CBCS SCHEME

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18MA33

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

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Thermodynamic Data Hand Book is permitted.
3. Assume missing data suitable if any.

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. Differentiate the following:
i) Reversible and irreversible processes
ii) Path and point function
iii) Cyclic and non cyclic processes
iv) Flow and non-flow processes. **(10 Marks)**

OR

2 a. Obtain the relation between centigrade scale and Fahrenheit scale with the help of linear equation between temperature (T) and thermometric property (X). **(10 Marks)**

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

Module-2

3 a. Differentiate between heat and work. **(10 Marks)**

b. A mass of gas is compressed in a quasi-static process from 80kPa, $0.1m^3$ to 0.4MPa, $0.03m^3$. Assuming that pressure and volume are related by PV^n = constant. Find the workdone by the gas system. **(10 Marks)**

OR

4 a. Explain Jaule's experiment and show $(\sum W)_{cycle} = (\sum Q)_{cycle}$. **(10 Marks)**

b. A reciprocating air compressor taken in $2m^3$/min air at 0.11MPa, 20°C and delivers it at 1.5MPa, 111°C to an after cooler where the air is cooled at constant pressure to 25°C. The power absorbed by the compressor is 4.15KW. Determine:
i) The heat transfer in the compressor and ii) The cooler. **(10 Marks)**

Module-3

5 a. Explain carnot engine with the help of block diagram and P-V diagram. **(10 Marks)**

b. A household refrigerator is maintained at a temperature of 2°C. Every time the door is opened, warm material is placed inside, introducing an average of 420kJ but, making only a small change in the temperature of the refrigerator. The door is opened 20 times a day and the refrigerator operates at 15% of ideal COP. The cost of work is 32 paisa per kW hr. What is the monthly bill for this refrigerator? The atmosphere is at 30°C. **(10 Marks)**

OR

6 a. State and prove Clausius inequality. **(10 Marks)**

b. 2kg of water at 80°C is mixed adiabatically with 3kg of water at 30°C in a constant pressure process of one atmosphere. Find the increases in entropy of total mass of water due to the mixing process (C_p of water = 4.187 kJ/kg-K). **(10 Marks)**

Module-4

7 a. Define the following:
i) Available energy
ii) Unavailable energy
iii) Dead state
iv) Irreversibility
v) Second law efficiency. **(10 Marks)**

b. 500kJ of heat is removed from a constant temperature reservoir at 835K. This heat is received by a system at a constant temperature of 720K. The temperature of the surroundings is 280K. Determine the net loss of available energy due to this irreversible heat transfer process. **(10 Marks)**

OR

8 a. Explain with neat sketch separating and throttling calorimeter. **(10 Marks)**

b. Ten kg of water at 45°C is heated at a constant pressure of 10 bar until it becomes superheated vapour at 300°C. Find the change in volume. Enthalpy, entropy and internal energy. **(10 Marks)**

Module-5

9 a. Prove that for polytropic process with a perfect gas

$$(s_2 - s_1) = \frac{(n-\gamma)}{(\gamma-1)(n-1)} R\, ln \frac{T_2}{T_1}.$$ **(10 Marks)**

b. An ideal gas cycle consisting of three processes uses Argon (molecular weight = 40) as a working substance process 1-2 is a reversible adiabatic expansion from $0.014m^3$, 700kPa, 280°C to $0.056m^3$. Process 2-3 is a reversible isothermal process and process 3-1 is a constant pressure process. Sketch the cycle on a P-V and T-S diagram and determine work transfer in each process. Assume $\gamma = 1.67$. **(10 Marks)**

OR

10 a. Write a note on Vander Walls equation and obtain constants a, b and R at critical point. **(10 Marks)**

b. Determine critical pressure of oxygen using
i) Perfect gas equation and
ii) Vander Waals equation of state $V_C = 0.0745 m^3/k\ mol$ $t_c = -118.1°C$ **(10 Marks)**

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