CBCS SCHEME

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21AU51

Fifth Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Heat transfer data hand book is permitted.***

Module-1

1 a. What are basic modes of heat transfer and what are the governing laws of these mode? **(10 Marks)**

b. A wire 0.5 mm in diameter is stretched along the axis of a cylinder 50 mm in diameter and 250 mm long. The Temperature of the wire is 750 K while the cylinder is at 25 K and the gas in it has K = 0.025 W/mK. Find the rate of heat transfer through the gas by conduction and radiation if the wire is black. **(10 Marks)**

OR

2 a. Derive three dimensional conduction equation in Cartesian Co-ordinates. **(10 Marks)**

b. A refrigerated container in the form of a cube with 2 m sides and 5 mm thick aluminum walls (K = 204 W/mK) is insulated with 0.1m layer of cork (K = 0.043 W/mK). Temperatures are T_i = -5°C and T_o = 20°C. Find the cooling load of the Refrigerator. **(10 Marks)**

Module-2

3 a. Find the expression for Temperature distribution and heat flow through rectangular fin of uniform cross section and it is sufficiently long. **(10 Marks)**

b. One end of a long rod is inserted into a furnace while the other projects into ambient air. Under steady state the temperature of the rod is measured at two points 75 mm apart and found to be 125°C and 88.5°C respectively while ambient temperature is 20°C, if the rod is 25 mm in diameter and h is 23.36 W/m^2 K. Find the thermal conductivity of rod material. **(10 Marks)**

OR

4 a. Derive the expression for Temperature distribution and Heat flow for a lumped heat analysis. **(10 Marks)**

b. An average human body modeled as a 30 cm diameter, 170 cm long cylinder has 72% of water by mass so that its properties can be taken as those of water at room temperature , ρ = 1000 kg/m^3 , C = 4180 J/kg K and K = 0.608 W/mK. A person is found dead at 5am in room, the temperature which is 20°C. Temperature of the body is measured to be 25°C when found and heat transfer coefficient is estimated to be 8 W/m^2K. Assuming the body temperature of living man is 37°C, estimate the time of death of the above person. **(10 Marks)**

Module-3

5 a. Derive the equation N_u = f(Gr. Pr) for free convection by dimensional analysis. **(10 Marks)**

b. A 0.15 m outer diameter pipe lies 2 m vertically and 8 m horizontally in a large room with an ambient temperature of 30°C. The pipe surface is at 250°C and has an emissivity of 0.60. Find the rate of heat loss from the pipe to the atmosphere. **(10 Marks)**

OR

6 a. What are the significance of Reynolds , Prandtl Nusselt and Stanton numbers in forced convection. **(10 Marks)**

b. It was found during a test in which water flowed with a velocity of 2.44 m/s through a tube (2.54 cm inner diameter and 6.08 m long) , the head loss due to friction was 1.22 m of water. Estimate the surface heat transfer coefficient based on Reynold's analogy.
Take $\rho = 998$ kg/m^3 and $C_p = 4.187$ kJ/kg K. **(10 Marks)**

Module-4

7 a. What are various types of heat exchangers? Discuss. **(10 Marks)**

b. A counter flow heat exchanger is to heat air entering at 400°C with a flow rate of 6kg/s by the exhaust gas entering at 800°C with a flow rate of 4 kg/s. The overall heat transfer coefficient is 100W/m^2 K and outlet temperature of air is 551.5°C. Specific heat of air, C_p for both air and exhaust gas can be taken as 1100 J/kg K. Calculate
i) heat transfer area needed ii) the number of transfer unit. **(10 Marks)**

OR

8 a. What are the different regimes of boiling? Explain. **(10 Marks)**

b. A tube of 15 mm outside diameter and 1.5m long is used for condensing steam at 40 kPa. Calculate the average heat transfer coefficient when the tube is i) Horizontal ii) Vertical and its surface temperature is maintained at 50°C. **(10 Marks)**

Module-5

9 a. State and explain : i) Stefan – Boltzmann law ii) Kirchhoff's law
iii) Weins displacement law iv) Planck's law. **(10 Marks)**

b. Assuming the sun to be a black body having surface temperature of 5800 K, calculate
i) The total emissive power ii) The wavelength at which the maximum spectral intensity occurs iii) The maximum value of E_{b_s} iv) Percentage of total emitted energy that lies in the visible range of 0.35μ to 0.76μ and v) The total amount of radiation energy that emitted by the sun per unit time if its diameter can be assume to be 1.391×10^9m. **(10 Marks)**

OR

10 a. What is Radiation shield? Explain. **(10 Marks)**

b. Two large parallel planes are at 1000 K and 600 K. Determine the heat exchange per unit area i) If the surfaces are black.
ii) If the hot one has an emissivity of 0.8 and cooler one 0.5. **(10 Marks)**

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