SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,Ramanagar District- 562112

SCHEME AND SYLLABUS

B.Tech. PROGRAMME– 2023-2024

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

Definitions / Descriptions

Definition of Credit:	
1 Hour Lecture (L) Per Week	01 Credit
1 Hour Tutorial (T) Per Week	0.5 Credit
1 Hour Practical (P) Per Week	0.5 Credit
1 Hour Project (J) Per Week	0.5 Credit

Course code and Definition:	
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management Courses
IPCC	Integrated Professional Core Course
PCC	Professional Core Courses
PEC	Professional Elective Courses
OEC	Open Elective Courses
SEC	Skill Enhancement Courses
UHV	Universal Human Value Course
PROJ	Project Work
INT	Internship

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Devarakaggalahalli , Harohalli , Kanakapura Road ,
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Implementation of National Education Policy (NEP) 2020 for the B.Tech students of Batch 2023-24

The implementation of Curriculum follows NEP 2020 and addresses the following features and categories of courses:

1. Student Centric flexible curriculum.
2. Inter-disciplinary Courses,
3. Multi-disciplinary Courses,
4. Ability Enhancement Courses,
5. Skill Enhancement Courses,
6. Value Added Courses,
7. Product Design and Development,
8. Internship (Rural Internship, Industry Internship, Research/Development Internship), and
9. Multiple Exit and Multiple Entry
    - Certificate in Engineering after completion of first year.
    - Diploma in Engineering after completion of second year.
    - Advanced Diploma in Engineering after completion of third year.
    - Degree in Engineering after completion of fourth year

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

SCHEME 2023 – 2027 Batch

Department of Mechanical Engineering

III SEMESTER

S. N	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1	BSC	23ME2301	Transforms and Numerical Techniques	MAT	3	0	0	0	03	60	40	100	**3**
2	IPCC	23ME2302	Engineering Materials	Mech	2	0	2	0	04	60	40	100	**3**
3	IPCC	23ME2303	Fluid Mechanics and Machines	Mech	3	0	2	0	05	60	40	100	**4**
4	IPCC	23ME2304	Machining Process and Metrology	Mech	2	0	2	0	04	60	40	100	**3**
4	PCC	23ME2305	Thermodynamics	Mech	3	0	0	0	03	60	40	100	**3**
5	IPCC	23ME2306	Computer Aided Machine Drawing	Mech	1	0	4	0	05	60	40	100	**3**
6	AEC	23LSXXXX	Liberal Studies – I	Any Dept.	1	0	0	0	01	100	--	100	**1**
7	SEC	23ME23XX	Skill Enhancement Course – I	Mech	0	0	4	0	04	100	--	100	**2**
8	SEC	23ME2308	Cognitive and Technical Skills -III	--	0	0	4	0	04				**2**
			Total		15	0	18	0	33				**24**

Skill Enhancement Course – I			
23ME2309	Autodesk Innovation Lab		

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

IV SEMESTER													
S. N	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1	BSC	23ME2401	Probability and Statistics	MAT	3	0	0	0	03	60	40	100	**3**
2	IPCC	23ME2402	Applied Thermal Systems	Mech	3	0	2	0	05	60	40	100	**4**
3	PCC	23ME2403	Kinematics and Dynamics of Machines	Mech	3	0	0	0	03	60	40	100	**3**
4	PCC	23ME2404	Mechanics of Solids	Mech	3	0	0	0	03	60	40	100	**3**
5	IPCC	23ME2405	Heat Transfer	Mech	3	0	2	0	05	60	40	100	**4**
6	IPCC	23ME2406	Machine learning	Mech	2	0	2	0	04	60	40	100	**3**
7	SEC	23ME24XX	Skill Enhancement Course – II	Mech	0	0	4	0	04	100	--	100	**2**
8	SEC	23ME2407	Cognitive and Technical Skills -IV	--	0	0	4	0	04				**2**
			Total		17	0	14		31				**24**

Skill Enhancement Course – II			
23ME2408	Bosch Rexroth Innovation Lab		

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

V SEMESTER													
S. N	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1	PCC		Microprocessors and Microcontrollers	Mech/ECE	3	0	0	0	03	60	40	100	3
2	PCC		Technologies for Rural India	Mech/CSE	2	0	0	2	04	60	40	100	**3**
3	IPCC		Design of Machine Elements	Mech	3	0	2	0	05	60	40	100	**4**
4	IPCC		Industrial Automation and Robotics	Mech	2	0	2	0	04	60	40	100	**3**
5	IPCC		Thermal management of Electronic devices	Mech	2	0	2	0	04	60	40	100	**3**
6	PEC		Professional Elective Course – I/MOOC	Mech	3	0	0	0	03	60	40	100	**3**
7	SEC		Skill Enhancement Course – III	Mech	0	0	4	0	04	100	-	100	**2**
8	SEC		Cognitive and Technical Skills -V	--	0	0	4	0	04				**2**
			Total		15	0	14	02	31				**23**

Skill Enhancement Course – III			
	CAE Lab-I (CATIA)		XXXXX
	CAE Lab-II (ANSA)		XXXXX

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

VI SEMESTER													
S.N	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practica	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1	HSMC		Management and Entrepreneurship	Mech/Guest	3	0	0	0	03	60	40	100	**3**
2	IPCC		Finite Element method	Mech	3	0	2	0	05	60	40	100	**4**
3	PCC		Mechanical Vibrations	Mech	2	0	2	0	04	60	40	100	**3**
4	OEC		Open Elective – I	---	3	0	0	0	03	60	40	100	**3**
5	PEC		Professional Elective Course – II/MOOC	Mech	3	0	0	0	03	60	40	100	**3**
6	PEC		Professional Elective Course – III	Mech	3	0	0	0	03	60	40	100	**3**
7	SEC		Cognitive and Technical Skills -VI	--	0	0	4	0	04	60	40	100	**2**
			Total		17	--	8	0	29				**21**

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
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VII SEMESTER													
S. N	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1	HSMC		Fundamentals of Economics	Mech	3	0	0	0	03	60	40	100	**3**
2	IPCC		Instrumentation and Control	Mech	2	0	2	0	04	60	40	100	**3**
3	OEC		Open Elective – II	--	3	0	0	0	03	60	40	100	**3**
4	PEC		Professional Elective Course – IV / MOOC	Mech	3	0	0	0	03	60	40	100	**3**
5	PEC		Professional Elective Course – V	Mech	3	0	0	0	03	60	40	100	**3**
6	PROJ		Capstone Project Phase- 1	Mech	0	0	0	06	03	100	--	100	**3**
			Total		14	0	2	6	19				**18**

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

VIII SEMESTER													
S. N	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1	PROJ		Capstone Project Phase - 2	Mech	0	0	0	22	22	60	40	100	11
2	INT		Research Internship/ Industry Internship	Mech	0	0	6	0	06	100	--	100	03
			Total		0	0	6	22	28				**14**

NOTE: Total Credits (I-Sem to VIII Sem) = 164 credits.

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

S.N	Domain-wise	Domain Clusters	PROFESSIONAL ELECTIVE COURSES				
			PEC-I	PEC-II	PEC-III	PEC-IV	PEC-V
			5th Semester	6th Semester		7th Semester	
1	**Domain-1**	**ROBOTICS & AUTOMATION**	Sensors & Actuators	Drives & Control systems	Robot Kinematics and Dynamics	Automation and Control	Robot Manipulators
		Course Code					
2	**Domain-2**	**ADDITIVE MANUFACTURING**	Automated Manufacturing Systems	Materials for Additive Manufacturing	Processing Of Plastics & Composites	Computational Tools for Additive Manufacturing	Powder Metallurgy
		Course Code					
3	**Domain-3**	**HYBRID & ELECTRIC VEHICLES**	Introduction to Hybrid & Electric Vehicles	Autotronics	Automotive Chassis & Transmission Systems	Fundamental of Drives and DC Machine Modeling	Advanced Energy Storage
		Course Code					
4	**Domain-4**	**RENEWABLE ENERGY**	Solar Energy Engineering	Wind Energy Systems	Hydrogen Energy and Storage	Energy management and economics	Energy system modelling and Analysis
		Course Code					
5	**Domain-5**	**General Mechanical Engineering**	Refrigeration and Air-conditioning	Micro Electro Mechanical Systems (MEMS)	Total Quality Management	Computational Fluid Dynamics (CFD)	Tool Design
	MOOC		1	2	3		
		Course Code					

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

OPEN ELECTIVES:

Open Elective –I (OEC-I)	Course Code	Open Elective –II (OEC-II)	Course Code
Fluids & Thermal Engineering		Automobile Engineering	
		Total Quality Management and Reliability	
Materials for Engineering applications			
		Renewable Energy Sources	
Industrial Robotics		Rapid Manufacturing Technologies	

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

MINORS DEGREE PROGRAM

Sl. No	Course Name	Course Code	Credits	Semester
1	Engineering Materials		3	3
2	Mechanics of Solids		3	4
3	Thermal System Engineering		3	5
4	Digital Manufacturing (Theory & Practice)		3	5
5	Product Design and development (Theory & Practice) -		3	6
6	Advances in Mechanical Engineering (Robotics, Electric Vehicle & Green Energy)		3	7
			18	

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
Ramanagar District- 562112

General Instructions:

- **Open Elective Courses:** At least two courses must be provided from each department and the courses shall be general course on emerging areas with broad coverage of syllabus so that student shall chose without any difficulty.
- **Honors Degree:** An Honors degree typically refers to a higher level of academic achievement in the major area. That is, certificate in his/her OWN major for Research orientation. The Credit requirement: **172 to 178 credits** (Major worth 160 credits + Honors 12 to 18 credits)
- **Minor Degree:** Minor is a secondary concentration of courses that often complements the honors. Minor in any OTHER branch for Improving Employability.
    - Minor is an option rather than a requirement for B. Tech students. They may opt for one of the Engineering or Non-engineering discipline as Minor, earning additional credits ranging from 12 to 18. However, students are permitted to choose only one Minor either from engineering or Non-engineering discipline.
    - This opportunity is ideal for students who took a Major out of necessity but would still like to pursue their passion in another discipline or to enrich/equip them for a specific profession where greater job opportunities exist. Another advantage of opting for a Major with a Minor is to earn standing credits for pursuing a Master's degree abroad or within India too.
    - Only students who satisfy a set of minimum eligibility criteria set forth by the university and meet certain pre-requisites, will be permitted to opt for a Minor.
    - Credit requirement: **172 to 178 credits** (Major worth 160 credits + Minor 12 to 18 credits)
    - Degree nomenclature: The degree will contain the Major / Major with Specialization. The Minor pursued by the student will be provided in the transcript along with details on courses completed and associated credits earned.
    - For e.g., For a student who pursued Computer Science and Engineering with a Minor in Industrial Psychology, the degree will read "B. Tech in Computer Science and Engineering", Transcripts of B. Tech will reflect the Minor courses and the Minor certificate in Industrial Psychology will be issued separately.

