CBCS SCHEME

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17AE/AS33

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019

Aerothermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamics Data Hand Book is permitted.

Module-1

1 a. Distinguish between:
i) Open and closed systems
ii) Intensive and extensive properties
iii) Mechanical and thermal equilibrium. **(10 Marks)**

b. A centigrade and a Fahrenheit thermometer dipped in a fluid recorded same numerical reading. Determine the temperature of the fluid expressed as Kelvin (K) and Rankine (R) and also find the identical numerical value shown by the thermometer. Absolute zero on K and R scale correspond to -459.7°F and -273.16°C. **(10 Marks)**

OR

2 a. Define work and heat. Write the similarities and dissimilarities (any four). **(10 Marks)**

b. A fluid at 0.7 bar occupying $0.09m^3$ is compressed reversibly to a pressure of 3.5 bar according to a law pV^n = constant. The fluid is then heated reversibly at constant volume until the pressure is 4 bar; the specific volume then being 0.5 m^3/kg. The fluid is restored back to its initial state by a reversible expansion process as per pV^2 = constant. Sketch the cycle on a p-v diagram and find:
i) The fluid mass
ii) The value of n in the first process
iii) The net work done. **(10 Marks)**

Module-2

3 a. State the first law of thermodynamics for a non-cyclic process and show that internal energy is a property of a system. **(10 Marks)**

b. A tank contains 12kgof water used for determining mechanical-thermal energy equalities. The total work input is 40Nm. Assuming the system is adiabatic, find: i) the change in specific and total internal energy ii) If a heat loss of 0.1 J/kg is recorded, what is the internal energy change, both specific and total, now? **(10 Marks)**

OR

4 a. Starting from first law equation for a closed system undergoing a non-cyclic process, derive an equation for an open system under steady state, steady flow conditions. List all the assumptions made. **(12 Marks)**

b. An air compressor with water jacket compresses 48.67 lps of air of specific volume 0.73 m^3/kg. The enthalpy of air is increased by 105 kJ/kg. The heat transfer rate to the cooling water jacket and the surrounding is 190 kJ/min. Determine the power required to drive the compressor assuming negligible changes in kinetic and potential energies. The flow is steady state. **(08 Marks)**

Module-3

5 a. Define the two statements of II laws of thermodynamics. Further prove that violation of clausius statement also violates Kelvin-Plank statement. **(10 Marks)**

b. An engine mounted on a ship has a thermal efficiency of 80% of that of the standard carnot cycle. The engine receives heat from the sea at 300K and rejects heat to the atmosphere at 280K. What quantity of heat must be extracted from the sea water to provide the required heating effect? The work output from the engine is dissipated using 500kg of water at 355K. Take Cp of sea water as 4.186 kJ/kg K. **(06 Marks)**

c. With a simple block diagram represent PMM of II kinds. Why it is not possible? **(04 Marks)**

OR

6 a. Derive clausius inequality and hence prove that entropy is a property. **(12 Marks)**

b. In a certain reversible process the rate of heat transfer to the system per unit temperature rise is constant at 2 kJ/°C. Determine the increase in entropy of the system if the temperature changes from 27°C to 127°C.
In a second process between the same end states if the above temperature rise is accomplished by using a string and stirrer, what is the change or increase in entropy? **(08 Marks)**

Module-4

7 a. Represent water existing in all phases at atmospheric pressure on a P-T diagram. Label all the three phases, fusion and vapourization lines, critical and triple point of water. **(06 Marks)**

b. Define critical point and triple point of water. **(04 Marks)**

c. A vessel contains 10kg of oxygen, 8kg of nitrogen and 25kg of carbon dioxide at 375K and 250kPa. Calculate the capacity of the vessel, the partial pressure of each gas present in the vessel and the total pressure in the vessel when the temperature is raised to 450K. **(10 Marks)**

OR

8 a. Distinguish between ideal and real gases. Write any two equations of state you know. **(06 Marks)**

b. Define compressibility factor. Determine the compressibility factor of nitrogen at 10MPa and -80°C and 0.5 MPa and 35°C. For N_2 take $T_c = 126.30K$ and $P_c = 3.398$ MPa. **(06 Marks)**

c. Using the relation $C_p - C_v = T\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial P}{\partial T}\right)_V$ for an ideal gas show that $C_p - C_v = R$. **(08 Marks)**

Module-5

9 a. Derive with usual notations an expression for the air standard efficiency of an Otto cycle. Represent the cycle on P-V and T-S diagrams. **(09 Marks)**

b. In a petrol engine the temperature at the beginning and at the end of compression are 300K and 750K. Find the compression ratio and air standard efficiency. **(06 Marks)**

c. State any six assumptions made in the analysis of air standard cycles. **(05 Marks)**

OR

10 a. With the help of T-S diagram deduce an expression for Rankine cycle efficiency. **(10 Marks)**

b. The following data are extracted from a steam power plant:
Steam at boiler inlet: 150 bar and 550°C
Reheated to : 40 bar and 550°C
Condensed to : 0.1 bar
Assuming all processes as ideal and using Mollier chart/steam tables determine:
(i) Quality at turbine exhaust ii) Cycle efficiency iii) Steam rate. **(10 Marks)**

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