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10AU65

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Heat & Mass Transfer

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Heat transfer data book and steam tables are permitted.***

PART – A

1 a. State assumptions and derive general 3 – dimensional heat conduction equation in Cartesian coordinates. **(08 Marks)**

b. State the laws governing three basic modes of heat transfer. **(06 Marks)**

c. A long hollow cylinder (k = 50 w/m.k) has an inner radius of 10cm and outer radius of 20cm. The inner surface is heated uniformly at constant rate of 1.16×10^5 W/m^2 and outer surface is maintained at 30°C. Calculate the temperature of inner surface. **(06 Marks)**

2 a. Derive an expression for temperature distribution and rate of heat transfer in plane wall with proper assumptions. **(10 Marks)**

b. A very long rod, 25mm in diameter, has one end maintained at 100°C. The surface of rod is exposed to ambient air at 25°C with convective coefficient of 10W/m^2.k.

i) What are heat losses form rods, constructed of pure copper (K = 398W/m.k) and stainless steel (k = 14W/m.k)? Also write the remarks.

ii) Estimate how long the rods must be, to be, considered infinite. **(10 Marks)**

3 a. A titanium alloy blade of an axial compressor for which K = 25 W/m.k, ρ = 4500kg/m^3 and C = 520J/kg.k is initially at 60°C. The effective thickness of the blade is 10mm and it is exposed to gas stream at 600°C, the blade experiences a heat transfer coefficient of 500W/m^2. k. Use low Biot number approximation to estimate the temperature of blade after 1, 5, 20 and100 seconds. **(10 Marks)**

b. Define Biot number and Fourier number? Write their physical significances. **(04 Marks)**

c. What are heisler charts? Explain their significances in solving transient conduction problem. **(06 Marks)**

4 a. Using Buckingham's π theorem, obtain relationship between Nu, Pr and Gr, bor natural convection heat transfer. **(12 Marks)**

b. The velocity distribution in the boundary layer is given by ; $\frac{u}{U}=\frac{y}{\delta}$, where 'u' is the velocity at a distance 'y' from the plate and u = U at y = δ, δ being boundary layer thickness. Find : i) the displacement thickness ii) Momentum thickness

iii) the energy thickness and iv) the value of $\frac{\delta^*}{\theta}$ **(08 Marks)**

PART – B

5 a. Explain the following briefly with sketches :
i) Boundary layer thickness ii) Thermal boundary layer thickness. **(12 Marks)**

b. The efficiency (η) of a fan depends on density (ρ) the dynamic viscosity (μ) of the fluid, the angular velocity (ω), diameter (D) of the rotor and discharge (Q). Expresses (η) in terms of dimensionless parameters. **(08 Marks)**

6 a. A heat exchanger is required to cool 55000kg/hr of alcohol from 66°C to 40°C using 40,000kg/hr of water entering at 5°C. Calculate :
   i) Exit temperature of water
   ii) Heat transfer rate
   iii) Surface area required for parallel flow type and counter flow type. **(08 Marks)**

   b. Derive an expression for effectiveness of parallel flow heat exchange by 'NTU' method with proper assumption. **(12 Marks)**

7 a. Distinguish between nucleate boiling and film boiling with neat sketch. **(06 Marks)**

   b. Determine the rate of heat loss by radiation from a steel tube of outside diameter 70mm and 3m long at a temperature of 227°C. If the tube is located with in a square brick conduit of 0.3m side and at 27°C. Take ε (steel) = 0.79 and ε (brick) = 0.93. **(10 Marks)**

   c. State and explain fick's law of diffusion. **(04 Marks)**

8 a. With reference to thermal radiation, explain the following terms :
   i) Black body and gray body
   ii) Specular and diffuse surface
   iii) Plank's law and weins displacement law
   iv) Radiosity and irradiation
   v) View factor and Radiation shield. **(10 Marks)**

   b. A steam condenser consist of 16 tubes arranged in 4×4 array, water flows through the tube at 65°C while steam condenses at 75°C over the tube surface. Find the rate of condensation if,
   i) Tube are horizontal
   ii) Tubes are vertical.

   Take latent heat of steam as 2300kJ/kg and properties of water at 70°C.
   $\rho = 977.8 \text{ kg/m}^3$
   $K_f = 0.668 \text{ W/m.k}$
   $\beta = 5.7 \times 10^{-3}$
   $C_p = 4.187 \text{ kJ/kg.k}$
   $\upsilon = 0.415 \times 10^{-6} \text{ m}^2/\text{s}$
   L = 1.2m, D = 25mm. **(10 Marks)**

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