An Autonomous Institute

Shree Warana Vibhag Shikshan Mandal's

Tatyasaheb Kore Institute of Engineering And Technology, Warananagar

NBA Accredited Institute

Department of Mechanical Engineering

Final Year B. Tech.

Mechanical Engineering

2026-27

B. Tech. In Mechanical Engineering

Syllabus Structure and Curriculum under Autonomy

SWVSM'S

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

An Autonomous Institute

Abbreviations

Sr.No.	Acronym	Definition
1	ISE	In-SemesterExamination
2	ISE-I	In-SemesterExamination-I
3	ISE-II	In-SemesterExamination-II
4	ESE	EndSemesterExamination
5	ISA	In-Semester Assessment (Term Work)
6	L	Lecture
7	T	Tutorial
8	P	Practical
9	CH	Contact Hours
10	C	Credit

Course/ Subject Categories

Sr. No.	Acronym	Definition
1	BSC	Basic Science Course
2	ESC	Engineering Science Course
3	PCC	Professional Core Course
4	OE	Open Elective
5	MDM	Multidisciplinary Minor
6	PEC	Professional Elective Course
7	EEC	Entrepreneurship/Economics/ Management Courses
8	VEC	Value Education Course
9	ELC	Experiential Learning Courses
10	VSEC	Vocational and Skill Enhancement Course
11	AEC	Ability Enhancement Course
12	HSSM	Humanities Social Science and Management

SWVSM'S

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

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Course/ Subject Categories

Year of Implementation	UG/PG	Subject Category	Branch	Sem	Course Number
23	UG	PCC	ME	3/4	01

Course OE / POE Code

Year of Implementation	UG/PG	Subject Category	Branch Code	Sem	Course Number	L- OE LP - POE
23	UG	PCC	ME	3/4	01	L / LP

SWVSM'S

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

An Autonomous Institute

(National Education Policy (NEP) 2020 Structure)

Vision

To be a leading Mechanical Engineering department recognized for fostering innovation, academic excellence, and ethical professionalism, contributing significantly to industry advancements and societal welfare.

MISSION STATEMENTS

- M1 Provide a dynamic learning environment that cultivates technical proficiency, critical thinking, and problem-solving skills among students.
- M2 Foster collaboration with industries to ensure curriculum relevance, facilitate internships, and promote entrepreneurial initiatives.
- M3 Promote a culture of research and innovation, encouraging faculty and students to engage in impactful projects addressing contemporary challenges.
- M4 Prioritize inclusivity by providing equal educational opportunities to all students, especially those from rural and underprivileged backgrounds.
- M5 Instill a commitment to lifelong learning, ethical values, and social responsibility, preparing graduates to make meaningful contributions to society and the environment.

Final Year B. Tech. In Mechanical Engineering

National Education Policy (NEP) 2020 Structure

(To be implemented from 2026 - 27)

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Final Year B. Tech. (Mechanical Engineering)

Semester-VII

(National Education Policy (NEP) 2020 Structure)

Credit Scheme

(To be implemented from 2026 - 27)

Sr. No.	Category	Sub Category	Course Code	Name of Course	Teaching Scheme					Examination & Evaluation Scheme			
					L	T	P	C	CH	Component	Marks	Min for Passing	
1	Programme Course	PCC	23UGPCC-ME701	Refrigeration and Air Conditioning	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
		PCC	23UGPCC-ME702	Mechanical System Design	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
		PCC	23UGPCC-ME703	Finite Element Analysis	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
		PEC-4	23UGPEC4-ME704	Professional Elective Course-4 (Specify PEC-4 Basket)	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
2	Experiential Learning Courses	ELC	23UGELC-ME705	Research Methodology	2	1	--	3	3	ESE	60	24	40
										ISE	40	16	
3	Multidisciplinary Courses	MDM-5	23UGMDM5-ME706L	Multidisciplinary Minor-5	2	--	--	2	2	ISA	50	20	20
4	Programme Course	PCC	23UGPCC-ME701LP	Refrigeration and Air Conditioning Lab	--	--	2	1	2	ISA	25	10	20
										POE	25	10	
		PCC	23UGPCC-ME 702LP	Mechanical System Design Lab	--	--	2	1	2	ISA	25	10	20
										POE	25	10	
		PCC	23UGPCC3-ME703L	Finite Element Analysis Lab	--	--	2	1	2	ISA	25	10	10
		PEC4	23UGPEC4-ME704L	Professional Elective Course-4 (Specify PEC-4 Basket) Lab	-	-	2	1	2	ISA	25	10	10
5	Experiential Learning Courses	ELC	23UGELC-ME707LP	Project Phase - I	--	--	4	4	4	ISA	50	20	40
										POE	50	20	
					16	**1**	**12**	**21**	**29**	**0**	**800**	**320**	**320**

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Final Year B. Tech. (Mechanical Engineering)

Semester-VII

(National Education Policy (NEP) 2020 Structure)

Credit Scheme

(To be implemented from 2026 - 27)

Program Electives Courses (PEC) Basket

PEC - 4			
Category	**Sub Category**	**Course Code**	**Name of Course**
Programme Course	PEC-4	23UGPEC4-ME7041	Industrial Instrumentation and Control
		23UGPEC4-ME7042	Plant Design Engineering
		23UGPEC4-ME7043	Computational Fluid Dynamics

PEC -5			
Category	**Sub Category**	**Course Code**	**Name of Course**
Programme Course	PEC - 5	23UGPEC5-ME8041	Cryogenics
		23UGPEC5-ME8042	Modelling and Simulation of Manufacturing Systems
		23UGPEC5-ME8043	Automobile and Electric Vehicles Engineering

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Final Year B. Tech. (Mechanical Engineering)

Semester-VIII

(National Education Policy (NEP) 2020 Structure)

Credit Scheme

Track – 1 Capstan /Academic Pattern

(To be implemented from 2026 - 27)

Sr. No.	Category	Sub Category	Course Code	Name of Course	Teaching Scheme					Examination & Evaluation Scheme			
					L	T	P	C	CH	Component	Marks	Min for Passing	
1	Programme Course	PCC	23UGPCC-ME801	Mechatronics	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
		PCC	23UGPCC-ME802	Noise and Vibrations	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
		PCC	23UGPCC-ME803	Industrial Engineering	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
		PEC	23UGPEC5-ME804	Professional Elective Course-5 (Specify PEC-5 Basket)	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
2	Multidisciplinary Courses	MDM-6	23UGMDM6-ME804L	Multidisciplinary Minor-6	2	--	--	2	2	ISA	50	20	20
4	Programme Course	PCC	23UGPCC-ME801LP	Mechatronics Lab	--	--	2	1	2	ISA	25	10	20
										POE	25	10	
		PCC	23UGPCC-ME802LP	Noise and Vibrations Lab	--	--	2	1	2	ISA	25	10	20
										POE	25	10	
		PCC	23UGPCC-ME802L	Industrial Training	--	--	2	1	2	ISA	50	20	20
										---	---	---	
		PEC	23UGPEC5-ME804L	Professional Elective Course-5 (Specify PEC-5 Basket) Lab	--	--	2	1	2	ISA	25	10	10
										---	---	---	
5	Experiential Learning Courses	ELC	23UGELC-ME806LP	Project Phase -II	--	--	4	4	4	ISA	100	40	40
										POE	75	30	30
					14	**0**	**12**	**21**	**26**	**0**	**800**	**320**	**320**

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Final Year B. Tech. (Mechanical Engineering)

Semester-VIII

(National Education Policy (NEP) 2020 Structure)

Credit Scheme

Track -2 Industrial Internship Pattern

(To be implemented from 2026 - 27)

Sr. No.	Category	Sub Category	Course Code	Name of Course	Teaching Scheme					Examination & Evaluation Scheme			
					L	T	P	C	CH	Component	Marks	Min for Passing	
1	Programme Course	PCC	23UGPCC-ME801	Mechatronics	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
		PCC	23UGPCC-ME802	Noise & Vibrations	3	--	--	2	3	ESE	60	24	40
										ISE	40	16	
2	Multidisciplinary Courses	MDM-6	23UGMDM6-ME804L	Multidisciplinary Minor-6	2	--	--	2	2	ISA	50	20	20
3	Experiential Learning Courses	ELC	23UGELC-ME805LP	Industrial Internship		--	10	8	10	ISA	100	40	80
										POE	100	40	
4	Programme Course	PCC	23UGPCC-ME801L	Mechatronics Lab	--	--	2	1	2	ISA	25	10	20
										POE	25	10	
		PCC	23UGPCC-ME802LP	Noise & Vibrations	--	--	2	1	2	ISA	25	10	20
										POE	25	10	
5	Experiential Learning Courses	ELC	23UGELC-ME806LP	Project Phase -II	--	--	4	4	4	ISA	100	40	40
										POE	75	30	30
					8	**0**	**18**	**21**	**26**	**0**	**800**	**320**	**320**

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Final Year B. Tech. (Mechanical Engineering)

Semester-III to VIII

Multidisciplinary Minor (MDM) Courses

(National Education Policy (NEP) 2020 Structure)

Credit Scheme

(To be implemented from 2024 - 27)

MultidisciplinaryMinor(MDM)in Mechanical Engineering

Sr. No.	Sem.	Category	Course Code	Name of Course	Teaching Scheme					Examination & Evaluation Scheme			
					L	T	P	C	CH	Component	Marks	Min for Passing	
1	III	MDM-1	23UGMDM1-ME307L	3D CAD Modelling	2	--	--	2	2	ISA	50	20	20
2	IV	MDM-2	23UGMDM2-ME406L	Materialsand Applications	2	--	--	2	2	ISA	50	20	20
3	V	MDM-3	23UGMDM3-ME505	Machining Processes with CNC	3	--	2	4	5	ESE	60	24	40
										ISE	40	16	
4	VI	MDM-4	23UGMDM4-ME606L	GDT Techniques in Engineering	2	--	--	2	2	ISA	50	20	20
5	VII	MDM-5	23UGMDM5-ME706L	Additive Manufacturing (3D Printing)	2	--	--	2	2	ISA	50	20	20
6	VIII	MDM-6	23UGMDM6-ME804L	Automation and Robotics in Manufacturing	2	--	--	2	2	ISA	50	20	20
					13	0	2	14	15		350	140	140

23UGPCCME701 - REFRIGERATION AND AIR CONDITIONING

Lectures: 03 hrs/week
Credits: 02

Evaluation Scheme:
ESE :60 Marks
ISE :40 Marks

Course Objectives:

1. To understand the fundamentals of refrigeration and air conditioning.
2. Study of various refrigeration cycles and evaluate performance using PH charts and/or refrigerant property tables.
3. Understand the basic air conditioning processes on psychrometric charts, calculate cooling load for its applications in comfort and industrial air conditioning

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Know the working principle of different types refrigeration system	Knowledge
CO2	Explain different air conditioning systems & Air distribution system with its components and functions	Knowledge
CO3	Compare the different types of refrigerants with their thermodynamic, physical, economical properties and their effects on environment	Understand
CO4	Calculate performance parameters of Vapour compression refrigeration cycle at different operating conditions	Apply
CO5	Find the suitable combinations of psychrometric processes for different air conditioning applications.	Apply
CO6	Estimate cooling and heating load calculations for the air conditioning system design by using psychrometric principle	Apply

Description:

The refrigeration process removes heat from an enclosed space to reduce and maintain the temperature for the contents of that space while Air conditioning is the heating, cooling, dehumidification, humidification, ventilation, and sterilization of air, This Course covers different types of refrigeration systems with respect to application as well as conventional and unconventional refrigeration systems. Thermodynamically analyzes refrigeration and air conditioning systems and evaluates performance parameters. Apply the principles of Psychometrics to design the air conditioning loads for the industrial applications.

Prerequisites:	1:	Basic Mechanical Engineering
	2:	Heat and Mass Transfer
	3:	Fluid properties and Fluid dynamics,

Section-I		
Unit 1	**Application of second law of thermodynamics: Introduction to refrigeration**	
	Refrigeration definition, Applications of second law of thermodynamics: Heat engine, refrigerator, Heat pump. Performance Index of these machines, Thermal Efficiency, COP, EER, Refrigeration Capacity, Ton of refrigeration Numerical on second law of thermodynamics.	**05Hrs**
Unit 2	**Refrigeration Systems**	
	(A)Air refrigeration system Open cycle And Closed cycle air refrigeration, Reversed Carnot cycle operating on air refrigeration system, Bell Coleman Cycle/Reversed brayton cycle, advantages and limitations of Air refrigeration system. Need of cooling for aircraft, refrigeration systems for aircraft **(B) Vapour Compression Refrigeration system** Simple vapor Compression refrigeration system, PH Chart, VCR cycles, Theoretical Analysis of VCR cycle, Effects of condenser pressure, evaporator pressure on the performance of VCR cycle, Effect of superheating and sub cooling on performance of VCR cycle. Actual VCR Cycle Advantages and limitations of VCR System, Numericals on performance of VCR cycle **(C) Vapour Absorption Refrigeration System** Required properties for selection of Refrigerant and Absorbent pair, Aqua ammonia absorption refrigeration system Li- Br absorption refrigeration system, PTX Chart, VAR Cycle, difference between VCR system and VAR system	**09Hrs**
Unit 3	**Refrigerant**	
	Functions, Generations of refrigerant, Classification of refrigerants, ideal refrigerant properties, Desirable properties Thermal and physical properties, refrigerant nomenclature, ODP, GWP, common refrigerants used, future refrigerants	**06Hrs**
Unit 4	**Psychrometric Properties of Air and Human Comfort**	
	Dry air, Wet Air, Psychrometric properties, derivations of Psychrometric properties, Psychrometric Chart, Psychrometric process Sensible heating, cooling Humidification Dehumidification ADP, Coil Condition lime, Sensible heat factor, Bypass factor, Air washer and its applications. Concept of human comfort and effective temperature, Comfort Chart	**06Hrs**

Unit 5	**Air Conditioning System and Heating and Cooling Load Calculations** Air-conditioning systems: Classification, system components, Comfort Air conditioning – Industrial air conditioning and Requirements – Air conditioning Load Calculations: Design of air conditioning systems, different Heat sources, - Adiabatic mixing of two air streams, sensible heat factor, RSHF, GSHF, ERSHF, Room apparatus dew point and coil apparatus dew point, Ventilation and infiltration, Inside and Outside Design condition. Cooling Load estimation	07Hrs
Unit 6	**Air Distribution System** Re-circulated air, Ventilation air, Duct work, Use of friction loss and rectangular equivalent of round duct chart, duct system, principle of duct sizing, diffusers, dampers, layout, duct systems for theaters, auditorium, hospitals, assembly shop etc. Energy Conservations and Green Buildings, Freeze drying, Pharmaceutical and hospital air conditioning, textile, car air conditioning (plant layout, system components and design conditioning).	07Hrs

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	--	--	--	--	--	--	--	--	--	--	--	--	2	--
CO2	3	--	--	--	--	--	--	--	--	--	--	--	--	2	--
CO3	3	2	2	--	--	2	--	--	--	--	--	--	--	2	--
CO4	3	3	2	--	--	--	--	--	--	--	--	--	--	2	--
CO5	3	3	2	--	--	--	--	--	--	--	--	--	--	2	--
CO6	3	3	2	--	--	--	--	--	--	--	--	--	--	2	--

References:

Text Books	
1	"Refrigeration and Air conditioning", Khurmi R. S., Gupta J. K, S. Chand Publication (Fifth edition)
2.	" Refrigeration and Air conditioning ", Arora C. P. , Khanna Publishers, New Delhi, 27th Edition.
3.	"Refrigeration and Air conditioning", Manohar Prasad., Willey Eastern Ltd, 1983
4.	"Refrigeration and Air conditioning", Ballaney P.L, Khanna Publishers, New Delhi, 1992
5.	"Basic Refrigeration and Air Conditioning", Ananthanarayanan, McGraw Hill Education 2013
6.	"Refrigeration and Air conditioning", R.K Rajput, S K KATARIA & SONS-NEW DELHI 2013

Reference Books	
1	"Principles of refrigeration,", Dossat Ray J, Willey Eastern Ltd, 2000
2	"Refrigeration and Air conditioning", Stockers W.F and Jones J.W, McGraw Hill International editions 1982.
3	"Air Conditioning Principles and Systems", Edward G. Pita, PHI 2002.
4.	ASHRAE & ISHRAE handbook .

Video Lectures (NPTEL and SWAYAM Portals)

Video Lectures 1 to 40. https://archive.nptel.ac.in/courses/112/107/112107208/

Sr. No.	Description	Signature
1	Name of Faculty A. S. Chavan	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME702 - MECHANICAL SYSTEM DESIGN

Lectures	:	3 Hrs/Week	**Evaluation Scheme**		
Credit	:	2	**ISE**	:	40 Marks
			ESE	:	60 Marks

Course Objectives: The objective of the course is to	
1	To develop understanding of the various design parameters of mechanical Systems
2	To introduce the students about concept of aesthetics, ergonomics and creativity considerations in product design.
3	To provide the knowledge of design of gear box and elaborate the significance of stepped regulation in design of machine tool speed box
4	Study design of various mechanical systems such as pressure vessel, brakes, clutches, I.C. Engine components and material handling systems.
5	To prepare the students to analyze design parameters to design various mechanical systems.
6	List different material handling systems and design of conveyor system.

Course Outcomes:		
COs	**At the end of successful completion of the course, the student will be able to**	**Blooms Taxonomy**
CO1	Explain the fundamental design considerations, ergonomic principles, aesthetics, and human–machine interaction involved in mechanical system design.	Understand
CO2	Analyze the stresses, failure criteria, and design requirements of pressure vessels and other mechanical system components using relevant engineering standards.	Analyze
CO3	Apply design principles to braking systems, clutch systems, gear boxes, and material handling equipment for specified operating conditions.	Apply
CO4	Apply design principles to braking systems, clutch systems, gear boxes, and material handling equipment for specified operating conditions.	Evaluate
CO5	Design mechanical systems such as pressure vessels, machine tool gear boxes, braking and clutch systems, I.C. engine components, and conveyor systems using standard design procedures.	Create
CO6	Prepare and interpret engineering drawings and design documentation for mechanical systems in accordance with industrial design practices.	Create

Description:

This course focuses on the systematic design of mechanical systems by integrating engineering design principles, ergonomics, aesthetics, and material selection. It covers the design and analysis of pressure vessels, braking and clutch systems, machine tool gearboxes, I.C. engine components, and material handling equipment using relevant design standards. The course equips students with the knowledge and skills required to develop safe, reliable, and efficient mechanical systems for industrial applications.

