CBCS SCHEME

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17AE33

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Aero Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use of thermodynamics data hand book and steam tables are permitted.

Module-1

1 a. Distinguish between :
i) Intensive and Extensive properties
ii) Microscopic and macroscopic view points
iii) Open and closed systems
iv) Thermal and mechanical equilibrium. **(08 Marks)**

b. Show that $T^{\circ}(k) = 273 + 100\dfrac{(L - L_i)}{(L_S - L_i)}$. **(06 Marks)**

c. Thermometer is calibrated with icepoints and steam points as fixed points referred 0°C and 100°C respectively. The equation used to establish the scale is $t = a \log_e x + b$
i) Determine the constants 'a' and 'b' interms of icepoint (x_i) and steam point (x_s)
ii) Show that $t^{\circ}c = \dfrac{100\log_e\left(\frac{x}{x_i}\right)}{\log_e\left(\frac{x_s}{x_i}\right)}$. **(06 Marks)**

OR

2 a. Define work and heat. Obtain an expression for work done by the polytrophic process. **(10 Marks)**

b. A spherical balloon has a diameter of 20cm and it contains air at a pressure of 1.5bar during a certain process, the diameter of a balloon increases to 30cm during which the pressure in proportional to diameter. Calculate the work done by the air inside the balloon during this process. **(10 Marks)**

Module-2

3 a. Define first law of thermodynamics for a cycle and deduce that energy is a property. **(10 Marks)**

b. A cylinder contains 1kg of a certain fluid at an initial pressure of 20bar. The fluid is allowed to expand reversibly behind a distance according to a law PV^2 = const until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regain its original position. Heat is added with the piston firmly locked in position until the pressure rises to original value of 20 bar. Sketch the cycle on PV diagram and calculate the net work done by the fluid for an initial volume of $0.5m^3$. **(10 Marks)**

OR

4 a. Write the steady flow energy equation for an open system and explain the terms involved in it. With the suitable assumption simplify SFEE for the following systems :
i) Compressor ii) Boiler. **(10 Marks)**

b. Air enters a nozzle at 2700KPa, velocity 30m/s, enthalpy 923kJ/kg and leaves at 700KPa and enthalpy of 660kJ/kg. If the heat loss is 1kJ/kg and mass flow rate is 0.2kg/s, find the exit velocity. **(10 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. State Kelvin plank and clauses statements of second law of thermodynamics and show that they are equivalent. **(10 Marks)**

b. A reversible heat engine operates with two environments. In the first if draws 1200KW from a source at 400°C and in the second it draws 2500KW, 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. A 5kg copper block at a temperature of 200°C dropped into an insulated tank containing 100kg oil at a temperature of 30°C. Find the increase in entropy of the universe due to this process when copper block and the oil reach thermal equilibrium. Assume that specific heat of copper and oil respectively are 0.4kJ/kg k and 2.1kJ/kg k. **(10 Marks)**

Module-4

7 a. Define a pure substance (water) the following :
i) Critical point
ii) Sensible heat
iii) Dryness fraction
iv) Latent heat of vaporization
v) Represent the same on a P-h diagram. **(10 Marks)**

b. A vessel of volume $0.04m^3$ contains a mixture of saturated water and saturated steam at a temperature of 240°C. The mass of the liquid present is 8kg. Find the pressure, the mass, the specific volume, enthalpy and internal energy. **(10 Marks)**

OR

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

b. Determine the specific volume of nitrogen gas at 10MPa and 150K based on :
i) Ideal gas equation
ii) Vander Waal's equation. **(08 Marks)**

c. State Dalton's Law of partial pressure and write the equation of it. **(04 Marks)**

Module-5

9 a. Derive an expression for air standard efficiency of Otto cycle, representing the processes on P-V and T-S diagram. **(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- at ratio ii) Heat supplied per kg of air iii) Cycle efficiency. **(10 Marks)**

OR

10 a. With the help of a block diagram, explain the working of a reheat Rankine cycle and show all the processes on a T-S or h-s diagram. **(10 Marks)**

b. What are the methods of increasing the efficiency of Rankine cycle? **(04 Marks)**

c. A Rankine cycle using water as the working fluid operates between the pressure limits of 10KPa and 15,000KPa. The maximum temperature of the cycle is 600°C. Determine :
i) Turbine work ii) Pump work. **(06 Marks)**

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