Printed Pages: 6 | 54 | EME-504

(Following Paper ID and Roll No. to be filled in your Answer Book)

Paper ID :140524 Roll No.

B.Tech.

(SEM. V) THEORY EXAM. 2015-16

HEAT & MASS TRANSFER (EME-504)

[Time:3 hours] [MaximumMarks:100]

SECTION-A

Q.1 Attempt all parts. All part carry equal marks. Write answer of each part in short. (2x10=20)

(a) How do thermal conductivities of gases and non-metals vary with temperature?

(b) Derive the expression for logarithmic mean area for the hollow cylinder.

(c) Discuss the physical significance of effectiveness.

(d) What do you understand by lumped system, explain it with suitable example?

(e) Thermal time constant and response of temperature measuring instrument.

(f) Explain one-seventh power law over a flat plate.

(g) Write down the assumptions which are made for the analysis of heat flow through the fin.

(h) Discuss the follwing.

(i) Nusselt number and its physical significance.

(ii) Grashoff's number and its physical significance.

(i) Write short note on fouling or scaling.

(j) A gray diffuse opaque surface (α =0.8) is at 100 ^{0}C and receives an radiation 1000 W/m^2. If the surface area is 0.1 m^2. Calculate:

(i) Radiosity of the surface.

(ii) Net radiation heat transfer rate from the surface.

(iii) Calculate above quantities if the surface is black.

SECTION-B

Note: Attempt any five questions from this section.

(10x5=50)

Q.2. What do you mean by modes of heat transfer? Describe its governing laws in detail. Also describe the case of combined heat transfer by required expression.

Q.3 What is thermometer well, describe it with neat sketch and prove that the temperatue measured by a thermomter well is not a true temperature of fluid.

Q.4 What do you mean by radiation shield? Derive the expression of net heat transfer rate for a system of two parallel plates separated by n-shields of exmissivity's $\in s1, \in s2, \in s3 .... \in sn$.

Q.5 Give the detail classification of heat exchanger. Write down the governing parameters for analysis of heat exchanger. Also explain the compact heat exchanger with neat sketch.

Q.6 Explain the following in details.

(i.) Intensity of radiation.

(ii.) Shape factor algebra, facts and properaties.

Q.7 Steam in the condenser of a power plant is to be condensed at a temperature of 30 ^{0}C with cooling water from a nearby lake, which enters the tubes of the condenser at 14 ^{0}C and leaves at 22 ^{0}C. The surface area of the tubes is 45 m2 an the overall heat transfer coefficient is 2100 W/m2 ^{0}C. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser. Heat of vaporization of water at 30^{0}C 2431 kJ/kg. and C_p=4184 J/kg ^{0}C.

Q.8 Determine the coefficient of heat transfer by free convection and maximum current density for a nichrom wire 0.5 mm in diameter. The surface of th ewire is maintained at 300 ^{0}C. The wire is exposed to still air at 20 ^{0}C and resistance per meter length of the wire is 6' Ω/m Use relation: $Nu=1.18\ (Gr\ Pr)^{1/8}$.

Use properaties of air at 160 ^{0}C-

$K_f = 0.0361$ W/m K, $\upsilon=30.35\times 10^{-6}$ m^2/s, Pr=0.687

Q.9 Consider a diffuse circular disk of 3diameter D and area A_i, and a plane diffuse surafaces of area $A_j << A_i$. The surfaces are parallel and A_j is located at a distance L from the center of A_j

Obtain the following expression for the view factor

$$F_{ij} = \frac{D^2}{D^2 + L^2}$$

SECTION-C

Attempt any two questions from this section. (15x2=30)

Q.10 (a) Derive the general heat conduction equation in Cartesian co-ordinate for homogenesous and isotropic material.

(b) A wall is constructed of servral layers. The first layer consists of bricks (k=0.66 w/m k), 25 cm thick, the second layer is 2.5 cm thick mortar (k=0.7 w/m k), the third layer 10 cm thick limestone (k=0.66 w/m k)and outer layer of 1.25 cm thick plaster (k=0.7 w/mk). The heat transfer co-efficient on interior and exterior of the wall fluid layers are 5.8 w/m^2 k and 11.6 w/m^{2}k, respectively. Find:

(i) Overall heat transfer co-efficient, (ii) Overall thermal resistance per m^2, (iii) Rate of heat transfr per m^2, if the interior of the room at 26 ^{0}C while outer air is at 7 ^{0}C, (iv) Temperature at the junction between mortar and limestone.

Q.11 (a) Write down the name of some common types of fin with neat sketch. Also derive the expression for heat dissipation through rectangular fin which is infinitely long.

(b) A Copper pipe carrying refrigerant at -20 ^{0}C is 10 mm in outer diameter and is exposed to ambient at 25 ^{0}C with convective coefficient of 50 W/m^2.k. It is proposed to apply the insulation of material having thermal conductivity of 0.5 W/ mk. Determine the thickness beyond which the heat gain will be reduced. Calculate the heat losses for 2.5 mm, 7.5 mm, and 15 mm thick layer of insulation over I m length.

Q.12 (a) Describe the boundary layer thickness and derive the expression for energy thickness.

(b) An iron sphere of diameter 5 cm is initially at a unifrom temprature of 225 ^{0}C. It is suddely exposed to an ambient at 25 ^{0}C with convection coefficient of 500 W/m^{2}k.

(i) Calculate the centre temperature 2 minute after the start of exposure.

(ii) Calculate the temperature at the depth of 1 cm from the surface after 2 minute of exposure.

(iii) Calculate the enegry removed from the sphere during this period. Take thermo-physical properties of iron plate:

k=60 W/mK, ρ=7850kg/m^3 ,C=460 J/Kg, α = 1.6x10^{-5} m^2/s

—x—