CBCS SCHEME

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18ME33

Third Semester B.E. Degree Examination, Dec.2024/Jan.2025
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Distinguish between :
i) Open system and closed system
ii) Macroscopic and Microscopic point of view
iii) Point function and path function
iv) Intensive property and extensive property
v) Quasistatic and actual process **(10 Marks)**

b. The temperature scale of certain thermometer in given by the relation $t = a\ell n(x) + b$, where 'a' and 'b' are constants and 'x' is the thermometric property of the fluid in the thermometer. If at ice and steam points, the thermometric property are found to be 1.5 and 7.5 respectively. What will be the temperature corresponding to the thermometric property of 3.5? **(10 Marks)**

OR

2 a. State and prove Zeroth law of Thermodynamics. **(06 Marks)**

b. Define the following :
i) Mechanical equilibrium
ii) Thermal equilibrium
iii) Chemical equilibrium **(06 Marks)**

c. The emf in a thermocouple with test junction at $t°_c$ on gas thermometer scale and the reference junction at ice point is given by $\in = 0.20t - 5 \times 10^{-4} t^2$ mv. The millivoltmeter is calibrated at ice and steam point. What will this thermometer reads in a place where the gas thermometer reads 50°C. **(08 Marks)**

Module-2

3 a. A system undergoes a proun in which the pressure and volume are related by an equation of the form PV^n = Constant. Derive an expression for displacement work during this process. **(06 Marks)**

b. Distinguish between heat and work in thermodynamics. **(04 Marks)**

c. A cylinder contains 1 Kg of certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversible behind a piston according to a law PV^2 = Constant until the volume is doubled, the fluid is then cooled reversibly at constant pressure until the piston regains its original positions, heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value. Calculate the network done by the fluid for an initial volume of $0.05m^3$. **(10 Marks)**

OR

4 a. Show that energy as a property of the system. **(06 Marks)**

b. Starting from the first law of thermodynamics for a closed system undergoing a non-cyclic process derive the steady state steady flow energy equation for the control volume. **(08 Marks)**

c. A store of 20 Kg mass and a tank containing 200 Kg water comprise a system. The stone is 15 mt above the water level initially. If the stone falls into water then determine :
Change in internal energy, Kinetic energy potential energy, heat and water when
i) The stone is about the enter the water
ii) The stone has come to rest in tank
iii) The heat is transferred to the surrounding is such an amount that the stone and water come to their initial temperature. **(06 Marks)**

Module-3

5 a. State and prove that Kelvin Plank and Clausins statements and second law of thermodynamics are equivalent. **(10 Marks)**

b. A reversible heat engine works between the two reservoirs at 1400 K and 350 K respectively. A reversible heat pump receives heat from the reservoir at 250K and rejects the heat to a reservoir at 350 K to which the heat engine also rejects the heat. The work at output from the engine is used to derive the heat pump. If the total heat supplied to the reservoir at 350 K is to be 100 kW. Find the heat to be received by the heat engine. **(10 Marks)**

OR

6 a. Show that entropy is a property. **(06 Marks)**

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

c. A heat engine absorbs 200 kJ/sec of heat at 227°C and rejects heat at 27°C. Three separate case of the heat rejection are reported.
i) 180 kJ/Sec heat is rejected
ii) 120 kJ/sec heat is rejected
iii) 60 kJ/sec heat is rejected
Classify each cycle. **(06 Marks)**

Module-4

7 a. Briefly explain available and unavailable engines referred to a cyclic process. **(06 Marks)**

b. A Carnot engine works between the temperature limits of 225°C in which water is used as the working fluid. If heat is supplied to the saturated liquid water at 225°C until it is converted into saturated vapour, determine per Kg of water.
i) The amount heat absorbed by the fluid
ii) The available energy
iii) The unavailable energy
Take Latent heat of water = 1858.5 kJ/Kg **(06 Marks)**

c. The fuel gas leaving a boiler at 300°C is cooled to 110°C by the air on its way to furnace. The specific heat at constant pressure for the gas is 0.24 kJ/Kg K and the sink temperature is 20°C. Determine the heat recovered from each kg of fuel gas and the available and unavailable portion of this heat. **(08 Marks)**

OR

8 a. With a neat sketch briefly explain the working of a throttling calorimeter to determine the quality of steam. **(08 Marks)**

b. Draw the phase equilibrium diagram for water on P-T coordinates, indicating triple and critical point. **(06 Marks)**

c. Find the specific volume enthalpy and internal energy of wet steam at 18 bar pressure and dryness fraction of 0.85. **(06 Marks)**

Module-5

9 a. State and explain Dalton's law and additive pressure and Amagat's law of volume additives. **(08 Marks)**

b. A gaseous mixture consists of 1 Kg of oxygen and 2 Kg of Nitrogen is initially at a pressure of 150 KPa and a temperature of 20 °C. If is heated at constant pressure until its temperature reaches 100°C. Determine :

i) Change in enthalpy
ii) Change in entropy
iii) Change in internal energy **(12 Marks)**

OR

10 a. Write short notes on the following :

i) Law of corresponding states
ii) Compressibility factor
iii) Generalized compressibility chart **(08 Marks)**

b. Determine the specific volume of helium at 200 KPa and 300 K using the Vander Waal's equation and the ideal gas equation of state. Take, Molecular weight of helium as 4 and the constants in the Vander Waal's equation a = 3.4 and b = 0.0234. **(06 Marks)**

c. Determine the mass of Nitrogen contained in a $35m^3$ vessel at 200 bar and 200 K by using

i) Ideal gas equation
ii) Generalized compressibility chart, for N_2 : $P_c = 33.94$ bar, $T_c = 126.2°C$. **(06 Marks)**

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