Prerequisites:	1	Analysis of Mechanical Elements
	2	Design of Machine Elements

Section – I		
Unit 1	**Aesthetic and Ergonomic Consideration in Design:** Basic types of product forms, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry, Contrast etc. Morgon'scolour code. Ergonomic considerations- Relation between man, machine and environmental factors. Design of displays and controls. Practical examples of products or equipment's using ergonomics and aesthetic design principles. Creativity Concept, Optimum and Adequate Design	**[6]**
Unit 2	**Pressure Vessel Design** Thin and thick cylinders; Failure criteria of vessels; Lame's equation; Clavarino's and Birnie's equation; Auto-frettage and compound cylinders; Types of pressure vessels Horizontal and vertical; Classification of pressure vessel as per IS:2825-1969, Introduction to design of pressure vessels as per IS Codes. Shell and end closures. Effect of opening and nozzles in shell and covers. Types of pressure vessel support.	**[7]**
Unit 3	**Design of Braking and Clutch System** **Brakes:** Design consideration in brakes, Band, Internal expanding shoe, External contracting shoe. Thermal consideration and rating of brakes. **Clutches:** Design requirement of friction clutches, Selection criteria. Torque transmitting capacity of single plate, Multi disc clutch, Cone clutch and Centrifugal clutch	**[7]**
Section – II		
Unit 1	**Design of Gear boxes for machine tool applications** Determination of variable speed range- Graphical representation of speeds- Structure diagram Deviation diagram- Ray diagram- Selection of optimum ray diagram- Difference between number of teeth of successive gears in a change gear box- Analysis of twelve speed gear box .	**[7]**
Unit 2	**Design of I. C. Engine Components** Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, Design of cylinder liners, Design of piston and piston-pins, Piston rings, Design of connecting rod, Design of crank-shaft and crank-pin.	**[7]**
Unit 3	**Design of Material Handling System** Design of belt and chain conveyors – Power requirement, Selection of belt and chain, Design of tension take up unit, Idler pulley.	**[6]**

Mapping of POs & COs:															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	–	–	1	–	–	–	–	2	–	–	2	--	--
CO2	3	3	2	2	2	–	–	–	–	–	–	–	3	--	--
CO3	3	3	3	2	2	–	–	–	–	2	–	–	3	2	--
CO4	3	3	2	2	2	–	–	–	–	2	–	–	3	3	--
CO5	3	3	3	2	3	–	2	–	–	2	–	2	3	3	--
CO6	2	2	3	2	3	–	–	–	2	2	2	2	3	3	--

References:	
Text Books	
1	"Design of machine element", V. B. Bhandari, Tata Mc-Graw Hill Publication, 3rd Edition.
2	"Mechanical System Design", S. P. Patil, Jaico Publication House, New Delhi, 2nd Edition. .
3	"Machine Tools Design", N. K. Mehta, Tata Mc- Graw Hill Publication, 5thEdition.
Reference Books	
1	"Process Equipment Design", M. V. Joshi,Macmillan Publication, 3rdEdition.
2	"Mechanical Engineering Design", Shigley and C. R. Miscke, Tata Mc-Graw Hill Publication
3	Material Handling Equipment's by N. Rudenko, Peace Publication.
Video Link	
1	https://www.udemy.com/course/learning-concepts-of-mechanical-system-design
2	*https://onlinecourses.nptel.ac.in/noc20_ch17/preview*
3	*https://archive.nptel.ac.in/courses/112/105/112105124/*

Sr. No.	Description	Signature
1	Name of Faculty Dr. Lingaraju S.V	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME703 - FINITE ELEMENT ANALYSIS

Lectures : **03** hrs. /week
Credits : **02**

Evaluation Scheme:
ISE: 40 Marks
ESE: 60 marks

Course Objectives: The objective of the course is to

1. Enable the students to understand fundamentals of finite element analysis
2. Understand the fundamentals of FEA and the principal's involved in the discretization of domain with various elements, and assembly of global stiffness matrix.
3. Solve various types of engineering problems using various forms of FEA technique.
4. Interpret the results obtained and approach to improve them.

Course Outcomes:

COs	At the end of successful completion of the course the student will be able to	Bloom's Taxonomy
CO1	Elaborate different types of Elements, their properties and domain of application in FEA.	Understand, Knowledge
CO2	Apply Stiffness matrix and Shape function for one dimensional structural problems.	Knowledge, Understand Apply
CO3	Interpret the results of Stiffness matrix and Shape function in one dimensional thermal element.	Knowledge, Understand Apply, Analyze
CO4	Apply FEM equations for two dimensional problems by using Constant Strain Triangle.	Apply, Analyze
CO5	Implement the concepts in FEA to formulate the Axisymmetric problem.	Apply
CO6	To analyze the planar truss for deflections and stresses problems using FEA approach.	Apply, Evaluate

Description:

The course, Finite Element Analysis is offered as the Engineering Science course. The subject deals with simulation of engineering problem using finite element technique and finding out the solution to the problem under consideration. Basically, it determines the behavior of a component under given type of loads and boundary conditions well before its actual manufacturing. This aspect of the subject makes it one of the most essential subject for Mechanical Engineering.

Prerequisites:	1:	Basics of Matrices and Heat Transfer
	2:	Analysis of Mechanical elements.
	3:	Design of Machine Elements

SECTION-I		
Unit 1	**Fundamental concepts of FEA**	
	Introduction to FEA, General FEM procedure, Simplification of problem through Symmetry, Various terminologies associated with FEA (Discretization, nodes and elements) Stiffness matrix and its properties. Application of FEM in various fields. Advantages and Disadvantages.	**07 Hrs.**
Unit 2	**One dimensional structural problems**	
	Introduction and types of One dimensional element, Derivation of Stiffness matrix and Shape function for one dimensional Linear element. Stress analysis of a Stepped bar and Torsion analysis of a shaft using 1 D element.	**07 Hrs.**
Unit 3	**One Dimensional heat transfer problems**	
	Introduction and types of one dimensional thermal element, Derivation of stiffness matrix for one dimensional thermal element, Thermal analysis of Composite Wall by using FEA.	**06 Hrs.**
SECTION-II		
Unit 4	**Two dimensional element**	
	Introduction to two dimensional element, Derivation of Stiffness matrix and Shape function for two dimensional linear elements. Numerical on two Dimensional analysis using two dimensional elements (Constant Strain Triangle)	**07 Hrs.**
Unit 5	**Axisymmetric formulation**	
	Introduction to axisymmetric elements, types and boundary conditions, formulation of axisymmetric elements, finite element modeling using triangular element.	**06 Hrs.**
Unit 6	**Analysis of Planar Truss**	
	Introduction to Planar truss, Local and Global coordinate systems, Derivation of Global stiffness matrix, Numericals on truss deflection and Stress Calculations.	**07 Hrs.**

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	1	1	1	--	1	--	--	--	--	--	--	1	1	--	--
CO2	2	2	2	--	1	--	--	--	--	--	--	1	2	--	--
CO3	2	3	3	--	2	--	--	--	--	--	--	1	2	--	--
CO4	3	3	3	--	2	--	--	--	--	--	--	1	2	--	--
CO5	3	3	3	--	3	1	1	--	--	--	--	2	2	--	--
CO6	3	3	3	--	2	2	2	1	--	--	--	1	2	--	--

References:

Textbooks	
1	"Introduction to Finite Elements in Engineering"; Chandrupatla - Belegundu, Prentice-Hall India.
2	"Textbook of Finite Elements Analysis", P. Sheshu, Prentice-Hall of India Private Limited, New Delhi.
3	Finite Element Analysis – Theory and Practice, M. J. Fagan, Longman Scientific & Technical
4	Finite Element Analysis, Udai Borker, Nandu Printers & Publishers Pvt. Ltd. Mumbai.
5	An Introduction to Finite Element Method; J. N. Reddy; 2/e, McGraw Hill International Editions, ISBN 0-07-112799-2
Reference Books	
1	Practical Finite Element Analysis, N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A.N.Thite, Finite to Infinite Publication
2	Finite Elements Analysis – Theory and Application with ANSYS, S. Mouveni, Prentice Hall Inc.
3	Concepts of Finite Element Methods, Manicka Selvam, SCITECH publication
4	Applied Finite Elements Analysis, Larry J. Segerlind, BSP Books Pvt. Ltd.

Link for Video Lectures:

https://archive.nptel.ac.in/courses/112/105/112105308/#

Sr. No.	Description	Signature
1	Name of Faculty Prof. Vikas N. Mane	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC4ME7041 - INDUSTRIAL INSTRUMENTATION AND CONTROL

Lectures: 03 hrs/week
Credits: 02

Evaluation Scheme:
ESE: 60 Marks
ISE: 40 Marks

Course Objectives:

1. To impart knowledge of architecture of the instrument & measurement system
2. To deliver working principle of mechanical measurement system
3. To study concept of mathematical modeling of the control system
4. To acquaint with control system under different time domain

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Explain the fundamentals of instrumentation, generalized measurement systems, static characteristics of measuring instruments, calibration techniques, and measurement errors.	Understand
CO2	Apply the operating principles and characteristics of displacement, strain, velocity, and acceleration measuring instruments for engineering measurement applications.	Apply
CO3	Apply suitable instruments for measuring pressure, vacuum, flow, and temperature by understanding their construction, working principles, and characteristics.	Apply
CO4	Construct mathematical models of mechanical and electrical control systems using system analogies and block diagram representations.	Create
CO5	Analyze the transient and steady-state responses of first- and second-order control systems for various standard input signals using transfer function concepts.	Analyze
CO6	Assess the stability of control systems using the Routh Stability Criterion and Root Locus technique and interpret the effect of poles and zeros on system stability.	Evaluate

Description:

Industrial Instrumentation and control is very important in industrial and manufacturing work. In any factory, every process must be properly monitored and controlled to ensure safe and efficient operation. Working with heavy machines and dangerous conditions makes measurement difficult, so accurate instruments are needed to obtain correct data. As machines become more complex, effective instrumentation and control systems help maintain quality, improve efficiency, and ensure safety. It is also important to develop mathematical models of systems and analyze their responses to standard input signals. Additionally, understanding system errors, different types of control systems, time-domain specifications, and stability analysis using root locus techniques is essential.

Prerequisites:	1:	Fluid mechanics, Applied physics.
	2:	Electrical technology basic terms.
	3:	Partial Differentiation, Laplace transformation, Differentiation and integration formulae.

Section-I		
Unit 1	**Basics of Instrumentation and Measurement**	
	Significance of mechanical measurements in engineering and industry; classification of measuring instruments; generalized measurement system and its components. Static characteristics of instruments including static calibration, accuracy, precision, reproducibility, linearity, sensitivity, threshold, resolution, hysteresis, drift, span, and range. Errors in measurement and their types such as gross, systematic, and random errors.	**06 Hrs**
Unit 2	**Measurement of Displacement, Strain, Velocity, and Acceleration**	
	Displacement Measurement: Potentiometer: Linear and rotary types, working principle, advantages and limitations. LVDT (Linear Variable Differential Transformer): Construction, working, characteristics, and applications **Strain Measurement:** Concept of strain and Gauge Factor, Strain Gauge Based Load Cells: Construction, working, and applications. **Measurement of Angular Velocity:** Tachometers: Mechanical and electrical types, Stroboscopic Method: Principle, working, and applications **Acceleration Measurement:** Accelerometer: Types, working principles, and characteristics	**07 Hrs**
Unit 3	**Measurement of Pressure, Vacuum, Flow and Temperature**	
	Pressure Measurement: Bourdon Tube: Construction, working, advantages and limitations, Diaphragm and Bellows: Types, working principles, and applications. **Vacuum Measurement:** Thermal Conductivity Vacuum Gauges: Principle, working, and applications. **Flow Measurement:** Bernoulli Flow Meter (Venturimeter): Working and applications, Rotameter: Construction, working. **Temperature Measurement:** Resistance thermometers, Thermistors and thermocouples.	**07 Hrs**
Section-II		
Unit 4	**Mathematical Model of Control System**	
	Introduction to control systems, Classification of control system. Mathematical Model of Control System, Mechanical Translational Systems, Grounded Chair Representation, Electrical Elements, Analogous Systems, Force – Voltage Analog, Force – Current Analog.	**06 Hrs**
Unit 5	**Transient Response**	
	General Form of Transfer Function, Concept of Poles and Zeros, Response of systems to various Inputs (Impulse, Step, Ramp & Sinusoidal). Transient Response Specification and steady state analysis of first and second order system. Time Domain specifications. Step response of second order system.	**07 Hrs**
Unit 6	**Root Locus**	
	Introduction to concepts of stability, Routh criteria for stability Significance of Root Locus, Construction of Root Loci, General Procedure, Effect of Poles and Zeros on the System Stability analysis using Root locus.	**07 Hrs**

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	–	–	1	–	–	–	–	–	1	–	–	–	–
CO2	3	2	2	–	1	–	–	–	–	–	2	–	–	2	–
CO3	3	2	2	–	3	–	-	–	–	–	2	–	–	3	–
CO4	3	3	2	2	2	–	–	–	–	–	3	1	2	–	–
CO5	3	3	2	3	2	–	–	–	–	–	3	1	2	–	–
CO6	3	3	3	3	2	–	–	–	–	–	3	1	2	–	–

References:

Text Books	
1.	Mechanical Measurements & Control by D. S. Kumar, Metropolitan Book Co. (P) Ltd.
2.	Mechanical Measurements and Instrumentation (Including Metrology and Control Systems) by R.K. Rajput, Published by S. K. Kataria & Sons.
3.	Mechanical Measurements Shawney/McGraw Hill Publishers.
Reference Books	
1.	Control System Engineering: R Anandnatarajan, P. Ramesh Babu, SciTech Publication.
2.	Automatic Control Engineering: F. H. Raven,, McGraw-Hill Book Company.
3.	Control Systems: A. Anand Kumar, Prentice Hall Publication.
4.	Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers.
5.	Instrumentation and Mechanical Measurements / A.K. Tayal / Galgotia Publications.

Video Lectures (NPTEL and SWAYAM Portals)

1. https://nptel.ac.in/courses/112107242
2. https://nptel.ac.in/courses/108106098
3. https://nptel.ac.in/courses/108103863

Sr. No.	Description	Signature
1	Name of Faculty Prof. A.R.Shinge	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC4ME7042 - PLANT DESIGN ENGINEERING

Lectures: 03 hrs/week
Credits: 02

Evaluation Scheme:
ESE :60 Marks
ISE :40 Marks

Course Objectives:

1. **To introduce** students to the fundamentals of plant design engineering, including the Oil & Gas industry, EPC organizations, engineering drawings, and the role of engineers in industrial plant projects.
2. **To develop** an understanding of equipment modelling, piping systems, structural components, material selection, and engineering standards used in industrial plant design.
3. **To familiarize** students with Process Flow Diagrams (PFDs), Piping and Instrumentation Diagrams (P&IDs), instrumentation systems, and their applications in process plant engineering.
4. **To prepare** students to interpret engineering drawings, select appropriate materials, and apply plant design concepts using modern engineering practices and 3D plant design software.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Explain the fundamentals of plant design engineering, the Oil & Gas industry, EPC organizations, engineering drawings, piping drawings, and the role of engineers in industrial plant projects.	Understand
CO2	List the equipment modelling concepts, piping systems, structural components, and relevant engineering standards used in plant design.	Remember
CO3	Apply the concepts of material selection, piping standards, equipment modelling, and structural design principles for various plant engineering applications.	Apply
CO4	Analyze Process Flow Diagrams (PFDs), Piping and Instrumentation Diagrams (P&IDs), instrumentation systems, piping layouts, and material specifications for process plant design.	Analyze
CO5	Evaluate engineering design requirements by selecting suitable materials, piping systems, equipment, and structural arrangements based on industrial standards and service conditions.	Evaluate
CO6	Develop integrated plant design solutions by interpreting PFDs, P&IDs, equipment layouts, piping systems, and structural models using modern plant design engineering concepts and software tools.	Create

Description:
This course provides a comprehensive introduction to **Plant Design Engineering**, covering the fundamentals of the Oil & Gas industry, EPC project execution, engineering drawings, and modern 3D plant design software. It emphasizes the principles of equipment, piping, structural systems, material selection, and engineering standards used in the design of industrial process plants. The course also introduces **Process Flow Diagrams (PFDs)**, **Piping and Instrumentation Diagrams (P&IDs)**, and their role in process control and plant documentation. Upon completion, students will be able to interpret engineering drawings, understand plant design workflows, and apply fundamental concepts required for careers in EPC, petrochemical, power, and process industries.

Prerequisites:	1:	Fluid Mechanics
	2:	Applied Thermodynamics
	3:	Fluid and Turbomachinery

Section-I		
Unit 1	**Introduction to Plant Design**	
	Introduction to Oil & Gas Sector including plot plan, functions and need of engineers. Introduction to EPC companies, departments, interfaces and role of engineers. Introduction to Various software available for 3d Plant Design, Welding and NDT.Introduction to Engineering Drawing and Piping Drawing including piping component drawings, joints and isometric.	**07Hrs**
Unit 2	**Introduction to Equipment**	
	Introduction to Equipment Modelling, Types of Process Equipment, Equipment Hierarchy and Work Environment, Equipment Hierarchy in AVEVA E3D. Primitive-Based Equipment Creation, Nozzle Creation and Equipment Modification, Standard Equipment Modelling, Engineering Standards for Equipment Modelling, Applications of Equipment Modelling	**07Hrs**
Unit 3	**Introduction to Piping**	
	Introduction to piping, Pipingcomponents, Piping codes and standards, Piping Layout, Stress Analysis of Piping, PipingSupports, Thermal Insulation of Piping. Fire Protection Piping System, Process and Oil systems Piping	**06Hrs**
Section-II		
Unit 4	**Introduction to Structures in Plant Design**	
	Structural Modelling - Beams and Columns, CantileverBeam, Beam modifying commands, Connections of beams and columns, Panels&Plates, Walls and Floors with their fittings, BaseFloor, Access, stairs and ladders	**07Hrs**

Unit 5	**Introduction to Materials used in Plant Design**	
	Material Standards and Specifications,Importance of materials in plant design, Factors influencing material selection, Service conditions and design requirements,Material Standards and Specifications in plant design, MOC (material for construction).Codes and Standard used in Plant design.	**07Hrs**
Unit 6	**Process Flow Diagram (PFD)&Piping and Instrumentation Diagram (P&ID)**	
	Process Flow Diagram (PFD) and Symbols. Piping and Instrumentation Diagram (P&ID), P&ID Symbols and Identification, Instrumentation and Control Systems, P&ID Development Process, Reading and Interpreting PFD and P&ID, Applications of PFD and P&ID, Industrial Standards and Best Practices.	**06Hrs**

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	–	–	2	–	–	–	–	1	–	–	2		
CO2	3	2	2	–	3	–	–	–	–	–	–	–	2		
CO3	3	3	2	–	2	–	–	–	–	–	–	–	2		
CO4	2	3	2	2	2	–	–	–	–	2	–	–	2		
CO5	2	3	3	2	2	2	2	2	–	–	–	2	2		
CO6	2	3	3	2	3	2	2	2	-	2	2	2	2		

References:

Text Books	
1	**Bausbacher, E. and Hunt, R.**, Process Plant Layout and Piping Design, Pearson Education, 1st Edition. (Primary textbook covering plant layout, equipment, piping, and engineering drawings.)
2.	**Mohinder L. Nayyar (Ed.)**, Piping Handbook, McGraw-Hill Education, 7th Edition. (Comprehensive reference for piping systems, components, materials, and design practices.)
3.	**Peter Smith and Richard W. Zappe**, Valve Selection Handbook: Engineering Fundamentals for Selecting the Right Valve Design for Every Industrial Flow Application, Gulf Professional Publishing, 6th Edition.(Useful for valves, piping components, and process systems.)
4.	**Frank R. Spellman**, *Handbook of Engineering Design*, CRC Press.*(Introduces engineering design principles, materials, and industrial practices.)*

Reference Books	
1	**Sam Mannan (Ed.)**, *Lees' Loss Prevention in the Process Industries*, Butterworth-Heinemann, 4th Edition.
2	**ASME B31.3**, *Process Piping*, American Society of Mechanical Engineers (Latest Edition).
3	**AVEVA E3D Design User Guide**, AVEVA Solutions Ltd. *(Reference manual for equipment, piping, structures, and plant modelling.)*
4	**T. Christopher Dickenson**, *Piping and Pipeline Calculations Manual*, Gulf Professional Publishing.
5	**ISO 10628**, *Flow Diagrams for Process Plants – General Rules*, International Organization for Standardization.

