MOHAN BABU UNIVERSITY

Sree Sainath Nagar, Tirupati – 517 102

MBU
MOHAN BABU
UNIVERSITY

DREAM. BELIEVE. ACHIEVE

SCHOOL OF ENGINEERING

B.Tech. Mechanical 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 MECHANICAL ENGINEERING

VISION

To be a premier centre of excellence by synergizing interdisciplinary curriculum and innovative research to produce globally competent mechanical engineers contributing to society through entrepreneurship and technological leadership.

MISSION

- Impart quality education to create globally competitive mechanical engineers for multicultural and multidisciplinary environments through the contemporary curriculum.
- Develop and maintain the state of art research facilities to enable the faculty and students to address the evolving needs of industry and society.
- Create and maintain a collegial, supportive, and diverse environment that encourages students, faculty, and staff to achieve to the best of their abilities.
- Instil entrepreneurial spirit in students through a multifaceted approach.
- Foster problem solving, leadership, teamwork skills, and the value of commitment, quality and ethical behavior in the students.

B.Tech. MECHANICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

After few years of graduation, the graduates of B.Tech. ME Program will be:

PEO 1. Pursuing higher education and research in Mechanical Engineering, business administration, or other disciplines.

PEO 2. Employed in the core, allied, and software companies.

PEO 3. Able to start entrepreneurial ventures in Mechanical Engineering and other interdisciplinary fields.

PEO 4. Engaged in lifelong learning through scientific temper to address changes in professional and social needs.

PROGRAM OUTCOMES

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

PSO1. Design, develop, analyze and maintain of mechanical systems and processes by applying the concepts of material science, Design, Manufacturing and Computer aided Manufacturing technologies

PSO2. Apply the principles of thermodynamics, Fluid mechanics and Heat Transfer in the thermal design of various components of fluid thermal systems and assess its performance.

PSO3. Identify, define, analyze, formulate, and solve problems related to industrial systems and services for optimized conditions by applying tools of Industrial Engineering and management for effective decision making and support purposes.

B.Tech.MechanicalEngineering

(Regular – 4 Years Program)

Basket Wise - Credit Distribution

Sl. 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.MechanicalEngineering

(Lateral Entry – 3 Years Program)

Basket Wise - Credit Distribution

Sl. 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 Program)

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	-
22EE102401	Basic Electrical and Electronics Engineering	3	-	2	-	4	-
22EE102402	Fundamentals of Electrical Engineering	2		2		3	-
22CS102401	Programming in C and Data Structures	3	-	2	-	4	-
22CS102001	Programming for problem solving	3	-	2	-	4	-
22ME105002	Engineering Workshop	-	-	2	-	1	-
22ME105001	Computer Aided Engineering Drawing	-	1	4	-	3	-
22ME111002	Technology Extension for Societal Problems	-	-	-	4	1	-
22AI105001	Design Thinking	-	1	2	-	2	-
22ME111001	Internship	-	-	-	-	2	-
22ME108001	Capstone Project	-	-	-	-	10	-
Language Basket (Min. 4 Credits to be earned)							
22LG102401	English for Professionals	2	-	2	-	3	-
22LG102402	Empowering your English	2	-	2	-	3	
22LG105402	Soft Skills	-	-	2	-	1	-
22LG101403	German Language	2	-	-	-	2	-
22LG101404	French Language	2	-	-	-	2	-

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
Mathematics Basket (Min. 9 Credits to be earned)							
22MM101402	Multivariable Calculus and Differential Equations	3	-	-	-	3	-
22MM102404	Transformation Techniques and Linear Algebra	3	-	2	-	4	-
22MM101406	Special Functions and Complex Analysis	3	-	-	-	3	-
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	-
Computing Tools (Min. 1 Credits to be earned)							
22EE105405	MATLAB Practice for Engineers	-	-	2	-	1	-
22CS105401	Python Programming for Engineers	-	-	2	-	1	-
Management Basket (Min. 5 Credits to be earned)							
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	-
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	-

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
22CE107603	Rural Technology	2	-	-	-	2	-
22LG107603	Spoken English	-	1	2	-	2	-
22LG107602	Essential Life Skills for Holistic Development	2	-	-	-	2	-
22AB107601	NCC/NSS Activities	-	-	-	-	2	-
22AB107602	Yoga	-	-	-	-	2	-
22MG107601	Innovation, Incubation and Entrepreneurship	2	-	-	-	2	-
22EE107601	Intellectual Property Rights	2	-	-	-	2	-
22EE107602	Fundamentals of Research Methodology	2	-	-	-	2	-

*Compulsory Course

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

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	-
22EE102401	Basic Electrical and Electronics Engineering	3	-	2	-	4	-
22CS102401	Programming in C and Data Structures	3	-	2	-	4	-
22ME105002	Engineering Workshop	-	-	2	-	1	-
22ME105001	Computer Aided Engineering Drawing	-	1	4	-	3	-
22ME111002	Technology Extension for Societal Problems	-	-	-	4	1	-
22AI105001	Design Thinking	-	1	2	-	2	-
22ME111001	Internship	-	-	-	-	2	-
22ME108001	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	-
22MM102404	Transformation Techniques and Linear Algebra	3	-	2	-	4	-
22MM101406	Special Functions and Complex Analysis	3	-	-	-	3	-
22MM101405	Numerical Methods, Probability and Statistics	3	-	-	-	3	-
22MM102452	Engineering Physics	3	-	2	-	4	-

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
22MM102451	Applied Physics	3	-	2	-	4	-
22EE105405	MATLAB Practice for Engineers	-	-	2	-	1	-
22CS105401	Python Programming for Engineers	-	-	2	-	1	-
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	-
Mandatory Courses (Min. 6 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	-
22LG107602	Essential Life Skills for Holistic Development	2	-	-	-	2	-
22AB107601	NCC/NSS Activities	-	-	-	-	2	-
22AB107602	Yoga	-	-	-	-	2	-
22MG107601	Innovation, Incubation and Entrepreneurship	2	-	-	-	2	-
22EE107601	Intellectual Property Rights	2	-	-	-	2	-
22EE107602	Fundamentals of Research Methodology	2	-	-	-	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	
22ME101001	Basic Engineering Mechanics	3	-	-	-	3	-
22ME102001	Material Science and Engineering	3	-	2	-	4	-
22ME102002	Manufacturing Technology	3	-	2	-	4	-
22ME105003	Computer Aided Machine Drawing	-	1	2	-	2	Computer Aided Engineering Drawing
22ME101002	Engineering Thermodynamics	3	-	-	-	3	-
22ME101003	Kinematics of Machinery	3	-	-	-	3	-
22ME102003	Fluid Mechanics	3	-	2	-	4	-
22ME102004	Strength of Materials	3	-	2	-	4	Basic Engineering Mechanics
22ME102005	Dynamics of Machinery	3	-	2	-	4	Basic Engineering Mechanics
22ME102006	Machine Tools	3	-	2	-	4	Manufacturing Technology
22ME102007	Engineering Metrology	3	-	2	-	4	-
22ME102008	Thermal Engineering	3	-	2	-	4	Engineering Thermodynamics
22ME102030	Fundamentals of Machine Design	3	-	2	-	4	
22ME101005	Industrial Engineering and Management	3	-	-	-	3	-
22ME101006	Applied Thermodynamics	3	-	-	-	3	Engineering Thermodynamics
22ME102009	Computer Aided Design and Manufacturing	3	-	2	-	4	-
22ME102010	Heat Transfer	3	-	2	-	4	Engineering Thermodynamics and Fluid Mechanics

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
22ME101007	Design of Machine Elements	3	-	-	-	3	Fundamentals of Machine Design
22ME101008	Operations Research	3	-	-	-	3	-
22ME101009	Operations Management	3	-	-	-	3	-

Program Elective (24 - 36 Credits)

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
			L	T	P	S	C	
22ME101010	Design Engineering	Tool Design	3	-	-	-	3	-
22ME101011		Composite Materials	3	-	-	-	3	Material Science and Engineering
22ME101012		Design of Transmission Systems	3	-	-	-	3	Fundamentals of Machine Design
22ME101088		IoT system design	3	-	-	-	3	
22ME102011		Finite Element Method	3	-	2	-	4	-
22ME101013		Design of Automotive Components	3	-	-	-	3	-
22ME101014	Manufacturing Technology	Engineering Metallurgy	3	-	-	-	3	-
22ME102012		Mechatronics	3	-	2	-	4	-
22ME102013		Hydraulics and Pneumatics	3	-	2	-	4	-
22ME102014		Industrial Automation and Robotics	3	-	2	-	4	-
22ME101015		Non-Traditional machining processes	3	-	-	-	3	-
22ME101086		Artificial Intelligence Applications in Mechanical Engineering	3	-	-	-	3	
22ME101087		Artificial Neural Networks and Fuzzy Logic	3	-	-	-	3	

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
			L	T	P	S	C	
22ME101016	Thermal Engineering	Automobile Engineering	3	-	-	-	3	-
22ME101017		Internal Combustion Engines	3	-	-	-	3	Thermal Engineering
22ME102015		Refrigeration and Air Conditioning	3	-	2	-	4	Thermodynamics
22ME101018		Non-Conventional Energy Sources	3	-	-	-	3	-
22ME101019		Power Plant Engineering	3	-	-	-	3	Thermodynamics, Thermal Engineering and Heat Transfer.
22ME101081		AI techniques for Renewable Energy Systems	3	-	-	-	3	
22ME101082		AI for transportation system	3				3	
22ME101083		Introduction to Marine and Aerial Robotics	3	-	-	-	3	
22ME101085		Artificial intelligence, machine learning and data analysis for photovoltaic systems	3	-	-	-	3	
22ME101020	Industrial Engineering	Fundamentals of Management	3	-	-	-	3	-
22ME101021		Statistical Inference and Modeling	3	-	-	-	3	-
22ME101022		Quality Management and Reliability Engineering	3	-	-	-	3	-
22ME101023		Optimization Techniques	3	-	-	-	3	-
22ME101024		Supply Chain Management	3	-	-	-	3	-
22ME102032		AI for Perception Planning and Control	3	-	2	-	4	-
22ME101084		Planning and Decision Making in Robotics	3	-	-	-	3	-

Specialization Elective (12 - 18 Credits)

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
			L	T	P	S	C	
22ME101025	Design Engineering	Tribology	3	-	-	-	3	-
22ME101026		Mechanical Behavior of Materials	3	-	-	-	3	-
22ME101027		Design of Pressure Vessels and Piping Systems	3	-	-	-	3	-
22ME101028		Machinery Fault Diagnosis and Signal Processing	3	-	-	-	3	-
22ME101029		Fundamentals of Microelectromechanical Systems	3	-	-	-	3	-
22ME101030		Soft Computing Techniques in Mechanical Engineering	3	-	-	-	3	-
22ME101031		Mechanical Vibrations	3	-	-	-	3	-
22ME101032		Design for manufacturing and assembly	3	-	-	-	3	-
22ME101033		Theory of Elasticity and Plasticity	3	-	-	-	3	-
22ME101034		Product Design for Manufacturing	3	-	-	-	3	-
22ME102029		Robotic Programming	3	-	2	-	4	-
22ME101073		Bio-Inspired Robotics	3	-	-	-	3	-
22ME101078		Field And Service Robotics	3	-	-	-	3	-
22ME101035	Manufacturing Technology	Advanced Casting Technology	3	-	-	-	3	Manufacturing Technology
22ME101036		Advanced Welding Technology	3	-	-	-	3	-

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
22ME101037		Sustainable Manufacturing	3	-	-	-	3	-
22ME101038		Rapid Prototyping	3	-	-	-	3	-
22ME101039		Surface Engineering	3	-	-	-	3	-
22ME102016		Industrial Internet of Things	3	-	2	-	4	-
22ME101040		Flexible Manufacturing Systems	3	-	-	-	3	-
22ME101041		Micro and Nano Manufacturing	3	-	-	-	3	-
22ME101042		Non-Destructive Testing	3	-	-	-	3	Material Science and Engineering
22ME101043		Modern Manufacturing	3	-	-	-	3	Manufacturing Technology
22ME101080		PLC and Data Acquisition System	3	-	-	-	3	
22ME102021		Artificial Intelligence & Machine Learning	3	-	2	-	4	
22ME102022		Cyber Physical Production Systems	3	-	2	-	4	
22ME101061		Intelligent Product design and Manufacturing	3	-	-	-	3	
22ME102025		Fundamentals of Cloud Computing	3	-	2	-	4	
22ME101068		Digital Manufacturing	3	-	-	-	3	
22ME102017	Thermal Engineering	Compressible Fluid Flow	3	-	2	-	4	-
22ME101044		Gas Turbines and Jet Propulsion	3	-	-	-	3	-
22ME101045		Alternative Fuels	3	-	-	-	3	-
22ME101046		Fuels and Combustion	3	-	-	-	3	-
22ME101047		Automotive Electronics	3	-	-	-	3	

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
22ME101048		Cryogenics	3	-	-	-	3	Refrigeration and Air conditioning
22ME101049		Turbo machines	3	-	-	-	3	Thermodynamics and Thermal Engineering
22ME101050		Hybrid and Electric Vehicles	3	-	-	-	3	-
22ME102031		Instrumentation and Control Systems	3	-	2	-	4	-
22ME102018		Computational Fluid Dynamics	3	-	2	-	4	Heat Transfer, Fluid Mechanics and Multivariable Calculus and Differential Equations
22ME102019	Industrial Engineering	Design and Analysis of Experiments	3	-	2	-	4	-
22ME101052		Simulation and Modeling Analysis	3	-	-	-	3	-
22ME101053		Management Information Systems	3	-	-	-	3	-
22ME101054		Agile Manufacturing	3	-	-	-	3	-
22ME101055		Lean Manufacturing Systems	3	-	-	-	3	-
22ME101056		E Commerce and Business Analytics	3	-	-	-	3	-
22ME101057		Enterprise Resource Planning	3	-	-	-	3	-
22ME101058		Financial Engineering	3	-	-	-	3	-
22ME101059		Industrial Safety and Maintenance Engineering	3	-	-	-	3	-
22ME101060		Marketing Management	3	-	-	-	3	-
22ME101070		Applied and Industrial Robotics	3	-	-	-	3	

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
22ME101074		Programmable Logic Controller in Automation	3	-	-	-	3	
22ME101077		Automatic Control Systems	3	-	-	-	3	
22ME102020		Industrial Cyber security	3	-	2	-	4	

UNIVERSITY ELECTIVE (09-12 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	-
22AI101701	Bioinformatics	3	-	-	-	3	-
22BS101701	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	-

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
22EC101704	Introduction to Nanotechnology	3	-	-	-	3	-
22AI101702	Introduction to Artificial Intelligence	3	-	-	-	3	-
22AI101703	Introduction to Data Science	3	-	-	-	3	-
22AI101704	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

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 (MBU)

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
22EE102401	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	3	-	2	-	4

Pre-Requisite -
Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:
This course is designed to provide an overview on the fundamentals of electrical and electrical engineering concepts and hands-on experience for non-electrical graduating students. The course address the fundamentals concepts of electrical circuits, operational aspects of motors, transformers and general electrical wiring systems. The course also emphasis on the illumination design, back-up supplies like UPS and Batteries, sensors and transducers, and principles of fundamental electronic devices and their applications.

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

CO1. Analyze the electrical circuits by applying the principles of electrical circuits.

CO2. Understand the operation of various motors used in domestic application, transformers and general wiring schemes.

CO3. Understand the operational aspects of UPS, batteries and design the appropriate lighting system for various industrial and domestic applications.

CO4. Understand the principle of various sensor and transducers to sense/measure various non-electrical parameters.

CO5. Understand the fundamentals of basic electronic devices, their characteristics and applications of electronic devices.

CO6. 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	-	-	-	-	-	-	-
CO2	3	2	-	-	-	1	-	-	-	-	-	-
CO3	3	2	2	-	-	1	1	-	-	-	-	-
CO4	3	1	-	-	-	1	-	-	-	-	-	-
CO5	3	1	-	1	2	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**-**	**3**	**3**	**-**	**-**

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

COURSE CONTENT

Module 1: FUNDAMENTALS OF ELECTRIC CIRCUITS (10 Periods)

Classification of network elements; Voltage-Current relations for passive elements; Kirchhoff's laws; Series-Parallel connection; Mesh and Nodal analysis (With DC Independent Sources only).

AC sources–Single loop generator, Phasor representation, Voltage, Current, Impedance, Power factor and Apparent power.

Module 2: ELECTRICAL SYSTEMS (09 Periods)

Motors: Types of motors, working principle and applications—DC motor, Three Phase Induction motor, Synchronous motor, Stepper motor.

Single Phase Transformer: Construction, principle of operation; EMF equation.

Electrical wiring: Methods of electrical wiring systems; Earthing procedure, Switch fuse unit (SFU), Operation of MCB and Relays.

Module 3: UTILIZATION OF ELECTRICAL SYSTEMS (09 Periods)

Illumination: Light sources, Terminologies, Laws of illumination; Types of lamps, Lighting calculations; Interior Lighting - Industrial lighting; Exterior lighting- Street lighting and Flood lighting.

Uninterruptible Power Supply (UPS) - Components in UPS, Functionality and Calculation of ratings for UPS components to a specific load.

Emergency supply: Batteries -Types of batteries, Elementary calculations for energy consumption for a specified application.

Module 4: SENSORS AND TRANSDUCERS (08 Periods)

Sensors- Light sensor, Voltage sensor, Temperature and Humidity sensor, Motion detection sensors, Wireless bluetooth sensors and Distance measurement with Ultrasound sensor.

Transducers -Basic requirements of transducers, Passive transducers - Strain gauge, Hall-Effect transducer, LVDT and Active transducers- Piezoelectric and Thermocouple, Data acquisition system (overview and concept only).

Module 5: FUNDAMENTALS OF ELECTRONICS ENGINEERING (09 Periods)

Half wave and full wave rectifier, Zener diode, characteristics, application – Regulator. BJT -operation; Introduction to Operational amplifier: Inverting and non-inverting amplifier. Application - Adder, Comparator, Integrator and Differentiator; Analog to Digital Convertors - Flash type and Successive approximation types; Digital to Analog converters - Weighed resistor and R-2R types.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Verification of Kirchhoff's laws (Mesh and Nodal Analysis).
2. Performance evaluation by brake test on DC Shunt Motor.
3. Performance evaluation of a 1-Phase Transformer by Load test.
4. Practicing plate and pipe earthing system.
5. Operation and testing of Fuse, MCB and Relays.

6. Design and estimation of wiring for a typical house: One lamp controlled by one switch, Two lamp controlled by two switch and stair case wiring.
7. Calibration of LVDT for linear displacement measurement.
8. Analyze the characteristics of Resistance Temperature Detector (RTD) sensor.
9. Analyze the characteristics of piezoelectric sensor.
10. Investigate ripple factor and load regulations of rectifier with and without filters.
11. Design of inverting and non-inverting amplifiers using op-amp.
12. D-A converter (R-2R ladder) using Op-Amp 741 with required voltage levels.

TEXT BOOKS:

1. Ashfaq Hussain, *Fundamentals of Electrical Engineering*, Dhanpatrai & Co. (P) Ltd., 3rd Edition, New Delhi, 2009.
2. R. L. Boylestad and Louis Nashelsky, *Electronics Devices and Circuits*, PHI, 11th edition, 2009.

REFERENCE BOOKS:

1. Wadhwa, C. L., *Basic Electric Engineering*. 4th Edition, New Age International Private limited.
2. D. Patranabis, *Sensors and Transducers*, PHI Learning Private Limited, 2nd Edition, 2003.
3. A.K.Sawhney, A Course in *Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai & Co., 19th Edition, 2015.
4. C.L. Wadhwa, Generation, *Distribution and Utilization of Electrical Energy*, New Age International Private Limited, 2015.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/108108076
2. https://nptel.ac.in/courses/108105061
3. https://nptel.ac.in/courses/108108147
4. https://nptel.ac.in/courses/108101091

WEB RESOURCES:

1. https://www.electrical4u.com/electric-circuit-or-electrical-network/
2. https://www.electronicshub.org/dc-circuits-basics/
3. https://www.electrical4u.com/working-of-electric-motor/
4. https://electricalbaba.com/what-is-ups-working-types-of-ups-explained/
5. https://www.lrc.rpi.edu/resources/publications/pdf/illuminationfund.pdf
6. https://www.sitsitamarhi.ac.in/wp-content/uploads/2020/04/file_5e8ef00b06190.pdf
7. https://www.electronics-tutorials.ws/io/io_1.html
8. https://www.homemade-circuits.com/making-ups-tutorial/
9. https://www.engineersgarage.com/introduction-to-uninterruptible-power-supply-ups-and-its-design-part-1-17/
10. https://www.dfliq.net/blog/the-basics-of-electrical-components/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE102402	FUNDAMENTALS OF ELECTRICAL ENGINEERING	2	-	2	-	3

Pre-Requisite -

Anti-Requisite Basic Electrical and Electronics Engineering

Co-Requisite -

COURSE DESCRIPTION: This course is designed to provide an overview on the fundamentals of electrical technology for non-electrical graduates. The course provides a deep insight about the various concepts such as network reduction techniques, analysis of DC and AC circuits; Constructional details, operation and applications of various Electrical Machines used in industry and for domestic applications.

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

CO1. Analyze the DC electrical circuits by applying the principles of network reduction techniques, mesh and nodal analysis.

CO2. Analyze the single phase AC electrical circuits to investigate the response and determine various electrical quantities.

CO3. Analyze the operational aspects of Single Phase Induction Motors and realize their applications.

CO4. Understand the operational aspects of Special Machines used in industry and for domestic applications.

CO5. Analyse the equivalent circuit of a single phase transformer, to determine the performance and assess its 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	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	2	-	1	-	-	-	-	-	-	-	-	-
CO4	3	3	-	1	-	1	1	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	1	1	2	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**-**	**1**	**2**	**1**	**1**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**

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

COURSE CONTENT

Module 1: DC CIRCUITS (08 Periods)

Classification of network elements; Voltage-Current relations for passive elements; Network reduction techniques-series, parallel, series-parallel circuits, current and voltage division rules; wye-to-delta and delta-to-wye transformations; nodal analysis and mesh analysis with dependent and independent DC sources.

Module 2: SINGLE PHASE AC CIRCUITS (08 Periods)

Analysis of single phase AC circuits: impedance and admittance, impedance triangle; Power triangle; Response of R, L and C elements with different combinations; Resonance, bandwidth and quality factor for series and parallel networks.

Module 3: SINGLE PHASE INDUCTION MOTOR (05 Periods)

Construction of single phase induction motor, capacitor start & run split phase induction motors operation and applications.

Module 4: SPECIAL MACHINES (04 Periods)

Constructional details, operation and applications of PMBLDC motor and stepper motor (VR and PM type only).

Module 5: SINGLE PHASE TRANSFORMERS (05 Periods)

Construction and working principle, EMF equation, losses, equivalent circuit, OC and SC tests on single phase transformer, predetermination of efficiency and regulation.

Total Periods: 30

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Verification of Kirchhoff's laws.
2. Verification of Mesh and Nodal Analysis.
3. Measurement of power and power factor in a single phase AC circuits.
4. Development of Locus diagram for RL and RC circuits.
5. Design a resonant circuits to select or reject the specified range of frequencies.
6. Brake test on single phase induction motor.
7. No-load and blocked rotor test on single phase induction motor.
8. OC and SC tests on a single phase transformer.
9. Separation of no-load losses of a single phase transformer.
10. Load test on single phase transformer.

RESOURCES

TEXT BOOKS:

1. A. Sudhakar, Shyammohan S Palli, *Circuits and Networks Analysis and Synthesis*, McGraw Hill Education (India) Private Limited, New Delhi, 5th Edition, 2015.
2. 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.

REFERENCE BOOKS:

1. Charles K. Alexander, Mathew N O Sadiku, *Fundamentals of Electric Circuits*, McGraw Hill Education (India) Private Limited, New Delhi, 5th Edition, 2013.
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. https://nptel.ac.in/courses/108108076
2. https://nptel.ac.in/courses/108105112

WEB RESOURCES:

1. https://www.electronicshub.org/dc-circuits-basics/
2. https://www.engineeringenotes.com/electrical-engineering/circuits/single-phase-ac-circuit-with-diagram-electrical-engineering/27590
3. https://siiet.ac.in/wp-content/uploads/2019/05/BEE.pdf
4. https://www.youtube.com/watch?v=fbwZkhaF0dk
5. https://people.ucalgary.ca/~aknigh/electrical_machines/fundamentals/f_main.html
6. https://www.electronics-tutorials.ws/transformer/transformer-basics.html

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22CS102401	**PROGRAMMING IN C AND DATA STRUCTURES**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed introduction and hands-on experience to programming in C language. Topics covered in the course includeAlgorithms, Flowcharts, Operators and expressions, Input and output functions, Control statements, Arrays, Strings, Functions, Pointers, User-defined data types, Linked lists, Overview of data structures, Stack, Queue, Searching algorithms, Sorting algorithms.

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

CO1. Develop flowcharts, algorithms for given problems.

CO2. Design algorithmic solutions by analyzing programming problems and using appropriate C language constructs.

CO3. Apply linear data structures such as arrays, linked lists, stacks, queues for efficient data organization and manipulation.

CO4. Select and apply appropriate techniques for searching and sorting problems.

CO5. Work independently and communicate effectively in oral and written forms.

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	3	-	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	2	3	3	2	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	3	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	3	**3**	**-**	**-**

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

COURSE CONTENT

Module 1: INTRODUCTION TO C PROGRAMMING (08 Periods)

Introduction to Algorithms and Flowcharts: What is an algorithm, Different ways of stating algorithms, Key features of algorithm, What are variables, Subroutines, Flowcharts, Strategy for designing algorithms, Tracing an algorithm to depict logic, Specification for converting algorithms into programs.

Basis of C Programming: Introduction, Structure of a C program, Concept of a variable, Data types in C, Program statement, Declaration, How does the computer store data in memory, Tokens, Operators and expressions, Expressions revisited, Type conversion in C.

Module 2: INPUT AND OUTPUT, CONTROL STATEMENTS (09 Periods)

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

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.

Module 3: ARRAYS AND STRINGS, FUNCTIONS (10 Periods)

Arrays and Strings: One-dimensional array – Declaration, Initialization, Manipulation; Multi-dimensional arrays – Declaration, Initialization, Manipulation; Strings – Declaration, Initialization, String input/output, Character manipulation, String manipulation; Arrays of strings – Declaration, Initialization, Manipulation.

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, USER-DEFINED DATA TYPES, LINKED LISTS (10 Periods)

Pointers in C: Understanding memory addresses, Address operator (&), Pointer, Arrays and pointers, Pointers and strings, Pointer arithmetic, Pointers to pointers, Array of pointers, Pointers to an array, Two-dimensional arrays and pointers, Dynamic memory allocation.

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

Linked Lists: Single linked lists – Definition, Representation, Operations, Inserting a node, Deleting a node; Applications of linked lists, Disadvantages of linked lists, Array versus linked list revisited.

Module 5: DATA STRUCTURES (08 Periods)

Basic Data Structures: Overview of data structures, Stack – Definition, Array representation, Implementation of stack operations using arrays; Queue - Definition, Array representation, Implementation of queue operations using array.

Searching and Sorting: Linear Search, Binary Search, Bubble sort, Selection sort.

Total Periods: 45

EXPERIENTIAL LEARNING

1. a) Let a and b are two integer variables whose values are 10 and 13 respectively. Write a program to evaluate the following arithmetic expressions.
   i) a + b   ii) a–b   iii) a * b   iv) a/b   v) a % b

   b) Write a program to evaluate the following algebraic expressions after reading necessary values from keyword.
   $(ax + b)/(ax - b)$
   $2.5 \log x + \cos 32^0 + | x^2 + y^2|$
   $x^5 + 10 x^4 + 8$ and $x^3 + 4 x + 2$
   ae^{kt}

2. a) Mr. Gupta deposited Rs.1000 in a bank. The bank gives simple interest at the rate of 15% per annum. Write a program to determine the amount in Mr. Gupta's account at the end of 5 years. (Use the formula I = PTR / 100)

   b) A cashier has currency notes of denominations Rs.10, Rs. 50 and Rs. 100. If the amount to be withdrawn is input in hundreds, find the total number of notes of each denomination the cashier will have to give to the withdrawer.

   c) In a town, the percentage of men is 52. The percentage of total literacy is 48. If total percentage of literate men is 35 of the total population; write a program to find the total number of illiterate men and women if the population of the town is 8000.

3. a) Write a program that prints the given three integers in ascending order using if - else.

   b) Write a program to calculate commission for the input value of sales amount.
   Commission is calculated as per the following rules:
   Commission is NIL for sales amount Rs. 5000.
   Commission is 2% for sales when sales amount is >Rs. 5000 and <= Rs. 10000.
   Commission is 5% for sales amount >Rs. 10000.

   c) If cost price and selling price of an item is input through the keyboard, write a program to determine whether the seller has made profit or incurred loss. Also determine how much profit or loss he incurred in percentage.

4. a) An insurance company calculates premium as follows:
   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 premium is Rs.4 per thousand and the policy amount cannot exceed Rs.2 lakhs.
   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.
   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.
   In all other cases the person is not insured.
   Write a 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.

   b) Write a program, which takes two integer operands and one operator as input from the user, performs the operation and then prints the result. (Consider the operators +, -, *, /, %. Use switch statement)

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

   b) A Fibonacci sequence is defined as follows: The first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence. Write a program to generate the first N terms of the sequence.

6. a) Write a program to find the largest and smallest number in a given list of integers.

   b) Write a program to perform addition of two matrices.

   c) Write a program to determine whether the given string is palindrome or not.

7. a) Write a program using functions to perform the following operations:
   To convert a given decimal number into binary number
   To convert a given binary number into decimal number

   b) Write a program using functions insert a sub-string in main string at a specified position.

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

   b) Write a program to accept the elements of the structure as: Employee-name, Basic pay. Display the same structure along with the DA, CCA and Gross salary for 5 employees.
   Note: DA=51% of Basic pay, CCA=Rs.100 consolidated.

9. A college has N number of students and the following details of all the students are maintained – register number, name, branch, phone number. Write a program to store the details of the students using a singly linked list. Develop functions to perform the following operations on the data.
   Insert new student's details
   Display the details of the students
   Delete a given student's information

10. a) Develop a menu driven program to perform the following operations on a stack of integers (Array implementation of stack with maximum size MAX)
    Push an element
    Pop an element
    Display the status
    Demonstrate overflow and underflow situations

    b) Develop a menu driven program to perform the following operations on a queue of characters (Array implementation of queue with maximum size MAX).
    Insert an element
    Delete an element
    Display the status
    Demonstrate overflow and underflow situations

11. Store register numbers of students who attended placement training program in a random order in an array. Write a function to search whether a student has attended placement training program or not using
    Linear Search
    Binary Search

12. Given marks of N number of students in mathematics subject, write a program to display the marks of students in ascending order using
    Bubble Sort
    Selection Sort

RESOURCES

TEXT BOOKS:

1. Pradip Dey and Manas Ghosh, *Programming in C*, Oxford University Press, 2018.
2. Debasis samanta, *Classic Data Structures*, 2nd Edition, PHI Learning, 2009.

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,* 17th Edition, BPB Publications, 2020.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106/104/106104128/
2. https://nptel.ac.in/courses/106/103/106103069/
3. https://www.digimat.in/nptel/courses/video/106105171/L01.html
4. https://nptel.ac.in/courses/106102064
5. https://nptel.ac.in/courses/106105171
6. https://archive.nptel.ac.in/courses/106/106/106106127/
7. https://www.youtube.com/watch?v=4OGMB4Fhh50
8. https://nptel.ac.in/courses/106105151

WEB RESOURCES:

1. https://www.coursera.org/learn/data-structures
2. https://www.edureka.co/blog/c-data-structures/
3. https://www.coursera.org/specializations/data-structures-algorithms
4. https://www.udemy.com/course/data-structures-and-algorithms-in-c/
5. https://www.udemy.com/course/data-structures-and-algorithms-in-c-for-beginners/
6. http://www.java2s.com/Tutorial/C/0260__Data-Structure/Catalog0260__Data-Structure.htm
7. https://www.programiz.com/dsa

SCHOOLCORE

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 andUnionsand FileHandling.

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 MappingTable:

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**	**-**	**-**	-	**-**	**-**	**-**

CorrelationLevels: 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 andexpressions,LvaluesandRvalues,Type conversion in C.
Input and Output: Basic screen and keyboard I/O in C, Non-formatted input and output,formattedinputandoutput functions.

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

Control Statements: Specifying test condition for selection and iteration, Writing testexpression, Conditional execution and selection, Iteration and repetitive execution, go to statement, Special control statements, Nested loops.
Introduction to Problem Solving: Algorithms, Flowcharts, Problem solving aspect, Top-downdesign, Implementation of algorithms, program verification and efficiencyof 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 with2D arrays; Strings – Declaration, Initialization, Printing strings, String input, Charactermanipulation, String manipulation; Arrays of strings – Initialization, manipulating stringarrays.
Functions: Concept of function, Using functions, Call by value mechanism, working withfunctions, 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 Nullpointers, 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, type def and its use, Arrays of structures, Arrays within structure, Structures and pointers,Structuresandfunctions;Unions,Enumerationtypes, 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

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 tofind the total number of illiterate men and women if the population of the town is7000.

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). WriteC program to find the distance travelled at regular intervals of time given the valuesof *u* and *a*. The program should provide the flexibility to the user to select his owntimeintervalsandrepeat thecalculationsfor differentvalues of*u* and a.

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

Consumptionunits	**Rate(inRupees/unit)**
0-100	4.0
101-150	4.6
151-200	5.2
201-300	6.3
Above300	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. Ifaperson'shealthisexcellentandthepersonisbetween25and35yearsofageand lives in a city, and is a male then the premium is Rs.4 per thousand and thepolicyamount cannotexceed Rs.2lakhs.

ii. If a person satisfies all the above conditions and is female then the premium isRs.3perthousandandthepolicyamountcannotexceedRs.1lakh.

iii. If a person's health is poor and the person is between 25 and 35 years of ageand lives in a village and is a male then premium is Rs.6 per thousand and thepolicycannotexceed Rs.10000.

iv. Inall othercasesthepersonisnotinsured.

WriteaCprogramtodeterminewhetherthepersonshouldbeinsuredornot,his/herpremiumrate andmaximumamountforwhichhe/she canbeinsured.

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

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

4 a) AFibonacci sequence is defined as follows:

The first and second terms in the sequence are 0 and 1. Sub-sequent termsare found by adding the preceding two terms in the sequence. Write a C program togeneratethefirst*n*terms ofthe 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: $1+x+x^2+x^3+\ldots+x^n$. 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 avalue 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 large stand 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 into 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. Afunctiontostore10 employeedetails.
ii. A function to implement the following rules while revising the basic pay.IfBasic-pay<=Rs.5000thenincreaseit by15%. IfBasic-pay>Rs.5000and<=Rs.25000then itincreaseby10%.IfBasic-pay>Rs.25000 then thereis no changeinBasic-pay.
iii. Afunctiontoprintthedetailsofemployeeswhohavecompleted20yearsofservicefrom 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

TEXTBOOKS:

1. Pradip Dey and Manas Ghosh, *Programming in C*, Oxford University Press, New Delhi, 2nd Edition, 2013.
2. R.G.Dromey, How to Solve it by Computer, Pearson Education, 1st Edition, 2013.

REFERENCE BOOKS:

1. Byron S Gott fried and Jitender Kumar Chhabra, *Programming with C*, McGraw Hill Education, 4thEdition, 2019.
2. YashavantKanetkar,*Let UsC*,BPBPublications,15thEdition,2017.
3. E. Balagurusamy,*ProgramminginC*,McGrawHillEducationPvt, Ltd, NewDelhi, 7thEdition, 2017.
4. BehrouzA.ForouzanandRichardF.Gilberg,*ComputerScience:AStructuredProgrammingApproachUsing C*,CengageLearning, 3rdEdition,2008.

SOFTWARE/TOOLS:

Software:TurboC++/DevC++

VIDEO LECTURES:

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

WEB RESOURCES:

1. LearnCProgramming-https://www.programiz.com/c-programming
2. LearnCProgramming-https://www.tutorialspoint.com/cprogramming/index.htm
3. CProgrammingExercises,Practice,Solution-https://www.w3resource.com/c-programming-exercises/
4. BasicprogrammingexercisesandsolutionsinC-https://codeforwin.org/2015/05/basic-programming-practice-problems.html
5. CProgrammingExercises,Practice,Solution-https://www.w3resource.com/c-programming-exercises/
6. BasicprogrammingexercisesandsolutionsinC-https://codeforwin.org/2015/05/basic-programming-practice-problems.html

SCHOOL CORE

Course Code	**Course Title**	**L**	**T**	**P**	**S**	**C**
22ME105002	**ENGINEERING WORKSHOP**	-	-	2	-	1

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Knowledge on various workshop hand and power tools; hands on experience in different manufacturing trades such as fitting, carpentry, sheet metal forming and foundry; Demonstration on dismantling and assembling of various two wheeler parts, power tools in machining and metal joining, basics of plumbing and working of 3D printer.

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

CO1. Design and model various basic prototypes in the trade of fitting such as square/half round mating, V- mating and dovetail mating from the given MS workpieces using fitting tools.

CO2. Develop different prototypes in the carpentry trade such as cross lap joint, dovetail / bridle joints and Mortise and Tenon joint using carpentry tools.

CO3. Design and model different prototypes in the sheet metal forming trade such as rectangular tray, square vessel/cylinder, Funnel as per the dimensions using sheet metal forming tools.

CO4. Develop sand mold using single piece pattern and split piece pattern in the foundry trade using foundry tools.

CO5. lop electric circuits for series and stair case connections.

CO6. Demonstrate the knowledge on power tools, plumbing operation, 3D printing technology involved in different engineering applications.

CO7. independently or in teams to solve problems with effective communication

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	-	1	-	-	-	-	-	-	3	-	-
CO2	3	3	3	1	-	1	-	-	-	-	-	-	3	-	-
CO3	3	3	3	1	-	1	-	-	-	-	-	-	3	-	-
CO4	3	3	3	1	-	1	-	-	-	-	-	-	3	-	-
CO5	3	3	3	1	-	1	-	-	-	-	-	-	3	-	-
CO6	3	1	1	1	1	1	-	-	-	-	-	-	3	-	-
CO7	-	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**1**	**1**	**1**	-	-	**3**	**3**	-	-	**3**	-	-

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

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. **FITTING:** Conduct a detailed study on various aspects in fitting trade which includes the details of fitting operations, safety precautions, types of tools, tool holders, miscellaneous tools, care and maintenance of hand tools, marking and measurement tool, and finishing tool.

   Exercises :

   Make a square/half round mating from the given MS workpieces

   Make a V- mating from the given MS workpieces

2. **CARPENTRY:** Conduct a detailed study on various aspects in carpentry trade which includes the details of types of wood, carpentry tools, wood working techniques, types of joints, safety precautions, and care and maintenance of tools.

   Exercises:

   Prepare a cross lap joint

   Prepare dovetail / bridle joints

3. **SHEET METAL FORMING:** Conduct a detailed study on various aspects in sheet metal forming which includes the details of sheet materials, hand tools, sheet metal fabrication, and safety and precautions

   Exercises:

   Fabricate a rectangular tray as per the dimensions

   Fabricate square vessel/cylinder as per the dimensions

4. **FOUNDRY:** Conduct a detailed study on various aspects in foundry which includes the details of moulding sand, properties of moulding sand, types of patterns and pattern, materials, foundry tools, and safety and precautions
   Exercises:
   Prepare a sand mold, using the given single piece pattern (stepped pulley/cube)
   Prepare a sand mold, using the given split piece pattern (pipe bent/dumbbell)

5. **ELECTRICAL WIRING:** Prepare electrical wiring with associated devices such as switches, distribution boards, sockets, and light fittings in a structure considering safety standards for design and installation.
   Exercises:
   Prepare electrical circuits with Series.
   Prepare electrical circuits with Stair case connections.

6. **DEMONSTRATION:**
   Demonstrate the usage of power tools.
   Demonstrate the plumbing operation and identify the essential tool and materials required for plumbing.
   Demonstrate the working of 3D printer

RESOURCES

REFERENCES:

1. P. Kannaiah and K. L. Narayana, *Workshop Manual*, SciTech Publishers, 2009.
2. K. Venkata Reddy, *Workshop Practice Manual*, BS Publications, 2008.
3. V. Ramesh Babu, *Engineering Workshop Practice*, V R B Publishers Private Limited, 2009.

ADDITIONAL LEARNING RESOURCES:

1. R. K. Jain, *Production Technology*, Khanna Publishers, 17th edition, 2012.
2. Kalpakjian, Serope, *Manufacturing Engineering and Technology*, Pearson Education, 7th edition, 2014.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=ZyN9Tw9VTSo
2. https://www.youtube.com/watch?v=A9m_3onoVV8
3. https://www.youtube.com/watch?v=PkjpmPLNKZs
4. https://www.youtube.com/watch?v=IDajw2S78zg

WEB RESOURCES:

1. https://www.jiit.ac.in/sites/default/files/Workshop_Lab.pdf
2. https://mechanicalenotes.com/engineering-workshop/
3. https://www.studocu.com/in/document/indian-institute-of-technology-guwahati/engineering-mechanics/engineering-workshop/8571486
4. https://lecturenotes.in/download/note/25089-note-for-engineering-workshop-ew-by-technical-genius

SCHOOL CORE

Course Code	**Course Title**	**L**	**T**	**P**	**S**	**C**
22ME105001	**COMPUTER AIDED ENGINEERING DRAWING**	-	1	4	-	3

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) lines (1D) and planes (2D) (inclined to both planes of projection) located in first quadrants
CO3. 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)
CO4. Develop lateral surfaces of solids of given objects for engineering communication using principles of engineering drawing and CAD tools.
CO5. Understand 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												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	3	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-	-	3	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**-**	**-**

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

COURSE CONTENT

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

Introduction to Engineering graphics: Principles, significance -Conventions in drawing-lettering - BIS conventions-Dimensioning principles and conventional representations – Lettering and dimensioning - Scales: Representative Fraction, Type of Scale, Plain and Diagonal Scale, Scale of chords.

Exercises:

1. Practice exercise on Basic Lettering Practice, Dimensioning Practice,
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:

1. Practice exercise with basic drawing commands
2. Practice exercise with editing commands

Module 2: CONICS, CURVES, PROJECTION OF POINTS, LINES AND PLANES (06 Periods)

Conics & Special Curves: (a) Conic sections: Construction of ellipse, parabola and hyperbola including the rectangular hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle. Drawing of tangents and normal to the above curves.

Exercises:

1. Practice exercises on Ellipse, Parabola, Hyperbola and Rectangular Hyperbola
2. Practice exercises on Cycloid, epicycloids, hypocycloid and Involutes
3. Practice exercises on Projection of points in 3rd angle projections

Projection of points, lines and planes: Projection of points in any quadrant, lines inclined to one or both planes, Traces, finding true lengths, angle made by line. Projections of regular plane surfaces and inclined to both the principal planes by rotating object method.

Exercises:

1. Practice exercises on Projection of points
2. Practice exercises on lines inclined to one plane
3. Practice exercises on lines inclined to both planes
4. Practice exercises on Projections of regular plane surfaces
5. Practice exercises on Projection of polygonal plane surfaces
6. Practice exercises on Projection of circular plane surfaces
7. Practice exercises on Projection of polygonal plane surfaces inclined to both principal planes
8. Practice exercises on Projection of circular plane surfaces inclined to both principal planes

Module 3: PROJECTION OF SOLIDS AND SECTION OF SOLIDS (8 Periods)

Projection of solids: Projection of regular solids in simple position, Projection of solids with axes inclined to one of the reference planes and parallel to the other, Projections of solids with axes inclined to both H.P. and the V.P.

Sections of solids: Section planes and sectional view of right regular solids- prism, cylinder, pyramid and cone, True shapes of the sections. Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

Exercises:

1. Practice exercises on Projections of regular solids
2. Practice exercises on Sections of solids
3. Practice exercises on Projection of pentagonal pyramids
4. Practice exercises on Projection of Hexagonal pyramids
5. Practice exercises on Projection of pentagonal pyramids inclined to both principal planes
6. Practice exercises on Projection of Hexagonal pyramids inclined to both principal planes
7. Practice exercises on Projection of pentagonal prism
8. Practice exercises on Projection of Hexagonal prism
9. Practice exercises on Projection of pentagonal prism inclined to both principal planes
10. Practice exercises on Projection of Hexagonal prism inclined to both principal planes

Module 4: DEVELOPMENT OF SURFACES (6 Periods)

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

Exercises:

1. Practice exercises on Development of surfaces of right regular solids
2. Practice exercises on Development of surfaces of pentagonal pyramids
3. Practice exercises on Development of surfaces of hexagonal pyramids
4. Practice exercises on Development of surfaces of pentagonal prism
5. Practice exercises on Development of surfaces of hexagonal prism

Module 5: ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS (10 Periods)

Orthographic Projections: Systems of projections, conventions and application to orthographic projections. Projections of regular plane surfaces-triangle, square, rectangle, pentagon, hexagon and circle-in simple positions inclined to both the planes; planes in different positions by change of position method only.

Isometric Projections: Principles of isometric projection- of simple solids and truncated solids – Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Isometric scale; Isometric views: lines, planes, simple solids.

Exercises:

1. Practice exercises on Orthographic Projections
2. Practice exercises on Isometric Projections

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.
3. T.Jeyapoovan, *Engineering Drawing and Graphics Using AutoCAD*, Vikas Publishing House, 3rd Edition, 2010.
4. Jolhe, *Engineering Drawing*, Tata McGraw Hill Education Private Limited, 1st Edition, 2007.
5. Basant Aggarwal, *Engineering Drawing*, Tata McGraw Hill Education Private Limited, 1st Edition, 2008

VIDEO LECTURES:

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

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22ME111002	TECHNOLOGY EXTENSION FOR SOCIETAL PROBLEMS	-	-	-	4	1

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed project based learning on identification of real world mechanical engineering and allied societal problems and leveraging technology extension to solve them through innovative solutions. Majorly, this emphasizes on 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 mechanical engineering systems or processes to solve complex mechanical 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 mechanical engineering and allied problems.

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

CO-PO-PSO Mapping Table:

Course Outcome	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	-	-	-	3	3	3	3
CO2	-	-	-	-	-	-	3	-	-	-	3	-	3	3	3
CO3	-	-	-	-	-	-	-	-	3	3	-	-	3	3	3
Course Correlation Mapping	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Correlation Levels: **3– High** **2 - Medium** **1– Low**

COURSE CONTENT

1. Identification of real world mechanical engineering and allied societal problems.
2. Field visits can be arranged by the faculty concerned
3. 6 – 10 students can form a team (within the same discipline)
4. Minimum of four hours per week on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified problem
6. Solution should be in the form of fabrication/coding/modeling/product design/process design/formulation of relevant scientific methodology(ies)
7. Public fund raising for implementation of the designed solution
8. Develop a strategy for implementation
9. Mobilization of necessary human resources and material
10. Implementation of the designed solution
11. Verification of the implemented solution
12. Consolidated report to be submitted for assessment
13. Participation, involvement and contribution in group discussions during the week with faculty concerned will be used as the modalities for the continuous assessment of the course.
14. Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility.
15. Contribution of each group member to be assessed

Total Periods: 45

PROJECT BASED LEARNING

Projects relevant to the course will be provided by the course instructor at the beginning.

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

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 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:

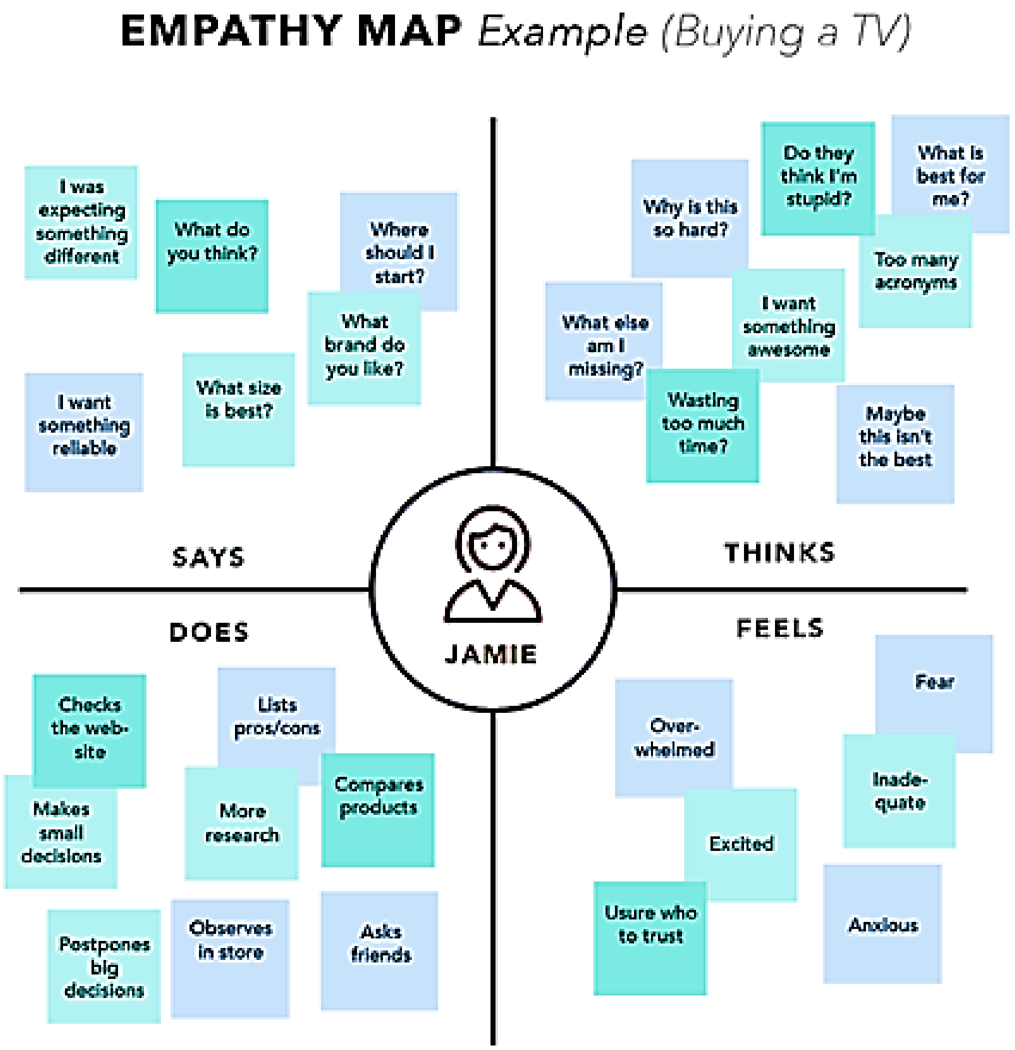
Introduction to Design Thinking – Design thinking Process, Definition, Importance, Phases of Design Thinking, Canva Tool.

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.

1. 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).
2. Create an Empathy Map using Coggle design thinking tool.

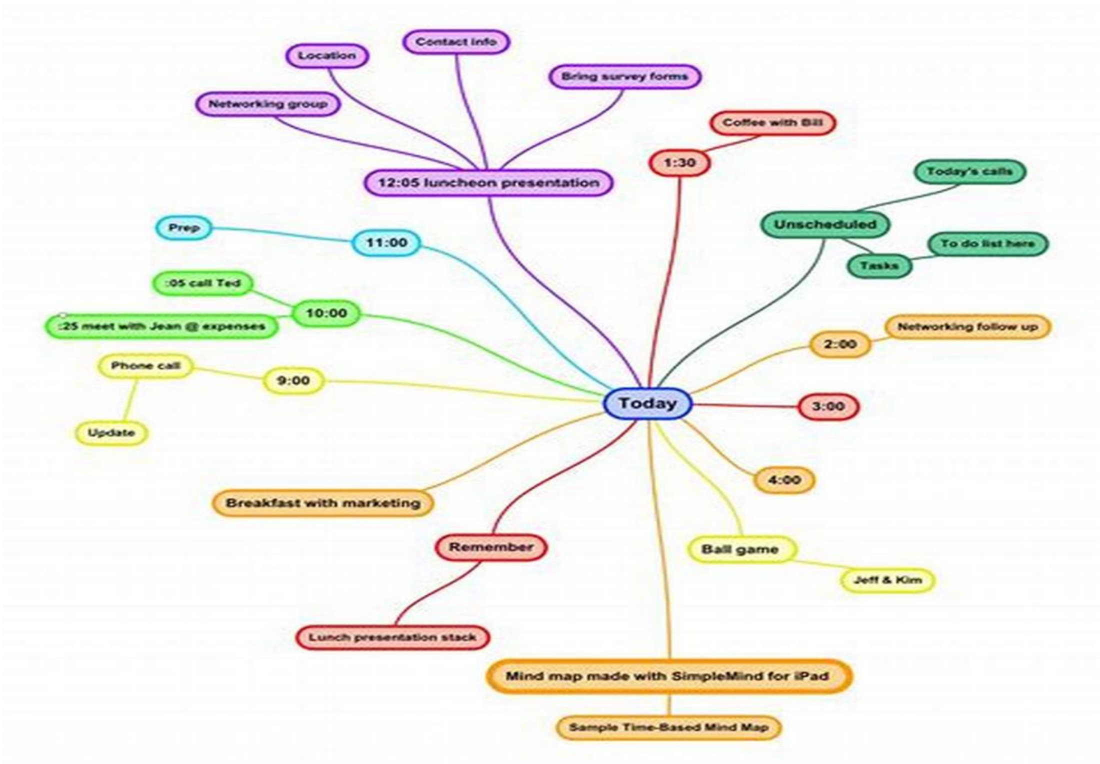
   Sample Empathy Map:



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

1. 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.
2. Create Mind Map for your problem statement using Coggle.

   Sample Mind Map:



3. 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.

1. Create an application prototype for product recommendation using **Marvel POP Software**.
2. Create a **low-fidelity paper prototype** by sketching out the product design and adding relevant functionality.
3. 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 Mc Graw Hill, First 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/

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
22ME111001	**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‟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 this course, the 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 the 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 Outcome	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	3	3
CO2	-	3	-	-	-	3	3	-	-	-	3	-	3	3	3
CO3	-	-	-	-	-	-	-	-	3	3	-	-	3	3	3
Course Correlation Mapping	**3**	**3**	**-**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Correlation Levels: **3– High** **2 - Medium** **1– Low**

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22ME108001	**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 this course, the students will be able to:

CO1. Create/Design mechanical engineering systems or processes to solve complex mechanical 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 mechanical engineering and allied problems.

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

CO-PO-PSO Mapping Table :

Course Outcome	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	-	-	-	3	3	3	3
CO2	-	-	-	-	-	-	3	-	-	-	3	-	3	3	3
CO3	-	-	-	-	-	-	-	-	3	3	-	-	3	3	3
Course Correlation Mapping	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

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. Analyzethe rules of English grammar in speaking and writing.

CO3. Demonstrate knowledge of English pronunciationin 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

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. *Quicksteps 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
22LG102402	**EMPOWERING YOUR ENGLISH**	2	-	2	-	3

Pre-Requisite -

Anti-Requisite English for Professionals

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. Develop skills and techniques to speak and write with cohesion.

CO2. Understand the usage of English grammar in speaking and writing.

CO3. Demonstrate knowledge of right pronunciationin speaking.

CO4. Apply the knowledge to build vocabulary in communication.

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

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: A TIME TO REMEMBER (06 Periods)

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

Module 2: TIME FOR CHANGE (05 Periods)

Reading for comprehension, Degrees of Comparison, Vocabulary, Listening.

Module 3: ULTRA MARATHON (05 Periods)

Reading comprehension, Listening, Vocabulary of sports, Pronunciation, speaking – Talk about favourite sport.

Module 4: HOTEL RESERVATIONS AND EXPENSES (08 Periods)

Hotel Reservations:

Reading comprehension – reading reviews, Speaking – calling to check into a hotel, make enquiries, framing questions, Grammar, Writing – writing reviews, Pronunciation.

Expenses:

Reading comprehension- analysing data, Vocabulary, Listening, Grammar - Tenses, Writing – writing a report. Speaking – Talk about making daily budget.

Module 5: BODY LANGUAGE (06 Periods)

Reading comprehension, Vocabulary, Listening, Grammar, Speaking – Talking about importance of body language, giving mini presentations.

Total Periods: 30

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/ Tone/ Intonation
7. Grammar
8. Email Writing

PART-B

Any four modules among the following:

1. Identifying induvial strengths and weaknesses raises self-awareness. Do a SWOT analysis and come up with an action plan to present in the classroom.
2. Prepare a sales pitch of your dream product/ app and explain USP.
3. "Gen -Z is a difficult generation". Do you agree with this statement? Tell why and how different Gen Z is.
4. Write an email to your Teacher of English explaining how a construction site near by is creating a hindrance to your learning.
5. Prepare a poster on the effects of social media on youth.
6. Give a short talk on the advantages and disadvantages of social media.
7. What are your thoughts on Mission Mars? Why do you think nations are investing heavily on this? Debate
8. Explain the downside of the development of current era.
9. Skills, Experience and education – which of these play an important role in life and why? Present your views
10. Talk about a time when you tried a weird / Awesome food. Describe your experience
11. Write an article on your experience of education. What are your recommendations to improve the system?

RESOURCES

TEXTBOOK:

Jack C Richards, "*Interchange Fourth Edition*", 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. *Quicksteps 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, 2003.

10. N.P. Sudharshanaand C.Savitha, *English for Technical Communication*, Cambridge University Press. 2016

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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. Analyzevarious 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

EXPERIENTIAL LEARNING

Any ten modules are mandatory among the following:

COURSE CONTENT:

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, Tele conferencing, Video conferencing, 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

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

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 (06 Periods)
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

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

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 $\rho = kxyz$.

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. Course instructor may change the activities and the same shall be reflected in 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 (MVC)
2. https://nptel.ac.in/courses/111106100 (ODE)
3. https://nptel.ac.in/courses/111103021 (PDE)

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
22MM102404	**TRANSFORMATION TECHNIQUES AND LINEAR ALGEBRA**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite

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:

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%20Applications.pdf

SCHOOL CORE

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

Pre-Requisite -

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 functionsand 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

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 $\rho = kxyz$.
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. . P. Bali and Manish Goyal, *A text book of Engineering Mathematics*, Laxmi ublications, 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

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?

RESOURCES

TEXT BOOKS:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44/e, 2019.
2. Introductory Methods of Numerical Analysis: S.S. Sastry, 5^{th} Edition, Prentice Hall of India, 2012.
3. Miller and Freund's Probability and Statistics for Engineers: Richard A Johnson, 8^{th} Edition,Prentice Hall of India, 2011.

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 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, 11th 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 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-pnjunction
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

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*, DhanpatRai 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

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, 11th edition, 2019.
2. S. S. Bhavikatti and K. G. Rajashekarappa, *Engineering Mechanics*, New Age International Publishers, 2nd 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*, 6th 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*, 9th 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
22EE105405	**MATLAB PRACTICE FOR ENGINEERS**	-	-	2	-	1

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course is emphasized on the fundamental concepts of MATLAB, visualization by interacting with MATLAB, advanced programming concepts decisions, loops and their control, debugging methods and applications of MATLAB for fundamental data analysis. The course also provides an overview of MATLAB integrated SIMULINK tool box and its application.

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

CO1. Develop syntax for creating vectors, matrices and perform operations on the arrays using MATLAB.

CO2. Create script and function m-files for developing MATLAB programs and syntax for visualizing the plots.

CO3. Develop syntax for advanced programming concepts such as decision and iterative programs, and tools for debugging and data analysis.

CO4. Apply the programming sills of MATLAB for solving engineering problems.

CO5. Develop Simulink models for modelling real world systems and understand their simulation in the SIMULINK environment.

CO6. 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	-	3	-	-	-	-	-	-	2
CO2	3	2	2	-	3	-	-	-	-	-	-	2
CO3	3	2	2	-	3	1	-	-	-	-	-	2
CO4	3	1	2	-	3	1	-	-	-	-	-	2
CO5	3	1	2	-	3	1	-	-	-	-	-	2
CO6	-	-	-	-	-	-	-	-	3	3	-	-
Course Correlation Mapping	**3**	**2**	**2**	**-**	**3**	**1**	**-**	**-**	**3**	**3**	**-**	**2**

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

EXPERIENTIAL LEARNING

Perform a minimum of two exercises from each section.

1. Salient features, The MATLAB Environment; MATLAB Basics – Variables, Rules for Naming of Variables; Numbers, formats; Input and output.

   Exercise: Perform all of the following.

   i. Defining variables in MATLAB.
   ii. Swapping of variables.
   iii. Special variable in MATLAB.
   iv. Input and output formats on the command window.

2. Matrices and Vectors: Creating, Indexing, Extracting, Manipulation.

   Exercise: *Perform all of the following.*

   i. Methods of generating vectors using linspace and colon operator.
   ii. Create a vector spanning the range from 0 to 2π , containing 100 equally spaced components, so that the first value is 0, and the last value is 2π .
   iii. Create a vector that goes at equal steps from −2 to +2 with an increment of 0.01.
   iv. Create the matrices with the help of the matrix generation functions:zeros, eye, and ones.
   v. Creating Matrices of different size and access the data form matrix, manipulate the matrix elements.

3. Operations: Operators, Arithmetic Operations; Elementary math functions.

   Exercise: *Perform all of the following.*

   i. Create two matrix of order 3x3 and perform the addition, subtraction, multiplication on the matrices on the command window.
   ii. Find the inverse, determinant and transpose of the matrix using math functions.
   iii. Perform dot operator on the matrix/vector elements.

4. Relational operations, Logical operations.

   Exercise: *Perform all of the following.*

   Create a matrix of size 10x10 and idenify the elements of the matrix based on the following criteria.

<	All the elements whose value is less than a specified number
<=	All the elements whose value is less than or equal to a specified number
>	All the elements whose value is greater than a specified number
>=	All the elements whose value is greater than or equal to a specified number
==	All the elements whose value is equal to a specified number
~=	All the elements whose value not equal to a specified number
&	*And operator*: elements between two specified limits.
|	*Or operator*: elements satisfying either of two criteria.

5. The Current Directory and Search Path; M-Files:Basic rules and anatomy of Script and Function M-Files, Creating, Saving and Executing Script and Function M-Files.

   Exercise: *Perform any two of the following (One script file and one function file).*

   i. Create a script file and write the program for addition, subtraction, multiplication and division of the numbers/Matrices and display them using formatted print.
   ii. Crate a script file and write a program to evaluate the following $\pi r^2; x^2 + 2x - 3; \sin(2t)$ by taking the input from the key board interactively.

iii. Develop a function file to take a vector as an input argument and return minimum and maximum numbers as an output arguments.

iv. Develop a function file to take a temperature in degrees as an input argument and return it in Fahrenheit as an output argument.

6. Basic 2-D Plots: Graphing with plot—Labels, title, legend, and other text objects, Modifying plots with the plot editor; Subplot for Multiple Graphs; 3-D Plots: Mesh and surface plots.

Exercise: *Perform all of the following.*

i. A simple sine plot: Plot $y = \sin(2x)\ 0 \le x \le 2\pi$, taking 100 linearly spaced points in the given interval. Label the axes and put title, xlabel, ylabel, grid, line options and legend on the plot.

ii. Write a script file to plot overlay plots on a same figure window and apply the plotting options on the graph.

iii. Write a script file to create multiple plots using subplot function and apply the plotting option on the graph.

iv. Write a script file to create 3-D plot and apply the plotting option on the graph.

7. **Data analysis functions**: isinteger, islogical, isnumeric, length, min, max, size, sort, sum, mean, std, corrcoef, roots, polyval, polyfit functions.

Exercise: *Perform all of the following.*

Write a script files to validate the applications of various data analysis functions mentioned.

8. **Conditional Statements**: if, if else, elseif and nested if conditions, switch.

Exercise: *Perform all of the following.*

i. Write a MATLAB if statement to calculate y where y = 1 if x > pi/2, y = sin(x) if x is in [0, pi/2] and y = 0 otherwise, by taking the input for x from the keyboard.

ii. Write a script file to validate if else and elseif syntax for decision making.

iii. Write a script file to apply switch and perform various tasks based on the switch input.

9. **Loops Structures**: *For* loop, *While* loop; Loop controls: *break*, *continue;* nested loops;

Errors and Debugging: Syntax errors, Errors in logic, Numerical Errors, Rounding error.

Exercise: *one exercise using for loop, one using While loop and one on loop control programs.*

i. Create a matrix A of size m × n, whose elements a(i, j) are calculated from the row and column indices as follows: $a(i,j) = (j-4)^2(i+1) + ij$

ii. Create a random matrix of order 10x10 and replace the upper triangle elements by the number 5, the lower triangle numbers by 4 and the diagonal elements by 1.

iii. Find and display all integers between 1 and 10000 which divide by 37.

iv. Write a program to terminate the iterations if the error is less than the specified tolerance limit.

v. Write a script to find the sum of n natural numbers, sum of squares of n natural numbers, sum of cubes of n natural numbers or a series.

vi. Write a script file to determine the number of terms required for the sum of the series 5*k*2 − 2*k*, *k* = 1, 2, 3, … , to exceed 10,000. What is the sum for this many terms?

vii. Determine how long it will take to accumulate at least $10,000 in a bank account if you deposit $500 initially and $500 at the end of each year, if the account pays 5 percent annual interest.

i. Write a program to exit the loop and to skip the loop base on the criteria mentioned.

10. Applications of MATLAB: introduction to images and types, two dimensional signals and gradient method of solving the linear equations and linear regression.

    Exercise: *one on image/signal processing and one on numerical techniques.*

    i. Load a JPEG image and plot the histograms of the red, green and blue planes of the image. Note; the histograms should appear on one figure.
    ii. Load an audio signal and plot the spectral information of the signal.
    iii. Solution to differential equations using *dsolve*function; integration using *int* function.
    iv. Gradient method of solving linear equations.
    v. Develop a linear regression line based on least square errors for fitting the given data and perform interpolation/extrapolation on the data set.

