerate the application of technology and resources.

CO5 Analyze the challenges of corporate governance in Indian scenario for the effective development of value-oriented organizations.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	-	1	1	-	1	-	-	1	-
CO2	3	2	1	-	1	1	-	-	-	-	1	-
CO3	3	2	1	-	1	1	-	-	-	-	1	-
CO4	3	2	1	-	1	1	-	-	-	-	1	-
CO5	3	2	1	-	1	1	-	1	-	-	1	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**1**	**1**	**-**	**1**	**-**	**-**	**1**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: STRATEGIC MANAGEMENT (09 Periods)

Introduction, Classes of decisions, Levels of strategy, Core competence, Strategic intent and stretch, Approaches to strategy making, Roles of different strategists, Strategic Management-Process, Benefits, Limitations; Ethics in strategic decision making, Principles of good strategy, Strategic Management in India; Common managerial strategy formulation tools.

Module 2: GLOBALIZATION (09 Periods)

Definition, Stages, Essential conditions for globalization, Globalization strategies, Competitive advantage of Nations and regions, Factors affecting Globalization, Globalization of Indian business.

Module 3: RESEARCH & DEVELOPMENT STRATEGIES (09 Periods)

Concept, Evolution of R and D Management, R and D as a business, R and D as competitive advantage, Elements of R and D strategies, Integration of R and D, Selection and implementation of R and D strategies, R and D trends and challenges.

Module 4: TECHNOLOGY MANAGEMENT AND TRANSFER (09 Periods)

Technology Management: Introduction, Technology-Definition, Components, Classification Features; Technology Management-Concept, Nature; Drivers of Management of Technology-Significance, Scope, Responding to technology challenges.

Technology Transfer: Introduction, Definition, Classification, Significance, Elements of process, Types of Technology Transfer, Package, Modes of Transfer, Routes, Channels and Effectiveness of Technology Transfer.

Module 5: CORPORATE GOVERNANCE: THE INDIAN SCENARIO (09 Periods)

Emergence of corporate governance in India-Landmarks, Models, Codes and status in India, Role and Responsibilities of Regulators, The Board of Directors; Corporate Governance- Specific issues in India, Family-owned Business, Corporate Governance and the Indian ethos.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Case studies: Using real-world examples of global businesses and their technological strategies, students can examine the challenges and opportunities presented by different markets and technologies. This can involve analyzing data, conducting market research, and making decisions based on their findings.

2. Simulation games: Students can participate in simulation games that allow them to make decisions about global strategy and technology in a virtual environment. This can help them understand the complexities of international business, such as navigating different cultures, regulations, and economic systems.

3. Industry partnerships: Partnerships with technology companies and global businesses can provide students with hands-on experience in global strategy and technology. This can include internships, shadowing, or working on real projects with industry professionals.

4. Project-based learning: Students can work on real-world projects that require them to apply their knowledge of global strategy and technology. This can include developing a business plan for a new product or service, designing a marketing campaign for a global audience, or analyzing the impact of a new technology on a specific industry.

5. Field trips: Visiting international businesses or attending technology conferences can provide students with a first-hand look at global strategy and technology in action. This can help them understand the challenges and opportunities of different markets and technologies, as well as connect with industry professionals.

(Note: It's an indicative one. Course instructor may change the activities and the same shall be reflected in course handout)

CASE STUDIES:

1. Tesla: Can Elon Musk's electric car company succeed globally?
2. Uber: How the ride-sharing giant is expanding its global footprint.
3. Alibaba: How China's e-commerce giant is competing on the global stage.
4. Airbnb: How the home-sharing platform is disrupting the global hotel industry.
5. Netflix: How the streaming service is expanding globally and adapting to local markets.

ARTICLES:

1. "Digital Transformation: Why it Matters for Global Business" by Forbes
2. "How AI is Changing Global Business Strategy" by Harvard Business Review
3. "The Future of Globalization: Exploring the Role of Technology" by World Economic Forum
4. "Globalization 4.0: What it Means for Technology and Strategy" by McKinsey & Company
5. "How Technology is Transforming Global Supply Chains" by MIT Sloan Management Review

RESOURCES

TEXT BOOKS:

1. Francis Cherunilam, *Strategic Management*, Himalaya Publishing House, 3rdEdition, 2002.

2. C. S. G. Krishnamacharyulu and Lalitha Ramakrishnan, *Management of Technology*, Himalaya Publishing House, Second Edition, 2012.

REFERENCE BOOKS:

1. White and Bruton, *The Management of Technology and Innovation: A Strategic Approach*, Cengage Learning, 1stEdition, 2007.
2. S.K.Mandak, *Ethics in Business and Corporate Governance*, TMH, 2ndEdition, 2012.

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/110106157/L01.html
2. https://www.digimat.in/nptel/courses/video/110106157/L43.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101704	**GREEN TECHNOLOGIES**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on green technology concepts, the role of industry and government in establishing green energy footprints and cleaner development mechanisms. It also presents energy-efficient and sustainable green production systems, concepts of energy ecosystems, and concepts of green buildings.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the green technology concepts and the consequences of greenhouse gas emissions.

CO2. Acquire basic knowledge on cleaner development mechanism, the importance of re-use of materials, and the oxidation technology for wastewater.

CO3. Go beyond energy-efficient machinery, biofuels, and environmentally friendly materials.

CO4. Acquire basic knowledge on man-made ecosystems, sources, and control of pollution.

CO5. Understand the concepts and requirements for green buildings.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	3	-	-	-	-	1
CO2	3	-	-	-	-	-	3	-	-	-	-	1
CO3	3	-	-	-	-	-	3	-	-	-	-	1
CO4	3	-	-	-	-	-	3	-	-	-	-	1
CO5	3	-	-	-	-	-	3	-	-	-	-	1
Course Correlation Mapping	**3**	**-**	**-**	**-**	**-**	**-**	**3**	-	-	-	-	**1**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO GREEN TECHNOLOGY ***(09 Periods)***

Green technology-definition, importance, factors affecting green technology. Global atmosphere- green house gases, global warming, acid rain, ozone depletion and photochemical smog. Role of industry, government and institutions; industrial ecology, role of industrial ecology in green technology.

Module 2: CLEANER DEVELOPMENT TECHNOLOGIES ***(08 Periods)***

Cleaner development mechanisms, role of industry; reuse, reduce and recycle, raw material substitution; wealth from waste; carbon credits, carbon trading, carbon sequestration, eco labeling. Oxidation technology for wastewater treatment - cavitation, fenton chemistry, photocatalysis and hybrid processes.

Module 3: ENERGY EFFICIENT SYSTEMS AND PROCESSES ***(09 Periods)***

Energy efficient motors, energy efficient lighting, control and selection of luminaries; bio-fuels, fuel cells- working, selection of fuels, Green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of sustainable green production systems.

Module 4: ENERGY ECOLOGY AND ENVIRONMENT ***(08 Periods)***

Concept and theories of ecosystems - energy flow in major manmade ecosystems- agricultural, industrial and urban ecosystems - sources of pollution from energy technologies and its impact on atmosphere - air, water, soil, and environment - environmental laws on pollution control – innovation and sustainability: - eco-restoration / phyto-remediation, renewable energy technologies, industrial ecology and agro ecology.

Module 5: GREEN BUILDINGS ***(10 Periods)***

Definition- Features and benefits, Fundamental planning decisions for energy efficient building-site selection, buildings forms and orientations, building fabrics and insulation, ventilation, passive solar features. Eco-friendly and cost effective materials, energy management. Rooftop solar photovoltaic system and solar tracking system, alternating roofing systems.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. The student shall prepare a report on the causes of global warming and should suggest possible remedies for reducing the global warming
2. The student shall prepare a report on the wastewater management system.
3. The student shall prepare a report on controlling pollution in the environment.
4. The student shall observe the various considerations in a greenhouse building and should prepare the report on the observations made and should suggest possible avenues for improvement.

(Note: It's an indicative one. Course instructor may change the activities and the same shall be reflected in course handout)

RESOURCES

TEXT BOOKS:

1. Khan B.H, *Non conventional energy resources*, Tata McGraw-Hill, New Delhi 2006.
2. Paul L. Bishop, *Pollution prevention –Fundamentals and Practices*, McGraw-Hill-international 2000.

REFERENCE BOOKS:

1. P. Aarne Veslind, *Introduction to environmental engineering*, Cenage Learning 2010.
2. Joseph A. Salvato, *Environmental engineering,* Wiley

3. Tom D Reynolds, *Unit operations and processes in environmental engineering*, PWS Publishing.
4. D. Y. Goswami, F. Kreith and J. F. Kreider, *Principles of Solar Engineering*, Taylor and Francis.
5. C. S. Solanki, *Solar Photovoltaics: Fundamental Applications and Technologies*, Prentice Hall.

WEB RESOURCES:

1. N. Vinutha bai, R. Ravindra, Energy efficient and green technology concepts, International Journal of Research in Engineering and Technology p 253-258, Volume: 03 Special Issue: 06, 2014, eISSN: 2319-1163 pISSN: 2321-7308.

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101702	**HUMAN RESOURCE MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Concepts of HRM; Environmental Scanning; Human Resource Planning; Job analysis; Job design; Job evaluation; Recruitment; Selection; Placement; Orientation; Training and Development; Performance appraisal; Merit rating; Compensation; Industrial relations; Trade unions; Industrial disputes; Ethical issues; Employee safety.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the knowledge on the principles, processes and practices of human resource management.

CO2. Analyze the key issues related to administering the human elements such as motivation, recruitment, training and development, compensation, appraisal, and career development.

CO3. Provide solutions to plan and manage human resource functions effectively within organization.

CO4. Apply HRM concepts and techniques in strategic planning to improve organizational effectiveness.

CO5. Evaluate HRM related social, cultural and safe responsibilities and issues in a global context.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	1	-	-	-	-	-	-
CO2	3	3	1	1	-	1	-	-	-	-	-	-
CO3	3	2	3	1	-	-	-	-	-	-	-	-
CO4	2	1	1	1	3	1	-	-	-	-	-	-
CO5	3	1	1	1	1	1	2	3	-	-	-	-
Course Correlation Mapping	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**3**				

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO HRM & HRP ***(09 Periods)***

Introduction to Human Resource Management (HRM): Objectives, Scope and significance of HRM, Functions of HRM, Prospects in HRM, Environmental scanning.

Human Resource Planning (HRP): Introduction, Nature and importance of HRP, Factors affecting HRP, The planning process, Human resource planning and the Government, Requisites for successful HRP, Barriers to HRP.

Module 2: RECRUITMENT AND PLACEMENT ***(09 Periods)***

Job Analysis – Nature and process of job analysis, Methods of collecting job data, Potential problems with job analysis, Requisites for job analysis; Job Design - Factors, Job design approaches, Contemporary issues; Job evaluation - Process, Methods; Recruitment - Nature, Purposes and importance, Factors governing recruitment, Recruitment process, Evaluation and control; Selection – Nature, Process, Barriers to effective selection, Evaluation of selection process, Placement; Separation.

Module 3: HUMAN RESOURCE DEVELOPMENT AND COMPENSATION ***(09 Periods)***

Orientation - Orientation programme, Requisites of an effective programme, Evaluation of orientation programme, Problems of orientation; Training and development – Nature, Inputs, Training process, Methods, Impediments to effective training, Management development, Career development, Talent management; Performance Appraisal - Nature, Appraisal process, Challenges of performance appraisal; Merit rating; Compensation - Philosophy, Components, Theories, Factors influencing employee compensation, Challenges, Wage and salary administration.

Module 4: INDUSTRIAL RELATIONS AND TRADE UNIONS ***(09 Periods)***

Industrial Relations (IR): Nature of IR, Importance of Peaceful IR; Approaches to IR - Unitary Approach, Pluralistic approach, Marxist approach; Parties to IR; IR strategy; Industrial Disputes - Nature, Causes, and Settlement.
Trade unions: Nature of trade unions, Strategic choices before unions, Union tactics, Trade union movement in India, Trends in trade union movement, Managing unions; Indian Factories Act; Employee’s compensation Act; Industrial disputes Act.

Module 5: ETHICAL ISSUES AND SAFETY ADMINISTRATION ***(09 Periods)***

Managing Ethical Issues in HRM: Nature of ethics, Sources of business ethics, Myths about ethics, Ethical dilemmas, HR ethical issues, Managing ethics, Improving ethical decision making.
Employee Safety: Safety, Need for safety, Types of accidents, Safety programme, ISO safety standards.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. What are the challenges that are faced by HR in effective performance management including performance appraisal in MNCs? Discuss in detail in the contemporary of HRM.
2. Evaluate employee relations in a comparative perspective across few countries of your choice. Describe in brief by taking a case study.
3. Visit an organization or industry and Evaluate HRM related social, cultural, ethical and environmental responsibilities and issues in a global context.

(Note: It's an indicative one. Course instructor may change the activities and the same shall be reflected in course handout)

RESOURCES

TEXT BOOKS:

1. Aswathappa K, *Human Resource Management,* Tata McGraw Hill Private Limited, 8th edition, 2017.
2. Garry Dessler and Biju Varkkey, *Human Resource Management,* Pearson India, 16th Edition, 2020.

REFERENCE BOOKS:

1. Raymond A. Noe, John R. Hollenbeck, *HRM: Gaining a Competitive Advantage*, TMH, 7th edition, 2010.
2. Bohlander George W, Snell Scott, *Principles of Human Resource Management,* Cengage Learning, 16th edition, 2016.
3. Edwin B. Flippo, *Personnel Management,* McGraw-Hill International editions, 6th edition, 1984.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/122105020
2. https://onlinecourses.nptel.ac.in/noc20_mg15/preview
3. https://www.digimat.in/nptel/courses/video/122105020/L01.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22SS101703	**INDIAN ECONOMY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Introduction; Elementary Economic Analysis; Economic Planning; Time Value of Money; Value Analysis/Value Engineering.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Understand the basic concepts of economics, economic analysis, economic planning and strata.