SCHOOL OF ENGINEERING
Dayananda Sagar University
Devarakaggalahalli , Harohalli , Kanakapura Road ,
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TRANSFORMS AND NUMERIAL TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	23ME2301	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Apply** their knowledge of Laplace transforms and inverse Laplace transforms to proficiently solve linear ordinary differential equations with constant coefficients, facilitating the analysis and modelling of complex systems.
2. **Analyze** periodic functions using Fourier series, assessing the convergence properties and precision of the series expansion, thereby enhancing their ability to understand and manipulate periodic phenomena.
3. **Utilize** complex exponential form, Fourier transforms of basic functions, and Fourier sine and cosine transforms to solve problems involving Fourier integrals, developing proficiency in applying these techniques to various mathematical scenarios.
4. **Employ** numerical methods, including Euler's Method, Runge-Kutta 4th order, Adams-Bashforth, and Adams-Moulton Methods, to solve differential equations and effectively analyze dynamic systems, enabling them to model real-world phenomena and make accurate predictions**.**
5. **Apply** finite difference methods, including the Crank-Nicolson method and appropriate techniques for hyperbolic PDEs, to effectively solve different types of partial differential equations (PDEs) such as elliptic, parabolic, and hyperbolic equations, enhancing their problem-solving skills in the context of differential equations and their applications.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I: Laplace Transform and Inverse Laplace Transform	09 Hours
Laplace Transforms of Elementary functions (without proof), ***(Text Book-1: Chapter 6: 203 to 207).*** Laplace Transforms of $e^{at}f(t), t^n f(t)$ and $\frac{f(t)}{t}$, Periodic functions, Unit step function and impulse functions ***(Text Book-1: Chapter 6:208-230)***. Inverse Laplace Transforms- By the method of Partial Fractions, Logarithmic and Trigonometric functions, Convolution Theorem, Inverse Laplace transform using Convolution Theorem ***(Text Book-1: Chapter 6: 238)***. Solution to Differential Equations by Laplace Transform. ***(Text Book-1: Chapter 238-242)***.	
UNIT – II: Fourier Series	**09 Hours**
Periodic Functions, Trigonometric Series ***(Text Book-1: Chapter 11: 495).*** Fourier series Standard function, Functions of any Period 2L, Even and Odd functions, Half-range Expansions. ***(Text Book-1: Chapter 11: 483-492).*** Practical Harmonic analysis (calculate average power and RMS values of periodic waveforms)	
UNIT – III: Fourier Transform	**06 Hours**
Calculation of Fourier integrals using complex exponential form ***(Text Book-1: Chapter 11: 510).*** Fourier transform of basic functions ***(Text Book-1: Chapter 11: 510-516).*** Fourier sine and cosine transforms. ***(Text Book-1: Chapter 11: 518-522).***	
UNIT – IV: Numerical Methods for Solving Ordinary Differential Equations	**07 Hours**
Euler's Method-Basic principles of Euler's method for solving first-order ODEs ***(Text Book-1: Chapter 1:10-12).*** Runge-Kutta 4th order ***(Text Book-1: Chapter 21:904).*** Multistep Methods-Explanation of multistep methods (Adams-Bashforth, Adams–Moulton Methods) ***(Text Book-1: Chapter 21:911-913).*** Second-Order ODE. Mass–Spring System (Euler Method, Runge–Kutta Methods) ***(Text Book-1: Chapter 21:916-918).***	
UNIT – V: Numerical Methods for Partial Differential Equations	**08 Hours**
Classification of PDEs (elliptic, parabolic, hyperbolic), ***(Text Book-1: Chapter 21:922-923).*** Finite Difference Methods (Laplace and Poisson Equations), Derivation of finite difference approximations ***(Text Book-1: Chapter 21:923-927).*** Crank–Nicolson Method ***(Text Book-1: Chapter 21:938-941).*** Method for Hyperbolic PDEs ***(Text Book-1: Chapter 21:943-945).***	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Apply Laplace transforms and inverse Laplace transforms to solve linear ordinary differential equations with constant coefficients, demonstrating proficiency in system analysis and modelling.
2	Analyse periodic functions using Fourier series and evaluate the convergence properties and precision of the series expansion.
3	Solve problems involving Fourier integrals by applying complex exponential form, Fourier transforms of basic functions, and Fourier sine and cosine transforms.
4	Utilize numerical methods such as Euler's Method, Runge-Kutta 4th order, Adams-Bashforth, and Adams-Moulton Methods to solve differential equations and analyze dynamic systems
5	Apply finite difference methods, including the Crank-Nicolson method and appropriate techniques for hyperbolic PDEs, to solve various types of partial differential equations (PDEs) such as elliptic, parabolic, and hyperbolic equations.

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2	1					1					
CO2	3	2	2						1					
CO3	3	2	2	1					1					
CO4	3	2	2	1					1					
CO5	3	2	2	1					1					

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, Wiley India.

REFERENCE BOOKS:

1. Higher Engineering Mathematics, B.S. Grewal, 2015, 43rd Edition, Khanna Publishers.
2. Higher Engineering Mathematics, John Bird, 2017, 6 th Edition, Elsevier Limited.

E-Resources:

1. https://nptel.ac.in/courses/111106139
2. https://nptel.ac.in/courses/111101164
3. https://nptel.ac.in/courses/111105038

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ENGINEERING MATERIALS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	23ME2302	**Credits**	:	03
Hours / Week	:	04 Hours	**Total Hours**	:	26+26 Hours
L–T–P–S	:	2–0–2–0			

Course Learning Objectives:

This course will enable students to:

1. **Analyse** the atomic/molecular structure difference between crystalline and non-crystalline materials.
2. **Determine** the tensile, compression, shear, and bending deformations of the metal specimen and describe the changes in specimen profile up to the point of fracture.
3. **Explain** the various phases present, composition, and mass fractions of the phases from a binary phase diagram.
4. **Understand** the types and applications of ceramics and polymers.
5. **Learn** the different manufacturing processes for composite materials.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method but different *types of teaching methods* that may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain the functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.
- Adopt ***Problem-Based Learning***, which fosters students' Analytical skills, and develops thinking skills such as evaluating, generalizing, and analysing information rather than simply recalling it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.
- **Practical experimentation** of material testing of different metals and alloys

UNIT – I	05 Hours

INTRODUCTION TO MATERIALS:
Introduction to materials, Overview of Crystal Structure, Solid Solutions, Hume Rothery Rules, Crystal Imperfections, Critical nucleus size, and Critical Free Energy.
CRYSTALLIZATION:
Mechanism of Crystallization, Nucleation, Nucleation- Growth, Single crystal, Polycrystalline Materials, Basic principles of solidification of metals and alloys. Solidification time, Cooling curves, Non- crystalline solids. functions

UNIT – II	05 Hours

TESTING OF MATERIALS:
Testing of materials under tension, compression, and shear loads, Hardness tests, fatigue, and creep test. Impact testing.
FATIGUE AND FRACTURE TEST:
Fatigue testing, Fracture, Types, Fracture mechanics. Characteristics of creep curve & steady-state creep. Fracture toughness &fatigue, Stress, and temperature effects.

UNIT – III	06 Hours

EQUILIBRIUM PHASE DIAGRAMS:
Particle strengthening by precipitation. Precipitation reactions. Phase Rule, Unary System, Binary Phase diagrams, and Iron-carbon system.
PHASE TRANSFORMATIONS.
Transformation rate effects and Isothermal transformations (TTT Curves), Continuous cooling transformations, Microstructure and property changes in the iron-carbon system, Iron-carbon equilibrium diagram, and Heat treatments.

UNIT – IV	05 Hours

STEEL AND MATERIAL PROPERTIES:
Classification of steels and cast iron, Microstructure, Effect of alloying elements on steel, Ferrous alloys, and their applications, High Resistivity and High-temperature alloys, Selection of material for various applications- case studies.
CERAMICS:
Ceramics, Glass Ceramics, Advanced Ceramics, Functional properties and applications of ceramic materials and Glasses.

UNIT – V	05 Hours

OPTICAL PROPERTIES OF MATERIALS
Electromagnetic radiation, light interaction with solids, atomic and electronic interaction, refraction, reflection, and absorption.
Light-emitting diodes, lasers, and optical fibres in communication

LAB COMPONENT

1. Tension Test- To understand the tensile characteristics of mild steel through tensile testing and thereby determine mechanical properties such as ultimate tensile strength, elastic modulus, proportionality limit, yield point, fracture stress, percentage elongation & reduction in area.
2. Compression Test- To determine the compressive strength of aluminium and cast-iron specimens and to identify the failure modes of ductile/brittle materials through evaluation of their failure modes of the above material.
3. Shear Test - To determine the ultimate shear strength of aluminium under single and double shear.

4. Bending Test - To investigate the relationship between load and span on the deflection of a simply supported beam Courseed to a concentrated load at the center. Also, evaluate the modulus of elasticity of the given beam from the test data.
5. Impact Test (Charpy and Izod) - To evaluate the energy absorbed during failure of a notched specimen Courseed to pendulum impact testing.
6. Brinell hardness Test -To determine the Brinell Hardness Number (BHN) of the given specimens.
7. Vicker's Hardness Test - To determine Vickers Hardness Number for a given specimen.
8. Wear Test - To understand the parameters that affect the wear rate using pin and disc apparatus.
9. Composite preparation- preparation of polymer composites through hand lay-up, vacuum bagging, and resin transfer molding process.
10. Demonstration of 3D printing of given polymer/metal/ceramic specimens

Course Outcome	Description
At the end of the course the student will be able to:	
1	Apply fundamental concepts of material science, including crystal structures, solid solutions, and crystallization mechanisms, to evaluate the mechanical properties of materials and also analyse fatigue behaviour under various loading conditions
2	Analyse equilibrium phase diagrams and phase transformations to understand and predict microstructure and property changes in materials, with a focus on the iron-carbon system and heat treatments.
3	Investigate the classification, microstructure, and properties of steels, cast irons, and ceramics to identify suitable materials for various engineering applications.
4	Investigate optical properties and interactions of materials to apply principles in developing LEDs, lasers, and optical fibres for communication.
5	Interpret various mechanical tests, including tension, compression, shear, bending, impact, hardness, and wear tests, as well as prepare and assess polymer composites

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	1	1	-	1	1	-	-	-	2	2
CO2	3	3	2	2	2	1	1	-	-	-	-	-	2	2
CO3	3	3	2	1	2	2	1	-	1	-	-	-	2	3
CO4	3	2	2	1	2	1	1	-	1	-	-	-	2	2
CO5	2	2	3	2	-	-	0	1	1	2	1	-	3	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. William D. Callister, Jr. (2020) "Materials Science and Engineering an Introduction", 2nd Edition, John Wiley & Sons, Inc.
2. V. Raghavan (2019), "Materials Science and Engineering", Prentice–Hall of India Pvt. Ltd

REFERENCE BOOKS:

1. J.M. Shackelford (2014), Introduction to Materials Science for Engineers, 5th Edition, Prentice Hall, Inc.
2. Suryanarayana, A. V. K. (2020), Testing of Metallic Materials, Prentice Hall India, New Delhi.
3. W. Bolton (2013), Engineering materials technology, 3rd Edition, Butterworth & Heinemann.

E-Resources:

1. https://nptel.ac.in/courses/113107078
2. https://nptel.ac.in/courses/103105219
3. https://nptel.ac.in/courses/112107221
4. https://www.coursera.org/learn/crystal-structures-and-properties-of-metals?

Activity-Based Learning (Suggested Activities in Class)

1. Real-world problem-solving and puzzles using group discussion. E.g. material identification, microstructure study of materials using an Optical microscope, etc.,
2. Demonstration of the fabrication of material using different techniques like stir casting, Hand layup, etc.

