CBCS Scheme

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15ME33

Third Semester B.E. Degree Examination, Dec.2017/Jan.2018
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer FIVE full questions, choosing one full question from each module.***
2. ***Use of thermodynamic data book is permitted.***

Module-1

1 a. Define the following with examples: (i) Open system (ii) Closed system (iii) Isolated system. **(06 Marks)**

b. List out similarities and dissimilarities between work and heat. **(04 Marks)**

c. The temperature t on a Celsius thermometer scale is defined interms of property P by the relation $p = e^{(t-B)/A}$ where A and B are constants. At ice and steam points the value of p is 1.86 and 6.81 respectively. Find the value of 't' for p = 2.5. **(06 Marks)**

OR

2 a. With examples, distinguish between :
(i) Intensive property and extensive property.
(ii) Point function and path function. **(04 Marks)**

b. Obtain an expression for work done by the isothermal process. **(04 Marks)**

c. A fluid in a horizontal cylinder fitted with a frictionless leak proof piston is continuously agitated by means of stirrer passing through the cylinder cover. The cylinder diameter is 400 mm. During a stirring process of 10 minutes, the piston moves slowly outwards to a distance of 485 mm against the atmospheric pressure. The net work done by the fluid during this process is 2000 Nm. Given that the speed of electric motor driving the stirrer is 840 rpm, estimate the torque required in driving the shaft and shaft output of the motor. **(08 Marks)**

Module-2

3 a. State the first law of thermodynamics applied to cyclic and non-cyclic processes. **(04 Marks)**

b. What is PMMK2? Why is it impossible? **(04 Marks)**

c. A centrifugal pump delivers 50 kg of water per second. The inlet and outlet pressures are 1 bar and 4.2 bar. The suction is 2.2 m below the centre of the pump and delivery is 8.5 m above the centre of the pump. The suction and delivery pipe diameter are 20 cm and 10 cm respectively. Determine the capacity of the electric motor to run the pump if pump efficiency is 85%. **(08 Marks)**

OR

4 a. Give Kelvin-Planck and Clausius statements of second law of thermodynamics. **(04 Marks)**

b. Show that for constant pressure process, the heat transfer is equal to change in enthalpy. **(04 Marks)**

c. Two Carnot engines work in series beween the source and sink temperatures of 550 K and 350 K. If both engines develop equal power, determine the intermediate temperature. **(08 Marks)**

Module-3

5 a. Explain how free expansion and friction makes the process irreversible. **(08 Marks)**

b. $0.12\ m^3$ of air at 1 bar and 120°C is compressed to $\frac{1}{10}$ of the original volume and a pressure of 35 bar. Heat is then added at constant pressure until the volume is doubled. Determine the change of entropy during each of these process. Take $C_p = 1.005$ kJ/kgK, $C_v = 0.7165$ kJ/kgK, $R = 0.287$ kJ/kgK. **(08 Marks)**

OR

6 a. What is internal and external irreversibility? **(03 Marks)**

b. Show that entropy is a property of a system. **(06 Marks)**

c. A heat engine receives 300 kJ/min of heat from a source at 327°C and rejects heat to a sink at 27°C. Three hypothetical amounts of heat rejections are given below (i) 200 kJ/min (ii) 150 kJ/min (iii) 100 kJ/min. From these results state which of these cases is a reversible cycle, irreversible cycle and impossible one. **(07 Marks)**

Module-4

7 a. Define available and unavailable energy. **(04 Marks)**

b. Draw phase equilibrium diagram for water on P-V coordinates and indicate relevant parameters on it. **(04 Marks)**

c. Write a note on Maxwell relations. **(08 Marks)**

OR

8 a. With a neat sketch, explain the working of combined separating and throttling calorimeter. **(08 Marks)**

b. Steam at 10 bar and dry state is cooled under constant pressure until it becomes 0.85 dry. Using steam tables, find the work done, change in enthalpy, heat transferred and change in entropy. **(08 Marks)**

Module-5

9 a. Give the statement of, (i) Dalton's law of additive pressures (ii) Amagat's law of volume additives. **(04 Marks)**

b. With usual notations, write the Beattie-Bridgeman equation of state. **(04 Marks)**

c. A mixture of ideal gas consists of 3 kg of N_2 and 5 kg of CO_2 and at a pressure of 300 kPa and temperature of 20°C. Find (i) Mole fraction of each constituent (ii) Equivalent gas constant of the mixture (iii) Equivalent molecular weight (iv) Partial pressures and volumes. **(08 Marks)**

OR

10 a. State and explain law of corresponding states. **(04 Marks)**

b. Define the following:

(i) Dry bulb temperature.
(ii) Wet bulb temperature.
(iii) Specific humidity.
(iv) Dew point temperature **(04 Marks)**

c. Determine the pressure in a steel vessel having a volume of 15 lit and containing 3.4 kg of N_2 at 400°C using (i) Ideal gas equation (ii) Vander-Waals equation. Also calculate the compressibility factor by using the answer obtained from the Vander –Waals equation of state. **(08 Marks)**

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