(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4078 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. V) ODD SEMESTER THEORY EXAMINATION 2010-11

HEAT & MASS TRANSFER

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt **all** questions. Marks are indicated against each question/part.

(2) Use the data and relations provided in the question paper.

(3) Assume missing data suitably, if any.

1. Answer any **four** parts of the following : **(5×4=20)**

(a) Derive an expression for critical radius of insulation for cylinder.

(b) Derive an expression for thermal resistance for spherical wall.

(c) What do you understand by contact resistance ?

(d) Derive general heat conduction equation in Cartesian coordinate system.

(e) A plane wall having a uniform energy generation per unit volume is exposed to a fluid. Assuming one-dimensional heat conduction, derive an expression for temperature distribution within the wall.

(f) What do you understand by the Heat Electrical analogy ? With the help of an example of walls in series explain its importance.

2. Attempt any **two** parts of the following : **(10×2=20)**

(a) Consider two long, very long rods (A and B) of the same diameter but different materials. One end of each rod is attached to a base surface at 100°C, and the rods are exposed to the ambient air at 20°C. By traversing the length of each rod with a thermocouple, it was observed that the temperatures of the rods were equal at the positions X_A = 0.15 m (for rod A) and X_B = 0.075 m (for rod B), where X is measured from the base surface. If the thermal conductivity of rod A is known to be k_A = 70 W/m.K, determine the value of k_B for rod B.

(b) Derive an expression for time constant of temperature measuring device. Discuss the effect of various parameters on the time constant.

(c) Derive an expression for heat transfer rate from a fin with insulated tip. Discuss the concept of corrected length of fin.

3. Answer any **two** parts of the following : **(10×2=20)**

(a) Explain the significance of various dimensionless numbers to natural convection. Discuss physical mechanism of free convection with the help of neat sketch.

(b) Air at temperature of 28°C flows with a velocity of 10m/s over a flat plate 0.5m long and 10 m wide. Find the heat transfer rate from the plate, if the plate is maintained at 300°C.

For air take : $\nu = 5.21 \times 10^{-4}$ m²/s; k = 0.0364 W/m. K; Pr = 0.687

Use the following expression for local Nusselt Number

$N_{uL} = 0.332\ Re_x^{1/2}\ Pr^{1/3}$.

(c) Oil at 150°C flows slowly through a long, thin-walled pipe of 30-mm inner diameter. The pipe is suspended in a room for which the air temperature is 20°C and the convection coefficient at the outer tube surface is 11 W/m². K. Estimate the heat loss per unit length of tube. Assume fully developed flow and negligible thermal resistance of tube wall.

For unused engine oil at 423 K : k = 0.133 W/m. K

4. Answer any **two** parts of the following : **(10×2=20)**

(a) What do you understand by the self radiation rule, summation rule and reciprocity rule ? Prove any two of them.

(b) What do you understand by the following ?

(i) Emissive power of a surface

(ii) Colored Surface

(iii) Kirchoff's Law.

(c) Consider two large, diffuse gray, parallel surfaces separated by a small distance. If the surface emissivities are 0.8, what emissivity should a thin radiation shield (placed between the surfaces) have to reduce the radiation heat transfer rate between the surfaces to 10% of the original ?

5. Answer any **two** parts of the following : **(10×2=20)**

(a) Saturated steam at 373 K condenses in a double pipe heat exchanger with a surface area of 0.5 m^2 and an overall heat transfer coefficient of 2000 W/m^2. K. Water enters at 0.5 kg/s and 288 K. Determine the outlet temperature of the water and the rate of steam condensation (Latent heat = 2257 kJ/ kg)

For Double pipe heat exchanger

$\varepsilon = 1\text{-}\exp(\text{-NTU})$; for $C_{min}/C_{max} = 0$

$\varepsilon = NTU/(1+NTU)$; for $C_{min}/C_{max} = 1$

(b) Derive an expression for molar diffusion rate for steady state equimolar counter diffusion.

(c) Discuss various modes of Pool boiling with the help of Pool boiling curve. List different regimes of forced convective boiling.