

10. Convective heat transfer coefficient does not depend on
- viscosity velocity temperature surface area
11. A steam condenser transfers 250 kW of thermal energy at a condensing temperature of 65°C. The cooling water enters the condenser at 20°C with a flow rate of 7500 kg/hr. If the overall heat transfer coefficient for the condenser surface is 1250 W/m²K, what surface area is required to handle this load?
- 7.08 m² 5.08 m² 4.08 m² 1.08 m²
12. A crossflow type air heater has an area of 50 cm². The overall heat transfer coefficient is 100 W/m²K and the heat capacity of both hot and cold streams is 1000 W/m K. The value of NTU is.....
- 1000 16 5 0.2
13. is not one of the common techniques to enhance heat in pool boiling.
- Mechanical agitation Surface vibration
 Chemical additive Finned surfaces addition
14. The overall heat transfer coefficient is W/m²K for heat exchangers involving phase changes.
- 0.1 - 9 10 - 99 100 - 9999 above 10000
15. Correction factor, F in heat exchanger does not typically depend upon
- fluid properties inlet temperature outlet temperature HE geometry
16. The use of heat exchangers with NTU value cannot be economically justified in practice.
- below 50 above 3 below 1.5 near zero
17. The emissivity and the absorptivity of a surface at a given temperature and wavelength are equal is based on.....
- Stefan Boltzmann's Statement Kirchoff's Law
 Planck's Distribution Theory Wien's Displacement Law
18. Most boiling heat transfer equipment in practice operate slightly below to avoid burnout.
- Maximum heat flux Leidenfrost point
 Film boiling Nucleate boiling
19. The radiosity of perfect black body is
- infinite 1
 equal to emissive power equal to radiation intensity
20. The radiation correction term for a typical thermometer reading with emissivity 0.5, surrounding surface temperature 10°C, thermometer reading 8°C and convective coefficient for the thermometric fluid 10 W/m²K is approximately
- $9 \times 10^6 \sigma$ $10^7 \sigma$ $7 \times 10^6 \sigma$ $6 \times 10^6 \sigma$

Level : B.E./B.Tech.
Year : III
Time : 2 hrs. 30 mins.

Course : MEEG 306
Semester : II
F. M. : 55

SECTION "B"

[55 marks]

Attempt *ALL* questions. Assume any missing values (if and only if needed). Students are permitted to use data books and formula set.

1. A homogeneous wall of area 'A' and thickness 'δ' has left and right-hand surface temperatures of 0°C and 40°C respectively. Determine the temperature at the center of the wall. [1]
 - a. How much material must be added and to which side of the wall if the temperature at the center is to be raised by 5°C. [3]
 - b. How much material must be removed and from which side of the wall if the temperature at the center of the wall is to be lowered by 5°C. [3]
 Express your answers in terms δ. Presume that the surface temperature remains the same before and after the alteration.

2. Heat flow occurs along the axis of a solid 'Chrome Brick' treated @ 550°C, which has the shape of a truncated cone as shown in Figure 1 with circumferential surface insulated. The base is at 300°C, and the area of section at a distance 'x' measured from the base of the cone is given by $A = 1.2(1 - 1.5x)$, where 'x' is in meters. If the plane at $x = 0.2\text{m}$ is maintained at 100°C, determine
 - a. The heat flow [2]
 - b. Temperature at $x = 0.1\text{ m}$ [1]
 - c. Temperature gradient at two faces and at $x = 0.1\text{m}$ [1]

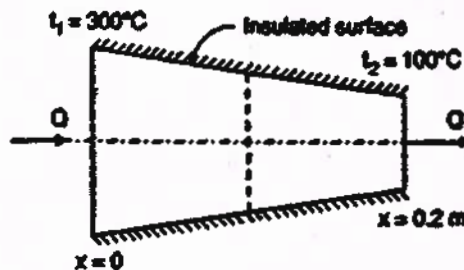


Figure 1

3. A 1 m long, 5 cm diameter, cylinder placed in an atmosphere of 40°C is provided with 12 longitudinal straight fins made of Phosphor Bronze treated @ 327°C, 0.75 mm thick. The fins protrude 2.5 cm from the cylinder surface. The heat transfer coefficient is 23.3 W/m²K. Calculate the rate of heat transfer if the surface temperature of cylinder is at 150°C. [5]