11. Basics of SIMULINK; Operating Principle And Management of Simulink: Constructing a Simulink Block Diagram, Parametrizing Simulink Blocks, Simulink Simulation; Solving Differential Equations with Simulink; Simplification of Simulink Systems: Construction of Subsystems.

    Exercise: *any one exercise.*

    i. A certain model of the motion light plastic ball tossed into the air is given by $mx'' + cx' + mg = 0;\ x'(0) = v_0 \ and\ x(0) = 0$ Here m is the mass of the ball, *g=9.8 m/s*^{2} is the acceleration due to gravity and *c* is a measure of the damping.
        a. Model this problem using Simulink.
        b. Determine how long it takes for the ball to reach it's maximum height?
        c. Assume that *c/m* = *5* s^{-1}. For v_0 = 5, 10, 15 and 20 m/s, plot the solution, x(t), versus the time.
        d. From your plots determine the rise time. Do these answers agree?
        e. What can you say about the time it takes for the ball to fall as compared to the rise time?

    ii. Develop a Simulink model to simulate the aircraft dynamics modelled as a transfer function $G(s) = \dfrac{964}{976s2 + 11.25s + 1}$ and the sensor for feedback as $H(s) = \dfrac{1}{0.01s + 1}$. Control the dynamics using an optimal PID controller to improve the dynamics. Investigate various time domain specifications before and after the use of PID controller.

12. Introduction to toolboxes

    Exercise: *Demonstrate any one toolbox.*

    i. Demonstration of *genetic algorithm* toolbox and its application to solve a test problem.
    ii. Demonstration of *fuzzy logic* toolbox and its application to solve a test problem.
    iii. Demonstration of *Neural Networks* toolbox and its application to solve a test problem.

TEXT BOOKS:

1. Chapman, Stephen J. *MATLAB programming for engineers*. Cengage Learning, 2015.
2. Pratap, Rudra. *Getting Started with MATLAB 5-A Quick Introduction for Scientists and Engineers*. 1998.

REFERENCE BOOKS:

1. Otto, Stephen Robert, and James P. Denier. *An introduction to programming and numerical methods in MATLAB*. Vol. 1. London: Springer, 2005.
2. Hunt, Brian R., Ronald L. Lipsman, and Jonathan M. Rosenberg. *A guide to MATLAB: for beginners and experienced users*. Cambridge university press, 2014.
3. McMahon, David. *MATLAB demystified*. New York, NY: McGraw-Hill, 2007.
4. Beucher, Ottmar, and Michael Weeks. *Introduction to MATLAB & SIMULINK (A Project Approach)*. Laxmi Publications, Ltd., 2008.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=qGiKv3-02vw
2. https://www.youtube.com/watch?v=EtUCgn3T9eE
3. https://www.youtube.com/watch?v=1PSFLKiEV7U
4. https://www.youtube.com/watch?v=pFICO_syIIs

WEB RESOURCES:

1. https://matlabacademy.mathworks.com/
2. http://jeti.uni-freiburg.de/vorles_stat_num/getstart.pdf
3. https://www.geeksforgeeks.org/variable-names-in-matlab/
4. https://www.educba.com/loops-in-matlab/
5. https://uomustansiriyah.edu.iq/media/lectures/6/6_2020_05_02!10_51_42_AM.pdf
6. https://www.tutorialspoint.com/matlab/matlab_plotting.htm
7. https://www.fsd.ed.tum.de/wp-content/uploads/Training_TUM_GS_Simulink_14b.pdf
8. https://eelabs.faculty.unlv.edu/docs/guides/Simulink_Basics_Tutorial.pdf
9. https://www.cs.uic.edu/~jbell/CourseNotes/Matlab/Functions.html
10. https://www.cs.uic.edu/~jbell/CourseNotes/Matlab/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22CS105401	**PYTHON PROGRAMMING FOR ENGINEERS**	-	-	2	-	1

Pre-Requisite -

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 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	3	3	3	3	-	-	-	-	-	-	-
CO4	3	2	2	2	3	-	-	-	-	-	-	-
CO5	3	3	3	3	3	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	3	3	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**-**	**-**	**-**

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

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 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.
   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) 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.

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.

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) 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.

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) 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.
Design a driver code to call the function using positional arguments, keyword arguments

Apply the necessary changes in Learner_Age_Days function, and design a driver code to call the function using default arguments.

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) 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.

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) 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_Infowhich has data members height and weight and member functions getdata() and display(). Display all the information using object of derived class.
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) 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.

The variable num has the data 100, the value of num dividing by the value 0.

To importing a library file matheqn, this library file not available in Python.

A num_List has the values[10,20,30].To print the fifth value of num_List[5]

A dictionary has the data, Dict_Univ = {'1':"MBU", '2':"Tirupathi", '3':"CSE"}. to print the fifth key value Dict_Univ[5]

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/

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

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 adjustment

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

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:

CongerJ, *Inspiring others: Th e language of leadership,* Academy of Management Executive, 5(1), 31-45, 1991

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. Interpretthescopeoforganizationalbehavioranditssignificance.

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

CO3. Demonstratetheimpactofmotivationandleadershipingroupdynamics.

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- Individualroles andorganizationalgoals–perspectivesofhumanbehavior- Perception– perceptualprocess

Module 2: LEARNING (06 Periods)

Learning - Learning Process- Theories- (Pavlov, Skinner and Thorndike) - Personality andIndividualDifferences -Determinants of Personality-Values, Attitudesand Beliefs.

Module 3: MOTIVATION AND LEADERSHIP (06 Periods)

Definition andnature of motivation, Theories of Motivation(Maslow,Alderfer)-Leadership–Traits-Styles–Leadershipskills–Challengestoleaders.

Module 4: ORGANIZATIONAL CONFLICTS (06 Periods)

Causesandconsequences-conflictandNegotiationTeamBuilding,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 tochange–Organizational development and OD interventions.

Total Periods:30

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),OrganizationalBehaviour,PearsonEducation,NewDelhi.
2. LuthansFred(1998),OrganizationalBehaviour, Tata McGraw Hill International Edition, NewDelhi
3. K.Aswathappa "Organizational Behaviour-Text, Cases and Games", Himalaya Publishing House, New Delhi, 2008.

REFERENCE BOOKS:

1. Steven LMc Shane, Mary Ann Von Glinow, Radha R Sharma: "Organizational Behaviour", TMH Education, New Delhi, 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

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

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

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**	**3**	**2**	**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

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. The course instructor may change the activities and the same 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

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. The course instructor may change the activities and the same 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 ondisasters, 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

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.

RESOURCES

TEXT BOOKS:

1. Sharma V. K., *Disaster Management, Medtech Publishing*, 2nd Edition, 2013.
2. 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 Hazardsand 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:

Thiscourse provides a detailed discussion ontechnology 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

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 the same shall be reflected in 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 -

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**	**-**	**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 (06 Periods)

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

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?

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, Entrepreneurship.

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

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

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 Outcome	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 Level	**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

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 Outcome	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 Level	**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*

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)

RESOURCES

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
22ME101001	**BASIC ENGINEERING MECHANICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSEDESCRIPTION:

This course provides the fundamental concepts of different force systems and equilibrium of force systems, effect of friction, centroid, centre of gravity, moment of inertia of composite areas and bodies, basics of kinetics and mechanical vibrations.

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

CO1. Analyze the equilibrium of concurrent forces in static particles.

CO2. Analyze the equilibrium of non-concurrent forces in static rigid bodies.

CO3. Analyze the effect of friction by applying the principles of Engineering Mechanics.

CO4. Analyze composite areas and bodies to find centroid, Centre of gravity and moment of inertia.

CO5. Apply D'Alembert's Principle, basic principles of Simple Harmonic Motion and vibrations to solve problems in mechanical systems.

CO-PO-PSO MappingTable:

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	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	-	**-**	-	-	**3**	-	-

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSECONTENT

Module 1: EQUILIBRIUM OF SYSTEM OF COPLANAR CONCURRENT FORCES (09 Periods)

Basic concepts, System of units, System of concurrent coplanar forces in plane, principleof transmissibility, Laws of mechanics, Resultant of forces, Parallelogram and triangular law of forces, Equilibrium of forces, Lami's theorem, Equilibrium of bodies, Equilibrium ofconnected bodies, Vectoria representation of forces, Vector operations of forces–addition,subtraction,dot product, cross product of vectors.

Module 2: EQUILIBRIUM OF SYSTEM OF COPLANAR NON-CONCURRENTFORCES (09 Periods)

Moment of a force, Varignon's theorem, Moment of a couple, Vectorial representation of moments and couples, Coplanarnon-concurrent forces, Resultant, Equilibrium of coplanar non-concurrent force system, Types of supports and loads,Types of frames, Perfect frame analysis, Method of joints, Method of sections.

Module 3: FRICTION (09 Periods)

Frictional force, Types of friction, Laws of friction, Co-efficient of friction, Angle of friction, Angle of repose, Cone of friction, Applications: Body on horizontal/inclined plane, Two bodies in contact, Ladder friction, Wedge friction.

Module 4: CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA (09 Periods)

Centroids of simple and composite areas, centre of gravity of bodies,Theorems of Pappusand Guldinus, Parallel axis and perpendicular axis theorems, Moment of Inertia of Composite areas, Radius of gyration–Section modulus, Mass Moment of Inertia of simple and composite masses.

Module 5: KINETICS AND MECHANICAL VIBRATIONS (09 Periods)

Kinetics of Rigid Bodies:

Introduction, ProblemsonD'Alembert'sprinciple, Impulse-momentum equation, Kinetics of circular motion, Rotation.

Mechanical Vibrations:

Definitions, Concepts–Simple Harmonic Motion–Free vibrations–Simple, compound and Tortional pendulum –Numerical problems.

Total Periods:45

EXPERIENTIAL LEARNING

1. List out the various examples of mechanics applications in daily life and explain them through Mechanics Principles.
2. Prepare models to show equilibrium of concurrent force system and non concurrent force system.
3. Visit Science centre, observe and experience the models related to Mechanics to gain practical knowledge and submit the reports.

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

CASESTUDIES/ARTICELS:

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

RESOURCES

TEXTBOOKS:

1. S.S.BhavikattiandK.G.Rajashekarappa,*EngineeringMechanics*,NewAgeInternational(P) Ltd.,3rdEdition,2009.
2. A. K. Tayal, *Engineering Mechanics Statics and Dynamics*, Umesh Publications, Delhi,14thedition,2011.

REFERENCEBOOKS:

1. C.LakshmanaRao,*EngineeringMechanics*,PrenticeHallIndiaLearningPrivateLimited,1st Edition,2003.
2. JLMeriamandLGKraige,*EngineeringMechanics-Statics*,7thEdition,2006.
3. K.VijayaKumarReddyandJ.SureshKumar,Singer's*EngineeringMechanics-Staticsand Dynamics*,BSPublications,3rdEdition,2010.
4. S.Timoshenko,D.H.YoungandJ.V.Rao,*EngineeringMechanics*,TataMcGraw-Hill EducationPvt. Ltd.,Revised 4thEdition,Special IndianEdition,2007.

WEBRESOURCES:

1. https://www.coursera.org/learn/engineering-mechanics-statics
2. https://nptel.ac.in/courses/112103109
3. https://www.youtube.com/playlist?list=PL63F5D8638872CC3E
4. https://www.youtube.com/watch?v=nGfVTNfNwnk

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102001	**MATERIAL SCIENCE AND ENGINEERING**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion and hands-on experience on materials structure and constitution of Alloys; also, it explicates different Heat treatment procedures. Further, it gives a comprehensive explanation on Properties of ferrous and non-ferrous materials and their alloys. In addition, it offers intricacies in Properties and applications of ceramics, polymers and composite materials.

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

CO1. Analyze the structural, constitutional characteristics, and defects of metals and alloys using appropriate tools and techniques.

CO2. Analyze the properties of materials and enhance the same through heat treatment processes.

CO3. Demonstrate knowledge of ferrous materials and its alloys for engineering applications.

CO4. Demonstrate knowledge of Non-ferrous materials and its alloys for engineering applications.

CO5. Demonstrate knowledge of Ceramics, Polymers, and Composite materials for suitable engineering applications.

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

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	2	-	-	-	-	1	-	-	3	-	-
CO2	3	3	1	1	-	-	-	-	-	1	-	-	3	-	-
CO3	3	1	-	1	-	-	-	-	-	-	-	-	3	-	-
CO4	3	1	-	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	1	-	1	-	-	-	-	-	-	-	-	3	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CourseCorrelation Mapping	**3**	**2**	**1**	**1**	**2**				3	**2**			**3**		

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

COURSE CONTENT

Module 1: MATERIALS STRUCTURE AND CONSTITUTION OF ALLOYS (10 Periods)

Materials Structure: Classification of Engineering Materials, levels of 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, lever rule, Iron-Iron-carbide diagram and its micro-structural aspects.

Module 2: HEAT TREATMENT OF STEELS (09 Periods)

Objectives of heat treatment, 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 (07 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 (10 Periods)

Ceramics: Classifications, Properties and Applications, Glass-ceramics, Polymers: Classification, Properties and Applications, Composites: Classifications, Properties and Applications of Polymer matrix composites, Ceramic matrix composites, Metal matrix composites and Nano-composites.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

MATERIALS STRUCTURE AND CONSTITUTION OF ALLOYS

1. Study the metallurgical instruments & microscope.
2. Preparation of specimen using cold setting die
   Preparation of specimen using hydraulic press
3. Experiment on Ultrasonic flaw detection
4. Experiment on Magnetic particle inspection
5. Experiment on Die-penetration
6. Study on Eddy current testing

HEAT TREATMENT OF STEELS

1. Study of the microstructures of heat treated steels
2. Measurement of hardness of heat treated and untreated steels
3. Determination of hardenability of steel by Jominey End Quench Test
4. Preparation and study of the microstructure of Non-Ferrous Alloys

FERROUS MATERIALS AND ALLOYS

1. Preparation and study of the microstructure of cast irons
2. Preparation and study of the microstructure of carbon steels
3. Determination of grain size, and phase distribution of specimens (any two ferrous materials) by Material Plus software

NON-FERROUS MATERIALS AND ALLOYS

1. Preparation and study of the microstructure of Non-Ferrous Alloys
2. Determination of grain size, and phase distribution of specimens (any two Non-ferrous materials) by Material Plus software

CERAMICS, POLYMERS AND COMPOSITES MATERIALS

1. Study on properties and applications of ceramics and polymers
2. Study on properties and applications of Metal matrix composites

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://nptel.ac.in/courses/113102080
2. https://nptel.ac.in/courses/113107078

WEB RESOURCES:

1. https://www.azom.com/articles.aspx
2. https://www.tandfonline.com/doi/abs/10.1081/CLT-100102421?journalCode=ictx19
   https://www.chemistryworld.com/copper/2220.tag

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102002	**MANUFACTURING TECHNOLOGY**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion and hands-on experience on fundamentals of manufacturing process such as casting, metal forming, metal joining, material preparation and polymer processing. This course also examines the knowledge with respect to forces distribution during various processes.

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

CO1. Apply knowledge to select suitable manufacturing process for a given product and understand the steps involved in metal casting, pattern making.

CO2. Analyse the working of cold working and hot working processes and evaluate the forces and power in rolling, forging and extrusion processes.

CO3. Analyse the working of various welding processes and summarize the applications, advantages of various welding processes.

CO4. Analyse the steps in making ceramics parts and manufacturing of powder metallurgy parts and demonstrate the application of plastic, ceramics and power metallurgy.

CO5. Apply knowledge to select appropriate methods of manufacturing plastics parts and demonstrate the application of plastic.

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

CO-PO-PSO Mapping Table:

CourseO utcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-	1	1	-	-	-	-	-	3	-	-
CO3	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO4	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO5	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO6	2	2	1	-	-	-	-	-	-	3	3	-	3		
Course Correlation Mapping	**2**	**1**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: PRIMARY MANUFACTURING PROCESSES (10 Periods)

Introduction: Importance and selection of manufacturing processes.

Casting Processes: Introduction to casting process, process steps; pattern: types, materials and allowance; Cores: Types of cores, core prints, principles and design of gating system; Solidification of casting: Concept, solidification of pure metal and alloy; Special casting processes: Shell casting, investment casting, die casting, centrifugal casting, casting defects and remedies.

Module 2: METAL FORMING PROCESSES (09 Periods)

Introduction: Introduction to metal forming, nature of plastic deformation, hot and cold working of metals, mechanics of metal forming.

Rolling: Principle, types of rolling mill and products, roll passes, forces in rolling and power requirements.

Forging: Principles of forging, tools and dies. Types: Smith forging, drop forging, forging hammers, rotary forging and forging defects. Sheet metal forming: Mechanics of sheet metal working, blanking, piercing, bending, stamping.

Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, wire drawing, tube drawing.

Module 3: METAL JOINING PROCESSES (09 Periods)

Metal Joining Processes: Classification of welding processes, types of welds and welded joints and V-I characteristics, arc welding, weld bead geometry, submerged arc welding, gas tungsten arc welding, gas metal arc welding. Applications, advantages and disadvantages of the above processes, other fabrication processes. Heat affected zones in welding.

Soldering and brazing: Types and their applications, Welding defects: causes and remedies.

Module 4: CERAMICS AND POWDER METALLURGY (09 Periods)

Ceramics: Classification of ceramic materials, properties and their application, ceramic powder preparation; Processing of ceramic parts: Pressing, casting, sintering; Secondary processing of ceramics: Coatings, finishing.

Powder Metallurgy: Principle, manufacture of powders, steps involved.

Module 5: PLASTIC PROCESSING (08 Periods)

Introduction to Plastics: Types, properties and their applications.

Processing of plastics: extrusion of plastics, transfer molding and compression molding, injection molding, thermoforming, rotational molding and blow molding.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. **METAL CASTING.**

   a) Gating Design and pouring time and solidification time calculations.
   b) Sand Properties Testing – Exercise for Strength and Permeability
   c) Gating Design and pouring time and solidification time calculations.
   d) Sand Properties Testing – Exercise for Strength and Permeability

2. **MECHANICAL PRESS WORKING.**

   a) Press Tool: Blanking and Piercing operation with Simple, Compound and Combination dies.
   b) Closed die forging, Deep Drawing and Extrusion operations.

3. **WELDING.**

   a) Lap joint and butt joint using arc welding process
   b) Lap joint and butt joint using arc welding process
   c) Lap joint by TIG and MIG welding process
   d) Simulation of welding

4. **MANUFACTUNRING PROCESSES.**

   a) Study of casting of ceramic parts
   b) Study of manufacturing of product through powder metallurgy route
   c) Additive manufacturing with 3D Printing
   d) Electro Discharge Machining (EDM)/ Wire cut EDM

5. **PROCESSING OF PLASTIC.**

   a) Producing a component using injection molding machine.
   b) Producing a component using blow molding machine

RESOURCES

TEXT BOOKS:

1. Rao P.N., "Manufacturing Technology – Volume I", 5th edition, McGraw-Hill Education, 2018.
2. Kalpakjain S and Schmid S.R., "Manufacturing Engineering and Technology", 7th edition, Pearson, 2018

REFERENCE BOOKS:

1. Millek P. Groover, "Fundamentals of Modern Manufacturing": "Materials, Processes and Systems", 4th edition, John Wiley and Sons Inc, 2010.
2. Sharma P.C., "A Text book of Production Technology", 8th edition, S Chand Publishing, 2014.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112107219
2. https://nptel.ac.in/courses/112104195

WEB RESOURCES:

1. https://www.my-mooc.com/en/mooc/fundamentals-manufacturing-processes-mitx-2-008x/
2. https://www.udemy.com/course/fundamentals-of-manufacturing-materials-processes-systems/
3. https://www.sme.org/sme-store/fundamental-manufacturing-processes/
4. https://www.fcusd.org/cms/lib/CA01001934/Centricity/Domain/4529/Fundamentals%20of%20Modern%20Manufacturing%20Materials%20%20Processes%20and%20Systems%20%204th%20Edition.pdf

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME105003	**COMPUTER AIDED MACHINE DRAWING**	**-**	**1**	**2**	**-**	**2**

Pre-Requisite - Computer Aided Engineering Drawing

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Principles of machine drawing; Sectional views; Tolerances; Thread profiles; Bolted joints; Locking arrangements for nuts; Foundation bolts; Keys; Assembling and Disassembling; Part drawing.

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

CO1. Develop suitable drawing views of machine elements and simple parts using CAD software.

CO2. Draw assembled views for the part drawings with suitable tolerances using conventions and CAD software.

CO3. Work independently and Communicate about the assembly and part drawings through the computer aided drawings.

CO-PO-PSO Mapping Table:

Course Outcome	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	1	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	3	1	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation level	**3**	**3**	**2**	**1**	**3**	**1**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**-**	**-**

Correlation Levels: 3– High 2 - Medium 1– Low

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

Exercises on machine drawing conventions using drafting software.
(Any three exercises)

a) Conventional representation of materials.
b) Conventional representation of machine components.
c) Conventional representation sectional views.
d) Conventional representation of limits, Fits and tolerances-form and positional tolerances and machining symbols.
e) Conventional representation of dimensioning on the drawings.

Exercises on drawing of machine elements and simple parts using drafting software. (Any three exercises)

a) Types of thread profiles-Square, Metric, ACME, Worm.
b) Bolted joints-Hexagonal bolt and nut, Square bolt and nut.
c) Locking arrangements for nuts-Locking by split pin, castle nut.
d) Foundation bolts- Eye, Bent and Rag foundation bolts.
e) Keys-Saddle key, Sunk key, Woodruff key, Kennedy key.
f) Riveted joints-Single riveted lap joints, Butt joints with single cover straps(Chain and zigzag using snap head riveters).

Assembly drawings.

Drawing of assembled views for the part drawings of the following, using conventions and easy drawing proportions. Representation of limits, fits and tolerances on assembly drawings. (Any three assembly drawings represented with dimensional and geometric tolerances)

a. Plummer block
b. Knuckle Joint
c. Eccentric pump
d. Screw jack
e. Universal coupling.

Part drawings.

Preparation of part drawing representing limits fits and tolerances and surface finish indications (Any TWO of the below mentioned part drawings ONLY).

a. Petrol Engine connecting rod
b. Single tool post
c. Tail stock
d. Socket and spigot joint
e. Oldham coupling

Note: Minimum 12 experiments shall be conducted.

RESOURCES

REFERENCES:

1. Narayana K.L., "Machine Drawing", 4th Edition, New Age International publishers, 2010
2. SVEC 20Computer Aided Machine Drawing Manual.

ADDITIONAL LEARNING RESOURCES:

1. N. Sidheswar, P. Kanniah and V.V.S. Sastry, Machine Drawing, Tata McGraw Hill, 2001
2. N. D. Bhatt, Machine Drawing, Charotar Publishing House Pvt Ltd, 2016.
3. K. R..Gopalakrishna, Machine Drawing, 9th Ed., Subhas Stores, Bangalore, 2005.

VIDEO LECTURES:

1. https://youtu.be/QVVdEi0k7pc
2. https://youtu.be/ptJfomL1I7o
3. https://youtu.be/6bCZtMPWLwk
4. https://youtu.be/-GXUZJEJkkY

WEB RESOURCES:

1. https://www.vlab.co.in/ba-nptel-labs-mechanical-engineering
2. https://docs.google.com/file/d/0B25ioeZd550hVnpDUXIxQzYxVkk/edit?resourcekey=0-ODfPP_cFtYBTfGl8ATQrXQ
3. https://www.engineersrail.com/screw-jacks/
4. https://youtu.be/h7p7yofUPCU

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME101002	**ENGINEERING THERMODYNAMICS**	**3**	**-**	**-**	**-**	**3**

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSEDESCRIPTION:

Thermodynamic system; Energy interactions; Heat and work Transfer in flow and non-flow systems; Laws of thermodynamics; Reversible and irreversible processes; Entropy; Equation of state; Pure substance; Thermodynamic Relations; Gases and gas mixtures and Gas power cycles.

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

CO1. Analyze thermodynamic systems using thermodynamic laws and estimate the thermodynamic properties during energy interactions in engineering application

CO2. Evaluate the feasibility of thermodynamic cycles and processes using second law of thermodynamics.

CO3. To apply the concept of entropy and exergy to different thermodynamic processes and cycles.

CO4. Analyze thermodynamic systems involving pure substances, mixtures and calculate thermodynamics properties based on thermodynamics relations.

CO5. Analyze basic thermodynamic cycles of various systems.

CO-PO-PSO MappingTable:

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	-
CO2	3	3	2	1	-	1	-	-	-	1	-	-	-	3	-
CO3	3	3	2	1	-	1	-	-	-	1	-	-	-	3	-
CO4	3	3	2	1	-	1	-	-	-	1	-	-	-	3	-
CO5	3	3	2	1	-	1	-	-	-	1	-	-	-	3	-
Course Correlation Mapping	3	3	2	1	-	1	-	-	-	1	-	-	-	3	-

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

COURSECONTENT

Module1: BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS (09 Periods)

Microscopic and macroscopic point of view, Thermodynamic systems, Control volume, Thermodynamic properties, Processes, Cycle, Homogeneous and Heterogeneous systems, Thermodynamic equilibrium, Quasi-static process, Work transfer and Heat transfer, Point and path function, Zeroth law of thermodynamics.

First Law of Thermodynamics: First law for a closed system undergoing a cycle, change of state, Limitations of first Law, Perpetual motion machine (PMM1) of first kind, Energy a property of system, First law applied to a flow process - steady flow energy equation (SFEE).

Module2: SECOND LAW OF THERMODYNAMICS (09 Periods)

Energy reservoir, Kelvin Planck and Clausius statements of second law and their equivalence, PMM of second kind, Heat engine, Refrigerator, Heat pump, Reversibility and Irreversibility, Carnot cycle, Carnot's theorem, Absolute thermodynamics temperature scale.

Module 3: ENTROPY AND AVAILABILITY (09 Periods)

Introduction, Clausius theorem, Clausius inequality, Entropy as a property, Principle of entropy increase and applications, Third law of thermodynamics. Availability and irreversibility, Available Energy, Maximum Work in a Reversible Process, Availability in Non - Flow and Flow Processes.

Module 4: PURE SUBSTANCE,THERMODYNAMIC RELATIONS AND PROPERTIES OF GAS MIXTURES (09 Periods)

Properties of pure substances: Introduction, P-V, P-T and T-S Diagrams for a Pure Substance, Quality and Dryness Fraction, Use of Steam Tables and Mollier Chart for thermodynamic properties.

Thermodynamic Relations: T-dS relations, Helmholtz and Gibbs functions, Gibbs relations, Maxwell relations.

Properties of gas mixtures: Ideal gas, equation of state, Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure

Module 5: POWER CYCLES (09 Periods)

Otto cycle, Diesel cycle and Dual cycle; Comparison of Otto, Diesel and Dual cycles - Description and representation on P–V and T-S diagram, Stirling cycle, Ericsson cycle, Joule cycle representation on P–V and T-S diagram.

Total Periods:45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Prepare a document to reduce energy consumption or improve energy efficiency in a real-world setting, such as a building or a vehicle.
2. Apply First and Second Law principles in I.C. Engine and prepare a document
3. To determine heat loss from pipe-in-pipe heat exchanger using SFEE and to verify entropy principle for the heat exchanger.

RESOURCES

TEXTBOOKS:

1. P. K. Nag, Engineering Thermodynamics, TMH, 6th Edition, 2017.
2. Chatttopadhyay, Engineering Thermodynamics, Oxford Publishers, 2nd edition, 2016.

REFERENCEBOOKS:

1. Yunus Cengel & Boles, *Thermodynamics–An Engineering Approach*, TMH, 8th Edition, 2015
2. Dr.R.Yadav, *Fundamentals of Engineering Thermodynamics*, Central publishing House, 7th Edition, 2004.
3. *Fundamentals of Thermodynamics* by Borgnakke & Sonntag, 7th Ed. Wiley India (P) Ltd

VIDEOLECTURES:

1. https://www.youtube.com/watch?v=9GMBpZZtjXM
2. https://www.digimat.in/nptel/courses/video/112105266/L01.html

WEBRESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_me120/preview
2. https://nptel.ac.in/courses/112105123
3. https://nptel.ac.in/course.php

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME101003	**KINEMATICS OF MACHINERY**	**3**	**-**	**-**	**-**	**3**

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Basic concepts and description of various plane mechanisms; Calculation of Displacement; Velocity and acceleration of simple plane mechanisms; Straight line mechanisms; Steering mechanisms; Hooke's joint; Concepts of Gears and Gear trains; Preparation of cam profiles.

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

CO1. Calculate degrees of freedom of kinematic pairs, kinematic chains and its inversions used in machines for engineering applications.

CO2. Analyze planar mechanisms for displacement, velocity and acceleration of different Points of it using relative velocity and Instantaneous center methods.

CO3. Analyze steering gear mechanisms for correct steering and Hookes joints for uniform velocity ratios.

CO4. Analyze the gears to avoid interference and gear trains to find the velocity and number of teeth of its components.

CO5. Draw the profile of the cam based on follower motions and calculate the velocity and acceleration of the follower.

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	-	-	-	-	-	-	3	-	-
CO2	3	3	3	-	-	1	-	-	-	-	-	-	3	-	-
CO3	3	3	3	-	-	1	-	-	-	-	-	-	3	-	-
CO4	3	3	3	-	-	1	-	-	-	-	-	-	3	-	-
CO5	3	3	3	-	-	1	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: MECHANISMS AND MACHINES (09 Periods)

Elements or Links, Classification- Rigid, Flexible and Fluid link; Types of kinematic pairs- Sliding, Turning, Rolling, Screw and Spherical pairs, Lower and Higher pairs, Closed and Open pairs; Constrained motions- Completely, Partially or successfully and incompletely constrained motion; Kinematic chain, Types of joints- Binary, Ternary and Quaternary joints; Number of Degrees of Freedom, Kutzbach and Grubler's Criteria, Inversions of plane mechanisms- Quadric cycle, Single slider and Double slider crank chains.

Module 2: VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (09 Periods)

Instantaneous center of rotation, Centrode and Axode, Relative motion between two bodies, Kennedy theorem (Three centers in line), Instantaneous center method to determine angular

velocity of links and linear velocity of point, Relative velocity method to determine velocity and acceleration diagrams for four bar mechanism, Slider-crank mechanism and its inversions, Coriolis component of acceleration.

Module 3: STRAIGHT LINE, STEERING GEAR MECHANISMS AND HOOKE'S JOINT (09 Periods)

Pantograph, Exact Straight Line Motion Mechanisms- Peaucellier, Hart and Scott Russell's mechanism; Approximate Straight Line Motion Mechanisms- Modified Scott Russell's mechanism, Watt's, Grasshopper, Tchebicheff's and Robert mechanisms; Steering mechanisms, Condition for correct steering, Davis Steering gear and Ackerman steering gear mechanisms, Single and double Hooke's joints.

Module 4: GEARS AND GEAR TRAINS (09 Periods)

Friction wheels and toothed gears, Types, Law of gearing, Sliding velocity of teeth, Forms of teeth- Cycloidal, Involute profiles; Expressions for path of contact and arc of contact, Contact ratio, Phenomena of interference, Condition for minimum number of teeth to avoid interference, Gear trains - Simple, Compound, Reverted and Epicyclic gear train; Compound Epicyclic Gear Train (sun and planet wheel), Differential gearbox for automobile.

Module 5: CAMS (09 Periods)

Introduction to cams and followers, Types, Terminology, Types of follower motion, Cam profile- For uniform velocity, SHM, Cycloidal and Uniform acceleration- and retardation of Knife edge, Roller followers (axis of follower passes through the axis of camshaft and offset), Maximum velocity and maximum acceleration during outward and return stroke.

Total Periods: 45

EXPERIENTIAL LEARNING

1. List out the various examples of mechanics applications in daily life and explain them through Mechanics Principles.
2. Prepare models to show equilibrium of concurrent force system and nonconcurrent force system.
3. Visit Science centre, observe and experience the models related to Mechanics to gain practical knowledge and submit the reports.

RESOURCES

TEXT BOOKS:

1. S. S. Rattan, Theory of Machines and Mechanisms, Tata McGraw Hill Education, 4thEdition, 2016.
2. R.S. Khurmi, Theory of machines, S.Chand Publications, 14th Revised Edition, 2012

REFERENCE BOOKS:

1. Ballaney. P. L., Theory of Machines and Mechanisms, Khanna Publishers, 2005
2. Joseph Edward Shigley and John Joseph Uicker,Jr., Theory of Machines and Mechanisms, MGH, 4th Edition, New York, August 2013.
3. Bevan T, Theory of Machines, CBS Publishers and Distributors, New Delhi, 2002.

VIDEO LECTURES:

1. https://www.youtube.com/playlist?list=PL63F5D8638872CC3E
2. https://www.youtube.com/watch?v=nGfVTNfNwnk

WEB RESOURCES:

1. https://www.coursera.org/learn/engineering-mechanics-statics
2. https://nptel.ac.in/courses/112103109

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102003	**FLUID MECHANICS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSEDESCRIPTION:
Properties of Fluids; Pressure Measurements; Types of flow; One-dimensional steady flow energy & momentum Equations; Flow measurements; Fluid flow; Impact of jets on stationary & moving plate; Hydraulic turbines & Pumps Components and its performance.

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

CO1. Calculate the properties of fluids using the principles of fluid properties.

CO2. Apply the principles of fluid kinematics and dynamics and determine the flow properties of the fluid.

CO3. Calculate the loss of energy in fluid flows using the principles of fluid flows.

CO4. Evaluate the hydrodynamic force acting on jets and the performance of Hydraulic turbines under various loading and head conditions.

CO5. Evaluate the performance pumps under various head conditions and analyze its performance characteristics curves.

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		-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	3	1	-	-	-	-	-	-	-	-	-	3	-
CO3	3	1	2	1	-	-	-	-	-	-	-	-	-	3	-
CO4	2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	1	2	3	2	-	-	-	-	-	-	-	-	-	1	-
Course Correlation Mapping	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	-	-	**3**	-

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

COURSECONTENT

Module1: PROPERTIES OF FLUIDS AND PRESSURE MEASUREMENT (09 Periods)

Properties of Fluids: Dimensions and units, Physical properties of fluids - Density, Specificweight, Specific volume, Specific gravity, Viscosity, Surface tension, Capillarity, Buoyancy, Vapor pressure and its influence on fluid motion, Bulk modulus, compressibility; Types of Fluids.

Pressure Measurement: Absolute Pressure, Gauge Pressure, Atmospheric Pressure, Vacuum Pressure, Manometers types - Piezometer, U-tube, Single column manometer and Differential manometers.

Module2: FLUID KINEMATICS AND DYNAMICS (09 Periods)

Kinematics: Classification of flow, the continuity equation for three dimensional flow (Cartesian coordinate only), Types of flow lines - stream, streak and path lines.

Dynamics: Equations of motion- Euler's and Bernoulli's equations, Application of Bernoulli's equations, Momentum equation and its application to pipe bend, moment of momentum equations.

Measurement of Flow: Venturimeter, Orifice meter, Rotameter and Pitot tube.

Module3: FLUID FLOWS (09 Periods)

Flow Over Flat Plate: Boundary Layer- Definition, thicknesses, characteristics along thinplate, laminar and turbulent boundary layers (No derivation) boundary layer in transition,Separation of boundary layer; submerged objects – drag and lift.

Flow Through Pipes: Reynolds experiment, Darcy Weisbach equation, Chezy's equation,Minor losses in pipes, Equivalent pipe, Pipes in series and pipes in parallel, Total energy line and Hydraulic Gradient Line

Module4: IMPACT OF JETS AND HYDRAULIC TURBINES (09 Periods)

Impact of Jets: Force exerted on stationary and moving plates- vertical, inclined and curved, Velocity diagrams, Work done and Efficiency.

Hydraulic turbines: Classification of turbines -Impulse, Reaction turbines; Pelton wheel, Francis turbine, Kaplan turbine – Construction, Working principle, velocity triangles and work done, Efficiencies; Draft tube theory, Types of draft tubes; Performance of hydraulic turbines -Geometric similarity, Specific speed, Unit quantities, Characteristic curves, Governing of turbines, Water hammer, Cavitation.

Module5: HYDRAULIC PUMPS (09 Periods)

Centrifugal pumps: Classification, Single stage Centrifugal pump - Working Principle, Work done and Efficiencies; Multi stage Centrifugal pump, Pumps in series, Pumps in parallel, Characteristic curves, Specific speed.

Reciprocating pumps: Construction and Working Principle of single acting, Double acting reciprocating pumps, Discharge, Work done, Slip, Indicator diagrams, Air vessels.

Total Periods:45

EXPERIENTIALLEARNING

LIST OF EXERCISES:

1. Calibration of Venturimeter
2. Calibration of Orificemeter
3. Calibration of rectangular notch
4. Determination of loss of head due to sudden contraction
5. Determination of friction factor for pipes
6. Verification of Bernoulli’s equation.
7. Impact of jet on vanes
8. Study of hydraulic jump.
9. Performance test on Pelton wheel turbine
10. Performance test on Francis turbine
11. Performance test on Kaplan turbine.
12. Performance test on single stage centrifugal pump
13. Performance test on multi stage centrifugal pump
14. Performance test on reciprocating pump

RESOURCES

TEXTBOOKS:

1. R.K. Rajput, Fluid Mechanics and Hydraulic Machines, S. Chand, 4th Edition, 2013.
2. Modi and Seth, Fluid Mechanics and Hydraulic Machinery, Standard book house, 17th Edition, 2011.

REFERENCEBOOKS:

1. R.K. Bansal, Fluid Mechanics and Hydraulic Machinery, Laxmi publications, 9th Edition, 2017.
2. K Subramanya, Fluid Mechanics and hydraulic machines, Mc Graw Hill Education, 2nd Edition, 2011.

VIDEOLECTURES:

1. https://www.coursera.org/videos/fe-exam/01fgu?query=fluid+mechanics&source=search
2. https://nptel.ac.in/courses/105103192

WEBRESOURCES:

1. https://archive.nptel.ac.in/courses/112/105/112105171/
2. https://nptel.ac.in/courses/112105269

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102004	**STRENGTH OF MATERIALS**	3	-	2	-	4

Pre-Requisite - Basic Engineering Mechanics

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course presents the Analysis of stresses and strains of mechanical and structural components; Shear force and Bending moment of beams; Bending and Torsional stresses and Deflection beams.

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

CO1. Calculate stresses, strains and elastic constants of structural member subjected to external loading.

CO2. Draw shear force and bending momentum diagrams for beams under various loading conditions.

CO3. Evaluate the bending and shear stresses in beam structure under transverse loading conditions

CO4. Estimate the torsional shear stress and deflection on circular shafts subjected torsion and find principal stresses from Mohr's circle diagram.

CO5. Analyse deflections of cantilever and simply supported beams using Double Integration method and Macaulay's method.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												ProgramSpecific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CourseCorrelation Mapping	**3**	**3**	**2**	**1**	-	-	-	-	-	**1**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: SIMPLE STRESSES AND STRAINS (08 Periods)

Types of Stresses, Strains, Hooke's law, Stress–Strain diagram, Working Stress, Factor of safety, Lateral strain, Poisson's ratio, Volumetric strain, Elastic Moduli and relationship between them, Bars of Varying section, Composite bars, Temperature stresses, Strain energy.

Module 2: SHEAR FORCE AND BENDING MOMENT (10 Periods)

Concept of shear force and bending moment, S.F and B.M. diagrams for cantilever, Simply supported, Overhanging beams subjected to Point loads, Uniformly distributed loads, Uniformly varying loads and combination of these loads, Point of contra flexure.

Module 3: BENDING AND SHEAR STRESSES (10 Periods)

Theory of simple bending, Bending equation, Determination of flexural stresses for simple cases, Section modulus, Shear stress formula, Shear stress distribution across various beams & sections - Rectangular, Circular, Triangular, I, T sections.

Module 4: TORSION (08 Periods)

Theory of pure torsion, Torsion Equation, Torsional moment of resistance, Polar section modulus; Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

Mohr's circle: Principal stresses and Mohr's circle for Biaxial Stresses – like stresses and unlike stresses; Mohr's circle for Complex Stresses.

Module 5: DEFLECTION OF BEAMS (09 Periods)

Relationship between curvature, slope and deflection, Slope and deflection of cantilever and simply supported beams by Double Integration method and Macaulay's method.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Tension test on mild steel/HYSD bar
2. Compression test on wood/bricks/mild steel
3. Compression test on coiled spring
4. Tension test on coiled spring
5. Bending test on carriage spring
6. Brinell and Rockwell hardness tests
7. Charpy and Izod impact tests
8. Shear test on mild steel
9. Bending test on simply supported beam
10. Bending test on cantilever beam

RESOURCES

TEXT BOOKS:

1. R.K. Rajput, A Textbook of Strength of Materials, 8th Edition, S. Chand Publishing, 2018
2. R.K. Bansal, A Textbook of Strength of Materials, 4th Edition, LP Publications, 2010
3. Ramamrutham S, Narayanan R., "Strength of Materials", 14th Edition, Dhanpat Rai Publications, 2011.

REFERENCE BOOKS:

1. James M.G, Timoshenko S.," Mechanics of Materials", 2nd Edition, CBS Publications, 2004.
2. Beer, J, Dewolf, "Mechanics of Materials", 3rd Edition, Tata McGraw-Hill Education, 2004.
3. Ferdinand L. S, Andrew, "Strength of Materials", 4th Edition, Addison Wesley publisher, 1990

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112107146
2. https://archive.nptel.ac.in/courses/105/105/105105108/

WEB RESOURCES:

1. https://www.springer.com/journal/11223
2. https://www.nuclear-power.com/nuclear-engineering/materials-science/material-properties/strength/
3. https://www.engineersedge.com/strength_of_materials.htm

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102005	**DYNAMICS OF MACHINERY**	3	-	2	-	4

Pre-Requisite Basic Engineering Mechanics
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION:
Clutches, brakes and dynamometers; Gyroscopic couple, Turning moment diagrams, flywheel design; Analysis and balancing of shaking forces in machines; Governors; Vibrations, single degree, Multi degrees of freedom vibrations, spring mass systems; transmissibility of forces, Dunkerley's method, Rayleigh's method; Whirling of shafts; isolation of systems.

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

CO1. Analyze clutches, brakes and dynamometers for the forces acting on it during its operation and calculate the forces involved in it.

CO2. Determine the effect of gyroscopic couple on transport vehicles for stabilization.

CO3. Analyze turning moment diagram for fluctuations of energy and flywheel for controlling the speed variations in machines.

CO4. Analyze the governors and calculate the forces acting on it during its operation.

CO5. Analyze the unbalanced forces of masses in engines using analytical and graphical methods.

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	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	-	**-**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: CLUTCHES, BRAKES AND DYNAMOMETER (10 Periods)

Clutches: Friction clutches- Single Disc or plate clutch, Multiple Disc Clutch, Cone Clutch, Centrifugal Clutch.

Brakes and Dynamometers: Simple block brakes-Single block, Pivoted block, Double block; simple Band brake, Differential Band Brake, Band and Block Brake, internal expanding brake. Dynamometers–absorption and transmission types.

Module 2: GYROSCOPE & TURNING MOMENT DIAGRAMS (09 Periods)

Gyroscope: Gyroscopic couple, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and ships.

Turning moment diagrams and Fly wheels: Turning moment diagrams for steam engine, IC Engine and multi cylinder engine, Crank effort - coefficient of Fluctuation of energy, coefficient of Fluctuation of speed – Fly wheels and their design, Fly wheels for Punching machines.

Module 3: GOVERNORS (08 Periods)

Introduction to Governors, Watt, Porter and Proell governors; spring loaded governors – Hartnell and Hartung governors with auxiliary springs; Sensitiveness, isochronism and hunting; Effort and power of a governor.

Module 4: BALANCING OF MASSES (09 Periods)

Balancing of Rotating Masses - Single and several masses in Single and multiple planes; Balancing of Reciprocating Masses - Primary and complete balancing of reciprocating parts of an engine, Analytical and graphical methods, Unbalanced forces and couples –V Engine balancing, Multi cylinder inline engine balancing and radial engine balancing.

Module 5: VIBRATIONS (09 Periods)

Classification, Free and forced vibration of single degree of freedom system, Role of damping, whirling of shafts and critical speeds, Simple problems on free, forced and damped vibrations, Vibration Isolation & Transmissibility, Transverse vibrations of beams with concentrated and distributed loads, Dunkerly’s method, Rayleigh’s method, Torsional vibrations - two and three rotor systems.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Determination of gyroscopic couple using Motorized gyroscope.
2. Determination of unbalanced couple and forces in static and dynamic balancing of rotating masses.
3. Determination of moment of inertia of a flywheel.
4. Determination of sensitivity, effort for Porter, Proell and Hartnell governors.
5. Draw the cam profile and study the jump-off phenomenon in a cam - follower mechanism.
6. Estimation of the frequency of undamped and damped force vibration of a spring mass system.
7. Determination of the natural frequencies of undamped and damped torsional vibration using single rotor shaft system and two rotor system.
8. Determination of critical speed of shaft with concentrated loads using whirling of shaft.

CASE STUDIES/ ARTICELS:

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

RESOURCES

TEXT BOOKS:

1. S.S.Rattan, *Theory of Machines and Mechanisms*, Tata McGraw Hill Publishers, 4th Edition, 2016.
2. R.S Khurmi, *Theory of Machines*, S.Chand Publications, 14th Revised Edition, 2012.

REFERENCE BOOKS:

1. Joseph Edward Shigley and John Joseph Uicker, Jr. *Theory of Machines and Mechanisms*, Second Edition, MGH, New York.
2. Ballaney P L, Theory of Machines and Mechanisms, Khanna Publishers, New Delhi,2005.
3. Bevan T, *Theory of Machines*, CBS Publishers and Distributors, NewDelhi, Third Edition, 2002.
4. J.S. Rao and R.V. Dukkipati, *Mechanism and Machine Theory*, New age International, Second Edition, 2007.

WEB RESOURCES:

1. https://archive.nptel.ac.in/courses/112/104/112104114/
2. https://www.classcentral.com/course/youtube-mechanical-dynamics-of-machines-47685
3. https://www.edx.org/course/machine-dynamics-with-matlab
4. https://ekeeda.com/degree-courses/mechanical-engineering/dynamics-of-machinery

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102006	MACHINE TOOLS	3	-	2	-	4

Pre-Requisite - Manufacturing Technology

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Theory and Mechanics of Metal cutting**;** Demonstration on lathe; drilling; milling; slotting machine; shaper; grinding machine;milling machine; provides skill on making products using machines tools Constructional and operational characteristics of special machines, and different work and tool holding devices;

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

CO1. Apply knowledge of cutting parameters and geometry of different cutting tools to leverage the tool life.

CO2. Analyze the mechanics of metal cutting to estimate cutting forces and machining parameters.

CO3. Demonstrate the basic structure, mechanism and operations of lathe machine.

CO4. Demonstrate the basic structure, mechanism and operations of Shaping, Slotting, and planning, drilling and boring machines.

CO5. Demonstrate the basic structure, mechanism and operations of grinding and milling machines.

CO6. Work individually or in a 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
CO1	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-	1	1	-	-	-	-	-	3	-	-
CO3	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO4	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO5	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO6	2	2	1	-	-	-	-	-	-	3	3	-	3		
Course Correlation Mapping	**3**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: THEORY OF METAL CUTTING (09 Periods)

Introduction- Purpose, principle, definition and requirement of machining; Machinability, Concept of Generatrix and Directrix; Basic elements of machining; cutting parameters- Cutting speed, Feed, Depth of cut; Cutting tool geometry– concept of rake and clearance angles, Nomenclature and Geometry of single point cutting tool; ASA, ORS and NRS systems; Conversion of tool angles using graphical method – ASA to ORS; Geometry of twist drill and milling cutter; Tool materials;

Module 2: MECHANICS OF MACHINING (09 Periods)

Mechanism of chip formation in – ductile and brittle materials; Types of chips; Chip breakers; Orthogonal and Oblique cutting; Mechanics of Orthogonal cutting – Shear angle, velocity relationship, shear strain; Cutting forces - Merchant's circle diagram and simple problems; Tool life; Tool failure; Thermal aspects-Coolants;

Module 3: LATHE MACHINES (09 Periods)

Engine Lathe - Principle of operation, Specifications of lathe, Types of lathes, Work andtoolholdingdevices,OperationsonLathe,MethodsofTaperturning,Specialattachments;**A utomaticlathes**-Classification–singlespindleandmulti-spindleautomaticlathes.

Module 4: SPECIAL MACHINES-I (09 Periods)

Shaping, Slotting and planning machines - Principle of operation, Classification, Principal parts, specifications, Operations performed, Machining time calculations.

Drilling and Boring Machines - Principle of operation, Specifications, Types of Drilling machines, Different Operations, Tool holding devices, Boring machines –Jig boring machines.

Module 5: SPECIAL MACHINES-II (09 Periods)

Grinding machine - Principle of operation, Types - cylindrical grinding machine, Surfacegrinding machine, Tool and cutter grinding machine, special types of grinding machines;Differenttypesofabrasives,bonds,specificationandselectionofgrindingwheel,Bal ancing, Loading and Glazing, Truing, Dressing of grinding wheel, Comparison ofgrinding,lapping and honing.

Milling machine: Principle of operation, Classification,Specifications, Up milling andDown milling, Types of Horizontal milling machines, Vertical milling machines, Millingoperations, Types of milling cutters, Tool and work holding devices, Methods of indexing,Accessories.

Total Periods: 45

EXPERIENTIAL LEARNING

Demonstration of construction and operations of general-purpose machines: Lathe, drilling machines, Milling machine, shaper, planer, slotting machine, cylindrical grinder, surface grinder and tool and cutter grinder.

1. Job on step turning and taper turning on Lathe machine.
2. Job on thread cutting and knurling on Lathe machine.
3. Drilling, tapping and reaming using radial drilling machine
4. V-Block shaping using shaping machine
5. Internal splines cutting using slotting machine
6. Single point cutting tool Grinding using tool and cutter grinder
7. Profile cutting using vertical milling machine
8. Spur gear cutting using horizontal milling machine
9. Surface grinding operation using surface grinder
10. Cylindrical grinding machine using cylindrical grinder

RESOURCES

TEXT BOOKS:

1. A.B.Chattopadhyay,*MachiningandMachineTools*,Wiley,2ndEdition,2017.
2. HazraChoudaryS.K.andHazraChoudaryA.K.,*ElementsofWorkshopTechnology*,VolII, Media Promoters,12thEdition,2007.
3. B.S.Raghuwanshi,*AcourseinWorkshoptechnology*,VolII,DhanpatRaiandCo(P)Ltd,9th Edition,1998.

REFERENCEBOOKS:

1. H.M.T.(HindustanMachineTools),*ProductionTechnology*,TataMegrawhillEducation,2013.
2. VijayKJain,Advanced*machiningprocesses*,Alliedpublishers,2012.
3. R.K.Jain,*ProductionTechnology*,KhannaPublishers,17thEdition,2012.

VIDEO LECTURES

1. https://archive.nptel.ac.in/courses/112/105/112105233/

WEB RESOURCES

1. https://archive.nptel.ac.in/courses/112/105/112105233/
2. https://www.mmsonline.com/
3. https://www.americanmachinist.com/
4. https://www.machinedesign.com/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102007	**ENGINEERING METROLOGY**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Limits, Fits and Tolerances; Limit Gauges and Gauge Design; Comparators; Linear Measurement; Measurement of Angles and Tapers; Flatness Measurement, Surface Roughness Measurement; Measurement of Displacement; Measurement of Speed, Stress & Strain Measurements; Measurement of Temperature; Measurement of Pressure.

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

CO1. Analyze the significance of accuracy and precision in linear measurement and tolerance analysis, and develop strategies for ensuring functional and cost-effective designs.

CO2. Analyze the principles and functions of different limit gauges to measure and validate dimensions and tolerances.

CO3. Demonstrate knowledge of the principles and applications of flatness and surface roughness measurement, and ensure the quality of flat and smooth surfaces in engineering applications.

CO4. Demonstrate knowledge of the principles and applications of the screw thread and gear measurement involving different measurement instruments to evaluate and ensure the quality of threaded fasteners and gears in engineering applications.

CO5. Demonstrate knowledge of stress, strain, temperature, and pressure measurement principles and applications and ensure the safety and efficiency of engineering systems under different loading and environmental conditions.

CO6. Work individually or in a 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
CO1	3	2	1	-	-	1	-	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	-	1	-	1	-	-	-	-	-	-	-	3	-	-
CO4	3	-	1	-	-	-	-	-	-	-	-	-	3	-	-
CO5	3	-	1	-	1	1	-	-	-	-	-	-	3	-	-
CO6	3	2	1	-	1	-	-	-	-	3	3	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	-	**1**	**1**	-	-	-	**3**	**3**	-	**3**	-	-

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

COURSE CONTENT

Module 1: LINEAR MEASUREMENT, LIMITS, FITS AND TOLERANCES (09 Periods)

Introduction: Metrology, Measurement, units, Range, accuracy, precision, types of errors, readability, calibration and reproducibility.

Linear Measurement: Length standard, Line, End and Wavelength standards, Slip Gauges - Calibration of the slip gauges, Numerical related to slip gauges, Dial indicator, micrometers.

Limits, Fits and Tolerances: Introduction, Definitions, fits and their types, Allowances, Unilateral and Bilateral Tolerance System, Hole and Shaft basis systems, Fundamental Tolerance, Numerical related to limits and fits. Interchangeability and Selective Assembly.

Module 2: LIMIT GAUGES, COMPARATORS, ANGULAR AND TAPER MEASUREMENT (09 Periods)

Limit Gauges: Gauges- Plug, Ring, Snap, Gap, Taper gauges, Taylor‛s principle. **Comparators:** Introduction to comparator, Characteristics, Classification of comparators, Mechanical comparators- Sigma Comparators, Optical Comparators, LVDT, Pneumatic Comparators.

Measurement of Angles and Tapers: Different methods-Bevel protractor, Angle gauges Spirit levels, Sine bar, Sine plate, Rollers and Spheres used to determine the tapers.

Module 3: FLATNESS, SURFACE ROUGHNESS MEASUREMENT (09 Periods)

Flatness Measurement: Measurement of flatness of surfaces, Straight edges, Surface plates, optical flat and Auto collimators, Interferometer and their uses. **Surface Roughness Measurement:** Differences between surface roughness and Surface waviness, Methods of measurement of surface finish- Profilograph, Talysurf; BIS symbols for indication of surface finish.

Module 4: SCREW THREAD AND GEAR MEASUREMENT (09 Periods)

Screw Thread Measurement: Elements of measurement, Errors in screw threads, Measurement of effective diameter, Angle of thread and Thread pitch by 2-wire and 3-wire methods, Profile thread gauges.

Gear Measurement: Gear measuring instruments, Gear tooth profile measurement, Measurement of diameter, Pitch, Finding pressure angle and Tooth thickness.

Module 5: STRESS, STRAIN, TEMPERATURE AND PRESSURE MEASUREMENT (09 Periods)

Measurement of Stress and Strain: Various types**-** Electrical strain gauge, Gauge factor, Method of usage of resistance strain gauge for bending, Compressive and tensile strains, Usage for measuring torque, Strain gauge rosettes.

Measurement of Temperature and Pressure: Standards and calibration, Thermal expansion methods, Thermoelectric sensors (thermocouples), Electrical Resistance sensors, Junction semiconductor sensors, Digital thermometers, Radiation methods, Pressure measurements - Standards and Calibration, Basic methods of pressure measurement, Dead weight gauge

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Calibration of Vernier Calipers, Micrometer, Vernier Height Gauge, Dial Gauge and measurement of dimensions of given components.
2. Measurement of dimensions of a part using limit gauges.
3. Measurement of internal bores by dial bore indicators.
4. Measurement of coordinates of a jig plate.
5. Measurement of radius of curvature of a given ring.
6. (a) Measurement of angle and taper by using Bevel protractor, Sine bars.
   (b) Measurement of angle of Taper plug gauge, Taper ring gauge, V- groove.
7. Measurement of gear elements by using Gear Tooth Vernier.
8. (a) Measurement of screw elements by using Tool Makers microscope.
   (b) Measurement of screw elements by using profilometer.
   (c) Measurement of effective diameter of an external thread by using Two Wire/Three wire method.
9. Study of angular measurement using Autocollimator.
10. Measurement of flatness using Spirit level.
11. Measurement of surface roughness using surface roughness tester.
12. Checking the limits of dimensional tolerances using electrical and optical comparators.
13. Study of Alignment test on lathe and milling machines and measurement of the Resultant force acting on the tool using Tool Dynamometers.
14. Process capability of Lathe measurement using Variable (or) Attribute chart.

RESOURCES:

TEXTBOOKS:

1. R.K. Jain, Engineering Metrology, Khanna Publishers, 20th edition, 2013.
2. M. Mahajan, Engineering Metrology, DhanpatRai and Co., 2nd edition, 2013.

REFERENCE BOOKS:

1. Thomas G. Beckwith, Roy D. Maragoni, John H. Lienhard V, Mechanical Measurements, Pearson Education International Publishers, 6th edition, 2013 .
2. Anand K Bewoor, Vinay A Kulkarni, Metrology & Measurement, McGraw Hill, 1st Edition, 2013.

VIDEO RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_me94/preview
2. https://www.digimat.in/nptel/courses/video/112104250/L01.html

WEB RESOURCES:

1. https://www.digimat.in/nptel/courses/video/112104250/L01.html
2. https://www.nitsri.ac.in/Department/Mechanical%20Engineering/MEC_405_Book_2,_for_Unit_2B.pdf

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102008	**THERMAL ENGINEERING**	3	-	2	-	4

Pre-Requisite Engineering Thermodynamics.

Anti-Requisite -

Co-Requisite -

COURSEDESCRIPTION:

Introduction to Internal Combustion (IC) engines; Components and working of 2-stroke and 4-stroke engines; Combustion phenomena in spark ignition and compression ignition engines; Performance parameters of an internal combustion engine; Gas turbines; Jet propulsions and Rocket propulsions; Reciprocating compressors; Rotary compressors; Concept of steam power cycles. Calculating the performance parameters of 2-stroke and 4- stroke I.C. Engines; Heat balancing of an engine; Practicing the valve and port timing diagrams; Determining frictional power for single and multi-cylinder engines; Compressor performance. Assembly and disassembly of an automobile models.

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

- **CO1.** Analyze the combustion process in IC engines and calculate the Performance parameters of IC Engines under various testing conditions.
- **CO2.** Analyze the gas turbines and jet propulsions using PV and TS diagrams and solve problems on it.
- **CO3.** Analyze the performance parameters of air compressors using principles of air compressors.
- **CO4.** Analyze the steam power cycles using PV and TS diagrams and calculate the thermal efficiencies of these cycles.
- **CO5.** Analyze the Performance characteristics of IC engines and reciprocating air compressor and determine volumetric and isothermal efficiency.
- **CO6.** Apply the basic concept to Study of boilers, steam condensers, steam turbines and steam nozzles.

CO-PO-PSO MappingTable:

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	1	-	-	-	-	-	-	3	-
CO2	3	3	1	1	-	1	1	-	-	-	-	-	-	3	-
CO3	3	3	1	1	-	1	1	-	-	-	-	-	-	3	-
CO4	3	3	1	1	-	1	1	-	-	-	-	-	-	3	-
CO5	3	3	1	1	-	-	-	-	-	-	-	-	-	3	-
CO6	3	3	1	1	-				3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**1**	**1**	**1**	**1**	**1**		**3**	**3**	**-**	**-**	**-**	**3**	**-**

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

COURSE CONTENT

Module1: INTERNAL COMBUSTION ENGINES (10 Periods)

Introduction, Classification of IC Engines, Engine components, Working of two stroke and four IC engines, Valve and port timing diagrams; Combustion in Spark Ignition (SI) Engines **-** Stages of combustion in SI engines, Factors influencing the flame speed, Phenomenon of knock in SI engines; Combustion in Compression Ignition (CI) Engines **-** Stages of combustion in CI engines, Factor affecting delay period; Phenomenon of knock in C.I engine, comparison of knock in SI and CI engines.

Module2: PERFORMANCE OF INTERNAL COMBUSTION ENGINES (09 Periods)

Performance parameters - Brake power, indicated power, Friction power, Mean effective pressure, Specific fuel consumption, Engine efficiencies, Performance calculations, Heat balance sheet; Measurement of brake power; Measurement of indicated power; Measurement of Friction power - Willian's line method, Morse test, motoring test and retardation test; Air and fuel measurement.

Module3: GAS TURBINES AND JET PROPULSIONS (09 Periods)

Gas Turbines: Classification of Gas Turbines, Components of simple gas turbine plant-Ideal Gas Turbine Cycle and its deviations with actual cycle; Turbine Work and Efficiency of Simple Gas Turbine Cycle, Condition for Optimum Pressure Ratio, Methods to improve Turbine Work - Inter cooling and Reheating; Methods to improve efficiency - Regeneration.

Jet Propulsion: Introduction, Classification of Jet Propulsion devices, Working of Air breathing engines- Turbojet Engine, Turbo Prop Engine, Ram Jet Engine and Pulse Jet Engine; Introduction to Rocket Engine.

Module4: AIR COMPRESSORS (09 Periods)

Introduction, Classification, Reciprocating Compressors - Principle of operation, work required, Isothermal efficiency, volumetric efficiency and effect of clearance, Single Stage and Multi Stage Compressors, Effect of Inter cooling and Pressure Drop in Multi - Stage Compressors; Rotary compressor - Working principles of Roots blower, Vane type Blower, Centrifugal Compressor, Axial Flow Compressors.

Module5: STEAM POWER CYCLES (08 Periods)

Carnot Cycle, Rankine Cycle-Schematic Layout, Thermodynamic Analysis; Effect of operating variables on the performance, Reheating and Regeneration, Modified Rankine Cycle; Low temperature power cycles, Binary vapour cycle and Cogeneration.

Total Periods:45

EXPERIENTIALLEARNING

LIST OF EXERCISES:

Minimum TWELVE experiments are to be conducted.

1. (a)ValveTimingDiagramusingamodelof4–SDiesel,CI engine

   (b) Port timing diagram of a model of 2-S, SI engine
2. Morse Test on 4-S, 4-C, Petrol Engine using Hydraulic loading
3. Retardation Test on 4-S, 1-C, Diesel Engine using Electrical loading
4. Performance Test on 2-S, 1-C, Petrol Engine using Electrical Loading
5. Economic speed test on 2-S, 1-C, Petrol Engine using Electrical Loading
6. Performance Test on 4-S, 1-C diesel Engine using Mechanical Loading
7. Heat Balance Test on 4-S, 1-C diesel Engine using Mechanical Loading Performance Test Variable Compression Ratio Engine (VCR Engine)

8. Motoring Test on Variable Compression Ratio Engine (VCR Engine)
9. Performance Test on 2-Stage Reciprocating Air compressor Unit
10. Dismantling/Assembly of Engines to identify the parts and their position in an engine
11. Performance and emission characterization tests on Computerized 4-S, 1-C, C.I. engine using Eddy Current loading, Exhaust gas analyzer and Smoke meter.
12. Performance test on vapour compression refrigeration system.
13. Study of boilers, steam condensers, steam turbines and steam nozzles.

RESOURCES

TEXT BOOKS:

1. R.K.Rajput, Thermal Engineering, Laxmi Publication, 9th Edition,2013
2. V.Ganesan,I.C.Engines,TMH,3rdEdition,2010

REFERENCE BOOKS:

1. M.L. Mathur & R. P. Sharma, Internal combustion engines, Dhanpat Rai & Sons, 8thEdition, 2014
2. R. S. Khurmi & J.S. Gupta, Thermal Engineering, S.Chand, 15th Edition, 2015.

VIDEO LECTURES:

1. https://www.youtube.com/playlist?list=PLx6sg1OjKASn6yf4zOsgUf6DF_Xo6jE9S
2. https://www.youtube.com/playlist?list=PLyqSpQzTE6M_fvM0LRk7V-5t5rW7rO5i5
3. https://www.youtube.com/playlist?list=PLfHBoVfSZP-kmJQjuyvH5w5h22frGJrYr

WEB RESOURCES:

1. https://nptel.ac.in/courses/112104077/
2. https://nptel.ac.in/courses/112104054/
3. https://nptel.ac.in/courses/112104072/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102030	**FUNDAMENTALS OF MACHINE DESIGN**	3	-	2	-	4

Pre-Requisite

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

General considerations of design, design process; Manufacturing considerations, BIS codes of materials; Combined stresses; theories of failure; Fatigue; Stress concentration; Goodman's line, Soderberg's line; shafts; keys; sleeve or muff, and Flange couplings, Flexible couplings; sleeve and cotter joint, Knuckle joint, mechanical springs.

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

CO1. Design the machine elements subjected to combined and structural loads considering design standards.

CO2. Design the parameters of power transmitting elements such as shafts, keys, couplings and joints.

CO3. Design threaded joints under eccentric loading conditions and welded joints for residual stresses.

CO4. Design journal, ball and roller bearings for the given application.

CO5. Design the parameters of springs and spur gears for the given application.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	2	-	-	-	-	-	-	3	-	-
CO2	3	2	3	2	-	2	-	-	-	-	-	-	3	-	-
CO3	3	3	2	3	-	2	-	-	-	-	-	-	3	-	-
CO4	3	3	3	3	-	3	-	-	-	-	-	-	3	-	-
CO5	2	2	3	3	-	2	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**-**	**2**	-	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

DETAILED SYLLABUS:

Module 1: DESIGN FOR COMBINED & FLUCTUATING LOADS (09 Periods)

Introduction to design, Types of design, General considerations of design, Design process; Manufacturing considerations in the design; BIS coding and Preferred numbers; Combined stresses, Various theories of failures.

Stress concentration, Notch sensitivity, Design for fluctuating stresses fatigue failure, Endurance limit, Estimation of Endurance strength - Goodman's line, Soderberg's line; Design of components for finite and infinite life.