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FLUID MECHANICS AND MACHINES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	23ME2303	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	39+26 Hours
L–T–P–S	:	3–0–2–0			

Course Learning Objectives:

This Course will enable students to:

1. **Define** basic properties of fluids and understand the continuum approximation.
2. **Describe** Lagrangian and Eulerian Approach for fluid flow Buckingham's Pi theorem
3. **Apply** dimensional analysis to design new pumps or turbines that are geometrically similar to existing pumps or turbines
4. **To study** the performance parameters of Impulse and Reaction turbines like Pelton wheel turbine, Francis turbine and Kaplan turbine
5. **To study** the performance parameters of Reciprocating, Centrifugal and Gear pumps

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**

Fluid Properties and Fluid Statics

Introduction, properties of fluids, viscosity, thermodynamics properties, surface tension and capillarity, vapour pressure. Types of fluid flows Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, Fluid Statics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid.

(Text Book-1: Chapter 1: 1.1 to 1.2)

UNIT – II	08 Hours
Fluid Kinematics and Dynamics Lagrangian and Eulerian Approach for fluid flow, Continuity equation Velocity and acceleration in a flow field, Potential and stream function, **Fluid Dynamics** Introduction, Equation of motion, Euler's equation of motion, and Bernoulli's equation derived from fundamental &Euler's equation, Bernoulli's equation for real fluids. Fluid Flow measurements-Venturimeter, orifice meter and Pitot tube. Flow through Pipes-Major & Minor losses in pipe flow. Numerical exercise. of large integers, ***(Text Book-2: Chapter 7: 7.1 to 7.6)***	
UNIT – III	**06 Hours**
Dimensional Analysis and Boundary Layers Introduction, Dimensional homogeneity –Buckingham theorem – Non-dimensional numbers – Model laws; Unit Quantities and Specific quantities, introduction to boundary layer theory – Laminar flow and Turbulent flow – Boundary layer thickness. ***(Text Book-2: Chapter 7: 7.2 to 7.3)***	
UNIT – IV	**09 Hours**
Hydraulic Turbines Euler's Turbine equation, Classification of turbines, Impulse and reaction turbines, Pelton wheel, Francis and Kaplan turbine –work done and efficiencies. Draft tube theory, Performance of hydraulic machines, unit and specific quantities, turbine governing. The Knapsack problem ***(Text Book-2: Chapter 9.1: 9.6).***	
UNIT – V	**08 Hours**
Pumps Classification, working, work done – monometric head- losses and efficiencies- specific speed-pumps in series and parallel-performance characteristic curves, NPSH. Reciprocating pumps: Working, Discharge, slip. ***(Text Book-2: Chapter 14: 14.1, 14.7***)	
List of Laboratory/Practical Experiments activities to be conducted (if any) : 26Hrs	
1. Rotameter Calculation of the Rate of Flow Using Rotameter	
2. Venturimeter Determination of the Co- Efficient of Discharge of the Venturimeter	
3. Orifice Meter Determination of the Co-Efficient of Discharge of the Given Orifice Meter	
4. Pipe Friction Determination of frictional loss in a pipe flow	
5. Pipe Fittings Determination of Loss of Head on Pipe Fittings	
6. Notch Determination of Co- efficient of Discharge of the Given Notch	
7. Centrifugal Pump Study of Performance Test On Centrifugal Pump	
8. Reciprocating Pump Study of Performance Test On Reciprocating Pump	
9. Gear Pump Test Rig Study of Performance Test On Gear Pump	
10. Pelton Wheel Turbine Study of Performance Test on Pelton Wheel Turbine	
11. Francis Turbine Study of Performance Characteristics Curves of Francis Turbine	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Analyse the rheological behaviour to classify fluids, and determine the pressure, velocity, and acceleration at a point in both static and moving fluids.
2	Apply Bernoulli's equation for a real fluid flowing between two sections for various engineering applications like measurement of discharge and estimation of losses
3	Develop non-dimensional groups for a physical phenomenon dependent on number of variables and also predict different flow regimes possible in case of a fluid -solid interaction based on Reynold's number
4	Calculate the power produced/ consumed and efficiencies obtained for a hydraulic machine by drawing the velocity triangles obtained from liquid and solid interaction
5	Compute the discharge, losses in a pipe flow and also predict performance of hydraulic machines for different operating conditions like varying load and discharge

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	3	-	-	-	-	-	-	-	-	3
CO2	3	2	2	2	2	-	-	-	-	-	-	-	-	3
CO3	3	3	1	3	2	-	-	-	-	-	-	-	-	3
CO4	3	3	3	2	2	-	-	-	-	-	-	-	-	3
CO5	3	3	3	3	2	-	-	-	3	2	1	-	-	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Textbooks:

1. Lal, J. (2016). *Hydraulic Machines*. Metropolitan Book Company Limited.
2. Cengel, Y. A., & Cimbala, J. M. (2006). *Fluid Mechanics: Fundamentals and Applications*. Tata McGraw-Hill Publishing Co. Ltd.

Reference Books:

1. Munson, B. R., Young, D. F., Okiishi, T. H., & Huebsch, W. W. (2009). *Fundamentals of Fluid Mechanics*. John Wiley & Sons Publications.
2. White, F. M. (2011). *Fundamentals of Fluid Mechanics*. John Wiley & Sons Publications.

E-Resources:

1. https://open.umn.edu/opentextbooks/textbooks/85
2. https://library.iitd.ac.in/index.php/node/81851
3. https://www.constructionplacements.com/books-on-fluid-mechanics/
4. https://searchworks.stanford.edu/view/11842972

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Machining Process and Metrology

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	23ME2304	**Credits**	:	03
Hours / Week	:	04 Hours	**Total Hours**	:	26+26 Hours
L–T–P–S	:	2–0–2–0			

Course Learning Objectives:

This Course will enable students to:

1. Understand the basic fundamentals and mechanics of metal cutting, tool geometry and life.
2. Explain the basic knowledge of various non-traditional machining processes
3. Impart knowledge on CNC machining operation
4. Describe and illustrate the concept of slip gauges and wringing phenomenon and Study on different types of mechanical and electrical compactors
5. Study the limits, fits, tolerances and gauges.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I MODULE 1: Theory of Metal Cutting	**05 Hours**

Types of cutting tool materials, cutting fluids, Single & Multi point cutting tool nomenclature, orthogonal and oblique cutting, mechanism of chip formation, types of chip, merchant analysis, Ernst-merchant's solution, shear angle relationship, problem of merchant's analysis, tool wear and tool failure effects of cutting parameters, tool life criteria, Taylor's tool life equation, problems.

. ***(Text Book-1: Chapter 1: 1.1 to 1.2)***

UNIT – II: Non-Traditional Machining Processes	**05 Hours**

Introduction, Classification, Abrasive jet machining, Ultrasonic machining, Water jet machining, Abrasive Water Jet Machining, Electro chemical machining, Electro Chemical Grinding, Electro-

discharge machining, Laser beam machining, Electron Beam Machining, Chemical Milling, Photochemical Milling process characteristics – applications, advantages and disadvantages.	
UNIT – III: Computer Numerical Control & Part Programming	**06 Hours**
Fundamentals of numerical control, advantages & classification of NC systems, Functions of MCU, principles of operation features, functions of CNC, Manual part programming, Codes and concepts, point to point and contour programming examples, 2-D simple problems of Drilling, Turning and Milling.	
UNIT – IV: Standards of Measurement in Metrology	**06 Hours**
Concept of metrology, role of standards, and standards of length Principles, calibration of standards, numerical problems, and slip gauges, set of gauges, wringing phenomena, manufacture of slip gauges. Numerical problems on building of slip gauges, Errors in measuring instruments, classification of errors, sources of errors and uncertainty. **Comparators** - mechanical, electrical, pneumatic and optical comparators **Advances in Metrology** Basic concept of lasers, laser Interferometers. Basic concept of CMM, Types of CMM.	
UNIT – V : System of Limits, Fits, Tolerance and Gauging	**04 Hours**
Indian standards, concept of limits of size and tolerances, interchange ability, selective assembly definition of fits, hole basis system, shaft basis system, types of fits and their designation, geometric tolerance. Classification of gauges, brief concept of design of gauges (Taylor's principles), Numerical problems.	
List of Laboratory/Practical Experiments activities to be conducted: 26 Hrs	
1. To Study Construction, Working and Performing Operations on a Lathe, Drilling, Grinding & Shaping Machine	
2. To study tool wear and tool life measurements for machinability	
3. Introduction of Computer Numerical Control Machines and working of few Models on CNC machine.	
4. Calibration of Micrometer, Vernier caliper, Thermocouple, Linear Variable Differential Transformer (LVDT), Load Cell To calibrate and measure the given component by using Micrometer, Vernier caliper, Thermocouple, Linear Variable Differential Transformer (LVDT), Load Cell	
5. Measurements using Optical Profile Projector, Toolmaker's Microscope To measure the screw thread parameters of a given specimen using Optical Profile projector & Tool Maker's Microscope	
6. Measurements of angle using Sine bar & universal bevel protractor To determine the unknown angle of the given specimen using sine bar with the help of slip gauge & universal bevel protractor	
7. Measurements of Screw thread parameters using two wire or three-wire methods - To find the effective diameter of a given screw thread by two or three wire method.	
8. Measurements of gear tooth profile using gear tooth Vernier caliper - To Measure the tooth thickness of the given gear using Gear Tooth Vernier Caliper	
9. Study the mechanism and working of 3D Printing machine	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Analyse and apply machining principles to optimize machining processes for efficiency and quality.
2	Evaluate and differentiate non-traditional machining processes suitable for advanced applications in machining.
3	Examine the operational mechanics of CNC machines and formulate part programs for 2D milling and drilling operations.
4	Apply measurement standards and system, Comparators and Slip gauges to calculate related errors during measurements.
5	Calculate tolerance, limits of size, fits, gauges and the various design concepts in gauging

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	3	-	1	-	-	2	-	1	2	-
CO2	3	2	2	3	2	1	1	-	-	-	-	2	2	-
CO3	2	2	3	2	1	2	-	-	-	-	-	2	3	-
CO4	3	3	3	3	2	1	1	-	-	2	-	2	3	-
CO5	3	2	3	2	3	1	1	-	3	2	-	1	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. P.N. Rao (2018) "Manufacturing Technology – Metal Cutting and Machine Tools," Volume-II,4 Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. R.K. Jain (2009), Engineering Metrology, Khanna Publishers, New Delhi.

REFERENCES:

1. M. P. Groover (2019), "Fundamentals of Modern manufacturing" -materials, processes and systems Third Edition, Wiley publications, 7th Edition.
2. Kaushik Kumar, Chikesh Ranjan and Paulo Davim (2020) CNC Programming for Machining, Springer International Publishing.
3. Ernest O. Doebelin (2019), Measurement Systems: Application and Design, SIE Publications
4. Beckwith Marangoni and Lienhard (2006), Mechanical Measurements, Pearson Education, 6th Edition

E-Resources:

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion. E.g., Fake coin identification, Cabbage puzzle, Konigsberg bridge puzzle etc.,
2. Demonstration of solution to a problem through programming.

