Total Printed Pages : 4 Roll No. ....

E-237

B. E. 6th Semester (Main & Re-Exam) Examination – May, 2016

HEAT TRANSFER

Branch : Mech. Engg.

Time : Three Hours] *[Maximum Marks : 75*

[Minimum Marks : 30

Note : Attempt *all* the questions of **Section – A**, *four* from **Section – B** and *three* questions from **Section – C.**

SECTION – A

(Objective Type Questions)

Note : This Section will contain *ten* objective type questions. They may be fill in the blanks, True/False or multiple choice type. 1.5 × 10 = 15

1. A composite slab has two layers of different material with thermal conductivity K_1 and K_2. If each layer has same thickness, the equivalent thermal conductivity of the slab would be :

   (a) $K_1 \ K_2$ (b) $K_1 + K_2$

   (c) $\dfrac{K_1 + K_2}{K_1 \ k_2}$ (d) $\dfrac{2K_1 \ K_2}{K_1 + K_2}$

2. Three metal walls of same wall thickness and cross sectional area have thermal conductivities K, 2K, 3K respectively. For the same heat transfer, the temperature drops across the wall will be in the ratio :

   (a) 1 : 2 : 3 (b) 3 : 2 : 1

   (c) 1 : 1 : 1 (d) None of the above

3. Indicate the metal with highest value of thermal conductivity :

   (a) Steel (b) Silver

   (c) Copper (d) Aluminium

P. T. O.

4. The unit of thermal diffusivity is :

(a) $m^2/hr°c$ (b) $K\,Cal/m^2hr$ (c) $m/hr°c$ (d) m^2/hr

5. For steady state, the constant value of thermal conductivity the temperature distribution associated with radial conduction through a cylinder has a :

(a) Linear (b) Logarithmic

(c) Parabolic (d) Exponential variation

6. Critical thickness of insulation for sphere is given by :

(a) K/h (b) $K/4\pi h$ (c) $h/2K$ (d) $2K/h$

7. Which of the following parameter does not appear in the formulation of Stefan-Boltzmann Law ?

(a) Absorptivity (b) Emissivity (c) Radiating area (d) Radiation flux

8. The free convection heat transfer is significantly affected by :

(a) Reynolds number (b) Grashof number

(c) Prandtl number (d) Stanton number

9. The ratio of kinematic viscosity to thermal diffusivity is known as :

(a) Prandtl number (b) Nusselt number

(c) Peclet number (d) Schmidt number

10. During the process of boiling and Condensation only a phase change taken place and one fluid remains at constant temperature and throughout the heat exchanger. In terms of NTU, the effectiveness of such an exchanger would be :

(a) $\frac{NTU}{1+NTU}$ (b) $1-\exp(-NTU)$ (c) $\frac{1-\exp(-2\,NTU)}{2}$ (d) None of these

SECTION – B

(Short Answer Type Questions)

Note : This Section will contain *six* questions. Students will ask to attempt any *four* questions out of *six* questions. $6 \times 4 = 24$

1. What do you mean by fouling factor ? State the cause of fouling.

2. Show that the resistance offered by a hollow sphere of radii r_1, r_2 and constant thermal conductivity K is given by :

$$R_{sph} = \frac{r_2 - r_1}{4\pi\, r_1\, r_2 K}$$

3. Calculate the Nusselt number in a horizontal electronic component with a surface temperature of 35° C, 5 mm wide 10 mm long, dissipating 0.1 W heat by free convection from its one side in to air at 20° C, take for air K = 0.026 W/mK .

4. State the Fourier's Law of heat conduction and by using it derive an expression for steady state heat conduction through a plane wall of thickness L maintains its two surfaces at temperature T_1 and T_2 respectively.

5. In a cylindrical fuel element for a gas cooled nuclear reaction, the heat generation rate within the fuel element can be approximated as

$$g(r) = g_0\left[1 - \left(\frac{r}{R}\right)^2\right] W/m^2$$

Where R is the radius of fuel element and g_0 is a constant.

The outer Surface is maintained at a uniform temperature T_0.

