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Question Paper Code : 71849

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Fourth Semester

Mechanical Engineering

ME 2251/ME 41/ME 1251/080120015/10122 ME 502 – HEAT AND MASS TRANSFER

(Common to Mechanical and Automation Engineering)

(Regulation 2008/2010)

(Common to PTME 2251/10122 ME 502 – Heat and Mass Transfer for Sixth Semester B.E. (Part-Time) Mechanical Engineering – Regulation 2009/2010)

Time : Three hours Maximum : 100 marks

Use of Heat and Mass Transfer Tables Permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by transient heat Conduction?
2. What is thermal diffusivity?
3. Define velocity boundary layer thickness.
4. Distinguish between laminar and turbulent flow.
5. How heat exchangers are classified?
6. Discuss the advantage of NTU method over the LMTD method.
7. State Kirchhoff's law?
8. Define Radiosity.
9. State Fick's law of diffusion.
10. Define molar concentration.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Differentiate between conductivity and Conductance. (4)

(ii) A steel pipe line (thermal conductivity k = 50 W/mK) of Inner diameter 100 mm and outer diameter 110 mm is to be covered with two layers of insulation each having a thickness of 50 mm. The thermal conductivity of the first insulation material is 0.06 W/mK and that of the second is 0.12 W/mK. Calculate the loss of heat per meter length of pipe and the interface temperature between the two layers of insulation when the temperature of the inside tube surface is 250°C and that of the outside surface of the insulation is 50°C. (12)

Or

(b) (i) With a neat sketch, explain different types of fin profile. (4)

(ii) A metallic Sphere of radius 10 mm is initially at a uniform temperature of 400°C. It is heat treated by first Cooling it in air (heat transfer coefficient h =10 W/m^2K) at 20°C until its central temperature reaches 335°C it is then quenched in a water bath at 20°C with h 6000 W/m^2K until the centre of the sphere Cools from 335°C to 50°C. Compute the time required for Cooling in air and water for the following Physical properties of the sphere density = 3000 kg/m^3, specific heat = 1000 J/kgk; thermal Conductivity = 20 W/mK, thermal diffusivity = $6.66 \times 10^{-6} m^2/s$ (12)

12. (a) (i) Explain the velocity boundary layer profile on a flat plate and mentions its significance. (4)

(ii) Engine oil at 20°C is forced Over a 20 cm square plate at a velocity of 1.2 m/s. The plate is heated to a uniform temperature of 60°C. Calculate the heat loss of the plate. (12)

Or

(b) (i) Considering a heated vertical plate in quiescent fluid, draw the Velocity and temperature profile. (4)

(ii) Water at 60°C enters a tube of 2.54 mm diameter at a mean flow velocity of 2 cm/s. Calculate the exit water temperature if the tube is 3 m long and the wall temperature is constant at 80°C. (12)

13. (a) (i) With a neat sketch explain various regimes of pool boiling. (4)

(ii) A 10 × 10 array of horizontal tubes of 1.27 cm diameter is exposed to Pure steam at atmospheric pressure. If the tube wall temperature is 98°C, estimate the mass of steam condensed assuming a tube length of 1.5 m. (12)

Or

(b) (i) What are the different type of fouling in heat exchangers? (4)

(ii) Water enters a cross flow heat exchanger (both fluid unmixed) at 5°C and flows at the rate of 4600 kg/h to cool 4000 kg/h of air that is initially at 40°C. Assume the overall heat transfer coefficient value to be 150 W/m²K. For an exchanger surface area of 25 m². Calculate the exit temperature of air and Water (12)

14. (a) Consider a cylindrical furnace with outer radius = 1 m and height = 1 m. The top (surface 1) and the base (surface 2) of the furnace have emissivities 0.8 & 0.4 and are maintained at uniform temperatures of 700 K and 500 K respectively. The side surface closely approximates a black body and is maintained at a temperature of 400 K. Find the net rate of radiation heat transfer at each surface during steady state operation.

Or

(b) Emissivities of two large parallel plates maintained at 800°C and 300°C are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square meter for these plate. Find the percentage reduction in heat transfer when a polished aluminium radiation shield (ε = 0.05) is placed between them. Also find the temperature of shield.

15. (a) Dry air at 27°C and 1 bar flows over a wet plate of 50 cm at 50 m/s. Calculate the mass transfer coefficient of water vapour in air at the end of the plate.

Or

(b) (i) What are the assumptions made in the 1-D transient mass diffusion problems? (4)

(ii) The dry bulb and wet bulb temperatures recorded by a thermometer in moist air are 27°C and 17°C respectively. Determine the specific humidity of air assuming the following values : Prandtl number = 0.74, Schmidt number = 0.6, Specific heat at constant pressure = 1.004 kJ/kgK, pressure = 1.0132×10^5 N/m². (12)