CBCS SCHEME

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18MR33

Third Semester B.E. Degree Examination, June/July 2023
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define the following with examples :
(i) Open system (ii) Closed system (iii) Isolated system (iv) Adiabatic system **(08 Marks)**

b. What is thermodynamic equilibrium? Explain how equilibrium can be achieved for a system. **(04 Marks)**

c. The temperature 't' on a Celsius thermometer scale is defined interms of property P by the relation $P = e^{\frac{(t-B)}{A}}$, 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. **(08 Marks)**

OR

2 a. Define work and heat in thermodynamics. Explain how both are path functions. **(08 Marks)**

b. A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to law PV^2 = constant 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 position until the pressure rises to original value of 20 bar. Calculate the net work done by fluid, for an initial volume of 0.05 m^3 **(12 Marks)**

Module-2

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

b. Derive steady flow energy equation for a single stream of flow entering and a single stream of fluid leaving the control volume. **(08 Marks)**

c. A fluid contained in a cylinder by a spring loaded frictionless piston, so that the pressure in the fluid is the linear function of volume, P = a + bV. The internal energy of the fluid is given by $u = 34 + 3.15\ PV$, where u is in kJ, P in kPa.f V is in m^3. If the fluid changes from 170 kPa, 0.03 m^3 to a final state of 400 kPa and 0.06 m^3 with no work other than that done on the piston. Find the magnitude and direction of the heat and work transfer. **(08 Marks)**

OR

4 a. Represent schematically heat engine and refrigerator. Give their performance. **(06 Marks)**

b. Prove that all heat engine working between two given thermal reservoir, the carnot engine is the most efficient one. **(08 Marks)**

c. A reversible heat engine is supplied 900 kJ of heat from a heat source at 500 K. The engine develops 300 kJ of network and rejects heat to two sinks at 400 K and 300 K. Determine the engine thermal efficiency and magnitude of heat interaction with each of the sink. **(06 Marks)**

Module-3

5 a. State and prove Clausius in equality. **(08 Marks)**

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

c. A heat engine receives 420 kJ/cycle of heat from a source at 327 °C and rejects heat reversibly to sink to 27 °C. There are no other heat transfer. For each case of the three hypothetical amounts of heat rejected (i), (ii) and (iii) given below. Compute the cyclic integral of $\frac{dQ}{T}$ from these results, classify the cycle,
   (i) 210 kJ/cycle is rejected.
   (ii) 105 kJ/cycle is rejected.
   (iii) 315 kJ/cycle is rejected. **(06 Marks)**

OR

6 a. Define the following :
   (i) Pure substance. (ii) Tripple point. (iii) Critical point.
   (iv) Quality of steam. (v) Subcooled liquid. **(10 Marks)**

b. A pressure cooker contains 1.5 kg of saturated steam at 5 bar. Find the quality of heat which must be rejected so as to reduce the quality to 60% dry. Determine the pressure and temperature. **(10 Marks)**

Module-4

7 a. Explain the following : (i) Gibs and Helmholtz function (ii) Maxwell relation. **(12 Marks)**

b. 1.2 m^3 of air is heated reversibly at constant pressure from 300 K to 600 K and is then cooled reversibly at constant volume back to initial temperature. If the initial pressure is 1 bar, calculate
   (i) The net heat flow.
   (ii) The overall change in entropy also draw T-S plot for the process. **(08 Marks)**

OR

8 a. Derive an expression of entropy change for,
   (i) Constant pressure process.
   (ii) Isothermal process
   (iii) Polytropic process. **(12 Marks)**

b. A fluid undergoes a reversible adiabatic compression from 0.5 MPa, 0.2 m^3 to 0.05 m^3 according to the law $PV^{1.3}$ = Constant. Determine the change in enthalpy, internal energy and entropy. Also determine the work and heat transfer during the process. **(08 Marks)**

Module-5

9 a. Explain the following :
   (i) Dalton's law and Amugat's law of additive volumes.
   (ii) Law of corresponding states.
   (iii) Compressibility chart.
   (iv) Compressibility factor. **(12 Marks)**

b. A mixture of gases contains 1 kg of CO_2 and 1.5 kg of N_2 the pressure and temperature of the mixture are 3.5 bar and 27 °C. Determine (i) The mass and mole fraction of each gas, (ii) Average molecular weight (iii) Gas constant (iv) Partial pressure. **(08 Marks)**

OR

10 a. Derive Vander Waals constant in terms of critical properties. **(12 Marks)**

b. Determine the pressure exerted by CO_2 in a container 1.5 m^3 capacity, when it contains 5 kg at 27 °C using (i) Ideal gas (ii) Vander Waals equation. **(08 Marks)**

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