25MEMJ203 : Thermodynamics

w. e. f. Academic Year:		2025-26
Semester:		3rd
Category of the Course:		PCC
Prerequisite:	Basic Mechanical Engineering	
Rationale:	This course provides a fundamental understanding of energy, heat, work, and their inter conversion, which are essential for analyzing and designing thermal and energy systems.	

Course Outcomes:

After Completion of the Course, Student will able to:

	Course Outcome (CO)	RBT Level (Cognitive Domain)	Marks % Weightage (approx.)
CO1	Explain fundamental concepts of thermodynamics including systems, properties, equilibrium, processes, phase changes, and laws of thermodynamics.	Understand	15
CO2	Analyze thermodynamic systems using the first and second laws, including energy interactions, entropy generation, and irreversibility.	Analyze	30
CO3	Apply thermodynamic principles to engineering devices such as turbines, compressors, heat exchangers, and combustion systems.	Apply	20
CO4	Evaluate performance of thermodynamic cycles including vapor, gas power, and refrigeration cycles based on efficiency and work output.	Evaluate	25
CO5	Develop and assess energy systems using exergy analysis and advanced thermodynamic concepts for	Apply	10

Teaching and Evaluation Scheme:

Teaching Scheme					Examination Scheme				
L	T	P	C	Hrs/Week	IE	EE	CIA	Practical/ Viva	Total Marks
3	0	2	4	5	40	60	30	20	150

IE: Internal Exam
EE: External Exam (End Semester)
CIA: Continuous Internal Assessment
Practical: Practical Exam (End Semester)

Detailed Syllabus:

Topic		Hrs.	% of Weightage
UNIT: 1	**Basic Concepts & First law of Thermodynamics**	5	11
Microscopic & macroscopic point of view, Thermodynamic system and control volume, Thermodynamic properties, processes and cycles, Thermodynamic equilibrium, Quasi-static process, pure substance, vapour liquid-solid phase in a pure substance, p-v-t			

surface, critical and triple point of pure substance. zeroth Law of thermodynamics, temperature scales with emphasis on understanding energy systems for sustainable engineering applications.			
UNIT: 2	**First law of Thermodynamics**	7	16
First law for a closed system undergoing a cycle and change of state, Energy-A property of the system, Perpetual motion machine of the first kind, steady flow energy equation applied to nozzle, diffuser, boiler, turbine, compressor, pump, heat exchanger, throttling process and filling and emptying process.			
UNIT: 3	**Second law of thermodynamics & Entropy**	8	18
Limitations of first law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence, Perpetual motion machine of the second kind, Carnot cycle, Carnot's theorem, corollary of Carnot theorem, thermodynamic temperature scale. Clausius theorem, the property of entropy, inequality of Clausius, entropy change in an open system, reversible and irreversible process, principle of increase of entropy, Third law of thermodynamics, Entropy and disorder			
UNIT: 4	**Exergy**	4	9
Exergy :Concept of exergy. Exergy of a heat input in a cycle, exergy destruction in heat transfer process, exergy of finite heat capacity body, exergy of closed and steady flow system, irreversibility, Gouy-Stodola theorem and its applications			
UNIT: 5	**Combustion of fuel**	6	13
Combustion of air, combustion equations, minimum air requirement, excess air and air fuel ratio, wet and dry analysis of products of combustion, conversion of volumetric analysis by mass, Determination of calorific value of fuel by Bomb calorimeter and Junkers gas calorimeter, Enthalpy of formation, Enthalpy of reaction, Adiabatic flame temperature.			
UNIT: 6	**Vapour power cycle , Gas Power cycles and Refrigeration cycles**	6	13
Vapor Power cycles: Carnot vapor cycle, Rankine cycle, comparison of Carnot and Rankine cycle, cycle analysis using steam tables and Mollier diagram, variables affecting efficiency of Rankine cycle			
UNIT: 7	**Gas Power cycles:**	5	11
Dual cycle, Comparison of Otto, Diesel and Dual cycles, air standard efficiency, mean effective pressure, brake thermal efficiency, relative efficiency, simple Brayton cycle, open and closed cycle, actual Brayton cycle, optimum pressure ratio for maximum thermal efficiency and work output, work ratio, air rate, effect of operating variables on the thermal efficiency and work output sustainable energy conversion			
UNIT: 8	**Refrigeration cycles:**	4	9
Reversed Carnot, Bell Coleman cycle, Vapour compression cycles (Expression for COP of the cycles and Numerical) with emphasis on energy-efficient refrigeration systems and environmentally friendly refrigerants.			
		45	**100**

List of Practical:

Topic	Hrs
To perform and measured (direct/indirect) various thermodynamic properties (temperature,pressure)	2
Compare temperature measuring instruments.	2
To performon viscometer (new instrument)	2
To measure density of various fluid (water, lubricating oil, petrol,diesel)	2
To study first law of thermodynamics for open system (flow process)-Axial compressor SFEE	2
Find performance for first law of thermodynamics (for open system (flow process)-pump)	2
To find COP of Vapour Compression Refrigeration Test rig (Application of 2nd law of thermodynamics)	2
Case study of exergy analysis.	2
To find out the calorific value of given fuel with the help of Oxygen Bomb calorimeter.	2
To study and comparison of Otto, diesel and dual cycle Analysis of Otto, Diesel and Dual Cycles.(Air standard efficiency and MEP calculation)	4
Performance Analysis of Rankine Cycle(Using steam tables and Mollier chart)	2
To perform on refrigeration cycle and its performance	2
	30

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks in Percentage					
Remember	Understand	Apply	Analyze	Evaluate	Create
7	8	20	30	20	15

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may very slightly from above table.

Reference Books:

1. Engineering Thermodynamics by P.K. Nag, Tata McGraw-Hill, New Delhi
2. Engineering Thermodynamics by B.L.Singhal,Tech-Max Publication,Pune
3. Engineering Thermodynamics by R.K. Rajput, Laxmi Publications, New Delhi
4. Fundamentals of Engineering Thermodynamics by R.Yadav, Central Publishing House, Allahabad
5. Thermodynamics – An Engineering Approach by Yunus Centel & Boles, Tata Mc Graw-Hill, New Delhi
6. Thermodynamics by J.P. Holman, Tata Mc Graw-Hill
7. An introduction to Thermodynamics by YVC Rao, New Age publishers, New Delhi
8. Thermodynamics – Theory & Application by Robert Balmer, Jaico publication house.
9. Fundamentals of Thermodynamics by Sonntag, Borgnakke & Van wylen, John Wiley & sons (ASIA) PVT. LTD.

Teaching Learning Method

- Power Point Presentation

Course Outcomes Mapping:

CO No.	Course Outcome (CO)	POs/PSOs Mapped	Cognitive Level (RBT)	Knowledge Category	Class Sessions (Lecture)
CO1	Explain fundamental concepts of thermodynamics including systems, properties, equilibrium, processes, phase changes, and	PO1, PO2, PO11, PSO1	Understand	Conceptual	5
CO2	Analyze thermodynamic systems using the first and second laws, including energy interactions, entropy generation, and irreversibility.	PO1, PO2, PO4, PO11, PSO1	Analyze	Analytical / Conceptual	15
CO3	Apply thermodynamic principles to engineering devices such as turbines, compressors, heat exchangers, and combustion systems.	PO1, PO2, PO3, PO4, PO5, PO11, PSO1,	Apply	Procedural	9
CO4	Evaluate performance of thermodynamic cycles including vapor, gas power, and refrigeration cycles based on efficiency and work output.	PO1, PO2, PO3, PO4, PO5, PO10, PO11	Evaluate	Analytical / Procedural	11
CO5	Develop and assess energy systems using exergy analysis and advanced thermodynamic concepts for improved efficiency and sustainability.	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO10, PO11, PSO1, PSO2	Apply	Analytical	5

Mapping of COs with POs & PSOs:

CO	PO											PSO	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3	2	–	–	–	–	–	–	–	–	1	2	–
CO2	3	3	–	2	–	–	–	–	–	–	2	3	–
CO3	3	2	2	2	1	–	–	–	–	–	2	3	2
CO4	3	3	2	2	2	–	–	–	–	1	2	3	2
CO5	3	3	3	2	2	2	1	–	–	1	3	3	2

3: High, 2: Medium, 1: Low

Sustainable Development Goals (SDG) Integration

This course integrates sustainability by emphasizing energy efficiency, optimal resource utilization, and environmentally responsible engineering practices. It supports the development of efficient thermal systems with reduced energy losses and environmental impact, aligning with SDG 4, SDG 9, SDG 11, and SDG 12.

SDG Mapping with Course Outcomes

CO	Course Outcome	Relevant SDGs	Justification
CO1	Explain fundamental concepts of thermodynamics including systems, properties, equilibrium, processes, phase changes, and laws of thermodynamics.	SDG 4	Builds strong foundational knowledge in thermodynamics for sustainable engineering education
CO2	Analyze thermodynamic systems using the first and second laws, including energy interactions, entropy generation, and irreversibility.	SDG 9	Promotes efficient analysis of energy systems and reduction of energy losses
CO3	Apply thermodynamic principles to engineering devices such as turbines, compressors, heat exchangers, and combustion systems.	SDG 9, SDG 12	Supports efficient energy conversion and responsible resource utilization
CO4	Evaluate performance of thermodynamic cycles including vapor, gas power, and refrigeration cycles based on efficiency and work output.	SDG 9, SDG 11	Ensures efficient and reliable systems contributing to sustainable infrastructure
CO5	Develop and assess energy systems using exergy analysis and advanced thermodynamic concepts for improved efficiency and sustainability.	SDG 9, SDG 12	Enhances energy efficiency, minimizes waste, and promotes sustainab