Module 2: DESIGN OF SHAFTS, KEYS, COUPLINGS AND JOINTS (09 periods)

Shafts: Shaft design - on the basis of strength and Torsional rigidity, ASME code for shaft design.

Keys: Design of Keys – Sunk keys: rectangular and square keys and Applications of keys.

Couplings: Design of couplings - Sleeve or Muff, Protected type Flange couplings, Bush-pin type, Applications of couplings.

Joints: Sleeve and cotter joint, Knuckle joint.

Module 3: DESIGN OF THREADED AND WELDED JOINTS (09 periods)

Threaded Joints: Basic Types of screw fastenings - cap screws, set screws; Bolts of uniform strength, locking devices, I.S.O. metric screw threads, bolts under tension, eccentrically loaded bolted joint in shear, eccentric load parallel and perpendicular to the axis of bolts, and plane containing the bolts.

Welded Joints: Introduction, welding process, types of welded joints, working stresses in welds, Strength of welds, Special cases of fillet welds, Eccentric loads on welded connections, Design procedure.

Module 4: BEARINGS (09 periods)

Journal bearing design, Ball and Roller Bearings, Static load, Dynamic load, Equivalent radial load, Design and Selection of ball and roller bearings.

Module 5: DESIGN OF MECHANICAL SPRINGS AND SPUR GEAR (09 periods)

Stress and deflections of helical springs, Design of helical springs, springs for fatigue loading, Energy storage capacity in helical springs, Concentric springs; Design procedure for spur gear.

Total Periods: 45

EXPERIENTIAL LEARNING

List of Experiments conducted in this laboratory:

I Modelling and drafting of machine parts, Die casts and sheet metal.

- **a** Prepare the solid model 1 of given figure with required dimensions in isometric representation
- **b** Prepare the Sheet metal part 1 of given figure with required dimensions in isometric representation
- **c** Prepare the Die cast part 1 of given figure with required dimensions in isometric representation

II **Concept of Mesh generation (1D, 2D and 3D) and Sensitivity analysis**

- **a** Generated 1-D mesh for given Simply Supported, Cantilever and Over hanging beams
- **b** Generation of 2D mesh for Sheet metal part and extract the mid-mesh. Check quality of mesh (Skegness, Jacobean, Aspect ratio) and eliminate errors. Reduce triangular elements to 5%.
- **c** Generation of 3D mesh for given part. Check quality of mesh (Skegness, Jacobean, Aspect ratio).

III **Static and dynamic analysis through Finite element modelling of mechanical problems using ANSYS**

- **a** Determination of deflection and stresses in 2D trusses and beams
- **b** Determination of deflections component and principal and Von-Mises stresses in simple 3D plane and axisymmetric components

IV **Fatigue analysis and comparison with respect to static and dynamic analysis.**

- **a** Fatigue analysis of connecting rod of an IC engine
- **b** Dynamic analysis of Aeroplane wind under dynamic forcing condition

V **Stead state and transient thermal analysis using ANSYS workbench.**

- **a** Conductive heat transfer Analysis of plane and axisymmetric components.
- **b** Convective heat transfer Analysis of 2D components

(Note:It'sanindicativeone.Courseinstructormaychangetheactivitiesandthesameshallbereflected in course handout)

RESOURCES

TEXTBOOKS:

1. V. B. Bhandari, Design of Machine Elements, Tata McGrawHill, 3rd Edition, 2010.
2. R.S. Khurmi & J.K. Gupta, Machine Design, Eurasia Publishing House (pvt.) Ltd. 2005

REFERENCE BOOKS:

1. Shigley's Mechanical Engineering Design Richard G. Budynas, and J. Keith Nisbett McGraw-Hill Education 10th edition, 2015.
2. Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M. John Wiley & Sons Third Edition, 2007 student edition.
3. Design and Machine Elements Spotts M.F., Shoup T.E Pearson Education 8th edition,2006

Data Book: Design data hand book for Mechanical Engineers in SI and Metric units by Balaveera Reddy and Mahadevan.N

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/105/112105124/
2. https://www.youtube.com/watch?v=TK4MX_42UU4

SOFTWARE/TOOLS:

1. CATIA, Pro-E, HYPERMESH, ANSYS,ABAQUSetc

WEB RESOURCES:

1. https://www.extrica.com/article/15775
2. https://www.sciencedirect.com/topics/engineering/automotive-component
3. https://lab.vanderbilt.edu/vumacs/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME101005	**INDUSTRIAL ENGINEERING AND MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Management – Concept; Staffing, Leading and Controlling; Leading Effective Teams, Planning and Implementing Change; Allowances and Standard time calculations; Line balancing, Maintenance; Statistical Process Control.

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

CO1. Demonstrate the knowledge on essentials of management theories and approaches by valuing ethics and social responsibility.

CO2. Analyze organizational structures and formulate leadership strategies for organizational transformation.

CO3. Apply work study techniques for uniform and enhanced production flow

CO4. Analyze maintenance and facility planning problems and solve anomalies in breakdown, availability and redundancy.

CO5. Apply quality control tools and techniques for acceptance decisions, process adjustments and minimal rework by following quality standards, industry Acts and safety measures.

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**

COURSE CONTENT

Module 1: ESSENTIALS OF MANAGEMENT (09 Periods)

Management–Concept, Process, Theories and Approaches; Management Roles and Skills Functions–Planning, Organizing, Staffing, Leading and Controlling; Decision Making–Concept, Process, Techniques and Tools; Business Ethics, Corporate Social Responsibility and Corporate Governance

Module 2: MANAGEMENT OF ORGANIZATIONAL BEHAVIOUR (09 Periods)

Leadership and management, Classic Motivational Theories, Situational leader ship, Effective Communication, Leading Effective Teams, Planning and Implementing Change, Leadership Strategies for Organizational Transformation.

Module 3: WORK STUDY (09 Periods)

Productivity, Method study– Steps, Charts and Diagrams, Principles of Motion economy; Work measurement – Time study – Rating, Allowances and Standard time calculations; Work sampling, Human Factors and Ergonomics.

Module 4: FACILITIES PLANNING AND MAINTANANCE (09 Periods)

Types of Production, Plant Location and Layout, Line balancing, Maintenance – Breakdown, Preventive and Predictive; 5S and TPM; Reliability – Series, Parallel, Series-Parallel device configurations, Bath-tub curve, MTBF, MTTR, Availability and Redundancy.

Module 5: QUALITY ASSURANCE AND INDUSTRIAL SAFETY (09 Periods)

Statistical Process Control – Control Charts for Variables and Attributes, Process Capability; Acceptance sampling – Sampling Plans, OC curve; ISO 9000 Standards and Total Quality Management, Benchmarking, Industrial Safety rules, Investigation and Analysis of Accidents, Indian Factories Act, Workmen Compensation Act and Industrial Disputes Act

Total Periods: 45

EXPERIENTIAL LEARNING

CASESTUDIES/ARTICELS:

1. Mary Barra's Leadership at General Motors - this case study could be used to discuss the management roles and skills functions, including planning, organizing, staffing, leading, and controlling
2. Uber's Organizational Culture - this case study could be used to discuss planning and implementing change, leadership strategies for organizational transformation, and situational leadership.
3. The Boeing 787 Dreamliner Project - this case study could be used to discuss productivity, method study, work measurement, and work sampling.
4. Amazon's Fulfillment Center Design - this case study could be used to discuss types of production, plant location and layout, line balancing, maintenance, and 5S and TPM.
5. Toyota's Quality Control Problem - this case study could be used to discuss statistical process control, process capability, and ISO 9000 standards and total quality management.

RESOURCES

TEXTBOOKS:

1. Mart and Telsang, Industrial Engineering and Production Management, S.Chand,2ndEdition,2006

2. Kenneth H.Blanchard,PaulHerseyandDeweyE.Johnson,ManagementofOrganizationalBehavior, Pearson,10th Edition,2015

REFERENCE BOOKS:

1. Harold Koontz, Heinz Weihrich, et al, Essentials of Management, McGraw Hill, 11th Edition,2020

2. MI Khanand N A Siddiqui, Industrial Engineering and Management, New AgeInternational,1stEdition,2018

VIDEO LECTURES:

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

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

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME101006	**APPLIED THERMODYNAMICS**	3	-	-	-	3

Pre-Requisite 22ME101002 - Engineering Thermodynamics

Anti-Requisite -

Co-Requisite -

COURSEDESCRIPTION:

Steam Boiler; Classification of Boilers; Working of Steam Boilers; Functions of Various Boiler Mountings and Accessories; Performance parameters of boiler; Characteristics off low through steam nozzles; Working of Steam Condensers and their performance; Cooling water requirements; Steam turbines and their analysis; Compounding and governing; Refrigeration systems; Psychrometry; Air conditioning systems.

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

CO1. Analyze the functional and performance characteristics boiler systems to determine its performance parameters.

CO2. Analyze the performance characteristic of steam nozzles and condensers and calculate its performance characteristics.

CO3. Analyze the performance characteristic of steam turbines using velocity diagrams and determine its performance characteristics.

CO4. Calculate the performance characteristics refrigeration systems.

CO5. Calculate the psychometric properties during psychometric process in air conditioning systems.

CO-PO-PSO MappingTable:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	3	1	-	-	-	-	-	-	-	-	-	3	-
CO3	3	1	2	1	-	-	-	-	-	-	-	-	-	3	-
CO4	2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	1	2	3	2	-	-	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	-	-	3	-

CorrelationLevels: **3:High; 2:Medium; 1:Low**

COURSECONTENT

Module1: STEAM BOILERS (09 Periods)

Classification of Boilers, Working of Fire Tube Boilers - Simple Vertical Boiler, Cochran Boiler, Cornish Boiler and Locomotive Boiler; Working of Water Tube Boilers–Babcock and Wilcox Boiler, Lamont Boiler and Benson Boiler; Functions of Boiler Mountings and Accessories; Boiler horse power, equivalent evaporation, efficiency and heat balance.

Draught: classification – Height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught, induced and forced draught

Module2: STEAM NOZZLES AND CONDENSORS (09 Periods)

Steam Nozzles: Classification, functions, Flow of steam through the Nozzles, Velocity of Steam at the exit of Nozzle- Ideal and Actual expansion through the Nozzle; Discharge through the Nozzle-Condition for maximum discharge through the Nozzle, Critical Pressure Ratio; Nozzle Efficiency and Velocity Coefficient, Wilsons Line.

Steam Condensers: Classification, Working of Jet and Surface Condensers, Vacuum Efficiency, Condenser Efficiency, Sources of air, Effect of air leakage in Condenser-Edward's Air Pump; Cooling Water Requirement.

Module3: IMPULSE TURBINES AND REACTION TURBINES (09 Periods)

Impulse turbine: Classification of Steam Turbines, Working of De-laval Impulse Steam Turbine, Pressure velocity variations, Combined Velocity diagrams of Impulse turbine, Effect of friction, Axial thrust, Tangential thrust and Power developed, Compounding and Governing.

Reaction Turbines: Working of Parson's Reaction Turbine, Degree of Reaction, Pressure velocity variations and combined velocity diagram of Reaction turbine.

Module4: REFRIGERATION (09 Periods)

Introduction to Refrigeration, Units of Refrigeration, Carnot Refrigerator, COP of a refrigerator, Heat Pump, Air refrigeration System-Working Principle and Essential Components of the Plant – COP – Representation of Cycle on T-S and P-h diagram; Vapour Compression Refrigeration (VCR) System – Working Principle and Essential Components of the Plant – COP – Representation of Cycle on T-S and P-h; Vapour absorption system- Working Principle and Essential Components of the Plant – COP; Introduction to refrigerants.

Module5: AIR CONDITIONING (09 Periods)

Psychrometry: Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process-adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Introduction Air Conditioning Systems-Classification of Air conditioning systems.

TotalPeriods:45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Study of boilers, steam condensers, steam turbines and steam nozzles.
2. Study of vapour absorption refrigeration systems and psychrometric process.
3. Performance Test on 2-Stage Reciprocating Air compressor Unit
4. Performance test on vapour compression refrigeration system

RESOURCES

TEXTBOOKS:

1. R.K.Rajput, Thermal Engineering, Laxmi Publication, 10th Edition,2018
2. Mahesh M. Rathore, Thermal Engineering, Tata McGraw-Hill Education, 1st Edition,2010.

REFERENCEBOOKS:

1. R.S.Khurmi& J.S. Gupta, Thermal Engineering, S.Chand, 15th Edition, 2015.
2. R.S.Khurmi& J.S. Gupta, Refrigeration and Air conditioning, S.Chand, 5th Edition, 2020.

VIDEOLECTURES:

1. https://archive.nptel.ac.in/courses/112/103/112103316/
2. https://nptel.ac.in/courses/112103275

WEBRESOURCES:

1. https://nptel.ac.in/courses/112103316
2. https://nptel.ac.in/courses/112106314

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102009	**COMPUTER AIDED DESIGN AND MANUFACTURING**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Fundamental and conventional CAD processes; Raster scan graphics co-ordinate system; Transformations; Geometric construction models; Curve representation methods; Computer Control in NC; GT; CAPP.

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

CO1. Demonstrate the basic concepts of CAD/ CAM, CIM to generate a suitable geometric model of an object.

CO2. Analyze algorithms for computer graphics and use geometric models to generate complex contours.

CO3. Develop the CNC code for complex machining process.

CO4. Demonstrate Computer aided manufacturing and computer aided quality control application over manufacturing.

CO5. Demonstrate knowledge of automation, robotics and applications.

CO6. Work individually or in a 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
CO1	3	1	1	-	1	1	-	-	-	-	-	-	3	-	-
CO2	3	3	1	1	1	1	-	-	-	-	-	-	3	-	-
CO3	3	3	1	1	2	1	-	-	-	-	-	-	3	-	-
CO4	3	1	1	1	1	1	-	-	-	-	-	-	3	-	-
CO5	3	1	-	-	1	1	-	-	-	-	-	-	3	-	-
CO6	3	2	1	-	1	-	-	-	-	3	3	-	3	-	-
Course Correlation Mapping	**3**	**3**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO CAD/CAM, CIM (10 Periods)

Computers in Industrial Manufacturing, Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Integrated Manufacturing (CIM), Design process, Product Life Cycle, CAD hardware, CAD Standards-Introduction, classification and Importance of CAD standards. Computer Integrated Manufacturing - Introduction, Types of Manufacturing System, Nature and role of the elements of CIM System, CIMS Benefits, Database requirements for CIM.

Module 2: COMPUTER GRAPHICS & GEOMTERIC MODELING (10 Periods)

Computer Graphics: Raster Scan Graphics: DDA Line Algorithm, Bresenham's Line algorithm, Coordinate system, 2D &3DTransformations (Scaling, Translation, Rotation & Reflection).

Geometric Modeling: Requirements of Geometric Modeling, Definition to Parametric and Non-parametric representation, Introduction to curve representation, Analytical and Synthetic curve representation (Bezier, B-spline & Nurbs).

Module 3: COMPUTER NUMERICAL CONTROL (09 Periods)

Introduction to CNC, CNC Hardware basics (Structure of CNC machine tools, Actuation systems, Feedback devices), CNC Tooling (Automatic tool changers, Work holding, CNC Programming, Part Programming fundamentals, Manual part programming methods, Preparatory Functions, Miscellaneous Functions, Canned Cycles.

Module 4: COMPUTER AIDED PROCESS PLANNING & QUALITY CONTROL (08 Periods)

Group Technology: Introduction, Part Family, Classification and Coding, Types of coding systems, Identification systems (RFID, Barcodes), Group Technology Cells, Benefits of Group Technology. Computer Aided Process Planning: Retrieval & Generative Computer Aided Process Planning and CAPP systems, CAPP implementation considerations, Benefits of CAPP.

Computer Aided Quality Control: Introduction, Inspection and Testing, Contact & Non-Contact inspection methods.

Module 5: AUTOMATION AND ROBOTICS (08 Periods)

Automation: Introduction to automation, Elements of automation, Types of automation systems, part transfer methods and mechanisms- flow lines-types.

Robotics: Introduction to robotics, Law of robotics, Anatomy, Configuration of robots, Robot end effectors-classification, Robotic joints, grippers.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Prepare the solid model1 of given figure with required dimensions in isometric representation.
2. Prepare the solid model2 of given figure with required dimensions in isometric representation.
3. Develop the part drawing of Knuckle joint assembly
4. Develop the part drawing of Plumber block assembly
5. Develop the part drawing of Crank hook assembly
6. Develop the part drawing of connecting rod in the orthographic representation.
7. Develop the part drawing of revolving center
8. Development of the part drawing of footstep bearing
9. Simulation of CNC Lathe and Milling Manual Part Programs.
10. Simulation of simple components on CNC Lathe 1
11. Simulation of simple components on CNC Lathe 2
12. Simulation of simple components using CANNED CYCLE
13. Simulation of simple components on CNC Milling

RESOURCES

TEXT BOOKS:

1. P.N. Rao, CAD/CAM: Principles and Applications, TMH, 2004.
2. Radhakrishnan and Subramaniah, CAD/CAM/CIM, New Age International, 2004.
3. Michael E.Mortenson, Geometric Modelling, wiley 2013.

REFERENCE BOOKS:

1. Ibrahim Zeid, CAD/CAM Theory and Practice, McGraw Hill,2010.
2. MikellP.Groover, Computer Aided Design & Computer Aided Manufacturing, PearsonEducation,2006.
3. E. Micheal, *Geometric Modelling*, John Wiley &Sons ,3rdedition 2013.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/102/112102101/
2. https://nptel.ac.in/courses/112102102

WEB RESOURCES:

1. https://mrcet.com/downloads/digital_notes/ME/IV%20year/CAD%20CAM%20Digital%20Notes.pdf
2. https://www.classcentral.com/course/swayam-cad-cam-computer-aided-design-computer-aided-manufacturing-22925
3. https://www.stem.org.uk/resources/elibrary/resource/450581/what-cad-and-cam
4. https://www.iare.ac.in/sites/default/files/lecture_notes/CAD_CAM_LECTURE_NOTES.pdf

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME102010	**HEAT TRANSFER**	3	-	2	-	4

Pre-Requisite Engineering Thermodynamics and Fluid Mechanics

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Modes of heat transfer; One-dimensional steady and transient conduction; Analysis of extended surfaces; Convection heat transfer; free and forced convection; boiling and condensation; Heat exchangers; radiation; Concept of black body; heat exchange between surfaces.

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

CO1. Apply the principles of heat transfer in steady state conduction and determine the heat transfer characteristics.

CO2. Analyze the fins to increase heat transfer rate and Transient heat conduction process for heat transfer characteristics.

CO3. Analyze fluid flow systems and determine heat transfer characteristics in forced and free convection process.

CO4. Design heat exchangers, boilers and condensers for the given heat transfer rates and determine heat transfer characteristics

CO5. Apply the principles of radiation in the heat exchange between black and grey bodies and determine heat transfer characteristics.

CO-PO-PSO MappingTable:

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	-
CO2	3	3	2	1	-	1	1	-	-	-	-	-	-	3	-
CO3	3	3	2	1	-	1	1	-	-	-	-	-	-	3	-
CO4	3	3	2	1	-	1	1	-	-	-	-	-	-	3	-
CO5	3	3	2	1	-	1	1	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**

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

COURSE CONTENT

Module 1: CONDUCTION HEAT TRANSFER (09 Periods)

Basics of Heat Transfer, Modes and Mechanism of heat transfer, Conduction, convection and radiation, General differential equation of heat conduction - Cartesian, Cylindrical and Spherical Coordinates; One dimensional steady state heat conduction - Conduction through plane wall, cylinders and spherical systems; Composite systems, Critical thickness of insulation.

Module 2: EXTENDED SURFACES AND TRANSIENT HEAT CONDUCTION (09 Periods)

Extended surfaces, Types of fins, - Efficiency, Effectiveness and Temperature distribution on Long Fin, Fin with Insulated Tip and Short Fin; Introductions to unsteady heat conduction - Lumped heat analysis, Infinite and semi-infinite solids, use of Heisler's chart.

Module 3: CONVECTION HEAT TRANSFER (09 Periods)

Boundary layer concepts - Hydrodynamic and thermal boundary layer theory, Dimensional analysis, Buckingham's π-theorem applied to forced and natural convection.

Forced convection: External flows - Flow over plates, cylinders and spheres; internal flows- flow through Horizontal pipe, annular pipe.

Natural convection: Flow over the vertical plate, horizontal plate, horizontal cylinders.

Module 4: HEAT EXCHANGERS AND PHASE CHANGE HEAT TRANSFER (09 Periods)

Heat Exchangers: Classification of Heat Exchangers, Overall Heat Transfer Coefficient and Fouling Factor, Log Mean Temperature Difference (LMTD): parallel & counter flow, Correction factor, Effectiveness - NTU methods of analysis of heat exchangers.
Boiling: Pool Boiling Regimes, Determination of Heat Transfer Coefficient in Nucleate Boiling, Critical Heat Flux and Film Boiling.
Condensation: Film wise and Drop wise Condensation, Nusselt's Theory of Condensation on a Vertical Plate.

Module 5: RADIATION HEAT TRANSFER (09 Periods)

Fundamentals of Radiation, Emission Characteristics - Irradiation, Total and Monochromatic radiation, Laws of Radiation - Planck, Wien's displacement, Kirchhoff, Lambert's cosine, Stefan–Boltzmann, Heat Exchange between Two Black Bodies and Gray Bodies, Concepts of Shape Factor, Emissivity, Radiation Shields.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Determination of Thermal conductivity of metal rod using thermal conductivity Apparatus.
2. Determination of Thermal conductivity of insulating powder material through concentric sphere apparatus.
3. Determination of Thermal conductivity of insulating material by lagged pipe apparatus.
4. Determination of Overall heat transfer co-efficient through Composite Slab Apparatus.
5. Determination of Temperature distribution and heat transfer rate in Transient heat conduction mode using the Transient heat conduction apparatus.
6. Determination of Convective Heat transfer coefficient in natural convection using natural convection apparatus.
7. Determination of Convective Heat transfer coefficient in forced convection using forced convection apparatus.
8. Determination of Temperature distribution, efficiency and effectiveness of Pin- Fin using pin-fin Apparatus.
9. Determination of overall heat transfer coefficient of Parallel and counter flow heat exchanger using Parallel and counter flow heat exchanger Apparatus.
10. Determination of Critical heat flux using the Critical Heat flux apparatus.
11. Determination of Heat transfer in drop and film wise condensation using drop and film wise condensation apparatus.
12. Determination of Stefan Boltzmann constant using the Stefan Boltzmann Apparatus.
13. Determination of Emissivity of a gray body using the Emissivity apparatus.
14. Study of two-phase heat flow in heat pipes.
15. Study of simulation of heat flow systems using simulation tools.

RESOURCES

TEXTBOOKS:

1. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age International, 5th Edition, 2017.
2. R.K.Rajput, Heat and Mass Transfer, S.Chand & Company Ltd, 7th Edition, 2018.

REFERENCEBOOKS:

1. Yunus Cengel, Heat and Mass Transfer, Mc Graw Hill Publications, 5th Edition, 2015.
2. Holman.J.P, Heat Transfer, TMH, 10th Edition, 2017.
3. P.K.Nag, Heat Transfer, McGraw Hill Education, 3rd Edition, 2011.

VIDEOLECTURES:

1. https://www.youtube.com/watch?v=7Bj3N1E7vZk
2. https://www.youtube.com/watch?v=a-lz-YzwvE8

WEBRESOURCES:

1. https://archive.nptel.ac.in/courses/103/105/103105140/
2. https://nptel.ac.in/courses/103103032
3. https://www.youtube.com/watch?v=MUC098hvqH4

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME101007	**DESIGN OF MACHINE ELEMENTS**	3	-	-	-	3

Pre-Requisite Fundamentals of Machine Design

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This is an advanced course on modeling, design, integration and best practices for use of machine elements such as bearings, springs, gears, and IC Engine parts.

COURSE OUTCOMES:

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

CO1: Predict appropriate bearing, from the standard catalog for varied applications

CO2: Calculate the design parameters for springs for the given application.

CO3: Design and applying various concepts to the spur and helical gears

CO4: Design and applying various concepts to the bevel and worm gears

CO5: Calculate the design parameters for Internal Combustion Engine parts.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	2	-	-	-	-	-	-	3	-	-
CO2	3	2	3	2	-	2	-	-	-	-	-	-	3	-	-
CO3	3	3	2	3	-	2	-	-	-	-	-	-	3	-	-
CO4	3	3	3	3	-	3	-	-	-	-	-	-	3	-	-
CO5	2	2	3	3	-	2	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

DETAILED SYLLABUS:

Module 1: BEARINGS (09 periods)

Introduction, classification of bearings, types of sliding contact bearings, bearing characteristic number and bearing modulus for journal bearings, coefficient of friction for journal bearings, critical pressure of the journal bearing, sommerfeld number, heat generated in a journal bearing, design procedure for journal bearings. design and selection of ball and roller bearings, dynamic equivalent load for rolling contact bearings, dynamic load rating for rolling contact bearings under variable loads, reliability of a bearing, selection of radial ball bearings.

Module 2: DESIGN OF MECHANICAL SPRINGS (09 periods)

Stress and deflections of helical springs, Design of helical springs, springs for fatigue loading, Energy storage capacity in helical springs, Concentric springs, Leaf Springs Construction of Leaf Springs, Equalized Stresses in Spring Leaves, Length of Leaf Spring Leaves, Standard Sizes of Automobile Suspension Springs, Material for Leaf Springs

Module 3: SPUR AND HELICAL GEARS (09 periods)

Spur Gears: Introduction, Classification of Gears, Terms used in Gears, Condition for Constant Velocity Ratio of Gears–Law of Gearing. Standard Proportions of Gear Systems Design Considerations for a Gear Drive, Beam Strength of Gear Teeth-Lewis Equation, Permissible Working Stress for Gear Teeth in Lewis Equation, Dynamic Tooth Load, Static Tooth Load, Wear Tooth Load, Causes of Gear Tooth Failure, Design Procedure for Spur Gears, Spur Gear Construction.

Helical Gears: Introduction, Terms used in Helical Gears, Face Width of Helical Gears, Formative or Equivalent Number of Teeth for Helical Gears, Proportions for Helical Gears, Strength of Helical Gears.

Module 4: BEVEL AND WORM GEARS (09 periods)

Bevel Gears: Introduction, Classification of Bevel Gears, Terms used in Bevel Gears, Determination of Pitch Angle for Bevel Gears, Proportions for Bevel Gears, Formative or Equivalent Number of Teeth for Bevel Gears-Tredgold's Approximation, Strength of Bevel Gears, Forces Acting on a Bevel Gear, Design of a Shaft for Bevel Gears.

Worm Gears:

Introduction, Types of Worms, Types of Worm Gears, Terms used in Worm Gearing, Proportions for Worms, Proportions for Worm Gears, Efficiency of Worm Gearing, Strength of Worm Gear Teeth, Wear Tooth Load for Worm Gear, Forces Acting on Worm Gears, Design of Worm Gearing.

Module 5: INTERNAL COMBUSTION ENGINE PARTS (09 periods)

Introduction, Principal Parts of an I. C. Engine, Cylinder and Cylinder Liner, Design of a Cylinder, Piston, Design Considerations for a Piston, Material for Pistons, Piston Head or Crown, Piston Rings, Piston Skirt, Piston Pin, Connecting Rod, Forces Acting on the Connecting Rod, Design of Connecting Rod, Crankshaft.

Total Periods: 45

EXPERIENTIALLEARNING

1. Design of Journal and Ball bearings as per the ASTM standards, list out real time industrial applications where these bearing are used.
2. Performing experiments on mechanical springs to determine deflections and stress values for railway wagon springs and find its deflections and stress values.
3. Design of Worm and Bevel gears and automobile parts using analytical and MATLAB/Python programming.

(Note:It'sanindicativeone.Courseinstructormaychangetheactivitiesandthesameshallbereflected in course handout)

RESOURCES:

TEXTBOOKS:

1. V. B. Bhandari, Design of Machine Elements, Tata McGrawHill, 3rd Edition, 2010.

2. R.S. Khurmi & J.K. Gupta, Machine Design, Eurasia Publishing House (pvt.) Ltd. 2005

REFERENCE BOOKS:

1. Shrigley's Mechanical Engineering Design Richard G. Budynas, and J. Keith Nisbett McGraw-Hill Education 10th edition, 2015.
2. Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M. John Wiley & Sons Third Edition, 2007 student edition.
3. Design and Machine Elements Spotts M.F., Shoup T.E Pearson Education 8th edition,2006

Data Book: Design data handbook for Mechanical Engineers in SI and Metric units by Bala Veera Reddy and Mahadevan.N

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/105/112105124/
2. https://archive.nptel.ac.in/courses/112/105/112105125/

WEB RESOURCES:

1. https://www.extrica.com/article/15775
2. https://www.sciencedirect.com/topics/engineering/automotive-component
3. https://www.buildyourownracecar.com/race-car-chassis-basics-and-design/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME101008	**OPERATIONS RESEARCH**	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. Apply linear programming techniques to solve complex problems and obtain optimal solutions

CO2. Analyze the transportation and assignment techniques to obtain optimal solution.

CO3. Analyze games through appropriate strategies to influence the game outcome. And apply suitable inventory control models for cost reduction.

CO4. Develop network models and solve project management issues involving diverse resources.

CO5. Apply queuing models to compute the relevant characteristics and simulate them.

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**

COURSE CONTENT

Module 1: LINEARPROGRAMMINGPROBLEM (09 Periods)

Requirements of Linear Programming Problem, Formulation, Graphical solution, Simplex method, Big-M method, Two Phase Method, Dual formulation, Dual Simplex Method, Linear Programming special cases-Infeasible solution, Unboundedness, Redundancy, Alternate Optimal solutions.

Module 2: TRANSPORTATION AND ASSIGNMENT MODEL (09 Periods)

TRANSPORATION: Methods to find Basic Feasible Solution- North-West corner rule, Least cost method, Vogel's approximation method; Modified distribution (MODI) method to find optimal solution, Special cases of transportation problems, Transshipment problem.

ASSIGNMENT MODEL: Hungarian method, Variants of Assignment Problem, Travelling Salesman Problem

Module 3: GAMETHEORYANDINVENTORYMODELS (09 Periods)

GAME THEORY – Two-person zero sum games, Saddle point, Pure strategy, Mixed strategy –Dominance, Algebraic method and Graphical method.

INVENTORYMODELS–Functions, Types, Associated costs, Factors involved in inventory problem analysis, Inventory costs and deterministic inventory control models-single item Inventory control models without shortages and with shortages, with quantity discounts

Module 4: NETWORKMODELS (09 Periods)

Network Flow models – Minimal Spanning Tree, Shortest Path Problem and Maximal Flow Problem, Project management through network analysis -Critical Path Method, Program Evaluation Review Technique, Cost analysis and Crashing.

Module 5: QUEINGANDSIMULATION (09 Periods)

Queuing: Infinite queue length model, Poisson arrivals and Exponential service times – single server and multi-server. Simulation: Monte Carlo simulation, Simulation of a waiting line problem, Simulation of inventory model.

Total Periods:45

EXPERIANTIAL LEARNING

CASESTUDIES/ARTICELS:

1. Lufthansa Cargo - Optimizing Capacity Utilization:
   This case study demonstrates how Lufthansa Cargo uses linear programming to optimize the utilization of cargo capacity on its aircrafts and increase profits.
2. DHL - Transport Optimization:
   This case study showcases how DHL, a global logistics company, uses transportation optimization models to minimize shipping costs and improve delivery times.
3. Amazon - Inventory Management:
   This case study examines how Amazon manages its inventory using deterministic inventory control models to balance the costs of holding inventory and the costs of stockouts.

RESOURCES

TEXT BOOKS:

1. Hamdy A Taha, Introduction to Operations Research, Pearson India,10th Edition,2017
2. J. K. Sharma, Operations Research: Theory and Applications, Macmillan, NewDelhi, 5th Edition,2013.

REFERENCE BOOKS:

1. Hillier, Libermann, Introduction to Operations Research, Mc Graw Hill Education (India) Private Limited, 10th Edition, 2017.
2. Kanti Swarup, P.K. Gupta, Manmohan, Operations Research, Sultan Chand&Sons, 2019.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=4U3B5lr-MqM
2. https://www.youtube.com/watch?v=Q31jKiEXxdc
3. https://www.youtube.com/watch?v=Dmw3OsyT5yw

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME101009	**OPERATIONS MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Operations Management, forecasting, production planning strategies, materials requirements planning

COURSEOUTCOMES:

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

CO1. Apply operations strategy through strategic means, measures and decisions for attaining operational excellence.

CO2. Model demand forecasting problems and develop accurate forecasts

CO3. Apply aggregate production planning techniques to order optimal material quantities.

CO4. Demonstrate lean management strategies for creating a stable workflow based on actual customer demand.

CO5. Apply operation scheduling and control issues for smooth production.

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	-	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	-	-	-	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***

COURSE CONTENT

Module 1: OPERATIONS MANAGEMENT CONCEPTS (09 Periods)

Introduction, Historical development, Information and Nonmanufacturing systems, Operations management, Factors affecting productivity, international dimensions of productivity, environment of operations, Production systems decisions.

Module 2: FORECASTING DEMAND (09 Periods)

Forecasting: objectives and uses, forecasting variables, Opinion and judgmental methods, Time Series Methods: Moving Average Method, Weighted Moving Average Method, Exponential smoothing, Regression and correlation methods; Application and control of forecasts.

Module 3: AGGREGATE PRODUCTION PLANNING (09 Periods)

Planning hierarchies in operations, Need for aggregate production Planning, Alternatives for managing supply and demand, Basic strategies for aggregate production planning - level, Chase and mixed, Aggregate Production Planning Methods, Master production scheduling. Introduction to aggregate capacity planning.

Module 4: MATERIAL REQUIREMENTS PLANNING & LEAN SYSTEMS (09 Periods)

MRP-underlying concepts, Bill of Material, System parameters, MRP logic, System refinements. Manufacturing Resource Planning, Enterprise Resource Planning. Just-in-Time, Pull method of materials flow, consistently high quality, Small lot sizes, Uniform workstation loads, Standardized components and work methods, Close supplier ties, Flexible workforce, Line flows, Automated production, Preventive maintenance, continuous improvement, Kaizen.

Module 5: MACHINE SCHEDULING & SUPPLY CHAIN MANAGEMENT (09 Periods)

Flow shop scheduling- Introduction, Johnson's rule for 'n' jobs on 2 and 3 machines, CDS heuristic, Palmer's Heuristic; Job scheduling- Types of schedules, Heuristic procedure, scheduling 2 jobs on 'm' machines, Supply chain components, Supply chain structures, Bullwhip effect, Role of information technology in Supply Chain Management

Total Periods: 45

EXPERIENTIAL LEARNING

1. Simulation Game: Students participate in a business simulation game where they manage the operations of a virtual company. They make decisions regarding production systems, productivity factors, and international dimensions of productivity to understand their impact on overall business performance.

2. Case Study Analysis: Students analyze real-world case studies of companies that faced challenges in forecasting demand. They examine the forecasting methods used, identify their strengths and weaknesses, and propose alternative approaches for better demand forecasting.

3. Group Project: Students form teams and simulate the process of aggregate production planning for a fictional company. They develop various strategies (level, chase, mixed) and create production plans based on different scenarios. They evaluate the effectiveness of each strategy and present their findings.

4. Factory Visit: Students visit a manufacturing facility that utilizes Material Requirements Planning (MRP) and Lean Systems. They observe the implementation of MRP in real-time and interact with employees to understand the challenges and benefits. They also analyze the lean manufacturing practices employed in the facility.

5. Supply Chain Simulation: Students participate in a supply chain management simulation exercise where they play different roles in the supply chain, such as manufacturer, distributor, and retailer. They experience the bullwhip effect and learn how information technology can be utilized to mitigate its impact.

RESOURCES

TEXT BOOKS:

1. B.Mahadevan, *Operations Management*, Pearson education, 2nd edition, 2010.
2. Everett E. Adams and Ronald J. Ebert, *Production and Operations Management*, PHI Learning, 5th edition, 2009.
3. Lee J Krajewski, Larry P Ritzman and M K Malhotra, *Operations Management – Processes and Value Chains*, 8th edition, 2008.

REFERENCE BOOKS:

1. S N Chary, *Production and Operations Management*, Tata-McGraw-Hill education (India), Pvt limited, 2013.
2. Monks J.G., *Operations Management*, Schaum's outline series, McGraw-Hill International Edition, 5th edition, 1996.
3. R Pannerselvam, *Production and Operations Management*, PHI learning, 2nd edition, 2009.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=fE-Z1RlFnLY
2. https://www.youtube.com/watch?v=EohOF0IdArE
3. https://www.youtube.com/watch?v=7fDr7kiLRxk
4. https://www.youtube.com/watch?v=1kU8HG5Y9Kc
5. https://www.youtube.com/watch?v=xZs7WsNPJXY

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101010	**TOOL DESIGN**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides the Basic cutting parameters; Determination of cutting forces; design of single and multi-point cutting tools; design of dies; design of jigs and fixtures.

COURSE OUTCOMES:

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

CO1. Demonstrate the knowledge of cutting tools and tool cost estimation for machining of materials.

CO2. Design single point cutting tools for effective metal removal.

CO3. Design multi-point cutting tool for effective metal removal rate and enhanced productivity.

CO4. Design dies for sheet metal operations.

CO5. Design jigs and fixtures for holding the work and guiding the tool.

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	-	-	-	-	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	-	-
CO5	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: INTRODUCTION TO CUTTING TOOLS (09 Periods)

Introduction, Different types of cutting tools used for machining, Designation of cutting tools, Types of systems used for designating cutting tools, Selection of tool material, Types, Properties and Characteristics of tool Material, Tool wear, Tool life criteria, variables affecting tool life and machinability, Taylor's tool life equation, Types of coolants, Elements of machining cost, Tool cost estimation.

Module 2: DESIGN OF SINGLE POINT CUTTING TOOLS (09 Periods)

Introduction, Basic Elements, Design of Tool Shank, Geometry of single point cutting tool, Nomenclature of single point cutting tool, Influence of Various Angles on Tool Design, Calculation of Forces and Design for Cutting Forces, Mechanics of orthogonal cutting, Merchant's circle diagram, Geometry and their interrelation, Theories of formation of chip and their effect.

Module 3: DESIGN OF MULTI POINT CUTTING TOOLS (09 Periods)

Introduction, Classification of multi point cutting tools, Drill geometry, Design of Drills, Rake & Relief angles of twist drill, Speed, Feed and depth of cut, Machining time.

Milling cutters: Up milling & down milling, Cutting speeds and Feed machining times-Design of form cutters, combination tools & reamers.

Module 4: DESIGN OF DIES FOR SHEET METAL OPERATIONS (09 Periods)

Design of sheet metal blanking and piercing: Fundamentals of die cutting operations, Types of presses, Die block design, Punch design, Cutting action in a die, Die clearance, Considerations in Press Tool Design, Design procedure for blanking die.

Design of sheet metal bending, forming, drawing and forging dies:

Bending dies, Forming dies, Drawing dies, Determination of blank size, Drawing force, Design procedure for a drawing die, Forging design, Design of forging dies.

Module 5: DESIGN OF JIGS AND FIXTURES (09 Periods)

Introduction, Concept of degrees of freedom, 3-2-1 principle of location, Principles of location and clamping for jig and fixtures design, Different types of locators and clamps, Jig bushes and its types, Different types of jigs and its design, Essential features of different types of fixtures, Design of fixtures, Indexing jigs and fixtures, Automatic clamping devices.

Total Periods: 45

EXPERIENTIAL LEARNING

1. List out the various examples of mechanics applications in daily life and explain them through Mechanics Principles.
2. Prepare models to show equilibrium of concurrent force system and nonconcurrent force system.
3. Visit Science centre, observe and experience the models related to Mechanics to gain practical knowledge and submit the reports.

(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.

RESOURCES

TEXT BOOKS:

1. Donaldson, Lecain and Goold, *Tool Design*, Tata McGraw Hill, 4th edition, 2012.
2. G.R.Nagpal, *Tool Engineering & Design*, Khanna Publishers, Tata McGraw Hill, 6th edition,2008.

REFERENCE BOOKS:

1. Surendra Kenav and Umesh Chandra, Satyaprakashan, *Production Engineering Design (Tool Design)*, New Delhi.
2. Amitabha Battacharya and Inyong Ham, *Design of Cutting Tools use of Metal Cutting Theory*, ASTME Publication, Michigan USA.
3. V.Arshinov, G.Alekseev, *Metal Cutting Theory and Cutting Tool Design*, MIR Publications.

WEB RESOURCES:

1. https://dokumen.tips/documents/nptel-metal-cutting-and-tool-design.html?page=1
2. https://alison.com/course/introduction-to-machining-and-tool-geometry

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101011	**COMPOSITE MATERIALS**	**3**	**-**	**-**	**-**	**3**

Pre-Requisite: - Materials Science and Engineering

Anti-Requisite: -

Co-Requisite : -

COURSE DESCRIPTION:

Composite materials and their classifications; various matrices and reinforcements; manufacturing process of various composites; analyzing the properties of composite materials.

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

CO1: Demonstrate types of composite materials for various engineering applications.

CO2: Analyze the effect of fibre length, fibre orientation and concentration on composite properties.

CO3: Demonstrate various manufacturing process for composite fabrication using suitable diagrams.

CO4: Apply appropriate joining and machining techniques and explore the challenges involved in those processes.

CO5: Analyze the failure behaviour during testing of composite materials.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	2	3	-	-	-	-	-	3	-	-
CO2	3	3	2	-	-	1	3	-	-	-	-	-	3	-	-
CO3	3	3	2	-	-	2	2	-	-	-	-	-	3	-	-
CO4	3	2	2	-	-	1	3	-	-	-	-	-	3	-	-
CO5	3	3	1	-	-	2	3	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**2**	**-**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO COMPOSITE MATERIALS (09 periods)

Composite Materials: Definition -Special Features of Composites - Drawbacks of Composites - Classification of Composite Materials: Particle Reinforced Composites - Dispersion Strengthened Composites - Fiber Reinforced Composites -Structural Composites, Processing techniques for Composite materials, Applications and Barriers of Composite Materials.

Module 2: RAW MATERIALS FOR COMPOSITE PRODUCTION (09 periods)

Matrix Phase: Types and Functions, **Reinforcements Phase:** Types and Functions, Effect of reinforcement (Fiber length, Fiber orientation and Concentration) on overall composite performance, Fabrics and its types, Prepegs and its types, Preforms and Honeycomb Materials, Molding compounds and its types.

Module 3: MANUFACTURING PROCESS OF COMPOSITES (09 periods)

Manufacturing Process: Basic Steps in a Composites Manufacturing Process.

Manufacturing Processes for Thermoset Composites: Prepegs Lay-Up Process, Wet Lay-Up Process, Spray-Up Process, Filament Winding Process, Pultrusion Process, Resin Transfer Molding Process, Compression Molding Process, Roll Wrapping Process, Injection Molding Process.

Manufacturing Processes for Thermoplastic Composites: Thermoplastic Tape Winding, Thermoplastic Pultrusion Process, Part Fabrication, Autoclave Processing, Diaphragm Forming Process, Injection Molding.

Module 4: JOINING AND MACHINING OF COMPOSITES (09 periods)

Joining: Definition, principles, selection and design guidelines surface preparation, types, advantages, limitations and failures modes in adhesive joints, Mechanical joints: Principles, types, advantages, limitations, design parameters, failure modes

Machining: Objectives of Machining, Challenges during Machining of Composites, Failure Mode during Machining of Composites, Cutting tools, Types of machining operations.

Module 5: TESTING OF COMPOSITES (09 periods)

Testing of Composites: Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing; Non – Destructive testing.

Total Periods: *45*

EXPERIENTIAL LEARNING

1. List out the various applications of natural composites, explain the characteristics of natural fibers.
2. Illustrate and give all the details explain filament winding process used to manufacture polymer matrix composites.
3. Write a program to add two multi-byte number and store the result as a third number. The number are stored in the form of the byte lists stored with the lowest byte first

(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. Sanjay K. Mazumdar, *"Composites Manufacturing - Materials, Product and Process Engineering",* CRC Press LLC, 1st edition, USA, 2002.
2. Deborah D. L. Chung, "Composite Materials – Science & Applications", 2nd edition, Springer
   Verlag, USA, 2009.

REFERENCE BOOKS:

1. Daniel B. Miracle and Steven L. Donaldson, ASM Handbook, "Composites", ASTM International, Vol-21, 2001.
2. William. D. Callister, *"Materials Science and Engineering-An Introduction",* John Wiley and sons, 7th edition, USA, 2007.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/104/112104229/
2. https://nptel.ac.in/courses/112104168

WEB RESOURCES:

1. https://mrcet.com/downloads/digital_notes/ME/III%20year/COMPOSITE%20%20MATERIALS%20NEW.pdf
2. http://www.gcekjr.ac.in/pdf/lectures/2020/4667I_5th%20Semester_Metallurgical%20And%20Materials%20Engineering.pdf

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101012	**DESIGN OF TRANSMISSION SYSTEMS**	3	-	-	-	3

Pre-Requisite Fundamentals of machine Design

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course is to gain knowledge on the principles and procedure for the design of Mechanical power Transmission components. Understand the standard procedure available for Design of Transmission of Mechanical elements and to learn to use standard data and catalogues.

COURSE OUTCOMES:

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

CO1. Design transmission elements like gears, belts, pulleys, bearings from the manufacturer's catalogue.
CO2. Analyze the forces acting and stresses in the machine components for designed mechanical properties.
CO3. Design and Develop effectively Bevel and Worm Gear for different loading conditions.
CO4. Design of multi speed gear box for machine tool applications with standard geometry
CO5. Use empirical relationships for solving complex problems in the design of IC engine parts.

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	2	-	-	-	-	1	-	-	3	-	-
CO2	3	3	1	1	-	-	-	-	-	1	-	-	3	-	-
CO3	3	1	-	1	-	-	-	-	-	-	-	-	3	-	-
CO4	3	1	-	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	1	-	1	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	**1**	**2**	-	-	-	**3**	**2**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: DESIGN OF FLEXIBLE ELEMENTS (09 Periods)

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

Module 2: SPUR GEARS AND PARALLEL AXIS HELICAL GEARS (09 Periods)

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

Module 3: BEVEL, WORM AND CROSS HELICAL GEARS (09 Periods)

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

Module 4: GEAR BOXES (08 Periods)

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications

Module 5: I.C ENGINE PARTS (10 Periods)

Design of I.C Engine Parts: piston, cylinder, Connecting Rod and Crankshaft.

Total Periods: 45

Note: Design data book is permitted for examination

EXPERIENTIAL LEARNING

Assignments

It shall consist of the preparation presentation and submission of assignments by student individually based on above syllabus. (It shall consist of knowledge of above topics, linking above topics and collection of Market standard, ISO standards, Company standards, survey for design of product)

Mini Project

One design Mini-Project is required to submit by group of two students to develop and apply knowledge of Machine Design and drafting software for any product or design system on basis of : (1) idea generation, (2) Creativity, Reliability and safety, (3) bounding solutions (4) Ergonomic Considerations (5) Use of International standards

RESOURCES

TEXT BOOKS:

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill, 3rd Edition, 2010.
2. R.S. Khurmi and J.K. Gupta, Machine Design, S. Chand, 14th Edition, 2012.

REFERENCE BOOKS:

1. Joseph E. Shigley, Mechanical Engineering Design, TMH Publishers, 9th Edition, 2011.
2. T. Krishna Rao, Design of Machine Elements Vol-II, I K International, 1st Edition 2008.
3. **Data Book**: Balaveera Reddy & Mahadevan. Design data Handbook for Mechanical Engineers, CBS publishers, 4th Edition, 2013.

VIDEO LECTURES:

1. https://youtu.be/CyrMpgktYUA
2. https://youtu.be/OssbWRN-gmk
3. https://archive.nptel.ac.in/courses/112/105/112105124/
4. https://archive.nptel.ac.in/courses/112/106/112106137/

WEB RESOURCES:

1. https://nptel.ac.in/courses/112105125
2. https://archive.nptel.ac.in/courses/112/106/112106137/
3. https://onlinecourses.nptel.ac.in/noc21_me06/preview

PROGRAME ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101088	**IOT SYSTEMS DESIGN**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: - Introduction to IoT, - IoT Hardware, - Manufacturing Information Sensing System, - IoT Protocols and Network Layer- IoT Applications

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

CO1. Understand the IoT concept and apply in the field of mechanical engineering

CO2. Explore IoT architecture for mechanical applications

CO3. Implement sensing elements for smart systems

CO4. Apply various Protocols in Networks

CO5. Identify coherence of IoT applications in various fields

CO-PO-PSO MappingTable:

Learning 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	-	-	-	-	-	-	3	-	-
CO2	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO3	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO4	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO5	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	-	**1**	**1**	-	-	-	-	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO IoT (09 Periods)

Definition and Characteristics of IoT, Genesis of IoT, IoT - Digitization, Impact, Convergence, Challenges, and Communication Models - APIs, IoT Network Architecture and Design: Drivers Behind New Architectures– Scale, Security, constrained Devices and Networks, Data, Legacy Device Support, Comparing IoT Architectures, M2M IoT standardized Architecture, IoT OSA Layer - Simplified IoT Architecture - Core IoT Functional Stack – Layer 1 to 3.

Module 2: IoT HARDWARE (09 Periods)

Introduction to Hardware used for IoT, Comparison of Microprocessors and Microcontrollers, Peripheral Interface Controller (PIC)- pin diagram, architecture, - ,Advanced Risc Machine (ARM) - Architecture. IoTplatforms design methodology, IoT physical devices and Endpoints, Open Source Microcontroller – pin diagram , Programming, Open Source Microprocessor - Hardware Layout, Operating system Programming.

Module 3: MANUFACTURING INFORMATION SENSING SYSTEM (09 Periods)

Real-Time and Multisource Manufacturing Information Sensing System, Sensor and Multiple sensor management system, RFID reader, Temperature and humidity sensor, Displacement sensor, Acoustic Emission,Acceleration sensor, Piezo electric Sensor, Smart water and electricity meters. Reconfigurable Manufacturing Systems (RMS), Manufacturing Grid (M- Grid), Cloud Manufacturing.Case studies on IoT Sensors and Smart system in Industries - Smart Assembly Station, Smart Trolley, Production Scheduling System.

Module 4: IOT PROTOCOLS AND NETWORK LAYER (09 Periods)

IoT protocols: Bluetooth, Zigbee, 6 LoWPAN Zigbee, Routing Protocol, Cognitive RPL (CORPL), Lossy Network, Channel Aware Routing Protocol (CARP), Dynamic Host Configuration Protocol (DHCP), Internet Control Message Protocol (ICMP), MAC Layer, Network layer- IPv4, IPv6. IoT Transportation layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Datagram Congestion Control Protocol (DCCP), Stream Control Transmission Protocol (SCTP), IoT service layer, IoT Security layer, MAC 802.15 and its applications.

Module 5: IoT APPLICATIONS (09 Periods)

Architecture for connected factory- Converged Plantwide Ethernet (CPwE) design, Architecture. Real-Time Location System (RTLS), Industrial automation control-EtherNet / IP, PROFINET, Media Redundancy Protocols (MRP), Industrial safety using Industrial Demilitarized Zone (DMZ), Edge Computing. Case study on IoT devices - Oil and Gas Industry, power utility Industry, supply chain management, Biomechanics,autonomous vehicle.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Begin with understanding what IoT (Internet of Things) is and its basic components like sensors, actuators, connectivity protocols (e.g., MQTT, CoAP), and IoT platforms.
2. Knowledge of JavaScript, Python, or Node.js can be beneficial for backend IoT applications.
3. Progress to more complex projects involving multiple sensors, actuators, and data processing.
4. Understand IoT security principles, including data encryption, authentication mechanisms, and secure firmware updates.
5. Learn industry best practices for designing scalable, secure, and interoperable IoT solutions.

RESOURCES

TEXTBOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet Things", First Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978 – 9386873743).
2. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on Approach)", First Edition, VPT, 2014 (ISBN: 978 – 8173719547).
3. Jonathan Follet, Designing for Emerging Technologies – UX for Genomics, Robotics and the Internet of things technologies, O' Reilly, 2014.

REFERENCE BOOKS:

1. Srinivasa K. G, "Internet of Things", CENGAGE Leaning India, 2017
2. Francis DaCosta, "Rethinking the Internet of Things – A Scalable Approach to Connecting Everything", A Press, 2013
3. Raj kamal, Internet of Things: Architecture and Design Principles", First Edition, McGraw Hill Education, 2017. (ISBN: 978 – 9352605224).

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=bdCdKdfDf7o
2. https://www.youtube.com/watch?app=desktop&v=wcqtGJe0oSc

WEB RESOURCES:

1. https://profile.iiita.ac.in/bibhas.ghoshal/IoT_2021/Slides/Lecture2_IoT_System_Design.pdf
2. https://resources.pcb.cadence.com/blog/2022-iot-design-tips-and-methodologies

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102011	**FINITE ELEMENT METHOD**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

The purpose of this course is to enable the students to appreciate the need for Finite element analysis and to develop the basic abilities of modelling and analysing the mechanical engineering problems. The course is analytical in nature and needs fair knowledge of Mathematical and computing. It include topic such as Discretization; Formulation of finite element expression; Finite Element approach to solve 1-D problems; beams; trusses; CST problems; Heat transfer problems and Dynamic analysis problems.

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

CO1. Apply FEM principles and approaches for solving One-dimensional field problems.

CO2. Analyse element stiffness matrices and shape functions for formulation of mathematical models to find stresses in trusses and beams.

CO3. Analyse CST element and axi-symmetric element for formulation of mathematic models and solve it by using Finite Element Methods.

CO4. Analyse iso-parametric elements and heat transfer problems for formulations mathematic models and solve it by using Finite Element Methods.

CO5. Analyse Lumped mass matrix and Eigen vectors for formulation of models and solve vibration analysis 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	-	-	2	-	-	-	-	-	-	3	3	3
CO2	3	3	3	-	-	2	-	-	-	-	-	-	3	-	3
CO3	3	3	3	-	-	2	-	-	-	-	-	-	3	-	3
CO4	3	3	3	2	-	2	-	-	-	-	-	-	3	-	3
CO5	3	3	3	2	1	2	-	-	-	-	-	-	3	3	3
Course Correlation Mapping	**3**	**3**	**3**	**2**	**1**	**2**	-	-	-	-	-	-	**3**	**3**	**3**

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

COURSE CONTENT

Module 1: INTRODUCTION TO FINITE ELEMENT METHOD (09 Periods)

Introduction to Finite Element Method for solving field problems, Stress and Equilibrium, Strain - Displacement relations, Stress - strain relations,

One-dimensional finite element method: Bar elements, Finite element modelling, coordinates and shape functions, Element matrices, assembling of global stiffness matrix and load vector, Principle of minimum potential energy, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element.

Module 2: TRUSSES & BEAMS (09 Periods)

Trusses: Plane trusses, local and global coordinate systems, formulation for direction cosines, Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, and temperature effects.
Beams: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses

Module 3: TWO-DIMENSIONAL & AXI-SYMMETRIC MODELS (09 Periods)

Two dimensional problems: Basic concepts of plane stress and plane strain, stiffness matrix of Constant Strain Triangle (CST) element, finite element solution of plane stress problems.
Axi-symmetric model: Finite element modelling of axi-symmetric solids subjected to axi-symmetric loading with triangular elements.

Module 4: ISO-PARAMETRIC FORMULATION & HEAT TRANSFER ANALYSIS (11 Periods)

Iso-parametric formulation: Sub parametric, super parametric and iso-parametric elements, 2 dimensional 4 noded iso-parametric elements, numerical integration.
Heat transfer problems: One-dimensional finite element formulation of heat transfer with conduction, convection and Heat transfer through fins, Two-dimensional finite element formulation.

Module 5: DYNAMIC ANALYSIS (07 Periods)

Introduction to dynamic considerations, Hamilton's principle, Dynamics of spring mass system, consistent mass matrix, Formulation of FEM model, element matrices, One-dimensional bar, truss, CST elements, Lumped mass matrices, Evaluation of Eigen values and Eigen vectors for a stepped bar and beam element. List of FEM software packages.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Simulate the stress concentration phenomena on a flat plate with central hole under the application of tensile load.
2. Determination of deflection and stresses in 2D trusses and beams.
3. Determination of deflections component and principal and Von-Mises stresses in simple 3D plane and axisymmetric components.
4. 2D problem with conduction and convection boundary conditions
5. Conductive heat transfer Analysis of plane and axisymmetric components
6. Simple fluid flow and heat transfer problems
7. Modal analysis of cantilever beam
8. Modal analysis of Simply supported beam and find Eigen values.
9. Convective heat transfer Analysis of 2D components.
10. Harmonic, transient and spectrum analysis of simple systems

RESOURCES

TEXT BOOKS:

1. Tirupati R. Chandrupatla & Ashok D. Belegundu, "*Introduction to Finite Elements in Engineering"*, 3rd Edition, PHI learning, 2011
2. Daryl L. Logan, "First course in the Finite Element Method", 4th Edition, Cengage Learning, 2007

REFERENCE BOOKS:

1. Rao, S. S., "Finite Element Methods in Engineering", 5th Edition, Elsevier, 2012.
2. Reddy J. N., "An Introduction to Finite Element Method," 3rd Edition, Tata Mc Graw-Hill 2005

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112104116
2. https://nptel.ac.in/courses/112106135

WEB RESOURCES:

1. https://www.simscale.com/blog/what-is-finite-element-method/
2. https://www.comsol.com/multiphysics/finite-element-method
3. https://www.jousefmurad.com/fem/the-finite-element-method-beginners-guide/
4. http://www.scholarpedia.org/article/Finite_element_method

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101013	**DESIGN OF AUTOMOTIVE COMPONENTS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course is designed to provide fundamental knowledge and skills to the students that are needed to design the commonly used automobile components. Imparts insights to steering mechanism, suspension systems and its importance in ride comfort and stability.

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

CO1. Apply knowledge to select suitable material for a given product and understand the steps involved in selection standards.

CO2. Understand the design consideration to control the emission and noise.

CO3. Understand the basics of mechanism of the suspension system and elements of suspension system.

CO4. Analyse the steering systems of the vehicles and understand its design criteria's.

CO5. Understand the loads moments acting on the frames and chassis of the vehicle and demonstrate the design of its components.

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	3	-	-	-	-	-	3	-	-
CO2	3	3	1	-	-	2	3	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	1	3	-	-	-	-	-	3	-	-
CO4	2	2	-	-	-	2	2	-	-	-	-	-	3	-	-
CO5	2	2	-	-	-	2	2	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**1**	**-**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: DESIGN CONSIDERATION (10 Periods)

Materials processing and design: Role of processing in design, Overviews of manufacturing processes and relation to design: casting, forging, sheet metal forming, machining, powder metallurgy, welding, heat treatment, assembly, Other factors affecting the design process and material properties, type of loading, stress concentrations, corrosion resistance, wear and abrasion resistance

Risk, reliability and safety: Risk and society: regulations, standards, risk assessment, Probabilistic approach to design, Reliability theory, failure rates, system reliability, Design for reliability, hazard analysis, fault tree analysis, Maintenance and repair.

Module 2: EMISSION AND NOISE CONTROL (09 Periods)

Design strategies to control emission from engines, effect of design and operating parameters on emission concentrations, modification in the engine design, exhaust

Emission control.

Noise, Vibration And Harshness, Sources of Noise, Measurement of Noise -Engine combustion noise, Inlet And Exhaust Noise, Traffic Noise, Vehicle Body Noise - control of noise.

Module 3: SUSPENSION SYSTEM (10 Periods)

Introduction, Types of suspensions, role of suspensions, Wheel travel requirement, Sprung & Unsprung mass distribution, Calculation of Tyre rolling radius, checking of camber change & Toe Change, front view swing arm length, side view swing arm length, Calculation of Jacking force & its effects on suspension, Camber change rate, Wheel base and wheel track change, Anti Dive and Anti-squat consideration

Dampers: Type of dampers, design of damper and its components, damping force calculation. Hysteresis curve.

Module 4: DESIGN OF STEERING SYSTEM (08 Periods)

Steering mechanism and linkage design for various types of steering gear box, Arrangements and design criterion for mechanical and power steering types, Steering geometry for Ackerman's steering.

Module 5: VEHICLE FRAME AND CHASSIS (08 Periods)

Study of loads-moments and stresses on frame members. Design of frame for passenger and commercial vehicle. Components of chassis, Types of chassis, cross section of chassis, material selection, chassis in passenger, commercial heavy vehicles. Stress calculation in chassis, fatigue analysis.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. **Automobile component drawing**
   A problem related to production drawings including geometric tolerance, fit and tolerance, dimensioning, surface finish of automobile components shall be assigned**.**
2. **I.C. engine component design**
   A problem to analyze and solve the practical problems including design of cylinder, cylinder head, stud bolts, crankshaft, connecting rod, piston assembly, valves and valve train.

RESOURCES

TEXT BOOKS:

1. Heldt P. M., “The Automotive Chassis”, 5th edition, Literary Licensing, LLC, 2012.
2. Giri.N.K, “Automobile Mechanics”, Special Edition, Khanna Publisher, New Delhi-2002

REFERENCE BOOKS:

1. Khurmi R.S., Gupta J.K., “Text Book of Machine Design”, Eurasia Publishing House, New Delhi.
2. Budynas R.G., Nisbett J. K., “Shigley’s Mechanical Engineering Design”, McGraw Hill latest edition.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/107/106/107106088/
2. https://nptel.ac.in/courses/107103084

WEB RESOURCES:

1. https://web.iitd.ac.in/~achawla/public_html/736/3-Automotive_chassis-design-v2.pdf
2. https://www.extrica.com/article/15775
3. https://www.sciencedirect.com/topics/engineering/automotive-component
4. https://www.buildyourownracecar.com/race-car-chassis-basics-and-design/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101014	**ENGINEERING METALLURGY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Iron ores, Alloys and their phase diagrams; various heat treatments; Materials and theirclassifications;FerrousandNonferrousmaterialsapplication;processingtechniques;Materialcharacterization; Analysingtheproperties ofmaterials.

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

CO1. To inculcate knowledge on the concepts of steel making methods using various furnaces and appropriate manufacturing techniques for various metals and alloys.

CO2. Analyze different phase transformations involved in metals and alloys.

CO3. Demonstrate knowledge of dislocation characteristics and strengthening mechanisms.

CO4. Analyzethemechanicalandmicrostructuralpropertiesofmaterialsbyapplicabletests and characterization techniques

CO5. Demonstrate knowledge of powder metallurgy process for manufacturing complex parts.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												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	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-		-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-		-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	-	-	-	-	-	**1**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: MELTINGOFMETALS (08 Periods)

Introduction,Oresof various metals, melting of iron, Blast furnace, Cupola furnace, puddling furnace, melting of steel, Bessemer converter process, L-D process, Basic open-hearth process, Electric furnace Melting of super alloys, Vacuum induction melting, Vacuumarc remelting.

Module 2: PHASE TRANSFORMATIONS (10 Periods)

Introduction-Solidification of metal in Ingot mould–Types of phase transformations – Nucleation and Growth Kinetics – Multiphase transformations, Pearlitic, Bainitic, Martensitic transformations–Formationofaustenite–Precipitationandagehardening–Specialpurpose heat treatment – Ferritic nitro carbonizing, Cementation, Boronizing, Salt nitriding.

Module 3: DISLOCATIONS AND STRENGTHENING MECHANISMS (10 Periods)

Basic Concepts, Characteristics of Dislocations, Slip Systems, Slip in Single Crystals, PlasticDeformation of Polycrystalline Materials, Deformation by Twinning, Strengthening by GrainSize Reduction, Solid Solution Strengthening, Strain Hardening, Recovery, Recrystallization,GrainGrowth.

Module 4: MATERIALTESTINGANDCHARACTERIZATIONTECH NIQUES (08 Periods)

Material Testing: Introduction, Tensile Testing, Hardness, Impact fracture testing, Fatigue,Creep.

Material characterization techniques: Introduction, steps in metallographic specimen preparation, Optical microscope (OM), Scanning electron microscope (SEM), Transmission electron microscope(TEM), X-raydif fraction(XRD), FourierTransform Infra-red Spectroscopy(FTIR).

Module 5: POWDER METALLURGY (09 Periods)

Introduction, Methods of production of metal powders, Atomization process, Electrolysis, Reduction, Mechanical Alloying, Particlesize, Shape and distribution, Mixing,Blending,Compacting,HotIsostaticpressing,ColdIsostaticpressing,Sintering,Applications,Advantagesand limitations of powder metallurgy

Total Periods: 45

EXPERIENTIAL LEARNING

Field trips and site visits: Visiting manufacturing facilities, metallurgical labs, and research centers can provide students with an opportunity to see real-world metallurgical processes in action and gain a better understanding of how metallurgy is applied in industry. Field trips and site visits can also provide students with an opportunity to network with professionals in the field and gain valuable industry insights.

RESOURCES

TEXT BOOKS:

1. AvnerS."*IntroductiontoPhysicalMetallurgy*",TataMcGrawHill,2ndEdition, 2001.R.
2. Balasubramaniam, Callister's Materials Science & Engineering, John Wiley and sons, 2nd edition, 2014.

REFERENCE BOOKS:

1. Agrawal B.K. "Introduction to Engineering Materials", Tata McGraw Hill, 1st Edition, 2007.
2. George E Dieter, Mechanical Metallurgy, Tata McGraw Hill, 3rd edition, 2013

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=wVZkdWEZv80&list=PLfIFNJ1DPG4k-kCcsI87fO7rwq9E4rQhh&index=5
2. https://www.youtube.com/watch?v=-IsH4dsjO4w&list=PLfIFNJ1DPG4k-kCcsI87fO7rwq9E4rQhh&index=12

WEB RESOURCES:

1. https://www.matweb.com/
2. https://www.asminternational.org/
3. https://www.wiley.com/enus/Materials+Science+and+Engineering%3A+An+Introduction%2C+10th+Edition-p-9781118324578

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102012	**MECHATRONICS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion and hands-on experience on Mechatronics system; Sensors; Transducers; Pneumatic and hydraulic actuation system, Mechanical and electrical actuation systems, signal conditioning and process controllers, also enables to make simple projects.