Develop a mathematical formulation assuming one dimensional heat flow.

6. A horizontal pipe 30.5 cm in diameter is maintained at a temperature of 250° C in a room where the ambient air is at 20° C. Calculate the free convection heat loss per metre length of pipe per hour.

Take the following properties at mean temperature

$(250 + 20)/2 = 135°C \quad K = 0.034$ W/mK

$\upsilon = 26.25 \times 10^{-6}$ m^2/s

$Pr = 0.68$

SECTION – C

(Long Answer Type Questions)

Note : This Section will contain *five* questions. Students will ask to attempt any *three* questions out of *five* questions. 12 × 3 = 36

1. A copper pipe carries process steam at 100° C and is 25 mm OD and 22 mm ID through a room which is at 30° C. The cost of heating by steam is SN.P per 4 × 10^3 KJ. Standard

85% magnesia insulation is available having ID of 25 mm and OD of 40 mm and cost Rs. 4 per metre length of pipe. How long must the pipe be in operation to recover the insulation cost ? The resistance of the fluid film is roughly constant and equals 0.05 m-K/W. K (copper) = 330 W/m-K ; K magnesia = 0.06 W/ m.K.

2. A composite wall of furnace is made up with 120 mm thick layer of fire clay bricks, whose thermal conductivity is expressed as :

   $K = 0.25\ (1 + 0.0009\ T)$ W/m° C the second layer, 600 mm thick of red brick (K = 0.78 W/mK). The inside surface of fire clay is at uniform temperature of 1250° C, while exterior surface of red brick is exposed to air at 40° C with heat transfer coefficient of 20 W/m^2 K, calculate :

   (i) Interface temperature

   (ii) Heat transfer rate for 1m^2 of furnace wall.

3. (a) Derive an expression for momentum transfer equation for flow over a flat plate.

   (b) Discuss laminar sub-layer, buffer layer and turbulent layer in a boundary layer.

4. Derive an expression for log mean temperature difference of Parallel flow heat exchanger.

   How this expression can be modified for counter flow heat exchanger.

5. In order to reduce heat loss from a steam pipe, asbestos insulation (K = 0.2 W/m-K) is used. The outer diameter of the pipe is 5 cm and the thickness of insulation is 20 cm. The pipe passes through a room having still air but with an electric fan. With the help of approximate assumption and some simple order of magnitude calculations, explain switching on or off of the fan make a significant difference in the heat loss from the pipe.

123

Theory

(Printed Pages 4) Roll No. 14800810941

E-448

B.E. VIth Semester Examination, May 2017

Heat Transfer

MECHANICAL ENGINEERING

Time : Three Hours] *[Max. Marks : 75*

[Min. Marks : 30

Note : Attempt **all** questions of **Section-A**, Four questions from **Section-B** and **three** questions from **Section-C.**

Section - A 1.5×10=15

(Objective Answer Type Questions)

1. The Fourier's law of heat transfer by conduction is expressed as

   (a) $Q = kA^2 \frac{dt}{dx}$ (b) $Q = kA \frac{dt}{dx}$

   (c) $Q = k^2A \frac{dt}{dx}$ (d) $Q = kA^3 \frac{dt}{dx}$

2. The heat transfer is constant when

   (a) temperature remains constant with time

   (b) temperature decreases with time

   (C) temperature increases with time

   (d) any of these.

3. The co-efficient of thermal conductivity is defined as

   (a) Quantity of heat transfer per unit area per one degree drop in temperature

   (b) Quantity of heat transfer per one degree temperature drop per unit area

   (c) Quantity of heat transfer per unit time per unit area

   (d) Quantity of heat transfer per unit time per unit area per one degree temperature drop per unit lenght.

P.T.O.

4. The thermal conductivity is expressed as

(a) W/mK (b) W/m^2K

(c) W/hmk (d) W/h^2W^2K.

5. Heat transfer from higher temperature to low temperature takes place according to

(a) Fourier law

(b) First law of thermodynamics

(c) Second law of thermodynamics

(d) Zeroth law of thermodynamics

6. The quantity of heat radiation is dependent on

(a) area of the body only (b) shape of the body only

(c) temperature of the body only (d) on all (a), (b) and (c).