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THERMODYNAMICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	23ME2305	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Introduce** basic concepts related to thermodynamic system
2. **Understand** Zeroth law of thermodynamics as basis for temperature measurement. · Define first law of thermodynamics as applied to a closed and open systems
3. **Explain** working of heat engine and refrigeration cycles and to define second law of thermodynamics: Kelvin Planck and Clausius Statement.
4. **Understand** the property entropy through Clausius inequality
5. **Understand** behaviour of ideal and real gases through equation of state and compressibility factor.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**

INTRODUCTION:

Basic Concepts of Thermodynamics: Introduction- Basic Concepts, Thermodynamic Equilibrium, Thermodynamic properties, Thermodynamic state, state point, path and process, quasi-static process, cyclic and non-cyclic processes, Energy and its forms, Work and heat (sign convention), Zeroth Law of Thermodynamics: Zeroth law of thermodynamics statement, Concept of Temperature and its' measurement. ***(Text Book-1: Chapter 1: 1.1 to 2.11)***

UNIT – II	08 Hours
First law of thermodynamics: Application to closed and open system, Joules experiments, equivalence of heat and work, Internal energy and enthalpy, energy as a property, specific heat at constant pressure and volume, PMM1, steady state, steady flow energy equation (SFEE), extension of first law to control volume, Limitations of first law of thermodynamics, Extension of SFEE to Various devices like-nozzle, turbine , pump/compressor, heat exchanger***(Text Book-1: Chapter 4: 4.1 to 5.4)***	
UNIT – III	**06 Hours**
Second Law of Thermodynamics: Thermal reservoirs, , devices converting work to heat in a thermodynamic cycle, heat engine, Efficiency reversed heat engine, heat pump, Refrigerator, Coefficient of Performance, Kelvin-Planck and Clausius statement of second law of thermodynamics, Equivalence of the two statements, reversible and irreversible processes, factors that make a process irreversible, Carnot cycle and Carnot engine, Carnot theorem and its corollaries. ***(Text Book-1: Chapter 6: 6.1 to 6.18)***	
UNIT – IV	**08 Hours**
Entropy: Classius Inequality: - Statement, proof, application to a reversible cycle, Entropy: Definition, a property, principle of increase of entropy, entropy as a quantitative test for irreversibility, Tds equation, calculation of entropy using TdS relations, entropy as a coordinate, Exergy(Available) and unavailable energy, Second law efficiency. ***(Text Book-1: Chapter 7: 7.1 to 7.18)***	
UNIT – V	**09 Hours**
Pure substance: Phase change process in a pure substance, Definition of triple, ice, steam and critical points, Property diagrams of pure substance, p-v, p-T, p-h, T-v, T-s diagrams, dryness fraction, use of steam tables. ***(Text Book-1: Chapter 9: 9.1 to 9.8)*** **Ideal and Real Gases** Gas laws- Boyle's Law, Charles Law, Gay-Lussac Law, Avogadro's law, equation of state - Vander Waals, Redlich-Kwong, Peng- Robinson etc. compressibility factor. ***(Text Book-1: Chapter 10: 10.1 to 10.19)***	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Apply laws of thermodynamics in temperature measurement and also calculate work and heat interaction of system with the environment
2	Analyse closed and open system performance using second law of thermodynamics
3	Calculate entropy change of a system and surrounding by undergoing a thermodynamic process
4	Estimate the maximum work potential of energy source based on the laws laid down by thermodynamics
5	Calculate thermodynamic properties of a pure substance in a given state

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	3	1	-	-	-	-	-	-	-	-	2
CO2	3	3	3	3	1	-	-	-	-	-	-	-	-	3
CO3	3	3	3	3	1	-	2	-	-	-	-	-	-	2
CO4	3	3	3	3	1	-	-	-	-	-	-	-	-	2
CO5	3	3	3	3	1	-	-	-	-	-	-	-	-	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. P.Nag (2017), Basic & Applied Thermodynamics, 2nd Edition, Mc Graw Hill Education.
2. Van Wylen, G.J., and Sonnatag, R.E., (2002), Fundamentals of Classical Thermodynamics for Engineers, 6th Edition, Wiley.

REFERENCE BOOKS:

1. Yunus A Cengel and Michael A Boles (2017), Thermodynamics: An Engineering Approach, McGraw Hill Education.
2. Michael J. Moran, Howard N. Shapiro (2006), Fundamentals of Engineering Thermodynamics, John Wiley & Sons Ltd, Chichester.

E-Resources:

1. https://nptel.ac.in/courses/102106026
2. https://www.classcentral.com/course/edx-thermodynamics-of-materials-21137
3. https://www.askiitians.com/iit-jee-thermal-physics/introduction-to-thermodynamics/
4. https://www.coursera.org/learn/thermodynamics-intro

Activity Based Learning (Suggested Activities in Class)

1. Use of simulations and modelling software to explore complex thermodynamic systems and see how changes in variables affect the overall behaviour of the system. For example, students could use a simulation to explore how changes in pressure and temperature affect the behaviour of a gas.
2. Experiments can help students visualize and experience the concepts they are learning about in class. For example, students could conduct experiments to measure the specific heat capacity of different materials or to observe phase changes in different substances.

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COMPUTER AIDED MACHINE DRAWING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	23ME2306	**Credits**	:	03
Hours / Week	:	05 Hours	**Total Hours**	:	65 Hours
L–T–P–S	:	1–0–0–4			

Course Learning Objectives:

The objectives of the Course are to:

1. Provide overview of various CAD software
2. Learn basics of sketching features
3. Create 3D models using extrude, revolve, draft & other advanced options
4. Introduce assembly concepts
5. Create simple & complex mechanical assemblies
6. Create industrial standard drawings with appropriate views including sectional views

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

Lecture method means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.

Interactive Teaching: *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.

- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I CAD OVERVIEW — 05 Hours

CAD OVERVIEW:

Preferences-Settings, User Interface- Familiarize the User Interface by creating a simple design Familiarize The User Interface of Fusion 360 (Toolbar, Marking Menu, Browser, And Time Line Controls, Change of Workspace) Familiarize the User Interface of FUSION 360 (Navigations and data panel interface, Design Units and Origin, Quick Shape Creation) Use of toolbar, marking menu, browser and time line controls, change of workspace, Navigations and data panel interface, Design Units and Origin, Quick Shape Creation.

(Text Book-1: Chapter 1)

UNIT – II SKETCHING WORKSPACE — 10 Hours

SKETCHING WORKSPACE:

Sketching Workspace: Creating a sketching geometry - Introduction to the Sketching Workflow

Sketch Entities,
(Text Book-1: Chapter 2)
Dimensioning, Sketch Constraints.
(Text Book-1: Chapter 3)
Additional Sketching Tools- Additional Entity Types, Editing Tools, Additional Dimension Tools, Moving and Copying, Rectangular and circular Patterns. Sketched Secondary Features using existing geometry. Pick and Place Features- Fillets, Chamfers, Holes, Editing Pick and Place Features. Construction of planes, axis and points, creating a sketch using Equation and Parameters.
(Text Book-1: Chapter 4)

UNIT – III SOLID MODELLING	**15 Hours**

SOLID MODELLING
Introduction-Solid Modelling Basic Part modelling features- Extrude and revolve. Additional Features and Operations- Draft, Shell, Rib, Split Face, Scale, Thread, Press Pull. Direct Modelling Development of multi section solids and sweep. Feature Duplication – mirroring and patterning.
(Text Book-1: Chapter 5, 6 & 7)
Design and Display Manipulation- Reordering, inserting, suppressing Features, Measure and Section Analysis, Develop the part models and prepare the drafting. List out the operations involved to prepare the components.
(Text Book-1: Chapter 8, 9 & 10))

UNIT – IV ASSEMBLY	**15 Hours**

ASSEMBLY
Distributed Design- Assembly Design Methods, Joint Origins and Assigning Joints. Component Design Tools- Rigid Groups, Interference Detection Multi-Body Design- Multi- Body Design Tools, Components, As-Built Joints
(Text Book-1: Chapter 11& 12)
Drawing Basics-Creating a New Drawing, Additional Drawing Views, Exploded Views, Manipulating Drawings. Detailing Drawings- Dimensions, Parts List and Balloons, Annotation and Dimension Settings, Drawing Output. Data exchange standards – IGES, STP, STL, STEP etc
(Text Book-1: Chapter 14))

UNIT – V MACHINE ASSEMBLY	**20 Hours**

MACHINE ASSEMBLY
Develop the assembly drawing from the given detailed drawing (Swivel bearing) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.5.8)
Develop the assembly drawing from the given detailed drawing (steam engine connecting rod end) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 19: 19.2)
Develop the assembly drawing from the given detailed drawing (Pressure relief valve) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.4.8)
Develop the assembly drawing from the given detailed drawing (Machine vice) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.3.9)

Develop the assembly drawing from the given detailed drawing (Tailstock) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.3.5)
Develop the assembly drawing from the given detailed drawing (Piston of a petrol engine) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.2.6)
Develop the assembly drawing from the given detailed drawing (Air valve) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.2.10)
Develop the assembly drawing from the given detailed drawing (Fuel Injector) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.2.11)
Develop the assembly drawing from the given detailed drawing (Speed reducer) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.5.15)
Develop the assembly drawing from the given detailed drawing (Drill jig) showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly
(Text Book-2: Chapter 18: 18.3.11)

Course Outcome	Description
At the end of the course the student will be able to:	
1	Evaluate the functionality of different tools and features within a CAD tool for machine assembly requirements.
2	Employ sketching tools and features in a CAD tool to create precise and complex 2D sketches, considering appropriate sketch entities, dimensions, and constraints.
3	Utilize design constraints and parameters in a CAD tool to develop parametric 3D models, allowing for modification and adaptation of empirical relations.
4	Assess machine assembly models in a CAD tool, to identify any potential interferences, clashes, or design issues.
5	Generate precise and professional manufacturing drawings with appropriate dimensions, annotations, and GD&T symbols using CAD tools.

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	-	2	-	-	-	-	-	-	1	3	-
CO2	3	1	1	-	3	-	-	-	2	2	-	1	3	-
CO3	3	2	1	-	3	-	-	-	2	2	-	1	3	1
CO4	3	2	1	-	3	-	-	-	3	3	-	2	3	1
CO5	2	1	1	-	3	-	-	-	1	3	-	2	3	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Textbooks:

1. Willis, J., & Dogra, S. (2018). *Autodesk Fusion 360: A Power Guide for Beginners and Intermediate Users*. Createspace Independent Publishing Platform.
2. Narayana, K. L., Kanniah, P., & Venkata Reddy, K. (2016). *Machine Drawing* (5th ed.). New Age International Publishers.

Reference Books:

1. Gopalakrishna, K. R. (2017). *Machine Drawing in First Angle Projection*. Subhas Publication.
2. Bhat, N. D., & Panchal, V. M. (2016). *Machine Drawing*. Charotar Publishing House.

E-BOOKS / ONLINE RESOURCES/VIRTUAL LABS:

1. https://www.gutenberg.org/ebooks/39033

MOOC:

1. https://www.coursera.org/learn/fusion-360-integrated-cad-cam-cae

Activity Based Learning (Suggested Activities in Class)

1. Activity which makes students to apply the machine drawing concepts learned in the course during the drafting of 3D machine parts and its assembly using CAD tool, will be discussed in class.
2. Activity that makes the students for the development of skill set in the 3D modelling tool (Fusion 360).
3. Activity provides space to students giving responsibility for their own learning to make them into independent thinkers.
4. Activity that makes the students to have critical thinking, developing an expert mind set in Geometric dimensioning and tolerances, problem-solving and teamwork.

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Skill Enhancement Course-I
Autodesk Innovation Lab

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	: 23ME2309	**Credits**	: 02
Hours / Week	: 04 Hours	**Total Hours**	: 52 Hours
L–T–P–S	: 0–0–4–0		

Course Description:

This course offers an in-depth exploration of Autodesk Inventor, focusing on mastering the creation and editing of 2D sketches and 3D models, designing and modifying complex parts and assemblies, constructing detailed surface models, and generating professional engineering drawings and documentation.

