R09

Code: 9A03505

B.Tech III Year I Semester (R09) Regular & Supplementary Examinations December 2014

HEAT TRANSFER

(Mechanical Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

Use of heat transfer data book and steam tables are permitted in the examination hall

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1 (a) Define heat flux and thermal diffusivity and explain its importance in conduction mode of heat transfer.

(b) A plane wall 80 mm thick (K = 0.15 W/mK) is insulated on one side while the other is exposed to environment at 90^0C. If the convective heat transfer coefficient between the wall and the environment is 560 W/m^2K, determine the temperature at the surface of the wall will be subjected.

2 (a) A composite slab consists of 250 mm fire clay brick (k = 1.09 W/mK) inside, 100 mm fired earth brick (0.26 W/mK) and outer layer of common brick (0.6 W/mK) of thickness 50 mm. If inside surface is at 1200^0C and outside surface is at 100^0C, find: (i) Heat flux. (ii) The temperature of the junctions and (iii) The temperature at 200 mm from the outer surface of the wall.

(b) How the thermal conductivity is being influenced by the temperature for solids, liquids and gases? Explain.

3 (a) For which solid is the lumped system analysis more likely to be applicable an actual apple or a gold apple of the same size? Why?

(b) A billet of steel of the form of a parallelepiped with dimensions 2 m x 2 m x 5 m, originally at 300^0C, is placed in a radiant furnace, where the furnace temperature is held at 1000^0C. Determine the temperature at the center after 30 minutes. For steel, the properties are k = 35 W/mK, ρ = 7800 kg/m^3, C_p = 0.83 kJ/kgK, while h = 233 W/m^2K.

4 (a) Water at the rate of 3 kg/s is heated from 5^0C to 15^0C by passing it through a 50 mm ID copper tube. The tube wall temperature is maintained at 90^0C. What is the length of the tube required?

b) (State and explain Buckingham's π – theorem.

5 (a) In a certain process, castor oil at 30^0C flows past a flat plate. The velocity of oil is 0.08 m/sec. The length of the plate is 5 m. The plant is heated uniformly and maintained at 90^0C. Calculate the following: (i) Hydrodynamic and thermal boundary layer thickness at the trailing edge of plate. (ii) Total drag force per unit width on one side of the plate. Take properties as, ρ = 956.8 kg/m^3 , K = 0.213 W/mK, V = 0.65 x 10^{-4} m^2/s

(b) Draw the boundary layer over the flat plate and explain the salient features.

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6 (a) What is the effect of inclination of the tube or plate on the average condensation heat transfer coefficient? Explain.

(b) An electrically heated copped kettle with a flat bottom of diameter 25 cm is to boil water at atmospheric pressure at a rate of 2.5 kg/h. What is the temperature of the bottom surface of the kettle?

7 An oil cooler of the from tubular heat exchanger cools oil from a temperature of 85^{o}C to 35^{o}C by a large pool of stagnant water assumed at constant temperature of 25^{o}C. The tube carrying oil is 35 m long and 25 mm inside diameter. The specific heat and specific gravity of oil are 2.51 kJ/kgK and 0.8 respectively. The average velocity of the oil is 60 cm/sec. Estimate the overall heat transfer coefficient obtained from the system.

8 (a) What is the Stefan –Boltzmann law? Explain the concept of total emissive power of a surface.

(b) A glass plate of area 450 cm^2 is used to view radiation from a surface. The transmissivity of glass is 0.5 from 0.2 to 3.5μ and its transmissivity is zero for any other wavelengths. The emissivity of glass is 0.3 up to 3.5μ and 0.9 above that. Calculate the energy absorbed in the glass and the energy transmitted if the furnace is a black body at 2000^{0}C.

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