

Course Code	Course Name	Credits
MEC305	Thermodynamics	03

Objectives:

1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize the application of the concepts of thermodynamics in vapour power, gas power cycles, compressible fluid flow

Outcomes: Learners will be able to....

1. Demonstrate application of the laws of thermodynamics to a wide range of systems.
2. Compute heat and work interactions in thermodynamics systems
3. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
4. Compute thermodynamic interactions using the steam table and Mollier chart
5. Compute efficiencies of heat engines, power cycles.
6. Apply the fundamentals of compressible fluid flow to the relevant systems

Module	Detailed contents	Hrs.
1	<p>Basic Concepts : Thermodynamics system and types, Macroscopic and Microscopic approach, Thermodynamic properties of the system, state, path, process and cycle, Point and Path functions, Quasi-static process & Equilibrium, Zeroth law of thermodynamics, Characteristic gas equation, Concept of Internal energy, Enthalpy, Heat and Work. Concept of PdV work.</p> <p>First Law of Thermodynamics: Statement & Equation, First law for Cyclic process (Joule's experiment), Perpetual Motion Machine of the First Kind, Application of first law to non-flow systems (Ideal gas processes with numerical) First law applied to flow system: Concept of flow process and flow energy, Concept of the steady flow process, Energy balance in a steady flow, Application of steady flow energy equation to nozzle, turbine, compressor, pump, boiler, condenser, heat exchanger, throttling device. Steady flow work, Significance of $-VdP$ work, Relation between flow and non-flow work</p>	07
2	<p>Second Law of Thermodynamics: Limitation of the first law of thermodynamics, Thermal reservoir, Concept of heat engine, Heat pump and Refrigerator, Statement of the second law of thermodynamics, Reversible and irreversible Process, Causes of irreversibility, Perpetual Motion Machine of the second kind, Carnot cycle, Carnot theorem.</p> <p>Entropy: Clausius theorem, Entropy is property of a system, Temperature-Entropy diagram, Clausius inequality, Increase of entropy principle, T ds relations, Entropy change During a process.</p>	08

3	<p>Availability: High grade and low-grade energy, Available and Unavailable energy, Dead State, Useful work, Irreversibility, Availability of closed system & steady flow process, Helmholtz & Gibbs function</p> <p>Thermodynamic Relations: Maxwell relations, Clausius-Clapeyron Equation, Mayer relation, Joule-Thomson coefficient (Only Theory)</p>	05
4	<p>Properties of Pure Substance: Advantages and applications of steam, Phase change process of water, Saturation pressure and temperature, Terminology associated with steam, Different types of steam. Property diagram: T-v diagram, p-v diagram, p-T diagram, Critical and triple point, T-s and an h-s diagram for water, Calculation of various properties of wet, dry and superheated steam using the steam table and Mollier chart.</p> <p>Vapour Power cycle: Principal components of a simple steam power plant, Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Reheat Rankine Cycle.</p>	07
5	<p>Gas Power cycles: Nomenclature of a reciprocating engine, Mean effective pressure, Assumptions of fair Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Comparison of Otto and Diesel cycle for same compression ratio, Brayton Cycle. Sterling Cycle, Ericsson Cycle, Lenoir cycle, and Atkinson cycle (Only theory).</p>	06
6	<p>Compressible Fluid flow: Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Stagnation properties, Application of continuity, momentum and energy equations for steady-state conditions; Steady flow through the nozzle, Isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio.</p>	06

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9th edition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, 5th edition, Longman Publishers
3. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India
4. Thermodynamics by P K Nag, 6th Edition, TMH
5. Thermodynamics by Onkar Singh, 4th Edition New Age International
6. Thermodynamics by C P Arora, 1st Edition TMH
7. Thermal Engineering By Ajoy Kumar, G. N. Sah, 2nd Edition, Narosa Publishing house
8. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
9. Fundamentals of Thermodynamics by Moran & Shapiro, Eighth Edition, Wiley
10. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., 9th Edition John Wiley & Sons
11. Thermodynamics by W.C. Reynolds, McGraw-Hill & Co
12. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/112/105/112105266/>
2. <https://nptel.ac.in/courses/112/103/112103275/>
3. <https://nptel.ac.in/courses/112/105/112105220/>
4. <https://nptel.ac.in/courses/101/104/101104063/>