Course Learning Objectives:

This Course will enable students to:

1. Demonstrate proficiency in using Autodesk Inventor software to create and edit 2D sketches and 3D models.
2. Apply skills to design and modify complex parts and assemblies using Autodesk Inventor's part and assembly workbenches.
3. Develop the ability to construct and manage detailed surface models and execute advanced surface operations.
4. Generate professional engineering drawings and documentation, including standard views, dimensions, and annotations, using Autodesk Inventor's drafting tools.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate theattainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information ratherthan simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible,it helps improve the students' understanding.

UNIT – I: Introduction to Autodesk Inventor and Basic Sketching	08 Hours

Week 1:

- **Introduction to Autodesk Inventor**
  - Overview of the software interface and workspace
  - Basic navigation and toolset introduction
- **2D Sketching Fundamentals**
  - Creating and editing 2D sketches
  - Basic sketch tools: lines, circles, arcs
  - Applying dimensions and constraints

Week 2:

- **Advanced Sketch Techniques**
  - Working with sketch constraints and relations
  - Modifying and optimizing sketches

Assignments/Project:

- Create and submit a set of 2D sketches incorporating various constraints and dimensions.

UNIT – II: Fundamentals of 3D Modeling	12 Hours

Week 3:

- **Introduction to 3D Modeling**
  - Basic 3D features: extrude, revolve, sweep, loft
  - Creating and modifying 3D parts from sketches

Week 4:

- **Part Workbench Basics**
  - Overview of part design tools and features
  - Applying basic 3D operations

Week 5:

- **Advanced 3D Modeling Techniques**
  - Using advanced features: fillet, chamfer, pattern, mirror
  - Managing part parameters and history

Assignments/Project:

- Develop a 3D model from provided sketches, applying advanced modeling techniques.

UNIT – III: Designing and Modifying Complex Parts and Assemblies	12 Hours

Week 6:

- **Designing Complex Parts**
  - Creating intricate parts using advanced features
  - Techniques for complex shape creation

Week 7:

- **Introduction to Assembly Workbench**
  - Creating assemblies from multiple parts
  - Applying assembly constraints: mate, flush, insert

Week 8:

- **Modifying and Troubleshooting Assemblies**
  - Techniques for modifying assemblies
  - Resolving common assembly issues and conflicts

Assignments/Project:

- Design and assemble a complex mechanical system using part and assembly workbenches.

UNIT – IV: Surface Modeling and Advanced Operations	12 Hours

Week 9:

- **Introduction to Surface Modeling**
  - Basics of surface modeling and its applications
  - Creating and managing surface bodies

Week 10:

- **Advanced Surface Operations**
  - Techniques for advanced surface creation: patch, trim, extend
  - Managing complex surfaces and blends

Week 11:

- **Surface Model Optimization**
  - Analyzing surface quality and making improvements
  - Repairing and refining surface models

Assignments/Project:

- Construct a detailed surface model incorporating advanced surface operations and optimization techniques.

UNIT – V: Engineering Drawings and Documentation	08 Hours

Week 12:

- **Creating Engineering Drawings**
  - Using the drafting workbench to generate 2D drawings from 3D models
  - Adding standard views, dimensions, and annotations
- **Documentation and Presentation**
  - Preparing and organizing engineering documentation
  - Best practices for professional presentation

Week 13:

- **Final Project Preparation**
  - Integrating skills from previous units to complete a final project
  - Preparing and presenting complete engineering drawings and documentation

Assignments/Project:

- Generate a comprehensive set of engineering drawings for a complex assembly, including all necessary annotations and documentation.

Course Outcome	Description
At the end of the course the student will be able to:	
1	Apply advanced sketch techniques to create and optimize a set of 2D sketches, demonstrating proficiency in using basic tools, constraints, and dimensions.
2	Develop and modify a 3D model from sketches by applying basic and advanced features, including extrude, fillet, and chamfer, and managing part parameters and history.
3	Construct and enhance a detailed surface model by applying advanced techniques such as patch, trim, and extend, and analyzing and optimizing surface quality for improved performance.
4	Apply advanced surface modeling techniques to construct and refine a detailed surface model, analyzing and improving surface quality through techniques such as patch, trim, and extend.
5	Generate and organize a comprehensive set of engineering drawings for a complex assembly by applying drafting techniques, adding standard views, dimensions, and annotations, and preparing the documentation for professional presentation.

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	2	2	-	3	-	-	-	2	2	-	3	2	2
CO2	2	2	2	1	3	-	-	-	2	2	-	3	2	2
CO3	3	2	3	1	3	-	-	-	2	1	-	3	3	3
CO4	2	2	2	1	3	-	-	-	2	2	-	3	3	3
CO5	3	2	3	1	3	-	-	-	2	2	-	3	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Text Books:

1. Autodesk Inventor 2024: A Tutorial Introduction by L. Scott Hansen (Author).
2. Autodesk Inventor Exercises: 200 Practice Drawings for Autodesk Inventor and Other Feature-Based Modeling Software,

Reference Books:

1. Autodesk Inventor 2023: A Power Guide for Beginners and Intermediate Users Users 4th ed. Edition, by CADArtifex, John Willis, Sandeep Dogra.

Assessment Methods:

- **Assignments and Projects:** Regular assignments and hands-on projects based on weekly topics.
- **Mid-Term Exam:** Assessment covering Units 1 through 3.
- **Final Project:** A comprehensive project that demonstrates proficiency in all course objectives, including engineering drawings and documentation.

Recommended Textbooks and Resources:

- Autodesk Inventor official documentation and tutorials
- Recommended textbooks on CAD modeling and engineering design
- Online resources and video tutorials for additional practice

Course Schedule:

- **Weeks 1-2:** Unit 1
- **Weeks 3-5:** Unit 2
- **Weeks 6-8:** Unit 3
- **Weeks 9-11:** Unit 4
- **Weeks 12-13:** Unit 5

This syllabus provides a structured path to mastering Autodesk Inventor, ensuring that students achieve the learning objectives through both theoretical instruction and practical application.

SCHOOL OF ENGINEERING
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PROBABILITY AND STATISTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	23ME2401	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Apply statistical principles and probability concepts to solve complex problems in real-world scenarios involving uncertainty and randomness.
2. Evaluate and select appropriate probability distributions and statistical techniques to analyze and interpret data accurately in various applications.
3. Justify the use of estimation methods and hypothesis testing techniques for drawing meaningful inferences about population parameters.
4. Analyze and interpret sample test results for different statistical relationships, such as means, variances, correlation coefficients, regression coefficients, goodness of fit, and independence, to make informed decisions.
5. Identify sample tests using appropriate statistical procedures to investigate the significance of observed data and communicate findings effectively.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I : Probability	**09 Hours**
Definitions of Probability, Addition Theorem, Conditional Probability, Multiplication Theorem, Bayes' Theorem of Probability	

UNIT – II: Random Variables and their Properties and Probability Distributions	**09 Hours**
Discrete Random Variable, Continuous Random Variable, Joint Probability Distributions Their Properties, Probability Distributions: Discrete Distributions: Binomial, Poisson Distributions and their Properties; Continuous Distributions: Exponential, Normal, Distributions and their Properties.	

UNIT – III: Estimation and testing of hypothesis	**06 Hours**

Sample, Populations, Statistic, Parameter, Sampling Distribution, Standard Error, Un-Biasedness, Efficiency, Maximum Likelihood Estimator, Notion & Interval Estimation.	
UNIT – IV: Sample Tests-1	**07 Hours**
Large Sample Tests Based on Normal Distribution, Small Sample Tests: Testing Equality of Means, Testing Equality of Variances, Test of Correlation Coefficient	
UNIT – V: Sample Tests-2	**08 Hours**
Test for Regression Coefficient; Coefficient of Association, 2 – Test for Goodness of Fit, Test for Independence.	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Apply the principles of probability to solve complex problems in various real-world scenarios.
2	Solve and compare different probability distributions, including discrete and continuous random variables, in order to make informed decisions and predictions.
3	Apply statistical estimation techniques, such as maximum likelihood estimation and interval estimation, to draw meaningful inferences about population parameters from sample data.
4	Examine hypothesis testing methods, including large and small sample tests, to assess the significance of observed data and draw valid conclusions.
5	Analyze statistical relationships and perform sample tests to assess the Equality of means in different populations, Correlation coefficients between variables to determine the strength and direction of the relationship. Independence of variables using appropriate statistical tests to assess the absence of any relationship.

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2		2				1					
CO2	3	2	2		2				1					
CO3	3	2	2						1					
CO4	3	2	2		2				1					
CO5	3	2	2		2				1					

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Textbook:

1. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (n.d.). *Probability & Statistics for Engineers and Scientists*. Pearson Education.

Reference Books:

1. Veerarajan, T. (n.d.). *Probability, Statistics and Random Processes*. Tata McGraw-Hill.

2. Trivedi, K. S. (1999). *Probability & Statistics with Reliability, Queuing and Computer Applications*. Prentice Hall of India.

E-Resources:

1. https://nptel.ac.in/courses/106104233
2. https://nptel.ac.in/courses/117103067
3. https://nptel.ac.in/courses/103106120
4. https://www.coursera.org/learn/probability-intro#syllabus
5. https://nptel.ac.in/courses/111104073

Activity Based Learning (Suggested Activities in Class)

1. Tools like Python programming, R programming can be used which helps student to develop a skill to analyze the problem and providing solution.
2. Regular Chapter wise assignments/ Activity/Case studies can help students to have critical thinking, developing an expert mind set, problem-solving and teamwork.

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Following are Activities Can carried out in place of Assignments using either R programming language or Python Programming or excel solver.

1. There are n people gathered in a room. What is the probability that at least 2 of them will have the same birthday? (Use excel solver, R Programming, Python Programming)
   a. Use simulation to estimate this for various n., and Produce Simulation Graph.
   b. Find the smallest value of n for which the probability of a match is greater than 0.5.
   c. Explore how the number of trials in the simulation affects the variability of our estimates.
2. **Case Study 1: Customer Arrivals at a Coffee Shop**
   a. Background: A coffee shop wants to analyze the number of customer arrivals during its morning rush hour (7:00 AM to 9:00 AM). The shop has been recording the number of customer arrivals every 15 minutes for the past month.
   b. Data: The data consists of the number of customer arrivals recorded at the coffee shop during each 15-minute interval for the past month.
   c. Here is a sample of the data:

Time Interval	Customer Arrivals
7:00 AM - 7:15 AM	**6**
7:15 AM - 7:30 AM	**4**
7:30 AM - 7:45 AM	**9**
7:45 AM - 8:00 AM	**7**
8:00 AM - 8:15 AM	**5**
8:15 AM - 8:30 AM	**8**
8:30 AM - 8:45 AM	**10**
8:45 AM - 9:00 AM	**6**

   analyze the customer arrivals and determine the probability distribution that best fits the data. Specifically, explore both discrete and continuous probability distributions, including the binomial, Poisson, exponential, and normal distributions.
3. **Case Study 2: Comparing the Performance of Two Groups**
   a. Suppose you are a data analyst working for a company that manufactures a new energy drink. The marketing team conducted a promotional campaign in two different cities (City A and City B) to determine the effectiveness of the campaign

in increasing sales. The sales data for a random sample of customers in each city was collected over a week. Your task is to compare the average sales between the two cities and test whether there is a significant difference in the variance of sales.

b. Data: Let's assume the following sample data for the number of energy drinks sold in each city:

City A: [30, 28, 32, 29, 31, 33, 34, 28, 30, 32]
City B: [25, 24, 26, 23, 22, 27, 29, 30, 26, 24]
perform a two-sample t-test to test the equality of means and a test for equality of variances using Python's SciPy library.