CO2 Demonstrate knowledge in capital budgeting, evaluation of engineering projects, depreciation policy and familiarize with the concepts of value analysis vs value engineering.

CO3 Analyze and apply financial information for the evaluation of finance.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	-	-	-	-	-	-
CO2	3	-	-	-	-	2	-	-	-	-	-	2
CO3	3	-	-	-	-	2	-	-	-	-	-	2
Course Correlation Mapping	3	-	-	-	-	2	-	-	-	-	-	2

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION ***(09 Periods)***

Economics-Flow in an Economy, Law of Supply and Demand; Micro and Macro Economics; Relationship between Science, Engineering, Technology and Economic Development; Concept of Engineering Economics-Types of Efficiency, Definition and Scope of Engineering Economics.

Module 2: ELEMENTARY ECONOMIC ANALYSIS ***(09 Periods)***

Economic Analysis – Meaning, Significance, Simple Economic Analysis; Material Selection for a Product, Substitution of Raw Material; Design Selection for a Product; Material Selection-Process Planning, Process Modification.

Module 3: ECONOMIC PLANNING ***(09 Periods)***

Introduction - Need For Planning in India, Five-year plans(1951-2012), NITI Aayog (from 2014 onwards); Inclusive Growth-Meaning, Significance, Need for inclusive growth in India, Strategy for more inclusive growth, Challenges and Prospects; Employment and Inclusive Growth in India, Role of engineers in sustaining inclusive growth.

Module 4: TIME VALUE OF MONEY ***(12 Periods)***

Concepts and Application; Capital Budgeting-Traditional and Modern Methods; Simple and Compound Interest, Cash Flow Diagram, Principle of Economic Equivalence; Evaluation of Engineering Projects - Present Worth Method, Future Worth Method, Annual Worth Method, Internal Rate of Return Method, Cost-benefit Analysis in Public Projects; Depreciation Policy-Depreciation of Capital Assets, Causes of Depreciation, Straight Line Method and Declining Balance Method.

Module 5: VALUE ANALYSIS/VALUE ENGINEERING ***(06 Periods)***

Introduction-Value Analysis, Value Engineering, Functions, Aims; Value Analysis vs Value Engineering; Value Engineering Procedure- Advantages, Application Areas.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Prepare a poster presentation on the impact of globalization on family structure and society.
2. Prepare a presentation on family setups of different countries and their peculiar customs if any.
3. Prepare a poster presentation on "Ancient hominin walked like a human but climbed like an ape."
4. Find out the problems of present society and being part of future generations and how you may help to strengthen environmental security.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Panneerselvam. R., *Engineering Economics*, PHI Learning Private Limited, New Delhi, 2nd edition, 2013.
2. Jain. T. R., V. K. Ohri, O. P. Khanna., *Economics for Engineers*, VK Publication, 1st edition, 2015.

REFERENCE BOOKS:

1. DuttRudar & Sundhram K. P. M., *Indian Economy*, S. Chand, New Delhi, 62nd revised edition, 2010.
2. Misra, S. K. & V. K. Puri., *Indian Economy*: *Its Development Experience*, Himalaya Publishing House, Mumbai, 32nd edition, 2010.

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22SS101704	**INDIAN HISTORY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Introduction; Ancient India; Classical and Medieval era; Modern India; India after independence.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Demonstrate contextual knowledge in the evolution of ancient and medieval Indian History and acquire an awareness of societal and cultural transformation.

CO2 Analyze the situations before and after Independence and assess the societal reforms implemented in India after Independence.

CO3 Practice culture transformations and appreciate its influence to adapt themselves in global scenarios.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	-	-	1	-	-	-	-	-	-
CO2	1	2	-	-	-	1	-	-	-	-	-	-
CO3	1	1	-	-	-	2	-	-	-	-	-	-
Course Correlation Mapping	2	1	-	-	-	2	-	-	-	-	-	-

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO INDIAN HISTORY ***(08 Periods)***

Elements of Indian History; History Sources: Archaeology, Numismatics, Epigraphy & Archival research; Methods used in History; History & historiography; Sociological concepts-structure, system, organization, social institutions, Culture and social stratification (caste, class, gender, power), State& Civil Society.

Module 2: ANCIENT INDIA ***(09 Periods)***

Mohenjo-Daro civilization; Harappa civilization; Mauryan Empire.

Module 3: CLASSICAL & MEDIEVAL ERA ***(12 Periods)***

Classic Era (200 BC - 1200 AD); Hindu - Islamic Era (1200 - 1800 AD).

Module 4: MODERN INDIA ***(06 Periods)***

Age of Colonialism (17th - 19th centuries); First war of Indian Independence; Freedom Struggle (1857-1947)

Module 5: INDIA AFTER INDEPENDENCE (1947 -) ***(10 Periods)***

The Evolution of the Constitution and Main Provisions; Consolidation of India as a Nation; Politics in the States; Indian economy; Modernization and globalization, Secularism and communalism, Nature of development, Processes of social exclusion and Inclusion, Changing Nature of Work and Organization.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Prepare a write-up on how to safeguard ancient monuments.
2. Analyze the most famous historically important place you visited.
3. Prepare a presentation on the ancient Seven Wonders of the World with their significance and how they are destroyed.
4. Prepare a presentation on "Wars of the past not only destroyed people and their livelihood but also the people's tradition and culture."
5. Prepare a poster on " Continents that No Longer Exist" with causes

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. K. Krishna Reddy, *Indian History,* Tata McGraw-Hill, 21st reprint, 2017.

REFERENCE BOOKS:

1. Guha, Ramachandra, *India after Gandhi*, Pan Macmillan, 2007.
2. Romila Thapar, *Early India*, Penguin India, New Delhi 2002.

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22SS101705	**INDIAN TRADITION AND CULTURE**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Basic traits of Indian Culture; Humanistic Reforms under Jainism and Buddhism; Culture in the medieval period; Socio Religious reforms in Indian Culture; Reform movements for harmonious relations.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Demonstrate knowledge of Vedic and Upanishadic culture and society to consider human aspirations, values and theories.

CO2 Understand the contributions of Buddhism and Jainism to Indian culture.

CO3 Examine the cultural conditions and achievements of India under Mouryas and Guptas.

CO4 Analyze social religious reforms and reform movements.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	1	-	-	-	-	-	-
CO2	3	-	-	-	-	1	-	-	-	-	-	2
CO3	2	-	-	-	-	3	-	-	-	-	-	-
CO4	2	-	-	-	-	3	-	-	-	-	-	2
Course Correlation Mapping	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: BASIC TRAITS OF INDIAN CULTURE ***(08 Periods)***

Meaning and definition and various interpretations of culture - Culture and its features - The Vedic and Upanishad culture and society - Human aspirations and values in these societies - Chaturvidha purushardhas, Chaturashrma and Chaturvarna theory.

Module 2: HUMANISTIC REFORMS UNDER JAINISM AND BUDDHISM ***(09 Periods)***

Salient features of Jainism - contributions of Jainism to Indian culture - Contributions of Aachaarya and Mahaapragya - Buddhism as a humanistic culture - The four noble truths of Buddhism - Contributions of Buddhism to Indian culture.

Module 3: CULTURE IN THE MEDIEVAL PERIOD ***(09 Periods)***

Unifications of India under Mouryas and Guptas and their cultural achievements - Cultural conditions under satavahanas - Contributions to Pallavas and cholas to art and cultural achievements of Vijayanagara rulers

Module 4: SOCIO RELIGIOUS REFORMS IN INDIAN CULTURE ***(09 Periods)***

Western impact on India - Introduction of Western education - social and cultural awakening and social reform movements of Rajaramohan Roy - Dayanandha Saraswathi - Anne Besant (theosophical society).

Module 5: REFORM MOVEMENTS FOR HARMONIOUS RELATIONS ***(09 Periods)***

Vivekananda, Eswarchandravidyasagar and Veeresalingam - emancipation of women and struggle against caste - Rise of Indian nationalism - Mahatma Gandhi – Non-violence and satyagraha and eradication of untouchability.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Identify different cultural festivals of Indian States and prepare a write-up on their uniqueness.
2. India has a rich history with numerous architectural wonders. Prepare a report on any three famous architectural wonders in India.
3. Explore the diverse flavors of Indian cuisine and prepare a poster on the different dishes and their distinctiveness.
4. India is a country of Unity in Diversity. Make a PowerPoint presentation on different traditional dresses of various cultural people.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Valluru Prabhakaraiah, *Indian Heritage and Culture*, Neelkamal Publications Pvt. Ltd. Delhi, 1/e, reprint 2015.

REFERENCE BOOKS:

1. L. P. Sharma, *History of Ancient India*, Konark Publishers, Pvt. Ltd. New Delhi, 2010.
2. L. P. Sharma, *History of Medieval India*, Konark Publishers, Pvt. Ltd. New Delhi, 2010.
3. The Cultural Heritage of India Vol-I, II, III, IV, V, The Ramakrishna Mission Institute of Culture, Calcutta

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101703	**INSTRUMENTATION IN INDUSTRIES**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on measurement of various parameters like displacement, force, torque, acceleration, velocity, density, viscometer, hygrometers, temperature, pressure, level and flow.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Select appropriate displacement, force and torque measuring devices for specific measurement application.

CO2 Identify suitable acceleration, velocity and density measuring devices for specific measurement application.

CO3 Apply suitable viscometer and hygrometer for measurement of viscosity, humidity and moisture for a specific application.

CO4 Select appropriate temperature and pressure transducer for an industrial requirement.

CO5 Identify appropriate level and flow transducer for measurement of level and flow for a specific application.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	3	-	-	-	-	-	-	-	-
CO2	3	2	-	3	-	-	-	-	-	-	-	-
CO3	3	2	-	3	-	-	-	-	-	-	-	-
CO4	3	2	-	3	-	-	-	-	-	-	-	-
CO5	3	2	-	3	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: DISPLACEMENT, FORCE & TORQUE MEASUREMENT ***(08 Periods)***

Displacement Measurement: Introduction, Strain gauge, LVDT, Capacitive Gauges and applications.

Force Measurement: Introduction, Analytical Balance, Spring Balance, Load cells.

Torque Measurement: Introduction, Strain gauge, Relative angular twist and applications.

Module 2: ACCELERATION, VELOCITY & DENSITY MEASUREMENT ***(08 Periods)***

Acceleration Measurement: Introduction, LVDT, Piezoelectric, Strain gauge and Variable reluctance type accelerometers and applications.

Velocity Measurement: Introduction, Revolution Counter, Capacitive Tacho, Drag-cup Type, Tacho and Stroboscope and applications.

Density Measurement: Introduction, Pressure type densitometers, Float type densitometers, Ultrasonic densitometer and gas densitometer.

Module 3: VISOCITY, HUMIDITY & MOISTURE MEASUREMENT ***(09 Periods)***

Viscosity Measurement: Introduction, friction tube viscometer, say bolt's viscometer, rotameter viscometer, Searle's rotating cylinder, cone and plate viscometer.

Humidity Measurement: Introduction, Dry and wet bulb psychrometers, Resistive and capacitive type hygrometers

Moisture Measurement: Introduction, Thermal Conductivity and Capacitive sensors, Applications of moisture measurement, Moisture measurement in solids.

Module 4: TEMPERATURE & PRESSURE MEASUREMENT ***(10 Periods)***

Temperature Measurement: Definitions and standards, RTD, Thermistor, Thermocouples: Laws of thermocouple, Reference junctions compensation, Radiation fundamentals, Radiation methods of temperature measurement, Total radiation pyrometers, Optical pyrometers, Applications.

Pressure Measurement: Introduction, manometer and its types, elastic transducers Bourdon tube, diaphragm, bellows, electrical types, resistive, inductive and capacitive, Thermal conductivity gage, Ionization gage, Sound level meter, Microphone, Applications.

Module 5: LEVEL & FLOW MEASUREMENT ***(10 Periods)***

Level Measurement: Introduction, Gauge Glass technique, Float Types – Float–and– tape method, Float–and–shaft method, Magnetic float types. Electrical types – Resistance switch type, Inductive and Capacitance type. Ultrasonic methods. Applications

Flow Measurement: Introduction, Head types – Orifice, Venturi, Flow Nozzle. Rotameter & types. Coriolis flow meter, Gyroscopic flow meter, Liquid bridge mass flow meter, Calorimetric flow meter. Electromagnetic flow meter, Ultrasonic flow meter, Hotwire anemometer type. Applications.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Record temperature from RTD and convert temperature in to voltage.
2. Measure the speed of rotating shaft using stroboscope.
3. Record level of the tank using suitable device.
4. Measure the flow rate of water in boiler plant.
5. Measure the displacement using LVDT.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. K. Sawhney, *A Course in Electrical and Electronics Measurements and Instrumentation*, Dhanpat Rai and Sons, New Delhi, 19th Revised Edition, 2013
2. D. Patranabis, *Principles of Industrial Instrumentation*, TMH, 3rd Edition, 2010.

REFERENCE BOOKS:

1. Ernest Doebelin & Dhanesh Manik, *Measurement Systems*, McGraw Hill International, 6th Edition, 2011.

VIDEO LECTURES:

1. https://www.vlab.co.in/
2. https://archive.nptel.ac.in/courses/103/103/103103135/
3. https://nptel.ac.in/courses/103103135

Web Resources:

1. https://www.tutorialspoint.com/electronic_measuring_instruments/index.htm
2. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/108105064/lec1.pdf
3. https://www.ibiblio.org/kuphaldt/socratic/sinst/book/liii.pdf.

