CBCS SCHEME

USN | | | | | | | | | | 18ME33

Third Semester B.E. Degree Examination, Aug./Sept.2020
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 hand book permitted.

Module-1

1 a. Define the following with example:
i) Closed system ii) Open-system iii) Isolated system iv) Intensive-property v) Extensive property. **(10 Marks)**

b. The temperature 't' on a thermometric scale is defined interms of a property 'P' by the relation t = alnp + b, where 'a' and 'b' are constants. The temperature of the Ice point and steam point are assigned numbers '0' and '100' respectively. Experiment gives values of 'P' as 1.86 and 6.81 at the Ice point and steam point respectively. Evaluate the temperature corresponding to a reading of P = 2.5 on the thermometers. **(10 Marks)**

OR

2 a. State Zeroth law of thermodynamics and explain in detail. **(04 Marks)**

b. Define Quasistatic process. What are its characteristics? **(06 Marks)**

c. The Emf in millivoltmeter in a thermocouple with the test junction at t°C on a gas thermometer scale and reference junction at Ice point is given by $e = (0.0367t + 1.33 \times 10^{-4}t^2)$mV. The millivoltmeter is calibrated at Ice and steam points. What will this thermometer read in a place where the gas thermometer reads 50°C? **(10 Marks)**

Module-2

3 a. Explain the pdv work and prove that work is a path function. **(05 Marks)**

b. Explain path and point function. **(05 Marks)**

c. A closed system undergoes a Quasistatic process according to the law $P = \left(V^2 + \frac{8}{V}\right)$, where 'P' is in N/cm^2 and 'V' is in m^3. Calculate work-done when 'V' changes from 10 to 30m^3. **(10 Marks)**

OR

4 a. Briefly describe internal energy in a property of the system. **(04 Marks)**

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

c. A turbine operates under steady flow conditions receiving steam at the following state; pressure is 1.2MPa, temperature is 188°C, enthalpy is 2785kJ/kg velocity is 34m/s and elevation is 3m. The steam leaves the turbine at the following state: pressure is 200MPa, enthalpy is 2512kJ/kg velocity is 100m/s and elevation is 0m. Heat is lost to the surroundings at a rate of 0.29kJ/s. If the steam flow rate is 0.42kg/s. Determine the power output from the turbine. **(10 Marks)**

Module-3

5 a. Establish the equivalence of Kelvin-Planck and Clausius statement. **(08 Marks)**

b. What is perpetual motion of II-kind? Explain. **(04 Marks)**

c. In a heat engine, the temperature of the source and sink are 700°C and 50°C respectively. The heat supplied is 5MJ/min. Find the power developed by the engine. **(08 Marks)**

OR

6 a. Show that entropy is a property of a system. **(04 Marks)**

b. State and explain Clausius inequality. **(08 Marks)**

c. 2.5kg of air at a pressure of a 2bar and 26°C forms a closed system, which undergoes a constant pressure process with a heat addition of 650kJ. Calculate: i) Find temperature ii) Change in internal energy iii) Work transfer iv) Change in entropy. **(08 Marks)**

Module-4

7 a. Derive the expression of maximum work obtainable from two finite bodies at temperatures of T_1 and T_2. **(10 Marks)**

b. $1.2m^3$ of air is heated reversibly at a 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 net heat flow and overall change in entropy. Also represent the process on T-S diagram. Take $C_P = 1.005\frac{kJ}{kg^\circ K}$; $R = 0.287\frac{kJ}{kg^\circ K}$; $C_V = 0.7165\frac{kJ}{kg^\circ K}$. **(10 Marks)**

OR

8 a. With neat sketch, explain the method of measurement of dryness fraction of steam using separating throttling calorimeter. **(10 Marks)**

b. Define the terms i) Sensible heat ii) Dryness fraction. **(04 Marks)**

c. Find the entropy of one kg of superheated steam at 25bar and a temperature of 290°C. The specific heat of the superheated steam is 2.1kJ/kg°K. **(06 Marks)**

Module-5

9 a. State the i) Gibb's Dalton's law of partial pressure ii) Amagat's law. **(04 Marks)**

b. A tank has a volume of $5m^3$ and contains 20kg of an ideal gas having a molecular mass of 25. The temperature is 15°C. What is the pressure? **(06 Marks)**

c. A vessel of $2.5m^3$ capacity contains 1kg-mole of Nitrogen (N_2) at 100°C. Evaluate the specific volume and pressure. If the gas is cooled to 30°C, calculate the final pressure, change in specific internal energy and specific enthalpy. The ratio of specific heats is 1.4. One kg-mole of Nitrogen is 28kg. **(10 Marks)**

OR

10 Define the following:

i) Ideal and real gas

ii) State and explain the Vander Waal's equation of state

iii) Compressibility factor

iv) Law of corresponding states

v) Beattie-Bridgeman equation. **(20 Marks)**

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