CBCS SCHEME

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18MR33

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

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 handbook and steam table are permitted.

Module-1

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

b. The readings T_A and T_B of two Celsius thermometers A and B agree at ice point and steam point, but elsewhere are related by the equation $T_A = L + MT_B + NT_B^2$ where, L, M and N are constants. When both thermometers are immersed in a system of fluid, a registers 11°C while B registers 10°C, determine the reading an A when B registers 37.4°C. **(10 Marks)**

OR

2 a. Describe the similarities and dissimilarities between work and heat. **(06 Marks)**

b. With the help of P-V diagram derive work-done expression for :
i) Isothermal process ii) Polytrophic process. **(06 Marks)**

c. A perfect gas is undergoing a process in which $T \alpha V^{2/5}$. Calculate the work-done by the gas in going from state 1 in which the pressure is 100 bar and volume is $4m^3$ to the state 2 in which volume is $2m^3$. Also calculate the final pressure. **(08 Marks)**

Module-2

3 a. With a neat sketch, explain Joule's experiment and hence define first law of thermodynamics. **(08 Marks)**

b. Write the expression for steady flow energy equation and define each term with units. **(04 Marks)**

c. A slow chemical reaction takes place at a constant pressure of 0.1MPa in a fluid. The fluid is surrounded by perfect heat insulator, during the reaction which begins at state 1 and ends at state 2. The insulation is then removed and 105kJ of heat flows into the surroundings as fluid goes to state 3. At state 1 fluid is having a volume of $0.003m^3$ and temperature 20°C, at state 2 the volume is $0.3m^3$ and 370°C, at state 3 the fluid reaches $0.06m^3$ and 20°C. If $U_1 = 0$ for the fluid system calculate U_2 and U_3. **(08 Marks)**

OR

4 a. State Kelvin-Planck and Clausius statement at second law of thermodynamics and show that they are equivalent. **(08 Marks)**

b. A reversible engine operates between 3 heat reservoirs 1000k, 800k and 600k and rejects heat to a reservoir at 300k, the engine develops 10KW and rejects 412kJ/min. If heat supplied by the reservoir at 1000k is 60% of heat supplied by the reservoir at 600k, find quantity of heat supplied by each reservoir. Also sketch the block diagram of the heat engine. **(12 Marks)**

Module-3

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

b. Prove that entropy of the universe is always increasing. **(06 Marks)**

c. A heat engine is supplied with 300kJ/s of heat at 290°C and heat rejection takes place at 8.5°C. The following results were collected. i) 215kJ/s are rejected ii) 150kJ/s are rejected iii) 75kJ/s are rejected specify which at the above data represents a reversible, irreversible or impossible results. **(06 Marks**

OR

6 a. Define dryness traction. What are the different methods used to measure dryness traction, with a neat sketch explain separating and throttling calorimeter. **(10 Marks)**

b. 0.1kg of saturated steam expands reversibly from 10 bar to 1 bar in a piston-cylinder device according to $PV^{1.3}$ = constant. Find the work and heat interactions during the expansion process. **(10 Marks)**

Module-4

7 a. Obtain four Maxwell's relation for simple compressible system in the form $\left(\frac{\partial M}{\partial y}\right)_x = \left(\frac{\partial N}{\partial x}\right)_y$. **(08 Marks)**

b. Derive an expression for change in entropy of a polytropic process. **(04 Marks)**

c. 2kg of air undergoes a polytropic process from 330k and $0.15m^3$ to 550k and $0.02m^3$. Determine : i) Work transfer ii) Heat transfer iii) Change in enthalpy iv) Change in entropy. **(08 Marks)**

OR

8 a. Show that the change in entropy when a perfect gas undergoes a polytropic change PV^n = constant is given by the expression $s_2 - s_1 = \frac{\gamma - n}{n-1} C_v \ell n \left(\frac{T_1}{T_2}\right)$. **(10 Marks)**

b. One kg of air initially at 1 bar and 160°C is compressed isothermally till the volume reduces to $0.28m^3$. Determine the work-done, heat transfer, change in internal energy and entropy. **(10 Marks)**

Module-5

9 a. State and explain Dalton's law of partial pressure. **(05 Marks)**

b. State and explain Amagot's law of additive volume. **(05 Marks)**

c. A mixture of 0.5kg carbon dioxide and 0.3kg of N_2 is compressed from P_1 = 1atm, T_1 = 20°C to P_2 = 5 atm in a polytropic process for which n = 1.3. Find : i) The final temperature ii) The work iii) Heat transfer iv) The change in entropy of the mixture. **(10 Marks)**

OR

10 a. Write short notes on :

i) Boyle's law
ii) Charle's law
iii) Vanderwaal's equation
iv) Baetic Bridgeman equation
v) Compressibility factor. **(10 Marks)**

b. A mixture of methane with just enough oxygen to permit combustion is burned. The temperature and pressure of the final mixture are 27°C and 101.3KPa respectively. Calculate : i) Mass fraction of reactants ii) Volume fraction of products iii) Partial pressure of water vapor in the products of combustion iv) Volume of products. **(10 Marks)**

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