EVENING

0 4 JAN 2023

Please check that this question paper contains 09 questions and 02 printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. .....

Program: B. Tech. (Batch 2018 onward)
Semester: 5th
Name of Subject: Heat Transfer
Subject Code: PCME-112
Paper ID: 16378
Scientific calculator is allowed.

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1. Parts A and B are compulsory
2. Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice
3. Any missing data may be assumed appropriately

Part – A **[Marks: 02 each]**

1.

a. Explain thermal conductivity and explain its significance in heat transfer.
b. What do you mean by critical thickness of insulation on cylinders?
c. Give the shape factor for a plane wall. What are the units of shape factor?
d. Define the term fin effectiveness.
e. Experimental results for local heat transfer coefficient h_x for flow over a flat plate with an extremely rough surface were found to be $h_x = ax^{-0.1}$, where a is a constant and x is distance from the leading edge of the plate. Develop an expression for ratio of average heat transfer coefficient h for a plate of length x to local heat transfer coefficient h_x at x.
f. Explain various boiling modes.

Part – B **[Marks: 04 each]**

2. The composite wall of an oven consists of three materials, two of them are of known thermal conductivity, k_A =20W/m.K and k_C = 50W/m.K and known thickness L_a =0.3 m and L_c = 0.15 m. The third material B which is sandwiched between materials A and C is of known thickness L_b = 0.15 m, but of unknown thermal conductivity k_B.
Under steady state operating conditions, the measurement reveals an outer surface temperature of material C is 20^0C and inner surface of A is 600^0C and over air temperature is 800^0C. The inside convection coefficient is 25W/m^2.K. What is the value of k_B?
3. Discuss modes of condensation. Why is drop wise condensation preferred?

4. Two pin fins are identical expect that the diameter of one is twice that of other. For which fin will have a) fin effectiveness and b) fin efficiency higher and why?
5. A steam power pipe is insulated to reduce the heat losses. However, the measurement reveal that rate of heat loss has increased instead of decreasing. Comment on the statement.
6. Calculate the approximate Reynolds number and state if flow is laminar or turbulent for a 10 m long yatch sailing at 13km/h in the sea water, ρ = 1000kg/m^3 and μ= 1.3x10^{-3} kg/m.s.
7. The average solar radiation flux on the earth's atmosphere is 1353W/m^2 and is known as solar constant. Calculate the temperature of sun (a blackbody), 1.392x10^6 km in diameter, when it has mean distance of 1.496x10^8 km from the earth's atmosphere.

Part – C **[Marks: 12 each]**

8. Determine the overall heat transfer coefficient for a plane slab of three layers in series and convection heat transfer coefficient on both boundary surfaces.

OR

Use dimensional analysis for forced convection to have a correlation between Nusselt number, Reynolds number and Prandtl number.

9. Consider a cylindrical furnace, whose radius is 1 m and equal to its height. The base and top surface of the furnace have emissivities 0.4 and 0.8 respectively, and are maintained at uniform temperatures of 700K and 500K. The curved cylindrical surface approximates a blackbody and is maintained at a temperature of 400K. Calculate the net rate of radiation heat transfer at each surface during steady conditions. Take view factor F_{1-2} = 0.38.

OR

The two insulation materials are purchased in powder form as A and B with thermal conductivities 0.005 and 0.035 W/m.K, respectively. These materials were to apply over a 40 cm diameter sphere as inner layer 4 cm thick and outer layer 5 cm thick, respectively. But, due to lapse of attention, the material B was applied as first layer and subsequently material A as outer layer. Estimate its effect on conduction heat transfer.

****