CBCS SCHEME

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18AE/AS32

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

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 Hand Book is permitted.

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. Define the following with examples: i) Open system ii) Closed system iii) Isolated system. And classify the following into open, closed and isolated system i) Radiator of a car ii) Thermosflask iii) Water pump iv) Pressure cooker. **(10 Marks)**

b. In 1709, Sir Isaac Newton proposed a new temperature scale. On this scale, the temperature was a linear function on Celsius scale. The reading on this at ice point (0°C) and normal body temperature (37°C) were 0°N and 12°N respectively. Obtain the relation between the Newton scale and the Celsius scale. **(10 Marks)**

OR

2 a. A system undergoes a process in which the pressure and volume are related by a equation of the firm pv^n = constant. Derive ∞ expression for displacement work during this process. **(10 Marks)**

b. 200kJ of work is supplied to a closed system. The pressure and volume relation is P = 8-5V, P in bar and V is in m^3.The initial volume is $0.5m^3$. Calculate final volume and pressure. **(10 Marks)**

Module-2

3 a. Describe the classic paddle wheel experiment performed by Joule. What conclusion was drawn based on the experimental observation. **(10 Marks)**

b. The properties of a system during a reversible constant pressure non-flow process at P = 1.6bar changed from $V_1 = 0.3m^3/kg$, $T_1 = 20°C$ to $V_2 = 0.55m^3/kg$, $T_2 = 260°C$. 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 per kg iv) Change in enthalpy per kg. **(10 Marks)**

OR

4 a. Modify the general Steady Flow Energy Equation (SFEE) for the following cases:
i) Steam turbine with negligible potential energy change if the process is adiabatic.
ii) Horizontal steam nozzle with negligible entrance velocity of steam, if the process is non-adiabatic. **(10 Marks)**

b. A turbine operating under steady flow conditions receives 4500kg of steam per hour. The steam enters the turbine at a velocity of 2800m/min, an elevation of 5.5m and a specific enthalpy of 2800kJ/kg. It leaves the turbine at a velocity of 5600m/min, an elevation of 1.5m and a specific enthalpy of 2300kJ/kg. Heat losses from the turbine to the surroundings amount to 1600kJ/h. Determine the power output of the turbine. **(10 Marks)**

Module-3

5 a. Write Kelvin-Planck and Clausius statements of second law of thermodynamics. Show that violation of Clausius statement leads to the possibility of a perpetual motion of second type. **(10 Marks)**

b. A reversible heat engine operates between two reservoirs at temperature 700°C and 50°C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 50°C and -25°C. The heat transfer to the engine is 2500kJ and the net work output of the combined engine refrigerator plant is 400kJ.

i) Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C.

ii) Reconsider (i) given that the efficiency of the heat engine and the COP of the refrigerator are each 45 percent of their maximum possible values. **(10 Marks)**

OR

6 a. Derive an expression for change in entropy of a closed system containing an ideal gas in terms of initial and final temperature, volumes and pressures. Also list the characteristics of entropy. **(10 Marks)**

b. A 50kg metal block at a temperature of 500°C is generated in 140kg of oil at 30°C. C_p of metal = 0.5kJ/kgK and C_p of oil = 2.5kJ/kg°K, assume no heat losses. Calculate change in entropy for a system consisting of oil and casing. **(10 Marks)**

Module-4

7 a. With the help of a neat P-T diagram for a pure substance and define:
i) Triple point and ii) Critical point. **(06 Marks)**

b. Sketch and explain the construction and working of a separating and throttling calorimeter used for determining the dryness fraction of steam in a boiler. **(08 Marks)**

c. Determine the specific volume, enthalpy and internal energy of wet steam at 18 bar, dryness fraction 0.85. **(06 Marks)**

OR

8 a. Derive an equation for internal energy and enthalpy with usual notations. **(06 Marks)**

b. Explain the following with relevant sketches:

i) Equation of state
ii) Coefficient of expansion and compressibility
iii) Specific heats
iv) Joule-Thomson coefficient. **(08 Marks)**

c. The equation of state in the given range of pressure and temperature is given by $V = \frac{RT}{P} - \frac{C}{T^3}$ where C is constant. Derive an expression for change of enthalpy and entropy for this substance. **(06 Marks)**

Module-5

9 a. With the help of P-V and T-S diagrams. Derive an expression for air standard efficiency of Otto cycle. **(10 Marks)**

b. The temperature and pressure of a diesel cycle at the end of constant volume heat rejection is 50°C and 1 bar respectively. If the compression ratio is 18:1 and the maximum cycle temperature is 1700K. Determine: i) Pressure and temperature at all the end states ; ii) Workdone/kg/cycle ; iii) Air standard efficiency. **(10 Marks)**

OR

10 a. Sketch the schematic diagram and corresponding T-S diagram of a reheat vapour cycle and evaluate an expression for reheat cycle efficiency. **(10 Marks)**

b. A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency work ratio and specific steam consumption. **(10 Marks)**