Question Paper Code	14051

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Third Semester

Mechanical Engineering

24MEPC301 – ENGINEERING THERMODYNAMICS

Regulations - 2024

(Use of Steam table, Mollier Chart, Compressibility Chart, Psychometric Chartis permitted)

Duration: 3 Hours   Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)
Answer ALL Questions

		Marks	K – Level	CO
1.	In an open system, which of the following can cross the system boundary?	1	K1	CO1
	(a) Only energy (b) Only mass (c) Both mass and energy (d) Neither mass nor energy			
2.	Which of the following best defines a thermodynamic system?	1	K1	CO1
	(a) A fixed quantity of matter or a region in space under study			
	(b) The surroundings interacting with a system			
	(c) A device that converts heat into work			
	(d) A form of energy stored within a substance			
3.	The steady flow energy equation (SFEE) is derived based on which principle?	1	K1	CO2
	(a) First law of thermodynamics for a control mass			
	(b) First law of thermodynamics for a control volume			
	(c) Second law of thermodynamics			
	(d) Conservation of momentum			
4.	In an isothermal process, the temperature of the system:	1	K1	CO2
	(a) Increases (b) Decreases (c) Remains constant (d) None of the above			
5.	The Second Law of Thermodynamics introduces the concept of:	1	K1	CO3
	(a) Energy conservation (b) Entropy (c) Enthalpy (d) Internal energy			
6.	The efficiency of a Carnot engine depends on:	1	K1	CO3
	(a) The working fluid used			
	(b) The temperature of the hot and cold reservoirs only			
	(c) The pressure at which it operates			
	(d) The mechanical design of the engine			
7.	The critical point of a pure substance is the point where:	1	K1	CO4
	(a) Liquid and vapour phases coexist			
	(b) Liquid and vapour phases become indistinguishable			
	(c) Solid and liquid phases coexist			
	(d) The pressure is minimum			
8.	If the dryness fraction of steam is 1, the steam is:	1	K1	CO4
	(a) Wet steam (b) Saturated liquid (c) Saturated vapour (d) Superheated steam			
9.	The term b in the Van der Waals equation accounts for:	1	K1	CO5
	(a) Molecular attraction (b) Molecular volume (repulsion) (c) Pressure correction (d) Temperature correction			
10.	Psychometric deals with the study of:	1	K1	CO6
	(a) Flow of gases (b) Mixtures of fuel and air			
	(c) Properties of air–water vapour mixtures (d) Heat transfer in solids			

PART - B (12 × 2 = 24 Marks)
Answer ALL Questions

11.	Define intensive and extensive properties.	2	K1	CO1
12.	State Zeroth Law of thermodynamics.	2	K1	CO1

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create   **14051**

13. What are the limitations of first law of thermodynamics?   *2 K1 CO2*

14. A gas absorbs 200 J of heat and does 120 J of work. Find the change in internal energy.   *2 K2 CO2*

15. Why Carnot cycle cannot be realized in practical?   *2 K2 CO3*

16. Write the expression for COP of a heat pump and a refrigerator.   *2 K2 CO3*

17. When do we call a steam to be superheated?   *2 K1 CO4*

18. What are the effects of condenser pressure on the Rankine Cycle?   *2 K1 CO4*

19. Distinguish between ideal and real gas.   *2 K2 CO5*

20. State the assumption made in kinetic theory of gases.   *2 K1 CO5*

21. State Dalton's law of partial pressure.   *2 K1 CO6*

22. What are the factors that affects bypass factor?   *2 K1 CO6*

PART - C (6 × 11 = 66 Marks)
Answer ALL Questions

23. a) i) Show that internal energy is a property.   *5 K2 CO1*

     ii) With neat sketch, Explain Closed, Open and Isolated systems with examples.   *6 K2 CO1*

OR

   b) i) Explain the Concept of Continuum with justification.   *5 K2 CO1*

     ii) With neat sketch, explain closed, open and isolated systems with examples.   *6 K2 CO1*

24. a) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 kPa pressure, and 0.95 m^3/kg volume, and leaving at 5 m/s, 700 kPa, and 0.19 m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 kW. (a) Compute the rate of shaft work input to the air in kW. (b) Find the ratio of the inlet pipe diameter to outlet pipe diameter.   *11 K3 CO2*

OR

   b) A fluid is filled in a cylinder by a spring loaded piston, so that the pressure in the fluid is linear function of the volume. P=a+bV. The internal energy is given by the following equation U=34+3.15PV, where U is in kJ/kg. P is in KPa, and V is in m^3. If the fluid changes form an initial state of 170kPa, 0.03m^3 to a final state of 400kPa, 0.06m^3, find the direction of heat flow and work.   *11 K3 CO2*

25. a) A reversible heat engine operates between two reservoirs at temperatures 700°C and 50°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 50°C and – 25°C. The heat transfer to the engine is 2500 kJ and the network output of the combined engine refrigerator plant is 400 kJ. (i) Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C; (ii) Reconsider (i) given that the efficiency of the heat engine and the C.O.P. of the refrigerator are each 45 per cent of their maximum possible values.   *11 K3 CO3*

OR

   b) A 5 kg copper block at a temperature of 200°C is dropped into an insulated tank containing 100 kg of oil at a temperature of 30°C. Find the increase in entropy of the universe due to this process when copper block and the oil reach thermal equilibrium. Assume that the specific heats of copper and oil are respectively 0.4 kJ /Kg K and 2.1 kJ /Kg K.   *11 K3 CO3*

26. a) Find the specific volume and enthalpy of steam at 9 bar when the condition of steam is a) Wet with dryness fraction 0.95 b) dry saturated   c) Super-heated temperature of 240°   *11   K3   CO4*

<div align="center">**OR**</div>

b) In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine: (i) The pump work, (ii) The turbine work, (iii) The Rankine efficiency, (iv) The condenser heat flow, (v) The dryness at the end of expansion. Assume flow rate of 9.5 kg/s   *11   K3   CO4*

27. a) Derive the Maxwell relations from the fundamental thermodynamic equations using appropriate partial derivatives.   *11   K3   CO5*

<div align="center">**OR**</div>

b) Derive the expression for the Joule–Thomson coefficient and explain its significance in real gas behavior.   *11   K3   CO5*

28. a) It is required to design an air-conditioning plant for a small office room for the following winter conditions: *11   K3   CO6*

   Outdoor air conditions   :   14°C DBT and 10°C WBT
   Required conditions   :   20°C DBT and 60% RH
   Amount of air circulation   :   0.3m³/min/person
   Seating capacity of office :   60

   The required condition achieved first by heating and then by adiabatic humidifying. Determine the following:
   (i)   Heating capacity of the coil in kW and the surface temperature required if the bypass factor of coil is 0.4
   (ii)   The capacity of the humidifier

<div align="center">**OR**</div>

b) It is required to design a stream mixture in chemical plant for the following conditions: *11   K3   CO6*

   Two air streams are mixed steadily and adiabatically, the first stream enters at 35°C and 30% R.H at a rate of 15m³/min, while the second stream enters at 12°C and 90%R.H. at a rate of 25m³/min. Assuming that the mixing process occurs at a pressure of 1 atm, determine the specific humidity, relative humidity, dry bulb temperature and volume flow rate of the mixture.