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Third Semester B.E. Degree Examination, Dec.2019/Jan.2020 Engineering Thermodynamics

Time: 3 hrs.

Max. Marks: 100

- Note:** 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamic data handbook, steam tables, psychrometry chart allowed.

Module-1

- 1 a. Differentiate:
- Intensive and Extensive property
 - Macroscopic and Microscopic approach
 - Closed and open system
 - Path function and point function. (08 Marks)
- b. State Zeroth law of Thermodynamics and explain. Thermocouple with test junction at $t^{\circ}\text{C}$ on a gas thermometer and cold junction at 0°C gives output emf as per the following relation. $e = 0.20t - 5 \times 10^{-4} t^2$ mV. Where 't' is the temperature. The millivoltmeter is calibrated at ice and steam points. What temperature would this thermometer show when gas thermometer reads 70°C . (12 Marks)

OR

- 2 a. Define work and heat from thermodynamics view point. Mention similarities between work and heat. (06 Marks)
- b. Derive an expression for workdone during quasistatic process. (06 Marks)
- c. Explain constant volume gas thermometer with neat sketch. (08 Marks)

Module-2

- 3 a. Explain Joule's experiment. Prove that internal energy is a property of the system. (10 Marks)
- b. 12kg of air per minute is delivered by a centrifugal air compressor. The inlet and outlet conditions of air are $\bar{V}_1 = 12\text{m/s}$, $P_1 = 1$ bar, $V_1 = 0.5\text{m}^3/\text{kg}$ and $\bar{V}_2 = 90\text{m/s}$, $P_2 = 8$ bar, $V_2 = 0.14\text{m}^3/\text{kg}$. The increase in enthalpy of air passing through the compressor is 150kJ/kg and heat loss to the surrounding is 700kJ/min . Calculate:
- Power required to drive the compressor
 - Ratio of inlet to outlet pipe diameter. (10 Marks)

OR

- 4 a. Define available and unavailable energy. (04 Marks)
- b. Prove that entropy is a property of a system. (08 Marks)
- c. Derive Clausius inequality. (08 Marks)

Module-3

- 5 a. Define:
- Air-fuel ratio
 - Excess air
 - Stoichiometric air
 - Enthalpy of combustion
 - Calorific value. (10 Marks)

- b. A 4 stroke, 4 cylinder petrol engine was tested at full throttle at constant speed. The cylinders have diameters of 80mm and stroke 100mm, fuel was supplied at the rate of 5.44 kg/hr and the plugs of the four cylinders were successively short circuited without the change of speed. The power measured was as follows:

With all cylinders working – 14.7 kW

With cylinder 1 cut off – 10.1 kW

With cylinder 2 cut off – 10.3 kW

With cylinder 3 cut off – 10.4 kW

With cylinder 4 cut off – 10.2 kW

Calorific value of the fuel used was 41900 kJ/kg. The clearance volume of each cylinder is 100CC. Determine: i) The mechanical efficiency ii) The indicated thermal efficiency
iii) The air standard efficiency. (10 Marks)

OR

- 6 a. Derive the expression for thermal efficiency and mean effective pressure for Diesel cycle. (10 Marks)
- b. During a test on a single cylinder 4 stroke cycle oil engine the following data and results were obtained. MEP = 5.6bar, swept volume = 14 litres, speed = 6.6RPS, load = 0.75kN, radius of brake drum = 0.7m, fuel consumption = 0.002kg/s, calorific value of fuel = 46000kJ/kg, cooling water circulation = 0.15kg/s, Temperature rise of cooling water = 33°C. Determine:
i) Brake power
ii) Indicated power
iii) Indicated thermal efficiency.
Also draw heat balance sheet on minute basis. (10 Marks)

Module-4

- 7 a. What is refrigeration? With neat diagram explain steam jet refrigeration system. (10 Marks)
- b. Atmospheric air at 76cm of Hg barometric pressure has 25°C DBT and 15°C WBT. With help of psychrometric table, Determine:
i) The relative humidity
ii) The humidity ratio
iii) The dew point temperature
iv) The enthalpy of air per kg of dry air
v) The partial pressure of vapour. (10 Marks)

OR

- 8 a. Explain winter air conditioning system with the help of schematic diagram. (08 Marks)
- b. A hall is to be air conditioned for 100 persons requiring 0.5m³/minute/person.
Outdoor conditions: 35°C DBT, 65% RH
Required conditions: 15°C DBT, 40% RH
The required conditions are achieved first by cooling and dehumidification and then by heating. Find: i) Capacity of the humidifier ii) Cooling coil capacity iii) Heating coil capacity. (12 Marks)

Module-5

- 9 a. Derive the expression for the isothermal work done by a reciprocating compressor of a single stage, neglecting clearance volume. (10 Marks)
- b. What do you understand by multistage air compressor? Mention the advantages of multistage air compression. (10 Marks)

OR

- 10 a. Explain various types of constant pressure gas turbines with neat sketch. (10 Marks)
- b. With a neat sketch, explain i) Turbojet engine ii) Rocket propulsion. (10 Marks)
