Total No. of Questions – [8] Total No. of Printed Pages 4

G.R. No.	

Paper Code: U359-153 (ESE)

December 2019/ENDSEM

T. Y. B. TECH. (Mechanical) (SEMESTER - I)

COURSE NAME: Heat Transfer

COURSE CODE: MEUA31173

(PATTERN 2017)

Time: [**2 Hours**] [Max. Marks: **50**]

(*) Instructions to candidates:

1) **Answer Q.1, Q.2, Q.3, Q.4, Q.5 OR Q.6, Q.7 OR Q.8**
2) **Figures to the right indicate full marks.**
3) **Use of scientific calculator is allowed**
4) **Use suitable data where ever required**

Q.1) a) Derive an expression for critical radius of insulation of cylinder using usual notations. Comment on significance of Critical Radius of Insulation. [6]

OR

b) A thermopane window consists of two 5 mm thick glass (k = 0.78 W/m.K) sheets separated by 10 mm stagnant air gap (k = 0.025 W/m.K). The convection heat transfer coefficient for inner and outside air are 10 W/m^2.K and 50 W/m^2.K, respectively. [6]
(a) Determine the rate of heat loss per m^2 of the glass surface for a temperature difference of 60°C between the inside and outside air.
(b) Compare the result with the heat loss, if the window had only a single sheet of glass of thickness 5 mm instead of thermopane.

Q.2) a) Three identical straight fins, 10 mm in diameter and 120 mm long are exposed to an ambient with convective heat transfer coefficient of 32 W/m^2.K. Compare their efficiency and relative heat flow performance. The three fin materials and their thermal conductivities are: [6]
Copper: 380 W/m.K, Aluminium : 210 W/m.K, Mild steel : 45 W/m.K.

OR

b) An electric motor is to be connected by a horizontal steel shaft (k = [6]

42.56 W/m.K), 25 mm in diameter to an impeller of a pump, circulating liquid metal at a temperature of 540°C. If the temperature of electric motor is limited to a maximum value of 52°C with the ambient air at 27°C and heat transfer coefficient of 40.7 W/m^2.K, what length of shaft should be specified between the motor and pump?

Q.3) a) Prove that $\frac{t - t_a}{t_i - t_a} = e^{-B_i \times F_o}$ with usual notations. [6]

OR

b) An aluminium sphere weighing 6 kg and initially at temperature of 350°C is suddenly immersed in a fluid at 30°C with convection coefficient of 60 W/m^2.K. Estimate the time required to cool the sphere to 100°C. Take thermo-physical properties as C = 900 J/kg.K, ρ= 2700 kg/m^3, k = 205 W/m.K. [6]

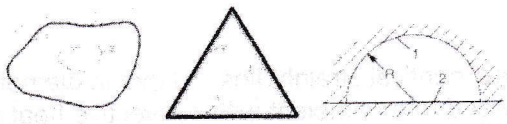
Q.4) a) Compare dropwise and film-wise condensation. [4]

OR

b) What is "Hydraulic Diameter" of a duct? Explain its significance in convection heat transfer. Calculate Hydraulic Diameter for: [4]

a. Rectangular cross-section, with side = 10 cm and 5 cm
b. Square cross section with side = 2 cm
c. Circular cross section with radius = 2 cm

Q.5) a) Calculate the view factor F_{1-1}, F_{1-2} and F_{2-1} for the following geometries [6]



(i) A black body inside a black enclosure.
(ii) A tube whose section is equilateral triangle.
(iii) Radiation exchange between a hemisphere and a plane surface.

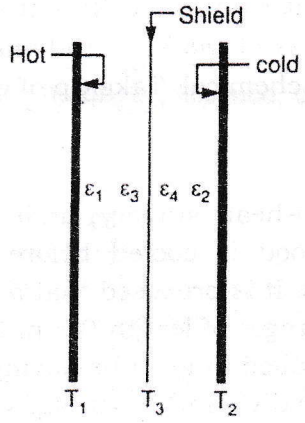
b) One side of metallic plate is insulated, while the other side [4]

absorbs a radiant heat flux of 900 W/m2. The convective heat transfer coefficient between the plate and ambient air is 10 $W/m^2.K$. The surface emissivity of the plate is 0.8. The surrounding and ambient air are at 27°C. Determine the temperature of the plate under steady state conditions.

c) State and explain Wien's Displacement law? What is diffuse body? [4]

OR

Q.6) a) Two large parallel planes with emissivity 0.6 are at 900 K and 300 K. A radiation shields with one side polished and having emissivity of 0.05, while the emissivity of other side is 0.4 is proposed to be used. Which side of the shield to face the hotter plane, if the temperature of shield is to be kept minimum? Justify your answer. [6]



b) What is radiation shied? Explain Summation Rule. [4]

c) Define absorptivity, reflectivity and transmissivity with simple sketch. [4]

Q.7) a) A heat exchanger is required to cool 55,000 kg/h of alcohol from 66°C to 40°C using 40,000 kg/h of water entering at 5°C. Calculate (i) exit temperature of water, (ii) heat transfer rate, (iii) surface area required for (a) parallel flow type, (b) counter flow type of heat exchanger. Take overall heat transfer coefficient U = 580 $W/m^2.K$, Cp (alcohol) = 3760 J/kg.K and Cp (water) = 4180 J/kg.K [6]

b) Calculate the overall heat transfer coefficient based on outer surface of a steel pipe (k = 54 W/m.K) with inner and outer diameters as 25 mm and 35 mm respectively. The inside and outside heat transfer coefficients are 1200 W/m^2.K and 2000 W/m^2.K, respectively. [4]

c) What do you mean by fouling factor? State the causes of fouling? [4]

OR

Q.8) a) A chemical having specific heat of 3.3 kJ/kg.K at a rate of 20,000 kg/h enters a parallel flow heat exchanger at 120°C. The flow rate of cooling water is 50,000 kg/h with an inlet temperature of 20°C. The heat transfer area is 10 m^2 and overall heat transfer coefficient is 1050 W/m^2.K. Find (i) The effectiveness of the heat exchanger, (ii) Outlet temperature of water and chemical. Take Cp of water as 4.186 kJ/kg.K. [6]

b) In an open-heart surgery, under hypothermic conditions, the patient blood is cooled before the surgery and rewarmed afterwards. It is proposed that a concentric tube, counter flow heat exchanger of length 0.5 m be used for this purpose with the thin walled inner tube having a diameter of 55 mm. If the water at 60°C and 0.10 kg/s is used to heat the blood entering the exchanger at 18°C and 0.05 kg/s, what is the temperature of blood leaving the exchanger? The overall heat transfer coefficient is 500 W/m^2.K and specific heat of the blood is 3500 J/kg.K. [4]

c) Why € - NTU method is superior to LMTD method? [4]

****** Best Wishes ******