CBCS SCHEME

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18MT72

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022
Thermal Engineering

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Heat transfer handbook is permitted.

Module-1

1 a. Define the following:
i) Open system
ii) Closed system
iii) Intensive property
iv) Extensive property
v) Thermodynamic state point
vi) Thermodynamic process. **(06 Marks)**

b. Explain Quasistatic process with a neat sketch. **(06 Marks)**

c. State the Zeroth law of thermodynamics. Explain thermodynamic equilibrium. **(08 Marks)**

OR

2 a. Derive an expression for displacement work of polytropic process with P-V diagram. **(08 Marks)**

b. State and explain thermodynamic definition of work. **(06 Marks)**

c. A fluid expands frinctionlessly in a closed system from a volume $0.1m^3$ to $0.16m^3$ in such a manner that the pressure is given by $P = \frac{C}{V^2}$, where C is constant. The initial pressure is 300Pa. Calculate the amount of work done. **(06 Marks)**

Module-2

3 a. Derive an expression for Steady Flow Energy Equation (SFEE) with suitable assumptions. **(08 Marks)**

b. With PV diagram define first law of thermodynamics under cycle process. **(04 Marks)**

c. A steam turbine is shown in Fig.Q.3(c) with properties at inlet and outlet. The mass flow rate of steam is 40kg/s. Calculate power developed by the turbine. Neglect heat interaction.

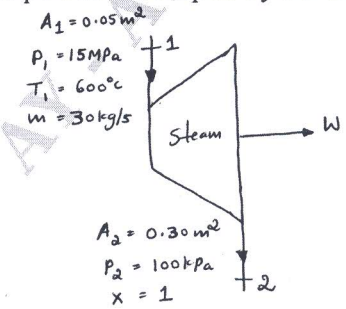

Fig.Q.3(c)

(08 Marks)

OR

4 a. State the Kelvin Plank and Claussius statement and explain its equivalent of the two statements. **(08 Marks)**

b. Explain PMM-I and PM-II kind. **(04 Marks)**

c. Derive an expression for COP of refrigerator and heat pump. **(08 Marks)**

Module-3

5 a. Derive an expression for air standard efficiency of Otto cycle with P.V. diagram and T-S diagram. **(10 Marks)**

b. Define the following: i) Mean effective pressure
ii) Air standard efficiency. **(04 Marks)**

c. Compare Otto, diesel and dual cycles. **(06 Marks)**

OR

6 a. Explain the modes of heat transfer with governing law and equations. **(12 Marks)**

b. Explain three kinds of boundary conditions. **(06 Marks)**

c. Define the following: i) Thermal conductivity ii) Heat transfer coefficient. **(02 Marks)**

Module-4

7 a. Derive the 3D conduction equation in Cartesian coordinator and reduce the equation to Fourier and Laplace equation. **(12 Marks)**

b. A furnace wall is made of 3 layers. First layer is of insulator brick of 12cm thickness (K = 0.6W/mK). The face is exposed to gases at 870°C with convection coefficient of 110W/m^2K. It is covered with 10cm thick layer of fire brick. (K = 0.8W/mK) with a constant resistance of 2.6 × 10^{-4} m^2/kW between 1st and 2nd layer. The 3rd layer is a plate of 10cm thickness (K = 4W/m K) with a constant resistance between 2nd and 3rd layer of 1.5 × 10^{-4} m^2K/W. The place is exposed to air at 30°C with convection coefficient of 15W/m^2K. Determine the heat flow and overall heat transfer coefficient. **(08 Marks)**

OR

8 a. Using dimensional analysis for the free convection heat transfer show that $N_u = f(Gr, Pr)$. **(10 Marks)**

b. Explain the following:
i) Natural convection ii) Local heat transfer coefficient iii) Grasshoff number
iv) Nusselt number v) Drag coefficient. **(10 Marks)**

Module-5

9 a. Explain the physical significance of the following: i) Reynolds number ii) Staton number iii) Prandtl number iv) Nusselt number. **(08 Marks)**

b. Using Buckingham π-theorem for forced convection heat transfer show that $N_u = C(R_e^m, P_r^n)$ with usual notations. **(12 Marks)**

OR

10 a. State and explain following radiation laws: i) Plank's law ii) Wein's displacement law iii) Stefan-Boltzmann law iv) Kirchoff's law. **(12 Marks)**

b. Two large parallel plates having emissivities at 0.3 and 0.5 are maintained at temperature of 800°C and 300°C respectively. A radiation shield having an emissivity of 0.05 on both sides is placed between the 2 plates. Calculate: i) heat transfer per unit area without shield ii) Find the temperature of the shield and heat transfer per unit area with shield. **(08 Marks)**

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