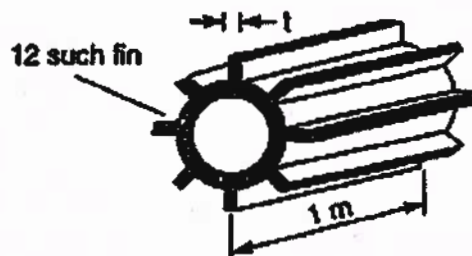


Figure 2

4. A hot surface at 100°C is to be cooled by attaching 3 cm long, 0.25 cm diameter aluminum fins treated at 300°C to it, with a center-to-center distance of 0.6 cm. The temperature of surrounding air is 30°C and heat transfer coefficient on surface is $35 \text{ W/m}^2\cdot\text{K}$. Calculate the rate of heat transfer from the surface for a $1 \text{ m} \times 1 \text{ m}$ section of the plate. Also determine the overall effectiveness of the fins. [6]

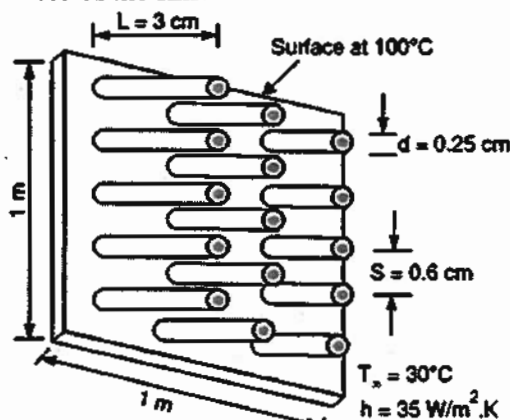


Figure 3

5. A hot square plate $40 \text{ cm} \times 40 \text{ cm}$ at 100°C is exposed to atmospheric air at 20°C . Make calculations for the heat loss from both surfaces of the plate if:
- The plate is kept vertically [3]
 - The plate is kept horizontally [3]

The following empirical correlations have been suggested.

$$\text{Nu} = 0.125 (\text{Gr} \times \text{Pr})^{0.33} \text{ for vertical position of the plate}$$

$$\text{Nu} = 0.72 (\text{Gr} \times \text{Pr})^{0.25} \text{ for upper surface}$$

$$\text{Nu} = 0.35 (\text{Gr} \times \text{Pr})^{0.25} \text{ for lower surface}$$

6. Air at 10°C and at a pressure of 100 kPa is flowing over a plate at a velocity of 3 m/s. If the plate is 30 cm wide and at a temperature of 60°C . Calculate the following quantities at $x = 0.3 \text{ m}$. [5]
- Velocity and thermal Boundary layer thickness
 - Local friction coefficient and Total drag force
 - Local convective heat transfer coefficient
 - The heat transfer from the plate
 - Local shear stress

7. A 2-shell passes and 4-tube passes heat exchanger is used to heat glycerin from 20°C to 50°C by hot water, which enters the thin-walled 2-cm-diameter tubes at 80°C and leaves at 40°C (Figure 4). The total length of the tubes in the heat exchanger is 60 m. The convection heat transfer coefficient is $25 \text{ W/m}^2\cdot^{\circ}\text{C}$ on the glycerin (shell) side and $160 \text{ W/m}^2\cdot^{\circ}\text{C}$ on the water (tube) side. Determine the rate of heat transfer in the heat exchanger.