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101704	**INTRODUCTION TO NANOTECHNOLOGY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The fundamental principles of nanoelectronics and the utilization of nanostructures as nano electronic devices.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the basic knowledge in nanoelectronics, crystal structure of semiconducting material various techniques for fabrication and measurement of nanostructure, semiconducting nano electronic devices.

CO2. Analyze Crystal structure of nanomaterials Nanostructure based device

CO3. Design and develop new nano devices for advanced technological applications.

CO4. Capable of solving problems in the field of nanoelectronics.

CO5. Involve and resolve the future research challenges in the fields related to nanoelectronics.

CO6. Apply the environmental context with ethical principle in developing new nano devices.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	2	2	3	-	-	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	-
CO5	3	3	-	-	3	-	-	-	-	-	-	-
CO6	3	-	-	-	-	3	3	2	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

MODULE-I: INTRODUCTION TO NANOELECTRONICS ***(08 Periods)***

The "Top-Down" Approach, Lithography, The "Bottom-Up" Approach; Why Nanoelectronics? Nanotechnology Potential. The Schr¨odinger wave equation, Wave mechanics of particles, Atoms and atomic orbitals

MODULE II: MATERIALS FOR NANOELECTRONICS ***(09 Periods)***

Semiconductors, Crystal lattices: bonding in crystals, Electron energy bands, Semiconductor heterostructures, Lattice-matched and pseudomorphic heterostructures; Organic semiconductors, Carbon nanomaterials: nanotubes and fullerenes.

MODULE III: FABRICATION AND MEASUREMENT TECHNIQUES FOR NANOSTRUCTURES ***(10 Periods)***

Bulk crystal and heterostructure growth: Nanolithography, etching, and other means for fabrication of nanostructures and nanodevices; Techniques for characterization of nanostructures, Spontaneous formation and ordering of nanostructures; Clusters and nanocrystals, Methods of nanotube growth, Chemical and biological methods for nanoscale fabrication, Fabrication of nanoelectromechanical systems.

MODULE IV : SEMICONDUCTING NANO STRUCTURES ***(09 Periods)***

Time and length scales of the electrons in solids, Statistics of the electrons in solids and nanostructures; The density of states of electrons in nanostructures, Electron transport in nanostructures, Electrons in Quantum well, Quantum wire and Quantum dots.

MODULE V : NANOELECTRONIC DEVICES ***(09 Periods)***

Resonant tunneling diodes, Field effect transistors, Single electron transfer devices, Potential effect transistors, Light emitting diodes and lasers; Nanoelectromechanical system devices, Quantum dot cellular automata.

Total No. of Periods: 45

EXPERIENTIAL LEARNING

1. Submission of report on specifications of Clean room.
2. Submission of report on specifications of Clean bench.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, *Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications,* Cambridge University Press, 2012.
2. George W. Hanson, *Fundamentals of Nanoelectronics*, Prentice Hall, 2007

REFERENCE BOOKS:

1. Mitin.V, Kochelap.V and Stroscio.M, *Introduction to Nanoelectronics*, Cambridge University Press, 2008
2. Karl Goser et.al, *Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum devices*, Springer, 2005.

VIDEO LECTURES:

1. Introduction to Nanotechnology, nanohub.org
2. https://nptel.ac.in/courses/103103033

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22AI101701	**INTRODUCTION TO ARTIFICIAL INTELLIGENCE**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on Introduction to Artificial Intelligence, Designing intelligent agents, Solving general purpose problems, Search in complex environments, Represent knowledge, Robotics, Ethics.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Analyze and Architect intelligent agents using Artificial Intelligence Techniques and principles

CO2 Analyze the usage of Knowledge representation techniques in Artificial Intelligence

CO3 Analyze and interpret the problem, identify suitable solutions using heuristic functions and search algorithms

CO4 Investigate robot hardware and frameworks for intelligent robotic perception.

CO5 Demonstrate knowledge on ethical implications of intelligent machines for providing privacy, trust, security and safety.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	1	-	-	-	-	-	-
CO5	-	-	-	-	-	1	-	2	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**-**	**-**	**1**	**-**	**2**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1 INTRODUCTION TO ARTIFICIAL INTELLIGENCE ***(09 Periods)***

Foundations of artificial intelligence, History of artificial intelligence, State of the art, Risks and benefits of AI, Intelligent agents – Agents and environments, The concept of rationality, Structure of agents.

Module 2 KNOWLEDGE & REASONING ***(09 Periods)***

Logic, Propositional Logic, Propositional Theorem Proving: Inference and proofs, Proof by resolution, Horn clauses and definite clauses.

First-Order Logic - Syntax and Semantics of First-Order Logic, Using First Order Logic, Knowledge Engineering in First-Order Logic. Inference in First-Order Logic: Propositional vs. First-Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution.

Module 3 PROBLEM SOLVING BY SEARCHING ***(09 Periods)***

Problem solving agents, Search algorithms, Uninformed search strategies, Informed search strategies – Greedy best-first search, A* search; Heuristic functions.

Module 4 SEARCH IN COMPLEX ENVIRONMENTS ***(09 Periods)***

Local search algorithms and optimization problems – Hill-climbing search, Simulated annealing, Local beam search, Evolutionary algorithms; Optimal decisions in games – The minimax search algorithm, Optimal decisions in multiplayer games, Alpha-Beta pruning, Move ordering; Monte Carlo tree search.

Module 5: ROBOTICS ***(09 Periods)***

Robots, Robot hardware, Robotic perception, Alternative robotic frameworks, Application domains.

Limits of AI, Ethics of AI – Surveillance, security and privacy, Fairness and bias, Trust and transparency, AI safety

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Design and implement agent programs for Table-driven agents using the agent function of vacuum-cleaner world. The agent cleans the current square if it is dirty, otherwise it moves to the other square.
2. Implement agent programs for Simple reflex agents and Model-based reflex agents using the agent function of vacuum-cleaner world.
3. Solve the travelling sales man problem using Hill Climbing search algorithm

(Note: It's an indicative one. The Course Instructor may change the activities and the same shall be reflected in Course Handout)

RESOURCES

TEXT BOOKS:

1. Stuart Russell, Peter Norvig, *Artificial Intelligence: A Modern Approach*, Prentice Hall, 4th Edition, 2020.

REFERENCE BOOKS:

1. Stephen Lucci, Danny Kopec, *Artificial Intelligence in the 21st Century*, Mercury Learning and Information, 3rd Edition,2018
2. Rich, Knight, Nair*, Artificial intelligence*, Tata McGraw Hill, Third Edition, 2009.
3. Deepak Khemani, *A First Course in Artificial Intelligence*, McGraw Hill Education, 2017.
4. Saroj Kaushik, *Artificial Intelligence*, Cengage Learning, 2011.

SOFTWARE/TOOLS:

1. Python
2. pandas, matplotlib

VIDEO LECTURES:

1. https://searchenterpriseai.techtarget.com/definition/AI-Artificial-Intelligence
2. http://aima.cs.berkeley.edu/
3. https://ai.google/education/
4. https://www.coursera.org/courses?query=artificial%20intelligence
5. https://www.edureka.co/blog/artificial-intelligence-with-python/

WEB RESOURCES:

1. http://www.airesources.org/
2. https://allthingsai.com/
3. https://designmodo.com/ai-tools-designers/
4. https://www.ulethbridge.ca/teachingcentre/chatgpt-ai-resources

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22DS101702	**INTRODUCTION TO DATA SCIENCE**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Introduction to Data Science; Data Collection and Data Pre-Processing, Exploratory Data Analytics, Model Development, and Model Evaluation**.**

COURSE OUTCOMES: *After successful completion of the course, students will be able to*:

CO1. Demonstrate knowledge on Data science concepts.
CO2. Perform data collection and pre-processing.

CO3. Perform exploratory data analytics.

CO4. Design and develop data visualization models.

CO5. Evaluate performance of data models.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	3	2	2	-	-	-	-	-	-	-
CO3	2	2	2	3	2	-	-	-	-	-	-	-
CO4	2	3	2	2	2	-	-	-	-	-	-	-
CO5	3	2	2	2	2	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High 2: Medium 1: Low

COURSE CONTENT

Module-1: INTRODUCTION ***(09 periods)***
Introduction to Data Science, Evolution of Data Science, Data Science Roles, Stages in a Data Science Project, Applications of Data Science in various fields, Data Security Issues.

Module-2: DATA COLLECTION AND DATA PRE-PROCESSING ***(09 periods)***
Data Collection Strategies, Data Pre-Processing- Overview, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization.

Module-3: EXPLORATORY DATA ANALYTICS ***(09 periods)***
Descriptive Statistics, Mean, Standard Deviation, Skewness and Kurtosis, Box Plots, Pivot Table, Heat Map, Correlation Statistics, ANOVA.

Module-4: MODEL DEVELOPMENT ***(09 periods)***
Simple and Multiple Regression, Model Evaluation using Visualization, Residual Plot, Distribution Plot, Polynomial Regression and Pipelines, Measures for In-sample Evaluation, Prediction and Decision Making.

Module-5: MODEL EVALUATION ***(09 periods)***
Generalization Error, Out-of-Sample Evaluation Metrics, Cross Validation, Overfitting, Under Fitting and Model Selection, Prediction by using Ridge Regression, Testing Multiple Parameters by using Grid Search.

Total periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. ***Use Case:*** A human can express his emotions in any form, such as the face, gestures, speech and text. The detection of text emotions is a content-based classification problem. Detecting a person's emotions is a difficult task, but detecting the emotions using text written by a person is even more difficult as a human can express his emotions in any form. Recognizing this type of emotion from a text written by a person plays an important role in applications such as chatbots, customer support forum, customer reviews etc. So you have to train a machine learning model that can identify the emotion of a text by presenting the most relevant emoji according to the input text.
2. ***Use Case:*** Customer Personality Analysis is a detailed analysis of a company's ideal customers. It helps a business to better understand its customers and makes it easier for them to modify products according to the specific needs, behaviours and concerns of different types of customers.
   You have to do an analysis that should help a business to modify its product based on its target customers from different types of customer segments. For example, instead of spending money to market a new product to every customer in the company's database, a company can analyze which customer segment is most likely to buy the product and then market the product only on that particular segment.

(Note: It's an indicative one. The Course Instructor may change the activities and the same shall be reflected in Course Handout)

RESOURCES

TEXT BOOK:

1. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly, 2015

REFERENCE BOOKS:

1. David Dietrich, Barry Heller, Beibei Yang, *Data Science and Big Data Analytics*, EMC 2013.
2. Davy cielen, *Introducing Data Science*, Manning Publications, 2022.
3. Chirag Shah, *A Hands-on Introduction to Data Science*, Cambridge University Press, 2020

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=JL_grPUnXzY&list=PLeo1K3hjS3us_ELKYSj_Fth2tIEkdKXvV
2. https://www.youtube.com/watch?v=-ETQ97mXXF0

WEB RESOURCES:

1. https://swayam.gov.in/nd1_noc19_cs60/preview
2. https://towardsdatascience.com/
3. https://www.w3schools.com/datascience/
4. https://github.com/jakevdp/PythonDataScienceHandbook
5. https://www.kaggle.com

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22AI101702	**INTRODUCTION TO MACHINE LEARNING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Introduction to machine learning, Bayesian concept learning, Supervised learning, Unsupervised learning, Artificial neural networks.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1	Analyze the process of machine learning modeling and evaluation to automatically infer a general description for a given learning problem.
CO2	Analyze the underlying mathematical models within machine learning algorithms and learning tasks.
CO3	Design and implement machine learning solutions for classification, regression, and clustering problems.
CO4	Design and implement efficient neural architectures to model patterns for a given learning problem.
CO5	Develop intelligent solutions to solve societal problems related to computer vision, information security, healthcare and other areas.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	2	3	3	3	3	-	-	-	-	-	-	-
CO4	3	3	3	1	-	-	-	-	-	-	-	-
CO5	1	3	3	3	3	3	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO MACHINE LEARNING ***(10 Periods)***

Machine Learning: Human learning, Types of human learning, Machine learning, Types of machine learning, Applications of machine learning, Issues in machine learning, Machine learning activities, Types of data, Selecting a model, Training a model, Model representation and interpretability, Evaluating performance of a model, Improving performance of a model.

Module 2: BAYESIAN CONCEPT LEARNING ***(07 Periods)***
Introduction, Importance, Bayes' theorem, Bayes optimal classifier, Naïve Bayes classifier, Applications of Bayes classifier.

Module 3: SUPERVISED LEARNING ***(10 Periods)***
Classification: Classification model, Classification learning steps, K-Nearest Neighbor, Decision Tree, Support vector machines.
Regression: Introduction, Simple linear regression, Improving accuracy of the linear regression model, Multiple linear regression, Assumptions and problems in regression analysis.

Module 4: UNSUPERVISED LEARNING ***(09 Periods)***
Introduction, Unsupervised vs supervised learning, Applications of unsupervised learning, Clustering as a machine learning task, Types of clustering techniques, Partitioning methods, K-Medoids, Hierarchical clustering, DBSCAN.

Module 5: ARTIFICIAL NEURAL NETWORKS ***(09 Periods)***
Artificial neuron, Types of activation functions, Early implementations of ANN, Architectures of neural network, Learning process in ANN, Backpropagation.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Use Naïve Bayes classifier to solve the credit card fraud detection problem.
2. Build a neural network that will read the image of a digit and correctly identify the number.

(Note: It's an indicative one. The Course Instructor may change the activities and the same shall be reflected in Course Handout)

RESOURCES

TEXT BOOKS:

1. Tom M. Mitchell, *Machine Learning*, McGraw Hill, 1997.
2. Saikat Dutt, Subramanian Chandramouli, Amit kumar das, *Machine Learning*, Pearson, 2019.