4. **case study 3:** testing independence between two categorical variables.
   a. Data: Sample of 100 employees, and each employee is classified as either Male or Female. They were asked to rate their job satisfaction on a scale of 1 to 5, where 1 represents low satisfaction and 5 represents high satisfaction. The data is as follows:

Employee	Gender	Job Satisfaction
1	Male	4
2	Female	3
3	Male	2
4	Female	5
...	...	...
100	Female	4

   b. Test for independence between gender and job satisfaction, use the chi-squared test in R.

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APPLIED THERMAL SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	23ME2402	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	39+26 Hours
L–T–P–S	:	3–0–2–0			

Course Learning Objectives:

This Course will enable students to:

1. Understand Vapour power cycles and calculation of heat, work interactions and thermal efficiency
2. Explain the working of a single stage and multistage compressor and to calculate work done, volumetric-isothermal-polytrophic efficiencies
3. Understand refrigeration cycle and calculation of COP and to study different types of refrigerants and to appreciate the use of eco-friendly refrigerants
4. Study combustion thermodynamics of fuels
5. Carry out tests to investigate the performance of internal combustion engines
6. Describe and illustrate the idea of Backtracking and Branch and Bound algorithm design techniques to solve a given problem.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	08 Hours
Gas Power Cycles Review of thermodynamics laws, Carnot, Otto, Diesel and Dual Cycles; simple Gas turbine cycle (Brayton cycle) and Modifications; Multistage compression with intercooling, Regeneration, reheat cycles practical gas turbine, cycles; Jet Propulsion cycles ***(Text Book-2: Chapter 13.1: 13.22)***,	
UNIT – II	**08 Hours**
Vapour Power Cycles and Combined cycle power plants Components of steam power plant, Carnot vapour power cycles, limitation of Carnot cycle, Simple Rankine cycle; Effect of pressure and Temperature on performance of Rankine Cycle, Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, feed water heaters. Reheat Rankine cycle, Supercritical Rankine cycle, combined gas and vapour cycle power plants. Numerical ***(Text Book-2: Chapter 12:12.1, 12.14)***	
UNIT – III	**06 Hours**
Reciprocating Compressors Classification; work done in a single stage compressor; efficiency; p-v diagram for an actual compressor and diagram factor; multistage compressor; Multistage compressor with intercooler, Performance parameters for reciprocating compressors ***(Text Book-2: Chapter 17:17.1, 17.06)***	
UNIT – IV	**10 Hours**
Refrigeration and Air conditioning Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Vapour absorption refrigeration system. Psychometric: Nomenclature, Definition, use of Psychometric chart, Introduction to air-conditioning, different types of air-conditioning systems***(Text Book-2: Chapter 14:14.1, 14.12)***	
UNIT – V	**08 Hours**
Combustion Thermodynamics Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency. Dissociation and equilibrium, emissions. ***(Text Book-2: Chapter 19:19.1, 19.10)***	

Sl. No	**List of Laboratory/Practical Experiments activities to be conducted (if any)** **Total 26 Hrs**
1	Determination of Flash point and Fire point of lubricating oil using Abel, Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
2	Determination of Calorific value of solid, liquid and gaseous fuels.
3	Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers.
4	Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke).
5	Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A-F Ratio, heat balance sheet
6	Determination of temperature distribution, fin efficiency in natural / forced Convection

Course Outcome	Description
At the end of the course the student will be able to:	
1	Calculate work obtained, mean effective pressure and thermal efficiency for Otto, Diesel, Dual and Bryton cycles, Thermal efficiency of Basic, modified, reheat and regenerative Rankine cycles
2	Calculate the work done and efficiency for single stage and multistage compressor
3	Analyze different refrigeration and air-conditioning cycles and combustion thermodynamics of fuels
4	Estimate the properties of fuels and lubricants like flash and fire point, viscosity and calorific value.
5	Calculate I C engine performance at different operating conditions and also to carry out heat balance

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	3	-	-	-	-	-	-	-	-	2
CO2	3	3	3	3	2	-	-	-	-	-	-	-	-	2
CO3	3	3	3	3	2	-	-	-	-	-	-	-	-	2
CO4	3	3	2	2	2	-	2	-	-	-	-	-	-	1
CO5	3	3	3	3	3	-	3	-	-	-	-	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Textbooks:

1. Kadambi, T. R., Seetaraman, K. B., & Kumar, S. (2019). *Applications of Thermodynamics*. Wiley India Private Ltd.
2. Nag, P. K. (2017). *Basics and Applied Thermodynamics* (2nd ed.). Tata McGraw-Hill.

Reference Books:

1. Cengel, Y. A., & Boles, M. A. (2017). *Thermodynamics: An Engineering Approach*. McGraw Hill Education.
2. Moran, M. J., & Shapiro, H. N. (2006). *Fundamentals of Engineering Thermodynamics*. John Wiley & Sons Ltd.

E-Resources:

1. https://nptel.ac.in/courses/112103307
2. https://archive.nptel.ac.in/courses/112/106/112106314/
3. http://gateandupscexammaterials.yolasite.com/resources/standard_books/Applied%20Thermodynamics%20by%20Onkar%20Singh.0001.
4. https://onlinecourses.nptel.ac.in/noc22_me113/preview

Activity Based Learning (Suggested Activities in Class)

1. students to conduct a thermodynamic analysis of a refrigerator using the principles of thermodynamics they have learned. This will help them understand how refrigerators work and how energy is transferred in a refrigeration cycle.
2. students to conduct experiments on the thermodynamic properties of materials, such as thermal conductivity and specific heat. This activity will help students understand how the properties of materials affect their thermodynamic behaviour.

KINEMATICS AND DYNAMICS OF MACHINES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	23ME2403	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Impart knowledge on the kinematics and dynamics of planar mechanisms
2. Analyze the bodies which is in motion using the basics of kinetics and kinematics
3. Determine the balancing of masses of rotating and reciprocating machine elements
4. Understand the principles of cams and followers
5. Distinguish the performance of different governors by characterize effort, power and sensitiveness
6. Understand the gyroscopic principle and verifying its effect by changing the torque.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I BASICS OF MECHANISMS — 07 Hours

BASICS OF MECHANISMS

Definitions Link or element, kinematic pairs, chain, Mechanism and Structure, Degrees of freedom, Grubler's criterion.

(Text Book-1: Chapter 1: 1.1, 1.2, 1.4, 1.5, .6, 1.7, 1.8, 1.9, 1.10, 1.11)

Inversions of various mechanism. Quick return motion Mechanisms.

(Text Book-1: Chapter 1: 1.12, 1.13, 1.16, 1.17, 1.18)

Straight line motion mechanisms. Intermittent Motion mechanisms. Toggle mechanism, Pantograph, Steering gears mechanism. Universal Hook's Joint.

(Text Book-1: Chapter 6: 6.1, 6.2, 6.4, 6.5, 6.7, 6.8,6.9)

UNIT – II KINEMATIC ANALYSIS — 07 Hours

KINEMATIC ANALYSIS

Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism.
(Text Book-1: Chapter 2 & 3: 2.1, 2.5, 2.6, 2.7, 2.8, 2.93.1, 3.2, 3.4)
Relative velocity and acceleration of particles in a common link and coincident Particles on separate links- Coriolis component of acceleration.
(Text Book-1: Chapter 2 & 3: 2.10, 3.5, 3.6)
Velocity Analysis by Instantaneous Center Method. Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.
(Text Book-1: Chapter 2 & 3: 2.12, 2.13, 2.14, 3.8)

UNIT – III STATIC AND DYNAMIC FORCE ANALYSIS	**08 Hours**

STATIC AND DYNAMIC FORCE ANALYSIS

Introduction, Static equilibrium. Equilibrium of two and three force members, members with two forces and torque, free body diagrams. Principle of virtual work, static force analysis of various mechanisms with and without friction.
(Text Book-1: Chapter 12 : 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8, 12.9)
Dynamic Force Analysis: D'Alembert's principle, inertia force and torque. Dynamic force analysis of four-bar and slider crank mechanism.
(Text Book-1: Chapter 13 : 13.1, 13.2, 13.3, 13.4, 13.5, 13.7, 13.10)

UNIT – IV BALANCING OF ROTATING AND RECIPROCATING MASSES	**07 Hours**

BALANCING OF ROTATING AND RECIPROCATING MASSES

Static and dynamic balancing. Balancing of single and several rotating mass.
(Text Book-1: Chapter 14 : 14.1, 14.2, 14.3, 14.4)
Balancing of single cylinder engine: multi cylinder-inline engine (primary & secondary forces), V-type engine. Balancing of locomotives
(Text Book-1: Chapter 14 : 14.6, 14.7, 14.8, 14.9, 14.10, 14.11)

UNIT – V CAMS, GOVERNORS, AND GYROSCOPE	**10 Hours**

CAMS, GOVERNORS, AND GYROSCOPE

Types of cams and followers. Development of cam profile for various types of followers and its different motion.
(Text Book-1: Chapter 7 : 7.1, 7.2, 7.3, 7.5, 7.8, 7.9)
Governors: Types of governors; governor characteristics, force analysis of centrifugal governors.
(Text Book-1: Chapter 16 : 16.1, 16.2, 16.3, 16.4, 6.5, 16.11, 16.12, 16.13, 16.14, 16.15, 16.16, 16.17)
Gyroscope: Vector representation of angular motion. Gyroscopic couple, effect of gyroscopic couple on ship, plane disc, aeroplane.
(Text Book-1: Chapter 17 : 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7)

Course Outcome	Description
At the end of the course the student will be able to:	
1	Analyse and interpret the behaviour of kinematic mechanisms to understand their motion characteristics
2	Apply kinematic principles and concepts to analyse the motion characteristics of mechanical systems and mechanisms.
3	Evaluate the equilibrium of rigid bodies Courseed to static and dynamic forces using appropriate
4	Determine the magnitude and location of balancing masses by utilizing appropriate balancing procedures
5	Analyse cam profiles for various followers, evaluate governor characteristics and perform force analysis of centrifugal governors, and apply gyroscopic principles to understand the effects on ships, planes, and discs.

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	-	1	-	-	-	1	-	-	-	2	-
CO2	3	3	2	2	1	1	-	-	2	-	-	-	3	2
CO3	3	3	2	2	1	1	-	-	2	-	-	-	3	2
CO4	3	2	2	-	-	1	-	-	1	-	-	-	3	2
CO5	3	2	1	-	-	-	-	-	1	-	-	-	2	-

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Textbooks:

1. Rattan, S. S. (2014). *Theory of Machines*. Tata McGraw-Hill Publishing Company Ltd.
2. Uicker, J. J., Pennock, G. R., & Shigley, J. E. (2010). *Theory of Machines & Mechanisms* (4th ed.). Oxford University Press.

Reference Books:

1. Bevan, T. (2005). *Theory of Machines* (3rd ed.). CBS Publication.
2. Ghosh, A., & Mallik, A. K. (1976). *Theory of Mechanisms and Machines* (3rd ed.). Affiliated East-West Press.

