This question paper contains 1 printed page.

3078 *Your Roll No.....*

MEM
Paper – ME.551
HEAT TRANSFER

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Time : 3 hours Maximum Marks : 100

(Write your Roll No. on the top immediately on receipt of this question paper)
Attempt any **five** questions. Heat and Mass Transfer Data Book is allowed.

Q.No.1 Derive the expression for total cost of heat exchanger and find out :
(i) the optimum size of pipe (ii) optimum outlet temperature of cold fluid (iii) optimum mass flow rate (8+6+6)

Q.No.2 (a) Prove that $Nu = \phi(\text{Re})\varphi(\text{Pr})$ in the forced convection heat transfer. (10)
(b) Derive the expression for thickness of boundary layer for flow over a flat plate using integral analysis. (10)

Q.No.3 Derive the expression for temperature distribution and rate of heat transfer in the (i) triangular fin and (ii) parabolic fin. (9+11)

Q.No.4 (a) Derive the expression for optimum economic thickness of insulation for (i) Flat surfaces (ii) cylindrical surfaces (6+6)
(b) Derive the temperature distribution and rate of heat transfer in the two-dimensional heat flow problems. (8)

Q.No.5 (a) In a manufacturing process stainless steel cylinders initially at 600 K are quenched by submersion in an oil bath maintained at 298 K with convective heat transfer coefficient of 495 W/m^2–K. Assume the length of each cylinder as 65 mm and diameter as 85 mm and 3 minute time required for the cooling process. Determine temperatures at the centre of the cylinder, at the centre of a circular face, and at the mid-height of the side. (10)
(b) Explain the utility of Reynolds analogy and Colebourn Analogy.
On which condition Colebourn analogy becomes Reynolds analogy .
Also prove that Stanton number becomes half of local friction coefficient (10)

Q.No.6 (a) Calculate analytically the radiation shape factor from a smaller area dA_1 to a circular disc A_2 of radius R which are parallel to each other. (10)
(b) Derive the expression for the shape factor for two rectangular and adjoining areas A_1 and A_2 at right angles with each other. (10)

Q.No.7 (a) The outer surface of a vertical tube, which is 1m long and has an outer diameter of 80 mm, is exposed to saturated steam at atmospheric pressure and is maintained at 50°C by the flow of cool water through the tube. Calculate the rate of heat transfer to the coolant and also the rate of steam condensed at the surface. (10)
(b) Derive the expression for the thickness of boundary layer and local heat transfer coefficient for laminar flow condensation on vertical plate. (10)

Q.No.8 (a) The bottom of a copper pan, 0.3m in diameter, is maintained at 118°C by an electric heater. Estimate the power required to boil water in this pan, evaporation rate and critical heat flux. (10)
(b) Prove that $Sh = \phi(\text{Re})\varphi(Sc)$ in the forced convection mass transfer. (10)