

11/11/2015

QP Code : 3267

(3 Hours)

[Total Marks : 80

Question no.1 is compulsory.

Attempt any THREE from question no. 2 to 6.

Use illustrative diagrams where ever possible.

Q1) Solve any Four

- What is meant by film condensation and dropwise condensation?
- What is Fin? What are the various types of fins?
- Explain the number of transfer units (NTU).
- Define Thermal Diffusivity and state its significance.
- Define: Radiosity and Irradiation.

20

Q2) a) Derive the relation for heat transfer through fin with insulated tip. State the assumptions clearly. 10

b) Explain the term 'Time Constant' of a thermocouple. 03

c) A copper wire of radius 0.5 mm is insulated uniformly with plastic ($k = 0.5 \text{ W/m K}$) sheathing 1 mm thick. The wire is exposed to atmosphere at 30°C and the outside surface coefficient is $8 \text{ W/m}^2 \text{ K}$. Find the maximum safe current carried by the wire so that no part of the insulated plastic is above 75°C . Also calculate critical thickness of insulation. For copper: thermal conductivity = 400 W/m K , specific electrical resistance = $2 \times 10^{-8} \text{ ohm-m}$. 07

Q3) a) Using dimensional analysis, derive an expression for forced convection:- 08

$$Nu = \text{Constant} \times (Re)^m \times (Pr)^n$$

b) Air at atmospheric pressure and 20°C flows with 6 m/s velocity through main trunk duct of air conditioning system. The duct is rectangular in cross-section and measures 40 cm X 80 cm. Determine heat loss per meter length of duct corresponding to unit temperature difference. 08

The relevant thermo-physical properties of air are: $\nu = 15 \times 10^{-6} \text{ m}^2/\text{hr}$, $\alpha = 7.7 \times 10^{-2} \text{ m}^2/\text{hr}$, $k = 0.026 \text{ W/m-deg.}^\circ\text{C}$.

$$\text{Use } Nu = 0.023 (Re)^{0.8} \times (Pr)^{0.4}$$

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c) What is meant by Fouling in Heat Exchangers 04

Q4) a) Distinguish between specular and diffuse radiation. 04

b) Prove that the total emissive power of black surface is π time the intensity of radiation. 06

c) 16.5 kg/s of the product at 650°C ($c_p = 3.55 \text{ kJ/kg K}$), in a chemical plant, are to be used to heat 20.5 kg/s of the incoming fluid from 100°C ($c_p = 4.2 \text{ kJ/kg K}$). If the overall heat transfer coefficient is $0.95 \text{ kW/m}^2\text{K}$ and the installed heat transfer surface is 44 m^2 , calculate the fluid outlet temperature for the counter flow and parallel flow arrangements. 10

Q5) a) Derive the relationship between the effectiveness and the number of transfer units for a parallel flow heat exchanger. 10

b) A thermocouple indicates a temperature of 800°C when placed in a pipeline where a hot gas is flowing at 870°C . If the convective heat transfer coefficient between the thermocouple and gas is $60 \text{ W/m}^2\text{K}$, find the duct wall temperature. $f(\text{thermocouple}) = 0.5$ 05

c) A thin copper sphere with its 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? 05

Q6) a) Write a short note (any Two) 08

- 1) Heisler chart
- 2) Importance of numerical methods
- 3) Heat Pipe

b) Draw the boiling curve and identify the different boiling regimes 05

c) A 15 mm diameter mild steel sphere ($k = 42 \text{ W/m}^{\circ}\text{C}$) is exposed to cooling airflow at 20°C resulting in the convective coefficient $h = 120 \text{ W/m}^2\text{C}$. 07

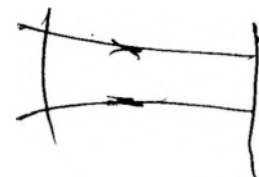
Determine the following

(i) Time required to cool the sphere from 550°C to 90°C .

(ii) Instantaneous heat transfer rate 2 minutes after the start of cooling.

For mild steel take: $\rho = 7850 \text{ kg/m}^3$, $c = 475 \text{ J/kg}^{\circ}\text{C}$, $\alpha = 0.045 \text{ m}^2/\text{h}$

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