TME - 505

1209

Odd Semester Examination 2018-19

B.TECH. (ME) (SEMESTER-V)

HEAT AND MASS TRANSFER

Time: 03:00 Hours **Max Marks :100**

Note: Attempt **ALL** the questions. Marks are shown against each question. Assume any missing data suitably.

1. Attempt any **FOUR** of the following : **(5x4=20)**

   (a) Name and briefly explain the various modes of heat transfer.

   (b) A solid copper sphere of 10 cm diameter [ρ = 8954 kg/m^3, c = 383 J/kg K, k = 386 W/mK], initially at a uniform temperature t_i = 250^0 C, is suddenly immersed in a well-stirred fluid which is maintained at a uniform temperature t_a = 50^0 C. The heat transfer coefficient between the sphere and the fluid is h = 250 W/m^2 K. Determine the temperature of the copper block at τ = 5 min after the immersion.

   (c) The inner surface of a plane brick wall is at 60^{0}C and the outer surface is at 35^{0}C. Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 220 mm thick. The thermal conductivity of the brick is 0.51 W/m ^{0}C.

   (d) State Fick's law of diffusion. Explain with the help of suitable mathematical expression and neat diagrams.

   (e) What is parallel flow and counter flow heat exchanger. Explain with the help of neat diagrams.

   (f) Write a short note on critical thickness of insulation for cylinder and sphere.

2. Attempt any **FOUR** of the following : **(5x4=20)**

(a) A steel pipe with 50 mm outer diameter is covered with a 6.4 mm asbestos insulation [k = 0.166 W/mK] followed by a 25 mm layer of fiber glass insulation [k = 0.0485 W/mK]. The pipe wall temperature is 393 K and the outside insulation temperature is 311 K. Calculate the interface temperature between the asbestos and fiber-glass.

(b) What is boiling heat transfer? Briefly explain the different types of boing heat transfer phenomenon.

(c) Briefly describe Biot and Fourier number with suitable mathematical expression.

(d) Define the terms total emissive power, spectral emissive power and emissivity.

(e) What are fins? Why they are used? Sketch some common types of fin configurations.

(f) The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold side are 75^0 C and 20^0 C respectively. The exit temperature of hot water is 45^0 C. If the individual heat transfer coefficients on both sides are 650 $W/m^{20}C$, calculate the area of heat exchanger.

3. Attempt any **TWO** of the following : **(10x2=20)**

(a) Derive the General Heat Conduction Equation in Cartesian Coordinates.

(b) Define the following numbers with suitable mathematical expression. Also give their significance

i. Nusselt Number

ii. Prandtl Number

iii. Reynolds Number

iv. Grashoff Number

(c) Air at 30^0 C flows with a velocity of 2.8 m/s over a plate 1000mm (length) x 600 mm (width) x 25 mm (thickness). The top surface of the plate is maintained at 90^0 C. value of k for the plate material is 25 W/m^0 C, calculate: (i) heat lost by the plate; (ii) bottom temperature of the plate. (iii) Average skin friction coefficient. (iv) Velocity boundary layer thickness

The thermo physical properties of air are: ρ = 1.06 kg/m^3, C_p= 1.005 kJ/kg K, k= 0.02894 W/m^0C, u= 18.97 x 10^{-6} m^2/s, α = 2.73 x 10^{-5} m^2/s.

4. Attempt any **TWO** of the following **(10x2=20)**

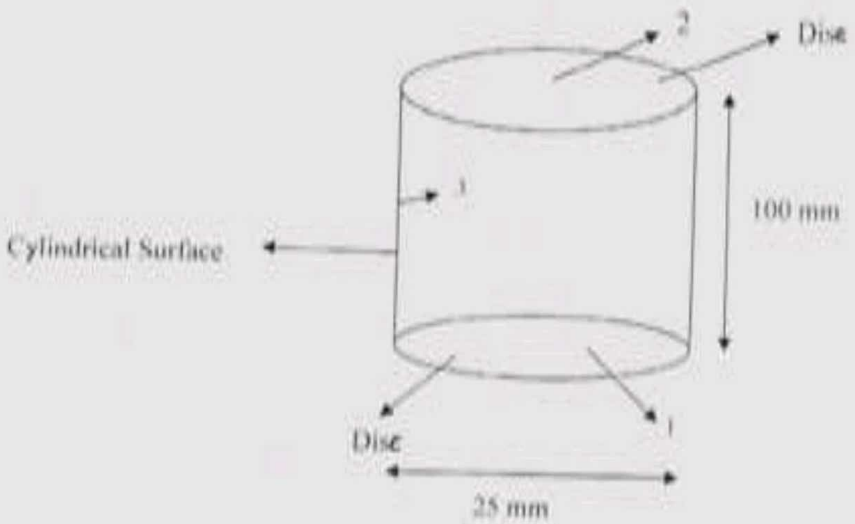
(a) An electric wire of 0.25 mm diameter, ϵ = 0.4 is placed within a tube of 2.5 mm diameter, ϵ = 0.6 having negligible thickness. This tube in turn is placed concentrically within a tube of 5 mm diameter, ϵ = 0.7. Annular spaces can be assumed to be evacuated completely. If the surface temperature of the outer tube is maintained at 5^0C, what must be the temperature of wire so as to maintain the temperature of inner tube at 120^0C?

(b) What do you understand by LMTD? Derive an expression of LMTD for a counter flow heat exchanger.

(c) An enclosure is formed by three surfaces. Details of their shape factors, emissivities and temperatures are as follows:

SURFACE	SHAPE	EMISSIVITY	TEMPERATURE
1	Curved Cylindrical	0.8	500^0 C
2	One end closing Disc	0.85	400^0 C
3	Other end closing disc	0.85	400^0 C

Diameters of two closing flat discs and interspacing between the two are 25 mm and 100 mm respectively. Shape factor between two identical discs is 0.05. Calculate the net rate of radiant heat flow leaving from surface 1 and reaching to each of the surfaces 2 and 3



5. Write short notes on any **FOUR** of the following : **(5x4=20)**

(a) Various regimes of pool boiling.

(b) Steady state Equimolar Counter Diffusion.

(c) Analogy between heat and electricity flow.

(d) Thermal boundary layer.

(e) Surface and space resistance for thermal radiation system.

(f) Conductivity and Thermal diffusivity of a body.

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