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Name...

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FIFTH SEMESTER B.TECH. (ENGINEERING) (09 SCHEME) DEGREE EXAMINATION, NOVEMBER 2015

ME/PTME/AM 09 501—HEAT AND MASS TRANSFER

Time : Three Hours Maximum : 70 Marks

Part A

Answer **all** *the questions.*

I. 1 Define overall heat transfer coefficient.

2 Define radiation shape factor.

3 Define drag coefficient and drag force.

4 Distinguish between film type and drop wise condensation.

5. Give two examples of convective mass transfer.

($5 \times 2 = 10$ marks)

Part B

Answer any **four** *questions.*

II. (a) Derive the differential equation for the temperature distribution in a straight triangular fin.

(b) Derive an expression for radiation heat exchange between two black surface using definition of irradiation and radiocity.

(c) What is Reynolds analogy ? Describe the relation between fluid friction and heat transfer.

(d) Define Nusselt, Reynolds, Prandtl and Stanton numbers. Explain their significance in forced convection.

(e) Explain the modes of pool boiling with a neat sketch.

(f) Explain Fick's law of diffusion. What is mass diffusivity and its dimension ?

($4 \times 5 = 20$ marks)

Part C

Answer **all** *questions.*

III. (a) Triangular fins of 2.5 cm thickness at base and 10 cm long and made from stainless steel (k = of the 17.7 W/mK and ρ = 7850 kg/m^3) are to be fitted to an air cooled cylinder wall. If the wall temperature is 600°C and the heat transfer coefficient between the solid surface and air at (T_∞ = 40°C) is 20 W/m^{2}K, derive an expression for temperature distribution along the fin. Also estimate the rate of heat flow per unit mass fin.

Or

Turn over

(b) Determine the number of shields required to keep the temperature of the outside surface of a hollow brick lining of a furnace 100°C. When the temperature of the inside surface of the lining is 500°C take the emissivity of brick lining as well as for shield as 0.87 ? Heat transfer to the surroundings from the outer surface takes place by radiation and conduction. The heat transfer coefficient for natural convection is given by $h_a = 1.44 \ (\Delta t)^{0.33}$ W/m²K. t_{air} is 25°C. Neglect the heat transfer by conduction and convection between the brick lining.

IV. (a) Air at a pressure of 8 KN/m² and a temperature of 250°C flows over a flat plate 0.3 m wide and 1 m log at a velocity of 8 m/s. if the plate is to be maintained at a temperature of 78°C estimate the rate of heat to be removed continuously from the plate. Also estimate the drag force exerted on the plate using the analogy between fluid friction and heat transfer.

Or

(b) In a straight tube of 60 mm diameter, water is flowing at a velocity of 12 m/s. the tube surface temperature is maintained at 70°C and the flowing water is heated from the inlet temperature 15°C to an outlet temperature of 45°C. Calculate the following : (a) the heat transfer coefficient from the tube surface to the water ; (b) the heat transfer ; and (c) the length of the tube.

V. (a) Two rectangles 0.8 by 0.8m are placed perpendicularly with a common edge. One surface has $T_1 = 1000 \ k \ \varepsilon_i = 0.6$, while the other surface is insulated and in radiant balance with a large surrounding room at 300 K. Determine the temperature of the insulated surface and the heat lost by the surface at 1000 K.

Or

(b) (i) Water at the rate of 3.8 kg/s is heated from 38°C to 55°C in a shell and tube heat exchanger. On the shell side one pass is used with water as the heating fluid, 1.9 kg/s entering the heat exchanger at 93°C. The overall heat transfer coefficient Is 1419 W/m²K, and the average water velocity in the 1.9 cm diameter tubes is 0.366 m/s. because of space of space limitation the tube length must not be longer than 2.5 m. Calculate the number of tube passes, the number of tube per pass and the length of the tubes, consistent with this restriction.

(ii) Obtain an expression for effectiveness in terms of NTU counter flow heat exchangers.

VI. (a) A vertical square plate 30 × 30 cm, is exposed to steam at atmospheric pressure. The plate temperature is 98°C. Calculate the heat transfer and the mass of steam condensed per hour.

Or

(b) Derive the general mass transfer equation in Cartesian co-ordinates :

i. Explain briefly three modes of mass transfer

ii. Define the following terms and give the physical significance of each.

(1) Mass transfer coefficient.

(2) Schmidt number.

(3) Lewis number.

(4 × 10 = 40 marks)