Video Lectures (NPTEL and SWAYAM Portals)

1. **https://www.youtube.com/@nptelhrd**
2. **https://www.youtube.com/@nptelhrd/playlists**
3. **https://www.youtube.com/@nptelhrd**

Sr. No.	Description	Signature
1	Name of Faculty Dr. Linga raju. S.V.	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC4ME7043 - INTRODUCTION TO CFD

Lectures: 03 hrs/week
Credits: 02

Evaluation Scheme:
ESE: 60 Marks
ISE: 40 Marks

Course Objectives:

1. Provide Fundamental fluid dynamic principles and their applications.
2. Introduction to computational modeling and numerical methods – Finite Difference Method; Finite Volume Method & Finite Element Methods.
3. Introduce the students to widely used techniques in the numerical solution for the field of heat transfer and fluid dynamics

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Explain the fundamental concepts of Computational Fluid Dynamics, governing equations, solution methodology, and the role of CFD in engineering analysis.	Understand
CO2	Apply appropriate grid generation techniques, discretization methods, and boundary conditions for solving engineering fluid flow and heat transfer problems.	Apply
CO3	Analyze heat conduction, convection–diffusion, and incompressible fluid flow problems using appropriate numerical methods.	Analyze
CO4	Apply the Finite Volume Method to formulate and solve one-, two-, and three-dimensional heat transfer and fluid flow problems.	Apply

Description:

This course introduces the fundamental concepts of Computational Fluid Dynamics (CFD) and its applications in solving engineering fluid flow and heat transfer problems. It covers the governing partial differential equations, grid generation, boundary conditions, and numerical discretization techniques including the finite difference, finite volume, and finite element methods. The course also introduces numerical approaches for solving conduction, convection–diffusion, and incompressible fluid flow problems, with emphasis on the Finite Volume Method. The knowledge gained through this course provides a foundation for understanding and applying CFD techniques in mechanical and related engineering applications.

Prerequisites:	1:	Fluid Mechanics
	2:	Heat and Mass Transfer
	3:	Applied Numerical Methods

Section-I		
Unit 1	**Introduction:**	
	What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Software, Solution methodology Preprocessing, Solver, Post processing.	**06 Hrs**
Unit 2	**Mathematical description of Physical Phenomenon**	
	Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems.	**07Hrs**
Unit 3	**Grid Generation and Discretization Methods**	
	Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discretization Concept, The Structure of the Discretization Equation. Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods.	**07 Hrs**
Section-II		
Unit 4	**Heat Conduction, Convection and Diffusion**	
	Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, Over relaxation and Under relaxation, Steady One-dimensional and Two Dimensional Convection Diffusion, Unsteady One-dimensional Convection.	**06 Hrs**
Unit 5	**Incompressible Fluid Flow**	
	Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, The Time-Averaged Equations for Turbulent Flow.	**07Hrs**
Unit 6	**Finite Volume Methods**	
	FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady	**07 Hrs**

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	3	-	-	-	--	--	--	--	--	--	--	--	3	--
CO2	3	3	-	-	-	--	--	--	--	--	--	--	--	3	--
CO3	3	3	-	-	-	--	--	--	--	--	--	--	--	3	--
CO4	3	3	3	-	3	--	--	--	--	--	--	--	--	3	--

References:

Text Books	
1	"An Introduction to Computational Fluid Dynamics: The Finite Volume Method – H. K. Versteeg and W. Malalasekera, 2nd Edition, Pearson Education, 2007.
2.	Computational Fluid Dynamics: The Basics with Applications – John D. Anderson Jr., McGraw-Hill Education, 1995.
3.	Numerical Heat Transfer and Fluid Flow – S. V. Patankar, Hemisphere Publishing Corporation, 1980.
Reference Books	
1	Computational Methods for Fluid Dynamics – Joel H. Ferziger and MilovanPerić, 3rd Edition, Springer, 2002.
2	Computational Fluid Mechanics and Heat Transfer – John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, 2nd Edition, Taylor & Francis, 1997.
3	Computational Fluid Dynamics – T. J. Chung, Cambridge University Press, 2002.
4	Computational Fluid Dynamics: Principles and Applications – JiyuanTu, Guan HengYeoh and Chaoqun Liu, 3rd Edition, Butterworth-Heinemann (Elsevier), 2018.
5	Fundamentals of Computational Fluid Dynamics – Patrick J. Roache, Hermosa Publishers.

Video Lectures (NPTEL and SWAYAM Portals)

1: https://www.nptel.ac.in/courses/112106186

2: https://nptel.ac.in/courses/101104450

3: https://onlinecourses.nptel.ac.in/noc25_me103/preview

4 https://onlinecourses.nptel.ac.in/noc22_ch20

Sr. No.	Description	Signature
1	Name of Faculty Asst. Prof. P.V. Kamble	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGELCME705 - RESEARCH METHODOLOGY

Lectures: 02 hrs/week

Tutorial: 01hr/week

Credits: 03

Evaluation Scheme:

ESE: 60 Marks

ISE : 40 Marks

Course Objectives:

1. To acquire basic understanding of research problem formulation.
2. To conduct a literature review to identify gaps, debates, and original works in the chosen field of study.
3. To formulate research questions or hypotheses based on theoretical frame works and literature reviews.
4. To collect data using chosen method sand tools with attention to validity and reliability

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	**Explain** the fundamental concepts, types, process, creativity, and ethical principles of scientific research.	Understand
CO2	**Identify, define, and formulate** research problems and **select** appropriate research designs for different research studies.	Apply
CO3	**Conduct** a systematic literature survey by identifying, evaluating, and synthesizing relevant scholarly sources to identify research gaps.	Apply
CO4	**Select and apply** appropriate primary and secondary data collection methods based on the research objectives and study requirements.	Apply
CO5	**Analyze** different research designs and **evaluate** suitable research methodologies for solving research problems.	Analyze
CO6	**Develop** hypotheses and **perform** hypothesis testing using appropriate statistical decision rules for interpreting research outcomes.	Create

Description:

This course introduces the fundamental concepts, principles, and processes of scientific research and research methodology. It covers research problem formulation, research design, literature survey, and ethical practices in research. The course provides knowledge of primary and secondary data collection methods and appropriate techniques for data collection. Students will learn the concepts of hypothesis formulation, hypothesis testing, and decision-making in research. Upon completion, students will be able to design, conduct, and evaluate research studies using systematic and scientific methods.

Prerequisites:	1:	Statics
	2:	Computer Applications
	3:	Engineering Mathematics

Section-I		
Unit 1	**Introduction to Research**	
	The concept of research, characteristics of good research, Application of Research, Meaning and sources of Research problem, characteristics of good Research problem, Research process, outcomes, application of Research, Importance of Review of Literature, Organizing the Review of Literature.	**06 Hrs**
Unit 2	**Types of Research**	
	Types of research, pure (basic, fundamental) and applied research, qualitative and quantitative. **Research Design** : Meaning, need, types of research design – Exploratory, Descriptive, Casual research Design, Components of research design, and Features of good Research design. Experiments, surveys and case study Research design	**06 Hrs**
Unit 3	**Methods of Data Collections:**	
	Methods of Data Collections: Concept of Data collection, Types of data, Methods of Primary Data Collection, Methods of Secondary Data Collection, Selecting an Appropriate Method of Data Collection.	**08 Hrs**
Section-II		
Unit 4	**Literature survey:**	
	Literature survey: Definition of literature and literature survey, need of literature survey, sources of literature, elements and objectives of literature survey, styles of literature survey, and strategies of literature survey.	**08 Hrs**
Unit 5	**Research Report**	
	Research report and its structure, journal articles – Components of journal article. Explanation of various components. Structure of an abstract and keywords. Thesis and dissertations . components of thesis and dissertations. Referencing styles and bibliography.	**06 Hrs**
Unit 6	**Ethics in Research**	
	Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good Researcher.	**06 Hrs**

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	–	–	–	–	–	3	–	–	–	2	--	3	--
CO2	3	3	2	2	–	–	–	2	–	–	–	2	--	3	--
CO3	2	3	–	3	2	–	–	2	–	2	–	3	--	2	--
CO4	2	3	2	3	3	–	–	–	–	2	–	2	--	3	--
CO5	3	3	2	3	2	–	–	–	–	–	–	3	--	3	--
CO6	2	3	3	3	2	–	–	2	–	2	–	3	--	3	--

References:

Reference Books	
1	**Creswell, John W., & Creswell, J. David.** *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (6th Edition). SAGE Publications.
2.	***Cooper, Donald R., & Schindler, Pamela S.*** Business Research Methods (14th Edition). McGraw-Hill Education.
3.	***Sekaran, Uma, & Bougie, Roger.*** Research Methods for Business: A Skill Building Approach (8th Edition). Wiley.
4.	***Kerlinger, Fred N., & Lee, Howard B.*** Foundations of Behavioral Research (4th Edition). Cengage Learning.
5.	***rochim, William M. K., Donnelly, James P., & Arora, Kanika.*** Research Methods: The Essential Knowledge Base (2nd Edition). Cengage Learning.

Text Books	
1	Business Research Methods – Donald R. Cooper & Pamela S. Schindler, 9th Edition, Tata McGraw-Hill.
2.	Research Methodology: Methods and Techniques – C. R. Kothari.
3.	Research Methods for Business – Uma Sekaran, 4th Edition, Wiley.
4.	Research Methodology: A Step-by-Step Guide for Beginners – Ranjit Kumar, 2nd Edition, Pearson Education.
5.	Marketing Research: An Applied Orientation – Naresh K. Malhotra & Satyabhushan Dash, 5th Edition, Pearson Prentice Hall.
6.	Research Methodology – P. Michael V.
7.	Foundations of Behavioral Research – Fred N. Kerlinger.

Video Lectures (NPTEL and SWAYAM Portals)

Research Methodology – IIT Madras (NPTEL/SWAYAM)
Research Methodology – IISER Kolkata (NPTEL/SWAYAM)
Research Methodology – IIT Madras (NPTEL/SWAYAM)
Research Methodology in Humanities and Social Sciences – IIT Roorkee (NPTEL/SWAYAM) .
Methodology of Educational Research (SWAYAM) –
Research Methodology in Humanities and Social Sciences – IIT Roorkee (NPTEL/SWAYAM)

Sr. No.	Description	Signature
1	Name of Faculty Dr. A.S. Todkar	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGMDM5ME706L - ADDITIVE MANUFACTURING (3D PRINTING)

Lectures: 02 hrs/week
Credits: 02

Evaluation Scheme:
ISA :50 Marks

Course Objectives:

1. To introduce the fundamentals, evolution, classifications, advantages, and major additive manufacturing processes such as SLA, LOM, FDM, SLS, SLM, and Binder Jetting.
2. To understand various materials used in additive manufacturing
3. To develop skills in 3D modeling using CAD software and create printable models considering design guidelines such as tolerances, supports, and file formats.
4. To explore industrial applications of additive manufacturing in aerospace, healthcare, automotive, electronics, defence, construction, food processing, and machine tools.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Explain the principles, classifications, processes, advantages, and limitations Of additive manufacturing technologies.	**Understand**
CO2	Select suitable materials, process parameters, and additive manufacturing techniques for different engineering applications.	Understand Apply
CO3	Design 3D models using CAD software and prepare printable files by applying design guidelines for additive manufacturing.	Understand Apply
CO4	Configure slicing software, operate 3D printers, and troubleshoot common printing problems using appropriate print settings and materials.	Understand Apply
CO5	Apply post-processing techniques, Surface Improvement, Accuracy, Process Planning and Control techniques	Analyze
CO6	Apply in Aerospace, Healthcare, Automotive, Defence, Construction, Food Processing, Machine Tools	Analyze

Description:

This course introduces the fundamentals of Additive Manufacturing (AM) and 3D Printing technologies. It covers AM processes, materials, 3D modeling, slicing software, printer setup, and post-processing techniques. Students learn to design printable models, optimize print parameters, troubleshoot printing issues, and select appropriate manufacturing processes. The course also explores industrial applications of additive manufacturing in aerospace, healthcare, automotive, defence, construction, and other engineering sectors.

Prerequisites:	1:	3D CAD Modeling
	2:	Material and Applications

Section-I

Unit 1	Additive Manufacturing Introduction	
	Introduction, Process, Classifications, Advantages, Additive v/s Conventional Manufacturing processes, Additive Manufacturing Technique - Stereo-Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Additive Manufacturing	**05Hrs**
Unit 2	Materials	
	Polymers, Metals, Non-Metals, Ceramics Process, Process parameter, Process Selection for various applications. Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials.	**04Hrs**
Unit 3	3 D Printing-3D Modeling and Design	
	History and evolution of 3D printing, Introduction to 3D modeling tools (Tinker CAD, Fusion 360, etc.), Designing printable models: tolerances, overhangs, supports, Exporting models (.STL, .OBJ)	**04Hrs**
	Section-II	
Unit 4	Ultimate Cura Software and Printer Setup	
	Introduction to Ultimate Cura software Print settings: layer height, infill, supports, temperature, speed, Material selection: PLA, ABS, PETG, resin, Printer calibration, Performing test prints, Identifying and fixing print failures (warping, stringing, layer shift)	**05Hrs**
Unit 5	Post Processing of Parts	
	Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques .Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Process Planning and Control	**04Hrs**
Unit 6	Application Domains	
	Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools	**04Hrs**

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	--	1	--	2	--	--	---	--	--	--	--	--	--	2
CO2	2	--	2	--	2	--	--	--	--	--	--	--	--	--	2
CO3	3	--	2	--	3	--	--	--	--	--	--	--	--	--	2
CO4	2	--	1	--	3	--	--	--	--	2	--	--	--	--	2
CO5	3	--	1	--	2	--	--	---	--	--	--	--	--	--	3
CO6	2	--	2	--	2	--	--	--	--	--	--	--	--	--	3

References:

Text Books	
1	*Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing* – Ian Gibson, David Rosen, Brent Stucker
2	*3D Printing: A Practical Guide for Librarians* – Sara Russell Gonzalez, Denise Beaubien Bennett
3	"Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Lan Gibson, David W. Rosen and Brent Stucker
4	"3D Printing and Design", Khanna Publishing House, Delhi. Khanna Editorial
5	Laser Additive Manufacturing of High-Performance Materials, Dong dong Gu
Reference Books	
1	*3D Printing and Additive Manufacturing: Principles and Applications* – Chee Kai Chua, Kah Fai Leong
2	*Mastering 3D Printing* – Joan Horvath
3	*Fusion 360 for Makers* – Lydia Sloan Cline

Video Lectures (NPTEL and SWAYAM Portals)

https://nptel.ac.in/courses/112103306
https://nptel.ac.in/courses/113108632

Sr. No.	Description	Signature
1	Name of Faculty - Prof. S. S. Mahadik	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME701LP - REFRIGERATION AND AIR CONDITIONING LAB

Practical's: 2 hrs per week
Credits: 01

Evaluation Scheme:
ISA: 25 Marks
POE: 25 Marks

Course Objectives: The objective of the course is to

1. Learn about various conventional and non-conventional refrigeration systems
2. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems
3. Apply basic concepts and analyze the performance of refrigeration and air conditioning system

Course Outcomes:

Cos	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Memorize classification,construction,working of different types of refrigeration system	Understand
CO2	Explain various equipments-operating principles, operating and safety controls employed in refrigeration air conditioning systems	Understand
CO3	Calculate cooling capacity and coefficient of performance by conducting test on vapor compression refrigeration system and Heat Pump	Apply
CO4	Calculate cooling capacity and coefficient of performance by conducting test on air conditioning test rig system	Apply

Description:

The Refrigeration and Air Conditioning (RAC) Practical course provides hands-on experience in operating, testing, and analyzing refrigeration and air conditioning systems. Students perform experiments to evaluate system performance, measure key parameters, and understand refrigeration components. The course develops practical skills in troubleshooting, safe operation, and performance analysis. It strengthens the understanding of HVAC&R concepts through laboratory experiments. Overall, it prepares students for industrial applications in refrigeration and air conditioning.

Prerequisites:	1:	Applied Thermodynamics
	2:	Heat and Mass Transfer
	3:	Fluid properties and Fluid dynamics,

Practicals :

Number	Practical/Experiment/Tutorial Topic	Hrs.	Cognitive levels of attainment as per Bloom's Taxonomy
1	Different refrigeration systems	2	Understand
2	Study and Demonstration of Domestic refrigerator and Water cooler	2	Understand
3	Trial on heat Pump	2	Apply
4	Trial on Refrigeration test rig	2	Apply
5	Trial on Air conditioning Test rig	2	Apply
6	Study different Compressors and Expansion devices used in vapour compression refrigeration system	2	Understand
7	Study different types of condensers and evaporators used in vapor compression refrigeration system	2	Understand
8	Industrial visit	2	Understand

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO11	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	--	--	--	--	--	--	--	--	--	--	--	2	--
CO2	3	2	--	--	--	--	--	--	--	--	--	--	--	2	--
CO3	3	3	2	2	--	--	--	--	--	--	--	--	--	2	--
CO4	3	3	2	2	--	--	--	--	--	--	--	--	--	2	--

References:

Text Books	
1	"Refrigeration and Air conditioning", Khurmi R. S., Gupta J. K, S. Chand Publication (Fifth edition)
2.	" Refrigeration and Air conditioning ", Arora C. P. , Khanna Publishers, New Delhi, 27th Edition.
3.	"Refrigeration and Air conditioning", Manohar Prasad., Willey Eastern Ltd, 1983
4.	"Refrigeration and Air conditioning",Ballaney P.L, Khanna Publishers, New Delhi, 1992
5.	"Basic Refrigeration and Air Conditioning",Ananthanarayanan, McGraw Hill Education 2013
6.	"Refrigeration and Air conditioning",R.K Rajput, S K KATARIA & SONS-NEW DELHI 2013

Reference Books	
1	"Principles of refrigeration,", Dossat Ray J, Willey Eastern Ltd, 2000
2	"Refrigeration and Air conditioning",Stockers W.F and Jones J.W, McGraw Hill International editions 1982
3	"Air Conditioning Principles and Systems",Edward G. Pita, PHI 2002
4	ASHRAE & ISHRAE handbook

Web Links/ Video Lectures

Lectures 1 to 40. https://archive.nptel.ac.in/courses/112/107/112107208/

Sr. No.	Description	Signature
1	Name of Faculty A.S.Charan	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME702LP - MECHANICAL SYSTEM DESIGN LAB

Practical's : 2 hrs/ week
Credits : 1

Examination Scheme
ISA : 25 Marks
POE :25Marks

Course Objectives: The objective of the course is to

The course aims to:

1. Study the concept of aesthetics, ergonomics and creativity considerations in product design.
2. Study design of various mechanical systems such as pressure vessel, brakes, clutches, machine tool gear box, I.C. Engine components and material handling systems.

CourseOutcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Explain the principles and various aspects of aesthetics and ergonomics in the design of mechanical systems.	Remember
CO2	Apply engineering design principles to pressure vessels, machine tool gearboxes, and material handling systems for specified operating conditions.	Apply
CO3	Determine the design parameters for clutches, brakes, and I.C. engine components to satisfy functional and performance requirements.	Evaluate
CO4	Prepare detailed and assembly drawings of mechanical systems based on standard design practices and engineering specifications.	Create

Description:

This lab course is introduced to have insight of complete design procedure of mechanical systems such as gear box, pressure vessel, clutch, brakes and I. C. Engine components. It is very important at this stage to understand all design activities for designing and developing successful mechanical system. Students will prepare the drawing sheets for different mechanical system components.