REFERENCE BOOKS:

1 Manaranjan Pradhan, U Dinesh Kumar, *Machine Learning Using Python*, Packt Publishing, 2019.
2 Aurelien Geron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, O'Reilly, 2nd Edition, 2019.
3 Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press, 4th Edition, 2020.
4 Shai Shalev Shwartz, Shai Ben David, *Understanding Machine Learning: From Theory to Algorithms*, Cambridge University Press, 2014.

VIDEO LECTURES:

1 https://nptel.ac.in/courses/106106202/
2 https://www.coursera.org/learn/machine-learning
3 https://onlinecourses.nptel.ac.in/noc23_cs18/preview
4 https://onlinecourses.nptel.ac.in/noc23_cs87/preview
5 https://onlinecourses.nptel.ac.in/noc23_ee87/preview
6 https://www.coursera.org/learn/ntumlone-algorithmicfoundations
7 https://www.coursera.org/specializations/machine-learning-introduction
8 http://ndl.iitkgp.ac.in/document/YkxlRXFvZXJrTDBkVzVVZi9ESjl6eXpRZkxRc2lhOWhlVXBhUVVWaXZlNDNyZUVldU9LdlYvd20wbkQ4MC92UQ
9 https://www.coursera.org/learn/unsupervised-learning-recommenders-reinforcement-learning

WEB RESOURCES:

1 https://www.ibm.com/topics/machine-learning
2 https://www.simplilearn.com/tutorials/machine-learning-tutorial/what-is-machine-learning
3 https://www.w3schools.com/python/python_ml_getting_started.asp
4 https://developers.google.com/machine-learning/crash-course
5 https://www.greenteapress.com/thinkstats/
6 https://info.deeplearning.ai/machine-learning-yearning-book
7 https://www.kaggle.com/code/kanncaa1/machine-learning-tutorial-for-beginners
8 https://machinelearningmastery.com/machine-learning-in-python-step-by-step/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CS101701	INTRODUCTION TO PYTHON PROGRAMMING	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is aimed at offering the fundamental concepts of Python scripting language to the students. It starts with the basics of Python programming and deals with lists, dictionaries, functions, exceptions and files. The objective of this course is to enable the students to develop the applications using the concepts of Python.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the basic terminology used in computer programming to write, compile and debug programs in Python programming language.

CO2. Use appropriate data type for handling user data and write optimized programs using the functions, and statements.

CO3. Manage the exceptions raised during the program execution and avoid abrupt termination of the program execution.

CO4. Process files and solve real world problems using classes and objects in the Python programming environment.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	2	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	2	-
CO4	2	3	3	-	-	-	-	2	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	-	**-**	**2**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DATA TYPES AND INPUT/OUTPUT ***(09 Periods)***

Internal working of Python, Python character set, Tokens, Python Core Data Types (list, set, tuple, and dctionary), The print () function, Assignment of values to variables, The input() function, The eval() function.

Module 2: OPERATORS AND CONTROL STATEMENTS ***(09 Periods)***

Operators- Arithmetic Operators, Operator precedence and Associativity, Bitwise operator, The compound assignment operator; Decision statements- Boolean operators, Boolean Expressions and Relational operators, Decision making statements; Loop Control Statements-while loop, range() function, for loop; break statement, continue statement.

Module 3: FUNCTIONS AND LISTS ***(09 Periods)***

Functions- Syntax and basics of a function, Use of a function, Parameters and arguments in a function, The local and global scope of a variable, The return statement, Recursive functions, The lambda function; Lists-Creating Lists, Accessing the elements of a List, List slicing, Python in-built functions for lists, List Comprehension, List Methods, Passing list to a function, Returning a list to function.

Module 4: TUPLES, SETS AND DICTIONARIES ***(09 Periods)***

Tuples - Creating tuples, tuple() function, Inbuilt functions for tuples, Indexing and Slicing, Operations on tuples, Passing variable length arguments to tuples, Sort tuples, Traverse tuplesfrom a list, The zip()function, The Inverse zip(*) function; Sets - Creating sets, The set in and not in operator, The Python Set Class, Set operations; Dictionaries -Basics of Dictionaries, Creating a Dictionary, Adding and replacing values, Retrieving values, Formatting dictionaries, Deleting items, Comparing two dictionaries, Methods of dictionary class, Traversing dictionaries, Nested dictionaries, Traversing nested dictionaries.

Module 5: V FILES ***(09 Periods)***

File Handling-Opening a file, Writing Text, Closing files, Writing numbers to a file, Reading Text, Reading numbers from a file, Appending data, seek() function.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Calculator: Create a basic calculator program that can perform addition, subtraction, multiplication, and division operations. You can enhance it by adding more functionality, such as handling decimal numbers or including additional mathematical operations.
2. Develop recursive functions to solve problems that involve self-referential definitions.
3. Develop program to create dictionaries, add, retrieve and delete items from dictionaries.
4. Word Counter: Design a program that counts the number of words, characters, or lines in a given text file. You can also include additional features like finding the most common words or displaying statistics about the text.
5. Tic-Tac-Toe: Implement a two-player tic-tac-toe game where users take turns marking Xs and Os on a 3x3 grid. Determine the winner or detect a tie by checking the board after each move.
6. Dice Rolling Simulator: Create a program that simulates rolling dice. Allow the user to specify the number of dice to roll and display the results. You can also add features like keeping track of the roll history or calculating the probability of certain outcomes.

(Note: It’s an indicative one. The Course Instructor may change the activities and the same shall be reflected in Course Handout)

RESOURCES

TEXTBOOKS:

1. Ashok Namdev kamthane and Amit Ashok Kamthane, *Programming and Problem solving with PYTHON*, McGraw Hill Education, 1st Edition, 2016.

REFERENCE BOOKS:

1. Allen Downey, *Think Python*, Green Tea Press, 1st Edition, 2016.
2. W.J. Chun, *Core Python Programming*, Prentice Hall, 3rd Edition, 2013.
3. Kenneth A. Lambert, *Fundamentals of Python*, Cengage, 2nd Edition, 2015.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc19_cs41/preview
2. https://www.coursera.org/specializations/python
3. https://www.coursera.org/learn/python-for-applied-data-science-ai
4. https://www.youtube.com/watch?v=WGJJIrtnfpk
5. https://www.youtube.com/watch?v=_uQrJ0TkZlc
6. https://www.udemy.com/topic/python/
7. https://freevideolectures.com/course/2512/python-programming

WEB RESOURCES:

1. https://www.w3schools.com/python/
2. https://www.programiz.com/python-programming
3. https://www.geeksforgeeks.org/python-programming-language/
4. https://www.javatpoint.com/python-lists
5. https://www.learnpython.org/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CB101704	**INTRODUCTION TO INTERNET OF THINGS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is emphasize on the Architecture of IoT and Summarize the roles of various organizations for IoT, To Develop simple applications using Arduino and Rasberry, Test for errors in the application, Predict the market value, Experiment with embedded boards for creating IoT prototypes, To understand the domain specific IoTs and IoT system management.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Understand the fundamental concepts of IoT and physical computing.

CO2 Demonstrate knowledge on variety of embedded boards and IoT Platforms

CO3 Understand the communication protocols in IoT communications.

CO4 Demonstrate knowledge on Domain specific IoT applications.

CO5 Understand the IoT System management and network management protocols.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-
CO5	3	2	2				-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**	-	-	-	-	-	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Overview of IoT ***(09 Periods)***

The Internet of Things: An Overview, The Flavour of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things?

Design Principles for Connected Devices: Calm and Ambient Technology, Privacy, Web Thinking for Connected Devices, Affordances.

Prototyping: Sketching, Familiarity, Costs Vs Ease of Prototyping, Prototypes and Production, Open source Vs Close source, Tapping into the community.

Module 2: Embedded Devices: ***(09 Periods)***
Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, Mobile phones and tablets, Plug Computing: Always-on Internet of Things

Module 3 Communication in the IoT: ***(09 Periods)***
Internet Communications: An Overview, IP Addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols
Prototyping Online Components: Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols Protocol

Module 4 Domain specific IoTs ***(09 Periods)***
Introduction: Home automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and Lifestyle

Module 5 IoT and M2M ***(09 Periods)***
Introduction- M2M, Difference between IoT and M2M, SDN and NFV for IoT
IoT System Management with NETCONF-YANG: Need for IoT Systems Management, Simple network management protocol(SNMP), Network operator requirements, NETCONF,YANG

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. (a) Design and Simulate LED 7-Segment Display interfacing with Arduino.
   (b) Design and Simulate Servo motor interfacing with Arduino.
2. (a) Design and Simulate ultrasonic sensor and LCD interfacing with Arduino.
   (b) Design and Simulate Flame Sensor interfacing with Arduino.

(Note: It's an indicative one. The Course Instructor may change the activities and the same shall be reflected in Course Handout)

RESOURCES

TEXT BOOKS:

1. Adrian McEwen, Hakim Cassimally, *Designing the Internet of Things*, Wiley Publications, 2012
2. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-On Approach*, Universities Press, 2014.

REFERENCE BOOKS:

1. Pethuru Raj, Anupama C. Raman, *The Internet of Things, Enabling technologies and use cases*, CRC Press.

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/106105166/L01.html
2. https://www.youtube.com/watch?v=oBZnySDgst8

WEB RESOURCES:

1. https://www.arduino
2. https://www.raspberrypi.org/

University Elective

Course Code	Course Title	L	T	P	S	C
22ME101703	**MANAGEMENT SCIENCE**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Concepts of Management; Concepts Related to ethics and social responsibility; Human Resource Management; Operations Management; Statistical Process Control; Inventory Management; Marketing; Project Management; Project Crashing.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1 Demonstrate the concepts of management, its functions and processes used in optimum resource utilization within the context of ethics and social responsibility.

CO2 Apply the concepts of HRM for selection and management of human resources.

CO3 Analyze different operations management problems using quality management tools to produce effective, efficient and adoptable products/services

CO4 Identify different marketing strategies to maximize enterprise profitability and customer satisfaction within the realistic constraints

CO5 Develop network models in time-cost trade-off for effective project management.

CO-PO Mapping Table

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	-	1	1	1	1	-	-	1	-
CO2	3	2	1	-	1	-	-	-	-	-	1	-
CO3	3	3	1	1	1	-	-	-	-	-	1	-
CO4	3	2	1	-	1	1	-	-	-	-	1	-
CO5	3	3	3	1	1	1	-	-	-	-	2	-
Course Correlation Mapping	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**1**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: MANAGERIAL FUNCTION AND PROCESS ***(10 Periods)***

Concept and foundations of management, Evolution of management thought; Managerial functions – Planning, Organizing, Directing and Controlling; Decision-making; Role of manager, managerial skills; Managing in a global environment, Flexible systems management; Social responsibility and managerial ethics; Process and customer orientation; Managerial processes on direct and indirect value chain.

Module 2: HUMAN RESOURCE MANAGEMENT ***(08 Periods)***
Human Resource challenges; Human Resource Management functions; Human Resource Planning; Job analysis; Job evaluation, Recruitment and selection; Training and Development; Promotion and transfer; Performance management; Compensation management and benefits; Employee morale and productivity; Human Resource Information System.

Module 3: OPERATIONS MANAGEMENT ***(10 Periods)***
Fundamentals of Operations Management, Services as a part of operations management; Facilities location and layout; Line balancing; Quality management – Statistical Process Control, Total Quality Management, Six sigma; Role and importance of materials management, Value analysis, Make or Buy decision, Inventory control, Materials Requirement Planning, Enterprise Resource Planning, Supply Chain Management.

Module 4: MARKETING MANAGEMENT ***(08 Periods)***
Concept, evolution and scope; Marketing strategy formulation and components of marketing plan; Segmenting and targeting the market; Positioning and differentiating the market offering, Analyzing competition; Product strategy; Pricing strategies; Designing and managing marketing channels; Integrated marketing communications.

Module 5: PROJECT MANAGEMENT ***(09 Periods)***
Project management concepts; Project planning – Work Breakdown Structure, Gantt chart; Project scheduling – Critical Path Method, Program Evaluation and Review Technique, Crashing the project for time-cost trade off; Resource Levelling.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Find the social responsibilities in the context of management theoretically and practically in an organization? Explain them by taking a real case study in any organization (preferably in your organization).
2. Gaining market share should be one of management's primary goals because of its effect on operations and profitability. Comment. What Strategies Do Companies Employ to Increase Market Share?
3. A Gantt chart is a visualization that helps in scheduling, managing, and monitoring specific tasks and resources in a project. Prepare a gantt chart for Online food ordering system.

(Note: It's an indicative one. Course instructor may change the activities and the same shall be reflected in course handout)

RESOURCES

TEXT BOOKS:

1. MartandT. Telsang, *Industrial Engineering and Production Management,* S. Chand, 3rd Edition, 2018.
2. Koontz and Weihrich, *Essentials of Management*, TMH, New Delhi, 11th Edition, 2020.

REFERENCE BOOKS:

1. O.P. Khanna, *Industrial Engineering and Management,* Dhanpat Rai and Sons, 2018.
2. N.D. Vohra, *Quantitative Techniques in Management,* TMH, New Delhi, 5th Edition, 2014.
3. L.M. Prasad, *Principles and practice of Management,* S. Chand and Sons, 2019.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/122/106/122106032/
2. https://www.digimat.in/nptel/courses/video/122102007/L01.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101704	**MANAGING INNOVATION AND ENTREPRENEURSHIP**	3	-	-	-	3

Pre-Requisite	-
Anti-Requisite	-
Co-Requisite	-

COURSE DESCRIPTION:

Evolution of entrepreneurship from economic theory Managerial and entrepreneurial competencies; Concepts of Shifting Composition of the Economy Purposeful Innovation & Sources of Innovative Opportunity; The Innovation Process; Innovative Strategies; Entrepreneurial Motivation; Entrepreneurs versus inventors; Ethics and International Entrepreneurship; Strategic Issues in International Entrepreneurship; Problem solving Innovation and Diversification

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1. Demonstrate the principles of innovation process for establishing Industrial ventures.

