| 25UMET401 | FUNDAMENTALS OF THEMODYNAMICS | Category | L | T | P | R | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|---|
| | | PCC | 3 | 1 | 0 | 0 | 4 | 2025 |

**Preamble**: This course introduces the basic concepts and laws of thermodynamics in a simple and intuitive manner. The emphasis is on physical understanding and practical engineering applications rather than mathematical rigor, so that an average student can comfortably grasp the course.

**Prerequisite: ICM104 Introduction to Mechanical Engineering & Civil Engineering**

**Course Outcomes**: After the completion of the course, the student will be able to:

| CO | Course Outcomes | Knowledge Level |
|---|---|---|
| CO1 | Explain basic thermodynamic terms, systems, properties and energy forms. | K2 Understand |
| CO2 | Apply the first law of thermodynamics to simple closed and open systems. | K3 Apply |
| CO3 | Explain the concepts of heat engines, refrigerators and heat pumps using the second law. | K2 Understand |
| CO4 | Determine basic entropy changes and properties of pure substances | K3 Apply |

**Mapping of course outcomes with program outcomes and program specific outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | - | - | - | - | - | 1 | - | 2 | 1 |
| CO2 | 3 | 3 | 2 | 2 | - | - | - | - | - | 1 | - | 3 | 2 |
| CO3 | 3 | 2 | 2 | 1 | - | - | - | - | - | 1 | - | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | - | - | - | - | - | 1 | - | 3 | 3 |
| Avg | 3 | 2.5 | 1.75 | 1.5 | - | - | - | - | - | 1 | - | 2.5 | 2 |

**Mapping of course outcomes with Knowledge and Attitude Profile (WK)**

| | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | * | * | * | * | * | * | - | - | - |
| **CO2** | * | * | * | * | * | * | * | - | - |
| **CO3** | * | * | * | * | * | * | * | * | - |
| **CO4** | * | * | * | * | * | * | * | * | * |

**WKs Mapped with the course**

| WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|---|---|---|---|---|---|---|---|---|
| * | * | * | * | * | * | * | * | * |

**Mark Distribution:**

| Total Marks | CIE Marks | ESE Marks | ESE Duration |
|---|---|---|---|
| **100** | **40** | **60** | **2.5 hrs** |

**Continuous Internal Evaluation Pattern:**

Attendance : 5 marks
Continuous Assessment Test : 20 marks
Continuous Assessment Assignment : 15 marks

**SYLLABUS**

**Module 1 (12 hrs)**

Introduction to thermodynamics and applications. Macroscopic and microscopic viewpoints, continuum assumption. Systems and control volumes, types of systems. Properties, state, equilibrium. Processes and cycles. Zeroth law of thermodynamics and temperature scales. Forms of energy, internal energy, heat and work (conceptual emphasis). Path and point functions. Real-life thermodynamic systems: basic discussion on energy efficiency in household systems.

**Module 2 (14 hrs)**

First law for closed systems. Moving boundary work and polytropic processes. Energy balance for closed systems (moderate numericals). Flow work and enthalpy. Mass and energy balance for control volumes. Steady Flow Energy Equation (SFEE). Applications to nozzles, diffusers, throttling valves, mixing chambers. Thermal reservoirs. Heat engines, refrigerators and heat pumps. Thermal efficiency and COP.

**Module 3 (14 hrs)**

Kelvin–Planck and Clausius statements. Perpetual motion machines. Reversible and irreversible processes. Carnot and reversed Carnot cycle. Carnot principles and thermodynamic temperature scale. Entropy – definition and physical meaning. Increase of entropy principle. Entropy change for simple processes (moderate numericals). Isentropic efficiency (basic turbine/nozzle problems). Concept of

exergy and irreversibility (introductory level only).

**Module 4 (16 hrs)**

Pure substance, phase change processes. T–v, p–v and p–T diagrams. Triple point and critical point. Dryness fraction. Property calculations using steam tables (moderate difficulty). Mollier chart (reading and interpretation only). Ideal gas equation and gas constants. Deviation from ideal gas behavior. Compressibility factor (qualitative). Van der Waals equation (concept only). Introduction to real gas behavior in high-pressure systems (conceptual discussion).

***Students should undergo a related Field/Industrial Visit as part of the course.***

**Text Books:**


1. Çengel, Y. A., Boles, M. A., & Kanoğlu, M., *Thermodynamics: An engineering approach*. McGraw Hill, 2011.
2. Nag, P. K., *Engineering thermodynamics* (6th ed.). McGraw Hill Education, 2017..