Prerequisites:	1:	Analysis of Mechanical Elements
	2:	Design of Machine Elements

Practical's:

Sr. No.	Practical Topic	Hrs.	Bloom's Taxonomy
1	Assignment based on :Aesthetics and Ergonomics(A case Study)	2	Remember
2	Assignment based on Design of I.C.Engine Components	2	Remember
3	Assignment based on Clutches and Brakes	2	Apply
4	Assignment based on Design of Material Handling System	2	Evaluate
5	A detail design report and A2 size sheet containing working drawing of detail and assembly of i) Design of Machine Tool Gear Box. (Three Stage, Twelve speed gear Box)**Note: Compulsory to all.**	2	Create
6	A detail design report and A2 size sheet containing working drawing of detail and assembly of i. Pressure vessel design / Brake design or Clutch design **(Note: Any one sheet from the above)**	2	Create

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	–	–	1	–	–	–	–	2	–	–	2	--	--
CO2	3	3	3	2	2	–	–	–	–	2	–	–	2	--	--
CO3	3	3	2	2	2	–	–	–	–	–	–	–	2	--	--
CO4	2	2	3	2	3	–	–	–	--	2	-	2	2	--	--

References:

Text Books	
1	"Design of Machine Element" V. B. Bhandari, TataMc-GrawHillPublication,3rdEdition.
2	"MechanicalEngineeringDesign",ShigleyandC.R.Miscke,TataMc-GrawHillPublication
3	"Machine Tools Design",N.K. Mehta, Tata Mc- Graw Hill Publication, 5thEdition.
4	. "Design of Machine Tools", S.k. Basu and D.K. Pal Oxford and IBH Publication, 6thEdition

Reference Books	
1	I.S.:2825 Code for Unfired Pressure Vessels
2	"Handbook of Gear Design", Jitin Maitra, Tata Mc-Graw Hill Publication.
3	"Mechanical Design Synthesis with Optimization Applications" ,Johnson R.C.,Von-Nostrand Reynold Publications.
4	"Engineering Design", Dieter G.E., Tata Mc- Graw Hill Publication, 4thEdition.
5	"Theory and Design of Pressure Vessels", by John F Harvey.

Sr. No.	Description	Signature
1	Name of Faculty Dr. Lingaraju. S. V.	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCC3ME703L - FINITE ELEMENT ANALYSIS LAB

Practical: 02 hrs/week
Credits: 01

Evaluation Scheme:
ISA: 25 Marks

Course Objectives: The objective of the course is to

1. To use ANSYS to perform FEA of engineering component.
2. To formulate the FE model of the given component in ANSYS.
3. Write a program in APDL to prepare FE model as given in the problem.
4. To obtain and improvise the results till safe values.

Course Outcomes:

COs	At the end of successful completion of the course the student will be able to	Bloom's Taxonomy
CO1	Understand the concept of Discretization and Finite Element model.	Remember, Understand
CO2	Formulate and solve the problem by theoretical and ANSYS approach.	Remember, Understand, Application
CO3	Formulate and solve the problem by APDL.	Remember, Understand, Application
CO4	Evaluate the required engineering parameters and improvise the results.	Remember, Understand, Application, Synthesis

Description:

The course, Finite Element Analysis Lab is offered as the Engineering Science course. The Lab deals with simulation of engineering problem using finite element technique and finding out the solution to the problem under consideration using CAE Software like ANSYS. Basically, it determines and displays the behavior of a component under given type of loads and boundary conditions in terms of visually observable graphical results. This aspect of the subject makes it one of the most essential subjects for Mechanical Engineering. Performing CAE Analysis of various types of engineering components using ANSYS is the of prime focus in this Lab. Through 5 Practicals students will understand the fundamentals of FEA & ANSYS and will carry out FEA of the components like Beams of various types, Bars, Composite walls, Thin plates, Shafts under torsion, Trusses, Fins. The Lab also exposes the students to solve these problems using APDL, a programming language used with ANSYS.

Prerequisites:	1:	Basics of Software operation
	2:	Heat transfer, Analysis of Mechanical elements.
	3:	Design of Machine Elements

Practical:

Number	Practical / Experiment	Hrs.	Cognitive levels of attainment according to Bloom's Taxonomy.
1	**Assignment on Discretization** Types of elements, choice of element and type of meshing	2	Remember, Understand
2	**Finite Element Analysis of Stepped bar (Two or Three Steps only) using:** a) Finite Element Approach(Theory) b) Finite Element Software (ANSYS) Compare the results obtained by above methods.	2	Apply, Evaluate Analyze
3	**Finite element analysis of STEPPED BAR in ANSYS using APDL.**	2	Understand, Apply, Create
4	**Finite element analysis of Composite wall (Minimum three slabs)** a) Finite Element Approach(Theory) b) Finite Element Software ANSYS Compare the results obtained by above methods.	2	Apply, Evaluate Analyze
5	**Use of standard CAE software like ANSYS to perform FEA of Planar Truss.**	2	Apply, Evaluate
6	**Use of standard CAE software like ANSYS to perform FEA of Simply Supported / Cantilever / Fixed Beam.**	2	Apply, Evaluate

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2	3	3	--	2	--	--	--	--	--	--	1	2	--	--
CO2	3	3	3	--	2	--	--	--	--	--	--	1	2	--	--
CO3	3	3	3	--	3	1	1	--	--	--	--	2	2	--	--
CO4	3	3	3	--	2	2	2	1	--	--	--	1	2	--	--

References:

Textbooks	
1	"Introduction to Finite Elements in Engineering"; Chandrupatla - Belegundu, Prentice-Hall India.
2	"Textbook of Finite Elements Analysis", P. Sheshu, Prentice-Hall of India Private Limited, New Delhi.
3	Finite Element Analysis – Theory and Practice, M. J. Fagan, Longman Scientific & Technical
4	Finite Element Analysis, Udai Borker, Nandu Printers & Publishers Pvt. Ltd. Mumbai.
5	An Introduction to Finite Element Method; J. N. Reddy; 2/e, McGraw Hill International Editions, ISBN 0-07-112799-2
Reference Books	
1	Practical Finite Element Analysis, N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A.N.Thite, Finite to Infinite Publication
2	Finite Elements Analysis – Theory and Application with ANSYS, S. Mouveni, Prentice Hall Inc.
3	Concepts of Finite Element Methods, Manicka Selvam, SCITECH publication
4	Applied Finite Elements Analysis, Larry J. Segerlind, BSP Books Pvt. Ltd.

Sr. No.	Description	Signature
1	Name of Faculty Prof. Vikas N. Nare	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC4ME704L - INDUSTRIAL INSTRUMENTATION AND CONTROL LAB

Lectures: 02 hrs/week
Credits: 01

Evaluation Scheme:
ISA: 25 Marks

Course Objectives:

1. To impart knowledge of architecture of the measurement system
2. To deliver working principle of mechanical measurement system
3. To study concept of mathematical modeling of the control system
4. To acquaint with control system under different time domain

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Classify various types of measuring systems and explain their static characteristics and different types of measurement errors.	Knowledge, Understand
CO2	Classify and select suitable measuring instruments for linear displacement, angular displacement, strain, angular velocity, and acceleration measurement.	Understand Apply
CO3	Classify and select suitable measuring instruments for pressure, flow, and temperature measurement.	Understand Apply
CO4	Develop mathematical models of different control systems and analyze their response for standard input signals.	Analyze Create
CO5	Analyze the responses of first- and second-order control systems and determine their time-domain specifications.	Apply Analyze
CO6	Evaluate the stability of control systems using the Root Locus technique and interpret the stability of the system.	Evaluate

Description:

Instrumentation and control is at the core of all industrial and manufacturing activities. Within a production facility, every process must be carefully monitored and controlled to proceed in a predetermined fashion like optimized and safe. When working with heavy and dangerous equipment, getting accurate measurements can be a very difficult process. This is why instrumentation is so important. Because of the number of processes involved in modern machines, accurate instrumentation and control is needed to ensure that everything is operating properly.

Prerequisites:	1:	Fluid mechanics, Applied physics.
	2:	Electrical technology basic terms.
	3:	Partial Differentiation, Laplace transformation, Differentiation and integration formulae.

Practicals:

Sr. No.	Practical Topic	Hrs.	Bloom's Taxonomy
1	Study of measuring instruments and understanding of static characteristics and errors	2	Remember Understand
2	Study of displacement, strain, angular velocity, and acceleration measurement	2	Understand Apply
3	Study of pressure, flow and temperature measurement	2	Understand Apply
4	Study of different control systems and prepare mathematical modeling of control systems	2	Analyze Create
5	Study of response of systems for various input signals and determine time-domain specifications of a second-order system	2	Analyze Evaluate
6	Study and analysis of the stability of control systems using the Root Locus method	2	Analyze Evaluate

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	-	1	2	–	–
CO2	3	2	1	-	3	-	-	-	-	-	-	1	2	–	–
CO3	3	2	1	-	3	-	-	-	-	-	-	1	2	–	–
CO4	2	3	3	2	2	-	-	-	-	-	1	2	3	–	–
CO5	2	3	2	3	2	-	-	-	-	-	1	2	3	–	–
CO6	2	3	1	3	2	-	-	-	-	-	1	2	3	–	–

References:

Text Books	
1.	Mechanical Measurements & Control by D. S. Kumar, Metropolitan Book Co. (P) Ltd.
2.	Mechanical Measurements and Instrumentation (Including Metrology and Control Systems) by R.K. Rajput, Published by S. K. Kataria & Sons.
3.	Mechanical Measurements Shawney/McGraw Hill Publishers.

Reference Books	
1.	Control System Engineering: R Anandnatarajan, P. Ramesh Babu, SciTech Publication.
2.	Automatic Control Engineering: F. H. Raven,, McGraw-Hill Book Company.
3.	Control Systems: A. Anand Kumar, Prentice Hall Publication.
4.	Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers.
5.	Instrumentation and Mechanical Measurements / A.K. Tayal / Galgotia Publications.

Video Lectures (NPTEL and SWAYAM Portals)

1. https://nptel.ac.in/courses/112107242
2. https://nptel.ac.in/courses/108106098
3. https://nptel.ac.in/courses/108103863

Sr. No.	Description	Signature
1	Name of Faculty Prof. A.R. Shinge	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC4ME7042L - PLANT DESIGN ENGINEERING LAB

Practical's: 02hrs./week
Credits: 01

Evaluation Scheme:
ISA :25 Marks

Course Objectives:

1. **To provide** hands-on training in AVEVA E3D software for creating and modifying 3D models of process equipment, piping systems, and structural components used in industrial plants.
2. **To develop** practical skills in modelling plant layouts, routing pipelines, creating structural assemblies, and generating engineering drawings using industry-standard design practices.
3. **To familiarize** students with engineering standards, modelling workflows, and multidisciplinary coordination followed in Engineering, Procurement, and Construction (EPC) projects.
4. **To prepare** students to apply modern 3D plant design tools for solving real-world engineering problems and developing industry-ready skills for careers in the Oil & Gas, Petrochemical, Power, and Process Industries.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	**Apply** the fundamentals of AVEVA E3D software to create and modify equipment models, including site, zone, equipment, and nozzle modelling.	Apply
CO2	**Develop** piping models by creating pipes, piping components, routing pipelines, and modifying piping elements using AVEVA E3D.	Create
CO3	**Construct** structural models, including beams, columns, panels, floors, walls, stairs, and ladders, using AVEVA E3D software.	Create
CO4	**Generate** engineering drawings and drafting outputs from 3D plant models using AVEVA E3D to support industrial documentation and fabrication.	Create

Description:

This laboratory course provides hands-on training in **AVEVA E3D** for developing intelligent 3D plant models used in engineering, procurement, and construction (EPC) projects. Students gain practical experience in modelling equipment, piping systems, and structural components, along with generating engineering drawings and documentation. The course emphasizes industry-standard modelling practices, design accuracy, and multidisciplinary coordination in plant design. Upon completion, students will be equipped with the practical skills required for careers in **Oil & Gas, Petrochemical, Power, Chemical, and Process Industries.**

Prerequisites:	1:	Fluid Mechanics
	2:	Applied Thermodynamics
	3:	Fluid and Turbomachinery

Sr. No.	Practical Topic	Hrs.	Bloom's Taxonomy
1	**Modelling of Equipment using E3D Software** • Introduction to E3D • Site and zone creation • Equipment creation • Modifying equipment • Nozzle creation • Nozzle modification • Standard Equipment • Equipment Arrangement	4	Create
2	**Modelling of Piping using E3D Software** • Pipe creation • Pipe component creation • Component modification • Pipe Routing	4	Create
3	**Modelling of Structure using E3D Software** • Structural Modelling - Beams and • Columns • Cantilever Beam • Beam modifying commands • Connections of beams and columns • Panels & Plates • Walls and Floors with their fittings • Base Floor • Access, stairs and ladders	4	Create
4	**Drafting using E3D Software**	2	Create

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	2	–	3	–	–	–	–	–	–	1	2		
CO2	3	3	3	1	3	–	–	–	–	–	–	2	2		
CO3	3	3	3	1	3	–	–	–	–	–	–	2	2		
CO4	2	2	3	2	3	–	–	–	–	2	2	2	2		

References:

Text Books	
1	**Bausbacher, E. and Hunt, R.**, Process Plant Layout and Piping Design, Pearson Education, 1st Edition. (Primary textbook covering plant layout, equipment, piping, and engineering drawings.)
2.	**Mohinder L. Nayyar (Ed.)**, Piping Handbook, McGraw-Hill Education, 7th Edition. (Comprehensive reference for piping systems, components, materials, and design practices.)
3.	**Peter Smith and Richard W. Zappe**, Valve Selection Handbook: Engineering Fundamentals for Selecting the Right Valve Design for Every Industrial Flow Application, Gulf Professional Publishing, 6th Edition.(Useful for valves, piping components, and process systems.)
4.	**Frank R. Spellman**, *Handbook of Engineering Design*, CRC Press.*(Introduces engineering design principles, materials, and industrial practices.)*
Reference Books	
1	**Sam Mannan (Ed.)**, *Lees' Loss Prevention in the Process Industries*, Butterworth-Heinemann, 4th Edition.
2	**ASME B31.3**, *Process Piping*, American Society of Mechanical Engineers (Latest Edition).
3	**AVEVA E3D Design User Guide**, AVEVA Solutions Ltd. *(Reference manual for equipment, piping, structures, and plant modelling.)*
4	**T. Christopher Dickenson**, *Piping and Pipeline Calculations Manual*, Gulf Professional Publishing.
5	**ISO 10628**, *Flow Diagrams for Process Plants – General Rules*, International Organization for Standardization.

Video Lectures (NPTEL and SWAYAM Portals)

Sr. No.	Description	Signature
1	Name of Faculty Dr. S. V. Ungrayy.	f. Hishi
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC4ME7043L - INTRODUCTION TO CFD LAB

Practical's:2hrs/week
Credits:1

ExaminationScheme
ISA:25 Marks
POE:NA

CourseObjectives: Theobjectiveofthecourseisto
1. To familiarize students with numerical solution techniques used in CFD.
2. To develop computational programs for engineering problems.
3. To understand FDM and FVM.
4. To interpret computational results.

CourseOutcomes:

Cos	**Attheendofsuccessfulcompletionofthecourse,thestudentwillbeable to**	**BloomsTaxonomy**
CO1	Develop computational solutions using numerical methods.	Apply
CO2	Perform grid generation and discretization.	Apply
CO3	Analyze heat transfer and fluid flow numerical solutions.	Analyze
CO4	Interpret and validate computational results.	Evaluate

Description:

This practical session provides exposure to the fundamental concepts of Computational Fluid Dynamics (CFD) through the numerical solution of engineering heat transfer and fluid flow problems. It focuses on the implementation of governing equations, grid generation, discretization techniques, and appropriate boundary conditions. Students develop and analyze numerical solutions for conduction, convection–diffusion, and incompressible flow problems using computational approaches. The laboratory complements the theory course by enhancing analytical thinking, numerical problem-solving skills, and the understanding of CFD techniques for engineering applications.

Prerequisites:	1:	Fluid Mechanics
	2:	Heat and Mass Transfer
	3:	Applied Numerical Methods
	4:	Engineering Mathematics

Practicals:

Sr.No.	Assignment	Hrs.	Bloom'sTaxonomy
1	Study the Computational Fluid Dynamics (CFD) solution methodology and numerical approaches used for solving engineering fluid flow and heat transfer problems.	2	Understand
2	Generate structured computational grids (H-type, O-type, and C-type) for simple two-dimensional geometries and study the effect of grid arrangement on numerical analysis.	2	Apply
3	Develop a numerical solution for one-dimensional steady-state heat conduction using the Finite Difference Method (FDM) and analyze the temperature distribution.	2	Apply
4	Develop a numerical solution for one-dimensional transient heat conduction using the Finite Difference Method (FDM) and study the transient temperature variation.	2	Apply
5	Develop a numerical solution for the one-dimensional convection–diffusion equation using the Finite Difference Method (FDM) and analyze the effect of convection and diffusion.	2	Analyze
6	Develop a numerical solution for the one-dimensional steady diffusion equation using the Finite Volume Method (FVM) and compare the results with the analytical solution.	2	Analyze
7	Develop a numerical solution for the one-dimensional convection–diffusion equation using the Finite Volume Method (FVM) and analyze the influence of discretization on the numerical solution.	2	Analyze
8	Carry out anassignment to solve a simple engineering heat transfer or fluid flow problem using an appropriate numerical method, and present the computational results with suitable interpretation and validation.	2	Evaluate

MappingofPOs&COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Ifapplicable		
													PSO1	PSO2	PSO3
CO1	3	2	--	--	3	--	--	---	--	--	--	--	--	--	--
CO2	3	3	--	2	3	--	--	---	--	--	--	--	--	--	--
CO3	3	3	--	3	2	--	--	---	--	--	--	--	--	3	--
CO4	3	3	2	3	3	--	--	---	--	--	--	2	--	--	--

References:

TextBooks	
1	An Introduction to Computational Fluid Dynamics: The Finite Volume Method – H. K. Versteeg and W. Malalasekera, 2nd Edition, Pearson Education, 2007.
2.	Numerical Heat Transfer and Fluid Flow – S. V. Patankar, Hemisphere Publishing Corporation, 1980.
3.	Computational Fluid Dynamics: The Basics with Applications – John D. Anderson Jr., McGraw-Hill Education, 1995.
ReferenceBooks	
1	Computational Methods for Fluid Dynamics – Joel H. Ferziger and MilovanPerić, 3rd Edition, Springer, 2002.
2	Computational Fluid Mechanics and Heat Transfer – John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, 2nd Edition, Taylor & Francis, 1997.
3	Computational Fluid Dynamics – T. J. Chung, Cambridge University Press, 2002.
4	Computational Fluid Dynamics: Principles and Applications – JiyuanTu, Guan HengYeoh and Chaoqun Liu, 3rd Edition, Butterworth-Heinemann (Elsevier), 2018.
5	Fundamentals of Computational Fluid Dynamics – Patrick J. Roache, Hermosa Publishers.

