PAPER ID-310140

Roll No: | | | | | | | | | | | | | |

**BTECH**
**(SEM V) THEORY EXAMINATION 2024-25**
**HEAT & MASS TRANSFER**

**TIME: 3 HRS** **M.MARKS: 70**

**Note:** Attempt all Sections. In case of any missing data; choose suitably.

## SECTION A

**1. Attempt *all* questions in brief.** **2 x 07 = 14**

| Q no. | Question | CO | Level |
|---|---|---|---|
| a. | Define heat transfer and its importance in engineering. | 1 | K1 |
| b. | List the factors affecting thermal conductivity. | 1 | K1 |
| c. | Explain how extended surfaces enhance heat transfer. | 2 | K2 |
| d. | Differentiate between steady-state and transient heat conduction. | 2 | K2 |
| e. | State the relation between fluid friction and heat transfer in forced convection. | 3 | K1 |
| f. | State Planck's law and its significance. | 4 | K1 |
| g. | State the significance of fouling factors in heat exchangers. | 5 | K1 |

## SECTION B

**2. Attempt any *three* of the following:** **07 x 3 = 21**

| Q no. | Question | CO | Level |
|---|---|---|---|
| a. | Use the concept of critical radius to determine whether adding insulation increases or decreases heat loss. | 1 | K3 |
| b. | Summarize the errors that occur in temperature measurement due to thermometer wells. | 2 | K2 |
| c. | Apply the empirical heat transfer relation to calculate the heat transfer coefficient for natural convection over a vertical plate. | 3 | K3 |
| d. | Determine the heat transfer rate between two non-black surfaces in an enclosure using the radiation network approach. | 4 | K3 |
| e. | Describe the principle behind the LMTD method and also Compare dropwise and filmwise condensation. | 5 | K2 |

## SECTION C

**3. Attempt any *one* part of the following:** **07 x 1 = 07**

| Q no. | Question | CO | Level |
|---|---|---|---|
| a. | Compare the heat conduction equations in rectangular, cylindrical, and spherical coordinates. | 1 | K4 |
| b. | A plane wall is 150 mm thick and its wall area is 4.5 m². If its conductivity is 9.35 W/m°C and surface temperatures are steady at 150°C and 45°C, determine:<br>(i) Heat flow across the plane wall.<br>(ii) Temperature gradient in the flow direction. | 1 | K3 |

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**4. Attempt any *one* part of the following: 07 x 1 = 07**

| Q no. | Question | CO | Level |
|---|---|---|---|
| a. | Identify the key assumptions made in the lumped capacitance method. | 2 | K1 |
| b. | A 50cm × 50 cm copper slab 6.25 mm thick has a uniform temperature of 300°C. Its temperature is suddenly lowered to 36°C. Calculate the time required for the plate to reach the temperature of 108°C. Take ρ= 9000kg/$m^3$, c = 0.38 kJ/kg°C, k = 370W /m°C and h = 90W /$m^2$°C. | 2 | K3 |

**5. Attempt any *one* part of the following: 07 x 1 = 07**

| Q no. | Question | CO | Level |
|---|---|---|---|
| a. | Differentiate between laminar and turbulent flow heat transfer in natural convection. | 3 | K4 |
| b. | Explain the analogy between momentum and heat transfer in turbulent flow over a flat surface. | 3 | K2 |

**6. Attempt any *one* part of the following: 07 x 1 = 07**

| Q no. | Question | CO | Level |
|---|---|---|---|
| a. | Compare the emissive properties of black bodies and gray bodies with examples. Also assess the impact of surface geometry on shape factors in radiation heat transfer. | 4 | K4 |
| b. | A small sphere (outside diameter = 60 mm) with a surface temperature of 300° C is located at the geometric centre of a large sphere (inside diameter = 360 mm) with an inner surface temperature of 15° C. Calculate how much of emission from the inner surface of the large sphere is incident upon the outer surface of the small sphere; assume that both sides approach black body behaviour. What is the net interchange of heat between the two spheres? | 4 | K3 |

**7. Attempt any *one* part of the following: 07 x 1 = 07**

| Q no. | Question | CO | Level |
|---|---|---|---|
| a. | Differentiate between the NTU and LMTD methods in terms of their applicability and advantages. | 5 | K5 |
| b. | Two fluids, A and B exchange heat in a counter-current heat exchanger. Fluid A enters at 420°C and has a mass flow rate of 1 kg/s. Fluid B enters at 20°C and has a mass flow rate of 1 kg/s. Effectiveness of heat exchanger is 75%. Determine: (i) The heat transfer rate. (ii) The exit temperature of fluid B. Specific heat of fluid A is 1 kJ/kg K and that of fluid B is 4 kJ/kg K. | 5 | K3 |