INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)

B.Tech III Semester End Examinations (Supplementary) - January/February, 2018

Regulation: IARE – R16

THERMODYNAMICS

(Mechanical Engineering)

Time: 3 Hours   **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) Classify thermodynamic systems with an example. **[7M]**

   (b) 0.5 kg of air is compressed reversibly and adiabatically from 80 kPa, 60°C to 0.4MPa, and is then expanded at constant pressure to original volume. Sketch these processes on the P-V and T-S planes. Compute the heat transfer and work transfer for the whole path. **[7M]**

2. (a) Show that energy is property of a system. **[7M]**

   (b) A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. **[7M]**
      i. Find the velocity at exist from the nozzle.
      ii. If the inlet area is 0.1 m^2 and the specific volume at inlet is 0.187 m^3/kg, find the mass flow rate.
      iii. If the specific volume at the nozzle exit is 0.498m3/kg, find the exit area of the nozzle.

UNIT – II

3. (a) State Kelvin-Planck and Clausius statement of II law of thermodynamics. Show that Kelvin Planck statement is equivalent to Clausius. **[7M]**

   (b) A Carnot Engine operates between source temperature of T_1 K and sink temperature of T_2 K. The difference between the source and sink temperature is 240. If the work developed by the Carnot engine is 0.74 times the heat rejected by Carnot engine to sink, find the efficiency of engine and also source temperature and sink temperature. **[7M]**

4. (a) State and prove clausius inequality. **[7M]**

   (b) 2 Kg of water is heated at 80°C and mixed adiabatically with 3 Kg of water at 30°C in a constant pressure process at 1 atmosphere. Find the increase in the entropy of the total mass of water due to the mixing process. (Cp of water = 4.187 KJ/Kg-K) **[7M]**

UNIT – III

5. (a) Explain throttling calorimeter with neat sketch? **[7M]**

(b) Steam expands entropically in a nozzle from 1 MPa, 250°C to 10 kPa. The steam flow rate is 1 kg/s. Find the velocity of steam at the exit from the nozzle, and the exit area of the nozzle. Neglect the velocity of the steam at the inlet to the nozzle. **[7M]**

6. (a) What are the two assumptions of real gas? Derive expression for Vander Waals equation for real gas. **[7M]**

(b) Steam initially at 1.5 MPa, 300°C expands reversibly and adiabatically in a steam turbine to 40°C. Determine the ideal work output of the turbine/ kg of steam. **[7M]**

UNIT – IV

7. (a) Consider a gas mixture that consists of 3 kgs of O_2, 5 kgs of N_2 and 12kg of CH_4. Determine
   i. Mass fraction of each component **[7M]**
   ii. Mole fraction of each component
   iii. Avg molecular mass and gas constant of the mixture.

(b) Represent the psychometric chart on co ordinates and also define the terms related to psychomerty.Represent the psychometric chart on co ordinates and also define the terms related to psychomerty. **[7M]**

8. (a) Define **[7M]**
   i. Pure substance
   ii. Dryness fraction
   iii. Irreversibility
   iv. Mole fraction.

(b) The analysis by weight of perfect gas mixture at 20°C and 1.3 bar is 10% O_2 (molecular mass 32), 70% N_2 (molecular mass 28), 15% CO_2 (molecular mass 44) and 5% CO (molecular mass 28) for a reference state of 0°C and 1 bar, Determine **[7M]**
   i. Partial pressure of the constituents.
   ii. Gas constant of mixture.

UNIT – V

9. (a) Represent the process involved in Otto-cycle on PV and TS, Diagram and derive its air standard efficiency. **[7M]**

(b) An air standard Otto-cycle is designed to operate with following data **[7M]**
   Maximum cycle pressure and temperature 5 mpa and 2250 k
   Minimum cycle pressure and temperature 0.1 mpa and 300k
   Determine the net work output per unit mass of working fluid and thermal efficiency

10. (a) Derive an expression for COP of Bell Coleman cycle with the help of PV and TS diagram. **[7M]**

(b) A refrigerator system operating on a reversed system operating on reversed Carnot cycle produces 400 kg/hr of ice at -5°C from water at 30°C. Make calculation for **[7M]**
   i. Power required to drive the machine
   ii. Heat rejected from the system. Take latent heat of freezing of 335 KJ/Kg and specific heat of ice is 2.1 KJ/Kg-K.

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