Video Lectures (NPTEL and SWAYAM Portals)

1:	https://www.nptel.ac.in/courses/112106186
2:	https://nptel.ac.in/courses/101104450
3:	https://www.nptel.ac.in/courses/112106317

Sr. No.	Description	Signature
1	Name of Faculty Asst. Prof. P.V. Kamble	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGELCME707LP - PROJECT PHASE – I

Practicals: 04 hrs./week
Credits: 04

Evaluation Scheme:
POE :50 Marks
ISA :50 Marks

Course Objectives:

1. Embed the skill in group of students to work independently on a topic/ problem/ experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.
2. Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	think creatively on real life engineering problem.	Knowledge, Understand,
CO2	apply engineering knowledge to deduce proper solution to real life engineering problems.	Knowledge, Understand, Application
CO3	work in a team and acquire collaborative skills to achieve common goals.	Knowledge, Understand, Application
CO4	learn independently, reflect on their learning and take appropriate actions to improve it.	Knowledge, Understand, Application Synthesis
CO5	communicate effectively and present ideas clearly with specific audience in written and oral forms.	Knowledge, Understand, Application Synthesis
CO6	Plan for activities in order to complete the task in predefined time.	Knowledge, Understand, Application Create

Description:
The project work phase I can be a design project / experimental project and or computer simulation project or any of the topics related with Mechanical engineering stream. The project phase I work is allotted in groups on different topics. The students' groups are required to undertake the project Phase-I during the seventh semester and the same is continued in the eighth semester (Phase-II). Project Phase-I consists of reviews of the work carried earlier and the submission of preliminary report. Report should highlight scope, objectives, methodology, approach and tools to be used like software and others, outline of project and expected results and outcome along with timeframe. The project phase I work is to be extended for project phase II at B. Tech. (Mech.) Sem. VIII with same group working under guidance of same Faculty member assigned for project phase I.

Prerequisites:	1	Fundamentals of Mechanical Engineering
	2	Report writing and Presentations Skills
	3	Basic Communication skills

Project Work Phase I Load:

A batch of maximum TWO groups of four to five students per group, shall work under one Faculty member of department.

The group should comprise MINIMUM 3 Students.

Project work Phase I Term Work:

The term work under project submitted by students shall include

1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly.

The contents of work diary shall reflect the efforts taken by project group for

a. Searching suitable project work

b. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring up the project.

c. Day to day activities carried out related to project work for entire semester.

d. Synopsis. The group should submit the synopsis in following form.

i. Title of Project

ii. Names of Students

iii. Name of Guide

iv. Relevance

v. Present Theory and Practices

vi. Proposed work

vii. Expenditure

viii. References

2.Synopsis: The synopsis shall be signed by each student in the group, approved by the guide and endorsed by the Head of the Department

3. Presentation: The group has to make a presentation in front of the Faculty members of department at the end of semester. Project Phase I Report Format: Project Phase I report should be of 20 to 25 pages (typed on A4 size sheets).

4. Project Work Phase I Report Format:

The following format should be strictly followed.

1. Page Size: Trimmed A4
2. Top Margin: 1.00 Inch
3. Bottom Margin: 1.32 Inches
4. Left Margin: 1.5 Inches
5. Right Margin: 1.0 Inch
6. Para Text: Times New Roman 12 Pt. font
7. Line Spacing: 1.5 lines
8. Page Numbers: Right aligned at footer. Font 12 Pt. Times New Roman
9. Headings: New Times Roman, 14 Pt., Bold face
10. References: References should have the following format

For Books: "Title of Book", Authors, Publisher, Edition

For Papers: "Title of Paper, Authors, Conference Details, Year

Important Notes:

1.Each Project group should continue maintaining a diary for project and should write

(a) Book/s referred
(b) Company/ies visited
(c) Person/s contacted
(d) Computer work done
(e) Papers referred
(f) Creative thinking.

2. The Diary along with Project Work Phase I Report shall be assessed at the time of oral examination

3. One copy of the report should be submitted to Institute/ Department, one copy to Guide and one copy should remain with each student of the project group.

In-Semester Assessment (ISA):

Department will constitute an Evaluation Committee to review the project phase I work. The evaluation committee consists of faculty members of which internal guide and another expert in the specified area of the project. The completion of work, the submission of the report and assessment should be done at the end of Part-I (Seventh semester).

Mark Distribution:

Concept – 05 Marks,

Work Done – 20 Marks,

Presentation – 15 Marks,

Report – 10 Marks

Practical Oral Examination (POE):

Oral examination shall be conducted with presentation of the project phase I.

The distribution of marks shall be

- 10 marks for contribution of the student in the project work
- 20 marks shall be awarded for achieving the objectives of the project set forth.
- 20 marks for Question/ Answer

*The external examiner shall be preferably an Industrial expert from the same field.

Mapping of POs & COs															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2	2	2	3	--	3	--	--	--	3	2	--	1	1	1
CO2	3	3	3	--	3	1	2	2	1	2	2	2	1	1	1
CO3	--	--	--	--	--	--	--	2	3	2	3	2	--	--	--
CO4	3	--	--	3	3	--	2	--	2	3	2	3	3	3	3
CO5	--	--	--	--	2	--	--	--	--	3	--	--	--	--	--
CO6	--	--	--	--	--	--	--	3	--	--	3	--	2	2	2

Sr. No.	Description	Signature
1	Name of Faculty K. D. Joshi	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME801 - MECHATRONICS

Lectures: 3 Hrs/Week
Credit : 3

Evaluation Scheme
ISE : 40 Marks
ESE : 60 Marks

Course Objectives: The objective of the course is to	
1	Learn how to apply the principles of mechatronics and automation for the development of system.
2	Learn the automation technology and industrial automation as applications of mechatronics in manufacturing system.
3	To supply qualified personnel to meet the requirement of mechatronics systems.
4	To prepare mechanical engineering students for advanced graduate studies in mechatronics, Manufacturing engineering and related field.

Course Outcomes:		
COs	**At the end of successful completion of the course, the student will be able to**	**Blooms Taxonomy**
CO1	Understand and Elaborate mechatronics system, sensors and transducers.	Knowledge, Analyze
CO2	Design mechatronics system with logic gates, microprocessor and microcontroller.	Knowledge, Design
CO3	Study of signal conditioning process and its basic components.	Understand, Knowledge
CO4	Understand and identify PLC, input output devices and its basic components.	Understand, Knowledge
CO5	Design and develop PLC program for the problem under consideration.	Design, Apply
CO6	Study of human machine interface, SCADA,VFD, DCS for mechanical and Electronics system interface.	Understand, Knowledge

Description:

Mechatronics engineering also called mechatronics is an interdisciplinary branch of engineering that focuses on the integration of mechanical, electrical and electronic engineering systems, and also includes a combination of robotics, electronics, computer science, telecommunications, systems, control, and product.

Prerequisites:	1	Basics of Electrical wiring
	2	Basics of Electronics
	3	Instrumentation and Automation

Section–I		
Unit 1	**Introduction to Mechatronics :** Introduction to mechatronics, advantages and disadvantages, applications of mechatronics systems, Sensors & Transducers, Types of sensors: Position Sensors, Proximity sensors, Incremental & absolute encoders, Displacement sensors, Velocity sensors, advances in sensors.	7 Hrs
Unit 2	**Logic gates, microprocessor and micro controller :** Introduction to digital logic gates, Boolean algebra, combinational and sequential logic gates, introduction and types of flip flop, introduction to microprocessor and microcontroller, comparison between microprocessor and microcontroller.	6 Hrs
Unit 3	**Signal Conditioning :** Signal conditioning process, operational amplifier (inverting amplifier, non-inverting amplifier, summing, integrating amplifier, differtianting amplifier, logarithmic amplifier), protection, filtering, data acquisition, multiplexer, analog to digital converter (ADC) and digital to analog converter (DAC).	7 Hrs
Section–II		
Unit 4	**Introduction to PLC :** Introduction, definition and types of PLC, History and origin, major components of PLC, input output devices, PLC advantages and disadvantages, physical and internal relays, relay logic. Always ON always OFF contacts.	7 Hrs
Unit 5	**PLC programming fundamentals :** Physical components Vs. program components, update–solve–update, disagreement circuit, majority circuit, oscillator, holding (sealed or latches) contacts, fail safe circuits, PLC timer and counter functions. Industrial applications – Automatic liquid filling system, liquid mixture, traffic control etc.	7 Hrs
Unit 6	**Introduction to HMI and SCADA :** Introduction Human machine Interface (HMI), Difference between HMI and PLC, Introduction to SCADA and its industrial applications, Introduction to DCS and VFD, Introduction and applications of Raspberry Pi.	6 Hrs

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO
CO1		1											2	-	3
CO2			2	2						2			2	-	3
CO3												3	2	-	3
CO4	3				2								2	-	3
CO5							2						2	-	3
CO6									3				2	-	3

References:	
Text Books	
1	Mechatronics – Nitaigour P. Mahalik, ISBN 1259082318, 9781259082313, Publisher Tata McGraw - Hill Education
2	Microprocessor Architecture, Programming, and Applications with the 8085, by Ramesh Gaonkar (Author) Publisher : Penram International Publishing (1December2000) ISBN-10:8187972092
3	Mechatronics : Electronic Control Systems in Mechanical and Electrical Engineering by W. Bolton (Author), Publisher : Pearson Education; 4th edition (1January 2010) ISBN-10:8131732533
Reference Books :	
1	Introduction to Mechatronics (Oxford Higher Education) by Dr. K. K. Appukuttan Publisher : Oxford University Press (2nd August 2007), ISBN-10:0195687817
2	Programmable Logic Controllers : Principles and Applications, by John W. Webb, Ronald Reis, Publisher : Prentice Hall India Learning Private Limited; 5th edition (25March 2002), ISBN-10:013041672X
3	SCADA : Supervisory Control and Data Acquisition, by Stuart A Boyer, International Society of Automation; 4th edition (15th February 2016)
4	Programmable Logic Controllers: Programming Methods and Applications by John R. Hackworth (Author), Frederick D. Hackworth Jr. (Author), Publisher : PHI; Har / Com edition (11 April 2003) ISBN-10:0130607185
5	Human Machine Interaction by Dhananjay R. Kalbande, Prashant Kanade, Sridari Iye Publisher : Wiley's India
Video Links :	
1	**https://nptel.ac.in/courses/112107298** **(For Mechatronics)**
2	**https://nptel.ac.in/courses/112103174** **(For PLC)**

Sr. No.	Description	Signature
1	Name of Faculty Prof. Vikas N. Mane	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME802 - NOISE & VIBRATIONS

Lectures: 03 hrs/week
Credits: 03

Evaluation Scheme:
ESE :60 Marks
ISE :40 Marks

Course Objectives:
1. To Introduce students the concepts, principles and framework of Vibrations
2. To understand vibration analysis techniques for different types of vibrations.
3. To acquaintwiththeprinciplesofvibrationmeasuring instruments.
4. To createawarenessaboutprinciplesofsoundlevelmeasurementand noise.

Course Outcomes:

COs	**At the end of successful completion of the course, the student will be able to**	**Blooms Taxonomy**
CO1	Understand the various types of vibrations and their principles	Understand
CO2	Apply various methods for solving single Degree of Freedom (DOF) vibration problems.	Apply
CO3	Analyze the problems on Two DOF system.	Analyze
CO4	Analyze the problems on multi DOF system.	Analyze
CO5	Understand different types of Vibration Measuring Instruments.	Understand
CO6	Demonstrate the Noise and its various standards	Apply

Description:

Noise and Vibrations is a core Mechanical Engineering subject that deals with the generation, transmission, measurement, analysis, and control of mechanical vibrations and the noise produced by machines and structures. The course covers the fundamental principles of free and forced vibrations, damped and undamped systems, multi-degree-of-freedom systems, vibration measurement, balancing of rotating and reciprocating machines, sound generation, sound propagation, noise measurement, and various noise and vibration control techniques.

The subject integrates theoretical concepts with practical applications to improve machine performance, reliability, safety, and human comfort. It equips students with analytical and experimental skills to identify vibration-related problems and develop effective solutions in engineering systems. Also provides practical knowledge applicable in industries such as automotive, aerospace, manufacturing, power plants, construction, railways, and renewable energy.

Prerequisites:	1:	Analysis of Mechanical Element
	2:	Theory of Machine II

Section-I		
Unit 1	**Introduction**	
	Vibration and oscillation, Causes and effects of vibrations, Vibration parameters – spring, mass, damper, Degree of freedom, Staticequilibriumposition,Vibrationclassification, Equivalentstiffnessofspringcombination.	**04Hrs**
Unit 2	**Single DOF System**	
	a) Introduction to Single DOF System, single DOF Un-dampedfreevibrations Dampedfreevibrations,Typesof damping, Logarithmic decrement b) ForcedVibrations:Introduction, Forcetransmissibility andmotion transmissibility,Vibrationisolation	**06Hrs**
Unit 3	**TwoDOF System**	
	Free un damped vibrations– Introduction to free un damped longitudinal vibrations of two DOF system, Principalmodesandnaturalfrequencies, free torsional vibration of two rotor system, Transverse vibrationsof two DOF system.	**06Hrs**
Section-II		
Unit 4	**IntroductiontoMulti DOF System**	
	Freevibrations of Multi DOF System, stiffness in fluence Rayleigh' smethod, Holzer's method.	**05Hrs**
Unit 5	**Vibration Measuring Instruments**	
	Classification of vibration measuring instrument, Instruments for measurement of displacement, velocity, acceleration and frequency of vibration, Vibration exciters &FFT analyzer	**05Hrs**
Unit 6	**Noise**	
	a) Introduction to sound, Sound Level & Decibels. b) Introduction to Noise, Auditory &Non auditory effects of noise on people, Noise standards and limits in INDIA.	**04Hrs**

Mapping of Pos& COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	--	--	--	1	--	--	---	--	--	--	1	1	--	--
CO2	3	2	1	--	-	--	--	--	--	--	--	1	2	--	--
CO3	2	2	1	--	--	--	--	--	--	--	--	1	2	--	--
CO4	2	2	1	2	--	--	--	--	--	--	--	1	2	--	--
CO5	3	--	--	--	2	--	--	--	--	--	--	1	1	--	--
CO6	2	--	--	--	1	--	2	--	--	--	--	1	1	--	--

References:

Text Books:	
1	MechanicalVibrations",SingiresuS.Rao,PearsonEducation,ISBM–81-297-0179-0-(2004).
2	MechanicalVibrations",G.K.Grover,PublishedbyNemchandandBrothers, Roorkee.
3	MechanicalVibrations",G.K.Grover,PublishedbyNemchandandBrothers, Roorkee.
4	TheoryofVibrationswithApplications,W.Thomson,PearsonEducation,2nd Edition..
5	MechanicalVibration",DrDebabrataNag,WileyIndiaPvt.Ltd,ISBN 978-81-265-3090-8.
Reference Books:	
1	MechanicalVibration,AustinChurch,WielyEastern.2nd Edition
2	Mechanical Vibrations", J.P.DenHartog,TataMcGrawhill Book Company Inc., 4th Edition.
3	VibrationsandNoiseforEngineers,KewalPujaraDhanpatRaiandSons, (1992)
4	Mechanical vibration", William J Palm III Wiley India Pvt.Ltd.,ISBN 978-81-265-3168-4,1st Edition

Video Lectures (NPTEL and SWAYAM Portals)

Sr. No.	Description	Signature
1	Name of Faculty Dr. P.J. Patil	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME803 - INDUSTRIAL ENGINEERING

Lectures: 03 hrs/week
Credits: 02

Evaluation Scheme:
ESE: 60 Marks
ISE: 40 Marks

Course Objectives:

1. To introduce students with the concepts, principles and framework of Industrial Engineering and various productivity enhancement techniques.
2. To understand Method study and Time study techniques.
3. To make the students aware about types of plant layout, tools and techniques of material handling.
4. To teach the students, concepts of value engineering, job evaluation and merit rating.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Explain the concepts, principles, and framework of Industrial Engineering and Productivity enhancement approaches.	Understand
CO2	Describe different time study and work measurement techniques for productivity improvement.	Understand Remember
CO3	Study various principles of motion economy related to Productivity improvement.	Understand
CO4	Measure and calculate basic time, standard time for a component.	Apply Evaluate
CO5	Describe different types of plant layouts and material handling equipments.	Understand
CO6	Explain the role of value analysis, job evaluation and merit rating in improving productivity	Understand

Description:

In order to sustain in today's competitive world and to satisfy customers every industry is adopting cost reduction techniques to enhance the productivity. In order to achieve it industries use techniques like method study, work measurement, work sampling, principles of motion economy, plant layout and material handling and value analysis etc.Students must be acquainted with these techniques so as to be able to apply them in the industries.

Prerequisites:	1:	Manufacturing Processes
	2:	Metrology & Quality Control

	Introduction to Industrial Engineering & Productivity

Unit 1	A) **Introduction to Industrial Engineering:** Definition, objectives & role of industrial engineering, functions of industrial engineering department, Scope & responsibilities of industrial engineering, qualities & responsibilities of an industrial engineer, Tools and techniques of industrial engineering. B) **Productivity**: Concept, objectives, Factors affecting productivity, techniques to improve productivity, Productivity measurement models, problems on productivity.	**06 Hrs**
Unit 2	**Method Study** Historical background, role of work study in improving productivity, method study procedure, Recording techniques in method study- A) **Indicating process sequence-** i) Outline process chart ii) Flow process chart (man, machine and material type) iii)Two handed process chart, B) **Using a time scale**-i) Multiple activity chart C) **Diagrams indicating movements**-i) Flow diagram, ii)String diagram, iii) Cyclegraph, Chronocycle graph, v) Travel chart, templates, models, critical analysis.	**08 Hrs**
Unit 3	**Motion Study & Human Factor Engineering (Ergonomics)** A) **Motion Study:** Principles of motion economy, micro motion study, Therbligs, SIMO charts, MEMO motion study. B) **Human Factor Engineering (Ergonomics):** Introduction, objectives definition, man machine system, physiological work measurement, design of controls.	**06 Hrs**
Unit 4	**Work Measurement (Time Study)** Definition, objectives & techniques of work measurement, procedure, time study equipment, performance rating, different types of allowances, concept of normal time, basic time and standard time, calculation of standard time, work sampling, procedure of work sampling, advantages and limitations of work sampling techniques.	**08 Hrs**
Unit 5	**Facility Design** A) **Plant Layout:** Plant site selection, factors influencing the selection, objectives for pre-planning of a plant layout, types of plant layout, advantages and disadvantages of layout, principles of plant layout, tools and techniques of layout planning. B) **Material handling:** Objectives of material handling system, functions and principles of material handling, factors to be considered for selecting material handling equipment, types of material handling equipments.	**06 Hrs**
Unit 6	**Value analysis & Job evaluation and merit rating** A) **Value analysis:** Definition, basic concept of value analysis and engineering, steps, evaluation, applications of value analysis, role of value analysis towards improvement in productivity. **B) Job evaluation and merit rating:** **Job evaluation:** Definition, objectives, steps in job evaluation, Methods of job evaluation (a) Ranking method, b) Job classification method, with their advantages and disadvantages. **Merit rating:** Introduction, objectives, different methods of merit rating	**06 Hrs**

	a) Ranking scale method, b) Employee comparison method, c) Check list method with their advantages and disadvantages.	

