CBCS SCHEME

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15AE53

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of data hand book and steam tables are allowed .***
3. ***Assume missing data suitably.***

Module-1

1 a. Explain different modes of mass transfer. **(08 Marks)**

b. Explain hydrodynamic boundary layer. **(08 Marks)**

OR

2 a. Explain Fick's law of diffusion **(08 Marks)**

b. Explain following :
i) Mass concentration ii) Mole concentration iii) Mass fraction iv) Mole fraction. **(08 Marks)**

Module-2

3 a. A thin metal surface sphere of dia 300mm is used to store liquefied gas at $-200°C$. To reduce heat leakage from atmosphere at 30°C. It insulted by 2 layers of insulation each 30mm thick. First layer of insulating material has thermal conductivity of 0.06W/mK second layer has 0.6 W/mk, determine heat leakage.
i) When better insulation is next to sphere
ii) When better conductor is immediately next to sphere. **(08 Marks)**

b. A Furnace wall is made up of 3 layers of thickness 250m, 100mm, 150mm with thermal conductivities of 1.65W/mK, K, 9.2W/mK respectively. The inside is exposed to gases at 1250°C with convective coefficient of $25W/m^2K$ and the inside surfaces at 1100°C. Outside surface is exposed to air at 25°C with convection coefficient of $12W/m^2K$. Determine :
i) The unknown 'K' ii) Overall heat transfer coefficient iii) All surface temperatures **(08 Marks)**

OR

4 a. Obtain temperature distribution equation for lumped heat system and hence obtain expression for total heat transfer in such system. **(08 Marks)**

b. The nose section of missile is formed at a 6mm thick stainless steel plate and is held at 40°C initially. The missile enters the denser layer of atmosphere at a very high velocity. The effective temperature of air, surrounding the nose region attains the value 2200°C and the surface convective coefficient is 3400 W/m^2K. Calculate maximum permissible time in these surroundings if maximum metal temperature is not to exceed 1000°C. Take for steel $\rho = 7800\ kg/m^3$, c = 465J/kg-K and K = 5h w/mK **(08 Marks)**

Module-3

5 a. Obtain dimensionless numbers for natural convection using Buckingham's theorem. **(08 Marks)**

b. A circular hot plate 15cm in diameter maintained at 160°C atmospheric air at 20°C. Calculate the convection heat loss from both the faces of plate, when upper surface is heated and lower surface is cooled and plate is kept in horizontal position. **(08 Marks)**

OR

6 a. Water flows through a 5cms diameter tube at a velocity of 1m/sec. Find the heat lost in a length of 2m in the water temperature is 40°C and wall temperature is 80°C. **(08 Marks)**

b. Air at 25°C and atmospheric pressure flows across a heated cylinder of diameters 7.5cm. If the velocity of air flow is 1.2 m/sec and cylinder surface is maintained at 95°C, find rate of heat transfer. **(08 Marks)**

Module-4

7 a. Explain Planck's distribution law and Wein's displacement law. **(04 Marks)**

b. It is observed that the intensity of radiation emitted by the sun is maximum at a wavelength of 0.5μ. Assume sun as black body, calculate surface temperature and emissive power. **(04 Marks)**

c. A radiation shield is provided between 2 large parallel iron plate to reduce heat transfer between them by 8 times. If the emissivity of the iron is 0.65, what should be the emissivity of shield material? **(08 Marks)**

OR

8 a. Obtain LMTD equation for counter flow heat exchanger. **(08 Marks)**

b. A 2 shell pass 4 tube pass counter flow heat exchanger with a flow arrangement has a water on a shell side special liquid on the tube side. The water is cooled from 18°C to 6°C with special liquid entering at −1°C and leaving at 3°C. The overall heat transfer co-efficient is 600W/m^2°C. Calculate heat transfer area required to heat load of 2400W. **(08 Marks)**

Module-5

9 a. With neat sketch, explain main parts of thrust chamber. **(08 Marks)**

b. With neat sketch, explain heat transfer distribution in thrust chamber. **(08 Marks)**

OR

10 a. Obtain species conservation equation. **(08 Marks)**

b. An open pan 20cm in dia and 8cm deep contains water at 25°C and is exposed to dry atmospheric air. If the rate of diffusion of water vapour is 8.54×10^{-4} kg/h, find diffusion coefficient of water in air. Take saturation pressure of H_2O = 0.03165 bar at 25°C. **(08 Marks)**

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