Thermodynamics and Heat Transfer

Course code: ME 101

Lecturer: 3 **Year: I**
Tutorial: 1 **Part: I**
Practical: 1.5 **Course Credit: 3**

Course Objective:

To deliver fundamental concepts, thermodynamics laws, thermodynamics cycles, Heat Transfer, and their applications.

	Teaching Schedule Hours/Week			Evaluation Scheme				
				Internal Evaluation		Final Evaluation		Total
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	125
Cr	3	1	1.5	40	10	60	15	

Unit 1: Introduction and Energy Transfer (6 hours)

1.1. definition and applications of thermodynamics
1.2. microscopic versus Macroscopic analysis
1.3. Basic Concepts and Definitions:
  1.3.1. System, Boundary, Surrounding, and Universe
  1.3.2. Closed systems, open systems, and Isolated systems
  1.3.3. Thermodynamics Properties: Intensive and extensive properties: Definitions and examples
  1.3.4. Thermodynamics: state, Path, Process, Reversible and Irreversible processes, Quasi-static equilibrium process
  1.3.5. Thermodynamic Equilibrium, Mechanical Equilibrium, Chemical Equilibrium, and Thermal Equilibrium
1.4 Properties: Pressure, Temperature, Specific volume, Specific weight
1.5 Equality of Temperature: Zeroth Law of Thermodynamics
1.6 Energy Transfer as Heat and Work
  1.6.1 Definition of energy and its concept: Internal Energy, Potential Energy, and Kinetic Energy
  1.6.2 Stored Energy, Transient Energy, and Total Energy
  1.6.3 Energy Transfer: Heat and Work
  1.6.4 Derivation of Displacement Work (Quasi-static work) transfer
  1.6.5 Power

Unit 2: Properties of Simple Compressible Substance (6 hours)

2.1 concepts of pure substance and Simple Compressible Substance
2.2 State postulate of simple compressible substance
2.3 Formation of steam from ice to vapor using P-v, T-q, and T-v diagrams

2.4 Two-phase (liquid-vapor) system: Saturation curves, critical point, sub-cooled (compressed liquid), saturated liquid, wet vapor, saturated vapor, superheated vapor, quality(dryness fraction), moisture content using P-v diagram, T-v diagrams, P-h diagram, T-s diagram, and h-s diagram.
2.5 thermodynamics properties: Internal energy, Enthalpy, volume, Entropy, and specific heats
2.6 Tabulated data and Graphical data presentation

Unit 3: First law of Thermodynamics (9 hours)

3.1 Joule's experiment
3.2 Definition of the first law of thermodynamics: application to a process, cyclic process, and none cyclic process
3.3 Concept of control volume: first law applied to control volume, unsteady state, and steady-state analysis for control volume
3.4 control volume applications: work and flow applications for both steady and unsteady flow
3.5 other statement of the first law of thermodynamic

Unit 4: Second law of Thermodynamics (9 hours)

4.1 Drawbacks of the First law of thermodynamics
4.2 necessity of the second law of thermodynamics
4.3 statement of Second law of thermodynamics: Claussius, Plank kelvin, and their equivalence; other statements of second law of thermodynamics
4.3 Entropy: change of entropy for Ideal gas
4.4 causes of irreversibility
4.5 application of Second Law to Closed and Open Systems
4.6 derivation of governing equation for a reversible adiabatic process
4.7 Carnot cycle, Carnot theorem
4.8 Simple compressible refrigeration system, Heat pump, and heat engine

Unit 5: Thermodynamics cycles (9 hours)

5.1 operation of for stroke engine: suction stroke, compression stroke, expansion stroke, and exhaust stroke
5.2 classification of heat engine
5.3 Otto cycle, Diesel cycle, Brayton cycle open and closed), Rankine cycle: efficiency derivation

Unit 6: Heat Transfer (6 hours)

6.1 Definition compared to thermodynamics
6.2 basic modes of heat Transfer: Conduction, Convection and Radiation
6.3 Fundamental and subsidiary laws of heat transfer
6.3 Fourier law of heat conduction: application to steady state one dimensional for a plane wall and a hollow cylinder
6.4 Heat transfer through composite wall and composite cylinder
6.5 concept of thermal resistance: Electrical analog
6.6 concept of overall heat transfer coefficient: both for composite wall and composite cylinder
6.7 Convection: Natural or free and forced convection
6.8 thermal radiation
    6.8.1 Absorptivity, Reflectivity, transmissivity
    6.8.2 Concept of the black body, white body, opaque body, Grey body, and transparent body
    6.8.3 Stefan's law, concept of emissive power, emissivity

Practicals:

1. Temperature measurement
2. COP measurement for Refrigeration and Heat Pump
3. Measurement of thermal conductivity
4. Emissivity measurement

Textbook

1. R. D. Yadav, "A Text Book of Thermodynamics", Prativa Publication (P) Ltd.

References

2. M. C. Luitel, "Fundamental of Thermodynamics and Heat Transfer" Athrai Publication (P) Ltd.
3. R.K. Rajput, "Thermal Engineering" Laxmi Publications (P) Ltd., India
4. Dr. D.S. Kumar, "Thermal Science & Engineering", S.K. Kataria & Sons, India
5. Domkundwar Kothandaraman Domkundwar, "A course in Thermal Engineering", Dhanpat Rai & son, India
6. J.P. Holman, "Heat Transfer", McGraw-Hill

Distribution of marks:

The final evaluation will have questions from all the units. The marks distribution for all the units will be as follows:

		Scheduled Hours	Marks
Unit 1	**Introduction and Energy Transfer**	8	11
Unit 2	**Properties of Simple Compressible Substance**	7	9
Unit 3	**The first law of Thermodynamics**	8	11
Unit 4	**The second law of Thermodynamics**	8	11
Unit 5	**Thermodynamics cycles**	8	10
Unit 6	**Heat Transfer**	6	8
Total		**45**	**60**

Note: The marks distribution shown in the table above might be subjected to minor changes.