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B. M. S. College of Engineering, Bengaluru - 560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: III**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 19AE3DCATD **Max Marks: 100**
Course: Aero Thermodynamics **Date: 21.09.2023**

Instructions

- Answer any Five full questions, choosing one full question from each unit
- Missing data, if any may suitably assumed.
- Scientific calculator and steam data handbook are allowed to use.

UNIT - I

1. a) Distinguish between: **9**
   i. Classical and Statistical thermodynamics.
   ii. Open system and Closed system
   iii. Intensive and Extensive properties

   b) Write a note on absolute temperature with the help of fundamental law. **3**

   c) Unit mass of a certain fluid is contained in a cylinder at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to a law $PV^2 = C$ until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position; heat is then supplied reversibly with the piston firmly locked in piston until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid, for an initial volume of 0.05 m^3. **8**

UNIT - II

2. a) With a neat sketch explain the famous Joule's law. **8**

   b) An air turbine forms part of an aircraft refrigeration plant. Air at a pressure of 295 kPa and a temperature of 58°C flows steadily into the turbine with a velocity of 45 m/s. The air leaves the turbine at a pressure of 115 kPa, a temperature of 2°C and a velocity of 150 m/s. The shaft work delivered by the turbine is 54 kJ/kg of air. Neglecting changes in elevation, determine the magnitude and sign of the heat transfer per unit mass of air flowing. For air, take Cp = 1.005 kJ/kg K and the enthalpy h = Cp.t. **8**

   c) Write the steady flow energy equation for i) adiabatic nozzle ii) throttling process **4**

UNIT - III

3. a) State and explain Kelvin-Plank and Clausius statement of II law with the help of diagram. **8**

   b) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and -20°C. The heat transfer to the heat engine is 2500 kJ and the net work output of the combined engine refrigerator plant is 360 kJ. a.) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. b.) Reconsider given that the efficiency of the heat engine and the COP of the refrigerator are each 40 % of their maximum possible values. **12**

OR

4. a) State and prove "Clausius Inequality". **8**

   b) Show that Entropy is a property of a system. **4**

   c) 1 kg of ice at -8°C is exposed to the atmosphere which is at 22°C. The ice melts and comes into thermal equilibrium with the atmosphere. Calculate the entropy increase of the universe. Assume the following: Cp of ice = 2.10 kJ/kg K, Latent heat of fusion of ice, h_{fg} = 333.5 kJ/kg. Also draw the T-S diagram for ice water from -8°C to 22°C. **8**

UNIT - IV

5. a) Define the following terms with reference to the pure substances and also represent on the TS diagram. **8**

      i) Latent heat of vaporization
      ii) Subcooled liquid
      iii) Degree of superheat
      iv) Dryness fraction

   b) Sketch and explain the P-T diagram of water. **4**

   c) A mass of wet steam at temperature 165°C is expanded at constant quality 0.8 to pressure 3 bar. It is then heated at constant pressure to a degree of superheat of 66.5°C. Find the enthalpy and entropy changes during expansion and during heating. Draw the T-S diagram. **8**

OR

6. a) Explain the following: **10**

      i) Compressibility factor
      ii) Reduced properties
      iii) Law of corresponding states
      iv) Vander walls equation of state
      v) Universal gas constant

b) A mixture of ideal gases contains 3 kg N_2 and 5 kg CO_2 at pressure of 300 kPa and temperature of 20°C. Solve for i) mass fractions and mole fractions of each gas ii) molecular weight of the mixture iii) gas constant of the mixture iv) partial pressures and partial volumes of the mixture **10**

UNIT - V

7. a) With the help of P-V and T-S diagram. Derive an expression for the air standard efficiency of an Otto cycle. **7**

b) Compare Otto cycle, Diesel cycle and Dual cycle with the help of T-S diagram. **3**

c) Explain the Rankine cycle with a neat sketch and mention the various methods to improve the efficiency of Rankine cycle with the help of a T-S diagram. **10**

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