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

CO1. Design mechatronic systems considering components, control systems and ethics as design constraints.

CO2. Demonstrate the knowledge on actuation systems used in automation.

CO3. Demonstrate the knowledge of sensors and transducers to monitor and control the behavior of a process.

CO4. Demonstrate knowledge on programmable logic controllers and its integration in various applications

CO5. Demonstrate the knowledge on signal conditioning and process controllers used in mechatronics.

CO6. Work individually or in a team to solve problems in mechatronics approach 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	-	3	-	-	-	-	3	-	-
CO2	3	1	1	1	-	1	-	-	-	1	-	-	3	-	-
CO3	3	1	-	1	-	1	-	-	-	-	-	-	3	-	-
CO4	3	1	-	1	-	1	-	-	-	-	-	-	3	-	-
CO5	3	1	-	1	-	1	-	-	-	-	-	-	3	-	-
CO6	1	1	-	-	-	1	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**1**		**1**		**3**	**3**	**3**			**3**		

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

COURSE CONTENT

Module 1: MECHATRONICS SYSTEMS (09 Periods)

Definition, Elements of mechatronics System, Difference between Traditional and mechatronics system, Measurement systems, Control systems, Examples of Automatic control systems: Examples - Automatic car parking gate system, Washing machine, Automatic Camera, Pick and Place Robot arm, Advantages and Disadvantages of mechatronics systems. Mechatronics approach to design, Ethics as design constraint.

Module 2: ACTUATION SYSTEMS (09 Periods)

Mechanical Actuation systems-Mechanical Systems, Electrical Actuation systems, Pneumatic and hydraulic Actuation systems: Basic Elements, Directional control valves, Pressure control valves, Cylinders, Process control valves, Rotary actuators

Module 3: SENSORS AND TRANSDUCERS (09 Periods)

Sensors: Introduction, Types of and sensors and transducers, Performance terminology. Static and dynamic Characteristics; Displacement sensors, Position sensors, Acceleration-Piezoelectric accelerometer, Temperature sensors, Light sensors, Selection of Sensors.

Module 4: PROGRAMMABLE LOGIC CONTROLLER (09 Periods)

Introduction to PLC's, basic structure, Principle of operation, Programming and concept of ladder diagram, concept of latching & selection of a PLC. Integration: Introduction & background, Advanced actuators, Pneumatic actuators, Industrial Robot, different parts of a Robot-Controller, Drive, Arm, End Effectors, Sensor & Functional requirements of robot.

Module 5: SIGNAL CONDITIONG AND PROCESS CONTROLLERS (09 Periods)

Process Controller - Principles, Two position controller, Proportional (P) controllers, Integral (I) controllers, Derivative (D) controllers; Composite controller Modes – Proportional Integral (PI), Proportional Derivative (PD), Three mode controller (PID); Selection of controllers, Syllabus

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Identification and familiarization of the following components: resistors, inductors, Capacitors, diodes, transistors, LED's.
2. Familiarization with the following electrical machines: Induction motors, DC motors, synchronous motors, single phase motors.
3. Familiarization with the following mechanical components: gears, gear train, bearings, couplings, tachometer
4. Run the stepper motor at different speed and different direction
5. To design a voltage regulator using zener diode. Discuss the behavior of the regulator for various loads.
6. To verify truth tables of various logic gates and flip flops

7. To study Position sensors and compare with ideal characteristics
8. To measure the characteristics of LVDT using linear displacement trainer kit.
9. To study Range sensors and compare with ideal characteristics
10. To study Optical sensors and compare with ideal characteristics
11. A/D and D/A Conversion
12. Study of robot end effectors
13. Machine Vision System

RESOURCES

TEXT BOOKS:

1. Bolton, "Mechatronics", Pearson, Singapore.
2. Mahalik, "Principles, concepts and applications Mechatronics", TMH.

REFERENCE BOOKS:

1. Ramesh Gaonkar, "Introduction to 8085-PENRAM", International Publishing.
2. Mechatronics by HMT Ltd. – Tata McGrawHill, 1 st Edition, 2000. ISBN:9780074636435.
3. NitaigourPremchandMahalik , Mechatronics-Principles, Concepts and Applications, Tata McGraw Hill, 1stEdition, 2003 ISBN.No. 0071239243, 9780071239240.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me27/preview
2. https://uwaterloo.ca/mechanical-mechatronics-engineering/current-students-mechatronics-engineering/mechatronics-capstone-engineering-projects

WEB RESOURCES:

1. http://emcoep.vlabs.ac.in/Exp8/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines
2. http://ee-iitb.vlabs.ac.in/ee-iitb/exp1/index.html
3. http://slcoep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab
4. http://vlab.amrita.edu/index.php?sub=59&brch=165&sim=903&cnt=2
5. http://vlabs.iitkgp.ernet.in/be/exp1/index.html

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102013	**HYDRAULICS AND PNEUMATICS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion and hands-on experience on Basic fluid power system; Hydraulic components and its use; Hydraulic circuits and its application; Fundamentals of pneumatics; Pneumatic components and its use; Pneumatic circuits; Application; Design of hydraulic and pneumatic systems for various applications; Logic gates, PLC in Pneumatics.

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

CO1. Introduce basics of Hydraulics and pneumatics

CO2. Describe Various components of hydraulic system and maintenance of hydraulic system

CO3. Design the hydraulic circuits

CO4. Explain the Pneumatic system and its components.

CO5. Illustrate electro pneumatic control in multi cylinder applications

CO6. Demonstrate the design and analyse of hydraulic and pneumatic circuits

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO1	PO2	PO6	PO1	PO2	PO9	PO1	PO2	PO12	PO1	PO2	PSO3
CO1	3	1	1	1	2	1	-	-	-	-	-	-	3	-	-
CO2	3	3	-	1	-	1	-	-	-	-	-	-	3	-	-
CO3	3	3	3	1	-	1	-	-	-	-	-	-	3	-	-
CO4	3	2	2	1	-	1	-	-	-	-	-	-	3	-	-
CO5	3	2	-	1	-	1	-	-	-	-	-	-	3	-	-
CO6	3	2	-	1	-	1	-	-	3	3	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**-**	**-**

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

COURSE CONTENT

Module 1: INTRODUCTION TO HYDRAULIC POWER (09 Periods)

Introduction to Hydraulic Power, Pascal's law, Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance.

Hydraulic Actuators and Motors: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors and piston motors.

Module 2: CONTROL COMPONENTS IN HYDRAULIC SYSTEMS (09 Periods)

Control Components in Hydraulic Systems: Directional Control Valves, spool valve, pressure control valves – direct and pilot operated types, flow control valves.

Maintenance of Hydraulic systems: Hydraulic oils – Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.

Module 3: HYDRAULIC CIRCUIT DESIGN AND ANALYSIS (09 Periods)

Hydraulic Circuit Design and Analysis: Control of single and Double – acting Hydraulic cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits

Module 4: PNEUMATIC CONTROLS (09 Periods)

Choice of working medium, characteristics of compressed air, preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air- Piping layout.

Pneumatic Actuators: Linear cylinders, end position cushioning, seals, Rod – less cylinder, Rotary cylinder, poppet valves, slide valves, suspended seat type slide valve. Direct and indirect actuation pneumatic cylinders.

Module 5: MULTI-CYLINDER APPLICATIONS (09 Periods)

Coordinated and sequential motion control, Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Electro-Pneumatic control: Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Design and testing of hydraulic circuits
2. Design and testing of pneumatic circuits
3. Simulation of basic hydraulic and pneumatic circuits
4. Study of PLC on Automation production system
5. Study of robotic end effectors, robotic arm and its configurations.
6. Electro pneumatic circuit to control the single acting cylinder
7. Design/modeling of any two different types of grippers.
8. Exercise on pick and place robot in robot simulation software
9. Two case studies of applications in industry
10. Electro-pneumatic circuit for extension and Retraction of double acting cylinder.
11. Control the single acting and double acting cylinders using pilot valves
12. Control the single acting and double acting cylinders using pilot valves

RESOURCES

TEXT BOOKS:

1. Anthony Esposito, *Fluid Power with applications*, Pearson education, Inc 2000.
2. Andrew Parr, *Pneumatics and Hydraulics,* Jaico Publishing Co. 2000.

REFERENCE BOOKS:

1. S. R. Majumdar, *Pneumatic systems*, Tata McGraw Hill, 1995.
2. Pippenger Hicks, *Industrial Hydraulics*, McGraw Hill, New York. 2001.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/106/112106300/
2. https://archive.nptel.ac.in/courses/112/105/112105047/

WEB RESOURCES:

1. https://archive.nptel.ac.in/content/storage2/courses/112106175/Module%201/Lecture%201.pdf
2. https://www.mekanizmalar.com/menu-pneumatic.html
3. https://pc-coep.vlabs.ac.in/exp/direct-single-acting-cylinder/theory.html

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102014	INDUSTRIAL AUTOMATION AND ROBOTICS	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Automation in Production System; Advanced Automation Functions; Material Handling Systems; GT and Cellular Manufacturing; FMS; Introduction of Robots classifications; Components; Robot programming; Robot Application in Industry; Future Application and Challenges.

COURSE OUTCOMES:

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

CO1. Demonstrate knowledge on Industrial automation components and systems used in automated manufacturing industries.

CO2. Design material handling systems for a manufacturing plant based on its working principle and capabilities.

CO3. Analyze transfer lines in automation involving Manufacturing Cells, GT, Cellular Manufacturing, FMS, and FMS.

CO4. Demonstrate the concepts involved in robot systems.

CO5. Develop programming for robotic applications.

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

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												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	3	1	1	1	-	-	-	-	-	-	3	-	-
CO3	3	3	1	-	1	1	-	-	-	-	-	-	3	-	-
CO4	3	1	-	-	1	1	-	-	-	-	-	-	3	-	-
CO5	3	3	3	1	1	1	-	-	-	-	-	-	3	-	-
CO6	3	2	1	-	1	-	-	-	-	3	3	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO AUTOMATION (09 Periods)

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

Module 2: MATERIAL HANDLING SYSTEMS (09 Periods)

Overview of Material Handling Systems, Rotary feeders, oscillating force feeder, vibratory feeder, elevator type and Centrifugal type feeders, Principles and Design Consideration, Material Transport Systems, Storage Systems.

Module 3: AUTOMATION IN MANUFACTURING (09 Periods)

Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation, Flow lines &Transfer Mechanisms, Fundamentals and Analysis of Transfer Lines, product design for automatic assembly.

Module 4: INTRODUCTION TO ROBOTICS (09 Periods)

Robot, Brief History, Classifications, Laws of Robotics, Robotic system, Robot anatomy, common robot configurations, coordinate system, Joint notation schemes, Work volume, Degrees of freedom, Components, End effectors – Classification of End effectors, Tools as end effectors; Teach pendant, sensors, Specification of robots, Applications, safety measures.

Module 5: ROBOT PROGRAMMING AND APPLICATIONS (09 Periods)

Robot programming: Types, Features of languages and Software packages.

Robot application: Robot Application in Industry, Task programming, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Demonstration of robot configuration.
2. Demonstration of robot with 2 dof, 3 dof, 4 dof etc.
3. Design/modeling of any two different types of grippers
4. Two assignments on programming the robot for applications
5. Two programming exercises for robots
6. Exercise on welding robot in robot simulation software
7. Exercise on pick and place robot in robot simulation software
8. Exercise on robotic simulation software
9. Two case studies of applications in industry
10. Study of automation processes such as Distribution station, Testing station, Pick and place, Fluidic muscle press, and storing.
11. Study of PLC on Automation production system
12. Study of robotic end effectors, robotic arm and its configurations
13. Design and testing of hydraulic circuits
14. Design and testing of pneumatic circuits
15. Simulation of basic hydraulic and pneumatic circuits

RESOURCES

TEXT BOOKS:

1. M.P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education, 4th Edition, 2016.
2. M.P.Groover, Industrial Robotics: Technology, Programming, and Applications, Tata McGraw-Hill Edition 2008.

REFERENCE BOOKS:

1. W.P.David, Industrial Automation, Wiley-Interscience, 1st Edition, 1991.
2. John. J. Craig, Introduction to Robotics: Mechanics and Control, Edition 3, Pearson/Prentice Hall, 2005.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112101098
2. https://archive.nptel.ac.in/courses/112/105/112105249/

WEB RESOURCES:

1. https://kanchiuniv.ac.in/coursematerials/Robotics%20and%20Automations%20material_M_Vinoth%20Kumar.pdf
2. https://vptbgh.odishavikash.com/assets/files/notes/PdfFiles/INDUSTRIAL%20ENGINEERING%20&%20MANAGEMENT.pdf
3. https://cw.fel.cvut.cz/old/_media/courses/b4m36uir/lectures/b4m36uir-lec01-handout.pdf
4. https://mrcet.com/downloads/digital_notes/CSEDS/ROBOTICS%20AND%20AUTOMATION.pdf

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101015	NON-TRADITIONAL MACHINING PROCESSES	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

The course details various non-conventional manufacturing processes. It consists of manufacturing processes classification and necessity of non-conventional manufacturing processes. Also details about the working principle, mechanism of material removal, sources of energy used for material removal, the set up/equipment and relative advantages and disadvantages.

COURSE OUTCOMES:

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

CO1. Demonstrate the knowledge on chemical energy-based machining processes.

CO2. Demonstrate the knowledge on electrochemical energy-based machining processes.

CO3. Demonstrate the knowledge mechanical energy-based machining process

CO4. Demonstrate the knowledge on electrical energy-based machining processes.

CO5. Demonstrate the knowledge on thermal energy-based machining process.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO2	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO3	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO4	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO5	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**1**	-	-	-	**1**	**1**	-	-	-	-	-	**3**	**-**	-

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

COURSE CONTENT

Module 1: CHEMICAL ENERGY BASED PROCESSES (09 periods)

Need for non-traditional machining methods, Classification of modern machining processes, Comparative study of different processes, Considerations in process selection, Materials and its applications.

Chemical machining —Fundamentals - Etchants — Maskant - techniques of applying maskants - Process Parameters — Surface finish and Material removal rate - Applications.

Module 2: ELECTRO-CHEMICAL ENERGY BASED PROCESSES (09 periods)

Principles of ECM- Surface Roughness and Material removal rate- Process Parameters — Electro Chemical Grinding - Electro Chemical Honing — Electro Chemical Deburring-Applications.

Module 3: MECHANICAL ENERGY BASED PROCESSES (09 periods)

Electric Discharge machining (EDM)- working Principle-Process Parameters-Surface Finish and Material Removal Rate- electrode / Tool - Power and control Circuits-Mechanics of metal removal in EDM, process parameters, Selection of tool electrode and dielectric fluids, Methods of surface finish and machining accuracy, Characteristics of spark eroded surface and machine tool selection, Wire EDM-principle & its applications.

Module 4: ELECTRICAL ENERGY BASED PROCESSES (09 periods)

Electric Discharge machining (EDM)- working Principle-Process Parameters-Surface Finish and Material Removal Rate- electrode / Tool - Power and control Circuits-Mechanics of metal removal in EDM, process parameters, Selection of tool electrode and dielectric fluids, Methods of surface finish and machining accuracy, Characteristics of spark eroded surface and machine tool selection, Wire EDM-principle & its applications.

Module 5: THERMAL ENERGY BASED PROCESSES (09 periods)

Electron beam Machining: Generation and control of electron beam for machining, Theory of electron beam machining, Comparison of thermal and non-thermal processes, Applications, Advantages, Limitations.

Laser Beam Machining: General principle and application of laser beam machining, Thermal features, Cutting speed and accuracy of cut, Laser drilling.

Plasma Arc Machining: Principle, Metal removal mechanism, Process parameters, Accuracy and surface finish, Applications, Advantages and limitations.

Total Periods: 45

EXPERIENTIAL LEARNING

- Laboratory exercises - Students may work in a laboratory setting to gain hands-on experience with non-traditional machining processes. This may involve operating machinery, programming CNC machines, and using CAD/CAM software.
- Industry visits - Visiting manufacturing facilities that use non-traditional machining processes can provide students with an opportunity to observe and learn about the processes in action. This can help students understand how these processes are used in industry and the specific challenges and considerations involved.

RESOURCES

TEXT BOOKS:

1. Vijay.K.Jain *"Advanced Machining Processes"* Allied Publishers Pvt. Ltd., New Delhi, 2007
2. Pandey P.C. and Shan H.S. *"Modern Machining Processes"* Tata McGraw-Hill, New Delhi, 2007.

REFERENCE BOOKS:

1. Benedict. G.F. *"Nontraditional Manufacturing Processes",* Marcel Dekker Inc., New York, 1987.
2. Me Geough, *"Advanced Methods of Machining",* Chapman and Hall, London, 1998.
3. Paul De Garmo, J.T. Black, and Ronald. A. Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., 10thEdition, New Delhi, 2012

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=b24ohABQzN8&list=PLbMVogVj5nJQsoFXg-AZPbgAdJbMkHxLn
2. https://www.youtube.com/watch?v=Z0L0e7VzfOg&list=PLv9wpWNoC2_DrbrSV6aMkikw3qW1zit6V.
3. https://ocw.mit.edu/courses/mechanical-engineering/2-830j-nontraditional-machining-processes-spring-2007/lecture-notes/.
4. https://www.youtube.com/watch?v=RUjJ4xPpS50

WEB RESOURCES:

1. https://www.sme.org/technologies/articles/2019/may/manufacturing-engineering-source-guide-non-traditional-machining/
2. https://www.manufacturingtechnologyinsights.com/tag/non-traditional-machining-processes/
3. https://engineeringnotes.net/non-traditional-machining-processes/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101086	**ARTIFICIAL INTELLIGENCE APPLICATIONS IN MECHANICAL ENGINEERING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Introduction to Artificial Intelligence, Machine Learning and its Applications, Artificial Intelligence in Robotics, Deep Learning and its Applications, Application of Artificial Intelligence in Mechanical Manufacturing Industries.

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

CO1. Discuss the basics and the purpose of Artificial Intelligence.

CO2. Illustrate the different applications of Machine learning.

CO3. Apply the concept of AI in Robotics field.

CO4. Evaluate the different applications of deep learning methods

CO5. Apply the concept of Artificial Intelligence in Mechanical and Manufacturing Industries.

CO-PO-PSO Mapping Table:

Learning 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	-	-	-	-	-	-	3	-	-
CO2	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO3	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO4	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO5	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	-	**1**	**1**	-	-	-	-	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO ARTIFICIAL INTELLIGENCE (09 Periods)

Introduction to Al, Problem formulation, Problem Definition, Production systems, Control strategies, Search strategies, Problem characteristics, Production system characteristics, Specialized production systems, Problem solving methods, Problem graphs, Matching, Indexing and Heuristic functions, Hill Climbing, Depth first and Breath first, Constraints satisfaction — Related algorithms, Measure of performance and analysis of search algorithms.

Module 2: MACHINE LEARNING AND ITS APPLICATIONS (09 Periods)

Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation. Linear regression, Decision trees, over fitting. Instance based learning, Feature reduction, Collaborative filtering based recommendation. Probability and Bayes learning, Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM. Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning- case studies..

Module 3: ARTIFICIAL INTELLIGENCE IN ROBOTICS (09 Periods)

Reinforcement Learning- planning and search, localization, tracking, mapping and control- A* search algorithms- path smoothing algorithms - SLAM algorithm- Precision agriculture- Assistance robots-Robot Performance optimization-Case studies.

Module 4: DEEP LEARNING AND ITS APPLICATIONS (09 Periods)

Biological Motivation-Activation function-Cost function- Collaborative filtering-Vectorization-Back Propagation Algorithm with applications -Feed-Forward Neural Network Algorithm-Recurrent Neural Network Algorithm with applications -Convolutional Neural Network with applications.

Module 5: APPLICATION OF ARTIFICIAL INTELLIGENCE IN MECHANICAL MANUFACTURING INDUSTRIES (09 Periods)

Fault diagnosis- Quality inspection- Improving the safety of working places- Material modeling and smart materials-Automobile engineering- building self-driving cars and autonomous vehicles, Auto parking-Machine learning in Machine Tools and Manufacturing Industries

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Start with understanding the fundamentals of artificial intelligence, including machine learning (ML), deep learning, and neural networks. This knowledge forms the basis for understanding AI applications in any field.
2. Explore how AI techniques such as predictive analytics, computer vision, natural language processing (NLP), and reinforcement learning are applied in mechanical engineering contexts. For instance, predictive maintenance using AI algorithms can optimize machinery uptime and reduce downtime.
3. Study real-world applications where AI has been successfully integrated into mechanical engineering processes. This could include automated quality control in manufacturing, autonomous vehicles and robotics in industrial settings, or AI-driven design optimization.

4. Consider the ethical implications of AI applications in mechanical engineering, such as job displacement, safety concerns in autonomous systems, and data privacy issues. Understanding these aspects is crucial for responsible AI deployment.
5. AI is a rapidly evolving field, so be prepared for continuous learning and adaptation. Keeping your skills updated with new tools and techniques ensures you remain competitive in the job market.

RESOURCES

TEXTBOOKS:

1. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA, DOI: 10.4018/978-1-5225-3035-0,2022.ISBN13: 9781522530350
2. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.
3. Haykin Simon., Neural networks a comprehensive foundation, Pearson Education, 2nd Edition, ISBN-13: 978-0138958633, 1997.

REFERENCE BOOKS:

1. Donald.A.Waterman, A guide to expert systems Addison Wesley publishing company , 1997 7.
2. Kaushik Kumar, Divya Zindani, Paulo Davim, Artificial Intelligence in Mechanical and Industrial Engineering , ISBN 9781003011248, CRC Press, 2021.
3. IFR_Artificial_Intelligence_in_Robotics_Position_Paper_V02.pdf

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=NNS6G7T43UI
2. https://www.youtube.com/watch?v=fJ7b40KGPG4

WEB RESOURCES:

1. https://www.youtube.com/watch?v=_-g8PR7XKsE
2. https://www.youtube.com/watch?v=8bmMtPGpaI8
3. http://www.digimat.in/nptel/courses/video/106106126/L01.html
4. http://acl.digimat.in/nptel/courses/video/112103280/L01.html

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101087	**ARTIFICIAL NEURAL NETWORKS AND FUZZY LOGIC**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Essentials of Artificial Neural Networks Artificial Neuron Model, Operations of Artificial Neuron, The Linear Associator, Matrix Memories, Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART), Fuzzy sets, Membership, Uncertainty, Operations, Properties, fuzzy relations, cardinalities, membership functions, Fuzzy Logic System Components Fuzzification, Fuzzy logic control and Fuzzy classification.

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

CO1. Demonstrate the knowledge of the essential principles and models of both biological and artificial neural networks, including the structure and function of biological neurons, the operation of artificial neurons, their characteristics, architectures, and applications of artificial neural networks (ANNs).

CO2. Demonstrate the knowledge of associative memory paradigms, the architecture, training algorithms, stability of Bidirectional Associative Memory (BAM) & Hopfield Networks, and their mathematical foundations inclusive of practical applications.

CO3. Demonstrate the knowledge of the principles and mechanisms of Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART), which encompass competitive learning, vector quantization, self-organized learning networks, and the stability-plasticity dilemma, as well as their training algorithms, architectures, and practical applications.

CO4. Demonstrate the knowledge of classical and fuzzy set theory, including their properties, operations, and relations, as well as the concept of membership and uncertainty.

CO5. Demonstrate the knowledge of the components of fuzzy logic systems, including fuzzification, membership value assignment, rule base development, decision making, and defuzzification methods, as well as their applications in neural networks and fuzzy logic control.

CO-PO-PSO Mapping Table:

Learning 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	-	-	-	-	-	-	-	3	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-	3	-	-
CO3	3	2	-	-	1	-	-	-	-	-	-	-	3	-	-
CO4	3	2	-	-	1	-	-	-	-	-	-	-	3	-	-
CO5	3	2	-	-	1	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	3	2	-	-	1	-	-	-	-	-	-	-	3	-	-

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

COURSE CONTENT

Module 1: NEURAL NETWORKS AND ESSENTIALS OF ARTIFICIAL NEURAL NETWORKS (09 Periods)

Introduction to Neural Networks : Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Potential Applications of ANN.

Essentials of Artificial Neural Networks: Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANNConnectivity, Feed Forward Neural Networks Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.

Module 2: ASSOCIATIVE MEMORIES AND HOPFIELD NETWORKS (09 Periods)

Associative Memories: Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory, Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability Theorem.

Hopfield Networks: Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network.

Module 3: SELF-ORGANIZING MAPS (SOM) AND ADAPTIVE RESONANCE THEORY (ART) (09 Periods)

Self-Organizing Maps (SOM): Introduction, Competitive Learning, Vector Quantization, Self-Organized Learning Networks, Kohonen Networks, Training Algorithms, Linear Vector Quantization

Adaptive Resonance Theory (ART) : Introduction, Stability- Plasticity Dilemma, Feed forward competition, Feedback Competition, Instar, Outstar, ART1, ART2, Applications of ART.

Module 4: CLASSICAL AND FUZZY SETS: THEORY AND APPLICATIONS (09 Periods)

Classical Sets: Introduction to classical sets – properties, Operations and relations;

Fuzzy sets: Introduction, Membership, Uncertainty, Operations, Properties, fuzzy relations, cardinalities, membership functions.

Module 5: FUZZY LOGIC SYSTEMS: COMPONENTS AND APPLICATIONS (09 Periods)

Fuzzy Logic Systems: Components: Fuzzy Logic System Components Fuzzification, Membership Value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

Applications of Fuzzy Logic Systems: Neural network applications: Process identification, Fraction Approximation, Control and Process Monitoring, Fault diagnosis and Load forecasting. Fuzzy logic applications: Fuzzy logic control and Fuzzy classification

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. In a region that is susceptible to fluctuating weather conditions, an agricultural company is investigating the potential of fuzzy logic to implement automated irrigation systems. In order to optimise irrigation scheduling, how could fuzzy logic systems adjust to uncertainties in soil moisture levels and weather forecasts? Detailed plan that delineates the main components and decision-making processes is required.
2. In order to facilitate the early identification of critical conditions, a hospital is contemplating the implementation of fuzzy logic in its patient surveillance systems in intensive care units. Examine the benefits of employing fuzzy logic in comparison to conventional threshold-based monitoring systems. When instituting such a system, what ethical considerations should the hospital consider?
3. A company in a manufacturing environment intends to optimise the production process of a complex chemical compound by implementing a fuzzy logic control system. Outline the specific obstacles that the organisation may encounter in the process of establishing appropriate membership functions and establishing a strong rule base. What strategies would you suggest for surmounting these obstacles?

RESOURCES

TEXTBOOKS:

1. Neural Netwroks, Fuzy logic , Gnenetic algorithms: synthesis and applications by Rajasekharan and Rai- PHI Publication.
2. Introduction to Artificial Neural Systems- Jacek M.Zurada, Jaico Publishing House, 1997.

REFERENCE BOOKS:

1. Neural and Fuzzy Systems: Foundation, Architectures and Applications, - N. Yadaiah and S. Bapi Raju, Pearson Education
2. Neural Netwroks – James A Freeman and Davis Skapura, Pearson, 2002
3. Neural Netwroks – Simon Hykins, Pearson Education.
4. Neural Engineering by C. Eliasmith and CH. Anderson, PHI.
5. Neural Netwroks and Fuzzy Logic System by Brok Kosko, PHI Publications.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_ge07/preview
2. https://pragya.gmrgroup.in/courses/course-v1:GMR_IITKharagpur_NTPEL+127+2021_127/about
3. https://www.coursera.org/learn/neural-networks-deep-learning

WEB RESOURCES:

1. https://www.geeksforgeeks.org/difference-between-neural-network-and-fuzzy-logic/
2. https://www.sciencedirect.com/topics/chemical-engineering/fuzzy-neural-networks
3. https://ieeexplore.ieee.org/document/548204

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101016	**AUTOMOBILE ENGINEERING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:
Basic components and classification of automobiles; Fuel Supply System; Cooling System; Ignition System; Electrical Systems; Electronic Systems; Transmission System; Steering System; Suspension and Braking System.

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

CO1. Demonstrate the knowledge on vehicle structure, chassis layout and fuel supply systems.

CO2. Demonstrate the knowledge on cooling systems and ignition systems used in an automobile.

CO3. Demonstrate the knowledge on electrical and electronic systems used in automobile

CO4. Demonstrate the knowledge on construction and working of transmission systems and steering systems of an automobile.

CO5. Demonstrate the knowledge on construction and working of suspension and braking systems of an automobile

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	-	-	-	-	-	-	-	3	-
CO2	3	1	-	-	-	1	-	-	-	-	-	-	-	3	-
CO3	3	1	-	-	-	1	-	-	-	-	-	-	-	3	-
CO4	3	1	-	-	-	1	-	-	-	-	-	-	-	3	-
CO5	3	1	-	-	-	1	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**1**	-	-	-	**1**	-	-	-	-	-	-	-	**3**	-

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

COURSECONTENT

Module1: AUTOMOBILE BASICS AND FUEL SYSTEMS (09 Periods)

Classification of automobiles, Components of a four wheeler automobile, Chassis and body, Rear wheel drive, Front wheel drive, Four wheel drive, Turbo charging, Super charging, Oil filters, Oil pumps.

Fuel system: S.I. Engine - Fuel supply system, Mechanical and electrical fuel pump, Air and fuel filters, Carburetor types; C.I. Engine - Requirements of diesel injection systems, Types of injection systems, Fuel pump, Types of nozzles, Nozzle spray formation, Injection timing.

Module2: COOLING AND IGNITION SYSTEMS (10 Periods)

Cooling systems: Necessity of cooling system, Requirements of cooling systems, Types, Natural and Forced Circulation System, Thermostat, Types of radiators, Cooling Fan, Water pump, Antifreeze solutions.

Ignition systems: Function of an ignition system, Battery ignition system, Magneto coil ignition system, Electronic ignition system using contact breaker, Capacitive discharge ignition system.

Module3: ELECTRICAL AND ELECTRONIC SYSTEMS (08 Periods)

Electrical Systems: Electrical Systems - Introduction, Charging circuit, Generator, Current – voltage regulator; starting system; Bendix drive mechanism, solenoid switch, lighting systems, Horn, wiper.

Electronic Systems: Electronics Systems - Introduction, Electronic Control Unit (ECU), Variable Valve Timing (VVT), Active Suspension System (ASS), Electronic Brake Distribution (EBD), Electronic Stability Program(ESP) Traction Control System (TCS), Global Positioning System (GPS).

Module4: TRANSMISSION AND STEERING SYSTEMS (10 Periods)

Transmission systems: Types of clutches - Cone clutch, Single and multi plate clutch, Centrifugal clutch; Types of Gear box - Constant mesh, Sliding mesh, Synchromesh gear box; Gear shifting mechanism, Automatic transmission, Propeller shaft, Universal joint, Differential, Real axle arrangement.

Steering systems: Requirements and functions of steering system, Layout of steering system, Steering gears, Steering linkages; Under steering, Over steering, Steering ratio, Steering geometry - Camber, Caster, Toe-in, Toe out; Power steering, Wheel alignment and Balancing.

Module5: SUSPENSION AND BRAKE ACTUATING SYSTEMS (08 Periods)

Suspension systems: Introduction, Functions of suspension system, Elements of suspension systems, Rigid axle suspension system, Torsion bar, Shock absorber, Telescopic damper, Independent suspension system.

Brake actuating systems: Need and functions of braking system, Classification of brakes, Mechanical, Hydraulic, Pneumatic, Vacuum brake systems.

Total Periods:45

EXPERIENTIAL LEARNING

1. Vehicle Design: Students can design and build a small-scale vehicle model to understand the principles of vehicle design, such as suspension systems, steering mechanisms, and braking systems.
2. Engine Management System: Students can learn about the engine management system by building and programming a small-scale engine control unit (ECU) using microcontrollers, sensors, and actuators.
3. Vehicle Testing and Diagnosis: Students can learn about vehicle testing and diagnosis by designing and building a diagnostic tool that can identify and troubleshoot problems in a vehicle's electrical and mechanical systems.
4. Vehicle Dynamics: Students can learn about vehicle dynamics by designing and building a dynamic model of a vehicle using software tools like MATLAB and SIMULINK. They can analyze the vehicle's behavior under different driving conditions, such as acceleration, braking, and cornering.
5. Alternative Fuel Vehicles: Students can learn about alternative fuel vehicles by building and testing a small-scale prototype of an electric, hybrid, or hydrogen fuel cell vehicle. They can study the advantages and limitations of each alternative fuel technology and compare it with traditional gasoline engines
6. Autonomous Vehicles: Students can learn about autonomous vehicles by designing and building a small-scale prototype of an autonomous vehicle using sensors, cameras, and machine learning algorithms. They can study the challenges and opportunities of autonomous driving and evaluate its impact on society and the environment.

RESOURCES

TEXTBOOKS:

1. Dr. Kirpal Singh, Automobile Engineering, Vol.1&Vol.2, Standard Publishers distributor, 12th edition, 2011
2. R.K.Rajput, Automobile Engineering, Lakshmi Publication, 2nd Edition, 2014.

REFERENCEBOOKS:

1. V.M.Domkundwar, Automobile Engineering, Dhanpat Rai & Co, 1st Edition, 2013.

2. V.Ganesan, IC Engines, Tata McGraw-Hill, 3rd Edition, 2007.

VIDEOLECTURES:

1. "Automotive Engineering Fundamentals" by Chad Kennedy: https://www.youtube.com/watch?v=QXGyKxTVE7s
2. "Engine Technology International" by UKIP Media & Events: https://www.youtube.com/user/ETIOnline
3. "Automotive Suspension Design Basics" by Engineering Explained: https://www.youtube.com/watch?v=4G5WUYW8BHU
4. "Automotive Electronics and Control Systems" by Automotive Training and Resource Center: https://www.youtube.com/watch?v=uF0t8XyNR0M
5. "Vehicle Safety Crash Tests" by European New Car Assessment Programme (Euro NCAP): https://www.youtube.com/user/euroncapvideos
6. "Alternative Fuel Vehicles" by Engineering Explained: https://www.youtube.com/watch?v=OQu-oh6d1sA

WEB RESOURCES:

1. "Introduction to Automobile Engineering" by Prof. G. Senthilkumar: https://nptel.ac.in/courses/112/108/112108094/
2. "Vehicle Dynamics and Design" by Prof. A. Amirtham: https://nptel.ac.in/courses/112/108/112108144/
3. "Automotive Fuels and Lubricants" by Prof. M. M. Rahman: https://nptel.ac.in/courses/112/107/112107100/
4. "Automotive Engine Technology" by Prof. S. K. Som: https://nptel.ac.in/courses/112/107/112107060/
5. "Automotive Electronics" by Prof. M. Madheswaran: https://nptel.ac.in/courses/108/106/108106080/
6. "Vehicle Body Engineering" by Prof. D. Roy Mahapatra: https://nptel.ac.in/courses/112/107/112107100/

PROGRAM ELECTIVE

Course Code	COURSE	L	T	P	S	C
22ME101017	**INTERNAL COMBUSTION ENGINES**	3	-	-	-	3

Pre-Requisite Thermal Engineering

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Fuel air cycles and actual cycles of internal combustion engines; Combustion phenomena in spark ignition engine; Combustion phenomena in compression ignition engines; Engine friction and lubrication; Non-conventional engine.

COURSE OUTCOMES: After successful completionofthecourse,studentswill beableto:

CO1. Demonstrate the knowledge on internal combustion engine systems

CO2. Analyze fuel air cycles and actual cycles to find the various heat losses.

CO3. Analyze the combustion phenomenon inSI Engines and study the effect of variables on combustion phenomenon.

CO4. Analyze the combustion phenomenon in CI Engines and study the effect of variables on combustion phenomenon.

CO5. Demonstrate the knowledge on advances in Internal Combustion engines.

CO-PO-PSO MappingTable:

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	-	-	-	-	-	-	-	3	-
CO2	3	3	1	-	-	1	-	-	-	-	-	-	-	3	-
CO3	3	3	1	-	-	1	1	-	-	-	-	-	-	3	-
CO4	3	3	1	-	-	1	1	-	-	-	-	-	-	3	-
CO5	3	1		-	-	1	-	-	-	-	-	-	-	3	-
Course Correlation level	**3**	**2**	**1**	-	-	**1**	**1**	-	-	-	-	-	-	**3**	-

CorrelationLevels: ***3:High;*** ***2:Medium;*** ***1:Low***

COURSECONTENT

Module 1: INTERNAL COMBUSTION ENGINE SYSTEMS (09 Periods)

I. C. ENGINES - Classification - Working principles; Engine systems –Fuel, Carburettor,Fuel Injection, Ignition, Cooling and Lubrication System; principle of Wankle Engine,principles of supercharging and turbo charging.

Module 2: FUEL AIR CYCLES AND ACTUAL CYCLES (09 Periods)

Fuel Air Cycles: Assumptions for fuel–air cycles, Reasons for variation of specific heats of gases, change of internal energy and enthalpy during a process with variable specific heats, isentropic expansion with variable specific heats, effect of variable specific heats dissociation, comparison of air standard and fuel air cycles,

Actual Cycles: Effect of operating variables, comparison of air standard and actual cycles, effect of time loss, heat loss and exhaust loss in Petrol and Diesel engines.

Module 3: COMBUSTION IN S.I. ENGINES (09 Periods)

Stages of combustion in SI engines,combustion parameters,Flame front propagation, Factors influencing the flame speed, abnormal combustion, Phenomenon of knock in S.I engines, factors affecting knock in SI engine, Combustion chambers for SI Engines, Fuel Requirements and Fuel Rating, Emission from SI Engines and its control..

Module 4: COMBUSTION IN C.I. ENGINES (09 Periods)

Stages of combustion in C.I engines,combustion parameters, Factor affecting delay period; Phenomenon of knock in C.I engine,factors affecting knock in CI engine, comparison of knock in S.I and C.I engines, Combustion chambers for C.I engines, Fuel Requirements and Fuel Rating, Emission from CI Engines and its control.

Module 5: ADVANCED IC ENGINES (09 Periods)

Introduction, Common Rail Direct Injection Engine, Dual fuel and Multi-Fuel engine, free piston engine, Gasoline Direct Injection Engine, Homogeneous Compression Ignition Engine, Lean burn Engine, Stratified engine, Variable Compression ratio engineand LHR engines.

TotalPeriods:45

EXPERIENTIAL LEARNING

1. Dismantling and Assembling of Diesel engines
2. Dismantling and Assembling of Petrol engines
3. Servicing of Carburettor of petrol engines
4. Servicing of Fuel injection systems
5. Servicing of fuel pumps
6. Servicing of Ignition systems in SI engines
7. Dismantling and Assembling of Crank shaft in Diesel engines
8. Dismantling and Assembling of Crank shaft in Petrol engines
9. Servicing of Electrical Systems in SI engines
10. Servicing of fuel systems in CI and SI engines

RESOURCES

TEXTBOOKS:

1. V. Ganesan, *I.C. Engines*, TMH, 3rd Edition, 2008.
2. R.K.Rajput, *Thermal Engineering*, Laxmi publications, 8th Edition, 2010

REFERENCEBOOKS:

1. M.L Mathur&R.P.Sharma, *Internal combustion engines*, DhanpatRai& Sons, 8th Edition, 2014.
2. Mahesh M Rathore, *Thermal Engineering*, Tata Mcgrawhill Education, 2010.

VIDEOLECTURES:

1. https://youtu.be/cT9UN1XENNk
2. https://youtu.be/aaopC0Dftbo
3. https://youtu.be/fTAUq6G9apg
4. https://www.youtube.com/live/-LwmVczg4Dg?feature=share
5. https://www.youtube.com/live/-LwmVczg4Dg?feature=share

WEBRESOURCES:

1. https://www.youtube.com/live/V_6Z5uRM7wE?feature=share
2. https://www.youtube.com/live/kTpxyTdDwTc?feature=share
3. https://youtu.be/9U6jHB93beo

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102015	**REFRIGERATION AND AIR CONDITIONING**	3	-	2	-	4

Pre-Requisite Thermodynamics

Anti-Requisite -

Co-Requisite -

COURSEDESCRIPTION:

Refrigeration cycles; Application of thermodynamics; heat transfer to the refrigeration cycles; Analysis and design of various refrigeration systems; Study of components of refrigeration system; refrigerants selection; Psychrometry; Heat gain and Heat loss calculations. Air conditioning equipment; load calculations; heat pump circuits.

COURSE OUTCOMES:

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

CO1. Analyze the performance of air and vapour compression refrigeration systems and solve problems related to it.

CO2. Demonstrate the knowledge of desirable properties refrigerants and constructional features of refrigeration equipment.

CO3. Demonstrate knowledge of constructional features and working of vapor absorption refrigeration systems, steam jet refrigeration systems and nonconventional refrigeration system

CO4. Design the air conditioning systems using psychrometric principles by considering various heat loads

CO5. Demonstrate knowledge of comfort air conditioning, air conditioning equipment and heat pump circuit

CO-PO-PSO MappingTable:

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	-	-	-	-	-	-	3	-
CO2	3	1	-	-	-	1	1	-	-	-	-	-	-	3	-
CO3	3	1	-	-	-	1	1	-	-	-	-	-	-	3	-
CO4	3	3	-	-	-	1	1	-	-	-	-	-	-	3	-
CO5	3	1	-	-	-	1	1	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**2**	-	-	-	**1**	**1**	-	-	-	-	-	-	**3**	-

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

COURSE CONTENT

Module 1: AIR AND VAPOR COMPRESSION REFRIGERATION SYSTEMS (09 Periods)

Air refrigeration cycle: Introduction, open and dense air refrigeration cycle, Energy Efficiency Ratio (EER), BEE star rating Air refrigeration systems - Bell-Coleman cycle, applications; Aircraft air refrigeration systems: Need for aircraft refrigeration, simple air cooling system, simple air evaporative cooling system and bootstrap air cooling system;

Vapor compression refrigeration cycle: Effect of liquid subcooling & superheating, effect of evaporator and condenser pressures, Cascade refrigeration system.

Module 2: REFRIGERATION EQUIPMENT AND REFRIGERANTS (09 Periods)

Refrigeration equipment: Introduction, working and applications of Compressors, Condensers, Evaporators, Expansion devices.

Refrigerants: Classification, properties, ASHRAE numbering system for refrigerants, selection of refrigerants, alternate refrigerants, impact of refrigerants on environment.

Module 3: VAPOUR ABSORPTION REFRIGERATION SYSTEM AND EMERGING TECHNOLOGIES (09 Periods)

Classification, Working principle of NH3 – water system, Li Br – water (Two shells & four shells) system, Calculation of maximum COP, Electrolux refrigeration system.

Steam jet refrigeration system: Working principle, basic components.

Non-conventional refrigeration system: Principle and operation of Thermo-electric refrigerator, Thermoacoustic Refrigeration, Vortex tube.

Module 4: DESIGN OF AIR CONDITIONING SYSTEMS (09 Periods)

classification of air-conditioning systems, summer, winter and year round air conditioning systems; Different Heat sources: Adiabatic mixing of two air streams, Bypass factor, Room Sensible Heat Factor (RSHF), Grand Sensible Heat Factor (GSHF), Effective Room Sensible Heat Factor (ERSHF); cooling load calculations, sensible heat load, latent heat load.

Module 5: COMFORT AIR CONDITION AND EQUIPMENTS (09 Periods)

Comfort Conditions: need and requirements of comfort air conditioning, Thermal exchange of body with environment, concept of effective temperature, Comfort chart.

Air Conditioning Equipment: Introduction, working and applications of Humidifiers, Dehumidifiers; Air-filters, Fans, Blowers, Ducts.

Heat pump: Introduction, different heat pump circuits, air to air, water to air.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Perform fundamental operations like Cutting, bending and joining of copper tubing by brazing.
2. Perform Fundamental operations Flaring, Swaging and silver soldering.
3. Study the mechanical components of refrigerator and their types (Compressor/ Expansion devices/heat exchangers/evaporators).
4. Study different control devices of a refrigeration system.
5. Performance test on vapor compression refrigeration system by using different expansion devices.
6. Performance test on Water cooler.
7. Performance test on vapor absorption test rig
8. Study various components of room/central air conditioning system.
9. Study electrical circuits, leak testing, gas charging, Trouble shooting of refrigeration & air-conditioning system
10. Study the Complete Guide to ASHRAE Standards for Commercial HVAC Manufacturers
11. Find the performance parameters of Ice Plant.
12. Performance test on Air conditioning system.
13. Find the performance parameter of cooling tower.
14. Perform the experiment & calculate various Performance parameters on a blower apparatus (Air handling unit)
15. Design of Air conditioning Systems and ducts for a given space
16. Simulate air conditioning systems for the given application.

RESOURCES

TEXT BOOKS:

1. Domkundwar Arora Domkundwar, A Course in Refrigeration and Air conditioning, Dhanpat Rai publication, 8th Edition, 2018.
2. C.P Arora, Refrigeration and Air Conditioning, TMH, 8th Edition, 2017

REFERENCE BOOKS:

1. P.L.Ballaney, Refrigeration and Air Conditioning, Khanna Publications, 15th Edition, 2012
2. Manohar Prasad, Refrigeration and Air Conditioning, New Age International, 3rd Edition, 2016
   R.S.Khurmi& J.S. Gupta*, Refrigeration and Air conditioning,* S.Chand, 5th Edition, 2020.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=bN91qP-oBNI
2. https://www.youtube.com/watch?v=DI6z61l6MEs

WEB RESOURCES:

1. https://www.rajagiritech.ac.in/Home/mech/Course_Content/Semester%20VII/ME%20405%20Refrigeration%20and%20Airconditioning/Module%203.pdf
2. https://www.cedengineering.com/userfiles/Intro%20to%20Air%20Cond%20Systems.pdf
3. https://www.iare.ac.in/sites/default/files/lecture_notes/IARE_RAC_Lecture_Notes.pdf

PROGRAM ELECTIVE

CourseCode	Course Title	L	T	P	S	C
22ME101018	NON CONVENTIONAL ENERGY SOURCES	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Overview and importance of nonconventional energy sources; Solar Energy collection, solar energy storage and applications; Wind energy conversion; Biomass energy conversion; Geothermal energy Conversion; Ocean energy conversion: Ocean thermal energy conversion, Wave energy and tidal energy conversion.

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

CO1. Demonstrate the knowledge on energy resources, energy conservation and solar energy.

CO2. Analyze the performance characteristics of solar heat collectors.

CO3. Demonstrate the knowledge on PV systems, energy storage and conversion systems.

CO4. Demonstrate the knowledge on construction and working of wind energy and bio-energy conversion systems.

CO5. Demonstrate the knowledge on construction and working of Geothermal and Ocean Energy conversion systems.

CO-PO-PSO Mapping Table:

Course Outcome	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	-	-	-	-	-	-	3	-
CO2	3	3	1	1	-	1	1	-	-	-	-	-	-	3	-
CO3	3	1	1	-	-	1	1	-	-	-	-	-	-	3	-
CO4	3	1	1	-	-	1	1	-	-	-	-	-	-	3	-
CO5	3	1	1	-	-	1	1	-	-	-	-	-	-	3	-
Course Correlation level	**3**	**1**	**1**	**1**	-	**1**	**1**	-	-	-	-	-	-	**3**	-

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSECONTENT

Module 1: ENERGY CONSERVATION AND SOLAR ENERGY (09 Periods)

Energy sources and Conservation: Introduction, Conventional energy sources**,** Classification, Importance of renewable energy sources, energy alternatives, need and Principles of energy conservation.

Fundamentals of Solar Energy: Site selection for solar plant, Solar constant and solar radiation geometry, Solar time and day length, Estimation of monthly average daily total radiation on horizontal surface and tilted surface, Measurement of solar radiation - Pyranometer, Pyrheliometer and Sunshine recorder.

Module 2: SOLAR ENERGY COLLECTION DEVICES (09 Periods)

Flat plate collector, Losses through flat plate collector; Transmissivity of the cover system, Transmittance – Absorptance product, Parameters affecting the collector performance, Efficiency of flat plate collector, Selective surfaces, Air collectors and types, Classification of concentrating collectors.

Module 3: SOLAR ENERGY APPLICATIONS (09 Periods)

Solar Photo Voltaic Systems: Basic principle of PV cell, Arrangements of PV cells, classification of PV cell, Solar PV Applications.

Solar Thermal Applications: Methods of storing solar energy -sensible heat storage, latent heat storage, Applications -Solar water heating, Solar Refrigeration, Solar thermal power generation, Solar distillation.

Module 4: WIND ENERGY AND BIOMASS ENERGY CONVERSION (09 Periods)

Wind Energy Conversion: Introduction, Site selection for wind energy plant, General formula - Betz limit - Lift and Drag - Basis of wind energy conversion - Effect of density, frequency variances, angle of attack, and wind speed, classification and working of horizontal axis wind turbine - vertical axis Wind turbines, Types of blades, Wind energy conversion systems, environmental consideration.

Biomass Energy Conversion: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels , Classification of biogas plants, Types of Digesters – Floating drum, fixed dome type biogas plants, comparison; variations of Biogas models – pragati biogas model, Jwala biogas model, CAMATEC model and Deenabandhu biogas model, Factors affecting digester performance.

Module5: GEOTHERMAL AND OCEAN ENERGY CONVERSION (09 Periods)

Geothermal Energy Conversion: Introduction, geothermal sources - Hydro thermal resources, geo pressurized resources, hot dry rocks, Power generation through liquid dominated system, vapour dominated system, applications of geothermal energy, environmental consideration.

Ocean Energy Conversion: Ocean thermal Energy conversion - Lambert's law, OTEC conversion technologies- Claude cycle and Anderson cycle, Environmental impacts of OTEC;Tidal energy conversion - Principles of tidal and wave power generation, tidal energy conversion - single basin and double basin systems.

Total Periods:45

EXPERIENTIALLEARNING

1. Dismantling and Assembly of PV solar panels
2. Inspection of Circuit in the PV solar panels
3. Selection of Mono or Poly solar panels
4. Selection of suitable battery for the appropriate PV panel
5. Selection of Charge controller for the solar PV system
6. Positioning of the PV system with respect to the solar energy
7. Fixing of the automatic rotating element for the solar PV system
8. Cleaning of the PV system to maintain good efficiency
9. Providing suitable insulation material for the solar PV system
10. Providing rust free material at the periphery of the solar glass panels

RESOURCES

TEXT BOOKS:

1. G.D, Rai, *Non-conventional Energy Sources*, Khanna Publishers, 5th Editon, 2011.
2. B.H.Khan, *Non-conventional Energy Sources*, TMH, 3rd Edition, 2016.

REFERENCE BOOKS:

1 S.P.Sukhatme and J.K Nayak, *Solar Energy Principles of Thermal Collection and Storage*, TMH, 3rd edition, 2008.

2. W.R.Murphy&G.Mckay, *Energy Management*, Butterworth, London, 2nd Edition, 2007**.**

VIDEO LECTURES:

1. https://youtu.be/EKWQg5Rn0YM
2. https://youtu.be/18CLG_ey_aU
3. https://youtu.be/rP53_cqews4
4. https://youtu.be/Dd20RQNBwGY
5. https://youtu.be/6jG0SLbxzog

WEB RESOURCES:

1. https://youtu.be/sONXzogoMc4
2. https://www.youtube.com/live/7Ry643d3deE?feature=share
3. https://youtu.be/Zgp86PVXXuQ

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101019	**POWER PLANT ENGINEERING**	3	-	-	-	3

Pre-Requisite Thermodynamics, Thermal Engineering and Heat transfer.

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Energy sources; Types of Power Plants; Thermal power plant; Study of various systems of thermal power plant; Combustion and Firing Methods; Diesel Power plant; Gas Turbine Power Plants; Hydroelectric power plants and Nuclear power plants; Power generation and recovery systems; Various conventional and nonconventional sources of energy with power plant economics.

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

CO1. Demonstrate the knowledge on construction and working principles of various subsystems and pollution control methods in thermal power plant,

CO2. Demonstrate the knowledge on various components, working principle and performance improvements in diesel and gas power plants.

CO3. Demonstrate the knowledge on hydroelectric power plant and nuclear powerPlant and its pollution control methods.

CO4. Demonstrate the knowledge on working principles of non-conventional powergeneration units and direct energy conversion systems.

CO5. Calculate the cost of power generation for various power plants using differenttypes of tariff systems

CO-PO-PSO MappingTable:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	3	1	-	-	-	-	-	-	-	-	-	3	-
CO3	3	1	2	1	-	-	-	-	-	-	-	-	-	3	-
CO4	2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	1	2	3	2	-	-	-	-	-	-	-	-	-	1	-
Course Correlation Mapping	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	-	-	**3**	-

CorrelationLevels: ***3: High;*** ***2: Medium;*** ***1: Low***

COURSECONTENT

Module 1: THERMAL POWER PLANT (09 Periods)

Introduction to the sources of energy, Plant layout, selection of site for power plant, Coal handling systems, Overfeed and under feed stoker principles, Traveling grate stokers, Spreader stokers, Multi retort stokers, Pulverized fuel firing – Pulverized fuel handling Pulverizing mills, Pulverized fuel burners; Ash handling systems, Dust collectors. Thermal Power plant pollution.

Module 2: DIESEL ENGINE AND GAS TURBINE POWER PLANTS (09 Periods)

Diesel Power Plant: Essential components of diesel powerplant, Operation of diesel power plant, Plant layout with auxiliaries.

Gas Turbine Plant: Requirements, Functions, Classification, Construction, and Layout with auxiliaries.

Module 3: HYDRO ELECTRIC AND NUCLEAR POWER PLANTS (09 Periods)

Hydro Electric Power Plant: Selection of site for power plant, Typical layouts, Elements of plant, Classification of dams, Spillways, Surge tank, Draft tube, Classification of

Hydroelectric power plants, Hydrology, Hydrological cycle, Hydrographs;

Nuclear Power Plants: Requirements, Functions, Nuclear fuel, Breeding and Fertile materials, Nuclear reactor, React or operation, Types of Reactors - Pressurized water reactor, Boiling water reactor, Sodium-Graphite reactor, Fast breeder reactor, Homogeneous reactor, Gas cooled reactor; Nuclear power plant pollution.

Module 4: NON CONVENTIONAL POWER GENERATION ANDDIRECT ENERGY CONVERSION SYSTEMS (09 Periods)

Non-Conventional Power Generation: Solar, Wind, Tidal, Ocean energy conversion, Geothermal, and biogas power plants.

Direct energy conversion systems: Thermoelectric conversion system, Thermionic conversion system, Photovoltaic power systems, Magneto Hydrodynamic systems, Electro static mechanical generators, Electro gas-dynamic generators, and Fuel cells.

Module 5: POWER PLANT ECONOMICS (09 Periods)

Load curves, Load duration curve, Definitions of connected load, Maximum demand, Demand factor, Load factor, Plant capacity factor, Plant use factor, Diversity factor, Cost Analysis.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Theoretical study to conduct visual inspections of boiler tubes, steam drums, and headers
2. Theoretical study to perform water chemistry analysis to ensure proper boiler water chemistry
3. Theoretical study to conduct safety checks before and after starting up the boiler
4. Theoretical study to conduct visual inspections of turbine blades and nozzles
5. Theoretical study to test the turbine vibration levels to ensure smooth operation
6. Theoretical study to adjust the control parameters to optimize the power plant performance

RESOURCES

TEXTBOOKS:

1. R.K.Rajput, A Textbook of Power Plant Engineering, Laxmi Publications, 3rd edition,2014.
2. Arora and S. Domkundwar, A Course in Power Plant Engineering, DhanpatRai and Co, 3rd Edition, 2012.

REFERENCEBOOKS:

1. P.K.Nag, Power Plant Engineering, TMH, 2nd edition, 2006.
2. K.K Ramalingam, Power Plant Engineering, Scitech Publishers, 2nd edition, 2010.
3. Dr.P.C Sharma, Power Plant Engineering, SkKatariaandsons publishers, 8th Edition,2011.

VIDEOLECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me86/preview
2. https://elearn.nptel.ac.in/shop/nptel/power-plant-engineering/

WEBRESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_me10/preview
2. https://www.coursera.org/lecture/thermodynamics-intro/06-03-the-rankine-power-plant-sRbKi

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101081	**AI TECHNIQUES FOR RENEWABLE ENERGY SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This syllabus covers the foundational knowledge of renewable energy systems, the basics and advanced techniques of artificial intelligence, and their applications in optimizing and managing renewable energy.

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

CO1. Demonstrate a comprehensive understanding of various renewable energy sources, including solar, wind, hydro, biomass, and geothermal.

CO2. Understand and apply basic AI algorithms, including decision trees, support vector machines, and clustering techniques.

CO3. Implement AI models for accurate energy demand forecasting.

CO4. Develop and apply machine learning models for renewable energy forecasting.

CO5. Explore the integration of AI with IoT to create smart, sustainable energy solutions.

CO-PO-PSO Mapping Table:

Learning 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	-	-	-	-	-	-	-	3	-
CO2	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-
CO3	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-
CO4	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-
CO5	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO RENEWABLE ENERGY SYSTEMS (09 Periods)

Overview of renewable energy sources (solar, wind, hydro, biomass, geothermal), Importance and benefits of renewable energy, Basics of energy conversion and power generation, Challenges in renewable energy systems.

Module 2: FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE (09 Periods)

Introduction to AI: Definitions and History, Machine Learning: Supervised, Unsupervised, and Reinforcement Learning, Neural Networks and Deep Learning, AI Algorithms: Decision Trees, Support Vector Machines, and Clustering, Evaluation Metrics for AI models.

Module 3: AI APPLICATIONS IN RENEWABLE ENERGY SYSTEMS (09 Periods)

Predictive maintenance of renewable energy systems using AI, AI for energy demand forecasting, Optimization of energy storage systems, AI in smart grid technology, Case studies of AI in solar, wind, and other renewable energy sectors.

Module 4: AI TECHNIQUES FOR RENEWABLE ENERGY MANAGEMENT (09 Periods)

AI for energy efficiency and optimization, Machine learning algorithms for renewable energy forecasting, Intelligent control systems for renewable energy integration, Data analytics and big data in renewable energy, Role of AI in energy policy and regulatory compliance.

Module 5: FUTURE TRENDS AND RESEARCH DIRECTIONS (09 Periods)

Emerging AI technologies in renewable energy, Integration of AI with IoT for renewable energy applications, AI-driven innovations in energy storage technologies, Ethical, legal, and social implications of AI in renewable energy, Future challenges and research opportunities.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Develop a comprehensive understanding of photovoltaic (PV) systems, including their components, working principles, and applications in renewable energy.
2. Gain foundational knowledge in artificial intelligence (AI) and machine learning (ML) concepts, techniques, and tools relevant to the analysis and optimization of PV systems..
3. Use AI and ML algorithms to predict the performance of PV systems under various environmental and operational conditions, and to develop strategies for optimizing energy output and efficiency
4. Develop research and development skills by working on projects that require the application of AI, ML, and data analysis techniques to real-world problems in PV systems.

RESOURCES

TEXTBOOKS:

1. Renewable Energy: Power for a Sustainable Future by Godfrey Boyle, ISBN 9780199681273,3rd edition , Oxford University Press
2. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig,ISBN 978-0136042594, 3rd edition, Pearson
3. Artificial Intelligence in Renewable Energetic Systems: Smart Sustainable Energy Systems by Soteris Kalogirou, ISBN 978-1600212611, 1st edition, Nova Science Publishers Inc
4. Renewable Energy Forecasting: From Models to Applications edited by Georges Kariniotakis, ISBN 978-0081005040, I st edition, Woodhead Publishing Ltd
5. Artificial Intelligence and IoT-Based Technologies for Sustainable Farming and Smart Cities by Chinmay Chakraborty

REFERENCE BOOKS:

1. Renewable Energy Systems: The Choice and Modeling of 100% Renewable Solutions ISBN-13 : 978-0123750280,1st edition , Academic Press Inc
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville,1st edition, MIT Press.
3. Modern Approaches in Machine Learning and Cognitive Science: A Walkthrough: Latest Trends in AI: 885 (Studies in Computational Intelligence), by Vinit Kumar Gunjan (Editor), Jacek M. Zurada (Editor), Ninni Singh (Editor), ISBN 978-3031430084,1st edition, Springer International Publishing AG

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=pghjLyAmc5g
2. https://www.youtube.com/watch?v=LDED54mxDKo

WEB RESOURCES:

1. https://ieeexplore.ieee.org/document/9584587
2. https://www.sciencedirect.com/science/article/pii/S2352484722022818
3. https://www.mdpi.com/journal/sustainability/special_issues/artificial_intelligence_energy

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101082	AI FOR TRANSPORTATION SYSTEMS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This syllabus covers the foundational knowledge of transport systems, the basics and advanced techniques of artificial intelligence, and their applications in optimizing and managing transportation.

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

CO1. Demonstrate a comprehensive understanding of various transportation systems including public transit, freight, autonomous vehicles, and traffic management.

CO2. Understand and apply basic AI algorithms, including decision trees, support vector machines, and clustering techniques.

CO3. Analyze real-world case studies where AI has been successfully integrated into transport systems, such as self-driving cars and smart traffic lights

CO4. Develop and apply machine learning models for predictive maintenance of transport infrastructure.

CO5. Explore the integration of AI with IoT to create intelligent transport systems.

CO-PO-PSO Mapping Table:

Learning 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	-	-	-	-	-	-	3	-
CO2	3	2	1	-	1	1	1	-	-	-	-	-	-	3	-
CO3	3	2	1	-	1	1	1	-	-	-	-	-	-	3	-
CO4	3	2	1	-	1	1	1	-	-	-	-	-	-	3	-
CO5	3	2	1	-	1	1	1	-	-	-	-	-	-	3	-
Course Correlation Mapping	3	2	1	-	1	1	1	-	-	-	-	-	-	3	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO TRANSPORT SYSTEMS AND AI (09 Periods)

Overview of transportation systems (public transit, freight, autonomous vehicles, traffic management), Importance and benefits of AI in transport systems, Basics of transportation logistics and management, Challenges in modern transport systems,

Module 2: FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE (09 Periods)

Introduction to AI: Definitions and History, Machine Learning: Supervised, Unsupervised, and Reinforcement Learning, Neural Networks and Deep Learning, AI Algorithms: Decision Trees, Support Vector Machines, and Clustering, Evaluation Metrics for AI models.

Module 3: AI APPLICATIONS IN TRANSPORT SYSTEMS (09 Periods)

AI in traffic prediction and management, Autonomous vehicles: algorithms and safety measures, Route optimization and logistics planning, AI for public transport systems: scheduling and optimization, Case studies of AI in transport systems (e.g., self-driving cars, smart traffic lights),

Module 4: AI TECHNIQUES FOR TRANSPORT SYSTEM MANAGEMENT (09 Periods)

AI for predictive maintenance of transport infrastructure, Machine learning models for demand forecasting in transportation, Intelligent control systems for traffic signal optimization, Data analytics and big data in transportation, Role of AI in transportation policy and regulatory compliance.

Module 5: FUTURE TRENDS AND RESEARCH DIRECTIONS (09 Periods)

Emerging AI technologies in transportation, Integration of AI with IoT for intelligent transport systems, AI-driven innovations in mobility and smart cities, Ethical, legal, and social implications of AI in transport systems, Future challenges and research opportunities.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Understanding different transportation modes, Scheduling and routing. Operations and Infrastructure planning and management.
2. Gain knowledge in Observing traffic management centers and control rooms. Hands-on experience in planning, logistics, and operations.
3. Participating in research projects related to transportation innovation. Exploring new technologies like autonomous vehicles, smart cities, and IoT in transportation.

RESOURCES

TEXTBOOKS:

1. Transportation Systems and Engineering: Concepts, Methodologies, Tools, and Applications, Information Resources Management Association, ISBN 978-1466684737,3rd edition, Idea Group,U.S.
2. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig, ISBN 9780136042594, 3rd edition, Pearson
3. Artificial Intelligence: Foundations of Computational Agents by David L. Poole and Alan K. Mackworth,ISBN 978-1107195394, 2nd edition, Cambridge University Press
4. Autonomous Driving: How the Driverless Revolution will Change the World by Andreas Herrmann, Walter Brenner, et al. Emerald Publishing Limited
5. Urban Transport and Hybrid Vehicles by Seref Soylu,1st edition, In Tech.

REFERENCE BOOKS:

1. Handbook of Research on Artificial Intelligence Applications in Literary Works and Social Media, Pantea Keikhosrokiani, ISBN: 9781668462423, IGI Globa
2. Transportation Engineering: An Introduction by C. Jotin Khisty and B. Kent Lall, ISBN 978-9332569706,3rd edition, Pearson Education
3. Deep Learning by Ian Good fellow, Yoshua Bengio, and Aaron Courville,1st edition, MIT Press.
4. AI and Future Transport: A Roadmap for Next Generation Mobility by Vito Bobek

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=8rc9d2ldVdI
2. https://www.youtube.com/watch?v=ee4K8BhyXUU

WEB RESOURCES:

1. https://mindtitan.com/resources/blog/ai-in-transportation/
2. https://www.v7labs.com/blog/ai-in-transportation
3. https://integrio.net/blog/benefits-of-artificial-intelligence

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101083	INTRODUCTION TO MARINE AND AERIAL ROBOTICS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Marine Robotics, Motion and Control of Marine Vessels, Aerial Robotics, Motion and Control of Aerial Robots, Motion Planning and Collision Avoidance in Marine & Aerial Robotics.

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

CO1. Understand the different types marine robots, systems and configurations

CO2. Apply sea keeping concepts and control of marine robotics.

CO3. Understand different types aerial robots, systems and configurations.

CO4. Apply concepts of maneuver and control of aerial robotics.