CO2. Identify and analyze the gaps in an organization for innovation in the context of developed economies

CO3. Develop a comprehensive and well-planned business structure for a new venture.

CO4. Demonstrate knowledge on intellectual property rights, patents, trademarks, copyrights, trade secrets and commercialization of intellectual property.

CO5. Apply ethics in constructive innovation framework and problem solving.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	-	1	1	1	1	-	-	1	-
CO2	3	2	1	-	1	-	-	-	-	-	1	-
CO3	3	3	1	1	1	-	-	-	-	-	1	-
CO4	3	2	1	1	1	1	-	-	-	-	1	-
CO5	3	3	3	1	1	1	-	-	-	-	2	-
Course Correlation Mapping	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	-	-	**1**	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: CREATIVITY AND INNOVATION ***(09 Periods)***

Introduction, Levels of innovation, Purposeful innovation and the sources of innovative opportunity, The innovation process, Innovative strategies, Strategies that aim at introducing and innovation, Dynamics of ideation and creativity – Inbound, Outbound; Context and process of new product development, Theories of outsourcing.

Module 2: PARADIGMS OF INNOVATION ***(09 Periods)***

Systems approach to innovation, Innovation in the context of developed economies and Emerging economies, Examining reverse innovation and itsapplication,Performancegap,Infrastructuregap,Sustainabilitygap,Regulatory gap, Preference gap, organizational factors effecting innovation at firm level.

Module 3: SOUCES OF FINANCE AND VENTURE CAPITAL ***(09 Periods)***

Importance of finance, Comparison of venture capital with conventional development capital, Strategies of venture funding, Investment phases, Investment process, Advantages and disadvantages of venture capital, Venture capital developments in India.

Module 4: INTELLECTUAL PROPERTY INNOVATION AND ENTREPRENEURSHIP ***(09 Periods)***

Introduction to Entrepreneurship, Evolution of entrepreneurship from economic theory, Managerial and entrepreneurial competencies, Entrepreneurial growth and development, Concepts, Ethics and Nature of International Entrepreneurship, Intellectual property – forms of IP, Patents, Trademarks, Design registration, Copy rights, Geographical indications, Patent process in India.

Module 5: OPEN INNOVATION FRAME WORK & PROBLEM SOLVING ***(09 Periods)***

Concept of open innovation approach, Difference between open innovations and Cloud innovation approaches, Limitations and Opportunities of open innovation frame work, Global context of strategic alliance, Role of strategic alliance, Problem Identification and Problem Solving, Innovation and Diversification

Total Periods:45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Identify the Innovative Marketing Strategies for Startups
2. Identify the Coca-cola Company Intellectual Property Rights

(Note: It's an indicative one. Course instructor may change the activities and the same shall be reflected in course handout)

CASE STUDIES/ARTICELS:

Contemporary relevant case studies/ Articles will be provided by the course instructor at the beginning.

1. Tesla Inc.: Disrupting the Automobile Industry
   This case study examines how Tesla Inc. disrupted the traditional automobile industry through its innovative electric vehicles and sustainable energy solutions. It discusses the sources of innovative opportunity that Tesla leverages, the ideation and creativity dynamics involved in new product development, and the strategies that the company uses to introduce and market its innovations.

2. Google Inc.: Innovation in Developed Economies
This case study explores how Google Inc. became a global leader in the technology industry through its innovative search engine, advertising, and cloud computing solutions. It highlights the performance gap that Google addressed, the regulatory and sustainability gaps that it leveraged, and the impact of its innovation strategies on the company's growth and profitability.

3. Flipkart: From Startup to Unicorn
This case study examines how Flipkart, an Indian e-commerce company, secured venture capital funding to become one of the largest online marketplaces in India. It discusses the importance of finance in entrepreneurship, the advantages and disadvantages of venture capital, and the strategies that Flipkart used to attract venture funding.

4. Patanjali Ayurved: Building a Brand through Intellectual Property
This case study explores how Patanjali Ayurved, an Indian consumer goods company, built a strong brand through its intellectual property strategies. It discusses the forms of IP that Patanjali leverages, the patent process in India, and the impact of IP on the company's growth and profitability.

5. Procter & Gamble: Innovation through Open Innovation
This case study analyzes how Procter & Gamble, a global consumer goods company, leveraged open innovation to achieve unprecedented success in product development and marketing. It discusses the difference between open and cloud innovation approaches, the limitations and opportunities of open innovation, and the role of strategic alliances in global innovation.

RESOURCES

TEXT BOOKS:

1. Vinnie Jauhari, Sudhanshu Bhushan, *Innovation Management*, Oxford University Press, 1st Edition, 2014.
2. Drucker, P.F., *Innovation and Entrepreneurship*, Taylor & Francis, 2nd Edition, 2007.

REFERENCE BOOKS:

1. Robert D Hisrich, Claudine Kearney, *Managing Innovation and Entrepreneurship,* Sage Publications, 1st Edition, 2014.
2. V.K. Narayanan, *Managing Technology and Innovation for Competitive Advantage,* Pearson India, 1st Edition, 2002.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=wWsl48VLfVY
2. https://www.youtube.com/watch?v=dDpQ9ALKX0U
3. https://www.youtube.com/watch?v=Eu_hkxkJGTg

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101705	**MATERIAL SCIENCE**	**3**	**-**	**-**	**-**	**3**

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Materials Structure and Constitution of Alloys; Heat treatment of steels; Properties of ferrous materials and its alloys; Properties of non-ferrous materials and its alloys; Properties and applications of Ceramics, Polymers and Composite materials.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Ability to understand and apply the principles of materials science to analyze and design materials for specific applications.

CO2. Analyze the properties of materials and enhance the same through heat-treatment processes.

CO3. Demonstrate the knowledge of ferrous and Non-ferrous materials and its alloys for engineering applications.

CO4. Understand the relationship between materials properties and structure at the atomic and molecular level.

CO5. Demonstrate the knowledge of Ceramics, Polymers, and Composite materials for suitable engineering applications.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	-	-	-	-	1	-	-
CO2	3	3	1	-	-	-	-	-	-	1	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-
CO5	3	1	-	-	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: MATERIALS STRUCTURE AND CONSTITUTION OF ALLOYS ***(09 Periods)***

Materials Structure: Space lattice, Unit cells and Metallic crystal structures (SC, BCC, FCC and HCP), Crystal defects: Point, Line, Interstitial and Volume, Primary and secondary bonding in materials.

Constitution of Alloys: Necessity of Alloying, Gibbs's phase and Hume Rothery rule, Iron Iron-carbide diagram and its microstructural aspects.

Module 2: HEAT TREATMENT OF STEELS ***(09 Periods)***

Annealing, Normalizing, Tempering, Carburization and Hardening- Austempering, Martempering, Carburizing, Nitriding, Cyaniding, Carbo-Nitriding, Flame and Induction Hardening, Vacuum and Plasma Hardening, Time-Temperature-Transformation Diagrams and Continuous Cooling Transformation Diagrams.

Module 3: FERROUS MATERIALS AND ALLOYS ***(09 Periods)***

Steels: Structure, properties, classifications and applications of plain steels, Specifications of steels, Structure, properties, classifications and applications of low alloy steels, Hadfield manganese steels, Stainless steel and Tool steels.

Cast iron: Structure, properties and applications of Gray cast iron, White cast iron, Malleable cast iron, Nodular cast iron and Alloy cast iron.

Module 4: NON-FERROUS MATERIALS AND ALLOYS ***(09 Periods)***

Structure, properties and applications of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Nickel and its alloys, Magnesium and its alloys, Refractory and Precious metals.

Module 5: CERAMICS, POLYMERS AND COMPOSITES MATERIALS ***(09 Periods)***

Ceramics: Classifications, Properties and Applications, Glass-ceramics, Polymers: Classification, Properties and Applications, Polymerization Reaction,

Composites: Classifications, Properties and Applications of Polymer matrix composites, Ceramic matrix composites, Metal matrix composites and Nanocomposites.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Laboratory experiments allow students to apply theoretical concepts and learn how to conduct experiments safely and effectively. Some examples of laboratory experiments include mechanical testing of materials, heat treatment of metals, and microscopy analysis of materials.
2. Materials characterization techniques such as X-ray diffraction, scanning electron microscopy, and transmission electron microscopy can provide valuable insights into the structure and properties of materials. Students can gain hands-on experience with these techniques by conducting experiments and analyzing the results.

(Note: It's an indicative one. Course instructor may change the activities and the same shall be reflected in course handout)

RESOURCES

TEXT BOOKS:

1. V. Raghavan, *Materials Science & Engineering*, Prentice Hall of India, 5th edition, 2004.
2. R. Balasubramaniam, Callister's, *Materials Science & Engineering*, John Wiley and sons, 2nd edition, 2014.

REFERENCE BOOKS:

1. Sidney H. Avner, *Introduction to Physical Metallurgy*, Tata McGraw Hill, 2nd edition,1997.
2. George E Dieter, *Mechanical Metallurgy*, Tata McGraw Hill, 3rd edition, 2013.
3. Kodigre V D, *Material Science and Metallurgy*, Everest Publishing House, 31st edition, 2011.

VIDEO LECTURES:

1. https://ocw.mit.edu/courses/materials-science-and-engineering/3-012-fundamentals-of-materials-science-fall-2005/lecture-notes/
2. https://nptel.ac.in/courses/116/104/116104045/
3. https://www.youtube.com/watch?v=tsX-VYvkiJ8&list=PLJV_OG0NLkV8VRNFk-0AyDZz1pZym6V8j
4. https://www.khanacademy.org/science/materials-science

WEB RESOURCES:

1. https://www.doitpoms.ac.uk/tlplib/teachers.php
2. https://www.springer.com/journal/10853
3. http://dmse.mit.edu/
4. http://dmse.mit.edu/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22LG201701	**PERSONALITY DEVELOPMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course gives awareness to students about the various dynamics of personality development.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge in Self-Management and Planning Career

CO2. Analyze the functional knowledge in attitudes and thinking strategies

CO3. Learn and apply soft skills for professional success.

CO4. Function effectively as an individual and as a member in diverse teams

CO5. Communicate effectively in public speaking in formal and informal situations.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	3	-	-	-	-	2	-	-
CO4	1	1	-	-	-	-	-	-	3	3	-	-
CO5	-	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**2**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: SELF-ESTEEM & SELF-IMPROVEMENT ***(09 Periods)***

Know Yourself – Accept Yourself; Self-Improvement: Plan to Improve - Actively Working to Improve Yourself- Exercises- case studies

Module 2: DEVELOPING POSITIVE ATTITUDES ***(09 Periods)***

How Attitudes Develop – Attitudes are Catching – Improve Your Attitudes – Exercises- case studies

Module 3 **SELF-MOTIVATION & SELF-MANAGEMENT** ***(09 Periods)***

Show Initiative – Be Responsible Self-Management; Efficient Work Habits – Stress Management – Employers Want People Who can Think – Thinking Strategies- Exercises- case studies

Module 4 **GETTING ALONG WITH THE SUPERVISOR** ***(09 Periods)***

Know your Supervisor – Communicating with your Supervisor – Special Communication with yo Supervisor – What Should you Expect of Your Supervisor? – What your Supervisor expects of you - Moving Ahead Getting Along with your Supervisor- Exercises- case studies

Module 5 **WORKPLACE SUCCESS** ***(09 Periods)***

First Day on the Job – Keeping Your Job – Planning Your Career – Moving Ahead- Exercises- case studies

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. List out the self-improvements in you on the charts and explain in detail.
2. Discuss different famous personalities and their attitudes.
3. Describe different personalities with respect to self-motivation and self-management.
4. Imagine you are a supervisor and illustrate different special communications.
5. Assume and Interpret different experiences on the first day of your job.

(Note: It's an indicative one. Course instructor may change the activities and the same shall be reflected in course handout)

RESOURCES

TEXTBOOK:

1. Harold R. Wallace and L. Ann Masters, *Personal Development for Life and Work*, Cengage Learning, Delhi, 10th edition Indian Reprint, 2011. (6th Indian Reprint 2015)
2. Barun K. Mitra, *Personality Development and Soft Skills,* Oxford University Press, 2011.

REFERENCE BOOKS:

1. K. Alex, *Soft Skills*, S. Chand & Company Ltd, New Delhi, 2nd Revised Edition, 2011.
2. Stephen P. Robbins and Timothy A. Judge*, Organizational Behaviour*, Prentice Hall, Delhi, 16th edition, 2014

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=6Y5VWBLi1es
2. https://www.youtube.com/watch?v=H9qA3inVMrA

Web Resources:

1. https://www.universalclass.com/.../the-process-of-perso...
2. https://www.ncbi.nlm.nih.gov/pubmed/25545842
3. https://www.youtube.com/watch?v=Tuw8hxrFBH8

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CE101703	PLANNING FOR SUSTAINABLE DEVELOPMENT	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on sustainable development, environmental impact, sustainable policies, governance, theories and strategies, media and education for sustainability.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1	Compare sustainable development theories in national and global context to protect the society and environment.
CO2	Analyze the unforeseen environmental impacts on sustainable development to protect the society and environment.
CO3	Analyze policies and governance for sustainable development considering ethics, economics, society and environment.
CO4	Analyze systems and strategies for sustainable development using appropriate tools and techniques considering ethics, economics, society and environment.
CO5	Analyze the role of media and education in sustainable development using appropriate tools and techniques considering ethics, society and environment besides communicating effectively.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	-	-	2	2	-	-	-	-	-
CO2	3	3	-	-	-	2	2	-	-	-	-	1
CO3	3	3	-	-	-	2	2	2	-	-	1	-
CO4	3	3	-	-	2	2	2	2	-	-	1	-
CO5	3	3	-	-	2	2	2	2	-	1	-	-
Course Correlation Mapping	**3**	**3**	**-**	**-**	**2**	**2**	**2**	**2**	-	**1**	**1**	**1**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: SUSTAINABLE DEVELOPMENT ***(09 Periods)***

Definition and concepts of sustainable development, Capitalization of sustainability- National and global context; Sustainable development goals, Emergence and evolution of sustainability and sustainable development, Theories of sustainability, Case studies.

