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December 2024

B. Tech. (ME/ME) (Fifth Semester)

Heat and Mass Transfer (PCC-ME-501-21)

Time : 3 Hours] [*Maximum Marks : 75*

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other.

Part A

1. (a) Define Fourier number and its significance. **1.5**

(b) Define Path function and point function. **1.5**

(c) Define Fourier's conduction law. **1.5**

(d) Define Emissivity. **1.5**

(e) Define Grey and Black bodies. **1.5**

(f) State Fick's law of diffusion. **1.5**

(g) Define work and Heat. **1.5**

(h) Write application of Heat Exchangers. 1.5

(i) What do you understand by effectiveness of a Fin ? 1.5

(j) Define Bulk or Saturated Boiling. 1.5

Part B

2. (a) In Cartesian Coordinates, Derive the three dimensions conduction equation with heat sources, unsteady state, also define thermal diffusivity. 10

(b) A rod of 3 cm diameter and 20 cm length is maintained at 100 degree Celsius at one end and 10 degree Celsius at the other end. These temperature conditions are attained when there is heat flow rate of 6 W. If cylindrical surface of the rod is completely insulated, determine the thermal conductivity of the rod material. 5

3. (a) The interior of an oven is maintained at a temperature of 850 degree Celsius by means of a suitable control apparatus. The oven walls are 500 mm thick and are fabricated from a material of thermal conductivity 0.3 W/m

degree. For an outside wall temperature of 250 degree Celsius, workout the resistance to heat flow. 8

(b) Define conduction-convection system. Derive heat transfer when the fin is very long and the temperature at the end of the fin is essentially that of the surrounding fluid. 7

4. (a) Air at 20 degree Celsius flows over a flat surface maintained at 80 degree Celsius. Estimate the value of local heat transfer coefficient if the local heat flow at a point was measured as 1250 W/m^2. Take thermal conductivity of air as 0.028 W/m K. 7

(b) Define lumped heat capacity system and derive lumped heat capacity analysis. 8

5. (a) Derive laminar boundary layer equation on a flat plate. 8

(b) Two concentric cylinder having diameter of 10 cm and 20 cm, calculate the shape factor between open ends of the cylinder. If $L/r_2 = 20/10$ and $r_1/r_2 = 0.5$, from table Use $F_{21} = 0.4126$ and $F_{22} = 0.3286$. 7

6. (a) Define diffusion process in solids and liquids. **7**

(b) Define condensation heat transfer phenomena and types of condensations. **8**

7. (a) Analyze the design of heat exchanger with NTU method. **10**

(b) Define over all heat transfer coefficient for a heat exchanger. **5**