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BB84

M. Tech. EXAMINATION, 2020

(Second Semester)

(B. Scheme) (Re-appear)

MECHANICAL ENGINEERING

MEM504B

Advanced Heat Transfer

Time : 3 *Hours*] [*Maximum Marks :* 75

Before answering the question-paper candidates should ensure that they have been supplied to correct and complete question-paper. No complaint, in this regard, will be entertained after the examination.

Note : Attempt *five* questions in all, selecting at least *one* question from each unit. Assume suitable value for any missing data. All questions carry equal marks. Use of different related Tables and Charts is permissible.

Unit I

1. (a) An electric cable of 10 mm in diameter is to be laid in atmosphere at 20ºC. The estimated surface temperature of the cable due to heat generation is 65ºC. Find maximum percentage increase in heat dissipated when the wire is insulated with rubber having k = 0.155 W/m-K. Take h = 8.5 W/m^2-K. **7**

(b) Derive expression for temperature distribution for a rectangular fin when the end of the fin is insulated. **8**

2. Use separation of variable method to solve Laplace equation of two dimensional heat conduction. Mention limitations of this method. **15**

Unit II

3. Using exact solution approach, obtain the following equation for the solution of momentum equation for hydrodynamic boundary layer formed over a flat plate With usual notations. **15**

4. (a) Calculate the frictional drag on a plate 15 cm wide and 45 cm long placed longitudinally in a stream of oil (specific gravity 0.925 and kinematic viscosity 0.9 stoke) flowing with a free stream velocity of 6 m/s. Also find the thickness of boundary layer and shear stress at the trailing edge. **7**

(b) A flat plate 1 m wide and 1.5 m long is to be maintained at 90ºC in air when free stream temperature is 10ºC. Determine the velocity at which air must flow over the plate so that the rate of energy dissipation from the plate is 3.75 kW. (Take ρ = 1.087 kg/m^3, k = 0.028 W/m-K, C_p = 1007 J/kg-K, $\mu = 2.029 \times 10^{-5}$ kg/m-s, Pr = 0.703). **8**

Unit III

5. (a) A fluid is flowing in a pipe which is 300 mm in diameter, 3.5 m long and whose surface is maintained at constant temperature. The temperature of the wall surface at the inlet section of the pipe exceeds the fluid temperature by 40ºC. What is the rise in the fluid temperature at the end of the section of pipe ? **11**

(b) Explain thermally developing region and thermal entry length in case of hot fluid flowing through tube. **4**

6. Show that average heat transfer coefficient for the laminar film condensation on a vertical plate is equal to (4/3) times the local heat transfer coefficient at lower edge of the plate. Also mention all assumptions in this analysis done by Nusselt's. Begin your answer with first principle. **15**

Unit IV

7. (a) Write notes on the following : **8**

(i) Classification of heat exchanger

(ii) Plate heat exchanger. **8**

(b) Water enters the tubes of a single pass heat exchanger at 20ºC and leaves at 40ºC. On the shell side, 25 kg/min of steam condenses at 60ºC. Calculate the overall heat transfer coefficient and the required flow rate, if the area of the exchanger is 12 m^2. The latent heat is 2358 kJ/kg-K, C_p = 4174 J/kg-K. **7**

8 (a) A thin copper sphere with it internal surface highly oxidised, has a diameter of 20 cm. How small a hole must be made in the sphere to make an opening that will have an absorptivity of 0.9 ? **8**

(b) The filament of a 75 W light bulb may be considered a black body radiating into a black enclosure at 70ºC. The filament diameter is 0.1 mm and length is 5 cm. Considering the radiation, determine the filament temperature. **7**