E-Books / Online Resources/VIRTUAL LABS:

1. https://mm-nitk.vlabs.ac.in/

MOOC:

1. https://nptel.ac.in/courses/112105268
2. https://archive.nptel.ac.in/courses/112/104/112104114/#

Activity Based Learning (Suggested Activities in Class)

1. Activity which makes students to apply the concepts learned in the course to the development of mechanism based on the real time applications will be discussed in class.
2. Activity that makes the students for the development of skill set in analysis of mechanisms.

3. Activity provides space to students giving responsibility for their own learning to make them into independent thinkers.
4. Activity that makes the students to have critical thinking, developing an expert mind set, problem-solving and teamwork.

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Ramanagar District- 562112

MECHANICS OF SOLIDS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	23ME2404	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Explain about the analysis of stresses and strains in straight, Stepped and tapered sections, Composite sections under axial, shear & thermal loading conditions.
2. Describe the evaluation of compound stresses and strains in a structural member using analytical & Mohr's circle method. And
3. Determine the circumferential and longitudinal stresses in thin and thick cylindrical pressure vessels.
4. Describe about the construction of shear force and bending moment diagrams for cantilever, simply supported and overhanging beams Courseed to concentrated loads, uniformly distributed loads, moments and uniformly varying loads.
5. Calculate the shear stress due to torsion in tapered shaft, Shafts in series and Parallel, Thin Tubular and Thin-walled sections. And
6. Explain how to use Euler's Theory of Columns to calculate the buckling load of the columns with pinned ends, both ends are fixed, one end fixed & other is free and one end fixed & other is hinged.
7. Describe about computation of strain energy due to axial, shear, bending & torsional stresses. Clarify how to use Theories of Failure to determine the factor of safety when it is Courseed to combined stresses.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.

- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I Analysis of Stress and Strain	**08 Hours**

INTRODUCTION:
Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them.
Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change. ***(Text Book-1: Chapter 2: 2.3 to 2.11)***

UNIT – II Compound Stresses and Cylinders	**08 Hours**

Compound Stresses: Principal stresses and maximum shear stress, Planes of Principalstress and Maximum Shear stress, Normal stress on the planes of maximum shear stress, Mohr's circle for plane stress conditions. ***(Text Book-3: Chapter 3: 3.4, 3.5)***
Cylinders: Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, thin spherical Shell, thin cylinder with spherical ends. Thick cylinders: Lame's theory. ***(Text Book-2: Chapter 17: 17.4,17.5,17.10)***

UNIT – III Shear Forces and Bending Moments	**06 Hours**

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, Shear force and bending moments of cantilever, simply supported and overhanging beams Courseed to concentrated loads and uniformly distributed constant / varying loads. . ***(Text Book-2: Chapter 6: 6.3 to 6.18)***
Stress in Beams: Bending Theory**,** Bending and shear stress distribution in rectangular,I and T section beams. ***(Text Book-2: Chapter 7: 7.2 to 7.4)***

UNIT – IV Torsion and Columns	**09 Hours**

Torsion: Circular shafts, Power Transmission, Torsion of tapered shaft, Shafts inseries and Parallel, Thin Tubular and Thin-walled sections. ***(Text Book-1: Chapter 3: 3.3, 3.13).***
Columns: Euler's theory, Equivalent Length, Limitations of Euler's Formula, Rankines Formula ***(Text Book-2: Chapter 19: 19.3 to 19.10).***

UNIT – V Strain Energy and Theories of Failure	**08 Hours**

Strain Energy: Strain energy due to axial, shear, bending, torsion and impact load, Castigliano's theorem and their applications. ***(Text Book-1: Chapter 11: 11.2 to 11.12***)
Theories of Failure: Introduction, maximum principal stress theory (Rankine's theory), Maximum shearing stress theory (Guest's and Tresca's theory), maximum principal strain theory (St. Venant's theory), Maximum Strain energy theory (Haigh's
Theory) and Maximum Shear Strain Energy Theory (Mises' and Henkeys's Theory) ***(Text Book-2: Chapter 04: 4.1 to 4.4***)

Course Outcome	Description
At the end of the course the student will be able to:	
1	Apply fundamental concepts of stress, strain, and material properties to analyse and calculate stresses in various sections and composite materials, including the effects of temperature changes.
2	Analyse compound stresses in materials by determining principal stresses, maximum shear stresses, and normal stresses using Mohr's circle, and evaluate stresses and strains in thin and thick cylinders.
3	Evaluate shear forces and bending moments in various types of beams under different loading conditions and analyse stress distribution using bending theory for rectangular, I, and T section beams.
4	Apply torsion principles to analyse circular and tapered shafts, including power transmission and thin-walled sections, and assess column stability using Euler's and Rankine's formulas to determine critical loads and limitations
5	Analyse strain energy in materials Courseed to axial, shear, bending, torsion, and impact loads using Castigliano's theorem, and apply various theories of failure to predict material behaviour under complex stress conditions.

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	2	-	-	-	-	-	-	-	-	1	2
CO2	3	2	2	2	-	-	-	-	-	-	-	-	1	2
CO3	2	2	2	2	-	-	-	-	-	-	-	-	2	1
CO4	2	2	3	3	-	-	-	-	-	-	-	-	1	1
CO5	3	2	3	3	-	-	-	-	-	-	-	-	2	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Textbooks:

1. Beer, F. P., & Johnston, E. R. (2020). Mechanics of Materials (8th ed.). McGraw Hill.
2. Bhavikatti, S. S. (2017). Mechanics of Solids. New Age International Publications.

Reference Books:

1. Timoshenko, S. (2002). Strength of Materials (3rd ed.). CBS Publisher.
2. Ramamrutham, S. (2011). Strength of Materials. Dhanpat Rai Publishing Company.

E-Resources:

5. https://archive.nptel.ac.in/courses/105/105/105105108/
6. https://onlinecourses.nptel.ac.in/noc22_ce46/preview
7. https://www.youtube.com/watch?v=LIZ-PQbGZkA

Activity Based Learning (Suggested Activities in Class)

8. Real world problem solving and puzzles using group discussion.
9. Demonstration of solution to a problem through experiential learning.
10. Demonstrations using real objects, taking students on an educational tour.

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HEAT TRANSFER

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	23ME2405	**Credits**	:	04
Hours / Week	:	05 Hours	**Total Hours**	:	39+26 Hours
L–T–P–S	:	3–0–2–0			

Course Learning Objectives:

This Course will enable students to:

1. Understand the basic phenomenon of heat transfer and its importance in engineering applications.
2. Enable the students to understand the different modes of heat transfer like conduction, convection and radiation.
3. Understand the mechanism of heat transfer under steady and transient conditions
4. Illustrate the applications of convective heat transfer including heat exchangers, boiling & condensation
5. Understand the different laws of radiation and applying for solving engineering problems

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**05 Hours**

Modes of heat transfer: Basic laws governing conduction, Thermal conductivity. Conduction: Derivation of general three-dimensional conduction equation in Cartesian coordinate, discussion on 3-D conduction in cylindrical and spherical coordinate system. One dimensional conduction equation for plane, cylinder and spheres. Overall heat transfer coefficient, Thermal conductive resistance and numerical problems. Derivation for heat flow and temperature distribution in a plane for variable thermal conductivity case, critical thickness of insulation and numerical problems. ***(Text Book2: Chapter 1: 1.1, 1.6)***

UNIT – II	05 Hours
Heat transfer through rectangular fin, infinitely long fin, short fin with insulated tip and without insulated tips. FIN efficiency and effectiveness. Numerical problems. ***(Text Book 1: Chapter 3: 3.1, 3.8)*** **Transient Conduction**: Lumped parameter analysis, use of transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere, numerical problems ***(Text Book1: Chapter 4: 4.1, 4.7)***	
UNIT – III	**05 Hours**
Natural Convection: Introduction, laminar flow, momentum and energy equations for vertical flat plate, physical significance of Grashoff number, use of correlations for free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, numerical problems. ***(Text Book1: Chapter 6: 6.1, 6.7)*** **Forced Convection**: Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various correlations for hydro dynamically and thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems. ***(Text Book1: Chapter 9: 9.1, 9.7)***	
UNIT – IV	**06 Hours**
Fundamental concepts of radiation, different laws governing radiation heat transfer, Stefan Boltzman law, Kirchoff's law, Planck's law, Wein's displacement law, Intensity of radiation and Lambert's cosine law, Radiation shape factor, Heat exchange by radiation between two black and diffuse grey surfaces, radiation shields, numerical problems. ***(Text Book1: Chapter 12: 12.1, 12.11)***	
UNIT – V	**05 Hours**
Heat exchangers: Classification and applications, overall heat transfer coefficient, heat exchanger analysis–Logarithmic mean temperature difference for parallel and counter flow heat exchanger, effectiveness–number of transfer units, method for parallel and counter flow heat exchanger, introduction to cross flow heat exchanger, Logarithmic mean temperature difference correction factor. Numerical problems. ***(Text Book1: Chapter 11: 11.1, 11.08)*** **Condensation and Boiling**: Boiling heat transfer, types of boiling, pool boiling curve and forced boiling phenomenon, condensation heat transfer, film wise and drop wise condensation. (no numerical problems). ***(Text Book1: Chapter 10: 10.1, 10.11)***	

Sl. No	**List of Laboratory/Practical Experiments activities to be conducted (if any) Total 26 Hrs**
1	Determination of thermal conductivity of metal rod.
2	Determination of thermal conductivity of composite wall.
3	Experiment on transient conduction heat transfer
4	Determination of heat transfer coefficient in natural convection.
5	Determination of heat transfer coefficient in forced convection.
6	Determination of temperature distribution, fin efficiency in natural / forced Convection
7	Determination of emissivity of a test surface.
8	Determination of the emissive power of black body using Stefan's Boltzmann's constant
9	Determination of effectiveness and logarithmic mean temperature difference in parallel flow and counter flow heat exchanger

Course Outcome	Description
At the end of the course the student will be able to:	
1	Compute temperature distribution and heat flow in a steady and unsteady-state 1-D heat conduction problems for various arrangements and also predict the performance parameters for fin
2	Evaluate the principles of natural and forced convection, the significance of key dimensionless numbers, and applicable correlations, to solve complex numerical problems in convention heat transfer
3	Apply fundamental principles and laws of radiation heat transfer to solve complex heat transfer problems
4	Analyse performance characteristics of heat exchangers using LMTD and Effectiveness NTU approaches
5	Evaluate and synthesize experimental data to determine thermal conductivity, heat transfer coefficient, temperature distribution, fin efficiency, emissivity, and also critically assess the effectiveness of heat exchangers and black body radiation characteristics.

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	-	-	-	-	-	-	-	-	1	3
CO2	3	2	2	2	-	-	-	-	-	-	-	-	1	3
CO3	3	3	2	3	-	-	-	-	-	-	-	-	-	3
CO4	3	3	3	2	-	-	-	-	-	-	-	-	-	3
CO5	3	3	3	3	2	-	-	-	3	2	1	-	2	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Textbooks:

1. Incropera, F. P., & DeWitt, D. P. (2011). *Fundamentals of Heat and Mass Transfer*. John Wiley & Sons.
2. Holman, J. P. (2009). *Heat Transfer*. Tata McGraw-Hill.

Reference Books:

1. Nag, P. K. (2011). *Heat and Mass Transfer*. Tata McGraw-Hill.
2. Özisik, M. N. (2002). *Heat Transfer: A Basic Approach*. McGraw-Hill.