Module 2: ENVIRONMENTAL IMPACT ***(09 Periods)***

Climate change – Science, Knowledge and sustainability; Unforeseen environmental impacts on development, Challenges of sustainable development, Centrality of resources in sustainable development, Case studies.

Module 3: SUSTAINABLE POLICIES AND GOVERNANCE ***(09 Periods)***

Governance - Democracy and Eco–welfare; Global civil society and world civil politics, Civic environmentalism, Policy responses to sustainable development, Economics of sustainability, Social responsibility in sustainability, National action, ISO 14001: Environmental management system.

Module 4: SUSTAINABLE SYSTEMS AND STRATAGIES ***(09 Periods)***

Need for system innovation, Transition and co–evolution, Theories and methods for sustainable development, Strategies for eco–innovation, Ecological foot print analysis, Socio ecological indicators – Eco labels; Policy programmes for system innovation, Case studies.

Module 5: MEDIA AND EDUCATION FOR SUSTAINABILITY ***(09 Periods)***

Role of emerging media, Remarkable design and communication art, Activism and the public interest, Education for sustainability, Participation in decision making, Critical thinking and reflection, Case studies.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Submit a study report on the importance and implementation of United Nationals sustainable goals 17 among all the ratified nations.
2. Submit a study report on any one case study that the challenges being faced during the sustainable development goals implementation.
3. Submit a study report on the social responsibility in implementation of sustainability concept.
4. Prepare and submit a report on any two case studies that how the eco labels put on their products shall make the consumers feel satisfaction over the sustainable development.
5. Submit a report on the communication art and activism through media which makes the public interest that helps to contribute towards sustainable development.

RESOURCES

TEXT BOOKS:

1 John Blewitt, *Understanding Sustainable Development*, Earth Scan Publications Ltd., 2nd Edition, 2008.
2 Jennifer A. Elliot, *An Introduction to Sustainable Development*, Earth Scan Publications Ltd., 4th Edition, 2006.

REFERENCE BOOKS:

1 Peter Rogers, Kazi F Jalal and John A Boyd, *An Introduction to Sustainable Development*, Earth Scan Publications Ltd., 2006.
2 Simon Dresner, *The Principles of Sustainability*, Earth Scan Publications Ltd., 2nd Edition, 2008.
3 Peter Bartelmus, *Environment Growth and Development: The Concepts and Strategies of Sustainability*, Routledge, 3rd Edition, 2003.
4 Gabriel Moser, Enric Pol, Yvonne Bernard, MiriliaBonnes, Jose Antonio Corraliza and Maria Vittoria Giuliani, *People Places and Sustainability*, Hogrefe& Huber Publishers, 2nd Edition, 2003.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=a5i9RVyhBtc
2 https://www.youtube.com/watch?v=fH_iIVPTujE
3 https://www.youtube.com/watch?v=c2eNrFK5M8I
4 https://www.youtube.com/watch?v=qfOgdj4Okdw
5 https://www.youtube.com/watch?v=_qLqLJq2954

WEB RESOURCES:

1 https://civil.gecgudlavalleru.ac.in/images/admin/pdf/1594706742_III-II-OE-Planning-for-Sustainable-Development.pdf
2 https://www.academia.edu/26950843/Sustainable_Development_in_Practice_Case_Studies_for_Engineers_and_Scientists
3 https://www.academia.edu/24286208/The_Role_of_the_Professional_Engineer_and_Scientist_in_Sustainable_Development
4 https://byjusexamprep.com/liveData/f/2022/8/sustainable_development_goals_upsc_notes_43.pdf
5 https://sdgs.un.org/sites/default/files/2020-10/course%201_Peter_Tarr%20%20-%20%20Compatibility%20Mode.pdf

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101705	**PRINCIPLES OF COMMUNICATION ENGINEERING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Fundamentals of Communications; Analog and digital - modulation and Demodulation Techniques; Information theory and coding.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze different Analog and Digital Modulation Schemes to improve bandwidth and power efficiency.

CO2. Analyze Pulse Analog modulation Schemes.

CO3. Understand the concepts of Baseband & Passband Digital Transmission.

CO4. Analyze various error detection and correction codes for reliable transmission.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**-**	**-**	**-**	-	-	-	-	-

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: ANALOG MODULATION ***(13 Periods)***

Block diagram of Electrical Communication System, Types of Communications, Need for Modulation, Types of Amplitude Modulation- AM, DSBSC, SSBSC, Power and BW requirements, Generation of AM, DSBSC, SSBSC. Detection of AM - Diode detector, Product demodulation for DSBSC & SSBSC. Frequency & Phase Modulations.

Module 2: PULSE MODULATION ***(07 Periods)***

Elements & Advantages of Digital communication systems, PAM, Regeneration of Base band Signal, PWM and PPM, Time Division Multiplexing, Frequency Division Multiplexing.

Module 3: BASE BAND DIGITAL TRANSMISSION ***(07 Periods)***

Pulse Code Modulation- Advantages, Block diagram of PCM, Quantization, effect of Quantization, Quantization error. DM, ADM and Comparison of PCM,DM & ADM.

Module 4: PASS BAND DIGITAL TRANSMISSION ***(10 Periods)***

Digital Binary Schemes-ASK, FSK, PSK, DPSK, QPSK, Modulation and Demodulation - Coherent and Non-coherent techniques.

Module 5: INFORMATION THEORY AND CODING ***(08 Periods)***

Concept of Information, Entropy and Rate of Information, Coding efficiency, Shannon-Fano and Huffman Coding.

Error Correction and Detection Codes- Linear Block Codes, Cyclic Codes, Convolution Codes.

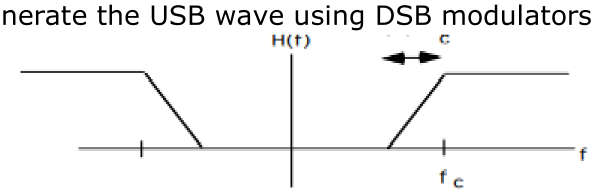
Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1 Suppose that a non-linear device is available for which the output current i0 and the input voltage vi are related by: $i_0(t) = a_1vi\ (t) + a_3v_3\, i(t)$ where a_1 and a_3 are constants. Explain how this device may be used to provide(a) a product modulator (b) an amplitude modulator.

2 A voice signal occupying the frequency band 0.3 - 3.4 KHz is to be modulated onto a carrier wave of frequency 11.6 MHz. High pass filters such as the one shown below are available. Design a system to generate the USB wave using DSB modulators and these filters.



3 In a binary PCM system, the output signal to-quantizing noise ratio is to be held to a minimum of 40 dB. Determine the number of required levels, and find the corresponding output signal to quantizing-noise ratio.

4 A bipolar binary signal $S_1(t)$ is a +1V or -1V pulse during the interval (O, T). Additive white noise with power spectral density $\eta/2 = 10^{-5}$ W /kHz. W/Hz is added to the signal. Determine the maximum bit rate that can be sent with a bit error probability of $Pe \leq 10^{-7}$

5 A compact disc (CD) recording system samples each of two stereo signals with a 16-bit analog-to digital converter (ADC) at 44.1 kb/s.

a) Determine the output signal-to-quantizing-noise ratio for a full-scale sinusoid.

b) The bit Stream of digitized data is augmented by the addition of error-correcting bits, clock extraction bits, and display and control bit fields. These additional bits represent 100 percent overhead. Determine the output bit rate of the CD recording system.

c) The CD can record an hour's worth of music. Determine the number of bits recorded on a CD. For a comparison, a high-grade collegiate dictionary may contain 1500 pages, 2 columns per page, 100 lines per column, 8 words per line, 6 letters per word, and 7 b per letter on average. Determine the number of bits required to describe the dictionary, and estimate the number of comparable books that can be stored on a CD.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1 R.P. Singh and S D Sapre, *Communication Systems - Analog and Digital*, TMH, 2nd edition 2007.

2 Simon Haykin, *Communication Systems*, John Wiley, 2nd edition 2007.

REFERENCE BOOKS:

1 Herbert Taub & Donald L Schilling, *Principles of Communication Systems*, Tata McGraw-Hill, 3rd Edition, 2009.

2 Sham Shanmugam, *Digital and Analog Communication Systems*, Wiley-India edition, 2006.

VIDEO LECTURES:

1 https://nptel.ac.in/courses/108/104/108104091/

2 https://onlinecourses.nptel.ac.in/noc19_ee47/preview

Web Resources:

1 https://studiousguy.com/basic-principles-of-communication/

2 https://www.tutorialspoint.com/principles_of_communication/principles_of_communication_modulation.htm

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101702	RELIABILITY AND SAFETY ENGINEERING	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on the fundamentals of reliability and safety engineering. The course emphasizes on various reliability measures used in assessing the performance of the system, evaluating the critical parameters of the network, and the techniques to assess the reliability of the system. The course also deals with safety management and measures in industrial and other hazardous environments.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. apply the various probability and statistics fundamentals into engineering systems to evaluate performance.

CO2. develop mathematical models for engineering networks/systems to evaluate the critical parameters for the reliability of a network/system.

CO3. analyze the time-dependent/independent characteristics of a repairable system and frequency durations techniques to assess the reliability

CO4. understand various safety management, policy, and planning strategies for personal and industrial safety.

CO5. understand various safety and hazard identification techniques and follow appropriate safety measures in industry and society.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	2	1	1	1	-	-	-	-
CO2	3	3	-	-	2	1	1	-	-	-	-	-
CO3	3	2	-	2	1	1	1	-	-	-	-	3
CO4	3	2	-	-	2	1	1	1	-	-	-	-
CO5	3	2	-	-	2	1	1	1	-	-	-	-
Course Correlation Mapping	**3**	**2**	**--**	**2**	**2**	**1**	**1**	**1**	**--**	**--**	**--**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: FUNDAMENTALS OF RELIABILITY ENGINEERING ***(09 Periods)***

Random variables, probability concepts, rules for probabilities of events. Probability density and distribution functions. Binomial distribution - Expected value and standard deviation for binomial distribution. Reliability functions, f(t), F(t), h(t) - Relationship between these functions, Exponential density and distribution functions, expected value and standard deviation of exponential distribution. Measures of reliability - MTTF, MTTR, MTBF. Bathtub curve.

Module 2: NETWORK MODELING AND RELIABILITY EVALUATION ***(09 Periods)***

Basic concepts - Evaluation of network reliability/unreliability, series systems, parallel systems, series - Parallel configuration systems. Redundant systems and its types. Evaluation of network reliability/unreliability using conditional probability method, tie-set and cut-set based approach, complete event tree and reduced event tree methods.

Module 3: MARKOV CHAIN AND MARKOV PROCESSES ***(09 Periods)***

Basic concepts, stochastic transitional Probability matrix, time dependent probability evaluation, Limiting State Probability, Absorbing states. Modelling concepts – State space diagrams, time dependent reliability evaluation of single component repairable model, two component repairable model. Frequency and duration techniques.

Module 4: BASICS OF SAFETY CONCEPTS ***(08 Periods)***

Introduction, goals, need for safety, history of safety movement – the evolution of modern safety concept, general concepts of safety management. Planning for safety- productivity, quality and safety, line and staff functions, budgeting for safety, safety policy.

Module 5: SAFETY TECHNIQUES AND APPLICATIONS ***(10 Periods)***

Introduction to safety techniques, Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of the performance of supervisors on safety. Hazard identification techniques, components of safety audit, types of audit, audit methodology, and process of safety reporting. Applications of industrial Safety, environmental safety, health safety, electrical safety, fire safety.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. The students shall understand various IEEE reliability standards to be followed in the engineering systems for the evaluation of reliability and asses performance.
2. Should collect various engineering components assembled and their network models for evaluations of network reliability indices.
3. The students to visit a nearby power or process industry to know about various types of failures and repair performance of various engineering components and cause of replacements.
4. Should collect information about various safety/alert sign boards and the relative measures for a particular situation.
5. Should understand the standard practices followed during the maintenance/commissioning of the electrical apparatus in any industry following the various safety precautions.

(Note: It’s an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Roy Billinton and Ronald N Allen, *Reliability Evaluation of Engineering Systems*, 2nd Edition, Springer, New York, 2013.
2. Frank R. Spellman, Nancy E. Whiting, *Safety Engineering: Principles and Practices*, 3rd Edition, Rowman & Littlefield, 2018.

REFERENCE BOOKS:

1. Charles E. Ebeling, *An introduction to reliability and maintainability engineering*, 2nd Edition Tata McGraw-Hill Education, 2010.
2. Dan Petersen, *Techniques of Safety Management: A Systems Approach*, 4th Edition American society of safety engineers, 2003.
3. Ajit Kumar Verma , Srividya Ajit , Durga Rao Karanki, *Reliability and Safety Engineering,* Springer London, 2016.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/105/108/105108128/
2. https://nptel.ac.in/courses/110/105/110105094/
3. https://www.youtube.com/watch?v=uutg8jKrL9w
4. https://www.youtube.com/watch?v=_c-iZ2BAXPw
5. https://www.youtube.com/watch?v=GeMCF3s5EDk
6. https://www.youtube.com/watch?v=xYWyype7cxE

WEB RESOURCES:

1 https://ieeexplore.ieee.org/document/9353567

2 https://www.ualberta.ca/engineering/mechanical-engineering/research/reliability-and-safety.html

3 https://ieeexplore.ieee.org/document/9353567

4 https://www.taylorfrancis.com/books/edit/10.1201/9781003140092/industrial-liability-safety-engineering-dilbagh-panchal-mangey-ram-prasenjit-chatterjee-anish-kumar-sachdeva

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CE101704	**REMOTE SENSING, GIS AND GPS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on photogrammetry, remote sensing, geographic information system, GIS spatial analysis. This course also examines remote sensing and GIS applications, global positioning system and its real-time applications.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Analyze photogrammetry and remote sensing to solve complex surveying problems using appropriate tools and techniques following the relevant guidelines and latest developments considering society and environment besides communicating effectively in graphical form.

