Reg. No. :

Question Paper Code : 40825

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

Third/Fourth Semester

Mechanical Engineering

ME 8391 – ENGINEERING THERMODYNAMICS

(Common to Automobile Engineering/Industrial Engineering/
Mechanical and Automation Engineering/Plastic Technology)

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Elucidate the importance of Zeroth law of thermodynamics.

2. Apply steady flow energy equation for a nozzle and State the assumption made.

3. What is PMM2 and why is it impossible?

4. Differentiate clearly between the High Grade Energy and Low Grade Energy.

5. Explain the P-T diagram for the heating process of water at constant pressure.

6. Draw the T-S and P-V diagram of an ideal Rankine cycle and explain.

7. Define Law of Corresponding states.

8. What is Joule – Thomson coefficient? What does it signify?

9. State and prove the Dalton's law of partial pressure

10. What is adiabatic saturation temperature?

PART B — (5 × 13 = 65 marks)

11. (a) A gas of mass 1.5 kg undergoes a quasi-static 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 0.20 m^3 and 1.20 m^3. The specific internal energy of the gas is given by the relation, u = 1.5 Pv – 85 kJ/kg, where P is in kPa band v is in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. (13)

Or

(b) Air is compressed from 100 kPa and 15°C to a pressure of 1000 kPa while being cooled at a rate of 20 kJ/kg by circulating water through the compressor casing. The volume flow rate of the air at the inlet conditions is 140 m^3/min, and the power input to the compressor is 520 kW. Determine (i) the mass flow rate of the air and (ii) the temperature at the compressor exit. (13)

12. (a) A heat pump is to be used to heat a house in winter and the reversed to cool the house in summer. The interior temperature is to be maintained at 20°C. Heat transfer through the walls and roof is estimated to be 0.525 kJ/s per degree temperature difference between the inside and outside. (i) If the outside temperature in winter is 5°C, what is the minimum power required to drive the heat pump? (ii) If the power output is the same as in part (i), what is the maximum outer temperature for which the inside can be maintained at 20°C? (13)

Or

(b) Air expands in a turbine adiabatically from 500 kPa, 400 K and 150 m/s to 100 kPa, 300 K and 70 m/s. The environment is at 100 kPa, 17°C. Calculate per kg of air (i) the maximum work output, (ii) the actual work output and (iii) the irreversibility. (13)

13. (a) A vessel of volume 0.05 m^3 contains a mixture of saturated water and saturated steam at temperature 250°C. The mass of the liquid present is 10 kg. Find the pressure, mass, specific volume, enthalpy, internal energy and entropy. (13)

Or

(b) A steam power station uses the following cycle : (13)

Steam at boiler outlet – 150 bar, 550°C

Reheat at 40 bar to 550 °C

Condenser at 0.1 bar.

Using the Mollier chart and assuming ideal processes, find the (i) quality at turbine exhaust (ii) cycle efficiency, and (iii) steam rate.

14. (a) 10 kmol of methane gas is stored in 5 m^3 container at 300 K. Calculate the pressure by (i) ideal gas equation and (ii) van der waals equation. Use the following constants 228.296 kPa.m^6/$kmol^2$ and 0.043 m^3/kmol. (13)

Or

(b) Derive the two TdS equations. (13)

15. (a) A gas mixture consists of 7 kg nitrogen and 2 kg oxygen, at 4 bar and 27°C. Calculate the mole fraction, partial pressures, molar mass, gas constant, volume and density. (13)

Or

(b) One kg of air at 40°C dry bulb temperature and 50% RH is mixed with 2 kg of air at 20°C DBT and 20°C dew point temperature. Calculate the temperature and specific humidity of the mixture. (13)

PART C — (1 × 15 = 15 marks)

16. (a) An aluminium block of C_p = 400 J/kg K with a mass of 8 kg is initially at 37 °C in a room air at 17 °C. It is cooled reversibly by transferring heat to a completely reversible cyclic heat engine until the block reaches 17°C, The 17°C room air serves as a constant temperature sink for the engine. Calculate (i) the changes in entropy for the block, (ii) the change in entropy for the room air and (iii) the work done by the engine. (15)

Or

(b) Air at 16 °C and 25 % relative humidity passes through a heater and then through a humidifier to reach final dry bulb temperature of 30°C and 50% relative humidity. Calculate the heat and moisture added to the air. (15)

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