CO5. Understand motion control and collision avoidance in marine and aerial robotics

CO-PO-PSO Mapping Table:

Learning 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	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	1	1	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	1	1	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	1	1	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	1	1	-	-	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Course Correlation Mapping	3	2	-	-	1	1	-	-	3	3	-	-	-	-	-

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

COURSE CONTENT

Module 1: MARINE ROBOTICS (09 Periods)

Types and classification of marine vessels, Systems & sub-systems, Hydrostatics, Buoyancy and Stability of marine vessels.

Module 2: MOTION AND CONTROL OF MARINE VESSELS (09 Periods)

Introduction to Seakeeping, motion in water, and control of marine vessels.

Module 3: AERIAL ROBOTICS (09 Periods)

Systems & configuration of aerial robots – Fixed wing and VTOL (Vertical Take-Off and Landing), Motion of AUV(Autonomous Underwater Vehicle).

Module 4: MOTION AND CONTROL OF AERIAL ROBOTS (09 Periods)

Maneuver and control of aerial robot at constant altitude. Introduction to motion in 3d space.

Module 5: MOTION PLANNING AND COLLISION AVOIDANCE IN MARINE & AERIAL ROBOTICS (09 Periods)

Mission requirements and motion planning techniques, Collision avoidance.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Visit a local harbor or marina and identify at least three different types of marine vessels. Describe their classifications and primary uses.
2. Conduct an experiment to determine the buoyancy and stability of various shapes of objects in water. Record and analyze your findings.
3. Simulate the motion of a marine vessel in a wave tank and observe its behavior. Describe how different wave conditions affect the vessel's stability.
4. Develop a basic control algorithm for maintaining the position of a marine vessel in a simulated environment. Test its effectiveness.
5. Compare and contrast the design and functionality of fixed-wing and VTOL (Vertical Take-Off and Landing) aerial robots. Create a presentation summarizing your findings.
6. Simulate the motion of an AUV in different underwater environments. Analyze how various factors (e.g., water density, current) affect its movement.
7. Program a drone to maintain a constant altitude while performing basic maneuvers. Evaluate the effectiveness of your control algorithm.
8. Using flight simulation software, practice controlling an aerial robot in 3D space. Document your learning experience and key takeaways.
9. Develop a mission plan for a marine or aerial robot to perform a specific task (e.g., search and rescue, environmental monitoring). Outline the key steps and considerations.
10. Create a simple collision avoidance system for a robot using sensors (e.g., ultrasonic, infrared). Test its effectiveness in avoiding obstacles.

RESOURCES

TEXTBOOKS:

1. Sabiha A. wadoo,pushkin kachroo, *Autonomous underwater vehicles, modelling, control design and Simulation*, CRC press, 2011.
2. Reg Austin, *Unmanned Aircraft Systems*, Wiley & Sons (2010).

REFERENCE BOOKS:

1. Paul Gerin Fahlstrom, and Thomas James Gleson, I*ntroduction to UAV system*s, John Wiley (2012).
2. Richard A Geyer, *Submersibles and their use in oceanography and ocean engineering*, Elsevier, 1997.
3. Ferial L hawry, *The ocean engineering*, CRC press,2000.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=0pTtmRA3An8
2. https://www.youtube.com/watch?v=_XMR9A828l0
3. https://www.youtube.com/watch?v=H-3Te25Z20g
4. https://www.youtube.com/watch?v=ogSQXPyt504

WEB RESOURCES:

1. https://www.marineinsight.com/
2. https://www.dronedeploy.com/
3. https://www.coursera.org/learn/robotics-learning

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101085	ARTIFICIAL INTELLIGENCE, MACHINE LEARNING AND DATA ANALYSIS FOR PHOTOVOLTAIC SYSTEMS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Introduction to Artificial Intelligence, Machine Learning and its Applications, data science and its, application of ANN and fuzzy logic for solar system.

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

CO1. The course will equip the participants for advanced technology development (R&D) with data analysis.

CO2. Students are exposed to learn Artificial intelligence in the area of sustainable energy conversion

CO3. Develop a comprehensive understanding of photovoltaic (PV) systems, including their components, working principles, and applications in renewable energy.

CO4. Use AI and ML algorithms to predict the performance of PV systems under various environmental and operational conditions, and to develop strategies for optimizing energy output and efficiency.

CO5. Employ machine learning techniques to forecast solar energy production based on historical data and weather predictions, improving efficiency of PV systems

CO-PO-PSO Mapping Table:

Learning 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	-	-	-	-	-	-	-	3	-
CO2	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-
CO3	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-
CO4	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-
CO5	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	3	2	1	-	1	1	-	-	-	-	-	-	-	3	-

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSE CONTENT

Module 1: INTRODUCTION TO ARTIFICIAL INTELLIGENCE & MACHINE LEARNING (09 Periods)

Introduction to Artificial Intelligence and Machine Learnings Basic concepts of AI, linear regression, learning schemes, shallow and deep learning, Principal component analysis, t-Distributed Stochastic Neighbour Embedding (t-SNE), k-fold cross validation, classification, clustering-k-means, support vector machine, Multiple linear regression, ANN: perceptron, back propagation, CNN.

Module 2: DATA ANALYSIS MACHINE LEARNING (09 Periods)

Introduction: Data Representation Python for data analysis, Num Py, panda, data frame, data cleaning, data representation-Matplotlib Matlab ANN tool kit

Module 3: MACHINE LEARNING AND ITS APPLICATION (09 Periods)

Sandia Model Sandia model: radiation model, radiation correction factors, PV model, inverter model, Pvlib data analysis tool kit.

Module 4: DATA SCIENCE AND ITS APPLICATIONS (09 Periods)

Data Analysis PV data analysis-excel sheet data, Big data analysis, data mining, missing values, normalization and standardization, split and data set, feature selection, dimension reduction, linear regression, support vector regression, mean score, mean absolute error, R2 score

Module 5: APPLICATION OF ARTIFICIAL NETWORK AND FUZZY LOGIC FOR SOLAR SYSTEM (09 Periods)

ANN solar cell models Solar energy forecasting, ANN solar cell models, ANN based MPPT-PSO trained ANN MPPT, Fuzzy logic based MPPT

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Start with understanding the fundamentals of artificial intelligence, including machine learning (ML), deep learning, and neural networks. This knowledge forms the basis for understanding AI applications in any field.
2. Explore how AI techniques such as predictive analytics, computer vision, natural language processing (NLP), and reinforcement learning are applied in mechanical engineering contexts. For instance, predictive maintenance using AI algorithms can optimize machinery uptime and reduce downtime.
3. Study real-world applications where AI has been successfully integrated into mechanical engineering processes. This could include automated quality control in manufacturing, autonomous vehicles and robotics in industrial settings, or AI-driven design optimization.
4. Consider the ethical implications of AI applications in mechanical engineering, such as job displacement, safety concerns in autonomous systems, and data privacy issues. Understanding these aspects is crucial for responsible AI deployment.
5. AI is a rapidly evolving field, so be prepared for continuous learning and adaptation. Keeping your skills updated with new tools and techniques ensures you remain competitive in the job market.

RESOURCES

TEXTBOOKS:

1. 1. Artificial Intelligence in Energy And Renewable Energy Systems, ISBN-13: 978-1600212611,Nova Science Pub Inc 39 | P a g e
2. Introduction to Machine Learning with Python: A Guide for Data Scientists 1st Edition, Andreas C. Müller, Sarah Guido, ISBN: 9781449369415, Publisher: O'Reilly
3. Haykin Simon., Neural networks a comprehensive foundation, Pearson Education, 2nd Edition, ISBN-13: 978-0138958633, 1997.

REFERENCE BOOKS:

1. 1. MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence1st ed, Phil Kim, publisher: ISBN-13: 978-1484228449, Apress
2. Kaushik Kumar, Divya Zindani, Paulo Davim, Artificial Intelligence in Mechanical and Industrial Engineering , ISBN 9781003011248, CRC Press, 2021.
3. IFR_Artificial_Intelligence_in_Robotics_Position_Paper_V02.pdf

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=My1_-ttLsfg&list=PLNZMKGYv14qLjeZyyoFIjvTZtEYZU0BVq
2. https://www.youtube.com/watch?v=Ot8VOUuaNQw

WEB RESOURCES:

1. https://link.springer.com/article/10.1007/s11831-024-10125-3
2. https://www.researchgate.net/publication/361697274_Machine_learning_in_photovoltaic_systems_A_review

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101020	**FUNDAMENTALS OF MANAGEMENT**	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 evolution

CO2. Apply the concepts of decision-making procedure for problem solving.

CO3. Apply the concepts of HRM for selection and management of human resources.

CO4. Evaluate leadership styles to anticipate the consequences of each leadership style.

CO5. Identify and evaluate social responsibility and ethical issues involved in business situations and logically articulate own position on such issues.

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	-	-	-	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

COURSE CONTENT

Module 1: INTRODUCTION TO MANAGEMENT (10 Periods)

Introduction to Management: Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of Management- Classical Approach- Scientific and Administrative Management; The Behavioral approach; The Quantitative approach; The Systems Approach; Contingency Approach, IT Approach.

Module 2: PLANNING AND DECISION MAKING (08 Periods)

Planning: Planning and Decision Making: General Framework for Planning - Planning Process, Types of Plans, Management by Objectives; Development of Business Strategy.

Decision Making: Decision Making Decision making and Problem Solving - Programmed and Non-Programmed Decisions, Steps in Problem Solving and Decision Making; Bounded Rationality and Influences on Decision Making; Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work.

Module 3: ORGANIZATION AND HUMAN RESOURCE MANAGEMENT (10 Periods)

Organization: Organization and HRM: Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization, Recentralization; Organizational Culture; Organizational Climate and Organizational Change.

Human Resource Management: Human Resource Management & Business Strategy: Talent Management, Talent Management Models and Strategic Human Resource Planning; Recruitment and Selection; Training and Development; Performance Appraisal.

Module 4: LEADERSHIP AND MOTIVATION (08 Periods)

Leadership: Leadership, Power and Authority, Leadership Styles; Behavioral Leadership, Situational Leadership, Leadership Skills, Leader as Mentor and Coach, Leadership during adversity and Crisis; Handling Employee and Customer Complaints,

Motivation : Team Motivation - Types of Motivation; Relationship between Motivation, Performance and Engagement, Content Motivational Theories - Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y.

Module 5: MANAGERIAL ETHICS (09 Periods)

Ethics and Business, Ethics of Marketing &Advertising, Ethics of Finance &Accounting, Decision-making frameworks, Business and Social Responsibility, International standards, Corporate Governance, Corporate Citizenship , Corporate Social Responsibility.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Case Study Analysis: Students analyze case studies of different organizations and their management practices. They identify and discuss the managerial roles, functions, and challenges faced by managers. They also explore how different management approaches have evolved over time and their application in real-world scenarios.
2. Simulation Exercise: Students participate in a simulated business scenario where they need to develop a strategic plan for a company. They work in teams and go through the planning process, including setting objectives, formulating strategies, and developing action plans. They also make decisions based on various scenarios and evaluate the outcomes.
3. Organizational Analysis: Students conduct an analysis of an organization's structure, culture, and climate. They visit a local company or use publicly available information to understand how the organization is designed, how departments are structured, and how decision-making authority is distributed. They also assess the organization's culture and analyze the impact of organizational change.
4. Leadership Development Workshop: Students engage in leadership development activities, such as team-building exercises, role-playing scenarios, and group discussions. They explore different leadership styles and skills and reflect on their own leadership capabilities. They also learn how to handle employee and customer complaints effectively.
5. Ethical Case Discussions: Students participate in group discussions centered around ethical cases in business, marketing, finance, and accounting. They analyze the ethical implications of different situations and propose solutions based on ethical principles and international standards. They also explore the concept of corporate social responsibility and its importance in modern business practices.

RESOURCES:

TEXT BOOKS:

1. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013.
2. Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.

REFERENCE BOOKS:

1. O.P. Khanna, *Industrial Engineering and Management,* Dhanpat Rai and Sons,2010.
2. Essentials of Management, Koontz Kleihrich, Tata McGraw Hill.
3. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012N.D. Vohra, *Quantitative Techniques in Management,* TMH, 2nd Edition, New Delhi.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=YFPaTuYmLPY
2. https://www.youtube.com/watch?v=KNFZXNWYVno

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101021	STATISTICAL INFERENCE AND MODELING	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Random vs Non-random sampling; Two tailed and one tailed Hypothesis testing, Type 1 and Type 2 errors, Hypothesis testing using z and t statistics; Completely Randomized design; Simple and Multiple Linear Regression; residual analysis; Decision making under uncertainty- Laplace, Hurwicz and Savage criteria

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

CO1. Apply sampling and estimation procedures to appropriately use and construe complex data.

CO2. Demonstrate the plausibility of pre-specified ideas about the parameters of the model by Hypothesis Testing

CO3. Design experiments by ANOVA and determine the existence of a statistically significant difference among several groups' means.

CO4. Developappropriateregressionmodelstopredictthedesiredparameters.

CO5. Apply non-para metric tests for uncertain distributions and decision analysis is to identify feasible and viable decision alternatives

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	-	-	-	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**	**-**	**-**	**-**	**3**

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

COURSE CONTENT

Module 1: SAMPLING AND ESTIMATION (08 Periods)

Random vs Non-random sampling, Errors in sampling, Central Limit Theorem, Types of estimates, Estimating population mean using z and t statistics, Confidence interval estimation, Maximum likelihood estimation

Module 2: HYPOTHESIS TESTING (09 Periods)

Procedure for Hypothesis testing, Two tailed and one tailed Hypothesis testing, Type 1 and Type 2 errors, Hypothesis testing using z and t statistics, Chi-square test – Goodness of fit, Test of independence and test of homogeneity

Module 3: ANALYSIS OF VARIANCE AND EXPERIMENTAL DESIGNS (09 Periods)

Analysis of variance, Completely Randomized design (One way ANOVA), Randomized Block design, Factorial Design (Two-way ANOVA)

Module 4: REGRESSION MODELING STRATEGIES (10 Periods)

Planning for modeling, Choice of the model, model formulation, Interpreting Modeling parameters, Assessment of model fit, Missing data; describing, Resampling, validating and Simplifying the model; Simple and Multiple Linear Regression, residual analysis, Collinearity, Multiple regression model with two independent variables.

Module 5: NON-PARAMETRIC STATISTICS AND STATISTICAL DECISION THEORY (09 Periods)

Runs Test, Mann-Whitney Test, Wilcoxon Test, Kruskal-Walis Test, Friedman Test, Spearman's Rank correlation.

Decision making under uncertainty - Laplace, Hurwicz and Savage criteria; Decision making under risk – Expected monetary Value, Expected Opportunity Loss, Expected Value of Perfect Information; Decision trees.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Data analysis and visualization: Students could work with real datasets and use statistical software to perform exploratory data analysis, create data visualizations, and identify patterns and trends in the data.
2. Hypothesis testing: Students could design and conduct experiments to test hypotheses, and analyze the results using statistical tests such as t-tests, ANOVA, or regression analysis.
3. Model building and validation: Students could develop predictive models using regression analysis, time series analysis, or other modeling techniques, and evaluate the accuracy of their models using validation techniques such as cross-validation.
4. Data-driven decision-making: Students could work on case studies that require them to analyze data, identify patterns and trends, and make data-driven decisions based on their findings.
5. Big data analytics: Students could work with large, complex datasets and learn how to use tools such as Hadoop, Spark, or SQL to extract insights and make predictions.

CASE STUDIES/ ARTICELS:

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

1. A/B testing in e-commerce: This case study could involve analyzing data from an A/B test to determine whether a new website design, pricing strategy, or product feature is effective at increasing conversions and revenue.

2. Predictive modeling in healthcare: This case study could involve using statistical models to predict the likelihood of patient readmissions, identify at-risk patients, or diagnose diseases based on patient symptoms and medical history.

3. Financial forecasting for a startup: This case study could involve using time series analysis to forecast sales, revenue, and expenses for a new business, and using the results to inform financial planning and decision-making.

4. Quality control in manufacturing: This case study could involve analyzing data from a production line to identify quality issues, determine the root cause of defects, and develop strategies to improve product quality and reduce waste.

5. Crime analysis in law enforcement: This case study could involve using statistical analysis to identify patterns and trends in crime data, predict crime hotspots, and develop strategies for preventing and reducing crime.

RESOURCES

TEXT BOOKS:

1. Naval Bajpai, Business Statistics, Pearson, Second Edition 2013.
2. Casella and Berger, Statistical Inference, Cengage Learning, 2001.

REFERENCE BOOKS:

1. Frank E HarrelJr.,RegressionModeling Strategies, Springer, Second Edition, 2006
2. Andrew Gelman and Jennifer Hill, Data Analysis using Regression and multi level/hierarchical models, Cambridge, 2007
3. J K Sharma, Business Statistics, Vikas, Fifth Edition, 2020

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=WkOinijQmPU
2. https://www.youtube.com/watch?v=fuBvQJP0ecw
3. https://www.youtube.com/watch?v=5KnJ-uVaoLE

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101022	**QUALITY MANAGEMENT AND RELIABILITY ENGINEERING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to Quality, Quality Costs, Quality Circles, QC Tools, Statistical Quality Control, Control Charts, Acceptance Sampling Evaluation, Reliability, Types of Failures, Reliability Improvement.

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

CO1. Demonstrate knowledge on the concepts of standardization and bodies of standardization for improvement of quality.

CO2. Apply quality control codes, standards, and techniques in controlling the quality of a product/ process.

CO3. Analyze sampling plans for continuous quality in production

CO4. Demonstrate knowledge on the reliability and failure concepts.

CO5. Develop failure hazard models to improve reliability

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	-	-	-	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: INTRODUCTION (09 Periods)

Definition of Quality, Quality Control, Factors Affecting Quality, Stages of Evaluation, Quality Management System, Quality Standards, Need for Standardization, Tools for Continuous Improvement-Deming cycle, Poka-Yoke, and Kaizen; Quality related costs, contemporary quality engineering philosophy, Quality systems and international standards, Quality Circles- Concepts, Objectives and advantages, QC Tools, Introduction to Six Sigma Concept, Advantages.

Module 2: STATISTICAL QUALITY CONTROL (09 Periods)

Introduction to SQC, Causes of Variation, Control Charts for Variables- X and R Charts; Interpretation of Control Charts, Control Charts for Attributes- P chart, C chart, U chart; Quality Rating System.

Module 3: ACCEPTANCE SAMPLING (09 Periods)

Acceptance Sampling Plans for Attributes- Types of Sampling Plans, Advantages and Disadvantages of Sampling Plans; Evaluation of Sampling Plans, OC Curve- Characteristics of OC Curve, Producer Risk and Consumer Risk, AOQ, AQL, ATI, ASN; Brief Introduction to Acceptance Sampling Plans for Continuous Production and Acceptance Sampling Plan for Variables.

Module 4: CONCEPTS OF RELIABILITY (09 Periods)

Quality and Reliability, Importance of Reliability, Reliability Data Collection, Failure Data Analysis- MTTF, MTBF, Failure Rate, Hazard Rate, Failure Rate Curve; Types of Failures- Hazard Models (Exponential and Weibull); System Reliability with Components in Series, in Parallel and Mixed configurations.

Module 5: RELIABILITY IMPROVEMENT (09 Periods)

Active and Standby Redundancies, Fault Tree Analysis, Reliability Optimization, Maintainability and Availability and Application of Reliability in Maintenance Strategies.

Total Periods:45

EXPERIENTIALLEARNING

1. Quality Management System Simulation: Students participate in a simulation exercise where they are tasked with implementing a quality management system in a simulated company. They identify factors affecting quality, develop quality standards, and utilize tools such as the Deming cycle, Poka-Yoke, and Kaizen to improve quality. They analyze the impact of these tools on the company's performance.
2. Control Chart Analysis: Students collect data from a manufacturing or service process and use statistical control charts to monitor and analyze the variation. They interpret the control charts for variables (X and R charts) and attributes (P chart, C chart, U chart) to identify any out-of-control situations and make appropriate adjustments.
3. Sampling Plan Evaluation: Students evaluate different acceptance sampling plans for attributes. They analyze the advantages and disadvantages of each plan and consider factors such as producer risk, consumer risk, average outgoing quality (AOQ), acceptable quality level (AQL), and average sample number (ASN). They use OC curves to understand the characteristics of the sampling plans.

4. Reliability Data Analysis: Students analyze real-life reliability data of products or systems. They calculate measures such as mean time to failure (MTTF), mean time between failures (MTBF), failure rate, and hazard rate. They plot failure rate curves and explore different hazard models (exponential and Weibull). They also analyze the reliability of systems with components in series, parallel, and mixed configurations.
5. Fault Tree Analysis: Students engage in a fault tree analysis exercise where they identify the potential failure modes and causes of a system. They construct fault trees to visually represent the relationships between failures and develop strategies to improve system reliability.

RESOURCES

TEXTBOOKS:

1. Dale H Bester field et al, *Total Quality Management*, Pearson Education,3rd edition, 2011.
2. L S Srinath, *Reliability engineering*, East west press, 4th edition, 2005.

REFERENCEBOOKS:

1. Howard Giltow, *Quality Management*, Tata McGraw Hill, 3rd edition,2008.
2. Amitava Mitra, *Fundamentals of Quality Control and Improvement*, Wiley, 3rd edition,2013.
3. Grant E.L, *Statistical Quality Control*, McGraw Hill education (India) Pvt. limited, 7th edition,2005.
4 Montgomery D. C., '*Introduction to Statistical Quality Control*', John Wiley - 2010
5 Ebeling C., '*An Introduction to Reliability and Maintainability Engineering*', Tata McGraw Hill Publishing Company Ltd. - 2004

VIDEO LECTURES/WEB RESOURCES:

1. https://www.youtube.com/watch?v=XxH3duLOIEg
2. https://www.youtube.com/watch?v=qb3mvJ1gb9g
3. https://www.youtube.com/watch?v=xJ3czkvNxpk
4. https://www.youtube.com/watch?v=uutg8jKrL9w
5. https://www.youtube.com/watch?v=rt-mppdgHrU

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

COURSE CONTENT

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 optimizationTechniques – 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

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.

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
22ME101024	**SUPPLY CHAIN MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Fundamentals of Supply Chain Management; Supply Chain Decisions; Achieving Strategic fit; Drivers and Metrics of Supply Chain; Inventory management in a supply chain; Supply chain integration; Distribution Resources Planning; Bullwhip Effect; Role of information technology in SCM; Designing and planning transportation networks through infrastructure and strategies; International and Contemporary issues in SCM; Demand and Supply planning; Mass customization; Global issues and Outsourcing problems; Supply Chain Operations Reference Model; Third-party logistics; Retailer-Supplier Partnership; Emerging trends in SCM.

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

CO1. Demonstrate knowledge of the supply chain and supply chain management concepts.

CO2. Analyze and provide strategies for inventory management in SCM.

CO3. Develop appropriate and customized strategies and policies for managing the supply chain by leveraging information

CO4. Design and plan efficient and responsive transportation networks.

CO5. Demonstrate knowledge on international and contemporary issues in managing supply chains effectively and efficiently

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	1	-	-	-	-	3	-	-	-	3
CO2	3	3	1	-	-	1	-	-	-	-	3	-	-	-	3
CO3	3	3	3	-	1	1	-	-	-	-	3	-	-	-	3
CO4	3	3	3	-	-	1	-	-	-	-	3	-	-	-	3
CO5	3	-	-	-	-	1	-	-	-	-	3	-	-	-	3
Course Correlation Mapping	**3**	**3**	**3**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**

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

COURSE CONTENT

Module 1: INTRODUCTION TO SCM (09 Periods)

Supply Chain - Definition, Objectives; Global optimization, Importance of Supply Chain Decisions, Decision Phases in a Supply Chain, SCM- objectives, Competitive and Supply Chain Strategies, Achieving Strategic fit, Obstacles to achieve strategic fit, Supply Chain Drivers and Metrics

Module 2: INVENTORY MANAGEMENT IN SCM (09 Periods)

Role of cycle inventory and safety inventory in a supply chain, Economic lot size model, Effect of demand uncertainty, Risk pooling, centralized and decentralized system, Managing inventory in the supply chain, Distribution Channel Management, Distribution Resource Planning (DRP).

Module 3: VALUE OF INFORMATION (09 Periods)

Bullwhip effect, Information and supply chain technology, Supply chain integration-Push, Pull and push-pull system; Demand-driven strategies, Role of Information Technology in SCM - Impact of the Internet on SCM; Decision support systems for SCM - Goals, Standardization and Infrastructure.

Module 4: DESIGNING AND PLANNING TRANSPORTATION NETWORKS (09 Periods)

The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and Policies, Design options for a transportation network, Trade-offs in transportation design, Third-party logistics and Tailored transportation.

Module 5: INTERNATIONALAND CONTEMPORARY ISSUES IN SCM (09 Periods)

Sales and Operations Planning, Mass customization, Global issues and Outsourcing problems, Aligning the Supply Chain with Business Strategy – Supply Chain Operations Reference (SCOR) Model, Retailer-Supplier Partnership, Collaborative Planning, Forecasting and Replenishment (CPFR), Vendor Managed Inventory, Distributors integration, Emerging trends in SCM.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Identify various Innovative techniques for effective and eco-friendly supply chain logistics and implement any one of the technique in a system.
2. Define SRM (supplier relationship management) at Toyota? And how do SRM specific activities with strategic suppliers differ from the way you manage supplier relations in general?
3. Identify Supplier relationship management process and how you distinguish between qualified and shortlisted suppliers.

RESOURCES

TEXT BOOKS:

1. Sunil Chopra & Peter Meindl, Supply Chain Management - Strategy, Planning & Operation, 6thEdition, Pearson Education Asia, 2016.
2. Janat Shah, Supply Chain Management: Text and Cases, 2ndEdition, Pearson Education, 2016.

REFERENCE BOOKS:

1. Thomas E Vollman and Clay Whybark D, Manufacturing Planning and Control for Supply Chain Management, Fifth Edition,Tata McGraw Hill, New Delhi, 2005
2. Simchi – Levi Davi, Kaminsky Philip and Simchi-Levi Edith, Designing and Managing the Supply Chain,Third Edition Tata McGraw Hill, New Delhi, 2007.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110107074
2. https://nptel.ac.in/courses/110108056

PROGRAME ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102032	**AI FOR PERCEPTION PLANNING AND CONTROL**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Basics of AI, Training concepts in machine learning, Overview of Fuzzy Logic, Concepts of neuro-fuzzy system and neural networks, Image classification and Object detection, Markov decision process, Deep reinforcement learning in planning and control.

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

CO1. Define various terminologies and concepts in artificial intelligence and machine learning

CO2. Formulate the mathematical basics of fuzzy logic and apply fuzzy logic problems to robotics applications.

CO3. Express the concepts of classical and convolutional neural networks.

CO4. Implement convolutional neural network architectures to various perception tasks.

CO5. Demonstrate the applications of reinforcement learning for planning and control tasks.

CO6. Implementation of algorithm and its performance evaluation for experimentation of Fuzzy logic and robotic controls.

CO-PO-PSO Mapping Table:

Learning 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	-	-
CO2	3	2	-	-	1	1	-	-	-	-	-	-	3	-	-
CO3	3	2	-	-	1	1	-	-	-	-	-	-	3	-	-
CO4	3	2	-	-	1	1	-	-	-	-	-	-	3	-	-
CO5	3	2	-	-	1	1	-	-	-	-	-	-	3	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**-**	**-**	**1**	**1**	-	-	**3**	**3**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO AI & ML (09 Periods)

Introduction to artificial intelligence - Intelligent agent - Categorization of AI - Overview of different forms of learning - Statistical decision theory – Machine learning - Feature selection and feature extraction - Training concepts in machine learning - Train-val-test split - Cross-validation - Generalization - Overfitting and Underfitting - Regularization techniques - Hyperparameters and tuning - Classification and Regression - Performance evaluation metrics for classification and regression algorithms.

Module 2: FUZZY LOGIC (09 Periods)

Introduction to fuzzy logic - Overview of Classical sets, their properties, and operation - Fuzzy set theory, properties of fuzzy sets and their operations - Fuzzy composition - Numerical examples - Membership functions - Fuzzy rule generation - Fuzzification and defuzzification - Fuzzy inference system - Example case studies for mobile robot navigation and manipulator control.

Module 3: CLASSICAL AND CONVOLUTIONAL NEURAL NETWORKS (09 Periods)

Overview of biological neuro-system - Single layer perceptron - Learning rules - Multilayer perceptron - Backpropagation - Introduction to neuro-fuzzy system - Architecture of neuro-fuzzy networks - Classical neural networks vs. deep learning - Convolutional neural networks - Activation functions - Optimization techniques - Deep learning hardware.

Module 4: CNN FOR PERCEPTION (09 Periods)

Image classification - LeNet, AlexNet, ResNet, and Inception architectures - Object detection - RCNN and YOLO architectures - Semantic and instance segmentation - Panoptic segmentation - Visual racking.

Module 5: PLANNING AND CONTROL (09 Periods)

Markov decision process - Deep reinforcement learning - POMDP - Deep-Q learning - Curriculum learning - Proximal policy optimization - Deep reinforcement learning in planning and control of autonomous ground robots and aerial robots: implementation in end-to-end decomposition manner.

TotalPeriods:45

EXPERIENTIALLEARNING

LIST OF EXERCISES:

1. Implementation of classification algorithm and its performance evaluation.
2. Linear regression algorithm and computation of its performance metrics.
3. Fuzzy logic control for mobile robotics application.
4. Fuzzy logic implementation for manipulator control.
5. Implementation of the backpropagation learning algorithm.
6. Implementation of gradient decent optimization algorithm.
7. CNN for object detection.
8. Image panoptic segmentation network.
9. DRL for autonomous navigation of mobile robots in end-to-end manner.
10. DRL in planning and control of mobile robots.

RESOURCES

TEXTBOOKS:

1. Bruno Siciliano, OussamaKhatib, "Handbook of Robotics", 2ndEdition, Springer, 2016.
2. Ian Goodfellow and YoshuaBengio and Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016.

REFERENCEBOOKS:

1. Simon Haykin, "Neural Networks and Learning Machines: AComprehensive Foundation", 3rd Edition, Pearson, 2011.
2. Timothy J Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, Wiley, 2011.

VIDEOLECTURES:

1. https://www.youtube.com/watch?v=pKeVMlkFpRc&list=PLwdnzlV3ogoXaceHrrFVZCJKbm_laSHcH
2. https://www.youtube.com/watch?v=GHpchgLoDvI&list=PLp6ek2hDcoNB_YJCruBFjhF79f5ZHyBuz
3. https://www.youtube.com/watch?v=TK7ORfbT5UI&pp=ygUvQUkgZm9yIFBlcmNlcHRpb24gUGxhbm5pbmcgYW5kIENvbnRyb2wgYnkgTlBURUw%3D
4. https://www.youtube.com/watch?v=yCZQ18SPP44&pp=ygUbQUkgZm9yIFBlcmNlcHRpb24gUGxhbm5pbmcg
5. https://www.youtube.com/watch?v=7Vy8970q0Xc&list=PLwJ2VKmefmxpUJEGB1ff6yUZ5Zd7Gegn2

WEBRESOURCES:

1. https://ojs.aaai.org/aimagazine/index.php/aimagazine/article/view/833
2. https://ojs.aaai.org/aimagazine/index.php/aimagazine/article/view/1545
3. https://ojs.aaai.org/aimagazine/index.php/aimagazine/article/view/833
4. https://link.springer.com/article/10.1023/A:1011286518035

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101084	PLANNING AND DECISION MAKING IN ROBOTICS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Introduction of Configurations and types, Degree of freedom computation, Inverse kinematics approach for a spatial parallel manipulator, Multi-Mobile Robot Systems, Control of Flexible Manipulators, Wheeled Mobile Robots, cooperative Manipulators, Historical overview, Control of cooperative manipulator

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

CO1. Derive the inverse kinematics and Jacobian of parallel manipulator

CO2. Understand the concept of multi-robot systems and their control challenges

CO3. Apply the concepts of modeling and control of flexible robots

CO4. Apply the mathematical concepts of modeling and control of wheeled mobile robot in uneven terrain

CO5. Understand the fundamentals of the cooperative robot, haptics, and tele robotic systems

CO-PO-PSO Mapping Table:

Learning 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	1	-	-	-	-	-	-	-	-	-	3
CO2	3	1	-	-	1	1	-	-	-	-	-	-	-	-	3
CO3	3	1	-	-	1	1	-	-	-	-	-	-	-	-	3
CO4	3	3	3	1	1	1	-	-	-	-	-	-	-	-	3
CO5	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: PARALLEL MECHANISMS (09 Periods)

Definitions, Configurations and types, Degree of freedom computation, Inverse kinematics approach for a spatial parallel manipulator, Jacobian computation method using vector loop equation, singularity computation, types and causes of the singularity, Introduction to forward kinematics and computation method, Study of pneumatically driven and wire driven parallel robot (any DoF).

Module 2: MULTI-MOBILE ROBOT SYSTEMS (09 Periods)

Introduction to multi-robot systems, Architecture for multi-robot systems, Communication systems and strategies, Networked Mobile Robots: Control methods, Communication for control, Communication for perception, control for communication, Introduction to swarm robots, Introduction to modular robotics, Application

Module 3: CONTROL OF FLEXIBLE MANIPULATORS (09 Periods)

Robots with Flexible joints, Dynamic model of link with flexible joints, regulation control, PD control with gravity compensation, Robot with flexible links, design issues and considerations, Modelling of flexible arms,Sensors for flexibility control, command shaping algorithm for control, Insight to feedback control of flexible link manipulators.

Module 4: WHEELED MOBILE ROBOTS (09 Periods)

Introduction to wheeled mobile robot (WMR), Dynamic of mobile robot, Two and three-wheeled WMR on flat surfaces , Wheel terrain interaction mechanics, Concepts of Slip,Slip Modelling, WMR on uneven terrain, and Design of Slip free motion on uneven terrain, Control of wheeled robot in rough terrain: slip compensated path follower, Introduction to modeling and control of tracked vehicle: control of sub tracks.

Module 5: ADVANCED TOPICS (09 Periods)

Introduction to cooperative Manipulators, Historical overview, Control of cooperative manipulator: Overview, Introduction to Haptics, Application of Haptics, Haptic Device Design: Actuator and sensor selection, Popular haptic device , Haptic Rendering, Haptic control loop, Overview of Impedance control, Control and stability of haptic interfaces, Introduction to tele robotic systems: actuators and sensor requirements, Application, Control Architecture, Bilateral control and force feedback, Communication and networking

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Explain various configurations of robot
2. Discuss different End effectors and reachable workspaces
3. Discuss various types of wheels to be used for wheeled mobile robots.
4. What are various issues to be considered for designing of manipulator

RESOURCES

TEXTBOOKS:

1. Alexander schlaelfer and ole blaurock, Robotic sailing, Proceedings of the 4th International sailing conference, Springer, 2011
2. Sabiha A. wadoo,pushkin kachroo, Autonomous underwater vehicles, modelling, control design and Simulation, CRC press, 2011
3. Reg Austin, Unmanned Aircraft Systems, Wiley & Sons (2010)

REFERENCE BOOKS:

1. Paul Gerin Fahlstrom, and Thomas James Gleson, Introduction to UAV systems, John Wiley (2012)
2. Gianluca Antonelli, Underwater robotics, Springer, 2014
3. Richard A Geyer, "Submersibles and their use in oceanography and ocean engineering", Elsevier, 1997
4. Ferial L hawry, The ocean engineering handbook, CRC press,2000

VIDEO LECTURES:

1. https://nptel.ac.in/courses/107106090
2. https://onlinecourses.nptel.ac.in/noc21_me44/preview

WEB RESOURCES:

1. http://motion.cs.illinois.edu/RoboticSystems/Kinematics.html
2. https://www.ri.cmu.edu/pub_files/pub3/muir_patrick_1988_1/muir_patrick_1988_1.pdf
3. http://www.diag.uniroma1.it/~deluca/rob1_en/16_Mobile_RobotsKinematics.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101025	**TRIBOLOGY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Tribology deals with friction, wear, and lubrication. This course will approach tribology in terms of both the science of basic mechanisms, and the technologies of design, manufacture and maintenance.

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

CO1. Understand the fundamentals of tribology and associated parameters and analyse of friction for the various applications.

CO2. Understand wear mechanisms, and identifying the root causes of wear-related failures.

CO3. Learn about the different types of lubricants and lubrication regimes used to optimize friction and wear performance in various applications

CO4. Comprehend the methods for characterizing surface roughness, including mean, ten-point average, and CLA methods, and be able to compute these parameters using appropriate techniques and instruments.

CO5. Apply the principles of surface engineering for different applications of tribology.

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	-	-	-	-	-	3	-	-
CO2	3	2	3	-	-	1	1	-	-	-	-	-	3	-	-
CO3	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO4	2	2	3	-	-	1	1	-	-	-	-	-	3	-	-
CO5	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
Course Correlation Mapping	**2**	**2**	**3**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO TRIBOLOGY AND FRICTION (10 Periods)

Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.

Friction: Origin, friction theories, measurement methods, friction of metals and non-metals. Rolling Friction, Source of Rolling Friction, Stick slip motion, laws of Friction.

Module 2: WEAR (09 Periods)

Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Mechanism of sliding wear of metals, Ceramics and Polymers, Wear mechanisms- Abrasive wear, Adhesive, Abrasive wear situations, tribo-chemical reactions, Corrosive wear, Surface Fatigue wear situations, Fracture wear, fretting, erosion, Estimation of wear rate.

Module 3: LUBRICANTS (08 Periods)

Introduction, effect and necessity of lubrication, Lubrication types, properties, Requirements of Lubricants, Testing methods, Hydrodynamic Lubrication, Elasto-hydrodynamic lubrication, Boundary Lubrication, solid and semi-solid lubricants, Solid Lubrication, Hydrostatic Lubrication.

Module 4: SURFACE TOPOGRAPHY (09 Periods)

Geometric Characteristics of Surfaces, Computation of Surface Parameters-Mean, Ten point average, CLA methods, Load bearing curve Film Parameters for Different Lubrication Regimes, Transition Between Lubrication Regimes, Health and safety aspects of lubricants.

Module 5: SURFACE ENGINEERING AND BEARING MATERIALS (09 Periods)

Scope of surface engineering, Surface modifications, Transformation Hardening, Surface fusion, Thermochemical processes, Surface coatings, Plating and anodizing, Fusion Processes, Vapour Phase processes, Chemical vapour deposition.

Bearing materials: selection of bearing materials, metal bearings, Non-metal bearings.

Total Periods: 45

EXPERIENTIAL LEARNING

1. To delineate the behaviour of interacting surfaces-associated practices, and mainly emphasizes on phenomenon of friction, wear and lubrication.
2. Experiments performed on various industrial materials in dry or lubricating conditions with the increase of lubricating oil temperature for measuring frictional wear, coefficient of friction, etc. under various load conditions.

RESOURCES

TEXT BOOKS:

1. B. Bhushan, Introduction to Tribology, John Wiley & Sons, Inc., New York, 2002
2. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Ltd, New Delhi, 2011.
3. Williams J.A, Engineering Tribology, Oxford Univ.Press, 2001.

REFERENCE BOOKS:

1. Majumdar B.C, Introduction to bearings, S. Chand & Co., Wheeler publishing, 1999.
2. Andras Z. Szeri, Fluid film lubrication theory and design, Cambridge University press, 1998.
3. Cameron A, Basic lubrication theory, Ellis Horwood Ltd., 2002.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112102014
2. https://archive.nptel.ac.in/courses/112/102/112102015/

WEB RESOURCES:

1. https://ocw.mit.edu/courses/2-800-tribology-fall-2004/pages/lecture-notes/
2. https://www.ocw.mit.edu/courses/2-800-tribology-fall-2004/resources/lecture-notes/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101026	**MECHANICAL BEHAVIOR OF MATERIALS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides the fundamental concepts Elastic and plastic behavior of materials. Strengthening mechanisms, fatigue and its factor affecting, creep and fracture.

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

CO1. Demonstrate the knowledge on mechanism involved in elastic and plastic behavior of materials.

CO2. Apply strengthening mechanism for ferrous and non ferrous materials.

CO3. Analyze Fatigue behavior of components using S-N curve.

CO4. Analyze fractures and determine its parameters.

CO5. Analyze the materials using creep tests for engineering 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	1	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	-	1	1	-	-	-	-	-	3	-	-
CO3	3	3	2	1	-	1	1	-	-	-	-	-	3	-	-
CO4	3	3	2	1	-	1	1	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	1	1	-	-	-	-	-	-	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

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

COURSE CONTENT

Module 1: ELASTIC AND PLASTIC BEHAVIOUR (09 Periods)

Elastic behavior of materials, Hooke's law, plastic behavior, dislocation theory, Burger's vectors and dislocation loops, dislocation desnity, stress fields and energies of dislocations, Jogs, dislocation sources, multiplication of dislocations, dislocation pile-ups, Slip and twinning.

Module 2: STRENGTHENING MECHANISMS (09 Periods)

Elementary discussion of cold working, grain boundary strengthening. Solid solution strengthening, Martensitic strengthening, Precipitation strengthening, Particulate Strengthening, Dispersion strengthening, Fiber strengthening, Examples of above strengthening mechanisms from ferrous and non-ferrous systems, Yield point phenomenon, strain aging and dynamic strain aging.

Module 3: FATIGUE BEHAVIOUR (09 Periods)

Fatigue: Stress cycles, S-N curves, Effect of mean stress, Factors affecting Fatigue, Structural changes accompanying fatigue, Cumulative damage, HCF / LCF, thermo - mechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines- Pari's Equation, Residual life prediction under Fatigue. Macro, Microstructural features of fatigue fracture.

Module 4: FRACTURE AND FRACTURE MECHANICS (09 Periods)

Types of fracture, Basic mechanisms of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, Determination of DBTT.

Fracture mechanics-Introduction, Modes of fracture, Stress intensity factor, Strain energy release rate, Fracture toughness and Determination of KIC, Introduction to COD, J integral.

Module 5: CREEP BEHAVIOUR AND TESTING (09 Periods)

Creep curve, Stages in creep curve and explanation, Structural changes during creep, Creep mechanisms, Metallurgical factors affecting creep, High temperature alloys, Stress rupture testing, Creep testing machines, Parametric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Students perform material testing experiments (e.g., tensile, compression, impact, hardness, and fatigue tests), collect data, and analyze results to understand material behavior under various loading conditions.
2. Failure Analysis through the examination of failed components, students investigate failure causes, study fracture surfaces, identify failure modes, and analyze underlying mechanical properties that contributed to the failure, enhancing understanding of material behavior under extreme conditions.
3. Engaging in design projects that involve material selection and structural analysis allows students to apply their theoretical knowledge to practical problems.

(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.

RESOURCES

TEXT BOOKS:

1. Dieter, G. E., *Mechanical Metallurgy*, McGraw-Hill Co., SI Edition.
2. Thomas H.Courtney, *Mechanical Behavior of Materials*, McGraw-Hilll, 2nd edition, 2019.

REFERENCE BOOKS:

1. Suryanarayana, A. V. K., *Testing of Metallic Materials*, Prentice Hall India, New Delhi.
2. Marc Andr'e Meyers and Krishan Kumar Chawla, *Mechanical Behavior of Materials* Cambridge University Press, 2009.
3. Prashant Kumar, *Elements of Fracture Mechanics*, McGraw-Hilll, 2009.

WEB RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_mm27/preview
2. https://archive.nptel.ac.in/courses/113/106/113106101/
3. https://in.coursera.org/courses?query=mechanics%20of%20materials
4. https://www.edx.org/course/mechanical-behavior-of-materials-part-1-linear-ela

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101027	DESIGN OF PRESSURE VESSELS AND PIPING SYSTEMS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Material selection, Estimation of stresses; Formulation of fatigue models, Factor of safety; Design of Heads, Covers, Nozzle, Gasket & End closure; Buckling phenomenon, buckling problems and Design of piping layout.

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

CO1. Understand force acting on pressure vessel components by applying conceptual knowledge of stresses and selection of materials for pressure vessels.

CO2. Analyze safety factors to find fatigue stresses in cylindrical plates to meet ASME Boiler standards.

CO3. Design pressure vessel components such as end closures, bolted flanges and supports to meet the applications.

CO4. Analyze the pressure vessel cylinders for protection against buckling effects in thick walled cylinders considering the standard solutions.

CO5. Design piping layout system consists of Tees, bends, bellows and valves to meet the piping ASME code standard 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	2	3	-	-	-	-	1	-	-	-	-	3	-	-
CO2	3	3	3	1	-	3	-	2	-	-	-	-	3	-	-
CO3	2	3	3	-	-	2	-	2	-	-	-	-	3	-	-
CO4	3	3	3	1	-	2	-	2	-	-	-	-	3	-	-
CO5	2	2	2	-	-	2	-	2	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**1**	**-**	**2**	**-**	**2**	**-**	-	**-**	-	**3**	**-**	-

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

COURSE CONTENT

Module 1: DESIGN OF CYLINDRICAL SHELLS (09 Periods)

Introduction to pressure vessels, Design Philosophy, Structural Integrity, material considerations, Stresses in pressure vessels, shrink fit stresses in built up cylinders, autofrettage of thick cylinders, thermal stresses and their significance, methods for determining stresses.

Design of Cylindrical Shells: ASME equations - Thin shell equations - Thick shell equations.

Module 2: FATIGUE ASSESSMENT AND DISCONTINUITY STRESSES (09 Periods)

Fatigue Assessment: Introduction to theories of failure; Allowable stress limits in ASME Boiler & Pressure Vessel, Design for cyclic loading, and Protection against fracture, S–N curves, Design curves, and Cumulative damage. Fatigue, shock, high pressure, high temperature, irradiation, corrosion, and other hostile environments.

Discontinuity Stresses -Beams on elastic foundation, Cutouts and Reinforcements. Stress concentration in plate having circular hole due to bi-axial loading, excessive elastic deformation, plastic instability, brittle, rupture and creep. Design of nozzle.

Module 3: END CLOSURES, BOLTED FLANGES & SUPPORTS: (10 Periods)

End Closures - Introduction to ASME equations for various types of heads – Hemispherical, flat, ellipsoidal, torispherical, and conical heads.

Bolted Flanges - Introduction to bolted flanges, RF and FF flanges - Gasket loading behaviour - Application of ASME equations for flange analysis and bolt design.

Design of Supports: Design of base plate and support lugs, Support skirts. Types of anchor bolt, its material and allowable stresses, Design for wind load- Design for seismic load- Theory of reinforcement - Design of cone cylinder intersections - Use of codes

Module 4: DESIGN OF PRESSURE VESSELS FOR BUCKLING LOADS (08 Periods)

Introduction to Buckling, types of Buckling, Elastic Buckling of circular ring and cylinders under external pressure, Collapse of thick walled cylinders or tubes under external pressure, Effect of supports on elastic Buckling of Cylinders, Design of circumferential stiffeners, Buckling under combined External pressure and axial loading.

Module 5: DESIGN OF PIPING LAYOUT (09 Periods)

Introduction to Piping layout, Flow diagram, piping layout and piping stress analysis; Flexibility factor and stress intensification factor; Design of piping system as per B31.1 piping code.

Introduction to Piping components, bends, tees, bellows and valves.

Design and analysis of piping systems – Pipes and tubing under external and internal pressure –design of tube-sheets and tube seats, and use of post-weld heat treatment to affect residual stress in final rupture

Total Periods: 45

EXPERIENTIAL LEARNING

1. Utilize CAD software, such as AutoCAD or Solid Works, to create 3D models of pressure vessels and piping systems. This allows you to develop design skills and visualize the components in a virtual environment.
2. Engage in laboratory work that involves the testing and analysis of pressure vessel and piping system components.
3. Conduct research on the various codes and standards that govern the design of pressure vessels and piping systems, such as ASME Boiler and Pressure Vessel Code, API standards, and ANSI/ASME B31 series.

RESOURCES

TEXT BOOKS:

1. John F. Harvey, "Theory and Design of Pressure Vessels", CBS Publishers and Distributors, 1987.
2. Somnath Chattopadhyay, Pressure Vessels: Design and Practice, 1st Edition, CRC Press, 2005.

REFERENCE BOOKS:

1. Henry H. Bedner, "Pressure Vessels, Design Hand Book", CBS publishers and Distributors, 1987.
2. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997.
3. Stanley, M. Wales, "Chemical process equipment, selection and Design",Buterworths series in Chemical Engineering, 1988.
4. Ellenberger P. - 'Pressure Vessels: ASME Code Simplified' - McGraw Hill Company - 2004, 8th Edition.

Note: Specified design data books are permitted in the examinations.

VIDEO LECTURES:

1. Lecture - 38 Design of Cylinders & Pressure Vessels - III - YouTube
2. Lecture - 37 Design of Cylinders & Pressure Vessels - II - YouTube

WEB RESOURCES:

1. Pressure Vessels: Types, Design, Supports, Applications, Materials (PDF) – What Is Piping
2. BPVC | Boiler and Pressure Vessel Code - ASME

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101028	**MACHINERY FAULT DIAGNOSIS AND SIGNAL PROCESSING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to Condition Based Maintenance, Types and Benefits of Vibration Analysis; Basic Signal Processing Techniques- visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring;Fault Detection- Vibration Criteria- Use of Frequency Spectra- CPB Spectrum;Diagnostic Techniques- Gear Diagnostics techniques- Bearing Diagnostics;Vibration Monitoring- vibration data collection, instruments, measurement location, time-domain analysis, frequency domain analysis.

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

CO1. Apply maintenance and condition monitoring techniques to machines.

CO2. Apply signal processing techniques to components of machines.

CO3. Analyze and correct the Machinery faults using fault Trending and Prognostics tools.

CO4. Analyze machine elements using various Diagnostic Techniques

CO5. Analyze characteristics of vibration using suitable monitoring techniques.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	2	-	-	-	-	1	-	-	3	-	-
CO2	3	3	1	2	-	-	-	-	-	1	-	-	3	-	-
CO3	3	1	2	1	-	-	-	-	-	-	-	-	3	-	-
CO4	3	1	2	2	-	-	-	-	-	-	-	-	3	-	-
CO5	3	1	-	2	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**2**	**2**	**2**	-	-	-	-	**1**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: CONDITION BASED MAINTENANCE (10 Periods)

Introduction, Maintenance Strategies, Condition Monitoring Methods- Vibration Analysis- Oil Analysis- Performance Analysis- Thermography; Types and Benefits of Vibration Analysis; Vibration Transducers- Absolute vs Relative Vibration Measurement -Proximity Probes -Velocity Transducers – Accelerometers -Dual Vibration Probes -Laser Vibrometers; Torsional Vibration Transducers- Shaft encoders- Torsional Laser Vibrometers; Condition Monitoring - Basic Problems.

Module 2: SIGNAL PROCESSING TECHNIQUES (09 Periods)

Basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring. Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic/random signal separation, Time-frequency analysis.

Module 3: FAULT DETECTION (09 Periods)

Introduction, Rotating Machines - Vibration Criteria- Use of Frequency Spectra- CPB Spectrum Comparison; Reciprocating Machines- Vibration Criteria for Reciprocating Machines- Time-Frequency Diagrams- Torsional Vibration; Fault Trending and Prognostics- Trend Analysis- Trending of Simple Parameters- Trending of Impulsiveness; Determination of Spall Size in Bearings; Advanced Prognostics- Data-Driven Models- Hybrid Models.

Module 4: DIAGNOSTIC TECHNIQUES (07 Periods)

Harmonic and Sideband Cursors; Minimum Entropy Deconvolution; Gear Diagnostics- Techniques Based on the TSA- Transmission Error as a Diagnostic Tool- Separation of Spalls and Cracks- Diagnostics of Gears with Varying Speed and Load; Rolling Element Bearing Diagnostics- Signal Models for Bearing Faults- A Semi-automated Bearing Diagnostic Procedure; Reciprocating Machine and IC Engine Diagnostics- Time-Frequency Methods- Cylinder Pressure Identification.

Module 5: VIBRATION MONITORING (10 Periods)

Vibration Monitoring Introduction, vibration data collection, techniques, instruments, measurement location, time-domain analysis, frequency domain analysis, time-frequency domain analysis and commonly witnessed machinery faults diagnosed by vibration analysis. Vibration signals from rotating and reciprocating machines – signal classification, signals generated by rotating machines, signals generated by reciprocating machines.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Study the art techniques in machinery condition monitoring along with the recent developments in the field of signal processing, thermography, ultra sonics apart from the traditional noise and vibration monitoring.

2. Workout using model-based fault reduction techniques usingartificial neural network is in wavelets and other signal processing techniques for doing a morerobust detection of faults in systems.

RESOURCES

TEXT BOOKS:

1. Robert Bond Randall, *Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications*, John Wiley & Sons Ltd., 2011 DOI:10.1002/9780470977668
2. R.A.Collacot, *Mechanical Fault Diagnosis*, Chapman and Hall Ltd., 1977.
3. R.C.Mishra, K.Pathak, *Maintenance Engineering and Management*, Prentice Hall ofIndia Pvt. Ltd., 2002.

REFERENCE BOOKS:

1. Dr. K.Balaveera Reddy, *ISTE Summer School on Machinery Diagnostics and Preventive Maintenance*, KREC, Surathkal, 1995.
2. John S.Mitchell, *Introduction to Machinery Analysis and Monitoring*, PennWell Books, 1993.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=bjKML-1-7Bw
2. https://youtu.be/zeQrj7I3m1U
3. https://youtu.be/6pKisBngOH0

WEB RESOURCES:

1. http://vlabs.iitkgp.ac.in/mssp/exp7/index.html#
2. https://archive.nptel.ac.in/content/storage/112/105/112105232/MP4/mod08lec36.mp4
3. https://archive.nptel.ac.in/content/storage/112/105/112105232/MP4/mod09lec41.mp4
4. https://onlinecourses-archive.nptel.ac.in/noc19_me27/preview

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101029	FUNDAMENTALS OF MICROELECTROMECHANICAL SYSTEMS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides the fundamental concepts of Micro Electro Mechanical Systems (MEMS), working principles of microsensors and microactuators, materials, micro fabrication processes, MEMS accelerometers, packaging of Microsystems and applications over different fields.

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

CO1. Understand the fundamentals of MEMS and an overview of materials used.

CO2. Demonstrate MEMS Components like micro-sensors and micro-actuators.

CO3. Understand working methodologies of MEMS accelerometers.

CO4. Use micro fabrication techniques and device packaging methods in manufacturing MEMS devices.

CO5. Analyze various MEMS devices for engineering 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	-	-	2	-	-	-	-	-	-	3	-	-
CO2	3	3	2	-	-	1	-	-	-	-	-	-	3	-	-
CO3	3	3	2	-	-	2	-	-	-	-	-	-	3	-	-
CO4	3	2	2	-	-	1	-	-	-	-	-	-	3	-	-
CO5	3	3	1	-	-	2	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO MEMS AND MICROSYSTEMS (09 Periods)

Introduction to MEMS, Energy domains and transducers, sensors and actuators, Microsystems versus MEMS, miniaturization, MEMS materials.

Module 2: 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.

Micro actuators: Electromagnetic and Thermal micro actuation, Mechanical design of micro actuators, Micro actuator examples, microvalves, micropumps, micromotors.

Module 3: MEMS ACCELEROMETERS (07 Periods)

Micro accelerometers for MEMS, Temperature and Damping analysis, Piezo elective accelerometer, Piezoresistive accelerometer, Piezo capacitive accelerometer technology.

Module 4: MEMS FABRICATION AND PACKAGING (12 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 5: MEMS APPLICATIONS (08 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 Periods: 45

EXPERIENTIAL LEARNING

1. Involve in MEMS hands-on fabrication processes like photolithography, etching, deposition, and packaging. Students learn cleanroom techniques, operate equipment, fabricate MEMS devices, and perform characterization techniques such as microscopy and electrical testing.
2. Explore the challenges and techniques involved in packaging MEMS devices for practical applications. This includes understanding packaging materials, assembly methods, hermetic sealing, and interconnection techniques.
3. Analyzing case studies of successful MEMS devices or projects provides insights into the practical applications and challenges associated with MEMS technology.

CASE STUDIES/ ARTICELS:

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

RESOURCES

TEXT BOOKS:

Tai-Ran Hsu, *MEMS & Microsystems, Design and Manufacture*, McGraw Hill Education (India) Pvt. Ltd., 27th reprint, 2018.

REFERENCE BOOKS:

1. G.K.Ananthasuresh, K.J.Vinoy, *Micro and Smart Systems*, New Delhi publication, 1st edition, 2011 Education (India) Pvt. Ltd.
2. NitaigourPremchandMahalik, *MEMS*, McGraw Hill Education (India) Pvt. Ltd., 11th reprint, 2016.

VIDEO LECTURES:

https://nptel.ac.in/courses/117105082

WEB RESOURCES:

1. https://nptel.ac.in/courses/117105082
2. https://archive.nptel.ac.in/courses/117/105/117105082/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101030	SOFT COMPUTING TECHNIQUES IN MECHANICAL ENGINEERING	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion and hands-on experience on Soft computing techniques; Genetic Algorithm; Fuzzy Logic; neural Network; Hybrid soft computing techniques; Application in Mechanical Engineering.

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

CO1. Demonstrate the knowledge on soft computing techniques and their applications.

CO2. Apply the genetic algorithms for solving Mechanical Engineering problems.

CO3. Apply the modern optimisation methods in solving engineering problems.

CO4. Formulate fuzzy sets and implement the fuzzy logic methods in solving engineering problems.

CO5. Analyse various neural network architectures.

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	3	-	-	-	-	-	3	-	-
CO2	3	3	1	-	-	2	3	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	1	3	-	-	-	-	-	3	-	-
CO4	2	2	-	-	-	2	2	-	-	-	-	-	3	-	-
CO5	2	2	-	-	-	2	2	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**1**	**-**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION OPTIMIZATION AND SOME TRADITIONAL METHODS (09 Periods)

Hard Computing: Features of Hard Computing, Examples of Hard.

Soft Computing: Features of Soft Computing, Examples of Soft Computing.

Hybrid Computing: Examples of Hybrid Computing. Principle of Optimization, Duality Principle, Traditional Methods of Optimization, Exhaustive Search Method, Random Walk Method, Drawbacks of Traditional Optimization Methods. Applications of Soft Computing, Applications of Soft Computing in Design and Development of Intelligent Autonomous Robots

Module 2: INTRODUCTION TO GENETIC ALGORITHMS (09 Periods)

Working Cycle of a Genetic Algorithm, Binary-Coded GA, Crossover or Mutation, A Hand Calculation, Fundamental Theorem of GA/Schema Theorem, and Limitations of a Binary-Coded GA, Constraints Handling in GA, Penalty Function Approach, and Combination of Local and Global Optimum Search Algorithms. Some Specialized Genetic Algorithms, Real-Coded GA, Micro-GA, Scheduling GA. Applications.

Module 3: NON-TRADITIONAL OPTIMIZATION METHODS (09 Periods)

Simulated Annealing, Working Principle, Particle Swarm Optimization, Comparisons Between PSO and GA.

Multi-Objective Optimization: Some Approaches to Solve Multi-Objective Optimization Problems, Weighted Sum Approach, Distance-based Pareto-GA (DPGA), Non-dominated Sorting Genetic Algorithms (NSGA)

Module 4: INTRODUCTION TO FUZZY SETS (10 Periods)

Crisp Sets.Notations Used in Set Theory, Crisp Set Operation, Properties of Crisp Sets, Fuzzy Sets, Representation of a Fuzzy Set, Difference Between Crisp Set and Fuzzy Set, Some Standard Operations in Fuzzy Sets and Relations, Measures of Fuzziness and Inaccuracy of Fuzzy Sets.

Fuzzy Reasoning and Clustering, Fuzzy Logic Controller, Fuzzy Clustering, Fuzzy C-Means & Entropy-based Fuzzy Clustering

Module 5: FUNDAMENTALS OF NEURAL NETWORKS (08 Periods)

Biological Neuron, Artificial Neuron, A Layer of Neurons, Multiple Layers of Neurons. Static vs. Dynamic Neural Networks, Training of Neural Networks

Examples of Neural Networks: Multi-Layer Feed-Forward Neural Network. Radial Basis Function Network (RBFN), Self-Organizing Map, Recurrent Neural Networks (RNNs)

Total Periods: 45

EXPERIENTIAL LEARNING

1. Identify the influential parameters of IC engine on the fuel consumption and formulate an optimization problem. Solve the formulated problem using advanced optimization technique and suggest the better optimal parameters.
2. Employ any one optimization technique to solve and identify the desired geometric dimension of a pressure vessel.

RESOURCES

TEXT BOOKS:

1. Pratihar D. K., "Soft Computing Fundamentals and Applications", 1st edition, Alpha Science, 2014.
2. Rajasekaran S, Vijayalakshmi G.A., "Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications," 1st Edition, PHI Publication, 2009

REFERENCE BOOKS:

1. Randy L.H., "Practical Genetic Algorithms", 2nd edition, John Wiley and Sons Inc, 2004.
2. Xin S.Y., "Nature Inspired Optimisation Algorithms", 1st edition, Elsevier, 2014.

VIDEO LECTURES:

1. http://nptel.ac.in/courses/106106046/
2. https://onlinecourses.nptel.ac.in/noc22_cs54/preview

WEB RESOURCES:

1. https://binaryterms.com/soft-computing.html
2. https://www.sciencedirect.com/science/article/pii/S1877050916325467#:~:text=Soft%20computing%20is%20based%20on,area%20in%20automatic%20control%20engineering.

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101031	MECHANICAL VIBRATIONS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

The Course is designed with the objective of providing a fundamental understanding of linear mechanical vibrations commonly seen in engineering structures and machines. It reviews the response characteristics of basic mechanical vibratory systems and implications of phenomena such as resonance for the basic mechanical system**.** It introduces fundamentals of vibration, Undamped free vibrations; Damped free vibration; Forced vibrations; Basic concepts on engineering measurements; Spectrum analysis; signal processing; vibration control..

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

CO1. Calculate the vibration parameters of damped and undamped free SDOF systems.

CO2. Analyse the vibration parameters in forced vibrations.

CO3. Calculate the natural frequencies vibrations in two-degree freedom systems.

CO4. Analyse torsional vibrations and calculate vibration parameters.

CO5. Analyse vibrations using various methods involved to enhance productivity.

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	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	-	1	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	-	1	-	-	-	-	-	-	3	-	-
CO4	3	3	2	1	-	1	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	3	1	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**3**	**1**	-	-	-	-	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: SINGLE DEGREE OF FREEDOM SYSTEMS - FREE AND DAMPED VIBRATIONS (09 Periods)

Fundamentals of vibration: Elements of a vibratory system, S.H.M, degrees of freedom; modeling of a system; concept of linear and non-linear systems; equivalent spring; linear and torsional systems.

Undamped free vibrations: Natural frequency by equilibrium and energy methods for longitudinal and torsional vibrations.

Damped free vibrations: Different types of damping, equivalent viscous damping; free vibrations with viscous damping: over damped, critically damped and under damped systems; initial conditions; logarithmic decrement; dry friction or coulomb damping, frequency and rate of decay of oscillations

Module 2: FORCED VIBRATIONS (09 Periods)

Constant harmonic excitation - steady state forced vibration, Impressed harmonic force, Impressed force due to unbalance; Motion excitation – amplitude, absolute, relative, Rotating with reciprocating unbalance; Transmissibility and Isolation – Force and Motion transmissibility; Damping – coulomb damping, Viscous damping.

Module 3: TWO DEGREE OF FREEDOM SYSTEMS (09 Periods)

Free vibrations of spring coupled systems - Natural frequencies and modes of vibration by classical method of spring-mass system; Forced vibration - Dynamic vibration absorber, longitudinal vibrations of bars.

Module 4: TORSIONAL VIBRATIONS (09 Periods)

Introduction, Torsional system, Damped mass and distributed mass systems, Natural frequencies and mode shapes - Rayleigh's method, Holzer method, Stodola method.

Module 5: VIBRATION MEASUREMENTS (09 Periods)

Vibration measurement - process, classification of measuring instruments; Vibrometers-Stylus type, optical type, seismic instrument, simple potentiometer; capacitance pick-up- Active type and passive type pick-ups; Accelerometers- FFT Spectrum analyzer and its applications; Vibration monitoring technique.

Total Periods: 45

EXPERIENTIAL LEARNING

1. The cockpit of a fire truck is located at the end of a telescoping boom. The cockpit, along with the fireman, certain weight. Find the cockpits natural frequency of vibration in the vertical direction.
2. Make cantilever beam and considered it as an aero plane wing. Measure the all possible vibrations using accelerometer and notify the salient observations.

RESOURCES

TEXT BOOKS:

1. Groover G.K, Nigam S.P., "Mechanical Vibrations", 8th Edition, Nemchand & Brother's 2008.
2. Rao S.S., "Mechanical Vibrations", 4th Edition, Pearson, 2003.

REFERENCE BOOKS:

1. Thompson W.T., "Theory of Vibration with Applications", 5th Edition Prentice Hall, 2008.
2. Sadhu Singh, "Mechanical vibrations and Noise control", 13th Edition, Dhanpat Rai & Sons, 2006.
3. Meirovitch, "Elements of Vibration analysis", 1st Edition, McGraw Hill Education (India) Pvt. Ltd, 2013.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112107212
2. https://nptel.ac.in/courses/112103111

WEB RESOURCES:

1. https://www.sciencedirect.com/topics/engineering/mechanical-vibration
2. https://mechanicalenotes.com/mechanical-vibrations/
3. https://ocw.mit.edu/courses/2-003sc-engineering-dynamics-fall-2011/pages/mechanical-vibration/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101032	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

The objective of course is identify the manufacturing constraints that influence the design of parts and part systems. Students will be introduced to the Design for Manufacturability (DFM) methodology, and will be motivated to understand infeasible or impractical designs

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

CO1. Outline the appropriate design for economical production and selection of various materials in manufacturing methods such as welding, forging and casting processes.

CO2. Analyse the machining considerations of punching and blanking process to easy of finishing operations to user.

CO3. Analyse the machining considerations of processes and redesigning system to easy of accessibility to user.

CO4. Analyse the working conditions of casting processes and modifying to economical designs with the help of computers.

CO5. Identify the environment consideration while designing a product.