**Reference Books:**


1. Moran, M. J., & Shapiro, H. N., *Fundamentals of engineering thermodynamics*. Wiley, 2006.
2. Sonntag, R. E., Borgnakke, C., & Van Wylen, G. J., *Fundamentals of thermodynamics* (8th ed.). Wiley, 2014.
3. Ansermet, J. P., & Bréchet, S. D., *Thermodynamics: Principles and applications* (1st ed.). Cambridge University Press, 2019.


**END SEMESTER EXAMINATION – MODEL QUESTION PAPER**

| | |
|---|---|
| **Course Code** | **25UMET401** |
| **Course Name** | **Fundamentals of Thermodynamics** |
| **Max. Marks: 60** | **Duration: 2.5 Hours** |

**Part A**

*(Answer all questions. Each question carries 3 marks)*

| Qn No. | Question | Marks | CO | BL |
|---|---|---|---|---|
| 1 | Define thermodynamic system and classify the different types of systems with suitable examples. | 3 | CO 1 | L2 |
| 2 | Differentiate between point function and path function. | 3 | CO 1 | L2 |
| 3 | Use the First Law of Thermodynamics to establish the energy balance for a closed system. | 3 | CO 2 | L3 |
| 4 | Relate the concept of enthalpy to energy interactions in steady flow systems. | 3 | CO 2 | L3 |
| 5 | Explain the Kelvin–Planck and Clausius statements of the Second Law of Thermodynamics. | 3 | CO 3 | L2 |
| 6 | Explain the concept of entropy and its physical significance. | 3 | CO 3 | L2 |

| | | | | |
|---|---|---|---|---|
| 7 | Interpret the concept of dryness fraction and discuss its significance in steam systems | 3 | CO 4 | L3 |
| 8 | Interpret the variation of the compressibility factor and relate it to the properties of real gases. | 3 | CO 4 | L3 |
| **Part B** (*Answer any one full question from each Module. Each carry 9 marks*) | | | | |
| **Module I** | | | | |
| **Qn No.** | **Question** | **Marks** | **CO** | **BL** |
| 9.a) | Explain the Zeroth Law of Thermodynamics and discuss its importance in temperature measurement. | 5 | CO 1 | L2 |
| 9.b) | Illustrate different forms of energy and classify thermodynamic processes with suitable examples. | 4 | CO 1 | L2 |
| **OR** | | | | |
| 10.a) | Explain macroscopic and microscopic approaches used in thermodynamics. | 5 | CO 1 | L2 |
| 10.b) | Describe thermodynamic properties, equilibrium and state with suitable examples. | 4 | CO 1 | L2 |
| **Module II** | | | | |
| **Qn No.** | **Question** | **Marks** | **CO** | **BL** |
| 11.a) | Apply the First Law of Thermodynamics to analyse a closed system undergoing a thermodynamic process. | 5 | CO 2 | L3 |
| 11.b) | Apply the Steady Flow Energy Equation to analyze the performance of steady flow devices and discuss its engineering applications | 4 | CO2 | L3 |
| **OR** | | | | |
| 12.a) | Apply the Steady Flow Energy Equation to determine the performance of a nozzle or diffuser. | 5 | CO 2 | L3 |
| 12.b) | Demonstrate the working of heat engines, refrigerators, and heat pumps based on thermodynamic principles. | 4 | CO2 | L3 |
| **Module III** | | | | |
| **Qn No.** | **Question** | **Marks** | **CO** | **BL** |
| 13. a | Explain the Second Law of Thermodynamics to explain the performance of the Carnot heat engine and Carnot refrigerator. | 5 | CO 3 | L2 |
| 13. b | Describe reversible and irreversible processes with suitable examples. | 4 | CO 3 | L2 |
| **OR** | | | | |
| 14. a | Explain the entropy change for simple thermodynamic processes. | 5 | CO 3 | L2 |
| 14. b | Explain the concepts of exergy and irreversibility in | 4 | CO 3 | L2 |

| | | | | |
|---|---|---|---|---|
| | engineering systems. | | | |
| **Module IV** | | | | |
| **Qn No.** | **Question** | **Marks** | **CO** | **BL** |
| 15. a | Apply steam tables to determine the thermodynamic properties of wet, saturated and superheated steam. | 6 | CO 4 | L3 |
| 15. b | Illustrate the significance of the triple point and critical point using the phase diagram of a pure substance. | 3 | CO 4 | L3 |
| **OR** | | | | |
| 16. a | Determine the properties of a pure substance using steam tables and the Mollier chart. | 6 | CO 4 | L3 |
| 16. b | Use the compressibility factor to assess the deviation of real gases from ideal gas behaviour. | 3 | CO 4 | L3 |

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