Total No. of Questions :10] [Total No. of Printed Pages : 5

Roll No ....

ME - 605

B.E. VI Semester

Examination, December 2012

Heat and Mass Transfer

Time : Three Hours

Maximum Marks : 100 ***Minimum Pass Marks :35***

Note: *Attempt One question from each unit*
All questions carry equal marks.

Unit - I

I. (a) Explain the reasons for poor thermal conductivity of a Non-metallic solid compared to a nonmetallic solid. 4

(b) State and write mathematical equations of different types of time independent boundary conditions used to solve the differential equation of conduction. 6

(c) Explain physical significance of critical radius of insulation.

An electrical cable is to be covered with rubber insulation (k=0.065 w/m-^{0}C). Assume surface temperature of cable to be 90^{0}C. Obtain heat loss to surrounding (h=7.5 w.m^2-^{0}C) at 25^{0}C from (i) bare wire, and (b) wire insulated upto critical radius. 10

OR

II. (a) Deduce expression of temperature distribution in an infinite slab whose thermal conductivity varies according to equation $k = k_0 (1+AT)$, where A is a constant and T is temperature. Plot the variation of k for positive and negative values of A. 10

(b) A 50 mm OD steel pipe is lagged with a 6mm thick layer of asbestos insulation (k=0.17 w/m-K) followed by a 25 mm thick layer of fiber glass insulation (k=0.05 w/m-K). The pipe wall temperature is 390 K and outer surface temperature is 310K. Calculate interface temperature. Discuss the effect of interchanging position of two insulations on the heat transfer rate. 10

Unit - II

III. (a) Define and differentiate between fin efficiency and fin effectiveness. 5

(b) Define thermometric error in temperature measurement. What parameters affect it? 5

(c) Temperature of a fluid flowing through a 100 mm dia duct is measured by a thermocouple installed in a thermometer well made from 6 mm ID and 8 mm OD copper tube. Temperature of duct wall is found to be 60^0C, while the thermocouple reads 90^0C. Estimate the true temperature of flowing fluid, if the allowable thermometric error is 2%. Also find out length of thermometer well. 10

OR

IV. (a) What is Biot number? Discuss its importance in unsteady state heat transfer by conduction. 5

(b) Deduce expression of unsteady state temperature distribution in a solid having large value of K.

Calculate temperature of a steel ball (5 cm dia, k = 40 w/m^2-^{0}C) 30 sec after its exposure to still air at 30^{0}C, when initial temperature of ball is 400^{0}C. Take for ball C_P = 4.2 kJ/kg-^{0}C, ρ = 7,800 kg/m^3 and for its surface h = 20 w/m^2-^{0}C. 15

Unit - III

V. (a) Differentiate between hydrodynamic and thermal boundary layers indicating the conditions for their formation. 5

(b) Differentiate between Nusselt and Biot numbers. 3

(c) Water is heated while flowing through a rectangular duct (20 x 30mm) at a velocity of 1.4 m/s. Water enters at 35^{0}C. The duct walls are maintained at 90^{0}C. Estimate the length of duct required to raise the temperature of water by 35^{0}C. 12

OR

VI. (a) Draw a pool boiling curve and explain different regimes of boiling . 6

(b) Explain the mechanisms of film and dropwise condensation. Which one is desirable and how it can be maintained? 6

(c) What are different ways of mass transfer? Define molar concentration, mass diffusivity and convective mass transfer. 8

Unit - IV

VII. (a) Explain terms: Fouling factor, LMTD, LMTD correction factor, NTU and effectiveness with reference to heat exchangers. 8

(b) Observations recorded during trial on a counterflow double pipe heat exchanger are :

Inner Tube side : Water enters copper tubes of 25 mm ID and 28 mm OD (k=350w/m-K) at 25^0C and leaves at 40^0C. Fouling factor = 0.0004, h=4500w/m^2-K.

Outertube side : Oil enters at 75^0C and leaves at 60^0C. Fouling factor = 0.001, h=1200w/m^2-K.

Draw temperature profiles.

Calculate overall heat transfer coefficient and length of heat exchangers. 12

OR

VIII. (a) In a gas turbine recuperator, the exhaust gases after expansion in the turbine are used to heat the compressed air so that the capacity is very close to unity. Show that under this condition for parallel flow heat exchanger :

$$\in = \frac{1}{2}\left\{1-e^{-2NTU}\right\}$$

in usual notations. 8

(b) For a clean heat exchanger U=1,000 w/m^2-^{0}C. Fouling reduces it by 10%. Calculate fouling factor.

Heated oil enters an exchanger at 150^0C and is cooled by water entering at 32^0C. When two fluids flow in parallel mode the exit temperatures of oil and water are 85^0C and 67^0C respectively. Determine exit temperatures of oil and water, if two fluids flow in counter flow mode. Assume no change U, flow rates and inlet temperatures. 12

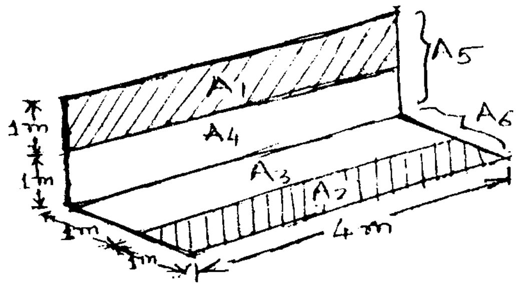
Unit - V

IX. (a) State, explain and draw the planc's law of distribution. 4

(b) What is geometric view factor? State various properties of shape factors. 6

(c) Define Irradiation and Radiocity. 4

(d) Calculate the radiation shape factor for the configuration shown in figure F_{12} 6



OR

X. (a) What is Lambert's cosine law? Explain. 4

(b) What are radiation shields? Discuss about their applications. 4

(c) Ten radiation shields are placed between two large parallel plates maintained at 1000 and 2000K. Emissivity of each shield is 0.8, while that of plate 1 and plate 2 is 0.7 and 0.3 respectively. Find the percentage reduction in heat transfer due to introduction of shields. 12

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