TE-Sem V - CBSGS - Mech 04/06/15

Heat Transfer

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** 20

a) What is meant by film condensation and dropwise condensation?

b) What is Fin? What are the various types of fins?

c) Explain the number of transfer units (NTU).

d) Define Thermal Diffusivity and state its significance.

e) Define: Radiosity and Irradiation.

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 W/m K) sheathing 1 mm thick. The wire is exposed to atmosphere at 30^0C and the outside surface coefficient is 8 W/m^2 K. Find the maximum safe current carried by the wire so that no part of the insulated plastic is above 75^0C. Also calculate critical thickness of insulation. For copper: thermal conductivity = 400 W/m K, specific electrical resistance = 2×10^{-8} ohm-m. 07

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

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

b) Air at atmospheric pressure and 20^0C 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: $\nu = 15 \times 10^{-6}$, $\alpha = 7.7 \times 10^{-2}$ m^2/hr, k = 0.026 W/m-deg.K

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

JP-Con. 11957-15.

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 ($c_p = 3.55$ kJ/kg K), in a chemical plant, are to be used to heat 20.5 kg/s of the incoming fluid from 100°C ($c_p = 4.2$ kJ/kg K). If the overall heat transfer coefficient is 0.95 kW/m^2 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 W/m^{2}K, find the duct wall temperature. ε (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 ($k = 42$ W/m °C) is exposed to cooling airflow at 20°C resulting in the convective coefficient $h = 120$ W/m^2 °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: $\rho = 7850$ kg/m^3, $c = 475$ J/kg °C, $\alpha = 0.045$ m^2/h

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