CBCS SCHEME

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17AE/AS33

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

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Thermal Data hand book is permitted. (Steam tables)***

Module-1

1 a. Define the following terms with example :
(i) Open system (ii) Closed system (iii) Intensive property
(iv) Extensive property **(10 Marks)**

b. Compare macroscopic and microscopic point of view. **(04 Marks)**

c. The readings t_A and t_B of two Celsius thermometers A & B agree at ice and steam point, but elsewhere are related by the equation $t_A = L + Mt_B + Nt_B^2$, where L, M and N are constants ; when both are immersed in a system of fluid, 'A' registers 11°C, while 'B' registers 10°C. Determine the reading on 'A' and 'B' registers 37.4°C. **(06 Marks)**

OR

2 a. Derive an expression for displacement work in case of polytropic process. **(05 Marks)**

b. Compare work and heat. **(05 Marks)**

c. A gas contained in a cylinder fitted with a piston, loaded with small number of weights is 1.3 bar pressure and 0.03 m^3 volume. The gas is heated until the volume increases to 0.1 m^3. Calculate the work done by gas in the following processes : (i) Pressure remains constant, (ii) Temperature remains constant and (iii) $PV^{1.3} = C$ during process. Show the processes on P-V diagram. **(10 Marks)**

Module-2

3 a. Prove that Internal energy is a property of system. **(05 Marks)**

b. With neat sketch explain Joule's Paddle wheel experiment and hence define I law of thermodynamics for a closed system undergoing a cycle. **(05 Marks)**

c. A fluid system undergoes a non-flow frictionless process following the pressure-volume relation as $P = \frac{5}{V} + 1.5$, where P is in bar and V is in m^3. During the process volume changes from 0.15 m^3 to 0.05 m^3 and system rejects 45 kJ of heat. Determine (i) Change in internal energy and (ii) Change in enthalpy. **(10 Marks)**

OR

4 a. Write steady flow energy equation for the following devices showing schematic diagram,
(i) Air compressor (ii) Turbine (iii) Nozzle (iv) Boiler. **(10 Marks)**

b. A steam turbine receives steam with a flow rate of 900 kg/min and experiences a heat loss of 840 kJ/min. The exit pipe is 3 m below the level of inlet pipe. Find the power developed by turbine if the pressure decreases from 62 bar to 9.86 kPa, velocity increases from 30.5 m/s to 274.3 m/s internal energy decreases by 938.8 kJ/kg and specific volume increases from 0.058 m^3/kg to 13.36 m^3/kg. **(10 Marks)**

Module-3

5 a. Schematically represent heat engine, heat pump and refrigerator and write their performance equation. **(06 Marks)**

b. State and prove that Kelvin Planck and Clausius statement of II law of thermodynamics are equivalent. **(06 Marks)**

c. Two Carnot engines A and B are connected in series between two thermal reservoirs maintained at 1000 K and 300 K respectively. Engine A receives 1750 kJ of heat from high temperature reservoir and rejects heat to carnot engine B, Engine B takes in heat rejected by engine 'A' and rejects heat to low temperature reservoir. If engine A and B have equal thermal efficiencies, determine

(i) The heat rejected by engine B.
(ii) The temperature at which heat is rejected by engine A.
(iii) The work done during process by engine A and B respectively. **(08 Marks)**

OR

6 a. State and prove Clausius Inequality. **(05 Marks)**

b. Prove that Entropy is a property of the system. **(05 Marks)**

c. A 5 kg copper block at temperature of 200°C dropped into an insulated tank containing 100 kg of oil at a temperature of 30°C. Find increase in entropy of universe due to this process when copper block and oil reach thermal equilibrium. Assume that the specific heat of copper and oil are 0.4 kJ/kg K and 2.1 kJ/kg K respectively. **(10 Marks)**

Module-4

7 a. Define the following terms :

(i) Pure substance
(ii) Critical point
(iii) Dryness fraction.
(iv) Triple point and
(v) Latent heat. **(10 Marks)**

b. 3 kg of steam at 18 bar occupies a volume of 0.225 cm^3. During a constant volume process to 10 bar. Determine (i) Final dryness fraction (ii) Final internal energy (iii) Change in entropy (iv) work done. **(10 Marks)**

OR

8 a. Write the Maxwell relations and explain the terms involved. **(08 Marks)**

b. Explain the law of corresponding states with generalized compressibility chart. **(06 Marks)**

c. Determine the pressure exerted by CO_2 in a container of 1.5 m^3 capacity when it contains 5 kg at 27°C using, (i) Ideal Gas equation and (ii) Vander Waal's equation. **(06 Marks)**

Module-5

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

b. An air standard Otto cycle has compression ratio of 8. The temperature and pressure at the beginning of compression ratio are 300 K and 102 kPa respectively. If the maximum cycle temperature is 1900 K, determine (i) Heat supplied / kg of air (ii) The net work done/kg of air and (iii) Thermal efficiency of cycle assume r = 1.4. **(10 Marks)**

OR

10 a. With the help of flow diagram and T-S diagram evaluate expression for efficiency of Reheat cycle. **(10 Marks)**

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

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