Hall Ticket No | | | | | | | | | | | Question Paper Code: AME003

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech III Semester End Examinations (Supplementary) - January, 2019

Regulation: IARE – R16

THERMODYNAMICS

Time: 3 Hours **(ME)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Draw an isothermal process on p-V and T-s diagram and derive the equation for work transfer. Work and heat are not properties. Justify. **[7M]**

   (b) A gas undergoes a thermodynamic cycle consisting of the following processes: **[7M]**

   • Process 1–2: Constant pressure p = 1.4 bar, $V_1 = 0.028\ m^3$, $W_{1-2} = 10.5$kJ

   • Process 2–3: Compression with pV = constant, $U_3 = U_2$

   • Process 3–1: Constant volume, $U_1 - U_3 = -26.4$ kJ. There are no significant changes in KE and PE.

   (i)Sketch the cycle on a p–V diagram

   (ii)Calculate the net work for the cycle in kJ.

   (iii)Calculate the heat transfer for process 1–2.

   (iv) Show that cycle $\sum_{cycle} Q = \sum_{cycle} W$

2. (a) What is meant by equilibrium? Explain types of equilibrium. For a system to be in thermodynamic equilibrium do the temperature and pressure have to be the same every where? Explain. **[7M]**

   (b) Air flows steadily at the rate of 0.4 kg/s through an air compressor,entering at 6m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg, and leaving at 4.5 m/s with a pressure of 6.9 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 88 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 59 W. Calculate the power required to drive the compressor and the inlet and outlet cross-sectional areas. **[7M]**

UNIT – II

3. (a) Kelvin-Planck & Clausius statements are equivalent to one another. Justify in words. Why is the second law of thermodynamics referred to as the law of degradation of energy? **[7M]**

   (b) A reversible cyclic heat engine operates between the maximum and minimum temperatures of 671^0C and 60^0C respectively. It drives a heat pump which uses river water at 4.4^{o}C to heat a block of flats in which the temperature is to be maintained at 21.1^{o}C. Assuming that a temperature difference of 11.1^{o}C exists between the working fluid and the river water, on the one hand, and the required room temperature on the other, and find the heat input to the engine per unit heat output from the heat pump. Why is direct heating thermodynamically more wasteful? **[7M]**

4. (a) Derive Maxwell equation. Elaborate the relationship between T, p, V, s in terms of partial derivatives. **[7M]**

   (b) 1 kg of ice at – 5°C is exposed to the atmosphere which is at 25°C. The ice melts and comes into thermal equilibrium. Determine the entropy increase of the universe. **[7M]**

UNIT – III

5. (a) Draw the phase equilibrium diagram for a pure substance on p-T and T-s coordinates with relevant constant property lines. Why does the fusion line for water have negative slope? **[7M]**

   (b) Steam initially at 0.3 MPa, 250°C is cooled at constant volume. **[7M]**
   (i) At what temperature will the steam become saturated vapour?
   (ii) What is the quality at 80°C?
   (iii) What is the heat transferred per kg of steam in cooling from 250°C to 80°C?

6. (a) Explain the procedure adopted in steam calorimetry? Why cannot a throttling calorimeter measure the quality, if the steam is wet? Explain how is the quality been measured? **[7M]**

   (b) 1 kg of water fills a 150 liter rigid container at an initial pressure of 2 MPa. The container is then cooled to 40^oC. Determine the initial temperature and final pressure of the water. **[7M]**

UNIT – IV

7. (a) Define Mass fraction and Mole fraction and deduce the relation between them. Explain Dalton's law of partial pressure? **[7M]**

   (b) A vessel contains at 1 bar and 20°C a mixture of 1 mole of CO_2 and 4 moles of air. **[7M]**
   Calculate for the mixture (i) The masses of CO_2, O_2 and N_2, and the total mass (ii) The percentage carbon content by mass; (iii) The apparent molecular weight and the gas constant for the mixture; (iv) The specific volume of the mixture.
   The volumetric analysis of air can be taken as 21% oxygen and 79% nitrogen.

8. (a) Define the terms dry bulb temperature(dbt), wet bulb temperature(wbt), dew point temperature, relative humidity, specific humidity, degree of saturation **[7M]**

   (b) Atmospheric air at 1.0132 bar has a dbt of 32°C and a wbt of 26°C. Compare (a) the partial pressure of water vapour, (b) the specific humidity, (c) the dew point temperature, (d) the relative humidity, (e) the degree of saturation (f) the density of the air in the mixture, (g) density of vapour in the mixture **[7M]**

UNIT – V

9. (a) Define compression ratio. What is the range for SI engines and the CI engines? What factors limit the compression ratio in each type of engine? **[7M]**

   (b) Draw p-V and T-s diagram for Diesel cycle. A diesel engine has a compression ratio of 15 and heat addition at constant pressure takes place at 6% of stroke. Find the air standard efficiency of the engine. Take γ for air as 1.4. **[7M]**

10. (a) Define air standard efficiency of an Otto cycle and show that the efficiency of Otto cycle is lower than that of Carnot cycle. **[7M]**

    (b) An engine of 250mm bore and 375mm stroke works on Otto cycle. The clearance volume is $0.00263m^3$. The initial pressure and temperature are 1bar and 50^oC. The maximum pressure is limited to 25 bars. Find the air standard efficiency and the mean effective pressure of the cycle? Assume ideal conditions? **[7M]**

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