Please check that this question paper contains___9_ questions and _2___ 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

EVENING

19 JUN 2023

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]**

Q1.

a). State Fourier's law of heat conduction? Why the negative sign is used.
b). Differentiate between natural and forced convection.
c). How the fin thickness influences the efficiency of a fin.
d). Define the critical thickness of insulation.
e). What are the advantages of the NTU method over the LMTD method?
f). What is a grey body?

Part – B **[Marks: 04 each]**

Q2. Derive the general heat conduction equation in cylindrical coordinates.

Q3. The inner surface of a plane brick wall is at 60°C and the outer surface is at 35°C. Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 220 mm thick. The thermal conductivity of the brick is 0.51 W/m°C.

Q4. A 10 mm cable is to be laid in atmosphere of 20°C with outside heat transfer coefficient 8.5 $W/m^{2o}C$. The surface temperature of cable is likely to be 65°C due to heat generation within. Will the rubber insulation, k = 0.155W/m °C, be effective? If yes how much?

Q5. A very long 25 mm diameter copper rod (k = 380 W/m°C) extends horizontally from a plane heated wall at 120° C. The temperature of the surrounding air is 25°C and the convective heat transfer coefficient is 9.0 $W/m^{2o}C$.

i.) Determine the heat loss;
ii.) How long the rod be in order to be considered infinite?

Q6. Derive the expression for LMTD of counter flow heat exchanger.

Q7. Explain the different theories of nucleation.

Part – C **[Marks: 12 each]**

Q8. A chemical having specific heat of 3.3 kJ/kg K flowing at the rate of 20000 kg/h enters a parallel flow heat exchanger at 120°C. The flow rate of cooling water is 50000 kg/h with an inlet temperature of 20°C. The heat transfer area is 10 m^2 and the overall heat transfer coefficient is 1050 W/m^2 K. Find: i). The effectiveness of the heat exchanger, ii). The outlet temperature of water and chemical. Take for water, specific heat = 4.186 kJ/kg K.

OR

A plate of length750 mm and width 250 mm has been placed longitudinally in a stream of crude oil which flows with a velocity of 5 m/s. If the oil has a specific gravity of 0.8 and kinematic viscosity of 1 stoke, calculate:

i). Boundary layer thickness at the middle of plate

ii). Shear stress at the middle of plate

iii). Friction drag on one side of the plate.

Q9. A 70 mm thick metal plate with a circular hole of 35 mm diameter along the thickness is maintained at a uniform temperature 250°C. Find the loss of energy to the surroundings at 27°C, assuming the two ends of the hole to be as parallel discs and the metallic surfaces and surroundings have black body characteristics.

OR

Explain the mechanism of filmwise and dropwise condensation.

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