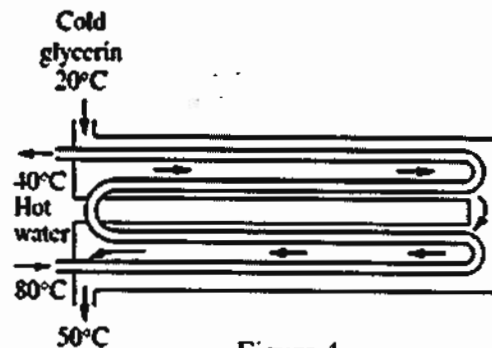


Figure 4

- Before any fouling occurs [3]
- After fouling with a fouling factor of $0.0006 \text{ m}^2\cdot^{\circ}\text{C}/\text{W}$ occurs on the outer surfaces of the tubes. [3]

8. Two identical counter flow type heat exchangers are available. Water at the rate of 3600 kg/h and at 30°C ($C_p = 4.2$ kJ/kg.K) is to be heated by cooling of an oil ($C_p = 2.1$ kJ/kg.K) at 90°C. The oil flow rate is 2700 kg/h. The heat transfer area in each heat exchanger is 4 m². The heat exchangers are connected in series on the water side and in parallel on the oil side. The oil flow rate is split in the ratio of 2 to 1 i.e., 1800 kg/h in the first and 900 kg/h in the second heat exchanger. Water enters the first heat exchanger at 30°C. Find the final water and oil exit temperatures. Overall heat transfer coefficient in each heat exchanger is 300 W/m².K. [5]

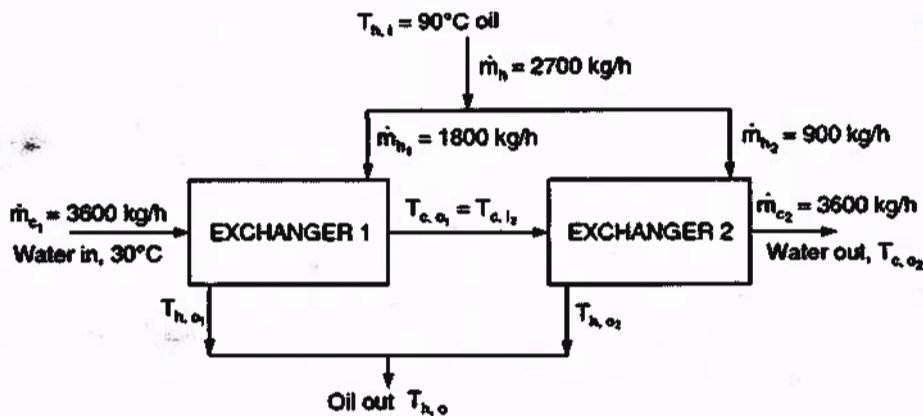


Figure 5

9. Two rectangular plates are at right angle in the following shown geometries. Calculate the view factor F_{1-2} for the given configurations. [4]

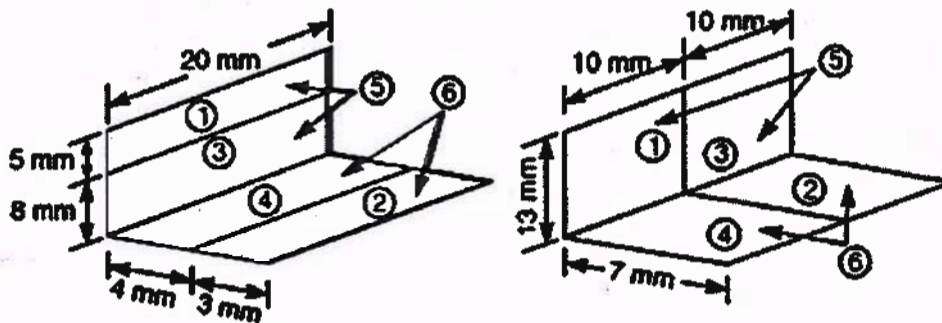


Figure 6

10. Two large parallel planes with emissivity 0.8 are exchanging heat by radiation. One plane has a temperature of 1000 K while the other is at 400 K. It is proposed to interpose a radiation shield with an emissivity value 0.05 on one side and 0.6 on the other side. The design conditions stipulate that the lower emissivity side should face the hotter plane. How would the shield temperature be affected if during installation, a mistake occurs, and the higher emissivity side is placed facing the hot side. [4]
11. Elucidate the significance of typical nodal points in a standard boiling curve. [3]