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	1	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	-	-	-	-	-	-	-	-	**3**	**-**	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO DESIGN FOR MANUFACTURING (09 Periods)

General design principles for manufacturability: strength and mechanical factors, mechanisms selection, evaluation method, Process capability: Feature tolerances, Geometric tolerances, Assembly limits, Datum features, and Tolerance stacks.

Factors Influencing form Design: Working principle, Material, Manufacture, and Design-Possible solutions, Materials choice, Influence of materials on form design, form design of Welded members, forgings and castings.

Module 2: EXTRUSION AND SHEET METAL WORK (08 Periods)

Design guidelines for extruded sections - design principles for punching, blanking, bending, and deep drawing – Keeler Goodman forming line diagram – component design for blanking.

Module 3: COMPONENT DESIGN-I : MACHINING CONSIDERATION (09 Periods)

Friction wheels and toothed gears, Types, Law of gearing, Sliding velocity of teeth, Forms of teeth- Cycloidal, Involute profiles; Expressions for path of contact and arc of contact, Contact ratio, Phenomena of interference, Condition for minimum number of teeth to avoid interference, Gear trains - Simple, Compound, Reverted and Epicyclic gear train; Compound Epicyclic Gear Train (sun and planet wheel), Differential gearbox for automobile.

Module 4: COMPONENT DESIGN-II : CASTING CONSIDERATION (09 Periods)

Redesign of castings based on parting line considerations, Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design, Modifying the design, group technology, Computer Applications for DFMA.

Module 5: DESIGN FOR THE ENVIRONMENT (10 Periods)

Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines, Example application, Lifecycle assessment, Basic method, Environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Visits to manufacturing facilities or factories where you can observe and learn about the manufacturing processes and assembly techniques used in different industries.
2. Build prototypes of your designs and test them for manufacturability and assembly.
3. Utilize computer-aided design (CAD) software with simulation capabilities to virtually test and optimize your designs for manufacturing and assembly.

RESOURCES

TEXT BOOKS:

1. Boothroyd, G, Heartz and Nike, *Product Design for Manufacture*, Marcel Dekker, 1994.
2. Bralla, *Design for Manufacture handbook*, McGraw Hill, 1999.
3. Dickson, John. R, and Corroda Poly, *Engineering Design and Design for Manufacture and Structural Approach*, Field Stone Publisher, USA, 1995.

REFERENCE BOOKS:

1. Boothroyd, G, *Design for Assembly Automation and Product Design*. New York, Marcel Dekker, 1980
2. Graedel T. Allen By. B, *Design for the Environment,* Angle Wood Cliff, Prentice Hall. Reason Pub.1996.
3. Fixel, J. *Design for the Environment* McGraw Hill., 1996.
4. Kevien Otto and Kristin Wood, *Product Design*. Pearson Publication, 2004.

VIDEO LECTURES:

1. https://www.youtube.com/playlist?list=PL63F5D8638872CC3E
2. https://www.youtube.com/watch?v=nGfVTNfNwnk

WEB RESOURCES:

1. https://www.plm.automation.siemens.com/global/en/our-story/glossary/design-for-manufacturing-and-assembly-dfma/53982
2. https://onlinecourses.nptel.ac.in/noc22_me11/preview

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101033	**THEORY OF ELASTICITY AND PLASTICITY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

In this course the concept of Plasticity, an important property of solids will be discussed in a comprehensive way. Idealization of physical system, representing the idealized system through mathematical equation and finally finding solution of those equations are the key features that constitute the structure of this course. This course emphasis will be given on both theory and applications.

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

CO1. Apply the principles of theory of elasticity and to solve the compatibility equations.

CO2. Apply the principles of virtual work, and its rate forms, plastic potential and flow rule associated with different yield criteria.

CO3. Derive and apply equations in the theory of plasticity such as incremental stress strain relationships and deformation theory of plasticity.

CO4. Develop stress strain relations and yield criterion for the analysis of structural elements.

CO5. Analyse the anisotropic material behaviour of uniaxial and multi-axial loading.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	2	3	-	-	-	-	-	3	-	-
CO2	3	3	1	-	-	1	3	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	2	2	-	-	-	-	-	3	-	-
CO4	2	2	-	-	-	2	3	-	-	-	-	-	3	-	-
CO5	2	3	-	-	-	2	2	-	-	-	-	-	3	-	-
Course Correlation Mapping	**2**	**3**	**1**	**-**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: FUNDAMENTAL OF ELASTICITY (10 Periods)

Introduction: Modelling Uniaxial behaviour in plasticity.Index notation, Cartesian tensors. Yield andfailurecriteriaStress,stressdeviatortensors. Invariants,principal,meanstresses. Elasticstrainenergy. Mohr'srepresentationofstressin2&3dimensions. Haigh-Westergaardstressspace.Equilibrium equations of a body.Yield criteria: Tresca's, von Mises rules, Drucker-Prager criterion,anisotropicyieldcriteria.

Strain at point: Cauchy's formulae for strains, principal strains, principalshear strains, derivativestrain tensor. Strain-displacementrelationships. Linear elastic stress strain relations, GeneralizedHooke'slaw,non-linearelasticstress strainrelations.

Module 2: PRINCIPLEOF VIRTUAL WORK AND CRITICAL LOADING (09 Periods)

Principleof virtual work andits rateforms: Drucker's stability postulate, normality, convexity, and uniqueness for an elastic solid. Incremental stresss train relations.

Criteria for loading and unloading: Elastic and plastic strain increment tensors, Plastic potential and flow rule associated with different Yield criteria, Convexity, normality, and uniqueness considerations for elastic–plastic materials. Expansion of a thick-walled cylinder.

Module 3: INCREMENTAL STRESS STRAIN RELATIONSHIPS AND DEFORMATION THEORY OF PLASTICITY (08 Periods)

Incremental stress strain relationships: Prandtl-Reuss material model. J2 deformation theory, Drucker-Prager material, General Isotropic materials.

Deformation theory of plasticity: Loading surface, Hardening rules. Flow rule and Drucker's stability postulate. Concept of effective stress and effective strain, mixed hardening material. Problems.

Module 4: STRESS STRAIN RELATIONS AND YIELD CRITERIA (09 Periods)

Stress Strain Relations: Introduction, types of materials, empirical equations, theories of plastic flow, experimental verification of St.Venant's theory of plastic flow, the concept of plastic potential, the maximum work hypothesis, mechanical work for deforming a plastic substance.

Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca's criteria, Geometrical representation, yield surface, yield locus (two-dimensional stress space), experimental evidence for yield criteria, energy required to change the shape with basic principle problems

Module 5: BOUNDING SURFACE THEORY (09 Periods)

Uniaxial and multiaxial loading anisotropic material behaviour. Theroms of limit analysis: Statically admissible stress field and kinematically admissible velocity field. Upper and lower bound theorem's, examples, and problems.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Application of Plasticity theories in wide range of engineering problems, such as those encountered in the forming of metals, the design of pressure vessels, the mechanics of armor penetration, the understanding of fatigue and the economical design of structures.

2. Design and application of plasticity theories to bending of beams, torsion of bars, partially plastic expansion of thick-walled pressure vessels, and the load carrying capacity of beams and framed structures, and plates and shells.

RESOURCES

TEXT BOOKS:

1. Timoshenko S.P. and Goodier J.N., *Theory of Elasticity*, Koakusha Publishers, 3rd edition, 1970.
2. Jagabanduhu Chakrabarty, *Theory of Plasticity*, Butterworth-Heinemann, 3rd edition, 2006.
3. C. R. Calladine*, Plasticity for Engineers: Theory and Applications,* Wood head publishing, 2010.

REFERENCE BOOKS:

1. W.F. ChensandD.J. Han, *Plasticityfor structuralengineers*, J. Ross Publishing, 2007.
2. Victor E. Saouma, *Mechanics of Materials-II, Fundamentals of Inelastic Analysis*, 2002
3. Sadhu Singh, *Theoryofplasticity*,Khanna Publishers, 1990.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/105105177
2. http://home.iitk.ac.in/~pmd/me721.html

WEB RESOURCES:

1. https://lecturenotes.in/download/note/34385-note-for-theory-of-elasticity-and-plasticity-tep-by-lukesh-parida
2. https://www.notes4free.in/vtu-notes/vtu-pdf-notes/Theory-of-plasticity-vtu-notes

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101034	**PRODUCT DESIGN FOR MANUFACTURING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides the Competitor and costumer – behaviour analysis, activity of concept generation, Structured approaches, Five step Method, variety component standardization, Assessing the need for industrial design, Cost estimation in design.

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

CO1. Demonstrate knowledge on strategic importance of product development

CO2. Gain proficiency in using the Five-Step Method for concept generation, which includes clarifying the design problem, conducting external and internal searches for inspiration and reflecting on the solutions and processes.

CO3. Demonstrate knowledge on Point out product architecture, industrial design and robust design.

CO4. Acquire proficiency in using QFD matrices to prioritize engineering characteristics, establish target values, and make design decisions based on customer needs.

CO5. Demonstrate knowledge on performance of the product for reliability and cost.

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	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	-	**-**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO PRODUCT DESIGN (09 Periods)

Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and costumer – behaviour analysis.

Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

Module 2: CONCEPT GENERATION AND CONCEPT SELECTION (09 Periods)

Concept Generation: Activity of concept generation, Structured approaches, Five step Method: clarify, Search Externally and internally, explore systematically, reflect on the solutions and processes.

Concept selection: Integral part of Product design process, methodology, benefits.

Module 3: PRODUCT ARCHITECTURE, INDUSTRIAL DESIGN AND ROBUST DESIGN (09 Periods)

Product Architecture: Implication, Product change, variety component standardization, Product performance, manufacturability.

Industrial Design: Assessing the need for industrial design, impact design process Integrate design process, assessing the quality of industrial design.

Robust Design: Introduction, various steps in robust design.

Module 4: DEVELOPMENT OF ENGINEERING SPECIFICATIONS (09 Periods)

Development of engineering specifications: Steps in development of engineering specification, identification of customer\s requirements, Quality Functional Deployment (QFD).

Module 5: PRODUCT EVALUATION (09 Periods)

Product Evaluation: Importance and goals of performance evaluation, robust design, sensitivity analysis, Cost estimation in design, design for reliability, design for environment and maintenance.

Total Periods: 45

EXPERIENTIAL LEARNING

The following is the sample. Faculty shall frame according to the course domain.

1. Arrange a visit to a manufacturing facility where students can observe and interact with professionals involved in the production process.
2. Encourage students to build physical prototypes of their product designs and conduct testing to evaluate manufacturing feasibility and performance.
3. Conduct an exercise where students estimate the manufacturing costs associated with their product designs.

RESOURCES

TEXT BOOKS:

1. Kari T. Ulrich and Steven D. E Springer, Product Design and Development ,McGraw Hill International Editions. 2015.
2. David G. Ullman, The Mechanical Design Process, McGraw Hill, New York,4th edition,2011.

REFERENCE BOOKS:

1. George E. Dieter, Engineering Design, McGraw Hill Education, New Delhi, 4th edition,2013.
2. A. K. Chitale, R. C. Gupta, product design and manufacturing, PHI Learning, 6th edition, 2014.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me83/preview
2. https://www.coursera.org/lecture/creative-design-prototyping-testing/introduction-to-product-design-and-development-Rcy11

WEB RESOURCES:

1. https://www.blur.design/design/product-design
2. https://www.toools.design/best-product-design-tools

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102029	**ROBOTIC PROGRAMMING**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Robotic programming; Robotic software functions; Program planning; Modes of programming; Commands for motion control; Lead through robotic programming; Textual robotic programming; End effectors and sensors commands; Program control and subroutines; VAL II Programming; AML Programming;

COURSE OUTCOMES:

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

CO1. Demonstrate the knowledge of basic planning schemes involved in the development of robotic programming.

CO2. Develop Programmes for robots based on the techniques of pendent and command control.

CO3. Demonstrate the knowledge of robotic languages for operations and control.

CO4. Develop Programs for robots on VAL II platform with complete command-based control.

CO5. Develop Programs for robots on AML platform with complete command-based control.

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

CO-PO-PSO Mapping Table:

Learning Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	1	-	-	-	-	-	-	3	-	-
CO2	3	3	1	-	-	1	-	-	-	-	-	-	3	-	-
CO3	3	2	-	-	-	1	-	-	-	-	-	-	3	-	-
CO4	3	2	-	-	2	1	-	-	-	-	-	-	3	-	-
CO5	3	3	-	-	2	1	-	-	-	-	-	-	3	-	-
CO6	2	2	1	-	-	-	-	-	-	3	3	-	3		
Course Correlation Mapping	**3**	**1**	**1**	**-**	**2**	**1**		**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: FUNDAMENTALS OF ROBOT PROGRAMMING (09 Periods)

Robot software functions - coordinate systems, Position control, Oher control functions, sub-routines, Planning of robotic programming using flowcharting - examples.

Module 2: METHODS OF ROBOT PROGRAMMING (09 Periods)

Online programming, off-line programming advantages of off-line programming; lead through methods - powered lead through, manual lead through, Teach pendant; Robot program as a path in space, defining position in space, motion interpolation, WAIT, SIGNAL and DELAY commands, Branching capabilities and Limitations of lead through methods.

Module 3: ROBOT LANGUAGES (09 Periods)

Textual robot Languages, first generation and Second-generation languages, Structure of a robot language - Operating Systems, Elements and Functions, Constants, Variables and Other data objects, Motion commands, Points in workspace, End effectors and sensor commands, Computations and operations, Program control and subroutines, Communications and Data processing.

Module 4: VARIABLE ASSEMBLY LANGUAGE (09 Periods)

Variable Assembly Language II - Introduction, Monitor commands, motion command, Hand Control, Configuration control, interlock commands, INPUT/OUTPUT Controls, Program Control, Examples

Module 5: A MANUFACTURING LANGUAGE (09 Periods)

A Manufacturing Language (AML) - Introduction, AML statements, Constant and variables, Program control statements, motion commands, Sensor commands; Grip sensing capabilities, Data processing, Examples.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Demonstration of robot configuration
2. Demonstration of robot with 2 dof, 3 dof, 4 dof etc.
3. Design/modeling of any two different types of grippers.
4. Two assignments on programming the robot for applications
5. Two programming exercises for robots
6. Exercise on welding robot in robot simulation software
7. Exercise on pick and place robot in robot simulation software
8. Exercise on robotic simulation software
9. Two case studies of applications in industry
10. Study of automation processes such as Distribution station, Testing station, Pick and place, Fluidic muscle press, and Storing.
11. Study of PLC on Automation production system
12. Study of robotic end effectors, robotic arm and its configurations.
13. Design and testing of hydraulic circuits
14. Design and testing of pneumatic circuits
15. Simulation of basic hydraulic and pneumatic circuits

SOFTWARE/Tools used:

- Offline robot programming software
- Aristo Robotic Simulation Software

RESOURCES

TEXT BOOKS:

1. Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas Odrey, Ashish Dutta *"Industrial Robotics (SIE): Technology, Programming and Applications*, McGraw Hill Education India, 2nd edition, 2017
2. S.R. Deb and S.Deb"*Robotic Technology and Flexible Automation*" McGraw Hill Education India. Second Edition, 2017.

REFERENCE BOOKS:

1. JohnJ.Craig , *Introduction to Robotics Mechanics and Control*, Pearson Education, fourth edition, 2017.
2. Fu, Lee and Gonzalez, *Robotics, control vision and intelligence*, McGraw Hill International, 2nd edition, 2017.

Web sources:

1. https://www.robotvirtualworlds.com/
2. https://robodk.com/
3. https://www.udacity.com/course/robotics-software-engineer--nd209
4. http://nptel.ac.in/courses/117/106/117106106/
5. http://nptel.ac.in/courses/108/104/108104080/

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me76/preview
2. https://onlinecourses.nptel.ac.in/noc22_de11/preview

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101073	BIO-INSPIRED ROBOTICS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This module lies at the intersection of robotics and biology. Through the abstraction of design principles from biological systems, it is possible to develop a range of core competences, including mechatronic systems, sensor and actuator technologies. By taking this module students will get an understanding of adaptivity and autonomy of animals through robotics, and have the opportunity to design, build and test novel robotic applications which are more adaptive, maneuverable, resilient, and energy efficient than current designs. Previous robots developed have included the Formica swarm robot, mobile platforms, swiming and flying robots, robotic heads and a range of advanced sensors.

COURSE OUTCOMES:

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

CO1. Explain the kinematics and programming of robots

CO2. Illustrate the different sensors used in robotics

CO3. Analyse the working of various actuators.

CO4. Explain the architecture different robots.

CO5. Explain the different robots in practices.

CO-PO-PSO Mapping Table:

Learning 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	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-	1	1	-	-	-	-	-	3	-	-
CO3	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO4	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO5	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
Course Correlation Mapping	**2**	**1**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: Introduction (09 Periods)

History, the mechanics and control of mechanical manipulators, inverse kinematics of manipulators, trajectory generation, force control, programming robots, manipulator kinematics, ctuator space, joint space, and cartesian space, repeatability and accuracy

Module 2: Bio-inspired Morphologies (09 Periods)

Biologically-inspired Robots introduction, Applications, Bio-inspired Sensors, Vision, Audition, Touch, Smell, Taste, Internal Sensors

Module 3: Bio-inspired Actuators (09 Periods)

Locomotion, Walking, Wall-Climbing, Swimming, Jumping, Flying, robot Madeleine, OCTARM robot, Grasping, Drilling

Module 4: Bio-inspired Control Architectures (09 Periods)

Behavior-Based Robotics, Learning Robots, Evolving Robots, Developing Robots, Energetic autonomy, Collective robotics, Biohybrid robots.

Module 5: Application of Robots (09 Periods)

The Future of Mobile Robotics, Space Robotics, Autonomous Aircraft, Military Reconnaissance, Underwater Inspection, Agriculture/Forestry, Aids for the Disabled, Entertainment, Domestic Robots, Delivery Robots, Intelligent Vehicles, Robots for Survey and Inspection, Mining Automation

Total Periods: 45

EXPERIENTIAL LEARNING

1. Design a simple Bio inspired Robot prototype

RESOURCES

TEXT BOOKS:

1. Yunhui Liu, Dong Sun., "Biologically Inspired Robotics", CRC Press, 2019
2. J.J. Craig. Introduction to Robotics: Mechanics and Control. Prentice Hall; 3rd edition, 2003

REFERENCE BOOKS:

1. Toshio Fukuda, Fei Chen and Qing Shi , Eds., "Bio-Inspired Robotics": MDPI , ISBN 978-3-03897-046-0, 2018.
2. Barbara Webb, Thomas R. Consi "Biorobotics: Methods and Applications", MIT Press direct, 2001.

VIDEO LECTURES:

1. https://wyss.harvard.edu/media-post/bioinspired-robotics-softer-smarter-safer/
2. https://meche.mit.edu/featured-classes/bio-inspired-robotics

WEB RESOURCES:

1. http://www.scholarpedia.org/article/Biologically_inspired_robotics
2. https://www.machinedesign.com/mechanical-motion-systems/article/21835853/7-bioinspired-robots-that-mimic-nature
3. https://www.nature.com/articles/d41586-022-03014-x
4. https://www.frontiersin.org/journals/robotics-and-ai/sections/bio-inspired-robotics

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101078	FIELD AND SERVICE ROBOTICS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides the fundamental concepts of service and field robots; challenges and types of localization, concept of planning and navigation, Ariel robots- Collision avoidance-Robots for agriculture, Wheeled and legged, Legged locomotion, Applications and case studies.

COURSE OUTCOMES:

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

CO1. Demonstrate the need and applications involved in field and service robots.

CO2. Analyze the challenges of localization in real world applications.

CO3. Analyze planning and navigation strategies devoid of obstacles.

CO4. Analyze the functional and operational characteristics of field robots.

CO5. Analyze the functional and operational characteristics of humanoids.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	1	1	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	1	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	-	**-**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION (09 Periods)

History of service robotics – Present status and future trends – Need for service robots - Applications- Examples and Specifications of service and field Robots. Non conventionalIndustrialrobots.

Module 2: LOCALIZATION (09 Periods)

Introduction – Challenges of Localization-Map Representation-Probabilistic Map based Localization – Montecarlolocalization – Land mark based navigation-Globally unique localization-Positioning be a consystems- Route ased localization.

Module 3: PLANNING AND NAVIGATION (09 Periods)

Introduction-Path planning overview- Road map path planning- Cell decomposition pathplanning-Potentialfieldpathplanning-Obstacleavoidance-Casestudies:Tieredrobotarchitectures.

Module 4: FIELD ROBOTS (09 Periods)

Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, Civilianandmilitaryapplications, Nuclearapplications, Spaceapplications.

Module 5: HUMANOIDS (09 Periods)

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditoryorientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motioncapture/Learningfromdemonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safetyandrobustness, Applications_Casestudies.

Total Periods: 45

EXPERIENTIAL LEARNING

1. To what extent do humanoid robots have the potential to revolutionize various industries and fields, such as healthcare, education, and manufacturing, and what ethical and societal implications should be considered as humanoid robots become more advanced and prevalent? Additionally, how can governments, businesses, and individuals work together to ensure that the development and deployment of humanoid robots is responsible and beneficial for all stakeholders?
2. Service robots have the potential to revolutionize the healthcare industry by improving patient care and reducing the workload of healthcare professionals. For example, robotic assistants can help patients with tasks such as getting in and out of bed, while telepresence robots can allow doctors to remotely examine and diagnose patients. However, the use of service robots in healthcare also raises ethical and societal concerns. Discuss.
3. Discuss any one case study presenting the challenges in obstacle avoidance w.s.r to Waymo's cars. Waymo's self-driving cars have undergone extensive testing in both simulated and real-world environments, and have accumulated millions of miles of driving experience. In 2018, Waymo launched a commercial self-driving car service in the Phoenix, Arizona area, allowing members of the public to hail a self-driving car using a smartphone app.

(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.

RESOURCES

TEXT BOOKS:

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots, Bradford Company Scituate, USA, 2004
2. RiadhSiaer, The future of Humanoid Robots- Research and applications“, IntechPublications, 2012.

REFERENCE BOOKS:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
2. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me76/preview
2. https://onlinecourses.nptel.ac.in/noc22_de11/preview

WEB RESOURCES:

1. https://ocw.mit.edu/courses/2-12-introduction-to-robotics-fall-2005/
2. https://www.robocup.org/
3. https://hricentral.org/
4. https://www.bostondynamics.com/robots

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101035	**ADVANCED CASTING TECHNOLOGY**	3	-	-	-	3

Pre-Requisite Manufacturing Technology
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION:
Equipment of moulds; production of moulds and cores; gating system; solidification; fluidity measurement; classification of melting furnaces; pouring techniques; mould casting techniques; casting defects; use of robots in castings; waste management.

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

CO1. Analyze the manufacturing process of molds and cores and evaluate their impact on product quality.

CO2. Develop approaches for improving the design of gating systems to attain the desired level of quality in casting.

CO3. Analyze the different types of pouring techniques used in casting and their impact on casting quality and production efficiency.

CO4. Analyze the different types of Mold casting techniques and their suitability for different applications.

CO5. Analyze the common and intricate casting defects, their causes, and the factors influencing their occurrence.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Out comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	1	-	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-		-	-	-	-	-	-	3	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO4	3	2	1	-	-	1	-	-	-	-	-	-	3	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	-	-	**1**	-	-	-	-	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: PRODUCTION OF MOULDS AND CORES (09 Periods)

Equipment for moulding, moulding technique – pattern utilization, hand and machine compaction, machine moulding, mould drying and hardening.

Cores and core making – core boxes, compaction, core hardening, closing of moulds.

Module 2: SOLIDIFCATION AND GATING SYSTEM (09 Periods)

Gating and risering, nucleation and grain growth, solidification of pure metal and alloys, rate of solidification, solidification contraction, gating and risering design calculation, fluidity and its measurement.

Module 3: MELTING AND POURING (09 Periods)

Melting Practice: Classification of melting furnaces, construction and operation of various furnaces-cupola and its design, electric arc furnaces, electric induction furnaces. Melting charge, melting conditions, melting losses, special melt treatment, melt quality control and recent development in metal melting.

Pouring: Metal temperature, pouring equipment and techniques.

Module 4: MOULD CASTING PROCESS (09 Periods)

Shell moulding, Centrifugal casting, Continuous casting, Investment casting, Die casting – Working and construction, advantages, limitations and applications.

Module 5: CASTING DEFECTS (09 Periods)

Casting defects, inspection, diagnosis and rectification, mechanization and automation in foundries, use of robots, pollution control, energy and waste management in foundries.

Total Periods: 45

EXPERIENTIAL LEARNING:

1. Current trends and advancements in casting technology.
2. Microstructure formation and its effects on casting properties.
3. Computer-aided casting design and simulation software.
4. Rapid prototyping and 3D printing in casting.
5. Non-destructive testing techniques for castings.
6. Visit to a casting foundry or manufacturing facility

RESOURCES

TEXT BOOKS:

1. Serope Kalpakjian, "Manufacturing processes for Engineering Materials", Addison, Wesley, 1997.
2. Fundamentals of metal casting technology - P.C. Mukherjee, Oxford and IBH.

REFERENCE BOOKS:

1. Mechanical Metallurgy, Dieter, Me Graw Hill, Kogakusha
2. Casting properties of metals and alloys - V. Korolkove.

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/112107215/L01.html
2. http://www.digimat.in/nptel/courses/video/112107083/L36.html

WEB RESOURCES:

1. https://www.academia.edu/34677417/Lecture_Notes_on_ADVANCED_CASTING_AND_WELDING_ACW_COURSE_CODE_BMS_405_PE_I_7th_Semester_B_Tech_in_Production_Engineering
2. https://www.iitg.ac.in/engfac/ganu/public_html/Metal%20casting%20processes_1.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101036	**ADVANCED WELDING TECHNOLOGY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to materials and their manufacturing techniques; Welding techniques and allied processes; Weld design; Special welding processes; Weld metal characterization; analysing the properties of weldment; standards and codes followed in industry.

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

CO1. Understand various welding processes and techniques, including gas tungsten arc welding, gas metal arc welding, shielded metal arc welding, and flux-cored arc welding.

CO2. Gain knowledge on advanced welding techniques, such as robotic welding, laser welding, Electron beam welding, friction stir welding processes.

CO3. Interpret the properties of various metals and alloys used in welding, including their mechanical, chemical, and metallurgical properties based on Heat flow.

CO4. Analyse the problems associated in real time applications including weld cracks with different welding processes.

CO5. Analysing of welding codes and standards: Students should understand the importance of welding codes and standards, including the American Welding Society (AWS) codes and standards, and how to apply them to welding projects.

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes												Program Specific Out comes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	-	-	-	-	-	-	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO WELDING AND ALLIED PROCESSES (09 Periods)

Importance and application of welding, classification of welding process. Selection of welding process -Brief review of conventional welding process: Gas welding, Arc welding, MIG, TIG welding. Resistance welding. Electroslag welding, Friction welding. Weldability of low Carbon Steel, Grey Cast Iron, Aluminium Alloys, Stainless steel, Soldering & Brazing.

Module 2: ADVANCED WELDING TECHNIQUES (09 Periods)

Principle and working and application of advanced welding techniques such as Plasma Arc welding, Laser beam welding, Electron beam welding, friction stir welding, Ultrasonic welding -Principle and working and application of advanced welding techniques such as explosive welding, underwater welding, magnetic pulse welding.

Module 3: HEAT FLOW IN FUSION WELDING PROCESSES (10 Periods)

Temperature distribution in Arc welding- Efficiency of Heat sources – Temperature distribution equations: Adams and Wells Modification, simple problems.

Heat flow in Electro slag welding, Underwater welding - Metallurgical effects of heat flow in welding – TTT Curves – CCT curves.

Module 4: CRACK IN WELDS (08 Periods)

Introduction to Defects – classification of defects – Arc welding defects: Surface & Subsurface defects. Weld cracks – Classification – Nomenclature, location and orientation of weld cracks – Factors contributing to weld cracking – specific weld cracks: chevron cracks, lamellar cracks, reheat cracks and stress corrosion cracking – case study.

Module 5: HEAVY WELDED FABRICATIONS, CODES AND STANDARDS (09 Periods)

Boilers and pressure vessels: Material selection, fabrication of conventional pressure vessels, weldability aspects of Pressure Vessels Steels, preheat and post heat treatments of Pressure Vessels, Aluminium Pressure Vessels. Pipe welding: pipe steels and Electrodes - Types of pipes joints - Types of Pipe Welding.

Introduction to codes and standards - Welding Procedure Specification (WPS)- Qualification of WPS, P Numbers, Procedure qualification specimens.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Provide opportunities for learners to work on welding projects that challenge their skills and knowledge. These projects could include welding high-strength materials, working with advanced welding techniques, or welding in difficult positions.
2. Encourage learners to work together on welding projects and share their experiences and knowledge. This can help them develop problem-solving skills and gain a deeper understanding of welding technology.

RESOURCES

TEXT BOOKS:

1. Dr.R.S.Parmar, *Welding Engineering and Technology*, Khanna Publishers, 2nd edition, 2010.
2. Richard L Little, Welding and Welding Technology, Tata McGraw Hill, 2004.

REFERENCE BOOKS:

1. Srinivasan.N.K., Welding Technology, Khanna Publications, Delhi, 1995.
2. Nadkarni S.V., *Modern Welding Technology*, Oxford IBH Publishers, 1996.

VIDEO LECTURES:

1. https://www.youtube.com/playlist?list=PL1E047EB19A0A96F4
2. https://www.youtube.com/playlist?list=PLI8-ly0Ri5vuuzSb0ipLdUsl3F_TvH-jp
3. https://www.youtube.com/playlist?list=PLgGZG5WjC4z1e19zGOFdAsiAMgOgQW_3K

WEB RESOURCES:

1. https://www.aws.org/
2. https://www.welding-encyclopedia.com/
3. https://www.twi-global.com/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101037	**SUSTAINABLE MANUFACTURING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Concept of sustainability; metrics of green manufacturing; economic and social dimensions of sustainability; Principles of green manufacturing; Principles of green manufacturing; Green supply chain

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

CO1. Demonstrate the knowledge of sustainable manufacturing tools and techniques for sustainable product development

CO2. Analyze sustainability assessment methods to infuse and manage the sustainability of a product.

CO3. Demonstrate the knowledge of life cycle analysis and allied tools.

CO4. Analyze the strategies for waste reduction through appropriate techniques.

CO5. Apply methods to infuse and evaluate sustainability in different product phases.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	1		3	-	-	-	-	-	3	-	-
CO2	3	2	1	-	1	1	3	-	-	-	-	-	3	-	-
CO3	3	2	1	-	-	-	3	-	-	-	-	-	3	-	-
CO4	3	2	-	-	-	-	3	-	-	-	-	-	3	-	-
CO5	3	2	1	-	1	1	3	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	-	**1**	**1**	**3**	**-**	-	**-**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO SUSTAINABLE MANUFACTURING (09 Periods)

Concept of sustainability, manufacturing, operations, processes, practices, Resources in manufacturing, five Ms, system approach to manufacturing, environmental, economic and social dimensions of sustainability, Environmental Impact of Manufacturing, Strategies for Green Manufacturing, Metrics for Green Manufacturing, Metrics Development Methodologies.

Module 2: TOOLS AND TECHNIQUES (09 Periods)

Principles of green manufacturing and its efficiency, Green manufacturing and sustainability, System model architecture and module, Design and planning, control or tools for green manufacturing (Qualitative Analysis), Consumption Analysis, Life Cycle Analysis, Efficiency, Sustainability tools). Standards for green manufacturing (ISO 14000 and OHSAS 18000), Waste stream mapping and application, Design for environment and for sustainability – Discuss the Product Life Cycle of manufactured goods.

Module 3: LIFE CYCLE ANALYSIS (09 Periods)

Remanufacture and disposal , tools for LCA, Concept of design for recycling, Green manufacturing Lean models, value analysis, carbon footprint, analysis for carbon footprint Green manufacturing- sustainability framework, Green manufacturing techniques- factors effecting sustainability.

Module 4: GREEN MANUFACTURING TECHNIQUES (09 Periods)

Dry and near-dry machining, edible oil based cutting fluids Green manufacturing techniques: cryogenic machining for eco-efficiency Green manufacturing, Lean manufacturing, Lean techniques for green manufacturing, Waste assessment and strategies for waste reduction in green manufacturing.

Module 5: SUSTAINABILITY ASSESMENT AND GREEN SUPPLY CHAIN (09 Periods)

Methods to infuse sustainability in early product design phases, concept models and various approaches in assessment, product sustainability and risk/benefit assessment, Green supply chain- techniques and implementation, Logistics management, Green Supply Chain as Product Life Cycle Management

Total Periods: 45

EXPERIENTIAL LEARNING

1. Prepare a report on green manufacturing techniques answering the following: What are the potential benefits and drawbacks of green manufacturing technologies for companies and the environment, and how can companies balance these factors to create sustainable and profitable manufacturing practices?
2. In what ways can sustainable manufacturing contribute to the achievement of the Indias' Sustainable Development Goals, and what role do governments, businesses, and consumers play in promoting sustainable manufacturing practices globally?
3. Discuss the Patagonia case of implementing cutting edge leading solutions in sustainability.

(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.

RESOURCES

TEXT BOOKS:

1. G. Atkinson, S. Dietz, E. Neumayer, Handbook of Sustainable Manufacturing‖. Edward Elgar Publishing Limited, 2007.
2. Klemes, J., 2011. Sustainability in the process industry. McGraw-Hill. 2011
3. M.Karpagam, Geetha Jaikumar, Green Management , Ane Books Pvt.Ltd. 2010

REFERENCE BOOKS:

1. M.K. Ghosh Roy, Design for Environment: A guide to sustainable Product Development Sustainable Development, Ane Books Pvt.Ltd, 2009.
2. Dornfeld, D.A. ed., Green manufacturing: fundamentals and applications. Springer Science & Business Media, 2012.
3. Ashby, M. F. Materials and the environment: eco-informed material choice. Elsevier, 2012.
4. D. Rodick, Industrial Development for the 21st century, sustainable development perspectives, UN New York, 2007

VIDEO LECTURES

1. https://www.coursera.org/learn/sustainable-development
2. https://archive.nptel.ac.in/courses/112/104/112104225/

WEB RESOURCES:

1. https://www.coursera.org/learn/sustainable-development
2. https://archive.nptel.ac.in/courses/112/104/112104225/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101038	**RAPID PROTOTYPING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: History of RP systems; Stereo; Datafiles and machine details; Solid Ground Curing; LOM,DMLS, Principle of operation, Machine details; Applications; Thermal jet printer; IndirectRapid tooling, Direct Tooling; Quick cast process; Rapid Tool; Software For RP; STL files; Rapid manufacturing process optimization; Vacuum Casting, Surface digitizing; data transfer to solid models, Reverse Engineering.

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

CO1. Demonstrate the working of different RPT techniques for producing various products.

CO2. Analyze the functional characteristics of stero lithography systems, SLS and FDM for complex applications.

CO3. Analyze the functional characteristics of SGC, LOM and concept modelers for complex engineering applications.

CO4. Demonstrate the knowledge on rapid tooling to manufacture intricate components.

CO5. Apply software tools for rapid prototyping and reverse engineering concepts in production for Industrial applications.

CO-PO-PSO Mapping Table:

Course Outcomes	**ProgramOutcomes**												**Program Specific Outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	1	-	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-	1	-	-	-	-	-	-	3	-	-
CO3	3	2	1	-	-	1	-	-	-	-	-	-	3	-	-
CO4	3	-	2	-	-	1	-	-	-	-	-	-	3	-	-
CO5	3	2	2	-	1	1	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**2**	-	**1**	**1**	**-**	**-**	-	**-**	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: FUNDAMENTALS OF RAPID PROTOTYPING (09 Periods)

Definition, Types of prototypes, Classification of RP Systems, Need for the compression inproduct Development, Historyof RP systems, Applications survey, Development of RPindustry.

Module 2: STEREOLITHOGRAPHY SYSTEMS, SLS AND FDM (09 Periods)

Stereolithography: Principle; Process parameters; Process details; Data preparation; Data files and machine details; Application.

Selective laser sintering: Machine types, Operating principle, Process parameters, Data preparation for SLS, Applications.

Fused deposition modeling: Principle, Process parameters, Path generation, Applications

Module 3: SOLID GROUND CURING (SGC), LOM AND CONCEPT MODELERS (09 Periods)

SGC: Principle, Machine details, Applications. Laminated Object Manufacturing: Principle, LOM materials, Processdetails, Application.

Concept modelers: Principle, Thermal jet printer, Sander’s model market, 3-Dprinter, Genisys X sprinter HP system –5, Object Quadra systems.

Module 4: RAPID TOOLING (09 Periods)

Laminate tooling-soft Tooling and Hard tooling.

Indirect Rapid tooling, Silicon rubber tolling, Aluminium filled epoxy tooling, Spray metal tooling, Castkirksite, 3D Keltool.

Direct Rapid Tooling-Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, Prometal, Sand casting tooling, DMLS

Module 5: SOFTWARE FOR RAPID PROTOTYPING AND REVERSE ENGINEERING (09 Periods)

STL files, Overview of Solid view, Magics, Magic communicator, Internet based software,Rapid Manufacturing Process Optimization.

Allied processes: Vacuum casting, Surface digitizing, Surface generation from point cloud, Surface modification, Data transfer to solid models.

ReverseEngineering:Capturing and reading the scan data, Align point clouds and simplify data, Polygon meshing and editing, Defining surface boundaries, applying nurbs, Exporting data, Reverse engineering update.

Total Periods: 45

EXPERIENTIAL LEARNING

1. 3D Printing: study and explore the possibilities of 3D printing technologies from 3D printer provision available and prepare a model.
2. Prepare a report with a suitable case of digital twinning. Discuss the challenges and future prospects.
3. Discuss any one in detailed case on usage of 3D printing technology in Automotive industries. Give a presentation on challenges in Reverse engineering.

(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.

RESOURCES

TEXT BOOKS:

1. Paul F. Jacobs, Stereo lithography and other RP and MTechnologies, SME, New York, 3rdedition, 1996.
2. Frank W. Liou, Rapid Prototyping and Engineering Applications, CRC Press Taylor and Francis Group, New York, Special Indian Edition, 2011.

REFERENCE BOOKS:

1. C. K. Chua, K. F. Leong, C. S. Lim, Rapid Prototyping -Principles and Applications, Yesdee publications Pvt. Ltd.,Mumbai, India, 2nd edition, 2010.
2. Hari Prasad, K.S. Badarinarayan, Rapid Prototyping andTooling, SIP PageTuners, Bangalore, 1stEdition, 2013.
3. Fiham D.T, Dinjoy S. S, Rapid Manufacturing, Verlog, London, 4th edition, 2002.

VIDEO LECTURES

1. https://onlinecourses.nptel.ac.in/noc22_me74/preview
2. https://www.coursera.org/specializations/rapid-prototyping-using-3d-printing

WEB RESOURCES:

1. Rapid Prototyping:https://www.sciencedirect.com/topics/engineering/rapid-prototyping
2. https://www.sciencedirect.com/book/9780128021748/additive-manufacturing-technologies -
3. https://makezine.com/ - This website provides tutorials, project ideas, and product reviews related to DIY electronics and prototyping, including rapid prototyping
4. https://hackaday.com/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101039	**SURFACE ENGINEERING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Mechanisms of wear; Metal cleaning; Techniques for surface modification or deposition of protective coatings; Rationale behind employing coatings; Quality assurance & testing.

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

CO1. Understanding of the physical, chemical, and mechanical properties of surfaces, as well as the factors that can affect those properties.

CO2. Demonstrate the principles of thermal spraying and electro deposited coatings for different applications.

CO3. Illustrate the principles of hot dip and diffusion coatings for engineering applications.

CO4. Identify the suitable non-metallic and conversion coatings for different surfaces.

CO5. Categorize the selection of cleaning and testing procedures of coatings for different industrial applications.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												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	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**-**	-	**-**	-	**-**	**1**	**-**	-	**3**	**-**	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO SURFACE ENGINEERING (10 Periods)

Introduction to tribology, surface degradation, wear and corrosion, types of wear-roles of friction and lubrication. Importance and necessity of surface engineering, past, present and future scenario of surface engineering, classification of surface engineering process, substrates and their pre-treatments. Materials for wear resistant applications – surface damages – structural modification – composition modification – coating. Organic, Inorganic and Metallic coatings - coating characteristics: coating thickness, continuity, hardness, adhesion, porosity, and bond strength.

Module 2: THERMAL SPRAYING AND ELECTRODEPOSITED COATINGS (09 Periods)

Thermal spraying materials, characteristics of thermal spray process, Spray fused coatings, principles of electro plating, properties and applications of electrodeposits, Principles of Non aqueous and electro less deposition, Plasma spraying, flame spraying, detonation spray coating.

Module 3: HOT DIP COATING AND DIFFUSION COATING (09 Periods)

Surface preparation, Batch coating and continuous coating process, coating properties and applications, principles of cementation, cladding-vacuum deposition, sprayed metal coating, structure of diffusion coatings, Chemical vapour deposition (CVD), Physical vapour deposition (PVD), Thin film Characterization techniques- Scanning Electron Microscopy and Energy Dispersive X-ray analysis

Module 4: NON-METALLIC COATING OXIDE AND CONVERSION COATINGS (09 Periods)

Plating coating, lacquers, rubbers and elastomers, vitreous enamels, anodizing Chromating, application to aluminium, magnesium, tin, zinc, cadmium, copper and silver, Phosphating primers.

Module 5: TESTING AND SELECTION OF COATINGS (08 Periods)

Quality assurance, the quality plan, design testing and inspection, thickness and porosity measurement, selection of coatings, Industrial applications of engineering coatings, Performance assessment of engineered surfaces- wear and corrosion. Cathodic protection, corrosion inhibitors - principles and practice - inhibitors for acidic neutral and other media.

Total Periods: 45

EXPERIENTIAL LEARNING

1. To engage in experiential learning in surface engineering, one approach is to participate in hands-on workshops or training programs. These can provide opportunities to work with different materials, equipment, and techniques under the guidance of experienced professionals. Some universities (Annamalai University/ANNA University/IITB/IITM/NITT) and DRDO Labs (ARCI, Hydrebad/ GTRE, Bangalore) also offer internships in surface engineering that include lab components.
2. Laboratory experiments: Learners could participate in laboratory experiments that involve surface modification techniques such as plasma treatment, chemical vapor deposition, or electroplating. These experiments could be designed to allow learners to observe the effects of different process parameters on the resulting surface properties.

RESOURCES

TEXT BOOKS:

1. Engineering Coatings-design and application-S. Grainger, Jaico Publishing House.
2. Principles of Metals surface treatment and protection- D.R. Gabe, Pergamon.
3. Surface Engineering for wear resistance- K.G Budinski, Prentice Hall.

REFERENCE BOOKS:

1. Electroplating Handbooks- N.V Parthasarathy, Prentice Hall.
2. Advances in surface treatment- Niku-Lavi, Pergamon.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112107248
2. https://www.youtube.com/watch?v=hCsRhiW1N4M
3. https://www.youtube.com/watch?v=YsFw9SI3xV4

WEB RESOURCES:

1. http://www.asminternational.org/materials-resources/results/-in-category/categories/surface-engineering
2. http://www.asme.org/topics-technology/surface-engineering
3. http://www.surfaceengineer.co.uk/forum

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102016	**INDUSTRIAL INTERNET OF THINGS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to the Industrial Internet; IIoT Reference Architecture; Design of Industrial Internet Systems; Modern Communication Protocols, Wireless Communication Technologies, The Access Network, Access Networks Connecting, Defining Industry 4.0,Introducing the Smart Factory, Smart Factories in Action, IOT – A Market Perspective, Technical Design constraints.

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

CO1. Analyze the functional, informational, and operational characteristics of IoT and IIOT architectures.

CO2. Design industrial internet systems encompassing access network technology and protocols.

CO3. Apply design principles, characteristics, and building blocks of Industry 4.0. for innovative manufacturing applications.

CO4. Demonstrate knowledge of IoT market perspective and Security issues in smart manufacturing.

CO5. Apply real-world design constraints for solving problems encountered in smart manufacturing.

CO6. Work individually or in a 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
CO1	3	3	1	1	1	1	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	1	1	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	1	1	-	-	-	-	-	-	3	-	-
CO4	3	1	1	1	1	1	-	-	-	-	-	-	3	-	-
CO5	3	3	3	1	1	1	-	-	-	-	-	-	3	-	-
CO6	3	2	1	-	1	-	-	-	-	3	3	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: IOT AND IIOT REFERENCE ARCHITECTURE (09 Periods)

Introduction: Introduction to the Internet of Things (IoT). Architecture, Enabling Technologies, Applications.

IIoT Reference Architecture: Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Module 2: DESIGN OF INDUSTRIAL INTERNET SYSTEMS AND ACCESS NETWORK TECHNOLOGY & PROTOCOLS (09 Periods)

Design of Industrial Internet Systems: The Concept of the IIoT, The Proximity Network, WSNEdge Node, Legacy Industrial Protocols, Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, Gateways.

Access Network Technology and Protocols: The Access Network, Access Networks Connecting Remote Edge Networks.

Module 3: INDUSTRY 4.0 AND SMART FACTORIES (09 Periods)

Industry 4.0: Defining Industry 4.0, Four Main Characteristics of Industry 4.0, The Value Chain, Industry 4.0 Design Principles, Building Blocks of Industry 4.0, Smart Manufacturing.

Smart Factories: Introducing the Smart Factory, Smart Factories in Action, Importance of Smart Manufacturing, Real-World Smart Factories - GE’s Brilliant Factory, Airbus: Smart Tools and Smart Apps, Siemens’ Amberg Electronics Plant (EWA), Industry 4.0: The Way Forward

Module 4: IOT MARKET PERSPECTIVE AND SECURITY ISSUES IN MANUFACTURING (09 Periods)

IoT Market perspective: M2M to IoT – A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, emerging industrial structures for IoT, The international driven global value chain and global information monopolies.

Security issues in Manufacturing: PLCs and DCS, Securing the OT, Network Level: Potential Security Issues, System Level: Potential Security Issues, Identity Access Management.

Module 5: REAL WORLD IOT DESIGN CONSTRAINTS AND INDUSTRIAL AUTOMATION (09 Periods)

Real-World IOT Design Constraints: Introduction, Technical Design constraints-hardware components, Data representation and visualization, Interaction and remote control.

Industrial Automation: Service-oriented architecture-based device integration, SOCRADES- realizing the enterprise integrated Web of Things, IMC-AESOP- from the Web of Things to the Cloud of Things.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Design and Simulate LED 7-Segment Display interfacing with Arduino.
2. Design and Simulate Servo motor interfacing with Arduino.
3. Design and Simulate ultrasonic sensor and LCD interfacing with Arduino.
4. Design and Simulate Flame Sensor interfacing with Arduino.
5. Design and Implement to capture Gas Sensor and send sensor data to cloud from your Node MCU device using Arduino IDE.
6. Design and Implementation of Humidity and Temperature Monitoring Using Arduino and upload data to cloud using MQTT.
7. Design and Implementation of an IoT ECG (Electrocardiogram) System to record hearts electrical activity.
8. Design and Simulate controlling an LED 7-Segment Display with Raspberry Pi.
9. Design and implementation of Raspberry Pi Home Security System with Camera and PIR Sensor with Email Notifications.
10. Design and Implement to upload Light sensor (TSL) data to cloud through Raspberry Pi.
11. Design and Implementation of Motion Detector with NodeMCU and BLYNK.
12. Design and Implementation of Fire notification IoT system with BLYNK.

RESOURCES

TEXT BOOKS:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress Publications, 2016.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

REFERENCE BOOKS:

1. Giacomo Veneri and Antonio Capasso, Hands-on Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0,Ingram Academic Services, 2018.
2. Vijay Madisetti and Arshdeep Bahga, Internet of Things A Hands-On- Approach, Orient Blackswan Private Limited, 2015.
3. Francis daCosta, Rethinking the Internet of Things: A Scalable Approach toConnecting Everything", 1stedition, Apress Publications, 2014.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2. http://www.nitttrc.edu.in/nptel/courses/video/106105195/L33.html

WEB RESOURCES:

1. https://www.classcentral.com/course/youtube-noc-jan-2019-introduction-to-industry-4-0-and-industrial-internet-of-things-47354
2. https://content.techgig.com/upskilling-at-techgig/iit-kharagpur-launches-free-online-course-on-iiot-and-industry-4-0/articleshow/82883232.cms
3. https://www.udemy.com/course/introduction-to-industrial-iot-for-it-professionals/
4. http://web.stanford.edu/class/archive/ee/ee392b/ee392b.1176/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101040	**FLEXIBLE MANUFACTURING SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion on modern trends in design and manufacturing using CAD/CAM. This course also examines the knowledge with respect to performance analysis techniques and preventive maintenance procedures in manufacturing.

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

CO1. Understand the basic concepts of FMS.

CO2. Apply the concept of system design procedures to different levels of Production.

CO3. Identify the system modelling issues and control them.

CO4. Apply the concept of group technology.

CO5. Design models of material handling 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	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	2	2	-	1	-	-	-	-	-	-	-	3	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	2	2	-	-	1	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: FLEXIBLE MANUFACTURING SYSTEMS (09 Periods)

Introduction: Definitions of manufacturing with input-output model, definition of system, basic problems concerning systems and system design procedure, modes of manufacturing – job/ batch/ flow and multi product, small batch manufacturing.

Module 2: SYSTEM MODELING ISSUES (09 Periods)

System modeling issues: Centralized versus distributed control; Real-time vs discrete event control; Forward vs. backward scheduling approaches with finite/infinite capacity loading; Modeling of absorbing states and deadlocks; Conflicts; Concurrency, and synchronization.

Module 3: SYSTEM MODELING TOOLS AND TECHNIQUES (09 Periods)

System Modeling Tools and Techniques: Introduction to mathematical modeling, optimization, and simulation; issues related with deterministic and stochastic models. Continuous and discrete mathematical modeling methods -discrete event, monte carlo method; Basic concepts of Markov chains and processes; The M/M/1 and M/M/m queue; Models of manufacturing systems including transfer lines and flexible manufacturing systems, introduction to Petri nets.

Module 4: GROUP TECHNOLOGY (09 Periods)

Introduction, objectives, part families, algorithms and models for G.T. - Rank order clustering, Bond energy, mathematical model for machine – component cell formation.

Module 5: MATERIAL HANDLING SYSTEMS: (09 Periods)

Conveyors - AGVs – industrial robots in material handling - AS/RS.

Interfacing of computers - machine tool controllers and handling systems: communications standards - programmable Logic Controllers (PLC's) – Interfacing - Computer aided Project planning – dynamic part scheduling.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Distinguish between continuous and discrete modeling techniques
2. Apply the concept of system design procedures to different levels of production
3. Design models of manufacturing systems
4. Bring out the relevance of the preventative maintenance.
5. Prepare a case study on performance of manufacturing system

RESOURCES

TEXT BOOKS:

1. H K Shivanand, ―Flexible Manufacturing Systems‖, New Age International, 1st Edition, 2006.
2. Mikell P Groover, "Automation Production systems, Computer Integrated Manufacturing", 5th Edition, Pearson, 2018.

REFERENCE BOOKS:

1. N. K. Jha, —Hand Book of Flexible Manufacturing Systems‖, Academic Press, 1st Edition, 2013.
2. P. Radha Krishnan, —CAD/ CAM/ CIM‖, New Age International, 4th Edition, 2016
3. David J.Parrish, "Flexible Manufacturing" Butterworth-Heinemann, 1990.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110106044
2. https://nptel.ac.in/courses/112104289

WEB RESOURCES:

1. http://ndl.ethernet.edu.et/bitstream/123456789/87815/6/Flexible%20Mnfg%20System-HK%20Shivanand.pdf
2. https://cime-mel423.weebly.com/uploads/4/4/3/5/44351541/lect11_aug27.pdf
3. https://ocw.mit.edu/courses/2-875-mechanical-assembly-and-its-role-in-product-development-fall-2004/0398b83e5b5837b3d62b575028e965c9_class22_fma.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101041	**MICRO AND NANO MANUFACTURING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides an awareness of different techniques used in micro and nano manufacturing. This course also helps to understand the tools and techniques used in material removal during micro and nano manufacturing. It gives in-depth idea of the conventional and non-conventional techniques used in micro and nano manufacturing.

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

CO1. Understand the various techniques used for micro manufacturing.

CO2. Analyse and apply process parameters and tools used for micro manufacturing.

CO3. Understand and fundamentals of Micro -Nano manufacturing material removal processes.

CO4. Understand conventional techniques and other processing routes in micro and nano manufacturing.

CO5. Understand non-conventional techniques and other processing routes in micro and nano manufacturing.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: MICRO FABRICATION TECHNIQUES: (09 Periods)

Introduction to Micro fabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect- Ratio Micromachinin

Module 2: MICROMACHINING TOOL (09 Periods)

Diamond Tools in Micromachining Diamond technology, Preparation of substrate, Modified HFCVD process, Nucleation and diamond growth, Deposition on complex substrates, Diamond micromachining.

Module 3: MATERIAL REMOVAL (09 Periods)

Material removal at micro-scale: size effect, chip thickness, Micro-Structure and Grain Size Effects; Tool geometry, Tool wear, and Tool Deflections, Tool Stiffness and Deflections under Dynamic Loading, Micro Turing and Micro Milling

Module 4: CONVENTIONAL MACHINING PROCESSES (09 Periods)

Conventional Processes: Micro-turning, Micro-drilling and Micro-milling Introduction, Micro-turning, Micro-drilling, Micro-milling, Product quality in micromachining Micro-grinding and Ultra-precision Processes Introduction, Micro and nano-grinding, Nano-grinding tools.

Module 5: NON-CONVENTIONAL MACHINING PROCESSES: (09 Periods)

Non-Conventional Processes: Laser Micromachining Introduction, Fundamentals of lasers, Laser microfabrication, Laser nanofabrication. Evaluation of Subsurface Damage in Nano and Micromachining Destructive evaluation technologies, Non-destructive evaluation technologies.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Study parameters and their effect on micro turning
2. Study of etching processing and their application
3. Metrology and Inspection at micro-scale
4. Study and characterization of nano structure.
5. Determine suitable manufacturing process along with instrumentation required for inspection of the same

RESOURCES

TEXT BOOKS:

1. J. Paulo Davim, Mark J. Jackson Nano and Micromachining, John Wiley & Sons, 2013.
2. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, 2006.

REFERENCE BOOKS:

1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
2. Yi Qin, Micro-manufacturing Engineering and Technology, William Andrew, 2015
3. V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/102108078
2. https://archive.nptel.ac.in/courses/117/108/102108078/

WEB RESOURCES:

1. http://www.nitttrc.edu.in/nptel/courses/video/102108078/lec56.pdf
2. http://home.iitk.ac.in/~vkjain/MMPs_L1_Intro._010113.pdf
3. https://inup.cense.iisc.ac.in/static/downloads/Introduction-to-Micro-Nanofabrication.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101042	**NON-DESTRUCTIVE TESTING**	3	-	-	-	3

Pre-Requisite Material Science and Engineering

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Non-Destructive Testing (NDT) is a specialized branch of engineering that involves the use of various methods and techniques to examine and evaluate the properties and integrity of materials, components, and structures without causing any damage. NDT is used in a variety of industries such as aerospace, automotive, manufacturing, and construction to ensure the safety, reliability, and quality of products and structures.

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

CO1. Identify and describe the various NDT methods and techniques, their principles, and their applications in industry.

CO2. Understanding of the physics and mathematics concepts behind NDT methods, such as wave propagation, refraction, reflection, attenuation, and absorption.

CO3. Perform and interpret the results of various NDT methods, including ultrasonic testing, radiography, magnetic particle testing, liquid penetrant testing, eddy current testing, and visual inspection.

CO4. Design and implement quality control procedures and interpret the results to ensure the accuracy and reliability of NDT results.

CO5. Analyse and evaluate NDT results and make decisions based on the results to ensure the safety and quality of products and 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	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO3	3	3	2	1	-	-	-	-	-	1	-	-	3	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	-	-	-	-	-	**1**	-	-	**3**	**-**	-

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

COURSE CONTENT

Module 1: INTRODUCTION AND VISUAL INSPECTION METHODS (09 Periods)

Scope and advantages of NDT. Comparison of NDT with DT. Some common NDT methods used since ages, Terminology. Flaws and Defects, Visual inspection-Unaided, Equipment used for visual inspection. Ringing test chalk test (oil whitening test). Attractive uses of above tests in detecting surface cracks, bond strength and surface defects.

Module 2: LIQUID PENETRANT TESTING AND MAGNETIC PARTICLE TESTING (09 Periods)

Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques, Tests stations, Advantages, types of penetrant and developers. Illustrative examples – Heavy castings of large size, frame of jet engine, porosity testing of nickel alloys, leak testing. Magnetic particle Inspection – Scope, principle, Ferro Magnetic and Non-ferro magnetic materials, equipment & testing. Advantages, limitations Interpretation of results. DC and AC magnetization, Skin Effect, use of dye and wet powders for magna glow testing, different methods to generate magnetic fields, Applications and demonstration

Module 3: RADIOGRAPHIC METHODS (09 Periods)

X-ray radiography principle, equipment and methodology. Applicability, types of radiations limitations. Interpretation of Radiographs, limitations of gamma-ray radiography –principle, equipment. Attenuation of electromagnetic radiations, source of radioactive materials and technique. Photo electric effect, Rayleigh's scattering (coherent scattering), Compton's scattering (Incoherent scattering). Pair production, Beam geometry, scattering factor. Precautions against radiation hazards. Xero-Radiography, Digital Radiography, Gamma ray Radiography, Safety in X- ray and Gamma ray radiography. Advantages of gamma ray radiography over X-ray radiography.

Module 4: ULTRASONIC TESTING AND ACOUSTIC EMISSION TESTING (09 Periods)

Introduction, Principle of operation, Piezoelectricity. Ultrasonic probes, CRO techniques, advantages, Limitation & typical applications. Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages& Limitations, Applications and demonstration.

Module 5: EDDY CURRENT TESTING AND THERMOGRAPHY (09 Periods)

Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages and Limitations and applications. Thermography – Introduction, Principle, Contact and Non-Contact inspection methods, Active and Passive methods, Liquid Crystal – Concept, example, advantages and limitations. Electromagnetic spectrum, infrared thermography-approaches, IR detectors, Applications and demonstration.

Total Periods: 45

EXPERIENTIAL LEARNING

- Students can learn how to identify and interpret various types of defects using different inspection techniques. For example, they can practice identifying cracks, voids, and inclusions in metals using ultrasonic testing or radiography.
- Students can gain experience operating NDT equipment, such as ultrasonic, radiographic, magnetic particle, and liquid penetrant testing equipment. They can also learn how to perform routine maintenance and calibration of the equipment.

RESOURCES

TEXT BOOKS:

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
   Research Techniques in NDT Vol.3, R.S. Shah, Academic 2002

REFERENCE BOOKS:

1. Paul E Mix, "Introduction to non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
2. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st Revised Edition, 2010.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/113/101/113101021/
2. https://nptel.ac.in/courses/113/105/113105039/
3. https://nptel.ac.in/courses/113/105/113105040/
4. https://nptel.ac.in/courses/113/105/113105041/
5. https://nptel.ac.in/courses/113/105/113105042/

WEB RESOURCES:

1. https://www.asnt.org/
2. https://www.nde-ed.org/
3. https://www.ndt.net/
4. https://www.bindt.org/
5. https://www.iaea.org/resources/ndt

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101043	**MODERN MANUFACTURING**	3	-	-	-	3

Pre-Requisite Manufacturing Technology

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Classification of non-traditional machining methods; rapid prototyping; principle of prototyping;mechanical process; chemical process; electrochemical process; laser beam machining; electron beam machining; plasma arc machining; metal removal mechanism; micro machining processes.

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

CO1. Demonstrate an understanding of the limitations of traditional manufacturing methods and the need for modern techniques.

CO2. Analyze the principles of non-conventional mechanical metal cutting processes, including advantages and limitations.

CO3. Analyze the principles, functional and operational characteristics of electrochemical and chemical processes.

CO4. Analyze the principles and functional and operational characteristics of Laser Beam Machining (LBM), Electron Beam Machining (EBM), and Powder Bed Additive Manufacturing (PAM).

CO5. Demonstrate knowledge of the different types of micromachining processes for specific manufacturing 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	-	-
CO2	3	2	-	-	1	-	1	-	-	-	-	-	3	-	-
CO3	3	2	-	-	1	-	-	-	-	-	-	-	3	-	-
CO4	3	2	-	-	1	-	1	-	-	-	-	-	3	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	-	-	**1**	-	**1**	-	-	-	-	-	**3**	-	-

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

COURSE CONTENT

Module 1: NEED FOR MODERN MANUFACTURING METHODS (09 Periods)

Non-traditional machining methods, Classification of Non-traditional methods, Selection for processing of different materials and applications.

Introduction to rapid prototyping, Classification of rapid prototyping methods, stereolithography, fused deposition methods, materials, principle of prototyping and applications

Module 2: MECHANICAL PROCESS (09 Periods)

Introduction, principle, process description, process capabilities, material removal mechanism, parametric analysis, tool design, limitations, and applications of Ultrasonic Machining (USM), Abrasive Jet Machining (AJM), Water Jet Machining (WJM) and Abrasive Water Jet Machining (AWJM) processes.

Module 3: ELECTROCHEMICAL & CHEMICAL PROCESSES (09 Periods)

Fundamental principle, process description, process capabilities, mechanism of material removal, surface finish and accuracy, limitations, and applications of Electrochemical Machining (ECM), Electrochemical Grinding (ECG), Electrochemical deburring, Electrochemical honing and Chemical Machining (C M) processes.

Module 4: LBM, EBM & PAM (09 Periods)

Laser Beam Machining (LBM): Working principle, type of lasers, machining applications of lasers, mechanism of material removal, shape and material, applications and limitation.

Electron Beam Machining (EBM): Generation and control of electron beam, EBM systems, process analysis & characteristics, mechanism of material removal, shape and material, applications and limitations.

Plasma Arc Machining (PAM) and Ion Beam Machining (IBM): Process principle, analysis and characteristics of process, mechanism of material removal, shape and material, applications and limitations.

Module 5: MICROMACHINING PROCESSES (09 Periods)

Introduction to micro machining methods; material removal mechanism and process capability of micro machining methods like micro -turning, micro-milling, micro-drilling, micro EDM, micro- WEDM, micro ECM, etc.

Total Periods: 45

EXPERIENTIAL LEARNING:

1. Use computer-aided design (CAD) and simulation software to create virtual models and simulate manufacturing processes.
2. Explore rapid prototyping techniques such as 3D printing or CNC machining to create prototypes of products or components.
3. Select a product or component and conduct a design for manufacturing analysis.
4. Set up a quality control exercise where you inspect manufactured components for defects using various inspection techniques such as visual inspection, measurement tools, and non-destructive testing methods.
5. Create a simulation of a supply chain for a product, considering aspects like sourcing, procurement, inventory management, and logistics.

RESOURCES:

TEXT BOOKS:

1. V. K. Jain, Advanced Machining processes, Allied publishers, New Delhi, 2008.
2. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata Mcgraw Hill,New Delhi, 2003

REFERENCE BOOKS:

1. V. K. Jain, Introduction to micro machining, Narosa publishing house, New Delhi, 1st Edition, 2010
2. D. T. Pham and S. S. Dimov, Rapid manufacturing, Springer-Verlag, 1st Edition, 2001.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/107/112107078/
2. https://www.youtube.com/watch?v=zR36urTYC4k

WEB RESOURCES:

1. https://www.studocu.com/in/course/indian-institute-of-technology-bombay/modern-manufacturing-process/5967310
2. https://www.fcusd.org/cms/lib/CA01001934/Centricity/Domain/4529/Fundamentals%20of%20Modern%20Manufacturing%20Materials%20%20Processes%20and%20Systems%20%204th%20Edition.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101080	**PLC AND DATA ACQUISITION SYSTEM**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Basics of PLC; PLC Troubleshooting and Maintenance; PLC programming; PLC arithmetic functions; PLC data handling functions; Case study of Tank level control system; introduction to computer control; data acquisition systems; sampling theorem.

COURSE OUTCOMES:

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

CO1. Analyze functional and operational characteristics of PLC's and allied components.

CO2. Program PLCs using various logical languages, to design and implement control systems in industrial settings.

CO3. Analyze nuances in PLC data handling functions and estimate the viability in diversified applications.

CO4. Demonstrate knowledge of computers in control systems.

CO5. Design, program, and deploy data acquisition systems using various sensors, data acquisition hardware, and software tools.

CO-PO–PSO Mapping Table:

Learning 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	-	-	-	-	-	-	3	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-	3	-	-
CO3	3	2	-	-	1	-	-	-	-	-	-	-	3	-	-
CO4	3		-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

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

COURSE CONTENT

Module 1: BASICS OF PLC (09 periods)

Definition and History of PLC-PLC advantage and disadvantages- Over all PLC systems-CPU and Programmer/Monitors-PLC input and output models - Architecture- PLC Programming language - Relay logic - Ladder logic - Programming of Gates - Flow charting as a programming method - connecting PLC to computer - PLC Troubleshooting and Maintenance.

Module 2: PLC PROGRAMMING (09 periods)

Programming of Timers - Introduction - ON delay, OFF delay, Retentive Timers - PLC Timer functions - Examples of timer function Industrial application. Programming Counters - up/down counter - Combining counter Examples of counter function Industrial application. PLC Arithmetic Functions - PLC number Comparison function.

Module 3: PLC DATA HANDLING FUNCTIONS (09 periods)

PLC Program Control Instructions: Master Control Reset - Skip Jump and Move Instruction. Sequencer instructions - Types of PLC Analog modules and systems, PLC analog signal processing - BCD or multi bit data processing - Case study of Tank level control system, bottle filling system and Sequential switching of motors.

Module 4: COMPUTER CONTROL – INTRODUCTION (09 periods)

Need of computer in a control system-Functional block diagram of a computer control system-Data loggers- Supervisory computer control- Direct digital control-Digital control interfacing-SCADA.

