CBCS SCHEME

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21AE/AS43

Fourth Semester B.E. Degree Examination, June/July 2023
Aero Engineering Thermodynamics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Distinguish between :
(i) Intensive property and Extensive property.
(ii) Microscopic and Macroscopic approach.
(iii) Open system and Closed system.
(iv) Thermal equilibrium, Chemical equilibrium and Mechanical equilibrium **(10 Marks)**

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

OR

2 a. Define a work and heat and give the similarities and dissimilarities of the heat and work. **(10 Marks)**

b. State the different types of work done. Obtain the expression for the displacement work in polytrophic process. **(10 Marks)**

Module-2

3 a. Define first law of thermodynamics for a cyclic and non-cyclic process and deduce the energy is a property. **(10 Marks)**

b. A piston and cylinder contains a fluid system which passes through a complete cycle of h processes. During a cycle. The sum of all heat transfer is (−170 kJ). The system completes 100 cycles/min. Complete the following table showing the method of each item and compute the net rate of work output in kW.

Process	Q(kJ/min)	W(kJ/min)	ΔU (kJ/min)
a – b	0	2170	
b – c	21000	0	
c – d	-2100		
d – a			-36600

(10 Marks)

OR

4 a. Write the steady flow energy equation for open system and explain the terms involved in it. With the suitable assumptions simply SFEE for the following systems :
(i) Turbine and Compressor
(ii) Nozzle and diffusor. **(10 Marks)**

b. 10 kg of fluid per minute goes through a reversible steady flow process. The properties of fluid at the inlet are P_1 = 1.5 bar, ρ_1 = 26 kg/m^3, C_1 = 110 m/s and U_1 = 910 kJ/kg and the fluid is rejector 55 kJ/s of heat and rises through 55 m at the exit the properties of fluid are P_2 = 5.5 bar, ρ_2 = 5.5 kg/m^3, C_2 = 190 m/s and U_2 = 710 kJ/kg. Determine (i) The change in enthalpy (ii) Work done during the process. **(10 Marks)**

Module-3

5 a. State Kelvin Plank and Clausius statement and show that they are equivalent. **(10 Marks)**

b. A reversible heat engine operates with two environments. In the first, it draws 12000 kW from a source at 400°C and in second it draws 25000 kW from a source at 100°C. In both the operations, the engine rejects heat to a thermal sink at 20°C. Determine the operation in which the engine delivers more power. **(10 Marks)**

OR

6 a. State and prove Clausius inequality. **(10 Marks)**

b. 1 kg of ice at −5°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere,

(i) Determine the entropy increase of the universe

(ii) What is the minimum amount of work necessary to convert the water back to ice at −5°C. Take C_P for ice = 2.093 kJ/kgK, the latent heat of fusion of ice is 333.3 kJ/kg. **(10 Marks)**

Module-4

7 a. Draw a neat sketch of TS and HS diagram representation of the various process in these diagram. **(10 Marks)**

b. A pressure cooker contains 1.5 kg of steam at 5 bar pressure and 0.8 dry. Find the quantity of heat must be rejected so that the quality of steam becomes 0.4 dry. **(10 Marks)**

OR

8 a. Derive and explain Maxwell's equation. **(08 Marks)**

b. Define the equation of state for a perfect gas and derive for equation of state and mention the equation for specific heat at constant volume constant pressure and relation between specific heat. **(12 Marks)**

Module-5

9 a. With the help of PV and TS diagram. Derive an expression for air standard efficiency of Otto cycle. **(10 Marks)**

b. In a air-standard diesel cycle, the compression ratio is 16, at the beginning of isentropic compression, the temperature is 15°C, ρ = 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate (i) The cut-off ratio (ii) The cycle efficiency (iii) The heat supplied per kg of air. **(10 Marks)**

OR

10 a. Sketch the schematic diagram and corresponding TS diagram, HS, derive an expression for efficiency of Rankine cycle. **(10 Marks)**

b. In a single heater regenerative cycle the steam enters the turbine at 30 bar, 400°C and the exhaust pressure is 0.10 bar. The feed water heater is a direct contact type which operates at 5 bar. Find (i) The efficiency and steam of the cycle (ii) The increase in mean temperature of heat addition, efficiency and steam rate, as compared to rankine cycle (without regeneration). Neglect pump work. **(10 Marks)**

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