E-Resources:

1. https://archive.nptel.ac.in/courses/103/105/103105140/
2. http://ecoursesonline.iasri.res.in/course/view.php?id=625
3. http://ecoursesonline.iasri.res.in/course/view.php?id=61
4. http://krunalkhiraiya.weebly.com/e-course-on-heat-transfer.html

Activity Based Learning (Suggested Activities in Class)

1. Conduct a thermal conductivity experiment: Provide students with materials such as different types of metals
2. Investigate the effects of insulation: Provide students with materials such as Styrofoam, cotton, and wool, and have them investigate the effects of insulation on heat transfer by measuring the rate of heat loss from a hot object that is wrapped in each material

MACHINE LEARNING
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	23ME2406	**Credits**	:	02
Hours / Week	:	03 Hours	**Total Hours**	:	13+26 Hours
L–T–P–S	:	1–0–2–0			

Course Learning Objectives:
This Course will enable students to:

1. Realize Machine Learning techniques in supervised and unsupervised learning.
2. Comprehend the ideas of ML and problem-solving techniques.
3. Use of Python Programming for different applications
4. Demonstrate the representation of knowledge and reasoning
5. Recognize the importance of ML in Mechanical Engineering

Teaching-Learning Process (General Instructions)
These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
- ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show ***Video/animation*** films to explain functioning of various concepts.
- Encourage ***Collaborative*** (Group Learning) Learning in the class.
- To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
- Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**

Introduction to Python, Basics: Basic types, variables, Decision making and Loops, Strings, Data Structures: Lists, Tuples, Sets, and Dictionaries Regular Expression Operations, Modules.
Object oriented programming in python: Classes, Constructors, and Object Methods. ***(Text Book-1: Chapter 5: 5.1 to 5.3, Chapter 6: 6.3 to 6.4, Chapter 7: 7.2 to 7.3)***

UNIT – II	

NumPy - Overview, NumPy Array creation and basic operations, NumPy Universal functions, Selecting and retrieving Data, Data Slicing.
Pandas - Overview, Object Creation: Series Object, Data Frame Object, View Data, selecting data by Label and Position, Data Slicing, Setting Data, applying functions to data, Analysing Datafor missing values.

Matplotlib - Overview, creating basic chart: Line Chart, Bar Charts and Pie Charts, Plotting from Pandas object, Saving a plot. ***(Text Book-1: Chapter 8: 8.4).***
UNIT – III **06 Hours**
INTRODUCTION: Introduction to Supervised learning, Linear Regression Logistic Regression, Naive Bayes, Decision Tree, KNN, Random Forest, Support VectorMachine Introduction to Unsupervised learning, PCA, clustering approaches: K-means, Hierarchical clustering Natural Language Processing: Language models, n-grams, Vector space models, Bag of words. ***(Text Book-1: Chapter 1: 1.1 to 1.2)***
UNIT – IV **08 Hours**
Neural Network basics: History behind neural networks, Relationship between biological neuron and artificial neuron, Perceptron and working mechanism, Architecture of artificial neuralnetwork, Types of activation functions. ***(Text Book-1: Chapter 3: 3.1, 3.2)***
UNIT – V **08 Hours**
Machine learning application using python for mechanical engineering datasets: mechanical vibrations - heat transfer - fluid mechanics – manufacturing process. Smart Manufacturing, Smart Transportation and Autonomous Vehicles. Robotics, Quality control. ***(Text Book-1: Chapter 12: 12.2, 12.3***)

Course Outcome	**Description**
At the end of the course the student will be able to:	
1	Apply object-oriented programming concepts proficiently in Python, demonstrating expertise in Python programming fundamentals through practical application.
2	Analyze data using NumPy for array operations, Pandas for data manipulation, and Matplotlib for creating and visualizing basic charts.
3	Evaluate supervised and unsupervised learning algorithms, including linear regression, logistic regression, decision trees, KNN, random forest, SVM, PCA, K-means, and hierarchical clustering, and apply natural language processing techniques
4	Analyze foundational aspects of neural networks, encompassing their working mechanism and architecture of artificial neural networks.
5	Apply machine learning techniques using Python to analyse dataset of mechanical vibrations, heat transfer, fluid mechanics, and manufacturing processes, and develop solutions for smart manufacturing, transportation

Table: Mapping Levels of COs to POs / PSOs

COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	1	1	3	-	-	-	-	1	-	2	1	1
CO2	3	3	3	1	3	-	-	-	-	2	-	3	1	1
CO3	3	3	3	3	3	-	-	1	1	2	-	3	1	1
CO4	3	3	2	2	3	-	-	-	-	-	-	2	1	1
CO5	3	3	3	2	3	-	-	1	2	2	-	2	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Textbooks:

1. Nagy, Z. (2018). *Artificial Intelligence and Machine Learning Fundamentals: Develop real-world applications powered by the latest AI advances*. Packt Publishing Ltd.
2. Raschka, S., & Mirjalili, V. (2017). *Python Machine Learning, Second Edition: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow*. Packt Publishing Ltd.

Reference Books:

1. Poole, D. L., & Mackworth, A. K. (2010). *Artificial Intelligence: Foundations of Computational Agents*. Cambridge University Press.
2. Nilsson, N. J. (2009). *The Quest for Artificial Intelligence*. Cambridge University Press.

E-Resources:

1. https://nptel.ac.in/courses/106/101/106101060/
2. http://cse01-iiith.vlabs.ac.in/
3. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=IntroToAlgorithms
4. https://www.coursera.org/specializations/algorithms

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion. E.g., Fake coin identification, Cabbage puzzle, Konigsberg bridge puzzle etc.,
2. Demonstration of solution to a problem through programming.

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Skill Enhancement Course-II

Bosch Rexroth Innovation Lab

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER –IV

Course Code	: 23ME2408	**Credits**	: 2
Hours / Week	: 4 Hours	**Total Hours**	: 52 Hours
L–T–P–S	: 0–0–4–0		

Course Learning Objectives:

This Course will enable students to:

1. Design, evaluate, and troubleshoot hydraulic and pneumatic systems, making sure to choose the right parts including accumulators, actuators, valves, and pumps.
2. Build and test hydraulic and pneumatic circuits with a variety of parts and tools. Examine the outcomes to make sure the system satisfies the required performance standards.
3. Utilize analytical thinking and problem-solving techniques to identify and fix problems with pneumatic and hydraulic systems, guaranteeing maximum efficiency and security.
4. Encourage a culture of creativity and ongoing development in the fluid power industry by keeping abreast of emerging technologies and developments in pneumatics and hydraulics.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate theattainment of the various course outcomes.

- ***Interactive Lectures and Demonstrations*** means Deliver engaging lectures that illustrate the theoretical ideas of pneumatics and hydraulics with the help of practical examples and system and equipment demonstrations.
- ***Hands-On Laboratory Exercises:*** By holding lab sessions where students may construct, test, and troubleshoot hydraulic and pneumatic circuits using industry-standard tools, you can provide them practical experience.
- ***Problem-Based Learning:*** Involve students in problem-based learning exercises where they are presented with real-world problems and scenarios to address utilizing their hydraulics and pneumatics expertise.
- ***Collaborative Projects:*** Students can be required to design, develop, and present hydraulic and pneumatic systems as part of collaborative projects that promote teamwork. This encourages the sharing of ideas and peer learning.
- ***Technical Documentation and Reporting:*** Require students to keep thorough lab notebooks, write reports, and draw schematic diagrams for their experiments and projects in order to highlight the value of technical documentation.
- ***Safety Training***: To ensure that students comprehend the correct handling, use, and upkeep of hydraulic and pneumatic equipment, provide thorough safety instruction. Stress how crucial it is to follow safety procedures in the lab.
- ***Case Studies and Application Examples****:* Present case studies and examples of hydraulic and pneumatic systems in various industries, such as manufacturing, automotive, and aerospace, to illustrate the practical applications and significance of fluid power technology.
- ***Continuous Assessment and Feedback****:* - Use techniques for continual evaluation, such as lab reports, quizzes, and practical exams, to gauge students' comprehension and development. Give pupils constructive criticism so they can get better.

BASIC & ELECTRO HYDRAULICS	20 Hours

- Characteristics of Industrial Hydraulics
- Comparison of Hydraulics Vs. Electrical
- Electronics, Pneumatics and Mechanical
- Applications of Hydraulics
- **Basic physical properties**
  - i. Pressure.
  - ii. Pascal's Law.
  - iii. Force transmission
  - iv. Pressure transmission
  - v. Displacement Transmission
  - vi. Flow rate and Flow Law.
- **Graphical Symbols and Hydraulic circuits.**
  - Hydraulic Fluids
  - Hydraulic pumps
  - Hydraulic Cylinder and Motor
- Hydraulic Control valves

i. PCV
ii. FCV
iii. DCV

BASIC & ELECTRO PNEUMATICS	32 Hours

- Characteristics of Industrial Pneumatics
- Comparison of Pneumatics Vs Electrical
- Electronics, Hydraulics and Mechanical
- Applications of Pneumatics
- Graphical Symbols and Pneumatic circuits.
- Generation of compressed air
- Processing of compressed air
- Maintenance unit
- Compressors
- Introduction to Relay Based Control System
- Function of Relays
- SPDT contacts
- Signal storage logic
- AND and OR logic

Hands-On-Training

Exercise 1: Extending a cylinder by operating a push button
Exercise 2: Signal storage by electrical self-locking, setting and resetting using a momentary-contact switch
Exercise 3: Mechanical locking by means of momentary-contact switch contacts
Exercise 4 Electrical locking by means of contactor contacts
Exercise 5: Signal storage by means of contactor contacts
Accumulator
Exercise 6: accumulator applications
Exercise 7: Pressure switches and proximity switches
Exercise 8: Advance control with time-dependent intermediate stop

Hands-On-Training

Exercise 1: Direct and indirect control of a single-acting cylinder, extending
Exercise 2: Direct and indirect control of a double-acting cylinder with pushbutton
Exercise 3: Signal storage by means of contactor contacts
Exercise 4: Controlling a double- acting cylinder, impulse valve, 2 push-buttons
Exercise 5: Displacement dependent control of a double acting cylinder, impulse valve
Exercise 6: Pressure-dependent control of 1 double-acting cylinder
Exercise 7: Time-dependent control of 1 double-acting cylinder
Exercise 8: Holding-element control of a double-acting cylinder with impulse valve, directly controlled
Exercise 9: Displacement-dependent control of a double-acting cylinder, impulse valve, cylinder switch
Exercise 10: Sequential control of 2 double-acting cylinders with impulse valves and signal overlapping
Exercise 11: Sequential control of 2 double-acting cylinders with spring return valves and step sequence

Course Outcome	Description
At the end of the course the student will be able to:	
1	Analyse the characteristics and applications of industrial hydraulics and pneumatics systems
2	Design and interpret hydraulic and pneumatic circuits using graphical symbols and standards
3	Evaluate the performance of hydraulic and pneumatic control valves and components through hands-on training exercises
4	Evaluate advanced control systems for hydraulic and pneumatic applications, incorporating time-dependent and displacement-dependent controls

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	-	-	-	-	3	3	-	-	-	1
CO2	3	3	3	3	-	-	-	-	3	3	-	-	-	2
CO3	3	3	3	3	-	-	-	-	3	3	-	-	-	2
CO4	3	3	3	3	-	-	-	-	3	3	-	-	-	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Text Books:

2. Hand Books & Manuals – Bosch Rexroth