CBCS Scheme

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15AE53

Fifth Semester B.E. Degree Examination, June/July 2018
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 heat and mass transfer data handbook is permitted.*

Module-1

1 a. Explain types of mass transfer with example. **(06 Marks)**
b. Briefly explain Fick's law of diffusion. **(04 Marks)**
c. State the laws governing three basic modes of heat transfer. **(06 Marks)**

OR

2 a. Briefly explain Stefan Boltzmann law. **(06 Marks)**
b. A 0.8m height and 1.5m wide double – plane window consists of two thick layers of glass (K = 78W/mK) separated by a 10mm wide stagnant air space (K = 0.026 W/mK). Determine the rate of heat transfer through this window and the temperature of the inside surface when the room is maintained at 20^0C and the outside air is at -10^0C, take the convection heat transfer co-efficients on the inside and the outside surfaces of the window as $10W/m^2$-K and $40W/m^2K$. **(10 Marks)**

Module-2

3 a. A 40 × 40cm copper slab 5mm thick at a uniform temperature of 250^0C, suddenly has its surface temperature lowered to 30^0C. Find the time which the slab temperature becomes 90^0C, $\rho = 900\ kg/m^3$, specific heat (c) = 0.38kJ/kg-K, K = 370W/m-K and convective heat transfer co-efficient (h) = $90W/m^2$ – K. **(08 Marks)**
b. Derive the general three dimensional conduction equation in Cartesian Co – ordinates and state the assumption made. **(08 Marks)**

OR

4 a. A stainless steel rod of outer diameter 1cm originally at a temperature of 320^0C is suddenly immersed in a liquid at 120^0C for which the convective heat transfer co-efficient is $100W/m^2K$. Determine the time required for the rod to reach a temperature of 200^0C. **(08 Marks)**
b. Derive an expression for instantaneous heat transfer and total heat transfer for lumped heat analysis treatment of heat conduction problem. **(08 Marks)**

Module-3

5 a. Dry air at atmospheric pressure and 20^0C is flowing with a velocity of 3m/s along the length of a long flat plate, 0.3m wide, maintained at 100^0C. Calculate the following quantities at x = 0.3m : i) Boundary layer thickness ii) Average friction co-efficient iii) Thickness of thermal boundary layer iv) Rate of heat transfer from the plate between x = 0 and x = x by convection. **(08 Marks)**
b. Define clearly and give expression for : i) Reynolds number ii) Prandtl number iii) Nusselt number iv) Stanton number. **(08 Marks)**

OR

6 a. Obtain an empirical expression in terms of dimensionless numbers for heat transfer co-efficient in the case of forced convection heat transfer. (08 Marks)

b. Explain the following : i) Velocity boundary layer ii) Thermal boundary layer iii) Thermal entry. (08 Marks)

Module-4

7 a. With assumptions, derive an expression for LMTD for a Parallel flow heat exchanger. (08 Marks)

b. An oil cooler consists of straight tube of 2cm outer diameter and 1.5cm inner diameter enclosed within a pipe and concentric with it. The external pipe is well insulated. The oil flow through the tube at 0.05kg/s (C_p = 2kJ/kg K) and cooling fluid flows in the annulus in the opposite direction at the rate of 0.1 kg/s [C_p = 4.2kJ/kg K]. The oil enters the cooler at 180°C and leaves at 80°C, while cooling liquid enter the cooler at 30°C. Calculate the length of the pipe required if heat transfer co-efficient from oil to the surface is 1720W/m^2 K and from metal surface to coolant is 3450W/m^2 K. Neglect the resistance of the tube wall. (08 Marks)

OR

8 a. Obtain an expression for the rate of heat transfer when radiation shield is introduced between two parallel plates. (08 Marks)

b. Consider two large parallel plates, one at 1000K with emissivity 0.8 and other is at 300K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer as a result of radiation shield. (08 Marks)

Module-5

9 a. Write a short note on Aerodynamic heating. (08 Marks)

b. The flow rate of hot and cold fluids running through a parallel flow heat exchanger are 0.2 and 0.5kg/s respectively. The inlet temperature on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer co-efficient on both sides are 650W/m^2 K. Calculate the area of heat transfer [for hot and cold fluid , C_p = 4.2 kJ/kg K]. (08 Marks)

OR

10 a. Explain the heat transfer concept for the following : (08 Marks)
i) Rocket thrust chamber ii) Gas turbine combustion chamber.

b. Explain the concept of ablative heat transfer with its application. (08 Marks)

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