Module 5: DATA ACQUISITION SYSTEMS (09 periods)

Sampling theorem - Sampling and digitizing Aliasing - Sample and hold circuit - Practical implementation of sampling and digitizing Definition, design and need for data acquisition systems Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation-Microprocessor/PC based acquisition systems.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Writing ladder logic or structured text programs for controlling industrial processes.
2. Creating an HMI to visualize and interact with PLC-controlled processes.
3. Exploring various communication protocols used in industrial automation (e.g., Modbus, Profibus, Ethernet/IP).
4. Integrating PLCs and Data Acquisition Systems into a larger automation system.
5. Applying PLCs and Data Acquisition Systems in specific industries (manufacturing, energy, automotive, etc.).
6. Identifying industry-specific challenges and best practices for effective implementation.

RESOURCES

TEXT BOOKS:

1. Petrezeulla, "Programmable Logic Controllers", McGraw Hill, 1989.
2. Curtis D. Johnson, "Process Control Instrumentation Technology", 8^{th} edition Prentice.

REFERENCES:

1. G.B.Clayton, "Data Converters", The Mac Millian Press Ltd., 1982.
2. John W. Webb & Ronald A Reis., "Programmable logic controllers- principles and applications", 5th Edition - PHI Learning Pvt. LTd, New Delhi-2010.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/108105062
2. https://www.coursera.org/lecture/intelligent-machining/programmable-logic-controllers-plc-fGz3r

WEB RESOURCES:

1. https://kanchiuniv.ac.in/coursematerials/PLC_K_Saraswathi.pdf
2. http://www.ieec.uned.es/investigacion/Dipseil/PAC/archivos/introtoplcs_SUPER.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102021	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Automation in Production System; Advanced Automation Functions; Material Handling Systems; GT and Cellular Manufacturing; FMS; Introduction of Robots classifications; Components; Robot programming; Robot Application in Industry; Future Application and Challenges.

COURSE OUTCOMES:

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

CO1. Understand the importance, principles, and search methods of AI

CO2. Acquire knowledge on predicate logic and Prolog

CO3. Understand the machine learning fundamentals

CO4. Work with supervised learning algorithms

CO5. Develop programming for unsupervised learning algorithms

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

CO-PO-PSO Mapping Table:

Learning 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	1	3	1	1	1	-	-	-	-	-	-	3	-	-
CO3	3	1	1	-	1	1	-	-	-	-	-	-	3	-	-
CO4	3	3	-	-	1	1	-	-	-	-	-	-	3	-	-
CO5	3	3	3	1	1	1	-	-	-	-	-	-	3	-	-
CO6	2	2	1	1	1	-	-	-	-	3	3	-	3		
Course Correlation Mapping	**3**	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTELLIGENT AGENT AND UNINFORMED SEARCH (09 Periods)

Introduction - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI – Intelligent Agents - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems -Uninformed Search - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search -Depth Limited Search

Module 2: PROBLEM SOLVING WITH SEARCH TECHNIQUES (09 Periods)

Informed Search - Greedy Best First - A* algorithm - Adversarial Game and Search - Game theory – Optimaldecisions in game - Min Max Search algorithm - Alpha-beta pruning - Constraint Satisfaction Problems (CSP)- Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

Module 3 LEARNING (09 Periods)

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models – Typesof learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Trainingand test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - Regression: LinearRegression - Logistic Regression.

Module 4 SUPERVISED LEARNING (09 Periods)

Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks - Decision Tree:Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - Naïve Bayesianclassification - Support Vector Machines (SVM).

Module 5 UNSUPERVISED LEARNING (09 Periods)

Unsupervised Learning – Principle Component Analysis - Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – Clustering: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

Total Periods: 45

EXPERIENTIAL LEARNING

1. Implement A* Search algorithm.
2. Implement AO* Search algorithm.
3. Implement Find S algorithm.
4. Implement candidate elimination algorithm
5. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples
6. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge toclassify a new sample.
7. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
9. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program

10. Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
11. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
12. Implement SVM Classification.
13. Implement Navie bayes classifier algorithm.

RESOURCES

TEXT BOOKS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

REFERENCE BOOKS:

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley EducationalPublishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106105077
2. https://archive.nptel.ac.in/courses/106/106/106106202/

WEB RESOURCES:

1. https://towardsdatascience.com/notes-on-artificial-intelligence-ai-machine-learning-ml-and-deep-learning-dl-for-56e51a2071c2
2. https://web.stanford.edu/class/cs106e/lectureNotes/L23NAIMachineLearning.pdf
3. https://backbencher.club/artificial-intelligence-and-machine-learning/
4. https://www.azdocuments.in/2021/11/artificial-intelligence-and-machine_6.html

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102022	CYBER PHYSICAL PRODUCTION SYSTEMS	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a detailed discussion and hands-on experience on Cyber-physical systems integratedcloud computing, cloud based monitoring and integrated communication systems. This course also discusses about intelligent manufacturing systems and the product life cycle, connecting them to the Internet and to each other

COURSE OUTCOMES:

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

CO1. Apply knowledge to select suitable cloud tools and cyber physical system technologies.

CO2. Analyse the working of cloud based distributed process planning.

CO3. Analyse the various geometric properties with respect to data storage and integrates with communication systems.

CO4. Analyse the intelligent manufacturing systems and process monitoring.

CO5. Apply knowledge to select appropriate methods of Optimization for production process and product life cycle.

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

CO-PO-PSO Mapping Table:

Learning 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	2	-	-	1	-	-	-	-	-	-	-	3	-	-
CO3	3	1	-	-	1	-	-	-	-	-	-	-	3	-	-
CO4	3	1	-	-	1	-	-	-	-	-	-	-	3	-	-
CO5	3	1	-	-	1	-	-	-	-	-	-	-	3	-	-
CO6	2	2	1	1	1	-	-	-	-	3	3	-	3		
Course Correlation Mapping	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: CLOUD COMPUTING AND CYBER PHYSICAL SYSTEM (09 Periods)

Introduction to Cloud computing: Technologies, Tools, challenges. Cloud Manufacturing: Concept, Technology, Applications and Challenges.

Technology in Cyber Physical System (CPS): Cloud Technology, Big Data, Industry 4.0. Key features in cyber physical production system.

Module 2: CLOUD BASED MONITORING (09 Periods)

Introduction to Distributed process planning (DPP), Web-based DPP: Design, Functional analysis and prototype implementations.

Cloud enabled DPP: multi-tasking machine, machine modes, setup frames, setup planning and setup merging.

Module 3: DATA STORAGE AND COMMUNICATION (09 Periods)

Geometric properties: Component identification, data storage. Subsurface properties: estimation of loads, Storage of load history, Data storage with sub-surface, Data storage within bulk materials.

Integrated communication systems: Radio frequency communication in metal components, Data transmission by optical signal coupling.

Module 4: INTELLIGENT MANUFACTURING SYSTEM (09 Periods)

Introduction to intelligent manufacturing system: Feeling Machine, Sensory Workpieces, feeling clamping system, Process monitoring for single item production, control of tool deflection in machining, Manipulation of workpiece surface and subsurface properties.

Module 5: PRODUCT LIFE CYCLE (09 Periods)

Paradigm of technical inheritance, Algorithmic design evolution based on product life cycle information, Evaluating life cycle data to enable condition based maintenance. Storing data within materials, Optimization of production process with sensitive machines. Benefits of CPS in work and process planning.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. **PRODUCT AND SYSTEM DESIGN.**
   e) Cyber physical product service system
   f) Product life cycle managements
2. **PRODUCTION SYSTEM ENGINEERING.**
   c) Identification of artifacts in CPPS.
   d) Next generation cyber physical automation system
   e) Information exchange within production system engineering
3. **COMMUNICATION AND NETWORKING.**
   e) Communications for CPS.
   f) Communications for Industrial internet of things.

4. **DATA ANALYTICS FOR MANUFACTURING.**
   e) Application of CPS in machine Tools.
   f) Manufacturing CPS (Industrial internet of things)
   g) Smart CPPS for digital production

5. **INFORMATION MODELING AND INTEGRATION.**
   c) Model driven system engineering
   d) Semantic technologies for data integration.
   e) Self-adaption in CPS.
   f) Service oriented architecture for industrial enterprises.

RESOURCES

TEXT BOOKS:

1. Wang, L., Wang, X. V. "Cloud-BasedCyber-Physical Systems in Manufacturing" Germany: Springer International Publishing, 2017.
2. Cyber-Physical and Gentelligent Systems in Manufacturing and Life Cycle: Genetics and Intelligence – Keys to Industry 4.0. Netherlands: Elsevier Science, 2017.

REFERENCE BOOKS:

1. Design, Applications, and Maintenance of Cyber-Physical Systems. (2021). United States: IGI Global.
2. Cyber-Physical Systems: Foundations, Principles and Applications. (2016). Netherlands: Elsevier Science.

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/106105195/L11.html
2. https://www.youtube.com/watch?v=wro3uoHR-ZY

WEB RESOURCES:

1. https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1900-202.pdf
2. https://www.iitg.ac.in/pbhaduri/GIAN-CPS/Doc/Lec-1.pdf
3. https://pure.strath.ac.uk/ws/portalfiles/portal/82509815/Yao_etal_JIM2017_Smart_manufacturing_based_on_cyber_physical_systems.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101061	INTELLIGENT PRODUCT DESIGN AND MANUFACTURING	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course teaches students about Product design, Intelligent Manufacturing, Process Modelling, Simulation, Production Modelling, and Monitoring, Production Planning and Control, Engineering Optimization, and Product Development and Modelling.

COURSE OUTCOMES:

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

CO1. Explain the concepts of computer integrated manufacturing

CO2. Demonstrate Knowledge base systems

CO3. Explain the concepts of machine learning

CO4. Illustrate the Process planning, its phases and problem-solving approach

CO5. Explain the different Models and Algorithms of group technology

CO-PO-PSO Mapping Table:

Learning 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	-	-
CO2	3	2	1	-	-	1	1	-	-	-	-	-	3	-	-
CO3	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO4	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO5	2	2	1	-	-	1	1	-	-	-	-	-	3	-	-
Course Correlation Mapping	**2**	**1**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION **(09 Periods)**

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture, and Data Flow, System Operation.

Module 2: KNOWLEDGE BASED SYSTEMS **(09 Periods)**

Components of Knowledge Based Systems - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

Module 3: MACHINE LEARNING **(09 Periods)**

Machine Learning - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

Module 4: AUTOMATED PROCESS PLANNING **(09 Periods)**

Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KRSES.

Module 5: GROUP TECHNOLOGY **(09 Periods)**

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Decentralize the production processes and create product architectures for distributed manufacturing
2. Build collaborative interfaces among smart manufacturing assets using cloud manufacturing

RESOURCES

TEXT BOOKS:

1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2. Artificial Neural Networks/ Yagna Narayana/PHI/2006
3. Automation, Production Systems and CIM / Groover M.P./PHI/2007
4. Neural networks: A comprehensive foundation/ Simon Haykin/ PHI.

REFERENCE BOOKS:

1. Artificial neural networks/ B. Vegnanarayana/PHI
2. Neural networks in Computer intelligence/ Li Min Fu/ TMH/2003
3. Neural networks/ James A Freeman David M S kapura/ Pearson education/2004
4. Introduction to Artificial Neural Systems/Jacek M. Zurada/JAICO Publishing House Ed. 2006

VIDEO LECTURES:

1. https://www.digimat.in/nptel/courses/video/112104230/L01.html
2. http://www.digimat.in/nptel/courses/video/112104251/L12.html

WEB RESOURCES:

1. https://embeddedcomputing.com/application/industrial/product-line-engineering-intelligent-manufacturing-for-intelligent-products
2. http://csm.iiitdm.ac.in/intelligent-manufacturing-lab/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102025	FUNDAMENTALS OF CLOUD COMPUTING	3	-	2	-	4

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION:

Systems Modeling; Virtual machines; Implementation Levels of Virtualization; Cloud Computing; Roots of Cloud Computing; infrastructure as a service & platform; software as a service & data security in the cloud.

COURSE OUTCOMES:

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

CO1. Analyze the desired features of a cloud, and evaluate their importance in meeting business requirements.
CO2. Demonstrate the knowledge of virtualization,and evaluate its role in enabling cloud-based services and applications.
CO3. Demonstrate the knowledge of essentials in cloud computing and their importance in meeting business needs.
CO4. Analyze the security risks associated with infrastructure as a service & platform, and develop strategies for mitigating these risks.
CO5. Analyze emerging trends and threats in cloud data security and cloud service provider (CSP) vulnerabilities, and develop strategies for mitigating these risks.
CO6. Work individually or in a team to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Learning 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	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO6	3	2	1	-	1	-	-	-	-	3	3	-	3	-	-
Course Correlation Mapping	**3**	**2**	**1**	-	**1**	-	-	-	-	**3**	3	-	**3**	-	-

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

COURSE CONTENT

Module 1: SYSTEMS MODELING (09 Periods)

System Models for Distributed and Cloud Computing- Cloud Computing in a Nutshell, Layers and Types of Clouds, Desired Features of a Cloud, Infrastructure as a Service Providers, Platform as a Service Providers, Challenges and Risks.

Module 2: VIRTUALIZATION (09 Periods)

Virtual machines, Implementation Levels of Virtualization –Virtualization Structures/Tools and Mechanisms-Virtualization of CPU, Memory, and I/O Devices

Module 3: CLOUD COMPUTING FUNDAMENTALS (09 Periods)

Definition of Cloud computing, Roots of Cloud Computing, Layers and Types of Clouds, Desired Features of a Cloud, Cloud Infrastructure Management.

Computing Paradigms: High-Performance Computing, Parallel Computing, Distributed Computing, Cluster Computing, Grid Computing.

Module 4: INFRASTRUCTURE AS A SERVICE & PLATFORM (09 Periods)

Virtual machines provisioning and Migration services-On the Management of Virtual machines for Cloud Infrastructures- Aneka -Integration of Private and Public Clouds.

Module 5: SOFTWARE AS A SERVICE & DATA SECURITY IN THE CLOUD (09 Periods)

Google App Engine, An Introduction to the idea of Data Security - The Current State of Data Security in the Cloud - Cloud Computing and Data Security Risk - Cloud Computing and Identity.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Study the installation procedure of open stack or open nebula to set up a private Cloud.
2. Find procedure to run the virtual machine of different configurations. Check how many virtual machines can be utilized at particular time.
3. Find procedure to attach virtual block to the virtual machine and check whether it holds the data even after the release of the virtual machine
4. Install a C compiler in the virtual machine and execute a sample program.
5. Show the virtual machine migration based on the certain condition from one node to the other.
6. Find procedure to install storage controller and interact with it.
7. Find procedure to set up the one node Hadoop cluster.
8. Mount the one node Hadoop cluster using FUSE.
9. Write a program to use the API’s of Hadoop to interact with it.
10. Write a word count program to demonstrate the use of Map and Reduce tasks.

RESOURCES

TEXT BOOKS:

1. Essentials of cloud Computing: K. Chandrasekhran, CRC press, 2014
2. Mastering Cloud Computing- Raj Kumar Buyya, Christian Vecchiola and S.TanuraiSelvi, TMH, 2012.

REFERENCES:

1. Cloud Computing Principles and Paradigms, by Rajkumar Buyya
2. Michael Miller, Cloud Computing: Web-Based Applications that change the way you Work and Collaborate Online, Que Publishing, August 2008.
3. Cloud Computing, A Practical Approach, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_cs14/preview
2. https://www.coursera.org/specializations/cloud-computing

WEB RESOURCES:

1. https://mrcet.com/downloads/digital_notes/IT/CLOUD%20COMPUTING%20DIGITAL%20NOTES%20(R18A0523).pdf
2. https://www.iare.ac.in/sites/default/files/lecture_notes/CC%20LECTURE%20NOTES.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101068	**DIGITAL MANUFACTURING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides a insight of digital manufacturing as a new manufacturing technology. Learner will understand how the digital technology has gradually been integrated into the lifecycle of product manufacturing, traditional manufacturing will be transformed and the level of modern manufacturing will be upgraded through information and digital technology, and digitalization will be the indispensable driving factor for the Whole product lifecycle in manufacturing.

COURSE OUTCOMES:

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

CO1. Understand the digital manufacturing system

CO2. Explain the manufacturing information management

CO3. Illustrate the manufacturing product life cycle.

CO4. Explain the technology management and strategies

CO5. Identify the key technologies and futuristic trends in digital manufacturing

CO-PO-PSO Mapping Table:

Learning 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	3	-	-
CO2	3	2	1	-	-	1	1	-	-	-	-	-	3	-	-
CO3	3	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO4	2	2	-	-	-	1	1	-	-	-	-	-	3	-	-
CO5	2	1	1	-	-	1	1	-	-	-	-	1	3	-	-
Course Correlation Mapping	**2**	**1**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	-	-	**1**	**3**	-	-

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

COURSE CONTENT

Module 1: System of Digital Manufacturing Science (09 Periods)

Introduction, Manufacturing as Craft and Technique, Manufacturing Becoming a Science, Concepts and Research and Development Status of Digital Manufacturing, Connotation and Research Method of Digital Manufacturing Science, Operation Mode and Architecture of Digital Manufacturing System, Modeling Theory and Method of Digital Manufacturing Science, Theory System of Digital Manufacturing Science.

Module 2: Computing Manufacturing (09 Periods)

Computing Manufacturing Methodology, Manufacturing Computational Model, Theoretical Units in Manufacturing Computing, Principal Properties of Manufacturing Information, Measurement, Synthesis and Materialization of Manufacturing Information, Integration, Sharing and Security of Manufacturing Information

Module 3: Intelligent Manufacturing (09 Periods)

Intelligent Multi Information Sensing and Fusion in the Manufacturing Process, Knowledge Engineering in the Whole Life Cycle of Manufacturing Product, Autonomy, Self-Learning, Adapting of Manufacturing System, Intelligent Manufacturing System

Module 4: Management of Technology (09 Periods)

Management of Technology (MOT), R&D System Framework and Management Mode, Technological Strategies Management and Technological Venture, Human–Machine Engineering on Digital Manufacturing Process and Production Patterns, MOT Mode Based on Cultural Differences and Ways of Thinking

Module 5: Key Technology and Future Development (09 Periods)

Various Digital Technologies in Product Lifecycle, Resource and Environment Technology, Management Technology, Control Technology, Digital Recognition and Integration Technology, Precision of Digital Manufacturing, Extremalization, Environmental Protection.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Part Modeling using software and CNC programming for the part
2. Part Modeling using software and prototyping using 3D printing

RESOURCES

TEXT BOOKS:

1. Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, "Fundamentals of Digital Manufacturing Science
   ", Springer-Verlag London Limited 2012
2. Zhuming Bi., "Practical Guide to Digital Manufacturing", Springer Cham, 2021

REFERENCE BOOKS:

1. Chandrakant Patel, Chun-Hsien Chen, "Digital Manufacturing", Elsevier, 2022.
2. Kaushik Kumar, DivyaZindani, J. Paulo Davim., "Digital Manufacturing and Assembly Systems in Industry 4.0", CRC Press, 2021.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/110/106/110106146/
2. https://www.coursera.org/lecture/introduction-digital-manufacturing-fusion-360/trends-in-manufacturing-lecture-YEZ6X

WEB RESOURCES:

1. https://www.twi-global.com/technical-knowledge/faqs/what-is-digital-manufacturing
2. https://www.plm.automation.siemens.com/global/en/our-story/glossary/digital-manufacturing/13157
3. https://www.themanufacturer.com/articles/what-is-digital-manufacturing/
4. https://www.techtarget.com/searcherp/definition/digital-manufacturing

SPECIALIZATION ELECTIVE

CourseCode	CourseTitle	L	T	P	S	C
22ME102017	**COMPRESSIBLE FLUID FLOW**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:
Fundamentals of compressible flows; Mach number; Effect of Mach number on compressibility; One dimensional isentropic flow; Development and strength of the shock Waves; Supersonic flows; Fanno flow and Rayleigh flow.

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

CO1. Analyze the flow characteristics of compressible flowsby solving governing equations.

CO2. Analyze one-dimensional flows in diffusers and nozzles.

CO3. Analyze compressible flow having shock waves and determine the strength of shock waves.

CO4. Apply governing equations to compressible flow through constant area duct with friction.

CO5. Apply governing equations to compressible flow through constant area duct with heat transfer

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

CO-PO-PSOMappingTable:

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	3	2	1	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	-	3	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	-	3	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	3	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	-	-	-	-	**3**	**3**	-	-	-	**3**	-

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSECONTENT

Module 1: FUNDAMENTALS OF COMPRESSIBLE FLOWS (09 Periods)

Introduction to Compressible Flow-Concept of continuum-system and control volume approach-conservation of mass, momentum and energy-stagnation state-compressibility-Entropy relations-Wave propagation-Acoustic velocity-Mach number-effect of Mach number on compressibility-Pressure coefficient-physical difference between incompressible, subsonic, sonic and supersonic flows-Mach cone-Sonic boom-Reference velocities-Impulse function-adiabatic energy equation-representation of various flow regimes on steady flow adiabatic ellipse.

Module 2: ONE DIMENSIONAL ISENTROPIC FLOW (09 Periods)

One dimensional steady isentropic flow-Adiabatic and isentropic flow of a perfect gas-basic equations-Area-Velocity relation using 1D approximation-nozzle and diffuser-mass flow rate-chocking in isentropic flow-flow coefficients and efficiency of nozzle and diffuser-working tables-charts and tables for isentropic flow-operation of nozzle under varying pressure ratios –over expansion and under expansion in nozzles.

Module 3: NORMAL SHOCK WAVES (09 Periods)

Irreversible discontinuity in supersonic flow-one dimensional shock wave-stationary normal shock-governing equations-Prandtl-Meyer relations-Shock strength-Rankine-Hugoniot Relation-Normal Shock on T-S diagram-working formula-curves and tables-Oblique shock waves -supersonic flow over compression and expansion corners (basic idea only)

Module 4: FLOW IN CONSTANT AREA DUCT WITH FRICTION (FANNO FLOW) (09 Periods)

Fanno curve and Fanno flow equations, solution of Fanno flow equations, variation of flow properties, variation of Mach number with duct length, isothermal flow in constant area duct with friction, tables and charts for Fanno flow, Experimental friction coefficients.

Module 5: FLOW IN CONSTANT AREA DUCT WITH HEAT TRANSFER (RAYLEIGH FLOW) (09 Periods)

Flow through constant area duct with heat transfer (Rayleigh Flow)-Governing equations-Rayleighline on h-s and P-v diagram-Rayleigh relation for perfect gas-maximum possible heat addition-location of maximum enthalpy point-thermal chocking-working tables for Rayleigh flow.

Compressible flow field visualization and measurement - Shadowgraph-Schlieren technique - interferometer - subsonic compressible flow field - measurement (Pressure, Velocity and Temperature) - Wind tunnels –closed and open type

Total Periods:45

EXPERIENTIAL LEARNING

1. Students could work in groups to conduct research on the history of compressible fluid flow and present their findings to the class.
2. Students could design and build a shock tube experiment to observe and measure normal and oblique shocks.
3. Students could work in groups to conduct experiments on the flow of real gases in a pipe and analyze the data using computational fluid dynamics software.
4. Students could design and build a supersonic wind tunnel to observe and measure nozzle flow and diffuser flow.
5. Students could work in groups to design and build a small-scale model of a supersonic aircraft and test it in a wind tunnel.
6. Students could work in groups to design and build their own wind tunnel and use it to test the flow characteristics of different objects.
7. Students could work in groups to use computational fluid dynamics software to simulate the flow of air over a wing and analyze the results.
8. Students could work in groups to design and present a concept for a new aircraft or rocket that incorporates principles of compressible fluid flow.
9. Students could work in groups on project to design and build a device that utilizes principles of compressible fluid flow to solve a real-world problem.
10. Students could work in groups to analyze a case study of a compressible fluid flow problem and present their findings to the class.

RESOURCES

TEXTBOOKS:

1. S.M.Yahya, Fundamentals of Compressible Flows, New age international publication, Delhi, 2018.
2. V. Babu, Fundamentals of Gas Dynamics, John Wiley & Sons, 2nd Edition, 2008

REFERENCEBOOKS:

1. Robert D. Zucker, Fundamentals of Gas Dynamics, John Wiley & Sons, 2nd Edition, 2002.
2. John. D. Anderson, Modern Compressible Flow, Mc Graw Hill.3rd Edition, 2017.
3. P. Balachandran,Fundamentals of compressible fluid dynamics-, PHI Learning, New Delhi, 2006.

VIDEOLECTURES:

1. https://www.youtube.com/playlist?list=PLBFB79B9FC254E3CF
2. https://www.youtube.com/watch?v=s7zybJxkNq8

WEBRESOURCES:

1. https://nptel.ac.in/courses/112/106/112106144/
2. https://nptel.ac.in/courses/112/105/112105063/
3. https://nptel.ac.in/courses/112/106/112106059/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101044	**GAS TURBINES AND JET PROPULSION**	3	-	-	-	3

Pre-Requisite --

Anti-Requisite --

Co-Requisite --

COURSE DESCRIPTION:
Jet propulsion gas turbine; engine types; performance; turbojet and turbofan engines; designs of compressor; combustor and turbines; Jet and Rocket propulsions.

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

CO1. Analyse the gas turbine cycles using PV and TS diagrams and solve problems.
CO2. Analyze gas turbines and Air compressors for performance characteristics.
CO3. Analyze the combustion process in gas turbines and determine its performance characteristics.
CO4. Apply the principles of Jet Propulsion and solve problems.
CO5. Demonstrate the knowledge of rocket propulsion systems.

CO-PO-PSO MappingTable:

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	-	-	-	-	-	-	-	3	-
CO2	3	3	1	-	-	1	-	-	-	-	-	-	-	3	-
CO3	3	3	1	-	-	1	-	-	-	-	-	-	-	3	-
CO4	3	3	1	-	-	1	-	-	-	-	-	-	-	3	-
CO5	3	-	-	-	-	1	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**

CorrelationLevels: ***3:High;*** ***2:Medium;*** ***1:Low***

COURSECONTENT

Module 1: ANALYSIS OF GAS TURBINE CYCLES (09 Periods)

Development of gas turbine, Classification of gas turbines, Gas turbine vs. reciprocating I C engine, Gas turbine vs steam turbine, Applications of gas turbines, the basic cycle Analysis of simple gas turbine cycle, Effect of thermodynamic variables on the performance of simple gas turbine plant, Improvements in simple gas turbine cycle, Actual gas turbine cycle, Closed cycle gas turbine, Helium cooled, closed gas turbine for nuclear power plants , Total energy system incorporating gas turbine, Semi-closed cycle gas turbine, Gas turbine plant arrangement.

Module 2: Gas TURBINES AND AIR COMPRESSOR (09 Periods)

Axial flow and radial flow turbines, impulse and reaction turbines, fundamental relations and velocity triangles, elementary vortex theory, limiting factors in turbine design, blade materials; blade attachments and blade cooling.

Centrifugal and Axial flow compressors, degree of reaction, design of impellers and Blading, vortex theory, elementary air-foil theory and cascade theory, performance characteristics.

Module 3: GAS TURBINE COMBUSTION CHAMBER (09 Periods)

Introduction, Requirements, Combustion process in gas turbine, Types of combustion chamber, Flow pattern in a combustion chamber, Performance and operating characteristics of combustion chambers, Fuel injection in combustion chamber, Effect of incomplete combustion.

Module 4: JET PROPULSION (09 Periods)

Introduction, Thrust, thrust vs. thrust horse power, Efficiencies, Airscrew, Turbojet, Thrust augmentation, Turboprop engine, Bypass and ducted fan engines, Regenerative ducted fan engine, Turbo shaft engine, Ram jet, Pulsejet, Comparison of various propulsion devices. Air craft launch and recovery systems (EMALS and AAG).

Module 5: ROCKET PROPULSION (09 Periods)

Introduction, classification of rockets, Principle of rocket propulsion, Analysis of an ideal chemical rocket, Optimum expansion ratio for rocket, The chemical rocket, Advantages of liquid propellant rockets over solid propellant rockets, Free radical Propulsion, Nuclear Propulsion, Ion propulsion, Plasma propulsion.

Total Periods:45

EXPERIENTIAL LEARNING

List of Exercises:

1. Field Trips: Field trips to power plants, refineries, and other facilities to observe and learn about the combustion process in practice.
2. Prepare a document for recent developments in the gas turbines
3. Use computer simulations to model the combustion systems under different operating conditions.
4. Prepare a document for Air craft launch and recovery system.

RESOURCES

TEXT BOOKS:

1. Mathur, M., and Sharma, R.P., "*Gas Turbines and Jet & Rocket Propulsion*", Standard Publishers, New Delhi, 2014.
2. Ganesan, V., *Gas Turbines* 3/e, Tata McGraw Hill Book Company, New Delhi, 2010.

REFERENCE BOOKS:

1. Yahya. S.M., *Fundamental of compressible flow with Aircraft and Rocket Propulsion*", New Age International (p) Ltd., New Delhi, 2005.
2. Cohen.H., Rogers R.E.C and Sravanamutoo, "*Gas turbine theory*", Addison Wesley Ltd., 1987.
3. Rathakrishnan. E., "*Gas Dynamics*", Prentice Hall of India, New Delhi, 2001.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=NiKwJ3zTlzY
2. https://www.youtube.com/watch?v=E4o8F8xv0Uo
3. https://www.youtube.com/watch?v=knnNYBZbjPw
4. https://www.youtube.com/watch?v=vdGwCkx70RI
5. https://www.youtube.com/watch?v=_ZqSHfhwb1U

WEB RESOURCES:

1. https://soaneemrana.org/onewebmedia/GAS%20TURBINE%20AND%20JET%20&%20ROCKET%20PROPULSION1.pdf
2. https://ftp.idu.ac.id/wp-content/uploads/ebook/tdg/DESIGN%20SISTEM%20DAYA%20GERAK/Fundamentals%20of%20Rocket%20Propulsion.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101045	**ALTERNATIVE FUELS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:
Basic idea of fuel production procedure, Effect on human health due to pollution caused by I.C engine, Needs of alternative fuel, Types of alternative fuel used in petrol and diesel engine.

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

CO1. Demonstrate the knowledge of automotive fuels and their storage and handling systems.

CO2. Analyze the desirable characteristics of alternate fuels.

CO3. Analyze composition and characteristics of alternate fuels for enhancing the performance and controlling the emission.

CO4. Demonstrate the knowledge of automotive emission, emission control methods and emission standards.

CO-PO-PSO MappingTable:

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	-	-	-	1	1	-	-	-	-	-	-	3	-
CO4	3	1	-	-	-	1	1	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**2**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSECONTENT

Module 1: ATOMOTIVE FUELS (09 Periods)

Introduction, Classification of fuels, Solid Fuels - Origin of coal, Wood and Charcoal, Composition of coal, Properties of different grades of coal, Preparation and storage of coal, Coal washing, Briquetting; Liquid fuels - Introduction, Chemical structure of petroleum-Paraffin Series, Olefin series, Napthalene series, Aromatic series, Production, composition, Petroleum refining; Gaseous fuels -Gasification of liquid fuel, Synthetic fuels.

Module 2: PROPERTIES OF ATOMOTIVE FUELS (09 Periods)

Introduction, Desirable properties of IC engine fuel - Moisture Content, Particle Size and Size distribution, Bulk Specific gravity,Calorific value, Specific gravity, flash and fire point, pour point, metal content, ultimate analysis, proximate analysis, fly ash analysis, Hard grove Grindeability Index, Density, Viscosity, Aromatic Content, Sulphur content, octane number and cetane number.

Module 3: ALCOHOLS AND VEGETABLE OILS AS ALTERNATE FUEL (09 Periods)

Alcohols: Introduction to alcohols, Production methods, Properties, use of alcohols in CI and SI engines, Reformulated gasoline for SI engine, Water Gasoline Mixture for SI engine, Alcohol for CI engine, Surface Ignition of Alcohols in CI engine.

Vegetable oil: Introduction, Edible and Non Edible oils, Various methods of using Vegetable oil in CI engine, Biodiesel-sources, Preparation of Biodiesel, Characteristics of CI engine with Biodiesel as fuel, Biodiesel oxidation stability, Blending, Preheating, emulsification.

Module 4: HYDROGEN AND BIOGAS AS ALTERNATE FUEL (09 Periods)

Production methods of hydrogen, Hydrogen Engine, Combustive properties of hydrogen, Problems in hydrogen as fuel, Techniques of using hydrogen in SI and CI engines. Hydrogen storage – safety aspects of hydrogen fuel. Biogas-various production methods-properties,Use in SI and CI engine,Performance and emission characteristics.

Module 5: IC ENGINE EMISSIONS AND CONTROL (09 Periods)

Engine Exhaust Emissions, Bharat stage emission standards (BSES), Euro norms, Flow in crevices, Leakage Past the exhaust valve, Valve overlap, Deposit on walls, Thermal Converters, Catalytic converters- Sulphur, Cold Start-Ups, CI engines-Particulate traps, Non exhaust Emissions-Evaporative emissions, Emissions control Technique, Modern evaporative emission control system, Crankcase Blowby, Intake manifold return PCV System, EGR, SCR.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Identifying the characteristics of Petrol
2. Identifying the characteristics of Diesel, Vegetable oil, Biodiesel etc.,
3. Identifying the chemical structure of Petroleum and Non Petroleum fuels
4. Study on the Storage features of various fuels
5. Study on Hydrogen as fuel for IC engines

6. Study on Retrofitment required for Hydrogen as fuel for IC engines
7. Study on the use of Alcohol as substitute for CI and SI engines
8. Study on the use of Biogas as substitute fuel for IC engines
9. Study on the various Emission control equipment
10. Study on the Cold startup aids for IC engines

RESOURCES

TEXT BOOKS:

1. AyhanDemirbas, '*Biodiesel A Realistic Fuel Alternative for Diesel Engines*', Springer-Verlag London Limited, 2008.
2. Devaradjane. Dr. G., Kumaresan. Dr. M., "*Automobile Engineering*", AMK Publishers, 13th Edition, 2013.

REFERENCE BOOKS:

1 Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, *The Biodiesel Handbook*, AOCS Press Champaign, Illinois 2005.

2. Richard L Bechtold P.E., *Alternative Fuels Guide book*, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

VIDEO LECTURES:

1. https://youtu.be/xd1alir07q4
2. https://youtu.be/TZNya1froj4
3. https://youtu.be/HSPVkUz5m5E
4. https://youtu.be/5DTGHssNbU0
5. https://youtu.be/ukXYiHuchm4

WEB RESOURCES:

1. https://youtu.be/OEbMqJ-b7Zc
2. https://youtu.be/11lRIfashus
3. https://youtu.be/9RaDMQRfzBs

SPECILIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101046	**FUELS AND COMBUSTION**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Basic idea of fuel production procedure, Effect on human health due to pollution caused by I.C engine, Needs of alternative fuel, Types of alternative fuel used in petrol and diesel engine.

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

CO1. Demonstrate the knowledge of fuels and their storage and handling systems.

CO2. Analyze the desirable properties of fuels.

CO3. Analyze composition and characteristics of alternate fuels for enhancing the performance

CO4. Understand stoichiometry combustion of fuels.

CO5. Analyze the different combustion technologies and evaluate the controlling methods.

CO-PO-PSOMappingTable:

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	-	-	-	-	-	-	3	-
CO2	3	3	-	-	-	1	1	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	1	1	-	-	-	-	-	-	3	-
CO4	3	2	-	-	-	1	1	-	-	-	-	-	-	3	-
CO5	3	2	-	-	-	1	1	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**2**	-	-	-	**1**	**1**	-	-	-	-	-	-	**3**	-

CorrelationLevels: 3:High; 2:Medium;1:Low

COURSECONTENT

Module 1: CLASSIFICATION OF FUELS **(09 Periods)**

Introduction, Classification of fuels, Solid Fuels - Origin of coal, Wood and Charcoal, Composition of coal, Properties of different grades of coal, Preparation and storage of coal, Coal washing, Briquetting; Liquid fuels - Introduction, Chemical structure of petroleum-Paraffin Series, Olefin series, Napthalene series, Aromatic series, Production, composition, Petroleum refining; Gaseous fuels -Gasification of liquid fuel, Synthetic fuels.

Module 2: PROPERTIES OF FUELS **(09 Periods)**

Introduction, Desirable properties of IC engine fuel - Moisture Content, Particle Size and Size distribution, Bulk Specific gravity, Calorific value, Specific gravity, flash and fire point, pour point, metal content, ultimate analysis, proximate analysis, fly ash analysis, Hard grove Grinde ability Index, Density, Viscosity, Aromatic Content, Sulphur content, octane number and cetane number.

Module 3: ALCOHOLS AND ALTERNATE FUELS **(09 Periods)**

Alcohols: Introduction to alcohols, Production methods, Properties, use of alcohols in CI and SI engines, Reformulated gasoline for SI engine, Water Gasoline Mixture for SI engine, Alcohol for CI engine, Surface Ignition of Alcohols in CI engine.

Hydrogen and Biogas: Production methods of hydrogen, Hydrogen Engine, Combustive properties of hydrogen, Problems in hydrogen as fuel, Techniques of using hydrogen in SI and CI engines. Biogas-various production methods-properties, Use in SI and CI engine, Performance and emission characteristics.

Module 4: STOICHIOMETRY OF COMBUSTION **(09 Periods)**

Estimation of minimum amount of air required for a fuel of known composition, theoretical and actual combustion processes - Air fuel ratio, estimation of dry flue gases for known fuel composition, calculation of the composition of fuel and excess air supplied from exhaust gas analysis, dew point of products, Adiabatic flame temperature, mechanism and kinetics of combustion.

Module 5: COMBUSTION TECHNOLOGY **(09 Periods)**

Stoichiometry and thermodynamics of combustion, calculation of heat of formation and heat of combustion, first law analysis of reacting system, combustion of oil, combustion of coal, combustion of gas, flue gas analysis, flame properties, draft system, combustion appliances, gas burners, functional requirement of burners, gas burner classification, stoker firing, pulverized system of firing, fluidized bed combustion process, combustion controls.

Total Periods: 45

EXPERIENTIAL LEARNING

LISTOFEXERCISES:

1. Field Trips: Field trips to power plants, refineries, and other facilities to observe and learn about the combustion process in practice.
2. Conduct experiments to analyze the physical and chemical properties of different types of fuels, such as coal, oil, and gas.
3. Set up a combustion test rig to analyze the combustion behavior of different fuels under different operating conditions.
4. Students to design and implement sustainability projects related to fuels and combustion.
5. Use computer simulations to model the behavior of fuels and combustion systems under different operating conditions.

RESOURCES

TEXTBOOKS:

1. Ayhan Demirbas, ‘Biodiesel A Realistic Fuel Alternative for Diesel Engines’, SpringerVerlag London Limited, 2008.
2. Devaradjane. Dr. G., Kumaresan. Dr. M., “Automobile Engineering”, AMK Publishers, 13th Edition, 2013.

REFERENCEBOOKS:

1. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
2. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

VIDEOLECTURES:

1. https://www.youtube.com/watch?v=3JX9ckQJKhI
2. https://www.youtube.com/watch?v=_v2G5S7V9Xk

WEBRESOURCES:

1. https://nptel.ac.in/courses/103105045/
2. https://nptel.ac.in/courses/103105035/
3. https://nptel.ac.in/courses/103105029/

SPECIALIZATION ELECTIVE

CourseCode	Course Title	L	T	P	S	C
22ME101047	**AUTOMOTIVE ELECTRONICS**	3	-	-	-	3

Pre-Requisite

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:
Electronic control in various systems in automobile; Importance of microcontrollers; Sensors and actuators used in automobile; Electronics engines; Automotive instrumentation in signal conversion and lightening system.

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

CO1. Demonstrate the working of various types of IC engines, electronic controls in automobiles and engine control methods

CO2. Analyze therole of automotive grade microcontrollers identify various components of micro computer in automobile

CO3. Apply the Design concepts to develop sensors, actuators and sensor monitoring mechanisms aligned to automotive systems and use different signal conditioning techniques, interfacing techniques and actuatormechanisms.

CO4. Apply research-based knowledge and research methods in Electronic Engine and vehicle management system to control emissions

CO5. Investigate the complex issues related to automotive instrumentation andapply appropriate techniques in automotive instrumentation system for the Society

CO-POMappingTable:

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	-
CO2	2	3	3	2	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	3	-	2	-	-	-	-	-	-	-	-	3	-
CO4	2	-	-	3	3	1	2	-	-	-	-	-	-	3	-
CO5	2	-	2	2	2	1		-	-	-	-	-	-	3	-
Course Correlation Mapping	**2**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSECONTENT

Module 1: INTRODUCTION TO AUTOMOTIVE SYSTEMS (09 Periods)

Need for electronic control in automobiles; various sub-systems of automobile: Engine, Transmission System, Steering and Brake Systems; Classification and working of IC engine: Gasoline, Diesel engines, 2-stroke, 4-stroke engines; Engine Control methods: Air-fuel ratio control, Spark timing, Start of fuel injection, etc.

Module 2: INTRODUCTION TO MICROCOMPUTER (09 Periods)

Microcomputer: Buses, memory, timing, CPU registers; Microprocessor architecture: Initialization, operation codes, program counter, branch and jump instructions, subroutine. Analog to digital converters and Digital to analog converters, sampling, polling and interrupts, digital filters, lookup table.

Module 3: SENSORS AND ACTUATORS (09 Periods)

Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor, Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensors, Position sensors: Throttle position sensors, accelerator pedal position sensors and crankshaft position sensors, Air mass flow sensors. Solenoids, stepper motors and relays.

Module 4: ELECTRONIC ENGINE AND VEHICLE MANAGEMENT SYSTEM (09 Periods)

Electronic engine control: Input, output and control strategies, electronic fuel control system, fuel control modes: open loop and closed loop control at various modes, EGR control, Electronic ignition systems–Spark advance correction schemes, fuel injection timing control. Cruise control system, Antilock braking system, electronic suspension system, electronic steering control, traction control system, Transmission control, Safety: Airbags, collision avoiding system, low tire pressure warning system.

Module 5: AUTOMOTIVE INSTRUMENTATION SYSTEM (09 Periods)

Input and output signal conversion, multiplexing, fuel quantity measurement, coolant temperature and oil pressure measurement, display devices- LED, LCD, VFD and CRT, On-board diagnostics (OBD), OBD-II, off-board diagnostics.

Total Periods:45

EXPERIENTIAL LEARNING

1. Hands-on troubleshooting of electrical circuits: Students could be provided with different electrical circuits and systems commonly found in automobiles and asked to identify and troubleshoot any issues that arise. This would give them practical experience in diagnosing and repairing common electrical problems.
2. Installation and testing of automotive electronics: Students could work on installing various electronic systems in a car, such as a car audio system or a GPS navigation system, and test the system to ensure that it is functioning properly.
3. Use of diagnostic equipment: Students could learn how to use diagnostic equipment such as oscilloscopes and multimeters to diagnose and repair electrical issues in automobiles.
4. Programming and software development: With the increasing use of software in modern vehicles, students could learn how to program and develop software for automotive systems, such as engine control modules or entertainment systems.

5. Safety considerations: Students could learn about the various safety considerations when working with automotive electronics, such as proper grounding and handling of electrical components.
6. Emerging technologies: Students could explore emerging technologies in automotive electronics, such as electric and hybrid vehicles, and learn about the challenges and opportunities that these technologies present.
7. Group projects: Group projects could be assigned where students would work on designing and building an electronic system for a vehicle, such as a dashboard display or a camera system.

RESOURCES

TEXT BOOKS:

1. William B Ribbens, Newne Butter, worth-Heinermann, Understanding Automotive Electronics, Understanding Automotive Electronics, William B Ribbens, Newne Butter worth-Heinermann, 7thedition 2012.
2. Crouse W H, Automobile Electrical Equipment, McGraw Hill, New York 2005.

REFERENCE BOOKS:

1. Bechhold "Understanding Automotive Electronics", SAE, 1998.
2. Robert Bosch "Automotive Hand Book", SAE 5/e, 2000.
3. Tom Denton, "Automobile Electrical and Electronic Systems" 3/e, Edward Arnold, London, 2004.
4. Eric Chowanietz, "Automotive Electronics", SAE International, USA, 1995.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=tyP97QbrsEI&list=PLAMZfGOiiA2NYHfC2tUIJVRLWf6dTEP0I
2. https://www.youtube.com/watch?v=6aVyHD_iiNU&list=PLAMZfGOiiA2NYHfC2tUIJVRLWf6dTEP0I&index=2
3. https://www.youtube.com/watch?v=5OfxuSi3WlU&list=PLAMZfGOiiA2NYHfC2tUIJVRLWf6dTEP0I&index=3
4. https://www.youtube.com/watch?v=tNEFU-I_4FM&list=PLAMZfGOiiA2NYHfC2tUIJVRLWf6dTEP0I&index=4
5. https://www.youtube.com/watch?v=hFrhmhE7aag&list=PLAMZfGOiiA2NYHfC2tUIJVRLWf6dTEP0I&index=5
6 https://www.youtube.com/watch?v=4Godh_7gW8g&list=PLAMZfGOiiA2NYHfC2tUIJVRLWf6dTEP0I&index=6

WEB RESOURCES:

1. "Automotive Electronics" by Prof. M. Madheswaran: https://nptel.ac.in/courses/108/106/108106080/
2. "Introduction to Automobile Engineering" by Prof. G. Senthilkumar: https://nptel.ac.in/courses/112/108/112108094/
3. https://onlinecourses.nptel.ac.in/noc20_de06/preview
4 https://archive.nptel.ac.in/courses/107/106/107106088/

SPECIALIZATION ELECTIVE

CourseCode	Course Title	L	T	P	S	C
22ME101048	**CRYOGENICS**	3	-	-	-	3

Pre-Requisite Refrigeration and Air conditioning

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Necessity of Low temperature, Multi stage refrigeration, Cascade system, Applications of low temperature, Properties of cryogenic fluids, Liquefaction of air, hydrogen and helium, gas separation and gas purification systems, Low temperature insulation, Storage systems and Cryogenic fluid transfer systems

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

CO1. Demonstrate the knowledge of cryogenic systems for low temperature applications.

CO2. Analyze the properties of cryogenic fluids for low temperature application.

CO3. Analyze the various refrigeration and liquefaction systems for low temperature application.

CO4. Analyze the various gas separation and gas purification systems for low temperature application.

CO5. Demonstrate the knowledge of cryogenic insulation for suitable storage and handling systems.

CO-PO-PSO MappingTable:

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	-	-	-	-	-	-	3	-
CO2	3	3	-	-	-	-	1	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	-	1	-	-	-	-	-	-	3	-
CO4	3	3	-	-	-	-	1	-	-	-	-	-	-	3	-
CO5	3	1	-	-	-	-	1	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**2**	**-**	**-**	**-**	-	**1**	**-**	**-**	**-**	-	**-**	**-**	**3**	**-**

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSE CONTENT

Module 1: CRYOGENIC SYSTEMS (09 Periods)

Introduction to Cryogenic Systems, Cryogenics – Definition, Historical development, Necessity of Low temperature, Limitations of vapour compression system for the production of low temperature, Multi stage refrigeration system - Cascade system.

Applications of Cryogenics: Applications in space, Food Processing, super conductivity, Electrical Power, Cryobiology, Medicine-Cryosurgery, Electronics and Cutting Tool Industry.

Module 2: PROPERTIES OF CRYOGENIC FLUIDS (09 Periods)

Effects on the properties of metals - Low Temperature properties of Engineering MaterialsMechanical properties, Thermal properties, Super conductivity and Super fluidity, Electric and magnetic properties T-S diagram of a cryogen; Properties of cryogenic fluids - Liquid Methane, Liquid Neon, Liquid Nitrogen, Liquid Oxygen, Liquid Argon, Liquid Air, Liquid hydrogen and helium

Module 3: REFRIGERATION AND LIQUEFICATION (09 Periods)

Manufacture of Dry ice, Joule's Thomson effect, Liquefication of air - Linde system, Claude system, Cascaded System, Liquefaction of neon, Hydrogen and Helium, Stirling Cycle Cryo Coolers, Gifford Mcmahon Cryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator.

Module 4: GAS SEPARATION AND GAS PURIFICATION SYSTEMS (09 Periods)

The thermodynamically ideal separation system properties of mixtures, Principles of gas separation, air separation systems, Hydrogen, Argon, Helium air separation systems, Gas purification methods.

Module 5: LOW TEMPERATURE INSULATION (09 Periods)

Types of Insulation - Reflective insulation, Evacuated powders, Rigid foams; Super insulation; Dewar vessels; Hazards in cryogenic engineering. Cryogenic fluid transfer systems. Transfer through un-insulated lines, vacuum insulated lines, porous insulated lines etc.

TotalPeriods: 45

EXPERIENTIAL LEARNING

1. Prepare a document on recent developments in the applications of cryogenic fluid.
2. Simulate liquification of hydrogen for the given application.
3. Conduct exercises on Cryogenic insulation for a given application.

RESOURCES

TEXTBOOKS:

1. Randal F.Barron, Cryogenic systems, McGraw Hill, 2nd edition, 1986

2. Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.

REFERENCEBOOKS:

1. Traugott H.K. Frederking and S.W.K. Yuan, Cryogenics, Low Temperature Engineering and Applied Sciences, Yutopian Enterprises, 2005.
2. A. R. Jha, Cryogenic Technology and Applications, Butterworth-Heinemann, 2005

VIDEOLECTURES:

1. https://www.youtube.com/watch?v=bN91qP-oBNI
2. https://www.youtube.com/watch?v=JQG2m9jSkws
3. https://www.youtube.com/watch?v=dbYrGxafciw
4. https://www.youtube.com/watch?v=BzmN-KuDXrM
5. https://www.youtube.com/watch?v=LWMX6f4aiao

WEBRESOURCES:

1. https://www.rajagiritech.ac.in/Home/mech/Course_Content/Semester%20VII/ME%20405%20Refrigeration%20and%20Airconditioning/Module%203.pdf
2. https://www.idealhy.eu/uploads/documents/IDEALHY_Cryogenics_2012_Precooling.pdf
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2732998/
4. https://www.sathyabama.ac.in/sites/default/files/course-material/2020-10/1-5_1.pdf

SPECIALIZATION ELECTIVE

CourseCode	Course Title	L	T	P	S	C
22ME101049	**TURBO MACHINES**	3	-	-	-	3

Pre-Requisite Thermodynamics and Thermal Engineering

Anti-Requisite --

Co-Requisite --

COURSE DESCRIPTION:

Definition of turbo machine, Radial flow compressors and pumps, Euler's Equation of Energy Transfer, vane congruent flow, influence of relative circulation, Principles of Axial fan and propeller, Flow through Centrifugal compressors, Axial turbine stages, stage velocity triangles, work, efficiency, blade loading, flow coefficient.

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

CO1. Model studies and thermodynamics analysis of turbomachines.

CO2. Analyze the energy transfer in Turbo machine with degree of reaction and utilisation factor.

CO3. Classify, analyze and understand various type of axial flow fans.

CO4. Classify, analyze and understand various type of centrifugal compressors.

CO5. Understand the concept of axial flow turbine and the problems involved during its operation.

CO-PO-PSO MappingTable:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-
Course Correlation Mapping	**3**	**2**	**1**	**-**	**-**	**-**	-	**-**	**-**	**-**	-	**-**	**-**	**3**	**-**

CorrelationLevels: ***3:High;*** ***2:Medium;*** ***1:Low***

COURSE CONTENT

Module1: INTRODUCTION& ANALYSIS OF TURBO MACHINES (09 Periods)

Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Unit and specific quantities, model studies and its numerical.

Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance.

Module2: ENERGY EXCHANGE IN TURBO MACHINES (09Periods)

Euler's Equation of Energy Transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor. Suction pressure and net positive suction head. Phenomena of cavitation in pumps. Concept of specific speed, Shape number. Axial, Radial and Mixed Flow Machines. Similarity laws.

Module3: FLOW THROUGH AXIAL FLOW FANS (09 Periods)

Flow through Axial flow fans - Principles of Axial fan and propeller, Application of fans for air circulation and ventilation, Stage pressure rise and work done, Slip stream and Blade Element theory for propellers, Performance and characteristics of Axial fans,

Module4: FLOW THROUGH CENTRIFUGAL COMPRESSORS (09 Periods)

Flow through Centrifugal compressors, Stage velocity triangles, specific work, forward, radial and backward swept vanes, Enthalpy entropy diagram, degree of reaction, slip factor, efficiency, Vane less and vaned diffuser systems, volute as spiral casing, Surge and stall in compressors.

Module5: AXIAL FLOW TURBINE (09 Periods)

Axial turbine stages, stage velocity triangles, work, efficiency, blade loading, flow coefficient, Single stage impulse and reaction turbines, degree of reaction, 50% reaction turbine stage, Radial equilibrium and Actuator disc approach for design of turbine blades, Partial admission problems in turbines, Losses in turbo machines.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Prepare document for analysis of various turbo machines.
2. Apply First and Second Law principles in turbo machines and prepare a document
3. Simulate axial flow turbine for a specific application.

RESOURCES

TEXT BOOKS:

1. S.M. Yahya, Turbines, Compreessors and Fans, Tata Mcgraw Hill.
2. Gopalakrishnan G, Prithvi Raj D, "A treatise on Turbomachines", Scitec Publications, Chennai, 2002.

REFERENCEBOOKS:

1. R.K.Turton, Principles of Turbomachinery, E & F N Spon Publishers, London & New York.
2. Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
3. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002

VIDEOLECTURES:

1. https://www.youtube.com/watch?v=dafjkTM2nlg
2. https://www.youtube.com/watch?v=TyygDiQPzaA
3. https://www.youtube.com/watch?v=zYr1La78UQ8&list=PLbFnetAJfrO5m76R-l8kWGImlZH-jCX5b

WEBRESOURCES:

1. https://www.pace.edu.in/img/course/Turbo_Machines_C303.pdf
2. https://bmsit.ac.in/public/assets/pdf/mech/studymaterial/18ME54%20-%20Keerthi%20Kumar.pdf
3. https://eurovent.eu/sites/default/files/field/file/PP%20-%202015-05-23%20-%20Attachment%20-%20Hudson%20tip%20clearance%20example%20-%20page%2015%20-%20figure%206.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101050	**HYBRID AND ELECTRIC VEHICLES**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

History of hybrid and electric vehicles; Drive trains; Configuration and control of electric components; Types of energy storage devices;Sizing the drive systems; Energy management strategies in hybrid and electric vehicles.

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

CO1. Analyze the performance characteristics of transmission systems in hybrid and electric vehicle (HEVs).

CO2. Demonstrate the knowledge of electric propulsion incorporated in HEVs.

CO3. Analyze the dimensional features drive systems for optimal matching of electric machine and the internal combustion engine.

CO4. Analyze and select the energy storage devices of hybrid and electric vehicle for the given applications.

CO5. Demonstrate the knowledge of the energy management strategies and implementation issues in hybrid and electric vehicles.

CO-PO-PSO MappingTable:

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	-	-	-	-	-	-	3	-
CO2	3	-	-	-	-	-	1	-	-	-	-	-	-	3	-
CO3	3	3	1	-	-	-	1	-	-	-	-	-	-	3	-
CO4	3	3	1	-	-	-	1	-	-	-	-	-	-	3	-
CO5	3	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Average	3	3	1	-	-	-	1	-	-	-	-	-	-	3	-
Correlation level	3	3	1	-	-	-	1	-	-	-	-	-	-	3	-

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSE CONTENT

Module 1: INTRODUCTION TO TRANSMISSION SYSTEMS (09 Periods)

Introduction: History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Comparison of transmission systems, Impact of modern drive trains on energy supplies.

Drive Trains for Hybrid and Electric Vehicles: Basic concept of traction, Types of drive – train topologies, power flow control, fuel efficiency analysis.

Module 2: ELECTRIC PROPULSION UNIT (09 Periods)

Introduction to electric components used in hybrid and electric vehicles, Configuration and control - DC motor drives, induction motor drives, permanent magnet motor drives, switch reluctance motor drives, drive system efficiency.

Module 3: SIZING THE DRIVE SYSTEM (09 Periods)

Matching the electric machine and the internal combustion engine, Sizing the propulsion motor, Sizing the power electronics, Selecting the energy storage technology, Supporting sub systems.

Module 4: ENERGY STORAGE (09 Periods)

Introduction to energy storage, Requirements in hybrid and electric vehicles, Types of energy storage and its analysis - Battery based, Fuel cell based, Super capacitor based, Fly wheel based, Hybridization of different energy storage devices.

Module 5: ENERGY MANAGEMENT STRATEGIES (09 Periods)

Introduction to Energy Management Strategies used in hybrid and electric vehicles, Classification of different Energy Management Strategies, Comparison of different Energy Management Strategies, Implementation issues of Energy Management Strategies

TotalPeriods:45

EXPERIENTIAL LEARNING

1. Making of Battery system for Electric Vehicles
2. Dismantling and Assembling of BLDC motors
3. Servicing of Electric Motors
4. Dismantling and Assembling of charge controllers
5. Servicing of Drive systems for Electric Vehicles
6. Servicing of Chain and Sprocket of Electric Vehicles
7. Provide and inspecting heat sink for the Battery systems
8. Servicing of Battery for Electric Vehicle
9. Servicing of Joints in the electrical connections in a EV system
10. Providing Prismatic Battery for EV system

RESOURCES

TEXT BOOKS:

1. IqbalHussain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
2. MehrdadEhsani, YimiGao, Sebastain.E, Gay, Ali Emadi, *Modern Hybrid Electric and Fuel cell Vehicles: Fundamentals Theory and Design*, CRC Press, 2004.

REFERENCE BOOKS:

1. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.
2. Tom Denton, *Electric and Hybrid Vehicles*, Routledge, 2016.

VIDEO LECTURES:

1. https://youtu.be/3E1SXG7VkQk
2. https://youtu.be/sdU-yDc9wq8
3. https://youtu.be/tJfERzrG-D8
4. https://youtu.be/e0nkkKDjY50
5. https://youtu.be/NUe90_k_pfA

WEB RESOURCES:

1. https://youtu.be/GHGXy_sjbgQ
2. https://youtu.be/EXcNXLv2W3A
3. https://youtu.be/MLkNHibqUa4

SPECIALIZATION ELECTIVE

Course Code	CourseTitle	L	T	P	S	C
22ME102031	INSTRUMENTATION AND CONTROL SYSTEMS	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Basic Principles of Measurement, Measurement of Displacement, Measurement of Temperature and Pressure, Measurement of Speed, Acceleration, Vibration, force, torque, Power, Stress, Strain, Level And Flow Measurement, Elements of Control systems

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

CO1. Demonstrate the knowledge on methods and instruments used for the measurement of Displacement

CO2. Demonstrate the knowledge on methods and instruments used for the measurement of Temperature and Pressure

CO3. Demonstrate the knowledge on methods and instruments used for the measurement of Speed, Acceleration, Force, Torque and Power.

CO4. Demonstrate the knowledge on stress and strain measurements Level and Flow measurements.

CO5. Demonstrate the knowledge of control systems.

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

CO-PO-PSOMappingTable:

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	-
CO2	3	2	-	-	1	1	-	-	-	-	-	-	-	3	-
CO3	3	2	-	-	1	1	-	-	-	-	-	-	-	3	-
CO4	3	2	-	-	1	1	-	-	-	-	-	-	-	3	-
CO5	3	2	-	-	1	1	-	-	-	-	-	-	-	3	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	3	-
Course Correlation Mapping	**3**	**2**	**-**	**-**	**1**	**1**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**3**	**-**

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSE CONTENT

Module 1: BASIC PRINCIPLES OF MEASUREMENT (09 Periods)

Measurement: Definition - Basic principles of measurement - Measurement systems, generalized configuration and functional descriptions of measuring instruments - examples. Dynamic performance characteristics - sources of error and uncertainity analysis, Classification and elimination of error.

Measurement of Displacement: Theory and construction of various transducers to measure displacement - Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures.

Module 2: MEASUREMENT OF TEMPERATURE AND PRESSURE (09 Periods)

Measurement of Temperature: Classification - Ranges - Various Principles of measurement - Expansion, Electrical Resistance - Thermistor - Thermocouple - Pyrometers - Temperature Indicators.

Measurement of Pressure: Units - classification - different principles used- Manometers, Piston, Bourdon pressure gauges, Bellows - Diaphragm gauges. Low pressure measurement - Thermal. conductivity gauges - ionization pressure gauges, McLeod pressure gauge.

Module 3: SPEED, ACCELERATION, VIBRATION, FORCE, TORQUE AND POWER MEASUREMENT (09 Periods)

Measurement of Speed: Mechanical Tachometers - Electrical tachometers - Stroboscope, Noncontact type of tachometer .

Measurement of Acceleration and Vibration: Different simple instruments - Principles of Seismic instruments - Vibrometer and accelerometer.

Measurement of Force, Torque and Power: Elastic force meters, load cells, Torsion meters, Dynamometers.

Module 4: STRESS, STRAIN, LEVEL AND FLOW MEASUREMENT (09 Periods)

Stress & Strain Measurements: Various types - electrical strain gauge - gauge factor - method of usage of resistance strain gauge for bending, compressive and tensile strains - usage for measuring torque, Strain gauge Rosettes.

Measurement of Level: Direct method - Indirect methods - capacitative, ultrasonic, magnetic, cryogenic fuel level indicators - Bubler level indicators.

Flow Measurement: Magnetic, Ultrasonic, Turbine flow meter, Hot - wire anemometer Laser Doppler Anemometer (LDA).

Module 5: SYSTEMS AND THEIR REPRESENTATION (09 Periods)

Elements of Control Systems: Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – Synchros – AC and DC servomotors – Block diagram reduction techniques – Temperature, speed & position control system

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Calibration of capacitive transducer for angular displacement.
2. Study and calibration of LVDT transducer for displacementmeasurement.
3. Calibration of Resistance Temperature Detector (RTD) for temperature measurement.
4. Calibration of Thermistor for temperature measurement.
5. Calibration of Thermocouple for temperature measurement.
6. Study and calibration of Photo speed pickups for the measurement ofspeed.
7. Calibration of Pressure Gauges.
8. Calibration of Strain gauge for temperature measurement.
9. Study and calibration of a Rotameter for flow measurement.
10. Study and calibration of Magnetic speed pickups for the measurement ofspeed
11. Study and use of a Seismic pickup for the measurement of vibrationamplitude of an engine bed at various loads.
12. Calibration of Mcleod gauge for low pressure**.**
13. Measurement and calibration of liquid level and analysis ofdifferent techniques
14. Measurement of viscosity, density, humidity and torques
15. Design of circuit to measure resistance and calibration torespective voltage
16. Data logging and analysis
17. Data acquisition, calibration and analysis using LabVIEW

RESOURCES

TEXTBOOKS:

1. D. S. Kumar, Mechanical Measurements and Control, Metropollitan Book, 5th edition, 2015.
2. S. Bhaskar, Basic Principles Measurements, Instrumentation and control systems, Anuradha Agencies, 2014.

REFERENCEBOOKS:

1. R.K. Jain, Mechanical and Industrial Measurements, Khance Publications, 12th edition, 2015.
2. Ernesto. Doebelin, Measurement systems application and design, Mc Grawhill Companies, 5th edition, 2003.
3. Bechwith, Marangoni, Lienhard, Mechanical Measurements, Pearson, 6th edition, 2006.

VIDEOLECTURES:

1. https://www.youtube.com/watch?v=Lf8h1OQV7E0
2. https://www.youtube.com/watch?v=LOU6ODaU6Jk

WEBRESOURCES:

1. https://nptel.ac.in/courses/112/104/112104100/
2. https://nptel.ac.in/courses/112/105/112105082/
3. https://nptel.ac.in/courses/112/102/112102049/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102018	**COMPUTATIONAL FLUID DYNAMICS**	3	-	2	-	4

Pre-Requisite Heat Transfer, Fluid Mechanics and Multivariable Calculus and Differential Equations

Anti-Requisite

Co-Requisite

COURSE DESCRIPTION:
Introduction to Computational Fluid Dynamics(CFD); Various Numerical methods; Solution methods for governing equations; Finite difference method and its application to heat transfer problems; Errors and stability analysis; Finite Volume method; Study flow analysis; Simple CFD techniques.

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

CO1. Apply governing equations of fluid dynamics for solving fluid mechanics and heat transfer problems.

CO2. Apply Discretization Techniques to solve algebraic equation of Grids With Appropriate Transformation.

CO3. Analyze numerical models of the Fluid flow and Heat transfer phenomenon using finite difference method as discretization and grid generation techniques for Parabolic Partial Differential Equations.

CO4. Analyze numerical models of the Fluid flow and Heat transfer phenomenon using finite difference method as discretization and grid generation techniques for elliptic and hyperbolic equations.

CO5. Analyze mathematical models of fluid dynamics using Finite volume approach.

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

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												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	3	2	1	1	-	-	-	-	-	-	-	-	3	-
CO3	3	3	2	1	1	-	-	-	-	-	-	-	-	3	-
CO4	3	3	2	1	1	-	-	-	-	-	-	-	-	3	-
CO5	3	3	2	1	1	-	-	-	-	-	-	-	-	3	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	3	-
Course Correlation Mapping	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**3**	**-**

CorrelationLevels: 3:High; 2:Medium;1:Low

COURSE CONTENT

Module 1: GOVERNING EQUATIONS (09 Periods)

Introduction, applications of CFD in diverse fields, Governing equations of fluid dynamics – Continuity, Momentum and energy equations; Generic differential and integral form for governing equations, Initial and Boundary conditions, Differences between Finite element method, Finite difference method and Finite volume method, Classification of partial differential equations – Hyperbolic, Parabolic, Elliptic and Mixed types; Applications and relevance.

Module 2: DISCRETIZATION TECHNIQUES (09 Periods)

Basic Aspects of Discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points.

Grids With Appropriate Transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.

Module 3: FINITE DIFFERENCE FORMULATIONS (09 Periods)

Parabolic Partial Differential Equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization.

Stability Analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion.

