CBCS SCHEME

USN

15ME33

Third Semester B.E. Degree Examination, June/July 2023
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer FIVE full questions, choosing one full question from each module.***
2. ***Use of thermodynamic data hand book is permitted.***

Module-1

1 a. Distinguish between the following:
(i) Microscopic and macroscopic point of view of thermodynamics.
(ii) Extensive and Intensive properties. **(05 Marks)**

b. Define the zeroth law of thermodynamics. A constant volume gas thermometer containing Helium gives a reading of gas pressure 'P' of 1000 mmHg and 1366 mmHg at ice point and steam point respectively. Assuming a linear relationship of the form, $t = \alpha + \beta P$, express the gas thermometer Celcius temperature 't' in terms of gas pressure 'P'. What is the temperature recorded by the thermometer when it registers a pressure of 1074 mmHg? **(06 Marks)**

c. Explain the thermodynamic definition of work with a suitable diagram. **(05 Marks)**

OR

2 a. Explain thermodynamic equilibrium concept. **(05 Marks)**

b. Deduce the expression for work in case of shaft work and electrical work. **(05 Marks)**

c. The combustion gases of an IC engine expand with in an enclosed piston and cylinder arrangement and follow the path $PV^{1.6} = C$. The pressure at the beginning of the power stroke is 5 MPa and volume 50 cm^3. At the end of the stroke the volume is 1500 cm^3. Calculate (i) The work developed during power stroke (ii) Average power developed by the gas if there are 20 power strokes per second. **(06 Marks)**

Module-2

3 a. State the first law of thermodynamics applied to cyclic and non-cyclic processes. **(04 Marks)**

b. What is PMMK2? Why is it impossible? **(04 Marks)**

c. A centrifugal pump delivers 50 kg of water per second. The inlet and outlet pressures are 1 bar and 4.2 bar. The suction is 2.2 m below the centre of the pump and delivery is 8.5 m above the centre of the pump. The suction and delivery pipe diameter are 20 cm and 10 cm respectively. Determine the capacity of the electric motor to run the pump if pump efficiency is 85%. **(08 Marks)**

OR

4 a. Give Kelvin-Planck and Clausius statements of second law of thermodynamics. **(04 Marks)**

b. Show that for constant pressure process, the heat transfer is equal to change in enthalpy. **(04 Marks)**

c. Two Carnot engines work in series beween the source and sink temperatures of 550 K and 350 K. If both engines develop equal power, determine the intermediate temperature. **(08 Marks)**

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-3

5 a. What are the factors, that makes a process irreversible? **(05 Marks)**

b. Derive Clausius inequality and comment on its outcome. **(05 Marks)**

c. A heat engine is shown in the Fig. Q5 (c) where 10000 KJ/hr of heat is supplied from source at 1400°C while the working fluid is at 540°C. 8000 KJ/hr of heat is rejected to a sink at temperature 5°C and working fluid is at 60°C. Calculate the following:

(i) Actual efficiency of the engine.

(ii) Fraction of the actual efficiency of the internally reversible efficiency.

(iii) Fraction of actual efficiency of the external reversible efficiency. **(06 Marks)**

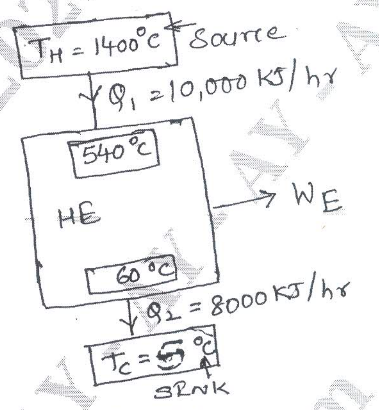

Fig. Q5 (c)

OR

6 a. Prove that entropy is a property. **(05 Marks)**

b. A closed system contains air at pressure 1 bar, temperature 290 K and volume 0.02 m^3. The system undergoes a thermodynamic cycle consisting of the following three processes: (i) Process 1 – 2 : constant volume heat addition till the pressure becomes 4 bar. (ii) Process 2 – 3 : Constant pressure cooling (iii) Process 3 – 1 : Isothermal heating to initial state. Represent the cycle in T-S and P-V plot. Evaluate the change of entropy for each case. Take $C_V = 718$ J/kg K, R = 287 J/kgK. **(07 Marks)**

c. Write a comment on thermodynamic temperature scale. **(04 Marks)**

Module-4

7 a. Define available and unavailable energy. **(04 Marks)**

b. Draw phase equilibrium diagram for water on P-V coordinates and indicate relevant parameters on it. **(04 Marks)**

c. Write a note on Maxwell relations. **(08 Marks)**

OR

8 a. With a neat sketch, explain the working of combined separating and throttling calorimeter. **(08 Marks)**

b. Steam at 10 bar and dry state is cooled under constant pressure until it becomes 0.85 dry. Using steam tables, find the work done, change in enthalpy, heat transferred and change in entropy. **(08 Marks)**

Module-5

9 a. Define as applied to ideal gas mixtures: (i) Mole fraction (ii) Dalton's law of partial pressures. (iii) Relative humidity. (iv) Due point temperature. **(08 Marks)**

b. A mixture of ideal gases contain 5 kg of N_2 and 8 kg of CO_2. The partial pressure of N_2 in the mixture is 120 KPa. Find (i) Mole fraction of N_2 and CO_2 (ii) Partial pressure of CO_2. (iii) Molecular weight of the mixture. **(08 Marks)**

OR

10 a. Write a brief note on: (i) Reduced properties. (ii) Law of corresponding states. **(04 Marks)**

b. Derive an expression for the Vander Waal's constants 'a' and 'b' in terms of critical properties. **(06 Marks)**

c. 1 kg of CO_2 has a volume of 0.86 m^3 at 120°C. Compute the pressure using
   (i) Ideal gas equation.
   (ii) Vander Waal's equation.

Take Vander Waal's constants for CO_2

$a = 365.6 \dfrac{KNm^4}{(kgmole)^2}$ and $b = 0.0423 \dfrac{m^3}{kgmole}$ **(06 Marks)**

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