CBCS SCHEME

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15ME33

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamics Hand Book is permitted.
3. Assuming missing data suitably (if any).

Module-1

1 a. Define the following: i) State ii) Thermodynamic equilibrium iii) Process and path **(06 Marks)**

b. Define: i) Ice point ii) Steam point on temperature scales
What do you understand by Thermodynamic temperature scale? **(06 Marks)**

c. The temperature t on a scale is defined in terms of a property K by the relation t = a ln k + b (where a and b are constants). The values of K are found to be 1.83 and 6.78 at the ice point and the steam point, the temperature of which are assigned numbers 0 and 100 respectively. Determine the temperature corresponding to a reading of K equal to 2.42 on the thermometer. **(04 Marks)**

OR

2 a. List similarities between Heat and Work. **(04 Marks)**

b. Obtain expressions for thermodynamic work for i) $PV = C$ ii) $PV^n = C$. **(06 Marks)**

c. A piston cylinder device operates 1 kg of fluid at 20atm pressure. The initial volume is $0.04m^3$. The fluid is allowed to expand reversibly following a process $PV^{1.45} = C$ so that the volume doubles. Fluid is then cooled at constant pressure until the piston comes back to the original position. Keeping the piston position unaltered head is added reversibly to restore it to the initial pressure calculate the work done in the cycle. **(06 Marks)**

Module-2

3 a. State first law of Thermodynamics for a closed system undergoing a cycle. Explain Joule's experiment. **(06 Marks)**

b. Show that energy is a properly and a point function. **(04 Marks)**

c. In a gas turbine the gas enters at the rate of 5kg/s with a velocity of 50m/s and enthalpy of 900kJ/kg and leaves the turbine with a velocity of 150m/s and enthalpy of 400 kJ/kg. The loss of heat from the gases to the surroundings is 25kJ/kg. Assume R for gas = 0.285kJ/kg K and C_p = 1.004 kJ/kg K and the inlet conditions to be at 100kPa and 27°C. Determine the power output of the turbine and the diameter of the inlet pipe. **(06 Marks)**

OR

4 a. State the two classical statements of the second law of thermodynamics. Indicate all processes on i) P-V and ii) T-S diagrams for a reversible carnot heat engine. **(06 Marks)**

b. A car engine with a power output of 48.47kW has a thermal efficiency of 24%. Determine the fuel consumption rate of this car if the fuel has a heating value of 44000kJ/kg. Express fuel consumption in both kg/s and kg/h. **(05 Marks)**

c. A heat pump is used to maintain the temperature of a house at 20°C. On a day when the outdoor air temperature drops to -2°C, the house is estimated to lose heat at a rate of 80000kJ/h. If the heat pump under these conditions has a COP of 2.5, determine: i) The power consumed by the heat pump ii) The rate at which heat is absorbed from the cold outdoor air. **(05 Marks)**

Module-3

5 a. What are internally and externally reversible processes? List the factors causing irreversibilities. **(04 Marks)**

b. Explain "The reversed carnot cycle" on a P-V diagram. State "Carnot Principles" pertaining to thermal efficiency of reversible and irreversible (actual) heat engines. **(06 Marks)**

c. A heat source at 800K loses 2000kJ of heat of a sink at i) 500K and ii) 750K. Determine which heat transfer process is more irreversible. **(06 Marks)**

OR

6 a. State and prove Clausius in equality. **(05 Marks)**

b. Discuss "The increase of entropy principle" and entropy generation applying Clausius inequality to a cyclic process. **(05 Marks)**

c. One kg steam at 2.0 bar and quality 0.9 is heated in a rigid vessel to a temperature of 400°C. Calculate the final pressure and change in entropy of steam. **(06 Marks)**

Module-4

7 a. Define:
i) Available energy
ii) Unavailable energy
iii) Dead state
iv) Maximum useful work
v) Second law efficiency. **(10 Marks)**

b. In a certain process, a vapour while condensing at 420°C, transfers heat to water evaporating at 250°C. The resulting steam is used in a power cycle which rejects heat at 35°C. What is the fraction of the available energy in the heat transferred from the process vapour at 420°C that is lost due to the irreversible heat transfer at 250°C? Represent the process on a T-S diagram. **(06 Marks)**

OR

8 a. Define: i) Triple point ii) Subcooled liquid. **(04 Marks)**

b. Sketch and explain throttling calorimeter. Also plot throttling process on T-S and h-s plots. **(06 Marks)**

c. A vessel of volume 0.04m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy. **(06 Marks)**

Module-5

9 a. State Dalton's law of partial pressures and define
i) Mole fraction ii) Gas constant for the mixture iii) Density of the mixture. **(08 Marks)**

b. A certain gas has $C_p = 1.968$ and $C_v = 1.507$ kJ/kg K. Find its molecular weight and the gas constant. A constant volume chamber of 0.3m^3 capacity contains 2kg of this gas at 5°C. Heat is transferred to the gas until the temperature is 100°C. Find the work done, the heat transferred, and the changes in internal energy, enthalpy and entropy. **(08 Marks)**

OR

10 a. Plot generalized compressibility chart and explain. **(06 Marks)**

b. Show that for an ideal gas $C_p - C_v = R$ **(04 Marks)**

c. Define i) Relative Humidity ii) Specific humidity iii) Wet bulb temperature. **(06 Marks)**

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