CO2 Analyze GIS to solve complex surveying problems using appropriate tools and techniques following latest developments besides communicating effectively in graphical form.

CO3 Analyze GIS spatial analysis to solve complex surveying problems using appropriate tools and techniques following latest developments besides communicating effectively in graphical form.

CO4 Analyze remote sensing and GIS applications to solve complex civil engineering problems using appropriate tools and techniques following the relevant guidelines and latest developments considering society, environment, sustainability and management principles besides communicating effectively in graphical form.

CO5 Analyze global positioning system to solve complex surveying problems using appropriate tools and techniques considering society and environment besides communicating effectively in graphical form.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	-	2	2	1	1	1	-	1	-	1
CO2	2	3	-	-	2	1	1	-	-	1	-	1
CO3	2	3	-	2	2	1	1	-	-	1	-	1
CO4	2	3	-	-	2	1	1	1	-	1	1	1
CO5	2	3	-	-	2	1	1	-	-	1	-	-
Course Correlation Mapping	**3**	**3**	**-**	**2**	**2**	**1**	**1**	**1**	-	**1**	**1**	**1**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: PHOTOGRAMMETRY AND REMOTE SENSING **(10 Periods)**

Photogrammetry: Principle of photogrammetry, Types of aerial photographs, Planning and execution of photographic flights, Geometry of aerial photographs, Scale of aerial photographs and its determination, Stereoscopy, Ground control, Mosaics, Parallax measurements for height determinations, Latest developments in photogrammetry.

Remote Sensing: Elements of remote sensing, Electromagnetic spectrum, Energy resources, Physics of radiant energy, Energy interactions with earth surface features and atmosphere, Data acquisition platforms Spectral reflectance curves, Resolution; Spectral properties of water bodies, soil and vegetation; Sensors and platforms, Visual interpretation techniques.

Module 2: GEOGRAPHIC INFORMATION SYSTEM **(09 Periods)**

GIS categories, Components of GIS, Fundamental operations of GIS, Spatial and non spatial data, Raster data and vector data, File management, Layer based GIS, Feature based GIS, Map projections, Latest developments.

Module 3: GIS SPATIAL ANALYSIS **(08 Periods)**

Database models, Data storage, Vector data storage, Attribute data storage, Data manipulation and analysis, Integrated analysis of the spatial and attribute data - DTM/DEM, Softwares – Arc GIS, QGIS and Global mapper, Latest developments in GIS software.

Module 4: REMOTE SENSING AND GIS APPLICATIONS **(09 Periods)**

Land use/Land cover classification, Rainfall-runoff studies, Flood and drought impact assessment and monitoring, Drainage morphometry, Watershed management for sustainable development, GIS based precision farming, GIS based natural resources management, Inland water quality survey and management, Regional and urban planning and management, GIS based highway alignment, GIS based traffic congestion analysis, GIS for public health – Case Studies.

Module 5: GLOBAL POSITIONING SYSTEM **(09 Periods)**

Global Positioning System (GPS) – Fundamental concepts, Components of GPS – Space segment, Control segment, User segment, Reference systems, Satellite orbits; Classification of GPS receivers, GPS observations, GPS measurements and accuracy of GPS, Applications.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Sound composing project: In this assignment, Select area and collect the geometry of aerial photographs and analyze the views.
2. Visit any meteorological department and understand about rain gauges and collect, analyse the data
3. Visit Geographical Information Systems Laboratory and understand about GIS and GPS Systems

(Note: It’s an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Shivam, P. and Shashikanth, T., *A Text Book of Basic Concept of Remote Sensing*, *GPS and GIS*, Sankalp Publication, 2020.
2. Anji Reddi, M., *A Text Book of Remote Sensing and Geographical Information Systems*, B. S. Publications, 2nd Edition, 2012.

REFERENCE BOOKS:

1. Bhatta, B., *Remote Sensing and GIS*, Oxford University Press, 2nd Edition, 2011.
2. Lillesand, T. M., Kiefer, R. W. and Chipman, J. W., *Remote Sensing and Image Interpretation*, John Willey and Sons (Asia) Pvt. Ltd., 7th Edition, 2014.
3. Chandra, A. M. and Ghosh, S. K., *Remote Sensing and Geographic Information System*, Narosa Publishing House, 2nd Edition, 2015.
4. Panigrahi, N., *Geographical Information Science*, University Press, 2nd Edition, 2013.
5. Peter A. Burragh and Rachael Mc Donnell, *Principles of Geographical Information Systems*, Oxford University Press, 2nd Edition, 2014.

VIDEO LECTURES:

1. http://nptel.ac.in/courses/105/107/105107206/
2. https://syslab.ceu.edu/videos/geospatial-technologies

WEB RESOURCES:

1. Digital Audio Signal Processing: https://www.udemy.com/course/introduction-to-geospatial-technologies-and-arcgis-interface/
2. Learn Audio Editing - for Beginners: https://www.youtube.com/ watch?v=xGgaV9r_kH8
3. https://storymaps.arcgis.com/stories/47e984aae614442cb80aa40d121b5fe

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CE101705	**SMART CITIES**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a discussion on smart city and infrastructure, smart governance, smart mobility, smart economy, smart environment, smart buildings, smart energy, smart water, smart living, smart people and case studies.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Understand the concept of smart cities and its infrastructure for ensuring safety and sustainability using appropriate techniques and management principles in India besides lifelong learning.

CO2 Analyse smart cities to solve problems associated with mobility and governance for the growing population by ensuring safety and sustainability, management using appropriate standards in India besides lifelong learning.

CO3 Analyse smart cities to solve problems associated with economy and environment for ensuring safety and sustainability, management using appropriate techniques and standards in India besides lifelong learning.

CO4 Analyse buildings, energy and water resource systems in smart cities to solve problems associated with the growing population for ensuring safety and sustainability, management using appropriate standards in India besides lifelong learning.

CO5 Analyse the smart cities to solve complex problems associated with people and living systems for ensuring safety and sustainability, management using appropriate techniques in India besides lifelong learning.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	2	3	1	2	-	1	1	2
CO2	3	3	-	1	2	3	3	2	-	1	1	2
CO3	3	3	-	1	2	3	3	2	-	1	1	2
CO4	3	3	-	1	2	3	3	3	-	-	1	2
CO5	3	3	-	1	2	3	3	2	-	-	1	2
Course Correlation Mapping	**3**	**3**	**-**	**3**	**2**	**2**	**2**	**2**	**-**	**1**	**1**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: SMART CITY AND INFRASTRUCTURE ***(09 Periods)***

Smart city - Concept, Objectives, History, Need; Key trends in smart city development, Government of India – Policy for smart city.

Infrastructure: Smart city infrastructure – Components, Challenges; Managing - Principle stake holders, Infrastructure in India and World, Dimensions of smart cities, Global standards and performance benchmarks, Practice codes, Infrastructure development, Integrated infrastructure management systems for smart city, Infrastructure management system applications for existing smart city, Various types of infrastructure systems, Infrastructure assessment.

Module 2: SMART GOVERNANCE AND SMART MOBILITY ***(09 Periods)***

Smart Governance: Definition, smart governance to citizens, Industries and commerce, Smart governance within government, Emerging trends in smart governance, Future of smart governance, Guidelines and standards for smart governance; IOT and ICT Application – Broadband city, Use of sensors, Intelligent city governance.

Smart Mobility: Intelligent transportation systems, Accessibility, Smart vehicles and fuels, GIS, GPS, Navigation system, Public transport, Traffic safety management, Logistics flows in cities, Mobility services, E-ticketing.

Module 3: SMART ECONOMY AND SMART ENVIRONMENT ***(09 Periods)***

Smart Economy: City branding, Market places and crowd funding, Innovation, entrepreneurship – E-business, E-commerce, Online integrated business platforms and networks; Local and global interconnectedness, Productivity, Flexibility of labour market.

Smart Environment: Network and environmental monitoring, Energy efficiency, Urban planning and urban refurbishment, Smart buildings and building renovation, Resource management, Environmental protection.

Module 4: SMART BUILDINGS, SMART ENERGY AND SMART WATER ***(09 Periods)***

Smart Buildings: Definition, Sustainable city – A green approach, Housing, Sustainable green building - Solar energy for smart city, Waste water management, solid waste management, 3Rs Policy, Green ratings.

Smart Energy: Current energy demand, Alternate energy sources, Renewable energy, Production, Solar energy, Wind energy, Energy from solid waste, Applications, Challenges in smart energy

Smart Water: Storage and conveyance system of water, Sustainable water and sanitation, Sewage systems, Flood management, Conservation system.

Module 5: SMART LIVING, SMART PEOPLE AND CASE STUDIES ***(09 Periods)***

Smart Living: Definition, Cultural facilities, World-class education, Tourist attractions, World-class hospitals, Latest technologies, Quality housing, Community and urban life management, Social cohesion.

Smart People: Definition, Human development index, Level of qualification, Graduate enrolment ratio, Lifelong learning, ICT Skills, Quality of smart people – Flexibility, Creativity to contribute to education, Democratic nature; Personality dimensions – Extroversion, Agreeableness, Consciousness, Emotional Stability, Open to experience.

Case Studies: Helsinki – Finland; Zurich - Switzerland; Oslo - Norway; Amsterdam - The Netherlands; New York - United States; Seoul (World's first Smart City) - South Korea.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Prepare a report on smart city infrastructure for south Indian cities.
2. Prepare a review on need for changes in transportation and governing policies in India.
3. Write a report on energy conservation and economy stability in world's first smart city.
4. Write a report on need and technologies to be adopted for green buildings in a smart city.
5. Prepare a case study report on Hyderabad, Telangana.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Li Xian Yi, *Smart City on Future Life - Scientific Planning and Construction*, Posts and Telecom Press, 2012.
2. Arpan Kumar Kar, Manmohan Prasad Gupta, P. Vigneswara Ilavarasan and Yogesh K. Dwivedi, *Advances in Smart Cities*, CRC Press, Taylor & Francis Group, Boca Raton, 2017.

REFERENCE BOOKS:

1. Nicos Komninos, *The Age of Intelligent Cities: Smart Environments and Innovation-for-all Strategies (Regions and Cities)*, Routledge Taylor & Francis Group, London, 2015.
2. Eleonora Riva Sanseverino, *Smart Rules for Smart Cities – Managing Efficient Cities in Euro-Mediterranean Countries*, springer for innovation, Springer, Italy, 2014.
3. Smart Cities Mission: A Step Towards Smart India, National Portal of India
4. Anthony M. Townsend, *Smart Cities – Big Data, Civic Hackers and The Quest for a New Uthopia*, W. W. Norton & Company, Inc., New York, 2013.
5. IoT Technician (Smart City) – MHRD, Govt. of India, 2nd Edition, 2022.

VIDEO LECTURES:

1. City of the Future: Singapore – Full Episode | National Geographic - YouTube
2. Integrated Waste Management for a Smart City - Course (nptel.ac.in)

WEB RESOURCES:

1. Smart Cities (nationalgeographic.org)
2. NPTEL :: Civil Engineering - NOC: Sustainable Materials and Green Buildings
3. Smart cities (europa.eu)
4. Top 7 Smart Cities in the World in 2023 (earth.org)

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EC101706	**SMART SENSORS FOR ENGINEERING APPLICATIONS**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Basics of sensors, characteristics of sensors and their responses; Smart sensors for Engineering, Science and Health Monitoring Applications; Applications of smart sensors and advancements in sensing Techniques.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyse the characteristics of transducers and estimate the response of sensors.

CO2. Understanding the working of various sensors in the context of their specialised domains.

CO3. Apply smart sensors for real time applications.

CO4. Apply the advanced techniques to smart sensors to provide solution to real time applications.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	-	**-**	**-**	**-**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: CONCEPTS OF SENSORS ***(08 Periods)***

Introduction to sensors and transducers. Need for sensors in the modern world. Different fields of sensors based on the stimuli, various schematics for active and passive sensors. Static and dynamic characteristics of sensors. ***zero, I and II order sensors:*** Response to impulse, step, ramp and sinusoidal inputs. Environmental factors and reliability of sensors.

Module 2: SENSORS IN ENGINEERING ***(07 Periods)***

Physical principles of sensors, Electric Sensors: Resistive, Capacitive, Inductive. Piezoelectric sensor. Photo elastic sensors, Fluid Mechanic sensors.

Module 3: HUMAN AND BIOMIMETIC SENSORS ***(10 Periods)***

Human sensors: vision, Taste and smell, Hearing, Somatic, Biomimetic Sensors, Electrochemical, Thermoelectric sensors, Optic sensors.

Module 4: APPLICATIONS OF SMART SENSORS ***(11 Periods)***

WSN Based Physiological Parameters Monitoring System: Measurement of Human Body Temperature. Intelligent Sensing System for Emotion Recognition: Aim of the Emotion Recognition System, Development of Intelligent Sensing System for Emotion Recognition. WSN Based Smart Power Monitoring System.