7. Conduction through flat-composite wall is given by

(a) $Q = \dfrac{t_1 - t_4}{\dfrac{x_1}{k_1A} + \dfrac{x_2}{k_2A} + \dfrac{x_3}{k_3A}}$ (b) $Q = \dfrac{t_1 - t_4}{\dfrac{k_1A}{x_1} + \dfrac{k_2A}{x_2} + \dfrac{k_3A}{x_3}}$

(c) $Q = \dfrac{(t_1 - t_4)A}{\dfrac{k_1}{x_1} + \dfrac{k_2}{x_2} + \dfrac{k_3}{x_3}}$ (d) $Q = \dfrac{\dfrac{k_1A}{x_1} + \dfrac{k_2A}{x_2} + \dfrac{k_3A}{x_3}}{(t_1 - t_4)}$

Where Q=heat transfer, t1, t2, t3 and t4 temperatures on surfaces of composite wall, x1, x2, x3, x4 thicknesses of different composite wall layers.

8. Conduction through hollow, radial one dimensional heat transfer is expressed as

(a) $Q = \dfrac{2\pi L(t_1 - t_2)k}{\log_e r_2/r_1}$ (b) $Q = \dfrac{2\pi L(t_1 - t_2)}{k(r_2 - r_1)}$

(c) $Q = \dfrac{2\pi L \log_e (t_1/t_2)}{(r_2 - r_1)k}$ (d) $Q = \dfrac{2\pi L(t_1 - t_2)k}{\log_e r_2/r_1}$

9. The radial heat transfer rate through hollow cylinder increases as the ratio of outer radius to inner radius.

(a) Decreases (b) Constant

(c) Increases (d) none of the

10. Stefan-Boltzmann law is expressed as

(a) $Q = \sigma AT^4$ (b) $Q = \sigma A^2T^4$

(c) $Q = \sigma AT^4$ (d) $Q = AT^4$

Section-B

6×4=24

(Short Answer Type Questions)

1. What is meant by critical thickness of insulation? Derive a relation for critical thickness of insulation for a cylinder.
2. Define and distinguish between (i) steady state (ii) unsteady state (iii) transient state of heat transfer.
3. Explain the analogy between heat transfer by conduction and flow of electricity through ohmic resistance.
4. What do you understand by the hydroynamic and thermal boundary layers? Illustrate with reference to flow over a flat heated plate.
5. How does a fin enhance heat transfer at a surface? What are various types of fins?
6. What is fouling factor in a heat exchanger? Discuss various types of heat exchangers?

Section-C

12×3=36

(Long Answer Type Questions)

1. Derive one-dimensional general differential heat conduction equation in the rectangular coordinates. Enumerate some of the empirical relations which are used to compute the convective coefficient for free convection.
2. Two long rods of the same diameter, one made of brass (k=85 W/m-deg) and the other of copper (k=375 W/m-deg), have one of their ends inserted into a

P.T.O

P. T. O.

furnace. At a section 10.5 cm away from the furnace, the temperature of the brass rod is 120^0C. At what distance from the furnace end, the sure temperature would be reached in the copper rod. Both rods are exposed to the same environment.

3. A plate of length 750mm 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.

4. Derive a relation for log mean temperature difference of a counter flow heat exchanger. Discuss compact heat exchangers.

5. A counter flow heat exchanger, through which passes 12.5 kg/s of air to be cooled from 540C to 146C, contains 4200 tubes, each having a diameter of 30 mm. The inlet and outlet temperatures of cooling water are 25C and 75C respectively. If the water side resistance to flow is negligible, calculate the tube length required for this duty.

   For turbulent flow inside tubes : $Nu=0.023\ Re^{0.8}\ Pr^{0.4}$

   Properties of the air at the average temperature are as follows:

   $\rho=1.009$ kg/m^3; $c_p=1.008$ KJ/kg^{0}C; $\mu=2.075\times10^{-5}$ kg/ms (Ns/m^2) and $k=3.003\times10^{-2}$ W/m0C.

