Printed Pages: 02 **Sub Code: KME-501**

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B.TECH
(SEM V) THEORY EXAMINATION 2022-23
HEAT AND MASS TRANSFER

Time: 3 Hours ***Total Marks: 100***

Note: Attempt all Sections. If you require any missing data, then choose suitably.

SECTION A

1. Attempt *all* questions in brief. **2 x 10 = 20**

(a) Explain the significance of Thermal Diffusivity.
(b) Define Critical radius of insulation.
(c) Explain the significance of Biot Number in transient heat conduction.
(d) Why are fins installed on the outer surface of electric motors?
(e) Define Prandtl Number.
(f) Define volume expansion coefficient and tell its significance in free convection.
(g) Define the following- Emissivity, Emissive Power.
(h) Explain black body and gray body.
(i) State Fick's Law of Mass diffusion.
(j) Differentiate between the mechanisms of film-wise and drop-wise condensation.

SECTION B

2. Attempt any *three* of the following: **10 x 3 = 30**

(a) For a solid cylinder with uniform heat generation, derive the following expressions- $T = T_a + [q_g.R/2h] + [q_g.R^2/4K\{1-r/R)^2\}]$
(b) State the assumptions made in Lumped Parametric analysis. For transient heat conduction, derive the following-
$\theta/\theta i = \exp(-Bi.Fo)$ where $\theta = T-T_a$
(c) Derive the Energy equation for thermal boundary layer over a flat plate
(d) What is radiation shield? Two large plate at temperatures 1000 K and 600 K have emissivity of 0.5 and 0.8 respectively . A radiation shield having emissivity 0.1 on one side and 0.05 on other side is paced between the plates. Determine the percentage reduction in heat transfer rate.
(e) Explain working principle of Heat pipe with neat sketch. Discuss pool boiling and also explain regimes of pool boiling with the help of diagram

SECTION C

3. Attempt any *one* part of the following: **10 x 1 = 10**

(a) Derive a general heat conduction equation for Cartesian co-ordinate.
(b) Consider steady state heat conduction across the thickness in a plane composite wall (composed of two layers) exposed to convection conditions on both sides- $h_i=20W/m^2K$, $h_o=50W/m^2K$, $T_i=20^0C$,$T_o=-2^0C$. The thermal conductivity and thickness of layer-1 are $K_1=20W/mK$, $L_1=0.30$ m. The thermal conductivity and thickness of layer-2 are $K_2=50$ W/mK, $L_2= 0.15$m. Determine interface temperature b/w two surfaces.

4. **Attempt any *one* part of the following:** **10 x 1 = 10**

(a) A copper sphere weighting 3 Kg is heated in a furnace to a temperature of 300°C and suddenly taken out and allowed to cool in ambient air at 25 °C.If it takes 60 min. For copper sphere to cool down to 35, what is the average surface heat transfer coefficient. Take density=8950 Kg/m^3. Cp=0.383KJ/Kg°C, K= 390 W/mK.

(b) Illustrate the following-

(i) What is meant by transient heat conduction?

(ii) What are Heisler charts? What is their significance in transient heat conduction?

(iii) What is response time of thermocouple?

5. **Attempt any *one* part of the following:** **10 x 1 = 10**

(a) Draw thermal boundary layer over a flat plate. Explain the following dimensionless numbers- Nusselt Number, Grashoff Number and Stanton Number.

(b) When 0.8 Kg of water per minute is passed through a tube of 20mm diameter. It is found to be heated from 22 to 50°C. The heating is accomplished by condensing steam on the surface of tube. Surface of tube is maintained at constant temperature of 85 °C. Determine the length of tube. For water at 60 °C- Cp=4.18 KJ/KgK, kinematic Viscosity= $0.568x10^{-6}$ m^2/s, K=0.659W/mK, Density =983Kg/m^3.

6. **Attempt any *one* part of the following:** **10 x 1 = 10**

(a) Define Radiation shape factor. Describe the various rules used in determination of radiation shape factor.

(b) Explain the following radiation laws- Kirchhoff's Law, Lamberts Cosine Law, Wein's Displacement Law, Planck's Law.

7. **Attempt any *one* part of the following:** **10 x 1 = 10**

(a) Derive expression for LMTD (Logarithmic Mean Temperature Difference) for a parallel flow heat exchanger.

(b) What is Fouling factor used in analysis of heat exchangers? 8000 kg/hr of air at 105°C is cooled by passing it through a counter flow heat exchanger. Find exit temperature of air if water enters at 15 °C and flows at the rate of 7500 kg/hr. U=145W/m^2K, A=20m^2.Solve by NTU method.