Module 4: ELLIPTIC AND HYPERBOLIC EQUATIONS (09 Periods)

Elliptic Equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods.

Hyperbolic Equations: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order TVD schemes, introduction to modern tools.

Module 5: FINITE VOLUME METHOD (09 Periods)

Introduction, Finding the flux at interface, Central schemes - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and MacCormack Method; Upwind Method in Finite Volume methods - Flux Splitting Method Steger and Warming, vanLeer, Roe's Method and finding Roe's Averages; Numerical procedure for SIMPLE algorithm, Boundary conditions for the pressure correction method; Stream function, Vorticity method, introduction to modern tools.

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Introduction to Modeling and simulation software to CFD problems
2. Solution for the one-dimensional wave equations using explicit method of laxusing finite difference method (code development)
3. Solution for the one dimensional heat conduction equation using explicitmethod using finite difference method (code development)
4. Generation of the Algebraic Grid (code development)
5. Generation of the Elliptic Grids (code development)
6. Solutions to Partial differential equations related to Elliptic Equations(code development)
7. Solutions to Partial differential equations related to Parabolic Partial Differential Equations (code development)
8. Solutions to Partial differential equations related to Hyperbolic Equations (code development)
9. Introduction to ANSYS Modeling and simulation software to aerodynamic problemsNumerical simulation of Flow over an airfoil using commercial softwarePackages
10. Numerical simulation of Supersonic flow over a wedge using commercialsoftware packages
11. Numerical simulation of Flat plate boundary layer using commercialsoftware packages
12. Numerical simulation of Laminar flow through pipe using commercialsoftware packages
13. Numerical simulation of Flow past cylinder using commercial softwarepackages

RESOURCES

TEXT BOOKS:

1. John. D. Anderson, Computational Fluid Dynamics, the Basics with Applications, Mc Graw Hill.6th Edition, 1995.
2. Hoffman, K.A., and Chiang, S.T., Computational Fluid Dynamics, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.

REFERENCE BOOKS:

1. Tapan K. Sengupta, Fundamentals of Computational Fluid Dynamics, 1st Edition, Universities Press, 2004.
2. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, 1st Edition, CRC, 1980.
3. Muralidhar, K.,andSundararajan,T. Computational Fluid Flow and Heat Transfer,NarosaPublishing, House 1995.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=8VjOoO9aAAs
2. https://www.youtube.com/watch?v=V3yqTPX9-sg

WEB RESOURCES:

1. https://nptel.ac.in/courses/112104057/
2. https://nptel.ac.in/courses/111108048/
3. https://nptel.ac.in/courses/112106178/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102019	**DESIGN AND ANALYSIS OF EXPERIMENTS**	3	-	2	-	4

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Fundamentals Of Experimental Designs; Single Factor Experiments; Factorial Designs; Special Experimental Designs; Taguchi Methods;

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

CO1. Demonstrate the concepts of Experimental Design and testing with ANOVA.

CO2. Apply the Single factor experiments practically.

CO3. Analyse factorial designs for main and interface effects.

CO4. Identify special experimental designs applicable for various systems.

CO5. Apply Taguchi models for practical situations.

CO6. Case study of design and analysis of experiments

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												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	-	-	-	3
CO5	3	3	3	1	1	1	-	-	-	-	2	-	-	-	3
CO6	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

COURSE CONTENT

Module 1: FUNDAMENTALS OF EXPERIMENTAL DESIGNS (09 Periods)

Hypothesis testing – single mean, two means, dependant/ correlated samples – confidence intervals, Experimentation – need, Conventional test strategies, Analysis of variance, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, testing using Analysis of variance.

Module 2: SINGLE FACTOR EXPERIMENTS (09 Periods)

Completely Randomized Design- effect of coding the observations- model adequacy checking - estimation of model parameters, residuals analysis- treatment comparison methods- Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test- testing using contrasts- Randomized Block Design – Latin Square Design- Graeco Latin Square Design – Applications.

Module 3: FACTORIAL DESIGNS (09 Periods)

Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares- 2^K Design with two and three factors- Yate's Algorithm- fitting regression model- Randomized Block Factorial Design - Practical applications.

Module 4: SPECIAL EXPERIMENTAL DESIGNS (09 Periods)

Blocking and Confounding in 2^K Designs- blocking in replicated design- 2^K Factorial Design in two blocks- Complete and partial confounding- Confounding 2^K Design in four blocks- Two level Fractional Factorial Designs- one-half fraction of 2^K Design, design resolution, Construction of one-half fraction with highest design resolution, one-quarter fraction of 2^K Design- introduction to response surface methods, central composite design.

Module 5: TAGUCHI METHODS (09 Periods)

Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments- Response Graph Method, ANOVA- attribute data analysis- Robust design- noise factors, Signal to noise ratios, Inner/outer OA design- case studies.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Experimental design: Students can design and conduct small experiments in a laboratory setting. This can involve identifying the factors and levels to be tested, selecting appropriate designs such as factorial, response surface, or mixture designs, and determining sample sizes. This hands-on experience can help students understand the practical aspects of experimental design and how to choose the most appropriate design for a specific problem.

2. Data collection and analysis: Students can collect data from the experiments they have designed and analyze the data using statistical software. This can include methods such as analysis of variance (ANOVA), regression analysis, and hypothesis testing. Students can learn how to identify significant effects, interpret statistical results, and draw conclusions from the data.

3. Simulation and virtual experiments: Students can use simulation software to design and analyze experiments in a virtual setting. This can involve creating scenarios with different factors and levels, running the simulations, and analysing the results. This experience can help students understand how to apply experimental design principles to a range of different scenarios and develop their analytical skills.
4. Field experiments: Students can participate in field experiments or observational studies. This can involve collecting data on a specific process or system, analysing the data using statistical techniques, and identifying areas for improvement. This experience can help students understand the challenges of conducting experiments in a real-world setting and how to adapt experimental design principles to different contexts.
5. Case studies: Students can analyse case studies from different industries and disciplines where experimental design has been used to solve real-world problems. This can help students understand the practical application of experimental design and the impact it can have on decision-making in various contexts.

(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. A/B testing for website optimization: This case study can involve the use of experimental design to test different versions of a website and optimize for user engagement or conversions. Students can analyse data using ANOVA or regression analysis to determine the most effective design.
2. Optimization of manufacturing processes: This case study can involve the use of experimental design to optimize manufacturing processes for a specific product. Students can collect data on different factors such as temperature, pressure, and time, and use statistical methods to identify the optimal combination of factors.
3. Product development: This case study can involve the use of experimental design to test new product designs and features. Students can use data analysis to identify which designs or features are most popular with consumers and optimize the product for maximum customer satisfaction.
4. Clinical trials: This case study can involve the use of experimental design to test new treatments or therapies in a clinical setting. Students can learn about the different phases of clinical trials, the importance of blinding and randomization, and how to analyze data using statistical methods.
5. Environmental monitoring: This case study can involve the use of experimental design to monitor environmental conditions and identify areas for improvement. Students can learn how to collect data on different factors such as temperature, humidity, and air quality, and use statistical methods to analyse the data and develop recommendations for improvement.

RESOURCES

TEXT BOOKS:

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley & sons, 2012.
2. Krishnaiah K,and Shahabudeen P, "AppliedDesign of Experiments and Taguchi Methods", PHI, India, 2011.

REFERENCE BOOKS:

1. Phillip J. Ross, "Taguchi Techniques for Quality Engineering", Tata McGraw-Hill, India, 2005.
2. Box, G. E., Hunter,W.G., Hunter, J.S., Hunter,W.G., "Statistics for Experimenters: Design, Innovation, and Discovery", 2nd Edition, Wiley, 2005.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=i5XBqCXzZ48
2. https://www.youtube.com/watch?v=dmvo_B91vlc

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101052	**SIMULATION AND MODELING ANALYSIS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Concepts of Simulation through examples; General principles of Simulation and random number generation; Random variate generation; Optimization via Simulation; Analysis of Simulation data; Data verification and validation; Output analysis; Simulation software.

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

CO1. Describe the role of important elements of discrete event simulation and modeling paradigm.

CO2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals

CO3. Interpret the model and apply the results to resolve critical issues in a real-world environment.

CO4. Analyze and validate the simulation data.

CO5. Develop skills to apply simulation software to construct and execute goal-driven system models.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												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	-	-	-	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

COURSE CONTENT

Module 1: INTRODUCTION TO SIMULATION (09 Periods)

Introduction to Simulation: Simulation, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study.

Simulation Examples: Simulation of Queuing systems, Simulation of Inventory System, Other simulation examples.

Module 2: GENERAL PRINCIPLES AND RANDOM NUMBERS (09 Periods)

General Principles: Concepts in discrete - event simulation, event scheduling/ Time advance algorithm, simulation using event scheduling.

Random Numbers: Properties, Generations methods, Tests for Random number-Frequency test, Runs test, Autocorrelation test.

Module 3: RANDOM VARIATE GENERATION AND OPTIMIZATION VIA SIMULATION (09 Periods)

Random Variate Generation: Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions, convolution methods- Erlang distribution, Acceptance Rejection Technique

Optimisation Via Simulation: Meaning, difficulty, Robust Heuristics, Random Search.

Module 4: ANALYSIS OF SIMULATION DATA, VARIFICATION AND VALIDATION OF MODEL (09 Periods)

Analysis of Simulation Data

Input Modelling: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis.

Verification and Validation of Model – Model Building, Verification, Calibration and Validation of Models.

Module 5: OUTPUT ANALYSIS AND SIMULATION SOFTWARE (09 Periods)

Output Analysis: Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations.

Simulation Software: Selection of Simulation Software, Simulation packages, Trend in Simulation Software.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Simulation software tools: Students can use simulation software tools to create models and simulate different scenarios. They can learn how to use tools like Arena, Simul8, or MATLAB/Simulink, among others. Students can also compare the results of different simulation runs to understand the impact of changing model parameters.
2. Hands-on simulation exercises: Students can design and run simulation exercises related to a specific domain, such as healthcare, supply chain, or transportation. For example, students can simulate a hospital emergency department to understand patient flow, staffing needs, and resource allocation. They can also design and run supply chain simulations to optimize inventory levels, production schedules, and distribution routes.
3. Role-playing simulations: Students can participate in role-playing simulations where they act as stakeholders in a system, such as customers, suppliers, or regulators. The simulation can be designed to reflect real-world situations where different stakeholders have conflicting goals and interests. For example, students can simulate a city council meeting where they debate the allocation of resources for different city services.
4. Model building and calibration: Students can design and build models from scratch, using data from real-world systems. They can calibrate the model by comparing its results to actual data, and refine it to better represent the system being modeled. For example, students can build a model of a traffic intersection and use it to optimize the timing of traffic lights.
5. Group projects: Students can work in groups to design and execute simulation projects related to a specific problem or question. They can use simulation to test different solutions and evaluate their effectiveness. For example, students can simulate the impact of different renewable energy policies on energy production and consumption in a city or state.
6. Expert guest speakers: Students can learn from experts in the field of simulation and modeling. Guest speakers can share their experiences with simulation, provide insights into real-world applications of simulation, and offer advice on how to build and execute effective simulations.

CASE STUDIES:

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

1. Queuing System Simulation: Students can simulate a queuing system, such as a bank or an airport, to analyze waiting times, service rates, and resource allocation. They can use simulation to test different scenarios, such as changing the number of servers or the arrival rate of customers, and evaluate the impact on system performance.
2. Healthcare System Simulation: Students can simulate a healthcare system, such as a hospital or a clinic, to analyze patient flow, resource utilization, and staff scheduling. They can use simulation to test different scenarios, such as changing the number of beds or the availability of medical equipment, and evaluate the impact on patient wait times and hospital capacity.

3. Manufacturing System Simulation: Students can simulate a manufacturing system, such as a factory or a production line, to analyze throughput, bottlenecks, and quality control. They can use simulation to test different scenarios, such as changing the number of workers or the production rate, and evaluate the impact on production efficiency and product quality.
4. Traffic Simulation: Students can simulate traffic flow in a city or a highway system to analyze traffic congestion, travel time, and emissions. They can use simulation to test different traffic management strategies, such as changing the timing of traffic lights or the speed limit, and evaluate the impact on traffic flow and environmental impact.
5. Weather Forecasting Simulation: Students can simulate weather patterns and forecast using models such as GFS (Global Forecasting System) or WRF (Weather Research and Forecasting). They can use simulation to predict weather patterns and analyze different scenarios such as the impact of climate change on weather patterns, and evaluate the impact of these scenarios on different sectors such as agriculture, transportation, and emergency response.
6. Game Theory Simulation: Students can simulate game theory scenarios to analyze decision-making strategies, player behavior, and outcomes. They can use simulation to test different game scenarios, such as prisoner's dilemma, and evaluate the impact of different strategies such as tit-for-tat or cooperation

RESOURCES

TEXT BOOKS:

1. Jerry Banks, John S Corson, Barry.L. Nelson, David M.Nicol and P.Shahabudeen, “Discrete Event Systems Simulation”, Fourth Edition, Pearson education, 2007.
2. Thomas J Schriber, “Simulation Using GPSS”, John Wiley, 2002.

REFERENCE BOOKS:

1. Geoffrey Gordon, “Systems Simulation”, Prentice Hall, 2002.
2. Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill International Editions – Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9.
3. Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, 2004, ISBN : 0-87692-028-8.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=Ej26SZrcPAg
2. https://www.youtube.com/watch?v=1rZvbe3FQU8

SPECILIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101053	**MANAGEMENT INFORMATION SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Process of MIS, Development of MIS within the organization, Management Process, Information Needs, System Approach in Planning Organizing and Controlling MIS, Current Trends in MIS, Transaction and application process Information system process; Unified communication and network; Security challenges in E-enterprises; characteristics and components of Decision Support System, System analysis and design

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

CO1. Relate the basic concepts and technologies used in the field of management information systems

CO2. Analyze various approaches to Management Information Systems.

CO3. Outline the role of the ethical, social, and security issues of information systems

CO4. Analyze the Decision Support System for various MIS applications.

CO5. Compare the processes of developing and implementing information systems.

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	1	-	-	-	-	-	-	-	-	3
CO2	3	-	1	-	-	1	-	-	-	-	-	-	-	-	3
CO3	3	-	1	-	1	1	-	-	-	-	-	-	-	-	3
CO4	3	-	1	-	-	1	-	-	-	-	-	-	-	-	3
CO5	3	1	-	-	-	1	-	-	-	-	-	-	-	-	3
Course Correlation Mapping	**3**	**1**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	-	**-**	**-**	**-**	-	**3**

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

COURSE CONTENT

Module 1: INTRODUCTION TO MIS (09 Periods)

The meaning and use of MIS, System View of Business, Process of MIS, Development of MIS within the organization, Management Process, Information Needs, System Approach in Planning Organizing and Controlling MIS

Module 2: TRENDS IN MIS (09 Periods)

Geographical Information Systems, Managing Global Information Systems, Artificial Intelligence, Current Trends in MIS, Contemporary Approaches to Management Information Systems

Module 3: TECHNOLOGY OF INFORMATION SYSTEM (09 Periods)

Data process- Transaction and application process Information system process; Unified communication and network; Security challenges in E-enterprises; Security threats and vulnerability-Controlling security threat and vulnerability.

Module 4: DECISION SUPPORT SYSTEM (09 Periods)

Managerial Decision Making, characteristics and components of Decision Support System, Models of Decision Making, MIS applications.

Module 5: SYSTEM ANALYSIS AND DESIGN (09 Periods)

System - Need for system analysis - System analysis of the existing system - System analysis of a new requirements - System Development Model - Structured System Analysis and Design - Object Oriented Analysis.

System Design: System design consideration, input/output design, forms design, file organization and database, data management, file design, program design, control and security.

Total Periods: 45

EXPERIENTIAL LEARNING

1. In the current e-world, any organization’s massive operations are managed by various types of information systems that help them to achieve their goals of providing superior services to their clients. Choose an organization of your choice (preferably your own organization) and discuss the essential Information systems, its features, issues, improvements to be made.
2. What is the role of MIS in modern Business? Identify some security threats and issues in implementing MIS in an organization.
3. Suppose one of your friend want to develop career in MIS. What skills and personal qualities do you think do you think he/she needs to build such a career in MIS?

RESOURCES

TEXT BOOKS:

1. Jawadekar, W.S., “Management Information Systems”, Tata McGraw Hill Private Limited, New Delhi, 2009.
2. Kenneth C. Laudon and Jane P. Laudon: “Management Information Systems” 9/e, Pearson Education, New Delhi.

REFERENCE BOOKS:

1. T Alex Leon and Mathew Leon: “Data Base Management Systems”, Vikas Publishing House, New Delhi.
2. Goyal, D.P.: “Management Information System”, MACMILLAN India Limited, New Delhi, 2008

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110105148
2. https://onlinecourses.swayam2.ac.in/cec21_ge05/preview

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101054	**AGILE MANUFACTURING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to types of production, agile manufacturing, agile practices, implementation of agile concepts, measurement of performance in agile manufacturing

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

CO1. Demonstrate fundamental knowledge on the concepts of agile manufacturing

CO2. Apply agile practices for better products.

CO3. Analyse the implementing possibilities of agile concepts.

CO4. Evaluate the performance of agile manufacturing.

CO5. Demonstrate the concepts of management in agile manufacturing

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	-	-	-	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***

COURSE CONTENT

Module1: INTRODUCTION TO AGILE MANUFACTURING (09 Periods)

Types of Production- The Agile Production Paradigm- History of Agile Manufacturing- Agile Manufacturing Vs Mass Manufacturing, Agile Manufacturing Vs Mass Customization- Agile Manufacturing Research Centers.

Module2: AGILE PRACTICES (09 Periods)

Agile Practices- Agile practice for product development - Manufacturing agile practices - understanding the value of investing in people, Concept models of Agile Manufacturing - Infusing managerial principles for enabling agility.

Module3: AGILE IMPLEMENTATION (09 Periods)

Implementing technology to enhance agility- Implementing new technology – reasons – guidelines preparation for technology implementation - A checklist, technology applications that enhance agility - agile technology make-or-buy decisions

Module4: PERFORMANCE MEASUREMENT IN AGILE MANUFACTURING (09 Periods)

Performance Measurement and Costing: Measurement of agility – methods – Scoring and Fuzzy approaches – Costing for Agile Manufacturing practices – Activity Based Costing. Creating the learning factory: Imperative for success, factory becoming a learning factory, building a road map for becoming a learning factory - core capabilities, guiding vision, leadership that fits, ownership and commitment, pushing the envelope, prototypes, integration, learning challenges for learning manufacturing business.

Module5: MANAGEMENT IN THE AGILE ORGANIZATION (09 Periods)

Old management styles, role of manger in an agile organization - vision champion, team leader, coach, business analyzer, supporting the new culture - performance appraisal systems, selection systems, reward and recognition systems, organizational measurement, organizational learning processes.

Total Periods: 45

EXPERIENTIALLEARNING

1. How the Sony company implements agile methodology in their project management?
2. Discuss the implementation of agile concept in Siemens digital factory
3. How the agile approach started in Mitsubishi in manufacturing of various components?

RESOURCES

TEXT BOOKS:

1. Gunasekaran A, “Agile Manufacturing, 21st Strategy Competitiveness Strategy”, Elsevier Publications, 2001.
2. Gopalakrishnan “Simplified Lean Manufacture – Elements, Rules, Tools and Implementation”, PHI Learning Private Limited, New Delhi, India, 2010.
3. Devadasan, S.R., Sivakumar, V., Mohan Murugesh, R., Shalij, P, R. “Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities”, Prentice Hall India, 2012.

REFERENCE BOOKS:

1. Goldman S L, Nagal R N and Preiss K, “Agile Competitors and Virtual Organizations”, Van Nostrand Reinhold, 1995.
2. Brian H Maskell, “Software and the Agile Manufacturer, Computer Systems and World Class Manufacturing, Productivity Press, 1993
3. Paul T. Kidd, “Agile Manufacturing -Forging new Frontiers”, Addison Wesley Publication 1994.

VIDEO LECTURES / WEB RESOURCES:

1. https://www.youtube.com/watch?v=_n28vUPJzxM
2. https://www.youtube.com/watch?v=Oo7gdvJ6FaU&list=PLEWFSKHjyrwy1bYSi1WsoPGDno-LKOnhV
3. https://www.youtube.com/watch?v=zu4spjJkH88
4. https://www.youtube.com/watch?v=wqlNBon4btg
5. https://www.youtube.com/watch?v=67NVUeFQMy4

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101055	**LEAN MANUFACTURING SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:
Introduction to types of production, lean manufacturing, lean tools and techniques, Kanban, JIT concept, lean management, and implementation

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

CO1. Demonstrate basic knowledge on the concepts of Lean manufacturing.

CO2. Apply lean tools and techniques for better products.

CO3. Analyse the implementing possibilities of lean concepts.

CO4. Evaluate the lean projects and selection process.

CO5. Demonstrate the implementing possibilities of lean 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	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	-	-	-	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: INTRODUCTION TO LEAN MANAGEMENT AND LEAN ELEMENTS (09 Periods)

Introduction to seven waste and their narration; Evolution of lean; Global competition, Lean Manufacturing, Value flow and Muda, Muri and Mura, Need for LM, Meeting the stake holders requirement, Elements of LM.

Module 2: LEAN TOOLS AND TECHNIQUES (09 Periods)

Various tool of LM, Fundamental blocks of Lean, Impact of 5 S tools, Need for TPM, Pillars of TPM, Implementation of TPM, Overall Equipment Effectiveness (OEE) and its computation.

Module 3: LEAN SYSTEM (09 Periods)

Lean systems: Features manufacturing and services, Work flow, Small lot sizes, Pull Method, Kanban, A3 problem solving, Just In Time.

Module 4: PROJECT SELECTION FOR LEAN (09 Periods)

Resource and project selection, Selecting projects, Process mapping, Current and future value stream mapping, project suitable for lean initiatives.

Module 5: LEAN MANAGEMENT AND IMPLEMENTATION (09 Periods)

Standardized work, Continuous improvement. Lean projects: Training, selecting the members, preparing project plan, implementation, review. Productivity Improvement: Process, machinery Operator and equipment

Total Periods: 45

EXPERIENTIAL LEARNING

1. Waste Walk: Students participate in a waste walk activity where they visit a workplace, such as a manufacturing facility or a service organization, to identify the seven wastes (muda). They observe and document instances of waste and discuss their findings, highlighting the importance of eliminating waste for improved efficiency.

2. Total Productive Maintenance (TPM) Simulation: Students participate in a TPM simulation exercise where they learn about the pillars of TPM and implement TPM practices on a simulated production line. They track and calculate Overall Equipment Effectiveness (OEE) to assess the impact of TPM on equipment performance and maintenance.

3. Value Stream Mapping (VSM) Exercise: Students work in teams to map the current state and future state value streams of a specific process. They identify areas of waste and propose improvements using lean principles such as work flow, small lot sizes, pull method, and Kanban. They also practice A3 problem-solving techniques to address process improvement challenges.

4. Process Mapping and Improvement Project: Students select a specific process or workflow and conduct a process mapping exercise. They identify opportunities for improvement and develop a project proposal outlining the goals, scope, and expected outcomes of the lean initiative. They present their project selection and mapping findings to the class.

5. Standardized Work Simulation: Students participate in a simulation exercise where they create and implement standardized work procedures for a specific task or process. They monitor the effectiveness of the standardized work and identify opportunities for continuous improvement.

RESOURCES

TEXT BOOKS:

1. Devadasan S R, Mohan Sivakumar V, Murugesh R and Shalij P R, “Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities”, Prentice Hall of India (PHI) Private Limited, New Delhi, India, 2012.
2. James P Womack and Daniel T Jones, “Lean Thinking, Banish Waste and Create Wealth in Your Corporation”, Simon & Schuster UK Limited, 2010.
3. William M Feld, “Lean Manufacturing, Tools, Techniques and How To Use Them”, The St. Lucie Press/APICS Series on Resource Management, 2001.

REFERENCE BOOKS:

1. Herron, C., and P. M. Braiden. "Defining the foundation of lean manufacturing in the context of its origins (Japan)." (2007): 148-157.
2. Stephens, Matthew P., and Fred E. Meyers. *Manufacturing facilities design and material handling*. Purdue University Press, 2013.

VIDEO LECTURES / WEB RESOURCES:

1. https://www.youtube.com/watch?v=gixa9MHNPaM
2. https://www.youtube.com/watch?v=lRtlqiHJ9mE
3. https://www.youtube.com/watch?v=4VIh3rvFtZ0
4. https://www.youtube.com/watch?v=1xGg2AzpxCE
5. https://www.youtube.com/watch?v=GJIk9ufu22M

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101056	E-COMMERCE AND BUSINESS ANALYTICS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to E-Commerce; E-Commerce Marketing; Business Analytics Fundamentals; Data Mining and Data Warehousing; Advanced Business Analytics;

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

CO1. Demonstrate the concepts E-Commerce, online payment system.

CO2. Apply the concepts of E-Commerce marketing for the development of the business.

CO3. Analyse the business analytics using R / Python.

CO4. Identify suitable data mining and data warehousing approaches.

CO5. Develop Big data analytics models using Artificial Intelligence.

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	-	-	-	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

COURSE CONTENT

Module 1: INTRODUCTION TO E-COMMERCE (09 Periods)

Overview of E-Commerce; Business models in E-Commerce; Evolution of E-Commerce; Trends in E-Commerce; E-Commerce Technologies; E-Commerce platforms; Online payment systems.

Module 2: E-COMMERCE MARKETING (09 Periods)

Marketing strategies for E-Commerce; Digital marketing for E-Commerce; SEO and SEM for E-Commerce; Social media marketing for E-Commerce; Email marketing for E-Commerce; Influencer marketing for E-Commerce; Content marketing for E-Commerce.

Module 3: BUSINESS ANALYTICS FUNDAMENTALS (09 Periods)

Introduction to Business Analytics; Business Intelligence Tools; Descriptive Analytics; Predictive Analytics; Prescriptive Analytics; Data Visualization Techniques; Introduction to R/Python for Analytics.

Module 4: DATA MINING AND DATA WAREHOUSING (09 Periods)

Data Mining Concepts; Techniques for Data Mining; Association Rule Mining; Clustering Techniques; Regression Analysis; Introduction to Data Warehousing; ETL Process.

Module 5: ADVANCED BUSINESS ANALYTICS (09 Periods)

Machine Learning and AI for Business Analytics; Text Mining and Sentiment Analysis; Time Series Analysis; Optimization Techniques; Deep Learning for Business Analytics; Big Data Analytics; Case Studies in Business Analytics.

Total Periods: 45

EXPERIENTIAL LEARNING

Experiential learning is a valuable approach for students to gain practical knowledge and skills in the field of e-commerce and business analytics. Here is a list of potential content for experiential learning in this subject:

1. E-commerce platform analysis: Students can conduct a comprehensive analysis of popular e-commerce platforms such as Amazon, eBay, and Alibaba. This analysis should focus on the platform's user interface, shopping experience, marketing strategies, and overall functionality.
2. E-commerce marketing campaign: Students can create a comprehensive e-commerce marketing campaign for a hypothetical or real e-commerce business. This campaign should include a detailed plan for different marketing channels such as email marketing, social media marketing, and paid advertising.
3. Business data analysis: Students can analyse a large data set for a real or hypothetical business, identifying trends, patterns, and actionable insights. This analysis should include data visualization, descriptive statistics, and predictive modelling.
4. Data visualization project: Students can develop an interactive dashboard or data visualization project using popular data visualization tools such as Tableau or Power BI. This project should highlight key performance indicators for a real or hypothetical business.

5. Business analytics simulation: Students can participate in a business analytics simulation, where they make data-driven decisions for a hypothetical business. This simulation should involve different scenarios and challenges, allowing students to practice critical thinking and decision-making skills.
6. Case studies analysis: Students can analyze real-world case studies related to e-commerce and business analytics, identifying key problems, opportunities, and solutions. This analysis should involve in-depth research and presentation skills.
7. Machine learning project: Students can work on a machine learning project related to e-commerce and business analytics. This project should involve data preparation, model building, and evaluation.
8. These are just a few examples of potential experiential learning content for e-commerce and business analytics. The specific content and approach will depend on the level of the course, the resources available, and the learning objectives

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

CASE STUDIES/ ARTICELS:

Here are some case studies for e-commerce and business analytics that can be used as examples or projects for students:

1. Amazon: The world's largest online retailer, Amazon, can be analysed as a case study to understand the importance of big data analytics and personalization in e-commerce. Students can research and analyse Amazon's recommendation engine, customer reviews, and supply chain management to gain insights into how Amazon has achieved its success.
2. Zara: As a case study in e-commerce, Zara can be analysed for its unique business model, which uses data analytics and inventory management to quickly produce and deliver fast-fashion to customers. Students can analyse how Zara's unique business model allows the company to adapt quickly to changing trends and keep up with customer demand.
3. Netflix: As a case study in business analytics, Netflix can be analysed for its data-driven approach to content creation and personalization. Students can analyse how Netflix uses data analytics to recommend content to users and create original content that meets the preferences of its viewers.
4. Warby Parker: As a case study in e-commerce, Warby Parker can be analysed for its disruptive business model in the eyewear industry. Students can analyse how Warby Parker's use of data analytics, direct-to-consumer sales, and innovative marketing strategies have allowed it to disrupt the traditional eyewear industry and gain a competitive advantage.
5. Airbnb: As a case study in e-commerce and business analytics, Airbnb can be analysed for its use of data analytics and machine learning to optimize pricing, improve search results, and increase conversions. Students can analyse how Airbnb's use of data analytics and machine learning has allowed it to achieve rapid growth and gain a competitive advantage in the sharing economy.

RESOURCES

TEXT BOOKS:

1. Kenneth C. Laudon and Carol Traver, E-Commerce 2020-2021: Business, Technology, Society, Pearson Education, 2020.
2. Christian Albright, Wayne Winston, and Christopher Zappe, Business Analytics: Data Analysis and Decision Making, Cengage Learning, 2016.

REFERENCE BOOKS:

1. Efraim Turban, Jon Outland, and David King, Electronic Commerce 2018: A Managerial and Social Networks Perspective, Springer International, 2017.
2. Avinash Kaushik, Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, Wiley, 2009.
3. John W. Foreman, Data Smart: Using Data Science to Transform Information into Insight, Wiley, 2013.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=zbcCdoHeS4w
2. https://www.youtube.com/watch?v=xKJjyn8DaAw

SPECIALIZATION ELECTIVE

Course Code	CourseTitle	L	T	P	S	C
22ME101057	**ENTERPRISE RESOURCE PLANNING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Management – Concept; Staffing, Leading and Controlling; Leading EffectiveTeams, Planning and Implementing Change; Allowances and Standard time calculations; Linebalancing,Maintenance;StatisticalProcessControl.

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

CO1. Understand and apply the basics of ERP

CO2. Implement the business modules of ERP

CO3. Analyze the key implementation issues of ERP

CO4. Demonstrate some popular products in the area of ERP

CO5. Analyze the current and future trends in ERP

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**

CorrelationLevels: 3:High; 2:Medium; 1:Low

COURSE CONTENT

Module 1: INTRODUCTION TO ERP (09 Periods)

Introduction: Overview of enterprise systems and Evolution - Risks and benefits - Fundamental technology - Issues to be consider in planning design and implementation of cross functional integratedERP systems.

Module 2: ERP SOLUTIONS AND FUNCTIONAL MODULES (09 Periods)

ERP Solutions and Functional Modules: Overview of ERP software solutions- small, medium and large enterprise vendor solutions, BPR and best business practices - Business process Management, Functionalmodules.

Module 3: ERPIMPLEMENTATION (09 Periods)

ERP Implementation: Planning Evaluation and selection of ERP systems - Implementation life cycle- ERP implementation, Methodology and Frame work- Training and Data Migration – PeopleOrganization in implementation-Consultants, Vendors and Employees.

Module 4: POST IMPLEMENTATION (09 Periods)

PostImplementation: MaintenanceofERP-Organizational and Industrial impact; Success and Failure factors of ERP Implementation

Module 5: EMERGING TRENDS ON ERP (09Periods)

Emerging Trends on ERP: Extended ERP systems and ERP add-ons-CRM, SCM, Business Analytics-Future trends in ERP systems-web enabled, Wireless technologies, cloud computing.

Total Periods: 45

CASESTUDIES/ARTICELS:

1. Nike's ERP Implementation: In 2000, Nike embarked on a multi-year project to implement an ERP system that would help streamline its operations and improve its supply chain management. However, the project faced numerous challenges, including resistance from employees, technical issues, and delays. The project eventually went live in 2004, but not without significant cost overruns and disruptions to Nike's business.
2. Hershey's ERP Implementation: In 1999, Hershey's implemented an ERP system to help automate and integrate its business processes. However, the implementation was plagued with problems, including technical glitches, data inaccuracies, and order fulfillment issues. As a result, Hershey's was unable to deliver products to retailers during the crucial Halloween season, resulting in a significant drop in sales and stock prices.
3. Nestle's ERP Implementation: In 2000, Nestle embarked on a global ERP implementation project to help standardize its business processes across different regions. The project faced numerous challenges, including cultural differences, resistance from employees, and technical issues. However, Nestle was able to successfully implement the system, resulting in improved efficiency and cost savings.

RESOURCES

TEXT BOOKS:

1. Alexis Leon, ERP demystified, secondEditionTataMcGraw-Hill,2008.
2. Sinha P. Magal and Jeffery Word, Essentials of Business Process, and Information System, WileyIndia,2012.
3. Jagan Nathan Vaman, ERP in Practice, Tata McGraw-Hill,2008

REFERENCE BOOKS:

1. Alexis Leon, Enterprise Resource Planning, second edition, TataMcGraw-Hill,2008.
2. Maha deo Jaiswal and Ganesh Vanapalli, ERPMacmillanIndia,2009
3. Vinod Kumar Gragand N.K. Venkita krishnan, ERP-Concepts and Practice, PHI,2006.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=NzyhYxUCjlg
2. http://www.digimat.in/nptel/courses/video/110105083/L10.html
3. https://www.youtube.com/watch?v=64UGBl1vDRM

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101058	**FINANCIAL ENGINEERING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course provides an in-depth exploration of financial engineering concepts and techniques, including derivative securities, risk management, and quantitative analysis. Students will develop an understanding of the role of financial engineering in modern finance, the risks and rewards of different financial instruments, and the principles of effective risk management. Through case studies and experiential learning activities, students will apply financial engineering concepts to real-world situations and develop the critical thinking and problem-solving skills necessary for success in the field.

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

CO1. Apply quantitative analysis and modelling techniques to analyse financial data and make informed financial decisions.

CO2. Analyze and evaluate the use of derivatives in risk management and develop hedging strategies using options, forwards, and futures contracts.

CO3. Analyze and evaluate fixed income securities, manage interest rate risk, and model credit risk using financial engineering techniques.

CO4. Develop and implement portfolio optimization and asset pricing models using modern portfolio theory, the Capital Asset Pricing Model (CAPM), and behavioural finance principles.

CO5. Analyze and evaluate advanced financial engineering topics, including exotic derivative securities, structured products, algorithmic trading, and machine learning in finance.

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	-	-	-	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

COURSE CONTENT

Module 1: INTRODUCTION TO FINANCIAL ENGINEERING (09 Periods)

Introduction to Financial Engineering and its applications in finance; Overview of financial markets, instruments, and institutions; Fundamentals of probability, statistics, and stochastic processes in finance; Quantitative analysis and modeling techniques in finance; Introduction to MATLAB and Excel for financial modeling and analysis.

Module 2: DERIVATIVES AND RISK MANAGEMENT (09 Periods)

Introduction to derivatives and their valuation; Options and option strategies; Forwards and futures contracts and their applications in risk management; Hedging techniques and risk management strategies using derivatives; Monte Carlo simulations and their applications in financial engineering.

Module 3: FIXED INCOME SECURITIES AND CREDIT RISK (09 Periods)

Valuation of fixed income securities; Interest rate risk management techniques; Modeling credit risk and its implications for financial engineering; Credit derivatives and their applications in risk management; Case studies of successful fixed income and credit risk management using financial engineering techniques.

Module 4: PORTFOLIO OPTIMIZATION AND ASSET PRICING (09 Periods)

Portfolio optimization and asset allocation techniques; Risk measurement and performance evaluation; Modern portfolio theory and its limitations; Capital Asset Pricing Model (CAPM) and its applications; Efficient Market Hypothesis and behavioural finance.

Module 5: ADVANCED FINANCIAL ENGINEERING (09 Periods)

Exotic derivative securities and their pricing; Structured products and their role in financial engineering; Algorithmic trading and high-frequency trading; Machine learning and artificial intelligence in financial engineering; Emerging trends and future directions in financial engineering.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Trading simulation: Have students participate in a trading simulation using a virtual trading platform, giving them the opportunity to practice trading strategies and risk management techniques in a simulated environment.
2. Case studies: Assign students case studies or real-world problems that require them to apply financial engineering concepts to real-world scenarios, allowing them to see how the concepts are applied in practice.
3. Guest speakers: Invite guest speakers from the financial engineering industry to come speak to the class and share their experiences and insights on the field.
4. Investment club: Form an investment club among students in the course, giving them the opportunity to pool their resources and make real investments in stocks, bonds, and other financial instruments.
5. Research project: Assign students a research project on a topic related to financial engineering, requiring them to conduct research, analyze data, and present their findings to the class.

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

CASE STUDIES/ ARTICELS:

1. Long-Term Capital Management (LTCM): The case of LTCM is a classic example of financial engineering gone wrong. Students could analyze the events leading up to the collapse of LTCM, the strategies they employed, and the risks they took. This case study could also focus on the role of financial engineering in modern finance and the need for effective risk management.
2. Mortgage-Backed Securities: The subprime mortgage crisis of 2008 provides a rich source of case studies related to financial engineering. Students could analyze the role of securitization, credit ratings, and derivatives in the crisis and explore ways to mitigate the risks associated with these financial instruments.
3. Derivatives Trading: This case study could focus on a specific derivatives trading strategy, such as the use of options or futures contracts. Students could analyze the risks and rewards of the strategy and assess its potential for generating profit or hedging risk.
4. Value at Risk (VaR): VaR is a popular risk management tool used in financial engineering. Students could analyze the use of VaR in a specific industry or company and assess its effectiveness in managing risk.
5. Black-Scholes Model: The Black-Scholes Model is a classic financial engineering formula used to price options contracts. Students could analyze the assumptions behind the model, the factors that affect option pricing, and the strengths and limitations of the model.

RESOURCES

TEXT BOOKS:

1. John C. Hull, Options, Futures, and Other Derivatives, Pearson, 2018.
2. T. R. Bielecki and M. Rutkowski, Financial Engineering: The Evolution of a Profession, Wiley, 2011.

REFERENCE BOOKS:

1. Steven E. Shreve, Stochastic Calculus for Finance I: Continuous-Time Models, Springer, 2004.
2. Salih N. Neftci, An Introduction to the Mathematics of Financial Derivatives, Elsevier Science, 2000.
3. Mary Jackson and Mike Staunton, Advanced Modelling in Finance Using Excel and VBA, Wiley, 2006.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=oX7iyvZsAak
2. https://www.youtube.com/watch?v=6APNi-wA-O8

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101059	**INDUSTRIAL SAFETY AND MAINTENANCE ENGINEERING**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to safety aspects in industries, facilities in the organization, industry acts, maintenance principles and policies

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

CO1. To provide exposure to the students about safety and health provisions related to hazardous processes as laid out in Factories act 1948.

CO2. To familiarize students with powers of inspectorate of factories.

CO3. Apply maintenance principles and practices.

CO4. Demonstrate maintenance policies

CO5. Evaluate the concepts of condition monitoring

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	-	-	-	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: FUNDAMENTALS OF INDUSTRIAL SAFETY ENGINEERING (09 Periods)

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and firefighting, equipment and methods.

Module 2: INDUSTRIAL SAFETY ACT AND PERSONAL PROTECTION (09 Periods)

General Safety Rules, Duties of Plant Safety Inspector, Investigation and analysis of Accidents, Indian Factories Act, Workmen Compensation Act, Industrial Disputes Act.

Personal protection in the work environment, Types of PPEs, Personal protective equipment - respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping.

Module 3: PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING (09 Periods)

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

Module 4: MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE (09 Periods)

pes of Maintenance– Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle – Principles and methods of lubrication – TPM

Module 5: CONDITION MONITORING (09 Periods)

Condition Monitoring – Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis

Total Periods:45

EXPERIENTIAL LEARNING

1. Workplace Hazard Assessment: Students visit a workplace and conduct a hazard assessment to identify potential mechanical and electrical hazards. They document the types of hazards, their causes, and propose preventive measures and procedures to control and mitigate them. They also discuss the salient points of the Factories Act 1948 related to health and safety.

2. Accident Investigation and Analysis: Students analyze case studies of industrial accidents and investigate the root causes. They apply the Indian Factories Act, Workmen Compensation Act, and Industrial Disputes Act to understand the legal and regulatory framework related to industrial safety. They discuss the duties of a plant safety inspector and learn how to conduct accident investigations.

3. Maintenance Planning Case Study: Students analyze a case study of a maintenance system and identify the objectives and principles of planned maintenance activities. They discuss the importance and benefits of sound maintenance systems, reliability, machine availability, and factors affecting availability. They explore maintenance organization structures and maintenance economics.

4. Preventive Maintenance Strategy Design: Students work in teams to develop preventive maintenance schedules and repair cycles for selected equipment or systems. They discuss the comparative merits of different maintenance categories and focus on preventive maintenance principles and methods. They also explore lubrication principles and methods and discuss the concept of Total Productive Maintenance (TPM).
5. Condition Monitoring Techniques: Students engage in hands-on activities to learn various condition monitoring methods and instruments. They explore temperature-sensitive tapes, pistol thermometers, and wear-debris analysis techniques. They compare the costs of implementing condition monitoring practices with and without them. They also discuss on-load and offload testing methods.

RESOURCES

TEXT BOOKS:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt. Ltd., New Delhi.
3. Srivastava S. K., Maintenance Engineering and Management, S. Chand & Company Ltd.,New Delhi, 1998.
4. Venkataraman, Maintenance Engineering and Management, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.5.
5. Srinath, L. S. *Reliability engineering*. New Delhi, Delhi: Affiliated East-West Press, 1991.

REFERENCE BOOKS:

1. Hoyos, Carl G., and B. M. Zimolong. *Occupational safety and accident prevention: behavioral strategies and methods*. Elsevier, 2014.
2. Friend, Mark A., and James P. Kohn. Fundamentals of occupational safety and health. Rowman & Littlefield, 2023.
3. Macdonald, Dave. *Practical industrial safety, risk assessment and shutdown systems*. Elsevier, 2003.

VIDEO LECTURES / WEB RESOURCES:

1. https://www.youtube.com/watch?v=v-eltsixu4I
2. https://www.youtube.com/watch?v=3VReVbsmjKI
3. https://www.youtube.com/watch?v=cnsFV2FxQmo
4. https://www.youtube.com/watch?v=aQeu5fynOLE
5. https://www.youtube.com/watch?v=p8B3OiIoynY

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101060	**MARKETING MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Introduction to Marketing and Market Analysis, Marketing environment, Product Decisions and Pricing Decisions, Product life cycle, Distribution Channels and Physical Distribution Decisions, Promotion mix, Sales promotion, Marketing Research and developing marketing strategy, Issues and Developments in Marketing.

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

CO1. Demonstrate the concepts of marketing and its strategy

CO2. Apply the concept ofProduct life cycle for pricing decision

CO3. Analyze distribution channels and decisions for sales promotion

CO4. Identify different marketing strategies to maximize enterprise profitability and customer satisfaction within the realistic constraints.

CO5. Analyze issues and developments in marketing for better services in marketing

CO-PO-PSO Mapping Table:

Course Outcomes	ProgramOutcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	1	-	2	-	-	3	-	-	-	3
CO2	3	2	1	-	-	1	-	2	-	-	3	-	-	-	3
CO3	3	2	1	-	-	1	-	2	-	-	3	-	-	-	3
CO4	3	2	1	-	-	1	-	2	-	-	3	-	-	-	3
CO5	3	2	1	-	-	1	-	2	-	-	3	-	-	-	3
Course Correlation Mapping	**3**	**2**	**1**	-	-	**1**	-	**2**	-	-	**3**	-	-	-	**3**

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

COURSE CONTENT

Module 1: INTRODUCTION TO MARKETING AND MARKET ANALYSIS (09 Periods)

Introduction: Concept, nature, scope and importance of marketing; Marketing concept and its evolution; Marketing mix; Strategic marketing planning – an overview. Market Analysis and Selection: Marketing environment – macro and micro components and their impact on marketing decisions; Market segmentation and positioning; Buyer behavior; consumer versus organizational buyers; Consumer decision making process.

Module 2: PRODUCT DECISIONS AND PRICING DECISIONS (09 Periods)

Product Decisions: Concept of a product; Classification of products; Major product decisions; Product line and product mix; Branding; Packaging and labeling; Product life cycle – strategic implications; New product development and consumer adoption process. Pricing Decisions: Factors affecting price determination; Pricing policies and strategies; Discounts and rebates.

Module 3: DISTRIBUTION AND PROMOTION (09 Periods)

Distribution Channels and Physical Distribution Decisions: Nature, functions, and types of distribution channels; Distribution channel intermediaries; Channel management decisions; Retailing and wholesaling. Promotion Decisions: Communication Process; Promotion mix – advertising, personal selling, sales promotion, publicity and public relations; Determining advertising budget; Copy designing and testing; Media selection; Advertising effectiveness; Sales promotion – tools and techniques.

Module 4: MARKETING RESEARCH AND MARKETING STRATEGY (09 Periods)

Marketing Research: Meaning and scope of marketing research; Marketing research process. Marketing Organisation and Control: Organising and controlling marketing operations.
Developing marketing strategy: differencing and positioning the market offering, developing new product, managing life-cycle strategies, designing marketing strategy for market order challengers, followers and niches, Designing and managing global marketing strategies.

Module 5: ISSUES AND DEVELOPMENTS IN MARKETING (09 Periods)

Issues and Developments in Marketing: Social, ethical and legal aspects of marketing; Marketing of services; International marketing; Green marketing; Cyber marketing; Relationship marketing and other developments of marketing

Total Periods: 45

EXPERIENTIAL LEARNING

1. Explain the role of marketing in modern organization for achieving goals? Briefly discuss with an example.
2. Marketing starts with consumers and ends with consumers. Comment and justify it in the context of marketing strategy.
3. What is the importance of brand and Identify the Characteristics to Consider When Choosing a Brand Name?

RESOURCES

TEXT BOOKS:

1. Kotler, Philip, "Marketing Management: Analysis, Planning, Implementations and Control", Pearson Education, New Delhi, 9th edition, 1997.
2. Saxena Rajan, "Marketing Management", Tata McGraw Hill, New Delhi, 3rd edition, 2005.

REFERENCE BOOKS:

1. Stanton William J., "Fundamentals of Marketing", McGraw Hill, 3rd edition, 1994.
2. McCarthy, E.J., Basic Marketing: A managerial approach, Irwin, New York, 1984.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110104068
2. https://nptel.ac.in/courses/110104070

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101070	**APPLIED AND INDUSRIAL ROBOTICS**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION:

Introduction to automation and robotics; design of end effectors; motion analysis; industrial robotic manipulators; differential transformation of manipulators; robot actuators; feedback components; robot application in manufacturing.

COURSE OUTCOMES:

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

CO1. Demonstrate knowledge of the basics of automation and robotics, including their history and applications in industry.

CO2. Analyze the principles of robotic motion analysis in diversified applications.

CO3. Model the motion of a robot using appropriate mathematical tools and techniques.

CO4. Analyze the functional and operational characteristics of different robot actuators and feedback components.

CO5. Demonstrate an understanding of the impact of robots on manufacturing efficiency and productivity, including safety considerations and regulations.

CO-PO Mapping Table:

Learning 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	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO3	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO4	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-
CO5	3	2	1	-		1	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	3	2	1	-	1	1	-	-	-	-	-	-	3	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION (09 Periods)

Automation and Robotics – An over view of Robotics – present and future applications. Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

Module 2: MOTION ANALYSIS (09 Periods)

Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.

Module 3: DYNAMICS & MOTIONS (09 Periods)

Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems. Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion – straight line motion.

Module 4: ROBOT ACTUATORS AND FEEDBACK COMPONENTS (09 Periods)

Actuators: Pneumatic, Hydraulic actuators, electric and stepper motors, comparison of Actuators.

Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools.

Module 5: ROBOT APPLICATION IN MANUFACTURING (09 Periods)

Material Transfer – Material handling, loading and unloading-Processing – spot and continuous arc welding & spray painting – Assembly and Inspection. Robotic Programming Methods – Languages: Lead through Programming, Textual Robotic Languages such as APT, MCL.

Total Periods: 45

EXPERIENTIAL LEARNING:

1. Exploration of vision systems integrated with industrial robots.
2. Learning about safety standards and regulations for industrial robots.
3. Engaging in real-world projects or case studies to solve specific industrial challenges using robotic systems.
4. Planning and control of robot manipulators for tasks such as pick-and-place, assembly, or material handling.
5. Safety standards and regulations for industrial robots.

RESOURCES

TEXT BOOKS:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

REFERENCE BOOKS:

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada, Slotine / Wiley Inter-Science

VIDEO RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc23_me51/preview
2. https://onlinecourses.nptel.ac.in/noc23_me67/preview

WEB RESOURCES:

1. https://vptbgh.odishavikash.com/assets/files/notes/PdfFiles/INDUSTRIAL%20ENGINEERING%20&%20MANAGEMENT.pdf
2. https://www.academia.edu/37378933/Lecture_Notes_for_SEM_4153_ROBOT_APPLICATIONS_IN_INDUSTRY

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101074	PROGRAMMABLE LOGIC CONTROLLER IN AUTOMATION	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course deals with some fundamentals of general controls, digital and analog IO, ladder logic programming, alarm/notification handling, emulation, PLC-based control systems, PLC programming experience with the basic tools required to create a complete PLC program using ladder logic common to most current platforms.

COURSE OUTCOMES:

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

CO1. Explain the control system and their components.

CO2. Analyse the working of S7-1200 Processor.

CO3. Explain the Timers and Counters in PLC system.

CO4. Illustrate the operations of Sensors, Signal Conditioning, Signal Conversion and Control Modes

CO5. Apply the knowledge to instruct the operations like Math, Move, and Comparison Instructions in PLC

CO-PO-PSO Mapping Table:

Learning 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	-	-
CO2	3	2	1	-	-	1	1	-	-	-	-	-	3	-	-
CO3	3	2	-	-	-	1	1	-	-	-	-	-	3	-	-
CO4	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
CO5	2	1	-	-	-	1	1	-	-	-	-	-	3	-	-
Course Correlation Mapping	**2**	**1**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION TO PLC CONTROL SYSTEMS AND AUTOMATION (09 Periods)

Control System Overview, Process Overview, Manual Control Operation, Automated-System Building, Hardwired Systems, Conventional Relays, Relay Logic System, Control Relay Application, Motor Magnetic Starters, Latch and Unlatch Control, PLC Overview, History of PLCs, PLC Architecture, Hardwired System Replacement, PLC Ladder Logic, Manual/Auto Motor Control, Process-Control Choices

Module 2: FUNDAMENTALS OF PLC LOGIC PROGRAMMING (09 Periods)

PLC Hardware, S7-1200 Processor, Operating Modes of the CPU, Communication Modules

Signal Boards, Input-Output Modules, Power Supply, S7-1200 PLC Memory Organization/Specifications, Processor Memory Map and Program Organization, Ladder-Logic Diagrams, PLC Input/Output Terminal Connection, PLC Boolean Instructions, Shift and Rotate Instructions, Program-Control Instructions, Sequential and Combinational Logic Instructions, The Set-Reset Flip-Flop Instructions, Set and Reset Output Instructions, Positive and Negative Edge Instructions, Logic Gates and Truth Tables, Combinational Logic Instructions, Illustrative Ladder Examples

Module 3 TIMERS AND COUNTERS PROGRAMMING (09 Periods)

Timer Fundamentals, ON-DELAY Timers (TONs), OFF-DELAY Timers (TOFs), Retentive/Time-Accumulator Timers (TONRs), Implemented Timer Applications, Counters Fundamentals, Count Up Counters (CTU), Count Down Counters (CTD), Count Up and Down Counters (CTUD), Implemented Counter Applications, Special Timing Instructions

Pulse Generation/Pulse Timer (TP), One-Shot Operations, Implemented One-Shot Application, Implemented Counter Applications

Module 4 INSTRUMENTATION AND PROCESS CONTROL (09 Periods)

Instrumentation Basics, Sensors Basics, Analog Sensors, Digital Sensors, Process-Control Elements, Basic Measurement System, Process-Control Variables, Signal Conditioning, Signal Transmitters, Signal Conversion, Analog-to-Digital Conversion, Digital-to-Analog Conversion, Quantification Errors and Resolution, Process-Control System, Control Process, Controlled Variables, Control Strategy and Types, Process-Control Loop, Control-System Error Quantification, Control-System Transient and Performance Evaluation, Closed-Loop Process-Control Types, ON/OFF Control Mode, Proportional Control Mode, Composite Control Mode, PLC/Distributed Computer Supervisory Control

Module 5 MATH, MOVE, AND COMPARISON INSTRUCTIONS (09 Periods)

Math Instructions, Numbering Systems, S7-1200 Data and Number Representation, Common Math Instructions, MOVE and TRANSFER Instructions, Comparison Instructions

Equal, Greater, and Less Than Instructions, IN RANGE and OUT RANGE Instructions, Implemented Industrial Application, Common Process-Control Tasks, Small Industrial Process-Control Application

Total Periods: 45

EXPERIENTIAL LEARNING

1. Write a documented ladder-logic program.
2. Getting familiar with Siemens S7-1200 PLC controller and software

RESOURCES

TEXT BOOKS:

1. Kamel, Khaled, and Eman Kamel. Programmable logic controllers: Industrial control. McGraw Hill Professional, 2013.
2. Mano, M. Morris. Digital logic and computer design. Pearson Education India, 2017

REFERENCE BOOKS:

1. Handbook, P. L. C. "Practical Guide to Programmable Logic Controllers." AutomationDirect. com
2. Jack, Hugh. Automating manufacturing systems with PLCs. Lulu. com, 2010.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/108105063
2. https://nptel.ac.in/courses/112102011

WEB RESOURCES:

1. https://www.inductiveautomation.com/resources/article/what-is-a-PLC
2. https://www.innovativeautomation.com/plc-programming-automation/

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME101077	AUTOMATIC CONTROL SYSTEMS	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course deals with the control of responses of many different types of systems such as mechanical, electrical, thermal, fluid and mixed systems. This course introduces design and modelling of a control system, theory of transfer functions, poles, zeros, block diagram algebra, transient response analysis of first and second order systems, stability and Routh's criteria, error analysis, PID control, root locus techniques, compensation techniques, introduction to the state space method and application of MATLAB in automatic control

COURSE OUTCOMES:

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

CO1. Understand the basic concepts in automatic control.

CO2. Analyse linear systems with respect to stability, steady state properties, controllability and observability, and fastness and damping.

CO3. Evaluate closed loop systems with respect to stability, as well as robustness against and sensitivity for model errors and disturbances

CO4. Interpret and apply graphical methods and tools like block diagrams, root locus, Bode and Nyquist diagrams.

CO5. Understand and design observers for estimating the states in state space models.

CO-PO-PSO Mapping Table:

Learning 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	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	-	1	-	-	-	-	-	-	-	3	-	-
CO3	2	2	3	-	1	-	-	-	-	-	-	-	3	-	-
CO4	2	2	3	-	1	-	-	-	-	-	-	-	3	-	-
CO5	3	2	3	-	1	-	-	-	-	-	-	-	3	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION (09 Periods)

Feedback systems, mathematical modelling of physical systems; Laplace transforms, block diagrams, signal flow graphs, state-space models.

Module 2: DOMAIN ANALYSIS (09 Periods)

Time domain analysis: performance specifications, steady state error, transient response of first and second order systems.

Module 3: STABILITY ANALYSIS (09 Periods)

Stability analysis: Routh-Hurwitz stability criterion, relative stability; proportional integral, PI, PD, and PID controllers; Lead, lag, and lag-lead compensators.

Module 4: ROOT-LOCUSANALYSIS (09 Periods)

Root-locus method: analysis, design; Frequency response method: Bode diagrams, Nyquist stability criterion, performance specifications, design.

Module 5: AUTOMATIC CONTROL (09 Periods)

Statespace methods: analysis, design.
Physical realizations of controllers: hydraulic, pneumatic, and electronic controllers.
Application of MATLAB in Automatic Control

Total Periods: 45

EXPERIENTIAL LEARNING

LIST OF EXERCISES:

1. Use MATLAB to verify polar plots (Nyquist plots)
2. Use MATLAB to verify Bode diagrams
3. Use MATLAB to verify root loci
4. Use MATLAB to check the validity of simplifying approximations
5. Study more complex problems with a computer-aided design

RESOURCES

TEXT BOOKS:

1. K. Ogata, Modern Control Engineering, 4th Ed., Pearson Education Asia, 2015.
2. B. C Kuo and F. Golnaraghi, Automatic Control Systems, 8th Ed., John Wiley, 2013.

REFERENCE BOOKS:

1. M. Gopal, Control Systems: Principles and Design, 2nd Ed., Tata McGraw-Hill, 2012
2. Richard C. Dorf, Robert H. Bishop, “Modern Control Systems”, Pearson, 2011
3. Wego Wang, “Mechatronics and Automatic Control Systems”, Springer International Publishing, 2013.

VIDEO LECTURES:

https://archive.nptel.ac.in/courses/112/107/112107240/

WEB RESOURCES:

1. https://ocw.mit.edu/courses/16-06-principles-of-automatic-control-fall-2012/pages/lecture-notes/
2. https://www.control.lth.se/fileadmin/control/Education/EngineeringProgram/FRTF05/engforel.pdf
3. https://www.egr.msu.edu/classes/me451/jchoi/2014/notes/ME451_L1_Introduction.pdf

SPECIALIZATION ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME102020	INDUSTRIAL CYBER SECURITY	3	-	2	-	4

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION:
This course will provide an understanding of the concepts and terminology, the complex industrial systems ecosystem, roles of different stakeholders, and state-of-practice as provided by standards and actual industrial cyber security work, and issues and methods essential for a deeper understanding of threats and their countermeasures, as well as of more specialised approaches and solutions. Basic concepts, definitions and taxonomy of dependable and secure computing (threat, vulnerability, risk, data integrity and availability, fault-tolerance) will be covered.

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

CO1. To showcase the landscape of industrial cyber security, including main risks and protection
CO2. To develop the understanding of most relevant cyber security mechanisms and insecure protocols
CO3. To analyse the cyber security anatomy of ICS attacks in specific industrial contexts
CO4. To plan for appropriate countermeasures and mitigations against industrial risks through proper risk assessment procedures.
CO5. To develop proper architecture for Industrial cyber security
CO6. Work individually or in a team to solve problems with effective communication.

CO-PO-PSO Mapping Table:

Learning 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	1	-	-	-	-	-	-	3	-	-
CO2	3	3	2	1	1	1	-	-	-	-	-	-	3	-	-
CO3	3	3	2	1	1	1	-	-	-	-	-	-	3	-	-
CO4	3	1	1	1	1	1	-	-	-	-	-	-	3	-	-
CO5	3	3	3	1	1	1	-	-	-	-	-	-	3	-	-
CO6	2	2	1	1	1	-	-	-	-	3	3	-	3		
Course Correlation Mapping	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	-	-

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

COURSE CONTENT

Module 1: INTRODUCTION (09 Periods)

An overview of an Industrial control system- view function, monitor function, control function; Industrial control system architecture- Programmable logic controllers, Human Machine Interface, Supervisory Control and Data Acquisition, Distributed control system, Safety instrumented system; Purdue model for Industrial control systems- The enterprise zone, Industrial Demilitarized Zone, The manufacturing zone.

Module 2: INSECURE BY INHERITANCE (09 Periods)

Industrial control system history, Modbus and Modbus TCP/IP- Breaking Modbus, Using Python and Scapy to communicate over Modbus; PROFINET-PROFINET packet replay attacks, S7 communication and the stop CPU vulnerability; Common IT protocols found in the ICS- HTTP, File Transfer Protocol, Telnet, Address Resolution Protocol, CMP echo request.

Module 3: ANATOMY OF AN ICS ATTACK SCENARIO (09 Periods)

Setting the stage, Slumbertown paper mill, Trouble in paradise, Building a virtual test network, Clicking our heels, cyber kill chain, Phase two of the Slumbertown Mill ICS attack,
Other attack scenarios

Module 4: INDUSTRIAL CONTROL SYSTEM RISK ASSESSMENT (09 Periods)

Attacks, objectives, and consequences, Risk assessments, risk assessment example, Asset identification and system characterization, Vulnerability identification and threat modelling, Discovering vulnerabilities, Threat modelling, risk calculation and mitigation.

Module 5: ICS SECURITY (09 Periods)

Physical ICS Security: The ICS security bubble analogy, Down to it – Physical security
ICS Network Security : Designing network architectures for security, Network segmentation, Resiliency and redundancy

Total Periods: 45

EXPERIENTIAL LEARNING

1. Perform Denial of Service (DoS) attacks using ARP Cache poisoning attacks
2. Perform DNS Spoofing attack using ARP Cache poisoning attacks
3. Perform Password stealing (over plaintext) using ARP Cache poisoning attacks
4. Use ‘nmap’ tool to perform vertical and horizontal scanning for checking open and closed ports.
5. You, as a SOC analyst noted that someone try to send information (PING) to unknown IP address and you are suspecting some malicious information might transferred in it. Analyse the log file and find the data. a) Find the source and destination IP of that log. b) Find the Data length (Bytes) and verify the checksum status on destination.
6. Configure burp suite in machine A and access the request and response going throw machine B. Both A and B machines should be pingable.
7. Intercept an https request through butpsuite using import/export CA certificates.
8. Familiarize with android application .apk files. By performing static and dynamic analysis on the app. Find the vulnerable application and document the inferences.
9. Analysis the Security Vulnerabilities of E-commerce services

10. Analysis the security vulnerabilities of E-Mail Application
11. Study of different types of vulnerabilities for hacking a websites / Web Applications
12. Steps to ensure Security of any one web browser (Mozilla Firefox/Google Chrome)
13. Study of the features of firewall in providing network security and to set Firewall Security in windows
14. Study of different wireless network components and features of any one of the Mobile Security Apps.

RESOURCES

TEXT BOOKS:

1. Ackerman, Pascal. *Industrial Cybersecurity: Efficiently secure critical infrastructure systems*. Packt Publishing Ltd, 2017.
2. Flaus, Jean-Marie. *Cybersecurity of industrial systems*. John Wiley & Sons, 2019.

REFERENCE BOOKS:

1. Thames, Lane, and Dirk Schaefer. *Cybersecurity for industry 4.0*. Heidelberg: Springer, 2017.
2. Petrenko, Sergei. *Developing a Cybersecurity Immune System for Industry 4.0*. CRC Press, 2022.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106106129
2. https://nptel.ac.in/courses/106105031/40

WEB RESOURCES:

3. https://mrcet.com/downloads/digital_notes/EEE/CyberSecurity.pdf
4. https://mrcet.com/downloads/digital_notes/CSE/III%20Year/AIML/III_II_CSE(AIML)_Cyber%20Security.pdf
5. https://industrialcyber.co/
6. https://www.mdu.se/download/18.4fa6f584172a25f5dcfe603/1592201257388/Introduction%20to%20Industrial%20Cybersecurity%20(Francesco%20Flammini)_200612.pdf

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**	**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 Learning 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

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 is 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

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
22AI101701	**BIOINFORMATICS**	3	-	-	-	3

Pre-Requisite -
Anti-Requisite -
Co-Requisite -

COURSE DESCRIPTION: This course focus onBiological 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

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
22BS101701	**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

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 (9 Periods)

Introduction – Communication Basics – Functions of Communication – Communication Networks – Interpersonal Communication – Informal Communication – Communication Barriers – Roles of a Manager.

Module 2: CORPORATE COMMUNICATION (9 Periods)

Introduction – Corporate Communication – Cross-Cultural Communication; Concept & Styles – Corporate Communication Strategy – Corporate Citizenship – Crisis Communication: Case Study.

Module 3: WRITING BUSINESS MESSAGES & DOCUMENTS (9 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 (9 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 (9 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

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

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 (9 Periods)

Introduction to Indian Constitution; Evolution of Indian Constitution; preamble and its philosophy

Module 2: UNION LEGISLATURE (9 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 (9 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 (9 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 (9 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

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

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. ' 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

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 Outcome	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

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

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

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

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.McIntyre, *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

EXPERIENTIAL LEARNING

1. List out various ways usedto 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*, 2^{nd} 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

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

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

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 Outcome	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

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

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

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

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

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

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 1: 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 2: 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 3: 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 nanoelectro mechanical systems.

Module 4: 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 5: 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
22AI101702	**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

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
22AI101703	**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	-	-	-	-	-	-	-
Level of 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

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
22AI101704	**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

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

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

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

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 ENTERPRENEURSHIP**	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

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	ProgramOutcomes											
	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

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 your 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

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

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.

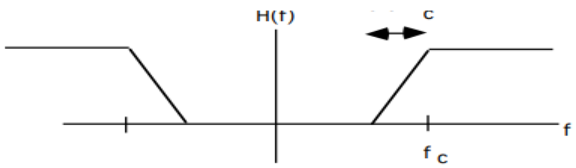
Error Correction and Detection Codes- Linear Block Codes, Cyclic Codes, Convolution Codes.

Total Periods: 45

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: $i_0(t) = a_1 vi\ (t) + a_3 v_3\ i(t)$ 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 $S_l(t)$ 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.

Determine the output signal-to-quantizing-noise ratio for a full-scale sinusoid.
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.
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 Outcome	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 Level	**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

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

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 -

COURSE DESCRIPTION: This course provides a discussion onsmart 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

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

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 Outcome	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

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

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

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