CBCS SCHEME

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17MR33

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
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 thermodynamics data book is permitted.

Module-1

1 a. Distinguish between: i) Microscopic and macroscopic point of view
ii) Intensive and extensive property
iii) Open, closed and isolated system **(06 Marks)**

b. Define a Quasi-static process. A platinum wire is used as a resistance thermometer. The wire resistance was found to be 10Ω and 16Ω at ice point and steam point respectively, and 30Ω at sulphur boiling point of 444.6°C. Find the resistance of the wire at 750°C, if the resistance varies with temperature by the relation $R = R_0(1 + \alpha t + \beta t^2)$. **(10 Marks)**

c. State Zeroth law thermodynamics. What is dia thermal and adiabatic wall? **(04 Marks)**

OR

2 a. Define heat and work from thermodynamic point of view and derive an expression for flow of work. **(06 Marks)**

b. A fluid is containing in a piston cylinder arrangement at a pressure of 10 bar and volume of 0.06 m^3. Calculate the work done by the fluid when it expands reversible as:
i) At constant pressure to a final volume of 0.025 m^3.
ii) According to the law PV = C to a final volume of 0.25 m^3.
iii) According to the law $PV^{1.3} = C$ to a final volume of 0.25 m3.
iv) According to the law $P = \frac{a}{V^2} - \frac{b}{V}$ to a final volume of 0.25 m^3 and final pressure of 5 bar where a and b are constants. Sketch all the process on a PV diagram. **(14 Marks)**

Module-2

3 a. State first law of thermodynamics for a process and show that energy is a property of the system. **(06 Marks)**

b. Derive the steady flow energy equation for a single stream of fluid entering and a single stream of fluid leaving the control volume. **(06 Marks)**

c. 1.5 kg of a gas undergoes a quasi static process in which the pressure and specific volume are related by the equation p = a + bv, where a and b are constant. The initial and final pressures are 1000 kPa and 200 kPa respectively. The corresponding volumes are 0.2 m^3 and 1.2 m^3. The specific internal energy of the gas is given by the relation u = 1.5 pv – 3.5, where u in kJ/kg, p in kPa and v in m^3/kg. Find the magnitude and direction of heat transfer and the change in internal energy of the gas during the process. **(08 Marks)**

OR

4 a. State and prove that Kelvin Plank and Clausius statements of second law of thermodynamics are equivalent. **(12 Marks)**

b. There are two ways to increase the efficiency of a Carnot engine.
i) Lowering the temperature T_2 of the low temperature reservoir by ΔT while keeping the temperature T_1 of the high temperature reservoir constant.
ii) Increasing the temperature T_1 by ΔT while keeping the temperature T_2 a constant which is more effective? Prove your answers. **(08 Marks)**

Module-3

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

b. A volume of 0.05 m^3 of a perfect gas for which R = 0.297 kJ/kgK is compressed reversibly in a cylinder according to the law $PV^n = C$ and then cooled at constant pressure. The initial temperature is 27°C and the final pressure is 8.5 times the initial pressure. The final volume is 0.007 m^3. Determine the following: (i) The final temperature after compression (ii) The final temperature (iii) The net heat transfer per kg (iv) The net change in specific entropy **(10 Marks)**

c. What do you understand by the entropy principle? **(02 Marks)**

OR

6 a. Define the following: i) Pure substance ii) Triple point iii) Critical point **(06 Marks)**

b. With a neat sketch, explain the measurement of dryness fraction of stream by using throttling calorimeter. **(08 Marks)**

c. Two boilers one with super heater and other without super heater are delivering equal quantities of stream into a common main. The pressure in the boiler is 20 bar. The temperature of steam from a boiler with a super heater is 350°C and temperature of the steam in the main is 250°C. Determine the quality of steam supplied by the other boiler. Take C_{Ps} = 2.25 kJ/kg. **(06 Marks)**

Module-4

7 a. Write notes on: (i) Maxwell's equations (ii) Clausius-Clapeyron equation **(12 Marks)**

b. 0.5 kg of air is compressed reversibly and adiabatically from 80 kPa, 60°C to 0.4 MPa and is then expanded at constant pressure to the original volume. Sketch these processes on the P-V and T-S planes. Compute the heat transfer and work transfer for the whole path. **(08 Marks)**

OR

8 a. Distinguish between Universal gas constant and particular gas constant. **(04 Marks)**

b. When a kg ideal gas undergoes a resisted polytropic process according to $PV^n = C$, show that the heat transfer during the process is given $Q = \left[\frac{n-\gamma}{n-1}\right] C_v (T_2 - T_1)$. **(08 Marks)**

c. 0.1 m^3 of air at 1 bar and 27°C undergoes the following process. Calculate the work-done, heat transferred, change in internal energy and entropy change in each case.
i) Isobaric process with volume doubling.
ii) Isothermal process with final volume 0.08 m^3.
Take C_p = 1 kJ/kgK, C_V = 0.72 kJ/kgK. **(08 Marks)**

Module-5

9 a. State and explain the following law:
i) Dalton's laws of partial pressures
ii) Amagati law of additive volumes **(12 Marks)**

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

OR

10 a. Define compressibility factor and compressibility chart. **(06 Marks)**

b. Derive Vander Waal's equation of state. **(08 Marks)**

c. The gas Neon has a molecular weight of 20.183 and its critical temperature, pressure and volume are 44.5 K, 2.73 MPa and 0.0416 m^3/kgmol. Reading from a compressibility chart for a reduced pressure of 2 and a reduced temperature of 1.3, the compressibility factor is 0.7. what are the corresponding specific volume, pressure, temperature and reduced volume? **(06 Marks)**

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