CBCS SCHEME

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17ME33

Third Semester B.E. Degree Examination, Feb./Mar. 2022
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 handbook is permitted.***
3. ***Assume suitable missing data.***

Module-1

1 a. Define intensive property, cyclic process, thermodynamic equilibrium, ice point, thermocouple. Also differentiate between open system, closed system and isolated system. **(10 Marks)**

b. The temperature 'T' on a thermometer scale is defined interms of a property 'P' by the relation $T = a \ln P + b$ where a and b are constants. Experiments give values of P as 1.86 and 6.81 at ice point and steam point respectively. Evaluate the temperature 'T' on the celsius scale corresponding to a reading of P = 2.5 on thermometer. **(10 Marks)**

OR

2 a. Explain with a neat sketch showing on P-V diagram the displacement work for different thermodynamic processes.
(i) Iso-baric process (ii) Iso-choric process
(iii) Isothermal process (iv) Polytropic process **(10 Marks)**

b. Gas from a bottle of compressed helium is used to inflate a balloon originally folded completely flat to a volume of 0.25 m^3. If the barometer reach 1.033 bar how much work is done by the system comprising Helium gas initially in the bottle, if the bottle is light and requires no stretching.

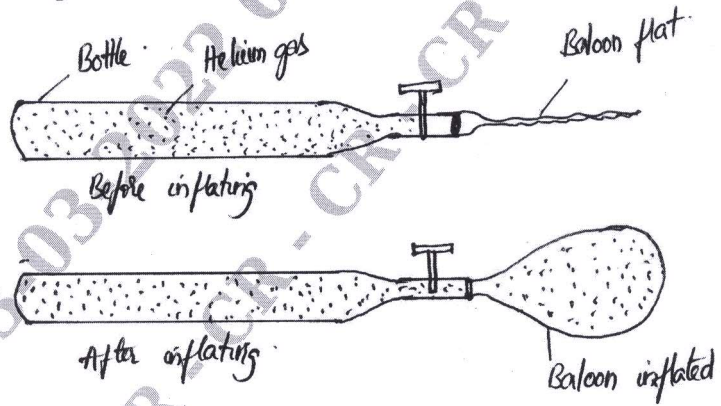

Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Define internal energy. Show that internal energy is a property of a system. **(10 Marks)**

b. A steam turbine receives a flow of 22700 kg/hr of steam while the power input is 500 KW. The inlet and outlet velocities of steam are 75 m/sec and 300 m/sec respectively. The inlet pipe is 3 mts above the exhaust. Neglecting the heat loss from the turbine, find the change in enthalpy per kg of steam. **(10 Marks)**

OR

4 a. What is Carnot cycle? Showing P-V diagram, explain the working operation of Carnot cycle on four processes. **(10 Marks)**

b. A reversible engine operates between temperature limits T_1 and T_2 ($T_1 > T_2$). The energy rejected from the engine A is received by a second reversible engine B at the same temperature T_2. Second engine B rejects energy to a reservoir at a temperature T_3($T_2 > T_3$). Show that the intermediate temperature T_2 is

(i) The geometric mean of temperatures T_1 and T_3 if both the engines have same efficiency ($T_2 = \sqrt{T_1 T_3}$).

(ii) Arithmetic mean of temperature T_1 and T_3 if both engines have same work transfer $\left(T_2 = \frac{T_1 + T_3}{2}\right)$.

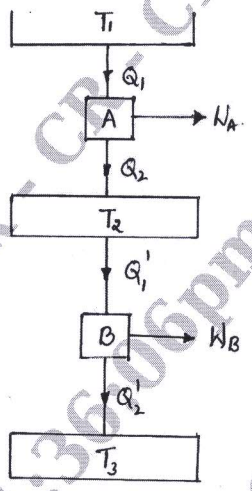

Fig.Q4(b) **(10 Marks)**

Module-3

5 a. Briefly explain reversible process and irreversible process, also mention conditions of reversibility and causes of irreversibility. **(10 Marks)**

b. Write the statement of Carnot theorem, and prove that reversible heat engine has higher efficiency than a regular heat engine $\eta_A > \eta_B$.

η_A = Efficiency of a reversible heat engine

η_B = Efficiency of a regular (any) heat engine **(10 Marks)**

OR

6 a. Define change in entropy. Show that entropy is a property of a system or a point function. **(10 Marks)**

b. A 30 kg of steel ball at 427°C is dropped in 150 kg of oil at 27°C, the specific heat of steel and oil are 0.5 kJ/kgK and 2.5 kJ/kgK respectively. Estimate the entropy change of steel, oil and that of the system containing oil and steel. **(10 Marks)**

Module-4

7 a. What is exergy and anergy, and irreversibility? Write the expression of irreversibility for:
(i) A non flow system (ii) Steady flow system **(10 Marks)**

b. Derive an expression for Maximum Work (W_{max}) in a steady flow system or control volume. **(10 Marks)**

OR

8 a. Define:
(i) Saturated temperature
(ii) Triple point
(iii) Dryness fraction
(iv) Critical point
(v) Superheated temperature.
Also draw neatly enthalpy-entropy (H-S) diagram showing all the details. **(10 Marks)**

b. What is calorimeter? Explain with a neat sketch the working operation of separating and throttling calorimeter. **(10 Marks)**

Module-5

9 Write Vander-Walls equation of state. Derive an expression for Vander-Walls constants in terms of critical constants as $a = \frac{27R^2t_c^2}{64p_c}$, $b = \frac{Rt_c}{8p_c}$. **(20 Marks)**

OR

10 a. Define:
(i) Dalton's law of partial pressure
(ii) Amagat's law of additive volumes
(iii) Compressibility factor
(iv) Law of corresponding states
(v) Dry bulb temperature, Wet bulb temperature Humidity **(10 Marks)**

b. Determine the mass of Nitrogen contained in a 35 m^3 vessel at 200 bar and 200 K by using :
(i) Ideal gas equation of state
(ii) The generalized compressibility chart. **(10 Marks)**

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