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Question Paper Code : 80837

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Third Semester

Mechanical Engineering

ME 2202/10122 ME 303/ME 1201/080190005/AT 36/ ME 33 — ENGINEERING THERMODYNAMICS

(Common to Automobile Engineering)

(Regulations 2008/2010)

(Also common to PTME 2202 for B.E. (Part-Time) Third Semester – Mechanical Engineering – Regulations 2009)

Time : Three hours Maximum : 100 marks

(Use of approved thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant property tables permitted in the examination).

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What is meant by quasi-static process in thermodynamics?

2. Distinguish between 'Macroscopic energy' and 'Microscopic energy'.

3. Differentiate between a Refrigerator and a heat pump.

4. What are available energy' and 'unavailable energy'?

5. Define a pure substance.

6. How is Triple point represented in the P-v diagram?

7. Define Joule-Thompson Coefficient.

8. Find the mass of 0.7 m^3 of wet steam at 150°C and 90% dry.

9. Define dew point temperature.

10. What is chemical dehumidification?

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) Define the following terms

(1) Thermodynamics

(2) Macroscopic approach

(3) Continuum. (6)

(ii) A gas of mass 1.5 kg undergoes a quasistatic expansion which follows a relationship $P = a + bV$ where 'a' and 'b' are constants The initial and final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.2 m^3 and 1.2 m^3. The specific internal energy of the gas is given by the relation $U = (1.5\ P - 85)$ kJ/g where P is in kPa and V is in m^3. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. (10)

Or

(b) (i) Define enthalpy. How is it related to internal energy? (4)

(ii) A fluid is confined in a cylinder by a spring-loaded frictionless piston so that the pressure in the fluid is a linear function of the volume $(p = a + bV)$. The internal energy of the fluid is given by $U = (34 + 3.15\ pV)$ where U is in kJ, p in kPa and V in cubic meter. If the fluid changes from an initial state of 170 kPa, 0.03 m^3 to a final state of 400 kPa, 0.06 m^3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer. (12)

12. (a) (i) State and prove Carnot theorem. (8)

(ii) Two reversible heat engines A and B ate arranged in series. Engine A rejecting heat directly to engine B, receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find

(1) The intermediate temperature between A and B

(2) The efficiency of each engine and

(3) The heat rejected to the cold sink. (8)

Or

(b) (i) Derive an expression for the change in entropy of a perfect gas during polytropic process in terms of T_1 and T_2. (8)

(ii) 2 kg water at 90°C is mixed with 3 kg of water at 10°C in an isolated system. Calculate the change of entropy due to the mixing process. (8)

13. (a) Steam at 480°C, 90 bar is supplied to a Rankine cycle. It is reheated to 12 bar and 480°C. The minimum pressure is 0.07 bar. Find the work output and cycle efficiency using steam tables with and without considering pump work. (16)

Or

(b) (i) Steam initially at 0.3 MPa, 250°C is cooled at constant volume. At what temperature will the steam become saturated vapour? What is the steam quality at 80°C. Also find what is the heat transferred per kg of steam in cooling from 250°C to 80°C. (12)

(ii) When will you call a vapour superheated? Give example. Also when will you call a liquid as compressed liquid? Give example. (4)

14. (a) (i) Derive Clausius–Clapeyrons equation. What assumptions are made in this equation? (10)

(ii) Consider an ideal gas at 303 K and 0.86 m^3/kg. As a result of some disturbance the state of the gas changes to 304 K and 0.87 m^3/kg. Estimate the change in pressure of the gas as the result of this disturbance. (6)

Or

(b) (i) From the basic principles, prove the following

$$c_p - c_v = -T\left(\frac{\partial V}{\partial T}\right)_p^2 \left(\frac{\partial p}{\partial v}\right)_T. \quad (8)$$

(ii) Verify the validity of Maxwell's relation $\left(\frac{\partial s}{\partial p}\right)_T = -\left(\frac{\partial v}{\partial T}\right)_p$ for steam at 300°C and 500 kPa. (8)

15. (a) (i) The sling psychrometer reads 40°C DBT and 28°C WBT. Calculate, specific humidity, relative humidity, vapour density in air, dew point temperature and enthalpy of mixture per kg of dry air. Assume atmospheric pressure to be 1.03 bar. (12)

(ii) What is wet ball depression and where is it equal to zero? (4)

Or

(b) (i) Explain adiabatic evaporative cooling. (6)

(ii) Air at 20 C 40% relative humidity is mixed adiabatically with air at 40° C, 40% relative humidity in the ratio of 1 kg of the former with 2 kg of the latter (on dry basis). Find the condition of air. (10)

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