SYLLABUS

Course Title: BASIC THERMODYNAMICS **Course code: 18ME33**

MODULE I

Fundamental Concepts & Definitions: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer.	Hours: 8
Blooms Taxonomy: L2 – Understanding, L3 – Applying, L4 – Analysing	

MODULE II

Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Problems. First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Extension of the First law to control volume; steady flow energy equation(SFEE), important	Hours 8
Blooms Taxonomy: L2 – Understanding L3 – Applying, L4 – Analyzing	

MODULE III

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump: Schematic representation, efficiency and COP. Reversed heat engine, schematic representation, importance and superiority of a reversible heat engine and irreversible processes, internal and external reversibility. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems Entropy: Clausius inequality, Statement- proof, Entropy-definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate.	Hours 8
Blooms Taxonomy: L2 – Understanding L3 – Applying, L4 – Analyzing	

MODULE IV

Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility. Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter.	Hours 8

Blooms Taxonomy: L2 – Understanding, L3 – Applying, L4 – Analyzing	
MODULE V	
Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties. **Real gases** – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases. work for compression. Steam nozzles: Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow.	Hours 8
Blooms Taxonomy: L2 – UnderstandingL3 – Applying,	

DAYS	TITTLE	SUB TOPICS	Course Outcomes (CO)
1.	**Fundamental Concepts & Definitions**	Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems	**CO1**
2.		Characteristics of system boundary and control surface, examples. Thermodynamic properties	**CO1**
3.		Definition and units, intensive, extensive properties, specific properties, pressure, specific volume	**CO1**
4.		Thermodynamic state, state point, state diagram, path and process, quasi-static process	**CO1**
5.		Cyclic and non-cyclic; processes; Thermodynamic equilibrium	**CO1**
6.		Definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics	**CO1**
7.		Temperature; concepts, scales, international fixed points and measurement of temperature	**CO1**
8.		Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer	**CO1**
9.	**Work and Heat**	Mechanics, definition of work and its limitations.	**CO2**
10.		Thermodynamic definition of work; examples, sign convention	**CO2**
11.		Displacement work; as a part of a system boundary, as a whole of a system boundary	**CO2**
12.		Expressions for displacement work in various processes through p-v diagrams. Shaft work; electrical work. Other types of work.	**CO2**
13.		Heat; definition, units and sign convention. Problems. First Law of Thermodynamics	**CO2**
14.		Joules experiments, equivalence of heat and work.	**CO2**

15.		Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes	CO2
16.		Energy, energy as a property, modes of energy, Extension of the First law to control volume; steady flow energy equation(SFEE), important	CO2
17.	**Second Law of Thermodynamics**	Limitations of first law of thermodynamics	CO3
18.		Thermal reservoir, heat engine and heat pump	CO3
19.		Schematic representation, efficiency and COP. Reversed heat engine, schematic representation, importance and superiority of a reversible heat engine and irreversible processes	CO3
20.		Internal and external reversibility. Kelvin - planck statement of the second law of thermodynamics	CO3
21.		PMM I and PMM II, Clausius statement of Second law of Thermodynamics	CO3
22.		Equivalence of the two statements; Carnot cycle, Carnot principles. Problems Entropy	CO3
23.		Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy	CO3
24.		Entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate.	CO3
25.	**Availability, Irreversibility and General Thermodynamic relations**	Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy....,.	CO4
26.		Maximum work, maximum useful work for a system and control volume, irreversibility	CO4
27.		Pure Substances: P-T and P-V diagrams, triple point and critical points	CO4
28.		Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor,	CO4
29.		Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams	CO4
30.		Representation of various processes on these diagrams. Steam tables and its use	CO4
31.		Throttling calorimeter, separating and throttling calorimeter.	CO4
32.		Saturated vapor and superheated vapor states of pure substance with water as example	CO4
33.	**Ideal gases and Real gases**	Ideal gas mixtures, Daltons law of partial pressures, , ,.	CO5
34.		Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases	CO5
35.		Air- Water mixtures and related properties.	CO5
36.		**Real gases** – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties	CO5
37.		Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart.	CO5

38.		Difference between Ideal and real gases	CO5
39.		Flow of steam through nozzles	CO5
40.		Work for compression. Steam nozzles:, shape of nozzles, effect of friction, critical pressure ratio, supersaturated flow.	CO5

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

/Text Book Details

- Basic and Applied Thermodynamics P.K.Nag, Tata McGraw Hill 2nd Ed., 2002
- Basic Engineering Thermodynamics A.Venkatesh Universities Press, 2008
- Basic Thermodynamics, B.K Venkanna, Swati B. Wadavadagi PHI, New Delhi 2010

Reference

- Thermodynamics- An Engineering Approach YunusA.Cenegal and Michael A.Boles Tata McGraw Hill publications 2002
- An Introduction to Thermodynamcis Y.V.C.Rao Wiley Eastern 1993,
- Engineering Thermodynamics .B.Jones and G.A.Hawkins John Wiley and Sons.

Faculty In-Charge **Head of the Department**