

Reg. No.																			
----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Question Paper Code	14034
---------------------	-------

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

Third Semester

Mechanical Engineering

20MEPC302– ENGINEERING THERMODYNAMICS

Regulations - 2020

(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart are permitted)

Duration: 3 Hours

Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

	Marks	K- Level	CO
1. A definite area or space where some thermodynamic process takes place is known as (a) thermodynamic system (b) thermodynamic cycle (c) thermodynamic process (d) thermodynamic law.	1	K1	CO1
2. When two bodies are in thermal equilibrium with a third body they are also in thermal equilibrium with each other. This statement is called (a) Zeroth law of thermodynamics (b) First law of thermodynamic (c) Second law of thermodynamics(d) Kelvin Planck's law	1	K1	CO1
3. For a reversible adiabatic process, the change in entropy is (a) zero(b) minimum(c) maximum(d) infinite	1	K1	CO2
4. The processes of a Carnot cycle are (a) two adiabatic and two constant volume (b) one constant volume and one constant pressure and two isentropic (c) two adiabatic and two isothermals (d) two isothermals and two isentropic.	1	K1	CO2
5. The main cause for the irreversibility is (a) mechanical and fluid friction(b) unrestricted expansion (c) heat transfer with a finite temperature difference(d) All of the above	1	K2	CO3
6. Availability function is expressed as (a) $a = (u + p_0v - T_0s)$ (b) $a = (u + p_0dv + T_0ds)$ (c) $a = (du + p_0dv - T_0ds)$ (d) $a = (u + p_0v + T_0s)$	1	K2	CO3
7. Dryness fraction of steam is defined as (a) mass of water vapour in suspension/(mass of water vapour in suspension + mass of dry steam) (b) mass of dry steam/mass of water vapour in suspension (c) mass of dry steam/(mass of dry steam + mass of water vapour in suspension) (d) mass of water vapour in suspension/mass of dry steam.	1	K1	CO4
8. Rankine cycle efficiency of a good steam power plant may be in the range of (a) 15 to 20% (b) 35 to 45% (c) 70 to 80% (d) 90 to 95%	1	K1	CO4
9. Boyle's law states that, when temperature is constant, the volume of a given mass of a perfect gas (a) varies directly as the absolute pressure (b) varies inversely as the absolute pressure (c) varies as square of the absolute pressure (d) does not vary with the absolute pressure	1	K1	CO5
10. In a gaseous mixture the specific volume of each component is given by (a) V/m (b) V_i / m_i (c) V/m_i (d) none of the above	1	K1	CO6

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

- | | | | |
|--|---|----|-----|
| 11. Differentiate between point and path function. | 2 | K2 | CO1 |
| 12. What is meant by steady and unsteady flow? | 2 | K1 | CO1 |
| 13. State Second law of Thermodynamics. | 2 | K1 | CO2 |
| 14. Define Clausius inequality. | 2 | K1 | CO2 |
| 15. What do you understand irreversibility? | 2 | K1 | CO3 |
| 16. Write the expressions for the energy of a closed system and open systems. | 2 | K2 | CO3 |
| 17. Sketch the p-T diagram for a pure substance. | 2 | K2 | CO4 |
| 18. List out the methods to improving the efficiency of Rankine cycle. | 2 | K1 | CO4 |
| 19. Indicate the significance of Compressibility factor. | 2 | K2 | CO5 |
| 20. State Joule-Thomson Coefficient. | 2 | K1 | CO5 |
| 21. Define Dalton's and Amagat's Law. | 2 | K1 | CO6 |
| 22. Sketch the sensible heating and sensible Cooling processes in psychrometric chart. | 2 | K2 | CO6 |

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

- | | | | | |
|-----------|---|----|----|-----|
| 23. a) | Derive the general steady flow energy equation for an open system and deduce the energy equation for (a) a nozzle, and (b) evaporator. | 11 | K3 | CO1 |
| OR | | | | |
| b) | In a gas turbine unit, the gases flow through the turbine is 12 kg/s and the power developed by the turbine is 12500 kW. The enthalpies of gases at the inlet and outlet are 1280 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate: (i) The rate at which heat is rejected to the turbine, and (ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m ³ /kg. | 11 | K3 | CO1 |
| 24. a) | A reversible heat engine operates between two reservoirs at temperatures 800°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 2600 kJ and the network output of the combined engine refrigerator plant is 450 kJ. (i) Calculate 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 42 per cent of their maximum possible values. | 11 | K3 | CO2 |
| OR | | | | |
| b) | A closed system contains air at a pressure 1 bar, temperature 300 K and volume 0.016 m ³ . This system undergoes a thermodynamic cycle consisting of the following three processes in series : (i) Constant volume heat addition till pressure becomes 6 bar, (ii) Constant pressure cooling, and (iii) Isothermal heating to initial state. Represent the cycle on T-s and p-V plots and evaluate the change in entropy for each process. Take cp = 0.718 kJ/kg K and R = 0.287 kJ/kg K. | 11 | K3 | CO2 |
| 25. a) | A steam plant working on a simple Rankine cycle operated between the temperature of 260°C and 95°C the steam is dry and saturated when it enters the turbine and expanded isentropic ally. Find Rankine efficiency. | 11 | K2 | CO3 |

OR

- b) In a reheat Rankine cycle, steam enters the steam turbine at 30 bar and 400°C and expands in a high pressure steam turbine to an intermediate pressure of 3 bar at which it is reheated to 400°C before entering the low pressure turbine. The condenser pressure is 0.5 bar. If the mass flow rate of steam is 40 kg/s. Find the specific steam consumption, the net work per kg. 11 K2 CO3
26. a) 5 kmol of carbon monoxide is stored in a 1.135 m³ container at 215 K. Determine the pressure using (i) ideal gas equation and (ii) van der Waals equation. The constants in the van der Waals equation are 146.3 kPa.m⁶/kmol² and 0.0394 m³/kmol. 11 K2 CO4
- OR**
- b) One kg of CO₂ has a volume of 1 m³ at 100°C. Find the pressure by (i) Van der Waals' equation (ii) Perfect gas equation. The Van der Waals' constants $a = 362850 \text{ Nm}^4/(\text{kg-mol})^2$ and $b = 0.0423 \text{ m}^3/(\text{kg-mol})$. 11 K2 CO4
27. a) Atmospheric air at 1.0132 bar has a DBT of 30°C and WBT of 25°C. Calculate; 11 K3 CO5
 (i) The partial pressure of water vapour
 (ii) Specific humidity
 (iii) The dew point temperature
 (iv) The relative humidity
 (v) The degree of saturation.
- OR**
- b) Consider a gas mixture that consists of 3 kg of O₂, 5 kg of N₂, and 12 kg of CH₄. Calculate (a) the mass fraction of each component, (b) the mole fraction of each component and (c) the average molar mass and gas constant of the mixture. 11 K3 CO5
28. a) (i) Derive Maxwell relations. 6 K2 CO4
 (ii) Explain the following Air- conditioning process – Adiabatic mixing process. 5 K2 CO5
- OR**
- b) (i) 5 kmol of carbon monoxide is stored in a 1.135 m³ container at 215 K. Determine the pressure using ideal gas equation. 6 K2 CO4
 (ii) A gas mixture consists of 7 kg nitrogen and 2 kg oxygen, at 4 bar and 27°C. Find the mole fraction, partial pressures, molar mass, gas constant, volume and density. 5 K2 CO5