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2	1	1	--	3	--	--	--	--	--	--	--	--	--	2
CO2	2	2	1	2	2	--	--	--	--	--	--	--	--	--	2
CO3	--	2	--	--	2	--	--	--	--	--	--	--	--	--	1
CO4	2	3	2	--	2	--	--	--	--	1	--	--	--	--	2
CO5	--	2	--	--	--	--	--	--	--	2	--	--	--	--	2
CO6	--	2	2	--	2	--	--	--	--	--	--	--	--	--	1

References:

Text Books	
1	M. Telsang, "Industrial Engineering and Production Management", S. Chand Publication.
2.	O.P. Khanna, "Work Study" Dhanpat Rai Publi. New Delhi.
3.	M Mahajan, Industrial Engineering and Production Management, DhanpatRai and Co.
4.	Banga and Sharma, Industrial Organization & Engineering Economics, Khanna publication
Reference Books	
1	R.M. Barnes, "Motion and time study design and measurement of work" John Willey & Sons Inc. 7th Edition
2	H.B. Maynard and others, "Industrial Engg. Handbook" IVth Edi. McGraw Hill Publication.
3	David Sumanth, "Productivity Engg. And Management", Tata McGraw Hill, New Delhi.

Sr. No.	Description	Signature
1	Name of Faculty: R.T. Shinde	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC5ME8041 - CRYOGENICS

Lectures: 03 hrs/week
Credits: 03

Evaluation Scheme:
ESE: 60 Marks
ISE: 40 Marks

Course Objectives: The objective of the course is to
1. Describe various methods to produce low temperature and phenomena at cryogenic temperature. 2. Understand the working principle of different cryogenic liquefaction and separation systems. 3. Study various Cryogenic refrigeration systems 4. Understand the application of Cryogenic technology in engineering in research and Industry.

Course Outcomes:

Cos	**At the end of successful completion of the course, the student will be able to**	**Blooms Taxonomy**
CO1	Know the working principle of different types liquefaction system with its components and function	Knowledge,
CO2	Summarize the applications of Cryogenics in different areas	Understand
CO3	Calculate performance parameters of different liquefaction systems	Apply
CO4	Describe gas separation and Purification systems	Knowledge
CO5	Explain Working of different types of Cry coolers	Understand
CO6	Explain different types of insulation systems and vacuum systems used in Cryogenics	Understand

Description:

The Cryogenic Engineering course introduces the principles of producing, storing, and handling extremely low temperatures. It covers the properties of cryogenic fluids, gas liquefaction systems, cryogenic insulation, storage vessels, and transportation methods. The course also explores applications in aerospace, medical, energy, and industrial sectors. Students gain an understanding of cryogenic equipment, safety practices, and system design. The course builds the knowledge required for modern low-temperature engineering applications.

Prerequisites:	1:	Basic knowledge of thermodynamics
	2:	Fundamental knowledge of refrigeration
	3:	Heat and Mass Transfer

Unit 1	**Introduction: Cryogenics**	
	Introduction: Cryogenics, Cryogenic Temperature scale, Historical Development of Cryogenics, Properties of cryogenic Fluids, Applications of cryogenics in different areas such as Space, Medical and Biological, Manufacturing processes. Behavior of Structural Materials at Cryogenic Temperature: Mechanical properties, Thermal properties.	**06Hrs**
Unit 2	**Liquefaction of Cryogenic Gases**	
	Ideal cycle, System performance parameters, Production of low temperature methods in Cryogenics (Joule Thomson effect, Adiabatic expansion), Liquefaction systems; Simple LindeHampson system, Pre-cooled Linde-Hampson system, Cascade system, Claude system, Comparison Of Above Systems.	**09Hrs**
Unit 3	**Liquefaction Systems for Neon, Hydrogen, Helium and Heat Exchanger**	
	Maximum Inversion temperature, Limitations of Linde -Hampson System for liquefaction of Neon, Hydrogen and Helium,Precooled Linde- Hampson system for Neon and Hydrogen, Claudes system for Hydrogen,CollinsHelium Liquefaction system, Heat exchanger used in liquefaction systems	**05Hrs**
Unit 4	**Cryogenic Refrigeration Systems**	
	Ideal refrigeration systems, Philips refrigerator,Vuilleumier refrigerator, Solvay refrigerator, Gifford McMahon refrigerator, Pulse tube refrigerator.	**06Hrs**
Unit 5	**Gas Separation and Purification**	
	Thermodynamic Ideal separation system, Temperature composition diagram, Principles of Gas separation, Principles of Rectifiers column, Air Separation Systems (Linde Single Column system, Linde double column system)	**07Hrs**
Unit 6	**Insulation & Vacuum Technology**	
	Cryogenic fluid storage, Vacuum insulation, Fibrous materials, Solid foams, Gas Filled powder, Comparison.: Importance, Pump Downtime, Flow regimes, Components vacuum systems, Mechanical Vacuum pumps,and Ion pumps	**07Hrs**

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO110	PO111	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	--	--	--	--	--	--	--	--	--	--	--	--	2	--
CO2	3	--	--	--	--	--	--	--	--	--	--	--	--	2	--
CO3	3	3	3	--	--	--	--	--	--	--	--	--	--	2	--
CO4	3	--	--	--	--	--	--	--	--	--	--	--	--	2	--
CO5	3	--	--	--	--	--	--	--	--	--	--	--	--	2	--
CO6	3	--	--	--	--	--	--	--	--	--	--	--	--	2	--

References:

Textbooks	
1	"CryogenicSystems",BarronF.Randall,OxfordUniversityPress,NewYork
2.	"Fundamental of Cryogenics",Mamata Mukhopadhyay, PHI, 2010
3.	"Introduction to Cryogenics Engineering and Gas liquefaction",P. K Bose,Everest Publishing house,2005
Reference Books	
1	"Cryogenic Research and Applications", Marshall Sitting and Stephen Kidd, D. Van Nostrand,IncUSA,(1963)
2	"Cryo-Cooler: Fundamentals Part-I", G.Walker, PlenumPress, NewYork.
3	"Experimental Techniques in low Temperature Physics' ', Guy, White, Clarendon Press, Oxford,(1987).

Web Links/ Video Lectures https://archive.nptel.ac.in/courses/112/101/112101004/

Sr. No.	Description	Signature
1	Name of Faculty A. S. Charan	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC5ME8042 - MODELLING AND SIMULATION OF MANUFACTURING SYSTEMS

Lectures: 03 hrs/week
Credits: 03

Evaluation Scheme:
ESE : 60 Marks
ISE : 40 Marks

Course Objectives: The objective of the course is to

1. Acquaint students with the fundamentals of discrete-event simulation modelling and its application in manufacturing and service systems.
2. Develop the ability to generate and test random numbers and random variates using various established techniques.
3. Enable students to build simulation models for queuing, inventory, and production systems using heuristic and algorithmic methods.
4. Equip students with skills to collect, analyze, and fit statistical input data distributions for simulation models.
5. Develop competency in verifying, validating, and analyzing the output of simulation models using industry-standard tools.
6. Introduce Monte Carlo simulation techniques for solving real-world manufacturing and operations problems.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Explain the concepts, principles, and methodology of modelling and discrete-event simulation used in manufacturing systems.	Understand
CO2	Apply random number generation and random variate generation techniques for developing stochastic simulation models.	Apply
CO3	Develop simulation models for manufacturing, inventory, and queuing systems using appropriate modelling and simulation techniques.	Evaluate
CO4	Analyze simulation input data, select appropriate probability distributions, and perform verification and validation of simulation models.	Analyze
CO5	Analyze simulation output data using appropriate statistical techniques to evaluate system performance.	Analyze
CO6	Evaluate manufacturing system performance and recommend suitable improvements using Monte Carlo simulation and simulation-based decision-making techniques.	Evaluate

Description:

This course introduces the principles and methodologies of modelling and simulation for manufacturing systems with emphasis on discrete-event simulation. It covers simulation modelling, random number and random variate generation, statistical input modelling, verification and validation, output analysis, and Monte Carlo simulation. The course enables students to analyze manufacturing systems and evaluate alternative system configurations for effective decision-making using simulation techniques.

Prerequisites:	1:	Basic knowledge of Probability and Statistics
	2:	Basic knowledge of Numerical Mathematics and Optimization
	3:	Basic knowledge of Manufacturing Processes and Systems

	Section – I	
Unit 1	**Introduction to Simulation**	
	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.	**7 Hrs**
Unit 2	**General Principles and Random Numbers**	
	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.	**7 Hrs**
Unit 3	**Random Variate Generation and Optimization**	
	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.	**7 Hrs**
	Section – II	
Unit 4	**Analysis of Input Data and Verification & Validation of Model**	
	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.	**8 Hrs**
Unit 5	**Analysis of Output Data**	
	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.	**8 Hrs**
Unit 6	**Problem Solving and Case Studies**	
	Introduction to Monte Carlo Simulation, Inventory Control Simulation using Monte Carlo Techniques, Problem Solving on Monte Carlo Simulation. Different case studies on usefulness of simulation modelling for real manufacturing system	**7 Hrs**

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	--	--	--	--	--	--	---	--	--	--	--	--	--	--
CO2	2	1	--	--	--	--	--	--	--	--	--	--	--	--	--
CO3	2	1	1	--	--	--	--	--	--	--	--	--	--	--	--
CO4	2	2	--	--	--	--	--	--	--	--	--	--	--	--	--
CO5	2	2	--	--	--	--	--	--	--	--	--	--	--	--	--
CO6	3	1	--	--	--	--	--	--	--	--	--	--	--	--	--

References:

Text Books	
1	Jerry Banks, John S. Carson II, Barry L. Nelson and David M. Nicol, Discrete-Event System Simulation, 5th Edition, Pearson.
2	Averill M. Law, Simulation Modeling and Analysis, 5th Edition, McGraw-Hill.
3	Geoffrey Gordon, System Simulation, PHI Learning.
Reference Books	
1	Narsingh Deo, System Simulation with Digital Computer, 3rd Edition, PHI Learning, 2004. ISBN: 978-0-87692-028-3
2	Frank L. Severance, System Modelling and Simulation: An Introduction, John Wiley & Sons, 2001.
NPTEL/Online Resources	
1	NPTEL Course: Simulation and Modelling, IIT Bombay — https://archive.nptel.ac.in/courses/112/107/112107220/
2	NPTEL Course: System Analysis and Simulation, IIT Delhi — https://nptel.ac.in/courses/112102014

Sr. No.	Description	Signature
1	Name of Faculty Dr. M. S. Dhuttargaon	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC4ME8043 - AUTOMOBILE AND ELECTRIC VEHICLES ENGINEERING

Lectures: 03 hrs/week
Credits: 02

Evaluation Scheme:
ESE :60 Marks
ISE :40 Marks

Course Objectives:

1. Describe importance and basic knowledge of automobiles and electric vehicles.
2. Classify various automobile layouts, bodies, types of transmission system, steering system, braking system, suspension system, EV batteries and motors.
3. Enable students to analyze and solve problems on performance of automobiles and EVs.
4. Create awareness about automobile pollution and its effect on environment.
5. Motivate students to do research in the field of electric vehicles.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Describe the history and development of automobiles, vehicle classification, layouts, body types, and the construction and working principles of clutch, gearbox, transmission, propeller shaft, differential, and final drive.	Knowledge Understand
CO2	Illustrate the construction and working of live and dead axles, steering mechanisms, suspension systems, and mechanical, hydraulic, pneumatic, and electronic braking systems used in automobiles.	Understand
CO3	Explain the construction and specifications of wheels and tyres, analyze vehicle motion resistance and traction characteristics, perform calculations related to vehicle propulsion, and describe recent automotive technologies.	Analyze
CO4	Discuss the need for electric vehicles, electric drive technologies, Indian EV policies, energy storage systems, and AC/DC charging systems used in electric vehicles.	Understand
CO5	Interpret the operating principles, characteristics, and applications of electrochemical batteries and regenerative braking systems used in electric vehicles.	Understand
CO6	Analyze the torque-speed characteristics of electric motors and select suitable motors and drive layouts for electric vehicle applications.	Analyze

Description:

This course introduces the fundamentals of automobile engineering, including the history and classification of automobiles, vehicle layouts, transmission systems, steering, suspension, braking systems, wheels, tyres, and vehicle performance. It also covers vehicle resistance, traction, propulsion, and recent automotive technologies such as Cruise Control, ABS, Electronic Brake Distribution (EBD), Traction Control System (TCS), Tire Pressure Monitoring System (TPMS), and Advanced Driver Assistance Systems (ADAS).

The course also provides an introduction to electric vehicle (EV) technology, covering electric drive systems, EV policies, charging systems, energy storage, battery technologies, battery pack design, regenerative braking, and electric motors used in EVs. Students will gain an understanding of conventional and electric vehicle systems and their applications in modern transportation.

Prerequisites:	1:	Basic knowledge of Engineering Mechanics, Engineering Physics and Engineering Mathematics
	2:	Fundamentals of Thermodynamics and Internal Combustion (IC) Engines.
	3:	Basic understanding of Electrical and Electronics Engineering.

Section-I		
Unit 1	**Automobile introduction and transmission system**	
	Automobile history and development, Classification, vehicle layouts- engine location and drive arrangement, specifications of vehicles, Type of vehicle bodies, Clutch – Function and requirements, Classification, Construction and working of Single-plate,Diaphragm spring and centrifugal clutches, Fluid flywheel. Gear Box – Necessity, classification, construction of manual gear box like Synchromesh, Epicyclic gear train, Automatic transmission, Torque convertor, Electronic transmission control, Overdrive. Propeller shaft, Differential and final drive.	**07Hrs**
Unit 2	**Steering ,Suspension and Braking Systems**	
	Live and dead axles, live axle arrangement Steering systems, function, principle of steering, steering gearbox, power steering, collapsible steering. Suspension system-Functions, Sprung and un sprung mass, Types of suspension linkages, types of spring - leaf, coil, air springs, telescopic shock absorber, Air suspension. Brakes: Need, principle, types, Mechanical, hydraulic and pneumatic brakes disc and drum types, airbrakes, servo and power braking, ABS, Electronic Brake Distribution (EBD).	**06Hrs**
Unit 3	**Wheels, Tyres and Performance of Automobile**	
	Wheels and Tyres: Wheel construction, alloy wheel, Types, tyre construction, tread design, specification. Resistance to vehicle motion, Air, Rolling and Gradient resistance, Power required for vehicle propulsion (Numerical on Vehicle resistance, engine power, power to wheels, tractive effort, draw bar pull, overall gear ratio, engine and vehicle speed), Recent Trends : Cruise Control, Adaptive Cruise Control (ACC), Electronic Stability Program (ESP), Traction Control System (TCS),TPMS, ADAS, Hill hold Assist, Park Assist etc.	**07Hrs**
Section-II		
Unit 4	**Introduction to Electric Vehicles**	
	Energy crises, Need of future transportation, Introduction and overview of Electric Drive Technologies and Configurations. EV – Indian strategies, Policies, R&D and Collaboration, Introduction to Energy Storage. Electric vehicle conductive AC charging system, DC charging system,	**06Hrs**
Unit 5	**Batteries for Electric Vehicles**	
	Electrochemical Batteries – Reactions and Thermodynamic, Voltage, Specific power and Energy, Working of Pb-Acid batteries, Ni-Fe, Ni- Cd, Ni-MH Batteries,Li- Polymer, Li-ion, Battery selection for Electric Vehicle, Regenerative Braking system. Life. Battery Storage, Battery Pack Design	**07Hrs**
Unit 6	**Electric Motors in Electric Vehicles**	
	Electric Motors used in electric vehicles, DC motors, Induction motors, Permanent Magnet motors, Switched Reluctance motors., Torque –speed characteristics of above mentioned motors, Comparison and its layout in EV, Selection of motor for EV, Motor location and drive from motor to wheels.	**07Hrs**

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	1	--	1	--	--	--	--	--	--	1	--	3	--
CO2	3	3	1	--	2	1	--	--	--	--	--	--	--	2	--
CO3	2	3	2	--	3	1	2	--	--	--	--	1	--	3	--
CO4	3	2	1	--	2	2	3	--	--	--	--	1	--	2	--
CO5	2	2	--	--	2	1	3	--	--	--	--	1	--	2	--
CO6	2	3	2	--	3	--	1	--	--	--	--	2	--	2	--

References:

Text Books	
1	"Automotive Mechanics", William Crouse, Donald Anglin, 10th Edition, McGraw Hill, India.
2.	"Automobile Engineering", G.B.S. Narang., 3rd Edition, Khanna Publication
3.	"Automobile Mechanics", Dr. N.K.Giri
4.	"Modern Electric, Hybrid Electric & Fuel Cell vehicles" Mehrdad Ehsani, 2nd edition, CRC press.
5.	"Electric & Hybrid Vehicles" Design fundamentals, Iqbal Husain, CRC press.
Reference Books	
1	"The Motor Vehicle", T.K. Garrett, K. Newton, W. Steeds, 13th Edition, Butterworth Heinemann, New Delhi.
2	"Automotive Mechanics", Joseph Heitner, 2nd Edition, Affiliated Eastern Law House, 1967.
3	"Electric cars: Technology" DelftX eCARS2x, Pavol Bauer, Marnix Wagemaker, TU Delft, The Netherlands
	"ELECTRIC VEHICLE TECHNOLOGY EXPLAINED" 2nd Edition, James Larminie & John Lowry, WILEY, A John Wiley & Sons, Ltd., Publication.

Video Lectures (NPTEL and SWAYAM Portals)

1 https://archive.nptel.ac.in/courses/107/106/107106088/
2 https://www.youtube.com/watch?v=Z8i1ClGy-ak
3 https://www.youtube.com/watch?v=LZ82iANWBL0
4 https://www.youtube.com/watch?v=UgtjRob5qMg&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr
5 https://www.youtube.com/watch?v=3E1SXG7VkQk&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=
6 https://www.youtube.com/watch?v=3E1SXG7VkQk&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=
7 https://www.youtube.com/watch?v=FXpAhoZ13r0&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=3

Sr. No.	Description	Signature
1	Name of Faculty: Prof. S.M. Gidaveer	for A Patil
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGMDM6ME804L - AUTOMATION AND ROBOTICS IN MANUFACTURING

Lectures: 02hrs/week

Credits: 02

Evaluation Scheme:

ISA :50 Marks

Course Objectives:

1. To introduce students to the fundamentals of automation and robotics used in modern industries.
2. To familiarize students with industrial robots, sensors, actuators, and automation systems.
3. To understand the role of PLCs, IoT, Artificial Intelligence, and Industry 4.0 in manufacturing.
4. To develop awareness of automation applications across different engineering disciplines.

Course Outcomes:

COs	**At the end of successful completion of the course, the student will be able to**	**Blooms Taxonomy**
CO1	Explain the fundamentals of manufacturing systems, automation, types of automation, automation pyramid, Computer Integrated Manufacturing (CIM), and their significance in modern engineering industries.	Understand
CO2	Describe the construction, components, working principles, safety aspects, and applications of industrial robots used in manufacturing and multidisciplinary engineering sectors.	Understand
CO3	Explain the functions and applications of industrial sensors, actuators, pneumatic and hydraulic systems, electric drives, PLC, HMI, and SCADA used in automation systems.	Understand
CO4	Analyze automated manufacturing systems including material handling systems, conveyor systems, AGVs, AS/RS, Flexible Manufacturing Systems (FMS), CNC automation, and collaborative robots (Cobots).	Analyze
CO5	Explain the concepts and applications of Industry 4.0, Smart Manufacturing, IIoT, Cyber-Physical Systems (CPS), Artificial Intelligence (AI), Digital Twin, and Predictive Maintenance in modern manufacturing.	Understand
CO6	Evaluate automation and robotics applications, industrial case studies, human–robot collaboration, safety, ethical considerations, emerging	Understand

	trends, and career opportunities for improving productivity, quality, safety, sustainability, and innovation.	

