OR

a) Consider the flow between parallel plates (1m width × 1m length) spaced 6mm apart. Calculate the compactness (m^2/m^3) of the surface exposed to the flow between parallel plates. Now suppose that straight plain fins of 0.05 mm thickness are installed between parallel plates and spaced on 1-mm centers. Calculate the compactness for this plate-fin surface.

b) Define effectiveness concept for double pipe heat exchanger with all four possible cases. Co-Current flow, hot fluid minimal, Co-Current flow, cold fluid minimal, Counter-Current flow, hot fluid minimal, Counter-Current flow, cold fluid minimal.

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MECM-104

M.E./M.Tech., I Semester

Examination, December 2014

Advanced Heat Transfer

Time : Three Hours

Maximum Marks : 70

Note: All questions carry equal marks, draw neat sketch and assume suitable data wherever you required.

1. a) Derive the one-dimensional heat-conduction equation.

b) A 6.0-cm-diameter pipe whose surface temperature is maintained at 210°C passes through the center of a concrete slab 45 cm thick. The outer surface temperatures of the slab are maintained at 15°C. Using the flux plot, estimate the heat loss from the pipe per unit length.

OR

a) What is the main assumption in the separation-of-variables method for solving Laplace's equation?

b) A 2.5-m-diameter sphere contains a mixture of ice and water at 0°C and is buried in a semi-infinite medium having a thermal conductivity of 0.2 W/m °C. The top surface of the medium is isothermal at 30°C and the sphere centerline is at a depth of 8.5 m. Calculate the heat lost by the sphere.

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2\. a) What is the basic procedure in setting up a numerical solution to a two-dimensional conduction problem?

b) What is meant by a lumped capacity? What are the physical assumptions necessary for a lumped-capacity unsteady-state analysis to apply?

OR

a) What initial conditions are imposed on the transient solutions in a long cylinder suddenly exposed to convection?

b) Describe how one-dimensional transient solutions may be used for solution of two and three-dimensional problems

3\. a) What is the Dittus-Boelter equation? When does it apply?

b) A semi-infinite slab of copper is exposed to a constant heat flux at the surface of 0.5 MW/m². Assume that the slab is in a vacuum, so that there is no convection at the surface. What is the surface temperature after 5 min if the initial temperature of the slab is 20°C? What is the temperature at a distance of 15 cm from the surface after 5 min?

OR

a) Explain Shape-factor algebra for open ends of cylinders

b) Water at an average temperature of 300 K flows at 0.7 kg/s in a 2.5 cm-diameter tube 6 m long. The pressure drop is measured as 2 kPa. A constant heat flux is imposed, and the average wall temperature is 55°C. Estimate the exit temperature of the water.

4\. a) Discuss electrical analogy when more than two grey bodies are involved in heat exchange.

b) Three parallel black walls, 1m wide form an equilateral triangle. One wall is held at 400 K, one is at 300 K, and the third is insulated. Find Q w/m and the temperature of the third wall.

OR

a) A small diameter heater is centered in a large cylindrical radiation shield. Discuss the relative importance of the emittance of the shield during specular and diffuse radiation.

b) Two parallel disks, 50 cm in diameter, are separated by a distance of 12.5 cm and enclosed by a large room at 300 K. One disk is maintained at a constant temperature of 800°C and has an emissivity of $\varepsilon = 0.8$. The other disk is perfectly insulated and has an emissivity of $\varepsilon = 0.1$. Calculate the net radiant energy lost by the disk maintained at 800°C.

5\. a) Explain why the temperature boundary layer grows much more rapidly than the velocity boundary layer in liquid metals.

b) Water at the rate of 68 kg/min is heated from 35 to 75°C by oil having a specific heat of 1.9 kJ/kg °C. The fluids are used in a shell-and-tube exchanger with the water making one shell pass and the oil making two tube passes and the oil enters the exchanger at 110°C and leaves at 75°C. The overall heat-transfer coefficient is 320 W/m² °C. Calculate the heat-exchanger area.