CBCS SCHEME

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17ME33

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

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Can you define and give examples to the following? i) Closed system, ii) open system, iii) isolated system. **(06 Marks)**

b. Can you distinguish between the following:
i) Microscopic and Macroscopic point of study
ii) Intensive and Extensive properties
iii) Work and Heat
iv) Path and Point functions. **(08 Marks)**

c. State and explain Zeroth law of thermodynamics. **(06 Marks)**

OR

2 a. Can you define thermodynamic definitions of work and heat? Write three important similarities between them. **(05 Marks)**

b. Can you derive expressions for work done of the following types of processes?
i) The process which follow the law, $P = C$
ii) The process which follow the law, $PV^{\gamma} = C$. **(06 Marks)**

c. Air at 1.02 bar, 22°C, initially occupying a cylinder volume of $0.015m^3$, is compressed reversibly and adiabatically by a piston to a pressure of 6.8 bar. Calculate: i) The final temperature ii) The final volume iii) The work done. **(09 Marks)**

Module-2

3 a. Write the first law statements for a system undergoing:
i) a cycle ii) a process iii) a steady flow process. **(06 Marks)**

b. Prove that internal energy – a property. **(04 Marks)**

c. Air flows steadily at the rate of 0.4 kg/s through an air compressor, entering at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg, and learning at 4.5 m/s with a pressure of 6.9 bar and a specific volume of $0.16m^3$/kg. The internal energy of air leaving is 88kJ/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 kJ/s. Calculate the power required to drive the compressor and the inlet and outlet pipe cross sectional areas. **(10 Marks)**

OR

4 a. Will you prove that two statements of second law of thermodynamics are equivalent? **(05 Marks)**

b. Can you explain carnot heat engine cycle with the help of P-V and T-S diagrams? **(07 Marks)**

c. A heat source S_1 can supply 6000 kJ/min at 300°C and another heat source S_2 can supply 60,000 kJ/min at 100°C. Which source between the two would you choose to supply energy to a carnot engine, that is to produce larger amount of power if the surroundings are at 27°C? Which engine is more efficient? **(08 Marks)**

Module-3

5 a. Can you define and give examples for reversible and irreversible processes? List the factors which makes the process irreversible. **(06 Marks)**

b. Will you prove that entropy a property of a system? **(06 Marks)**

c. A reversible heat engine converts one-sixth of the heat input into work. When the temperature of the sink is reduced by 62°C, its efficiency is doubled. Find the temperature of the source and the sink. **(08 Marks)**

OR

6 a. Derive an expression for change in entropy during constant pressure process. **(06 Marks)**

b. Explain the principle of increase of entropy. **(06 Marks)**

c. In a shell and tube heat exchanger 45kg of water per minute is heated from 60°C to 115°C by hot gases which enter the heat exchanger at 225°C. If the flow rate of gases is 90 kg/min, find the net change of entropy of the universe. C_p (water) = 4.18 kJ/kg.K; C_p(gas) = 1 kJ/kg.k. Assume that there are no losses. **(08 Marks)**

Module-4

7 a. Define available and unavailable energy and prove that the available portion of heat Q withdrawn from an infinite source is $(Q-T_0\Delta s)$. Where T_0 is dead state temperature and ΔS is change in entropy during the process. **(07 Marks)**

b. Obtain an expression for availability of a non-flow process. **(06 Marks)**

c. One kg of air at pressure P_1 and temperature 900K is mixed with one kg of air at the same pressure but at 500K. Determine the loss in availability if the atmospheric temperature is 300K. **(07 Marks)**

OR

8 a. Explain P-T diagram for water. **(06 Marks)**

b. Explain the method of determining the dryness fraction of the given sample of stream using throttling calorimeter with a neat sketch. **(07 Marks)**

c. Determine the enthalpy and internal energy of 2kg of steam at a pressure of 15 bar and 0.85 dryness. Also determine the heat supplied at constant pressure if the final condition of the steam is 70°C of superheat. Take Cp_s (superheated) = 2.25 kJ/kg. **(07 Marks)**

Module-5

9 a. Define the following terms: Mass fraction, Mole fraction, Specific humidity, Dry Bulb Temperature, Dew Point Temperature. **(05 Marks)**

b. Derive and expression for molecular weight and gas constant of a mixture of ideal gases in terms of mass fractions. **(06 Marks)**

c. A vessel of $0.2m^3$ capacity contains 2kg of CO_2 and 1.5kg of N_2 at 300K. Determine: i) Pressure in the vessel ii) Mole fraction of each constituent iii) R and M of the mixture. **(09 Marks)**

OR

10 a. Explain the reasons for deviations of Van-der Waal's equation from ideal gas equation. **(06 Marks)**

b. Explain the following:
   i) Law of corresponding states
   ii) Compressibility factor
   iii) Gibbos-Dalton's law. **(06 Marks)**

c. A container of $3m^3$ capacity contains 10kg of CO_2 at 27°C. Estimate the pressure exerted by CO_2 by using:
   i) Perfect gas equation
   ii) Van-der Waal's equation
   iii) Beattie Bridgeman equation. **(08 Marks)**

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