Description:		
This multidisciplinary minor course introduces the fundamentals of automation and robotics for students from other than mechanical engineering disciplines. It covers industrial automation, robotic systems, sensors, actuators, programmable logic controllers (PLCs), material handling systems, machine vision, and emerging technologies such as Industry 4.0, Industrial Internet of Things (IIoT), Artificial Intelligence, Digital Twins, and smart manufacturing. The course emphasizes industrial applications, case studies, and future career opportunities rather than mathematical analysis or robot programming.		
Prerequisites:	1:	Basic engineering knowledge and computer literacy.

Section-I		
Unit 1	**Introduction to Automation and Manufacturing**	
	Introduction to manufacturing systems, Need for automation, Types of automation (Fixed, Programmable, Flexible), Automation pyramid, Benefits and challenges of automation, Automation in different engineering sectors, Introduction to Computer Integrated Manufacturing (CIM).	**04 Hrs**
Unit 2	**Industrial Robotics**	
	Introduction to robotics, History and evolution of industrial robots, Robot anatomy and basic components, Degrees of freedom, End effectors, Robot drives (Electric, Hydraulic, and Pneumatic), Robot sensors, Industrial robot safety, and applications of robots in manufacturing and other engineering sectors.	**04 Hrs**
Unit 3	**Automation Components**	
	Industrial sensors and transducers, Proximity, temperature, pressure, and vision sensors, Actuators, Pneumatic and hydraulic systems, Electric drives, Basics of Programmable Logic Controllers (PLC), Human Machine Interface (HMI), and introduction to SCADA systems.	**05 Hrs**

Section-II		
Unit 4	**Automated Manufacturing Systems**	
	Material handling systems, Conveyor systems, Automated Guided Vehicles (AGVs), Automated Storage and Retrieval Systems (AS/RS), Flexible Manufacturing Systems (FMS), CNC automation, Collaborative Robots (Cobots), and applications of automated manufacturing systems.	**04 Hrs**
Unit 5	**Smart Manufacturing and Industry 4.0**	
	Introduction to Industry 4.0, Smart factories, Industrial Internet of Things (IIoT), Cyber-Physical Systems (CPS), Artificial Intelligence (AI) in manufacturing, Digital Twin, Predictive maintenance, and applications of smart manufacturing.	**04 Hrs**
Unit 6	**Applications, Case Studies and Future Trends**	
	Applications of automation and robotics in automotive, electronics, healthcare, agriculture, logistics, and construction industries, Industrial case studies, Human–Robot Collaboration (Cobots), Robot safety and ethical considerations, Emerging trends in automation and robotics, Career opportunities in automation and smart manufacturing	**05 Hrs**

Mapping of Pos& COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO 1	PSO 2	PSO 3
CO1	3	2	1	--	2	--	1	--	--	1	--	2	--	--	--
CO2	3	3	2	1	3	--	--	1	--	1	--	2	--	--	--
CO3	2	3	3	2	3	--	1	--	1	1	--	2	--	--	--
CO4	2	2	3	2	3	1	2	1	--	1	--	2	--	--	--
CO5	2	3	3	2	3	2	3	2	1	2	1	3	--	--	--
CO6	3	3	3	2	3	2	3	2	2	2	1	3	--	--	--

References:

Text Books	
1	Mikell P. Groover, **Automation, Production Systems and Computer-Integrated Manufacturing,** 5th Edition, Pearson.
2.	Saeed B. Niku, **Introduction to Robotics: Analysis, Control and Applications**, 3rd Edition, Wile
Reference Books	
1	John J. Craig, **Introduction to Robotics: Mechanics and Control**, Pearson.
2	Frank Lamb, **Industrial Automation: Hands-On**, McGraw-Hill.
3	Hugh Jack, **Automating Manufacturing Systems with PLCs.**
4	Shimon Y. Nof (Ed.), **Springer Handbook of Automation**, Springer.
5	B. S. Dhillon, **Robotics and Industrial Automation**, CRC Press.
6	Mikell P. Groover, **Fundamentals of Modern Manufacturing**, Wiley.

Sr. No.	Description	Signature
1	Name of Faculty Dr. Mahesh R. Jadhav	MRJadhav.
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME801LP - MECHATRONICS LAB

Practical : 2 hrs / week
Credits : 01

Examination Scheme :
ISA : 25 Marks
POE : 25 Marks

Course Objectives : The objective of the course is to
1. To learn how to apply the principles of Mechatronics and automation for the development of system. 2. To prepare Mechanical Engineering students for advanced graduate studies in Mechatronics, automation & Control system designs.

Course Outcomes :

Cos	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Understand and identify mechatronics system and its basic components and signal conditioning process	Understand Remember
CO2	Design a mechatronics system with sensors, transducers, Microprocessor and microcontroller.	Design Create
CO3	Understand and identify PLC and its input, output devices, PLC wiring diagram and their basic sketches.	Understand
CO4	Design and develop PLC and its programming for problem under consideration or any industrial applications.	Design Create

Prerequisites:	1	Basics of Electrical wiring
	2	Basics of Electronics
	3	Instrumentation and Automation

Practical:

Sr. No	Practical Topic	Hrs.	Bloom's Taxonomy
1	Demonstration of sensors (minimum four)	2	Understand
2	Assignment on microprocessor and microcontroller.	2	Understand, Knowledge
3	Assignment on study of signal conditioning process and its different operations	2	Understand, Knowledge
4	Fabrication of simple mechatronics working project by a group of 4/5 students using hardware and suitable software.	2	Create
5	PLC programming on industrial applications based on internal relays timers, counters, (Minimum 3 applications)	2	Apply Create
6	Assignment on HMI, SCADA and introduction of Raspberry Pi	2	Understand, Knowledge
7	Industrial visit to study of mechatronics system application & submission of visit report.	2	Analysis Evaluate

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Ifapplicable		
													PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	-	2	3	-	-	-	2	-	1	-	-	-	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO4	-	2	3	-	-	-	2	-	1	-	-	-	-	-	2

References:

Text Books

1	Mechatronics – Nitaigour P. Mahalik Mahalik, ISBN 1259082318, 9781259082313 Publisher Tata McGraw-Hill Education
2	Microprocessor Architecture, Programming, and Applications with the 8085, by Ramesh Gaonkar (Author) Publisher : Penram International Publishing (1December2000) ISBN-10:8187972092
3	Mechatronics : Electronic Control Systems in Mechanical and Electrical Engineering by W. Bolton (Author), Publisher : Pearson Education; 4th edition (1January 2010) ISBN-10:8131732533
4	Programmable Logic Controllers : Principles and Applications, by John W. Webb, Ronald Reis, Publisher : Prentice Hall India Learning Private Limited; 5th edition (25March 2002), ISBN-10:013041672X

Reference Books :

1	Introduction to Mechatronics (Oxford Higher Education) by Dr. K. K. Appukuttan Publisher : Oxford University Press (2nd August 2007), ISBN-10:0195687817
2	SCADA : Supervisory Control and Data Acquisition, by Stuart A Boyer, International Society of Automation; 4th edition (15th February 2016)
3	Programmable Logic Controllers: Programming Methods and Applications by John R. Hackworth (Author), Frederick D. Hackworth Jr. (Author), Publisher : PHI; Har / Com edition (11 April 2003) ISBN-10:0130607185
4	Human Machine Interaction by Dhananjay R. Kalbande, Prashant Kanade, Sridari Iye Publisher : Wiley's India

Video Links :

1	**https://nptel.ac.in/courses/112107298**	**(For Mechatronics)**
2	**https://nptel.ac.in/courses/112103174**	**(For PLC)**

Sr. No.	Description	Signature
1	Name of Faculty Prof Vikas N. Mane	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME802LP - NOISE &VIBRATION LAB

Practical	: 2 Hr/Week	**Evaluation Scheme**	
Credit	: 1	**ISA :**	25 Marks
		POE:	25 Marks

Course Objectives: The objective of the course is to

1. To introduce students the concepts, principles and framework of Vibrations
2. To understand vibration analysis techniques for different types of vibrations.
3. To acquaint with the principles of vibration measuring instruments.
4. To create awareness about principles of sound level measurement and noise..

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Understand the concept of Equivalent stiffness of spring combination & natural frequency for different types of vibrations.	Remember /Apply
CO2	Analyze logarithmic decrement for single DOF damped system	Analyze
CO3	Determine natural Frequency of different types of torsional vibrations.	Apply
CO4	Demonstrate the various types vibration exciters as well as different types of vibration and noise measuring instruments.	Understand

Description:

The **Noise & Vibration Laboratory** is designed to provide students with practical knowledge and hands-on experience in the measurement, analysis, and control of noise and vibration in mechanical systems. The laboratory complements the theoretical concepts covered in the Noise & Vibration course by enabling students to perform experiments using modern measuring instruments such as soundlevel meters, vibration analyzers, accelerometers, FFT analyzers, and data acquisition systems. Lab courseprovides practical knowledge applicable in industries such as automotive, aerospace, manufacturing, power plants, construction, railways, and renewable energy.

Prerequisites:	1	Analysis of Mechanical Element
	2	Theory of Machines-II

Practical's:

Sr. No.	Practical Topic	Hrs.	Bloom's Taxonomy
1	Experimentonequivalentspringmass system	2	Remember
2	Experimentonstudyofforcedvibration characteristics	2	Apply
3	DeterminationoflogarithmicdecrementforsingleDOFdamped system	2	Analyze
4	Experimentontorsionalvibrationoftworotorswithout damping	2	Apply
5	Demonstration of differenttypesof vibration exciters	2	Understand
6	Measurementofvibrationparametersusingvibrationmeasuring instruments	2	Understand
7	Measurement of Noisebyusingnoisemeasuring instruments.	2	Understand

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	--	--	--	--	--	---	--	--	--	--	1	--	--
CO2	2	2	1	--	--	--	--	--	--	--	--	--	1	--	--
CO3	2	2	--	--	--	--	--	--	--	--	--	--	1	--	--
CO4	3	--	--	-	1	1	2	--	--	--	--	--	1	--	--

References:

TextBooks:	
1	MechanicalVibrations",Singers S.Rao,PearsonEducation,ISBM–81-297-0179-0-(2004).
2	MechanicalVibrations",G.K.Grover,PublishedbyNemchandandBrothers, Roorkee.
3	MechanicalVibration",Dr.DebabrataNag,WileyIndiaPvt.Ltd,ISBN 978-81-265-3090-8.

Reference Books:	
1	MechanicalVibration,AustinChurch,WielyEastern.2nd Edition
2	Mechanical Vibrations", J.P.DenHartog,TataMcGrawhill Book Company Inc., 4th Edition.
3	VibrationsandNoiseforEngineers,KewalPujaraDhanpatRaiandSons, (1992)
4	Mechanical vibration", William J Palm III Wiley India Pvt.Ltd.,ISBN 978-81-265-3168-4,1st Edition

Sr. No.	Description	Signature
1	Name of Faculty Dr. Prashant .J. Pati	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPCCME802L - INDUSTRIAL TRAINING

Practical: 02 hrs/week
Credits: 01

Evaluation Scheme:
ISA: 50 Marks

Course Objectives:

1. To familiarize the students to work in an industrial environment.
2. Apply theoretical knowledge gained during the academic program to real-world industrial processes, equipment, and engineering practices.
3. Enhance professional competencies such as teamwork, communication, problem-solving, time management, ethics, and workplace discipline.
4. Prepare technical reports and presentations based on industrial observations, training activities, and project work, demonstrating analytical and documentation skills.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Understand and interpret the knowledge gained in the course work	Knowledge
CO2	Explain the organizational structure, workflow and manufacturing processes of the industry.	Understand
CO3	Demonstrate practical understanding of industrial equipment, processes and quality control techniques.	Apply
CO4	Apply engineering principles to analyze industrial operations and solve practical problems	Analyze
CO5	Follow industrial safety regulations, ethical practices, and environmental guidelines.	Apply
CO6	Prepare and present a comprehensive industrial training report highlighting observations, learning outcomes, and recommendations.	Create

Description:

The students who opted Track – 1 Capstan /Academic Pattern it is mandatory to complete Two Weeks Industrial Training immediately after completion of seventh semester and submit the report to respective guide as a part of ISA submission/Examination.

Report is based on compilation of work carried out during training like facility and layout planning, Industrial engineering- time study and motion study, Line efficiency, process improvement, Industrial automation etc.

Industrial Training Report Format	Maximum fifteen students in one batch, involving three groups of maximum five students, shall work under one teacher. The same group shall work for project under the same guide. However, each student should have different industrial training and its presentation. The report should be of 30 to 35 pages. For standardization of the report the following format should be strictly followed. 1. Page Size : Trimmed A4 2. Top Margin : 1.00 Inch 3.Bottom Margin : 1.32 Inches 4.Left Margin : 1.5 Inches 5.Right Margin : 1.0 Inch 6.Para Text : Times New Roman 12 Pt. font 7.Line Spacing : 1.5 lines 8.Page Numbers : Right aligned at footer. Font 12 Pt. Times New Roman 9. Headings : New Times Roman, 14 Pt., Bold face 10.Certificate : All students should attach standard format of Certificate as prescribed by the department. Certificate should be awarded for individual student. It should have signatures of Guide, Head of Department and Principal.

Mapping of Pos & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2	1	1	--	3	--	--	--	--	--	--	--	--	--	2
CO2	2	2	1	2	2	--	--	--	--	--	--	--	--	--	2
CO3	--	2	--	--	2	--	--	--	--	--	--	--	--	--	1
CO4	2	3	2	--	2	--	--	--	--	1	--	--	--	--	2
CO5	--	2	--	--	--	--	--	--	--	2	--	--	--	--	2
CO6	--	2	2	--	2	--	--	--	--	--	--	--	--	--	1

Sr. No.	Description	Signature
1	Name of Faculty: Prof. R.T. Salunkhe	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC5ME8041L - CRYOGENICS

Practical's: 2 hrs per week
Credits: 01

Evaluation Scheme:
ISA: 25 Marks

Course Objectives: The objective of the course is to
1. To understand the fundamental principles and applications of cryogenic engineering. 2. To introduce the fundamentals of cryogenic engineering and the properties of cryogenic fluids. 3. To understand various cryogenic gas liquefaction and refrigeration systems. 4. To study gas separation, cryogenic storage, insulation, and vacuum technologies.

Course Outcomes:

Cos	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Define and describe the fundamentals of cryogenics, cryogenic temperature scales, properties of cryogenic fluids, and their applications.	Knowledge
CO2	Explain the behavior of structural materials at cryogenic temperatures and the principles of cryogenic gas liquefaction systems..	Understand
CO3	Describe the working of cryogenic refrigeration systems, gas separation processes, and air separation systems.	Understand
CO4	Explain the concepts of cryogenic storage, insulation techniques, vacuum technology, and their importance in cryogenic applications.	Understand

Description:

The Cryogenics Laboratory (Theoretical) course provides conceptual and analytical understanding of cryogenic systems through theoretical experiments, assignments Students study cryogenic fluids, liquefaction cycles, refrigeration systems, gas separation, insulation, and vacuum technology

Prerequisites:	1:	Applied Thermodynamics
	2:	Heat and Mass Transfer
	3:	Fluid properties and Fluid dynamics,

Practicals:

Number	Practical/Experiment/Tutorial Topic	Hrs.	Cognitive levels of attainment as per Bloom's Taxonomy
1	Fundamentals and Applications of Cryogenics	2	Understand
2	Study of Cryogenic Gas Liquefaction Systems	2	Understand
3	Study of Liquefaction Systems for Neon, Hydrogen, and Helium	2	Understand
4	Study of Cryogenic Refrigeration Cycles	2	Understand
5	Study of Cryogenic Gas Separation Systems	2	Understand
6	Cryogenic Storage, Insulation, and Vacuum Systems	2	Understand

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO11	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	2	--	--	--	--	--	--	--	--	--	--	--	2	--
CO2	3	2	--	--	--	--	--	--	--	--	--	--	--	2	--
CO3	3	2	--	--	--	--	--	--	--	--	--	--	--	2	--
CO4	3	2	--	--	--	--	--	--	--	--	--	--	--	2	--

References:

TextBooks	
1	"Refrigeration and Air conditioning", Khurmi R. S., Gupta J. K, S. Chand Publication (Fifth edition)
2.	" Refrigeration and Air conditioning ", Arora C. P. , Khanna Publishers, New Delhi, 27th Edition.
3.	"Refrigeration and Air conditioning", Manohar Prasad., Willey Eastern Ltd, 1983
4.	"Refrigeration and Air conditioning",Ballaney P.L, Khanna Publishers, New Delhi, 1992
5.	"Basic Refrigeration and Air Conditioning",Ananthanarayanan, McGraw Hill Education 2013

6.	"Refrigeration and Air conditioning",R.K Rajput, S K KATARIA & SONS-NEW DELHI 2013
ReferenceBooks	
1	"Principles of refrigeration,", Dossat Ray J, Willey Eastern Ltd, 2000
2	"Refrigeration and Air conditioning",Stockers W.F and Jones J.W, McGraw Hill International editions 1982
3	"Air Conditioning Principles and Systems",Edward G. Pita, PHI 2002
4	ASHRAE & ISHRAE handbook

Web Links/ Video Lectures

Lectures 1 to 40. https://archive.nptel.ac.in/courses/112/107/112107208/

Sr. No.	Description	Signature
1	Name of Faculty A. S. Charan	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC5ME8042L - MODELLING AND SIMULATION OF MANUFACTURING SYSTEMS LAB

Practical: 02 hrs/week
Credits: 01

Evaluation Scheme:
ISA : 25 Marks

Course Objectives: The objective of the course is to
1. Develop simulation models for manufacturing systems using appropriate simulation software.
2. Apply random number generation and probability distributions in simulation experiments.
3. Perform verification and validation of simulation models.
4. Analyze simulation outputs for evaluating manufacturing system performance.
5. Apply Monte Carlo simulation techniques to solve industrial engineering problems.
6. Develop practical skills in interpreting and presenting simulation results for engineering decision-making.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Develop simulation models for manufacturing, inventory, and queuing systems using appropriate simulation software.	Evaluate
CO2	Perform verification, validation, and statistical analysis of simulation models to assess their correctness and performance.	Apply/ Analyze
CO3	Analyse simulation results to evaluate manufacturing system performance and identify opportunities for process improvement.	Analyze
CO4	Demonstrate the ability to conduct simulation experiments and present engineering solutions for real-world manufacturing problems.	Evaluate

Description:

This laboratory complements the theory course by providing practical exposure to modelling and simulation of manufacturing systems. Students develop simulation models using suitable software tools, conduct simulation experiments, verify and validate models, analyze input and output data, and evaluate manufacturing system performance. The laboratory includes industrial case studies that develop practical problem-solving and decision-making skills in manufacturing engineering.

Prerequisites:	1:	Basic knowledge of Probability and Statistics.
	2:	Basic knowledge of Numerical Mathematics and Optimization.
	3:	Basic knowledge of Manufacturing Processes and Systems.
	4:	Knowledge of Modelling and Simulation Theory.

