

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 placed 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- $h_i=20\text{W/m}^2\text{K}$, $h_o=50\text{W/m}^2\text{K}$, $T_i=20^\circ\text{C}$, $T_o=-2^\circ\text{C}$. The thermal conductivity and thickness of layer-1 are $K_1=20\text{W/mK}$, $L_1=0.30\text{ m}$. The thermal conductivity and thickness of layer-2 are $K_2=50\text{ W/mK}$, $L_2= 0.15\text{m}$. 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°C, what is the average surface heat transfer coefficient. Take density=8950 Kg/m³. 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°C 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= 0.568×10^{-6} m²/s, K=0.659W/mK, Density =983Kg/m³.
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/m²K, A=20m². Solve by NTU method.