CBCS SCHEME

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17AE/AS33

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
Aerothermodynamics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

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-1

1 a. Distinguish between : i) Microscopic and Macroscopic approaches
ii) Intensive and Extensive properties iii) Open and Closed system
iv) Thermal and Mechanical Equilibrium. **(10 Marks)**

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

OR

2 a. With the help of p – v diagram, show the polytropic work expression as $W_{1-2} = \frac{p_1v_1 - p_2v_2}{n-1}$. **(10 Marks)**

b. A gas system confined by a piston and cylinder, undergoes a change of state such that the product of pressure and volume remains constant. If the process begins at a pressure of 3 bar and a volume of $0.015m^3$ and proceeds until the pressure falls to half of its initial value. Determine the magnitude and direction of work flow. **(10 Marks)**

Module-2

3 a. State the First Law of Thermodynamics for a cyclic process and with a neat sketch, explain Joule's experiment. **(10 Marks)**

b. The properties of a system during a reversible constant pressure non flow process at p = 1.6 bar, changed from $v_1 = 0.3m^3/kg$, $T_1 = 20°C$ to $v_2 = 0.55m^3/kg$, $T_2 = 20°C$. The specific heat of the fluid is given by $C_p = \left[1.5 + \frac{75}{T+45}\right]$ kJ/kg °C, where 'T' is in °C. Determine
i) Heat added / kg ii) Work done / kg iii) Change in internal energy / kg
iv) Change in enthalpy / kg. **(10 Marks)**

OR

4 a. Mentioning all the assumptions, derive an expression for an open system under steady state steady flow conditions. **(10 Marks)**

b. 12kg of air per minute is delivered by a centrifugal air compressor. The inlet and outlet conditions of air are $V_1 = 12m/s$, $p_1 = 1$ bar, $v_1 = 0.5m^3/kg$ and $V_2 = 90m/s$, $p_2 = 8$ bar, $v_2 = 0.14m^3/kg$. The increase in the enthalpy of air passing through the compressor is 150kJ/kg and heat loss to the surrounding is 700kJ/min. Determine
i) Motor power required to drive the compressor ii) Ratio of inlet to outlet diameter.
(10 Marks)

Module-3

5 a. State two statements of Second Law of Thermodynamics. Further prove that violation of Kelvin Plank statement also violates Clausius statement. **(10 Marks)**

b. With a simple block diagram represent PMM of II kinds , why it is not possible also show $(COP)_{HP} = 1 + (COP)_{Refrigerator}$. **(10 Marks)**

OR

6 a. Derive Clausius inequality. **(10 Marks)**

b. Prove that Entropy is a property. **(10 Marks)**

Module-4

7 a. Sketch and explain P – T diagram of water. **(10 Marks)**

b. A vessel contains 10kg of Oxygen , 8 kg of Nitrogen and 25kg pof CO_2 at 375K temperature and 250 kPa pressure. Calculate the capacity of the vessel, the partial pressure of each gas present in the vessel and the total pressure in the vessel , when the temperature is raised to 450K. **(10 Marks)**

OR

8 a. Derive and explain Maxwell's equations. **(10 Marks)**

b. Determine the pressure exerted by CO_2 in a container of $1.5m^3$ capacity when it contains 5kg and 27°C. i) Using ideal gas ii) Using Vander Waal's equation. Vander Waal's constants $a = 365.6$ kN $m^4/(kg\ mol)^2$; $b = 0.0428 m^3/kg$ mol. **(10 Marks)**

Module-5

9 a. With the help of P – V and T – S diagrams, derive an expression for the air standard efficiency of a petrol engine (Otto cycle). **(10 Marks)**

b. In an air standard Diesel cycle, the compression ratio is 16. At the beginning of isentropic compression the temperature is 15°C and pressure is 0.1 Mpa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate
i) Cut – off ratio ii) Heat supplied per kg of air iii) Cycle efficiency. **(10 Marks)**

OR

10 a. With the help of T – S diagram , deduce on expression for Rankine cycle efficiency. **(10 Marks)**

b. A steam power plant operating on Rankine cycle gets steam at 40 bar and dry saturated. After doing work steam is exhausted at 0.3bar. If the steam flow rate is 60kg/sec, determine
i) Pump work ii) Turbine work iii) Cycle efficiency. **(10 Marks)**

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