CBCS SCHEME

USN

17AE53

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

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

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-1

1 a. Explain different modes of heat transfer. **(12 Marks)**

b. Define the following terms used in mass transfer.
i) Mass concentration
ii) Mole concentration
iii) Mass fraction
iv) Mole fraction. **(08 Marks)**

OR

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

b. Explain Ficks law of diffusion. **(08 Marks)**

c. Explain significance of Sherwood and Lewis number in mass transfer analogy. **(04 Marks)**

Module-2

3 a. The metallic steel pipe (k = 45w/mk) 5cm inner diameter and 6.5cm outer diameter is lagged with 2.75cm radial thickness of high temperature insulation having thermal conductivity of 1.1w/mk. The surface heat transfer co-efficient at inside and outside can be taken as $4650 w/m^2k$ and $11.5 w/m^2k$ respectively. If the steam temperature is 200°C and ambient temperature is 25°C. Determine :
i) Heat loss per meter length of pipe
ii) Temperature at interfaces. **(10 Marks)**

b. Obtain temperature distribution equation for system with negligible internal resistance and hence obtain expression for total heat transfer through it in terms of Biot and Fourier number. **(10 Marks)**

OR

4 a. A long steel cylinder 12cm in diameter and initially at 20°C is placed into a furnace at 820°C with the local heat transfer coefficient $h = 140\ w/m^2k$. Calculate the time required for axis temperature to reach 800°C. Also calculate the corresponding temperature at a radius of 5.4cm at that time. Take $\alpha = 6.11 \times 10^{-6} m^2/s$ and k = 21w/mk. **(08 Marks)**

b. Explain the concept of variable thermal conducing. **(04 Marks)**

c. A large slab of aluminium at a uniform temperature of 250°C is suddenly exposed to a concretive environment at 50°C with a heat transfer coefficient of $500 w/m^2k$. Estimate the temperature at a depth of 5cm after 1 hour. The thermal diffusivity and thermal conductivity of aluminium are $8.4 \times 10^{-5} m^2/s$ and 215w/mk respectively. **(08 Marks)**

Module-3

5 a. Obtain dimensionless numbers for natural convection using Buckingham's Pi theorem with usual notations. **(10 Marks)**

b. Water at 50°C enters a 1.5cm diameter and 3m long tube with a velocity of 60m/min. The tube wall is maintained at a constant temperature of 90°C. Calculate the total heat transferred if exit temperature is 64°C. **(10 Marks)**

OR

6 a. Explain hydrodynamic boundary layer theory and thermal boundary layer theory with suitable figures. **(08 Marks)**

b. Air flows through a long rectangular (30cm height × 60cm width) air conditioning duct maintains the outer duct surface temperature at 15°C. If the duct is uninsulated and exposed to air at 25°C, calculate the heat gained by the duct per meter length, assuming it to be horizontal. **(12 Marks)**

Module-4

7 a. Explain following :
   i) Specular reflection and diffuse reflection
   ii) Kirchoff's law
   iii) Lamberr's cosine law
   iv) Black body. **(08 Marks)**

b. Emissivities of two large parallel plates maintained at 800°C and 300°C are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square meter for these plates. **(04 Marks)**

c. The net radiation from the surfaces of two parallel plates maintained at temperature T_1 and T_2 is to be reduced by 79 times. Calculate the number of screens to be placed between the two surfaces to achieve this reduction in heat exchange, assuming the emissivity of the screen as 0.05 and that of the surfaces as 0.8. **(08 Marks)**

OR

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

b. Water enters a cross flow heat exchanger (both fluids unmixed) at 5°C and flows at the rate of 4600kg/n to cool 4000kg/n of air that is initially at 40°C. Assume overall heat transfer coefficient to be 150w/m^{2}K and area of 25m^2, calculate the exit temperature of air and water. Take C_{pw} = 4.18 kJ/kg k and C_{pair} = 1.01 kJ/kgk. **(08 Marks)**

c. A counter flow concentric flow heat exchanger is used to cool the engine oil [C_p = 2130J/kgk] from 160°C to 60°C with water available at 25°C as the cooling medium. The flow rate at the cooling water of inner diameter of 0.5m is 2 kg/s, while flow rate of oil through outer annulus of diameter 0.7m is also 2kg/s. IF U = 300w/m^{2}k, How long must be the heat exchanger to meet cooling requirement. **(04 Marks)**

Module-5

9 a. Explain heat distribution in rocket thrust chamber. **(08 Marks)**

b. Explain ablative heat transfer. **(08 Marks)**

c. Explain aerodynamic heating in Aerospace engineering. **(04 Marks)**

OR

10 a. Obtain species conservation equation using conventional notations. **(10 Marks)**

b. Ambient air at 20°C, flows past a flat plate with a sharp leading edge at 3m/sec. The plate is heated uniformly throughout its entire length and it is maintained at a surface temperature of 40°C. Calculate the distance from leading edge at which the flow in the boundary layer changes from laminar to turbulent. Assume transition occurs at a critical Reynolds number of 5×10^5. Determine :
   i) Thickness of hydrodynamic and thermal boundary layer at transition point
   ii) Local and average heat transfer coefficient
   iii) Total drag per unit width on one side of plate
   iv) Convective heat flow from plate to ambient air considering unit width of the plate. **(10 Marks)**

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