R09

Code No: D9101

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH II - SEMESTER EXAMINATIONS, APRIL/MAY 2012
ADVANCED HEAT AND MASS TRANSFER
(HEATING VENTILATION AND AIR CONDITIONING)

Time: 3hours **Max. Marks: 60**

Answer any five questions
All questions carry equal marks

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1. a) What is critical thickness of insulation and derive the same for cylinder and sphere?
   b) A steel tube of length 20 cm with internal and external diameters of 10 and 12 cm is quenched from 500^0C to 30^0C in a large reservoir of water at 10^0C. Below 100^0C the heat transfer coefficient is 1.5 kW/m^{2}K. Above 100^0C it is less owing to a film of vapour being producing at the surface, and an effective mean value between 500^0C and 100^0C is 0.5 kW/mK. The density of steel is 7800 kg/m^3 and the specific heat is 0.47 kJ/kg K. Neglecting the internal thermal resistance of the steel tube, determine the quenching time.

2. a) Explain the importance of Heisier charts in solving the transient heat conduction problems.
   b) A slab of Aluminum 10 cm thick is originally at a temperature of 500^0C. It is suddenly immersed in a liquid at 1000^0 C resulting it a heat transfer coefficient of 1200 W/m^{2}k. Determine the temperature at the centerline and the surface 1 min after the immersion. Also the total thermal energy removal per unit area slab during this period. The properties of aluminum for the given condition are: $\alpha = 8.4 \times 10^{-5}$m^2 /s, K=215 W/mK, ρ = 2700 kg/m^3, Cp= 0.9 kJ/kg.

3. a) Explain the terms 'hydrodynamic boundary layer' and 'thermal boundary layer', how are these thickness related to Prandtl number.
   b) Compute the coefficient of heat transfer from a vertical plate of height 2 m to the surrounding still air at 20^oC when the plate is maintained at 100^oC. Use the following relation $Nu_L = 0.15(Gr_L Pr_L)^n (Pr/Pr_s)^{0.25}$, Where all fluid properties except Pr_s (Pr at surface) are taken at the ambient temperature.

4. a) What is the criterion for transition from laminar to turbulent boundary layer in free convection on a vertical plate?
   b) Estimate power required to maintain a vertical heater surface at 130^0C in ambient air at 20^0C. The plate is 15 cm high and 10 cm wide. Consider equivalent radiation heat transfer coefficient as 8.5 W/m^{2}K.

5. a) Show that the Nusselt Number for the constant wall heat flux in the tube for the fully developed flow is 4.17.
   b) How to evaluate the heat transfer due radiation between the plates by the incorporation of radiation shields?

6. a) Estimate the power required to boil water in a copper pan 0.35 m in diameter. The pan is maintained at 120^0C by electric heater. What is the evaporation rate and also estimate the critical flux.
   b) Explain the phenomena of flow boiling through the tube along with boiling curve.

7. a) Prove that intensity of radiation is given by Ib = Eb/∏.
   b) State and explain Kirchoff's identity? What are the conditions under which it is applicable?
   c) A person standing 10m from a point heat source is subjected to a radiation intensity of 200×106 J/hr m^2. How far should he stand from the heat source to feel and intensity of half the previous value?

8. a) Derive the Roshenhow equation for the estimation heat transfer coefficient during evaporation.
   b) Explain the physical significance of the mass transfer coefficients and describe the analogy between heat transfer and mass transfer.

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