Section – I		
Sr. No.	**Lab Activity**	**Assigned Hours**
1	Introduction to simulation software environment and modelling workflow	2
2	Random number generation using Linear Congruential Generator and randomness testing	4
3	Simulation of a single-server queuing system, a multi-server queuing system, and a single-item inventory control system	6
4	Event scheduling and discrete-event simulation modelling	2
5	Input data collection, probability distribution fitting, and goodness-of-fit testing	2
6	Verification and validation of simulation models	2
7	Output analysis and confidence interval estimation	2
8	Monte Carlo simulation for inventory decision-making	2
9	Simulation of a production line/assembly line	2

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	--	--	--	--	--	--	---	--	--	--	--	--	--	--
CO2	2	1	--	--	--	--	--	--	--	--	--	--	--	--	--
CO3	2	1	1	--	--	--	--	--	--	--	--	--	--	--	--
CO4	2	2	--	--	--	--	--	--	--	--	--	--	--	--	--
CO5	2	2	--	--	--	--	--	--	--	--	--	--	--	--	--
CO6	3	1	--	--	--	--	--	--	--	--	--	--	--	--	--

References:

Text Books	
1	Jerry Banks, John S. Carson II, Barry L. Nelson and David M. Nicol, Discrete-Event System Simulation, 5th Edition, Pearson.
2	Averill M. Law, Simulation Modeling and Analysis, 5th Edition, McGraw-Hill.
3	Geoffrey Gordon, System Simulation, PHI Learning.
Reference Books	

1	Narsingh Deo, System Simulation with Digital Computer, 3rd Edition, PHI Learning, 2004. ISBN: 978-0-87692-028-3
2	Frank L. Severance, System Modelling and Simulation: An Introduction, John Wiley & Sons, 2001.
NPTEL/Online Resources	
1	NPTEL Course: Simulation and Modelling, IIT Bombay — https://archive.nptel.ac.in/courses/112/107/112107220/
2	NPTEL Course: System Analysis and Simulation, IIT Delhi — https://nptel.ac.in/courses/112102014

Sr. No.	Description	Signature
1	Name of Faculty Dr. M. S. Dhuttargaon	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGPEC5ME8043L - AUTOMOBILE & ELECTRIC VEHICLES ENGINEERING LAB

Practicals : 2 hrs/ week
Credits : 1

Examination Scheme
ISA : 25 Marks

Course Objectives: The objective of the course is to
1. Learn different parts of Automobiles and Electric Vehicles. 2. Study various Automobile layouts and EV configurations. 3. Study various Automobile systems. 4. Study various types of electric vehicle batteries and motors.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Identify and explain the construction, components, materials, and working principles of automobile chassis, transmission, steering, suspension, braking, and EV systems.	Understand
CO2	Demonstrate the operation, assembly, and functional characteristics of automobile and electric vehicle systems using laboratory models and actual vehicles.	Understand Apply
CO3	Analyze the performance, faults, and troubleshooting methods of automobile transmission, steering, suspension, braking, and final drive systems.	Analyze
CO4	Inspect vehicle maintenance practices and compare conventional automobile systems with electric vehicle technologies through industrial visits and practical demonstrations.	Analyze

Description:

Automobile & Electric Vehicles Engineering Lab consists of a practical study of Automobiles and Electric Vehicles (different parts and systems) with help of demonstration. During Lab course students will demonstrate and compare various automobile systems, EV batteries and EV motors.

Prerequisites:	1:	I. C. Engines
	2:	Theory of Machines
	3:	Electrical Technology

Practicals: (All experiments are to be performed)

Sr. No.	Practical Topic	Hrs.	Bloom's Taxonomy
1	Study and demonstration of four-wheeler chassis layout, vehicle body types, body components, and body materials.	2	Understand
2	Study and demonstration of the construction and working of a single-plate automobile clutch, including clutch plate lining materials and their applications.	2	Understand Apply
3	Study and demonstration of a synchromesh gearbox, including gear shifting mechanism, interlocking mechanism, necessity of synchronizers.	2	Understand Apply
4	Study and demonstration of the final drive and differential system, including types of final drive gears.	2	Understand Apply
5	Study and demonstration of front wheel steering geometry, steering mechanisms, wheel alignment, and wheel balancing.	2	Analyze
6	Study and demonstration of conventional and independent suspension systems, their components, working principles.	2	Understand
7	Study and demonstration of a hydraulic braking system, including brake bleeding procedure, component inspection,	2	Apply
8	Study and demonstration of different types of electric vehicle batteries	2	Understand
9	Study and demonstration of Battery Management System (BMS) and different electric vehicle configurations.	2	Understand
10	Study and demonstration of different types of electric vehicle motors (BLDC, PMSM, Induction Motor, Switched Reluctance Motor) and their applications.	2	Understand
11	**Industrial Visit:** Visit to an automobile service station for the study of vehicle maintenance and repair practices **OR** visit to an electric vehicle manufacturing/service industry. Students shall submit a detailed technical report.	4	Analyze

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO 3
CO1	3	1	--	--	2	--	--	---	--	--	--	1	--	3	--
CO2	2	2	1	--	3	--	--	---	1	1	--	--	--	3	--
CO3	2	3	2	1	2	1	--	---	--	--	--	--	--	2	--
CO4	1	2	--	--	1	2	2	---	1	2	--	2	--	2	--

References:

Text Books	
1	"Automotive Mechanics", William Crouse, Donald Anglin, 10th Edition, McGraw Hill, India.
2	"Automobile Engineering", G.B.S. Narang., 3rd Edition, Khanna Publication
3	"Automobile Mechanics", Dr. N.K.Giri
4	"Modern Electric, Hybrid Electric & Fuel Cell vehicles" Mehrdad Ehsani, 2nd edition, CRC press.
5	"Electric & Hybrid Vehicles" Design fundamentals, Iqbal Husain, CRC press.
Reference Books	
1	"The Motor Vehicle", T.K. Garrett, K. Newton, W. Steeds, 13th Edition, Butterworth Heinemann, New Delhi.
2	"Automotive Mechanics", Joseph Heitner, 2nd Edition, Affiliated Eastern Law House, 1967.
3	"Electric cars: Technology" DelftX eCARS2x, Pavol Bauer, Marnix Wagemaker, TU Delft, The Netherlands
4	"ELECTRIC VEHICLE TECHNOLOGY EXPLAINED" 2nd Edition, James Larminie & John Lowry, WILEY, A John Wiley & Sons, Ltd., Publication.

Video Lectures / Practical

Sr. No.	Link
1	https://www.youtube.com/watch?v=Sh6qZ-Sh7Jk
2	https://www.youtube.com/watch?v=A3fHQsIkYeU&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=5
3	https://www.youtube.com/watch?v=pk-xvzuxMPA&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=6
4	https://www.youtube.com/watch?v=2CGPfkvCpXw&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=8

Sr. No.	Description	Signature
1	Name of Faculty: Prof.S.M.Gidaveer	for A Patil
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	Faculty

23UGELCME806LP - PROJECT PHASE –II

Practicals: 04 hrs./week
Credits: 04

Evaluation Scheme:
POE :75 Marks
ISA :100 Marks

Course Objectives:

1. Embed the skill in group of students to work independently on a topic/ problem/ experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.
2. Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	think creatively on real life engineering problem.	Knowledge, Understand,
CO2	apply engineering knowledge to deduce proper solution to real life engineering problems.	Knowledge, Understand, Application
CO3	work in a team and acquire collaborative skills to achieve common goals.	Knowledge, Understand, Application
CO4	learn independently, reflect on their learning and take appropriate actions to improve it.	Knowledge, Understand, Application Synthesis
CO5	communicate effectively and present ideas clearly with specific audience in written and oral forms.	Knowledge, Understand, Application Synthesis
CO6	Plan for activities in order to complete the task in predefined time.	Knowledge, Understand, Application Create

Description:

The project work phase I can be a design project / experimental project and or computer simulation project or any of the topics related with Mechanical engineering stream. The project phase I work is allotted in groups on different topics. The students' groups are required to undertake the project Phase-I during the seventh semester and the same is continued in the eighth semester (Phase-II). Project Phase-I consists of reviews of the work carried earlier and the submission of preliminary report. Report should highlight scope, objectives, methodology, approach and tools to be used like software and others, outline of project and expected results and outcome along with timeframe. The project phase I work is to be extended for project phase II at B. Tech. (Mech.) Sem. VIII with same group working under guidance of same Faculty member assigned for project phase I.

Prerequisites:	1	Fundamentals of Mechanical Engineering
	2	Report writing and Presentations Skills
	3	Basic Communication skills

Project Work Phase I Load:

A batch of maximum TWO groups of four to five students per group, shall work under one Faculty member of department. The group should comprise MINIMUM 3 Students.

Project work Phase I Term Work:

The term work under project submitted by students shall include

1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly. The contents of work diary shall reflect the efforts taken by project group for

a. Searching suitable project work

b. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring up the project.

c. Day to day activities carried out related to project work for entire semester.

d. Synopsis. The group should submit the synopsis in following form.

i. Title of Project
ii. Names of Students
iii. Name of Guide
iv. Relevance
v. Present Theory and Practices
vi. Proposed work
vii. Expenditure
viii. References

2.Synopsis: The synopsis shall be signed by each student in the group, approved by the guide and endorsed by the Head of the Department

3. Presentation: The group has to make a presentation in front of the Faculty members of department at the end of semester. Project Phase I Report Format: Project Phase I report should be of 20 to 25 pages (typed on A4 size sheets).

4. Project Work Phase I Report Format:

The following format should be strictly followed.

1. Page Size: Trimmed A4
2. Top Margin: 1.00 Inch
3. Bottom Margin: 1.32 Inches
4. Left Margin: 1.5 Inches
5. Right Margin: 1.0 Inch
6. Para Text: Times New Roman 12 Pt. font
7. Line Spacing: 1.5 lines
8. Page Numbers: Right aligned at footer. Font 12 Pt. Times New Roman
9. Headings: New Times Roman, 14 Pt., Bold face
10. References: References should have the following format

For Books: "Title of Book", Authors, Publisher, Edition

For Papers: "Title of Paper, Authors, Conference Details, Year

Important Notes:

1.Each Project group should continue maintaining a diary for project and should write
- (a) Book/s referred
- (b) Company/ies visited
- (c) Person/s contacted
- (d) Computer work done
- (e) Papers referred
- (f) Creative thinking.

2. The Diary along with Project Work Phase I Report shall be assessed at the time of oral examination
3. One copy of the report should be submitted to Institute/ Department, one copy to Guide and one copy should remain with each student of the project group.

In-Semester Assessment (ISA):

Department will constitute an Evaluation Committee to review the project phase I work. The evaluation committee consists of faculty members of which internal guide and another expert in the specified area of the project. The completion of work, the submission of the report and assessment should be done at the end of Part-I (Seventh semester).

Mark Distribution:

Concept – 05 Marks,
Work Done – 20 Marks,
Presentation – 15 Marks,
Report – 10 Marks

Practical Oral Examination (POE):

Oral examination shall be conducted with presentation of the project phase I.
The distribution of marks shall be
- 10 marks for contribution of the student in the project work
- 20 marks shall be awarded for achieving the objectives of the project set forth.
- 20 marks for Question/ Answer

*The external examiner shall be preferably an Industrial expert from the same field.

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2	2	2	3	--	3	--	--	--	3	2	--	1	1	1
CO2	3	3	3	--	3	1	2	2	1	2	2	2	1	1	1
CO3	--	--	--	--	--	--	--	2	3	2	3	2	--	--	--
CO4	3	--	--	3	3	--	2	--	2	3	2	3	3	3	3
CO5	--	--	--	--	2	--	--	--	--	3	--	--	--	--	--
CO6	--	--	--	--	--	--	--	3	--	--	3	--	2	2	2

Sr. No.	Description	Signature
1	Name of Faculty K.D Joshi	
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

23UGELCME805LP - INDUSTRIAL INTERNSHIP

Practical Hours: 10 hrs/week
Credits: 08

Evaluation Scheme:
ISA :100 Marks
POE :100 Marks

Course Objectives:

1. To bridge the gap between theoretical knowledge and industrial practice.
2. To provide exposure to real industrial environments and work culture.
3. To develop professional, technical, and communication skills.
4. To enhance problem-solving and decision-making abilities.

Course Outcomes:

COs	At the end of successful completion of the course, the student will be able to	Blooms Taxonomy
CO1	Understand industrial operations, workflow, and organizational structure.	Understand
CO2	Apply mechanical engineering concepts in real-world applications.	Apply
CO3	Identify and follow safety standards and industrial regulations.	Apply
CO4	Analyze practical problems and suggest feasible engineering solutions.	Analyze
CO5	Demonstrate professional ethics, teamwork, and communication skills.	Apply
CO6	Prepare and present a detailed technical internship report.	Create

Description:

Under Internship, every student will undergo minimum 8 to 12 weeks (of the respective academic year from February to April) training in an industry. Each student will study the working of different departments of industry with implemented manufacturing technologies. Similarly student will identify a technical problem from selected industry and try to find out a feasible solution of the same. Student has to prepare and submit its report to the institute.

The Internship Pattern course is designed to provide students with hands-on experience in a professional work environment related to their field of study. Students will have the opportunity to apply theoretical knowledge gained in the classroom to real-world scenarios and gain practical skills. Through internships, students will develop industry-specific competencies, enhance their professional network, and gain a deeper understanding of their chosen field.

Prerequisites:	1:	Domain Knowledge of Mechanical Engineering.

Course Content	
Module 1	**Industry Orientation**
	Introduction to industry and its organization structure Overview of departments Study of plant layout and workflow
Module 2	**Safety and Work Ethics**
	Industrial safety rules and regulations. Professional ethics and discipline
Module 3	**Technical Exposure**
	Study of machines, tools, and equipment
Module 4	**Practical Work / Training**
	Hands-on involvement in assigned tasks Observation and participation in real-time operations Problem identification and solution approach
Module 5	**Skill Development**
	Communication and teamwork Time management and work responsibility Industrial documentation and reporting
Module 6	**Report Preparation and Presentation**
	Daily logbook maintenance Preparation of internship report Presentation/Viva-voce examination

Internship execution procedure

The Internship Cell in association with Training and Placement Cell will arrange internship for students in industries/organization before the start of 8th semester. The following general procedure shall be adopted for execution of internship.

Step 1: Identification and Selection of Industries/Organizations

The **Identification and Selection of Industries/Organizations** is the first and most crucial step in the execution of the industry internship program. The quality of internship directly depends on selecting appropriate industries that provide meaningful technical exposure to Mechanical Engineering students.

Step 2: Student Registration and Data Collection

The **Student Registration and Data Collection** process is an essential step in the execution of the industry internship program. It ensures proper planning, fair allocation, and alignment of student interests with available industry opportunities.

Registration may be done through: Online portal (Google Form), Offline submission (registration form),

Student information contents personal details, academic details, area of interest.
Students who arrange internships on their own must submit:
Offer/confirmation letter from the company, Details of organization and work profile.
The Internship Cell or faculty coordinator shall:
Verify the submitted information, Check eligibility criteria (attendance, academic status, etc.), Ensure correctness of documents submitted.

Step 3: Internship Allocation

The **Internship Allocation** process is a critical step in ensuring that students are placed in suitable industries where they can gain meaningful and relevant practical exposure. This step is carried out by the Internship Cell in coordination with the Training and Placement Cell.
Based on the available opportunities, students shall be allotted internships considering:
Student preferences, Academic performance (if required), Availability of seats in industries.

Step 4: Issuance of Internship Letters

The **Issuance of Internship Letters** is an important administrative step that formally authorizes students to undergo internship training in an industry or organization. It establishes official communication between the institute and the industry and ensures that the student is recognized as an authorized intern.
The internship letters issued by the institute shall include essential details such as permission to undergo internship, duration of the internship, and the purpose of the internship. These letters must be duly approved and signed by the Head of Department or the Principal to ensure authenticity and official recognition.

Step 5: Internship Execution

The **Internship Execution** phase is the core component of the industry internship program, where students undergo practical training in an industrial environment. During this phase, students are expected to actively engage in real-world engineering activities, observe industrial processes, and develop technical as well as professional skills.
At the time of reporting to the organization students must carry internship letter and valid ID proof, Report to the designated authority or industry supervisor, Proper reporting ensures smooth on boarding and formal entry into the organization.
After reporting, the organization may conduct an induction program to familiarize students with:
Company background and organizational structure, Different departments and their functions, Rules, regulations, and workplace policies, Safety practices and emergency procedures.
Students shall maintain a daily logbook or internship diary throughout the internship period.
Daily activities performed, Machines and processes observed, Technical learning and key observations, Update diary regularly and get verified by the industry supervisor.

Step 6: Monitoring and Support

The **Monitoring and Support** phase ensures that the internship is progressing effectively and that students are gaining meaningful industrial exposure. It involves continuous interaction between the

institute, students, and industry to address any issues and guide students throughout the internship period.

A faculty member designated as the **Internship Coordinator** shall continuously monitor the progress of students throughout the internship.

The monitoring process includes:
Reviewing student activities and involvement in assigned tasks, Ensuring that students are regularly attending the internship, Checking maintenance of logbook/diary, Collecting periodic updates or progress reports from students.

The faculty coordinator shall ensure that the internship is relevant to Mechanical Engineering and students are actively learning and not just observing.

Internship Monitoring

Each student is assigned a faculty mentor by the institute who monitors the progress of both the internship and project and helps the student to sort-out in issues/problems arising. The faculty is scheduled to make visits during the internship.
Note: Apart from scheduled visits, faculty on request of students/company will visit in case of any issue related to the internship project.

Evaluation of Internship

The industrial training of the students will be evaluated in following three stages:

1. **Evaluation by Industry**

The industry will evaluate the **student's industry internship by an industry supervisor (30% weight age)**, the key is to make the assessment **structured, objective,** Punctuality, eagerness to learn, Maintenance of Daily Diary **and aligned with real workplace performance** rather than just attendance.

2. **Internship Report**

The internship report submitted by the students shall be evaluated individually by the faculty member based on report format, neatness of figures and tables, company profile, process explanation, engineering concepts, actual work carried out, observations, and skills gained. This evaluation will carry a weight age of 30% of the total internship assessment.

3. **Evaluation through presentation/viva-voce at the Institute**

The students shall deliver a presentation on their industry internship report in front of an expert committee constituted by the department as per norms of the institute. The evaluation is based on the

following criteria: Quality of content presented, proper planning for presentation, technical content, Effectiveness of presentation, Depth of knowledge and presentation skills , attendance record, daily diary, departmental reports shall also be analyzed along with the Internship Report. It will carry 40% weight age of the total internship evaluation.

Mapping of Pos & COs:

	01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2	2	1	--	--	2	--	--	1	1	--	--	--	1	1
CO2	3	2	2	1	2	--	--	--	--	--	--	--	2	2	2
CO3	--	--	1	--	--	3	2	2	--	--	--	--	--	--	1
CO4	1	3	3	2	1	--	--	--	--	--	--	--	2	1	1
CO5	--	--	--	--	--	1	--	3	3	3	2	--	--	--	--
CO6	--	1	--	--	--	--	--	1	--	3	--	2	--	--	--

Sr. No.	Description	Signature
1	Name of Faculty prof. P.B. Kadam	PBK
2	Syllabus Structure and Content of Course Verified	
3	Approval of Board of Studies Chairman	

Member Secretary
Board of Studies

DEPARTMENT OF MECH. ENGINEERING
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Tal. Panhala
T.K.I.E.T Warananagar

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T.K.I.E.T., Warananagar

Principal
T.K.I.E.T., Warananagar

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