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L 1483

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2008.

Third Semester

Electrical and Electronics Engineering

ME 251 — THERMODYNAMICS

Time : Three hours

Maximum : 100 marks

Use of Steam Tables, Mollier Chart, HMT data book permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define a thermodynamic system. Classify thermodynamic systems.
2. Distinguish between heat and work.
3. What is relative efficiency as concerned to air standard cycle?
4. At a glance how do you identify SI engine and CI engines?
5. Define a steam turbine and state its fields of applications.
6. Define and explain the equivalent of evaporation.
7. Enumerate the applications of compressed air.
8. Define COP of a vapour compression system.
9. Enumerate the three modes of heat transfer.
10. Distinguish between a Black body and Gray body.

PART B — (5 × 16 = 80 marks)

11. (a) (i) A fluid is heated reversibly at a constant pressure of 1.05 bar until it has a specific volume of $0.1 \text{ m}^3/\text{kg}$. It is then compressed reversibly according to a law $pv = \text{constant}$ to a pressure 4.2 bar, then allowed to expand reversibly according to a law $pv^{1.7} = \text{constant}$, and finally heated at constant volume to the initial conditions. The work done in the constant pressure process is 515 N-m and the mass of the fluid present is 0.2 kg. Calculate the net work done on or by the fluid in the cycle and sketch the cycle on a p-v diagram. (10)
- (ii) Explain what is meant by reversible work? (6)

Or

- (b) (i) Air is compressed from an initial condition of 1 bar and 25°C to a final state of 5 bar and 25°C by three different mechanically reversible processes, Sketch the processes on the p-v diagram : (8)
- (1) Heating at constant volume followed by cooling at constant volume.
 - (2) Isothermal compression
 - (3) Adiabatic compression followed by cooling at constant volume.

Take specific heat at constant pressure as 1 and at constant volume as 0.718 kJ/kg K , Calculate the work required, heat transferred, and the changes in internal energy and enthalpy of the air for each process.

- (ii) 1.5 kg of :
- (1) Steam and (2) air at 1 bar, and 150°C is compressed reversibly and isothermally to a specific volume of $0.3 \text{ m}^3/\text{kg}$. Determine the change in enthalpy and entropy, heat transferred and work done during the processes. Represent the processes on the pv and T-S diagrams. (8)

12. (a) (i) Explain the working of the following air standard cycles with the help of T-s diagrams : (8)

(1) Carnot cycle

(2) Diesel cycle.

(ii) Give the description of an ideal cycle of internal combustion engine for dual fuel combustion, derive the formula for the thermal efficiency of the cycle and plot the cycle on T-s diagram. (8)

Or

(b) (i) Describe with neat sketches the working of two stroke cycle petrol engine. (8)

(ii) A Carnot engine working between 377°C and 37°C produces 120 kJ of work. Determine : (8)

(1) The heat added in kJ.

(2) The entropy change during heat rejection process.

(3) The engine thermal efficiency.

13. (a) (i) Explain the pressure compounded impulse steam turbine showing pressure and velocity variations along the axis of the turbine. (8)

(ii) Find the internal energy of 1 kg of steam at 20 bar when

(1) it is superheated, its temperature being 400°C .

(2) it is wet, its dryness being 0.9.

Assume superheated steam to behave as a perfect gas from the commencement of superheating and thus obeys Charles's law. Specific heat for steam = 2.3 kJ/kg K . (8)

Or

(b) (i) Define the following as related to steam turbines (8)

(1) Speed ratio

(2) Work done

(3) Diagram efficiency

(4) Stage efficiency.

(ii) Give the comparison between the fire tube and water tube boilers. (8)

14. (a) (i) A simple R 12 plant is to produce 5 kW of refrigeration. The condenser and evaporator temperature are 40°C and 10°C respectively. Determine :
- (1) COP
 - (2) Refrigerant flow rate
 - (3) Power required (8)
- (ii) Define and explain : (8)
- (1) Humidity ratio
 - (2) Relative Humidity
 - (3) Wet bulb temperature.

Or

- (b) A single stage double acting air compressor is required to deliver 14 m^3 of air per minute measured at 1.013 bar and 15°C . The delivery pressure is 7 bar and the speed 399 rpm. Take the clearance volume as 5% of the swept volume with the compression and expansion index of 1.3. Calculate :
- (i) Swept volume of the cylinder
 - (ii) The delivery temperature
 - (iii) Indicated power. (16)

15. (a) (i) Air stream at 27°C is moving at 0.3 m/s across a 100 W electric bulb at 127°C . If the bulb is approximated by a 60 mm diameter sphere, estimate the heat transfer rate and the percentage of power lost due to convection. (8)
- (ii) Define and Explain the terms fin efficiency and fin effectiveness. (8)

Or

- (b) (i) Define the critical thickness of insulation. Derive an expression for thickness of insulation for a cylindrical object. (8)
- (ii) Derive an expression for temperature distribution and heat transfer for a slab object in x direction, steady state, without heat generation and with thermal conductivity constant. (8)