CBCS SCHEME

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21MR34

Third Semester B.E. Degree Examination, June/July 2024
Thermodynamics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define work, from the thermodynamic point of view. Compare heat and work. **(07 Marks)**

b. With the help of P-V diagram derive work done expression for i) Isoterhmal process ii) Polytropic process. **(06 Marks)**

c. Two Celsius thermometer 'A' and B agree at ice point and steam point and are related by equation $t_A = L + Mt_B + Nt_B^2$ where L, M and N are constants. When both thermometers are immersed in a fluid A register's 26°C white B registers 25°C. Determine the reading of 'A' when 'B' reads 37.4°C. **(07 Marks)**

OR

2 a. State the first law of thermodynamics applied to cyclic process and non cyclic process. **(05 Marks)**

b. Derive the steady flow energy equation indicating all the terms in the equation. **(08 Marks)**

c. Steam expands through a turbine in a steady flow adiabatic process. The mass flow rate of the steam is 1.36kg/s. The entering state of steam is 34.48 bar and 538°C, while the existing state is 6.896 bar and 294°C. Neglecting the changes in kinetic and potential energies, find the power output for the turbine. Assume C_p for steam as 2.01 kJ/kg K. **(07 Marks)**

Module-2

3 a. State Kelvin-Plank and Clausius statement at second law of thermodynamics and show that they are equivalent. **(10 Marks)**

b. A reversible engine operates between 3 heat reservoirs 1000K, 800K and 600K and rejects heat to a reservoir at 300K, the engine develops 10kW and rejects 412 kJ/min. If heat supplied by the reservoir at 1000K is 60% of heat supplied by the reservoir at 600K, find quantity of heat supplied by each reservoir. Also sketch the block diagram of the heat engine. **(10 Marks)**

OR

4 a. State and prove Clausius inequality. **(08 Marks)**

b. Prove that entropy of the universe is always increasing. **(06 Marks)**

c. A heat engine is supplied with 300kg/s of heat at 290°C and heat rejection takes place at 85°C the following results were collected: i) 215kJ are rejected ii) 150kJ are rejected iii) 75kJ/S are rejected. Specify which at the above data represents a reversible, irreversible or impossible results. **(06 Marks)**

Module-3

5 a. Obtain four Maxwell's relation for simple compressible system in the form $\left(\frac{\partial M}{\partial y}\right)_x = \left(\frac{\partial N}{\partial x}\right)_y$. **(08 Marks)**

b. Write a note on compressibility factor and compressibility chart. **(06 Marks)**

c. 2kg of air undergoes a polytropic process from 330K and 0.15m^3 to 550K and 0.02M^3. Determine: i) Work transfer ii) Heat transfer iii) Entropy change. **(06 Marks)**

OR

6 a. Explain the following terms with reference to a combustion process:
   i) Excess air
   ii) Enthalpy of combustion
   iii) Enthalpy of formation
   iv) Combustion efficiency
   v) Adiabatic flame temperature **(10 Marks)**

   b. The product of combustion of an unknown hydrocarbon C_xH_y have following composition as measured by an orsat apparatus $CO_2 \rightarrow 8\%$, $CO \rightarrow 0.9\%$, $O_2 \rightarrow 8.8\%$, $N_2 \rightarrow 82.3\%$. Determine: i) Composition of fuel ii) A/F ratio @ % Excess air. **(10 Marks)**

Module-4

7 a. With the help of P-T diagram define i) Tripple point ii) Critical point. **(06 Marks)**

   b. With neat sketch, explain the working of throttling calorimeter. **(08 Marks)**

   c. Steam is throttled from a pressure of 15 bar to 1.5 bar. If the steam is dry saturated at the end of expansion. What is the dryness fraction at the beginning? Also calculate the change in entropy during throttling. **(06 Marks)**

OR

8 a. With the help of T-S diagram, and schematic diagram explain the working of open feed water regenerative vapour power cycle and express its overall efficiency. **(08 Marks)**

   b. A 40MW steam power plant working on a ranking cycle operated between boiler pressure of 4MPa and condenser pressure of 10kPa. The steam leaves the boiler and enters the steam turbine at 400°C isentropic efficiency of steam turbine is 85%. Determine :
   i) Cycle efficiency
   ii) Quality of steam from the turbine
   iii) Stem flow rate in kg/s consider the pump work. **(12 Marks)**

Module-5

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

   b. Minimum pressure and temperature in an otto cycle are 100kPa and 27°C. The amount of heat added to air per cycle is 1500kJ/kg. Determine :
   i) Pressure and temperature at all points of the cycle
   ii) Calculate the specific work
   iii) Thermal efficiency if compression ratio is 8:1
   Take for air $C_V = 0.718$kJ/kg and $\gamma = 1.4$. **(10 Marks)**

OR

10 a. Obtain an expression for maximum pressure ratio for Brayton cycle. **(06 Marks)**

   b. With neat sketch explain working of Ramjet engine. **(06 Marks)**

   c. In an air standard regenerative gas turbine cycle the pressure ratio is 5. Air enters the compressor at 10 bar 300K leaves at 490K. The maximum temperature in the cycle is 1000K.Calculate the cycle efficiency given that efficiency of the generator and the adiabatic efficiency of the turbine are 80% each. Assume for air the ratio of specific heat is 1.4 also show the cycle in T-S diagram. **(08 Marks)**

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