Module 5: ADVANCEMENTS IN SENSING TECHNOLOGY ***(09 Periods)***

Ecological Monitoring Using Wireless Sensor Networks: Overview, Challenges, and Opportunities. Development of an Embedded System-Based Gateway for Environmental Monitoring in Wild Fields. Advancements in Structural Health Monitoring.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Build a wireless sensor system for Environmental pollution monitoring.
2. Design a smart temperature measurement system using required accessories.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Patrick F Dunn, *Fundamentals of sensors For engineering and science*, CRC Press,2012.
2. Subhas C. Mukhopadhyay, Krishanthi P. Jayasundera, and Anton Fuchs, *Smart Sensors, Measurement and Instrumentation*, Springer,2013.

REFERENCE BOOKS:

1 Subhas Chandra Mukhopadhyay*, Intelligent Sensing, Instrumentation and Measurements*, Springer, Kluwer Academic Publishers,2013.

2 Henry Bolte, *Sensors – A Comprehensive Sensors,* John Wiley.

VIDEO LECTURES:

1 https://www.youtube.com/watch?v=oRydUfgMdgA

2 https://onlinecourses.nptel.ac.in/noc22_ee36/

Web Resources:

1. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1199&context=nasapub#:~:text=The%20smart%20materials%20examined%20include,%2C%20magneto%2Doptical%20materials%2C%20and
2. https://www.youtube.com/watch?v=q8UuRkOQ9A0
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8433768/
4. https://www.mdpi.com/1424-8220/21/17/5890

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22EE101703	**SUSTAINABLE ENERGY SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course designed emphasizes the operating principle of a range of non-conventional energy resources, energy harvesting and conversion principles and key performance characteristics. The energy conversion technologies will include energy conversion from, Solar, Wind, Ocean, Biomass, Geothermal and Fuel cells. The course also emphasizes on various types of hybrid energy storage systems with their relative advantages and disadvantages.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Understand the fundamental concepts of renewable energy sources and their endurance for sustainability.

CO2 Understand the various methods of harvesting solar energy, energy conversion principles, and operational aspects and environmental impacts of solar technologies.

CO3 Understand the various methods of harvesting wind energy, conversion principles, operational aspects, and environmental impacts of wind energy systems.

CO4 Understand the various methods of harvesting ocean energy, Biomass energy and geothermal energy, energy conversion technologies, operational aspects, and their impacts on the environment.

CO5 Understand the principle of harvesting energy from fuel cells and the operational aspects of hybrid energy storage systems.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	--	2	2	-	-	-	-	1
CO2	3	-	-	-	2	2	2	-	-	-	-	1
CO3	3	-	-	-	2	2	2	-	-	-	-	1
CO4	3	-	-	-	2	2	2	-	-	-	-	1
CO5	3	-	-	-	2	2	2	-	-	-	-	1
Course Correlation Mapping	**3**	**-**	**-**	**-**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**1**

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: INTRODUCTION TO SUSTAINABLE ENERGY SOURCES ***(07 Periods)***

Impact of conventional sources on Environment—acid rain, ozone layer depletion, Global warming, greenhouse effect and nuclear waste; Limitation of fossil fuels; Renewable energy sources; Renewable sources and their sustainable development.

Module 2: ENERGY FROM SOLAR ***(10 Periods)***

Introduction, solar radiation, Measurement of solar radiation—Pyranometer; Solar energy collectors; Flat plate collectors— Liquid and air (non-porous) types; Focusing type— Parabolic and Point types; Solar photovoltaic system— PV cell and its types, Configuration of solar panel, PV system; Applications: Solar pump, Solar water heater

Module 3: ENERGY FROM WIND ***(08 Periods)***

Introduction, power extraction from the wind, Wind turbines— Horizontal axis wind turbine—Propeller type and Vertical axis wind turbine— Darrieus rotor type; Basic components of wind energy conversion systems, Applications: Energy storage, Water pumping; Environmental impacts.

Module 4: ENERGY FROM OCEAN, BIOMASS AND GEOTHERMAL RESOURCES ***(12 Periods)***

Energy from ocean: Introduction, ocean thermal energy conversion (OTEC): Open and closed cycle power plants; Tidal energy: Schematic diagram of tidal power plant; Advantages and disadvantages.

Energy from Biomass: Introduction, biomass conversion technologies-direct, Thermochemical and Biochemical conversions; Biogas generation—Anaerobic digestion process.

Geothermal energy: Introduction, Geothermal resources, Geothermal power plants— Vapour dominated and liquid dominated; Environmental issues.

Module 5: FUEL CELLS AND HYBRID ENERGY SYSTEMS ***(08 Periods)***

Fuel Cells: Introduction, principle and operation of fuel cell, classification of fuel cells, advantages and disadvantages of fuel cells.

Hybrid energy systems: Need for hybrid systems, configuration and coordination, Block diagram approach of Stand-alone PV-wind system, PV-Diesel and Wind-diesel; energy storage systems — Ultra capacitors, SMES, Battery.

Total Periods: ***45***

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. The students shall visit a solar power plant, understand the operational aspects and should prepare a technical report on the plant visited.

2. The students shall visit a wind farm, understand the operational aspects, and should prepare a technical report on the plant visited.

3. The students shall visit a bio-mass energy conversion plant, understand the operational aspects and should prepare a technical report on the plant visited.

4. The students shall prepare a technical report on the need of a hybrid plant and find new avenues for a new hybrid system.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXT BOOKS:

1. Rai, G.D., *Non-conventional Energy Sources*, Khanna Publishers, New Delhi, 2017.
2. G.N. Tiwari and M.K. Ghosal, *Renewable energy resources: Basic principles and applications*, Alpha Science International Ltd., 2005.

REFERENCE BOOKS:

1. JhonTwidell and Tony Wier, *Renewable Energy Resources*, Taylor & Francis, 2nd edition, London and Newyork, 2006.
2. K.M. Mittal,*Non-conventional Energy Systems-Principles*, Progress and Prospects, Wheeler Publications, 1997.
3. S.Rao, Dr.B.B. Parulekar, *Energy Technology*, Third edition, Khanna Publications, 2013.
4. R. K. Rajput, *A textbook of power system engineering*, Laxmi publications (P) Ltd, 2016

VIDEO LECTURES:

1. https://nptel.ac.in/courses/103103206
2. https://nptel.ac.in/courses/121106014
3. https://youtu.be/mh51mAUexK4
4. https://youtu.be/UW4HYJ36q0Y

WEB RESOURCES:

1. www.mnre.gov.in
2. www.ireda.in

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CS101702	**WEB DESIGN FUNDAMENTALS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is designed to introduce the student to the technologies and facilities of web design: CSS, javascript, and jquery. Students will understand the web design process and use these software technologies together to produce web design projects.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the fundamentals of HTML 5 and the principles of web design.

CO2. Construct basic websites using HTML and Cascading Style Sheets.

CO3. Build dynamic web pages with validation using Java Script objects and by applying different event handling mechanisms.

CO4. Learn how to use HTML5 and other Web technologies to develop interactive and responsive web pages.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	2	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	2	-
CO4	2	3	3	-	-	-	-	2	-	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	-	**-**	**2**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION ***(09 Periods)***

Elements – Data types - Working with Text - Arranging Text - Displaying Lists - VAR Element - BDO Element - SPAN Element – DIV Element.

Module 2: LINKS AND URLS ***(09 Periods)***

Hyperlinks – URLs - Linking to a Mail System - Creating Tables - Inserting Images in a Web Page – Colors – Form Elements - Multiple-Choice Elements – Multimedia

Module 3: DYNAMIC HTML ***(09 Periods)***

Features of JavaScript - Programming Fundamentals - JavaScript Functions, Events, Image Maps, and Animations – JS Objects - Document Object - Validation, Errors, Debugging, Exception Handling, and Security

Module 4: CASCADING STYLE SHEET ***(09 Periods)***

CSS Syntax - CSS Selectors - Backgrounds and Color Gradients - Fonts and Text Styles - Creating Boxes and Columns - Displaying, Positioning, and Floating an Element - Table Layouts - : Effects, Frames, and Controls in CSS

Module 5: ADVANCED FEATURES OF HTML5 ***(09 Periods)***

Creating Editable Content - Checking Spelling Mistakes - Custom Data Attributes - Client-Side Storage - Drag and Drop Feature - Web Communication –**jQuery -** Fundamentals of jQuery - Callback Functions - jQuery Selectors - jQuery Methods to Access HTML Attributes.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Design a blog layout that includes header, navigation menu, content area, sidebar. Apply appropriate styling to each section.
2. Develop a java script based quiz that presents MCQs to the user and provides immediate feedback on their answers. Keep track of the score and display the final results at the end.
3. Build a web page that displays and image gallery. Each image should be a clickable link that opens the image in a larger view when clicked.

(Note: It's an indicative one. The course instructor may change the activities and the same shall be reflected in course handout.)

RESOURCES

TEXTBOOKS

1. DT Editorial Services, *HTML 5 Black Book*, Dreamtech Press, 2nd Edition, 2016.

REFERENCE BOOKS

1. Jennifer Niederst Robbins, *HTML5 Pocket Reference,* O'Reilly, 5th Edition, 2018.
2. Ben Frain, *Responsive Web Design with HTML5 and CSS3*, Packt, 2nd Edition, 2020.

VIDEO RESOURCES

1. https://www.youtube.com/watch?v=h_RftxdJTzs
2. https://www.youtube.com/watch?v=dlkWNdnO8ek

WEB RESOURCES

1. https://www.w3schools.com/html/
2. https://www.w3schools.com/css/
3. https://www.geeksforgeeks.org/web-technology/
4. https://www.smashingmagazine.com/2021/03/complete-guide-accessible-front-end-components/
5. https://css-tricks.com/
6. https://davidwalsh.name/css-optional

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22SS101706	**WOMEN EMPOWERMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Concept & Framework, Status of Women, Women's Right to Work, International Women's Decade, and Women Entrepreneurship.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Demonstrate the knowledge of the characteristics and achievements of empowered women and women's empowerment techniques by analyzing women's legal and political status.

CO2 Apply the knowledge of women's rights by analyzing various societal issues and obstacles in different fields, including science and technology.

CO3 Demonstrate the knowledge of the significance of women's participation in policy debates, National conferences, and common forums for equality and development by identifying and analyzing issues.

CO4 Analyze the concept of women's entrepreneurship, government schemes, and entrepreneurial challenges and opportunities.

CO-PO Mapping Table

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	1	3	-	1	–	–	-	-
CO2	3	1	-	-	-	2	-	-	-	–	-	-
CO3	3	1	-	-	-	2	-	-	-	3	-	-
CO4	3	1	-	-	-	-	-	-	-	-	2	-
Course Correlation Mapping	3	1	-	-	1	3	-	1	–	3	2	-

Correlation Levels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSE CONTENT

Module 1: CONCEPT & FRAMEWORK ***(09 Periods)***

Introduction– Empowered Women's Characteristics – Achievements of Women's Empowerment **Concept of Empowerment:** Meaning & Concept – Generalizations about Empowerment – Empowerment Propositions – Choices women can make for empowerment – Women's participation in decision making, development process & in Governance. **Framework for Empowerment** – Five levels of equality – Tenets of Empowerment– Elements – Phases and aspects – Techniques – Categories and Models – Approaches.

Module 2: STATUS OF WOMEN ***(09 Periods)***

Legal Status: Present Scenario – Call for Social Change – Significant Trends – Legal & Schemes – Personal Law – Joint Family – Criminal Law – Shift towards Dowry – Deterrent Punishment – Criminal Law (II Amendment) – Discrimination in Employment.

Political Status: Present Scenario – Political Participation & its NatureSocio–economic Characteristics – Political Mobilization: Mass Media – Campaign Exposure – Group Orientation – Awareness of issues and participation – Progress & Future Thrust.

Module 3: WOMEN'S RIGHT TO WORK ***(09 Periods)***

Introduction – Present Scenario – Changes in Policy & Programme – National Plan of Action– Women's Cells and Bureau – Increase in the work participation rate – Discrimination in the labour market – Women in unorganized sector – Issues and Obstacles– Women in Education – Women in Science & Technology – Case Study: Linking Education to Women's Access to resources.

Module 4: WOMEN'S PARTICIPATORY DEVELOPMENT ***(09 Periods)***

Dynamics of social change – conscious participation – Information Explosion – Organized Articulation – National Conference – Common Forums – Participatory Development – New Issues Identified – Role of other Institutions.

Module 5: WOMEN ENTREPRENEURSHIP ***(09 Periods)***

Introduction – Definition – Concept – Traits of women Entrepreneurs – Role of Women Entrepreneurs in India – Reasons for Women Entrepreneurship – Government schemes & Financial Institutions to develop Women Entrepreneurs – Key policy recommendations – Project Planning – Suggestions and measures to strengthen women entrepreneurship – Growth & Future challenges – Training and Opportunities – Case Study: Training Women as Hand–pump Mechanics– Case Study: Literacy for Empowering Craftswomen

Total Periods: 45

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Prepare poster presentation on "impact of women's self-help groups on their empowerment and socio-economic development."
2. Prepare a comparative analysis chart on the status of women in various countries.
3. Prepare a presentation on women and cultural responsibilities in different societies.
4. Prepare a presentation on the women of the past, present and future in terms of responsibilities and duties.
5. Prepare a presentation on the great women entrepreneurs of India.

(Note: It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. SahaySushama, *Women and Empowerment,* Discovery Publishing House, New Delhi, 2013.
2. NayakSarojini, Jeevan Nair, *Women's Empowerment in India*, Pointer Publishers, Jaipur, 2017.

REFERENCE BOOKS:

1. Baluchamy. S, *Women's Empowerment of Women*, Pointer Publishers, Jaipur, 2010.
2. Khobragade Grishma, *Women's Empowerment: Challenges and Strategies Empowering Indian Women*, Booksclinic Publishing, Chhattisgarh, 2020.

Web Resources:

1. https://www.economicsdiscussion.net/entrepreneurship/women–entrepreneurs–in–india
2. https://www.businessmanagementideas.com/entrepreneurship–2/women entrepreneurs