Total Printed Pages : 4

Roll No. ....

E-726

B. E. VIth Semester (Main & Re-Exam) Examination, May, 2018

HEAT TRANSFER

Branch : ME

Time : Three Hours]

[Maximum Marks : 75

Minimum Marks : 30

Note : Attempt ***all*** questions from ***Section – A*** (Objective type questions), ***four*** questions from ***Section – B*** (Short answer type questions) and ***three*** questions from ***Section – C*** (Long/ Essay type questions).

SECTION – A

[Marks : $1.5 \times 10 = 15$

1. The heat is absorbed by :

(a) Condenser (b) Evaporator

(c) Compressor (d) Thermostat

2. The Stefan Boltzman law states that :

(a) $E \alpha T$ (b) $E \alpha T^2$

(c) $E \alpha T^3$ (d) $E \alpha T^4$

3. The body which absorbs all radiations incident upon it, is called as :

(a) Black body (b) White body

(c) Opaque body (d) Transparent body

4. If the body is at thermal equilibrium, then the :

(a) Emissivity = absorptivity (b) Emissivity IZl absorptivity

(c) Emissivity IZl absorptivity (d) None of the above

P. T. O.

5. In radiative heat transfer, a gray surface is one :

(a) which appears gray to the eye

(b) whose emissivity is independent of wavelength

(c) which has reflectivity equal to zero

(d) which appears equally bright from all directions

6. Heat transfer takes place according to

(a) First Law of Thermodynamics (b) Second Law of Thermodynamics

(c) Third Law of Thermodynamics (d) Zeroth Law of Thermodynamics

7. Heat is mainly transferred by conduction, convection and radiation in

(a) insulated pipes carrying hot water (b) refrigerator freezer coil

(c) boiler furnaces (d) condensation of steam in a condenser

8. The value of Biot number is very small (less than 0.01) when

(a) The convective resistance of the fluid is negligible

(b) The conductive resistance of the solid is negligible

(c) The conductive resistance of the fluid is negligible

(d) None of these

9. The ratio of energy transferred by convection to that by conduction is called :

(a) Stanton number (b) Nusselt number

(c) Biot number (d) Preclet number

10. What happens when the thickness of insulation on a pipe exceeds the critical value ?

(a) Heat transfer rate increases

(b) Heat transfer rate decreases

(c) Heat transfer rate remain constant

(d) none of these

SECTION – B

[Marks : 6 × 4 = 24

Note: This Section Will contains *six* questions. Students will ask to attempt any *four* questions out of six questions.

1. What is Fourier's Law of heat conduction ?

2. What is a Fin ? Define efficiency and effectiveness of the fin.

3. What is Convective heat transfer ? Differentiate between Natural & Forced convection.

4. Sketch, temperature and velocity profiles in free convection on a vertical wall.

5. What is LMTD ? What are the assumptions made during LMTD analysis ?

6. What are the factors are involved in designing a heat exchangers ?

SECTION – C

[Marks : 12 × 3 = 36

Note: This Section Will contains *five* questions. Students will ask to attempt any *three* questions out of five questions.

1. A long rod is exposed to air at 298°C. It is heated at one end. At steady state conditions, the temperature at two points along the rod separated by 120 mm are found to be 130°C and 110°C respectively. The diameter of the rod is 25 mm OD and its thermal conductivity is 116 W/m°C. Calculate the heat transfer coefficient at the surface of the rod and also the heat transfer rate.

2. (i) Explain the different modes of heat transfer with appropriate expressions.

   (ii) A composite wall consists of 10 cm thick layer of building brick, k = 0.7 W/mK and 3 cm thick plaster, k = 0.5 W/mK. An insulating material of k = 0.08 W/mK is to be added to reduce the heat transfer through the wall by 40%. Find its thickness.

3. Explain for fluid flow along a flat plate :

   (a) Velocity distribution in hydrodynamic boundary layer

P. T. O.

(b) Temperature distribution in thermal boundary layer

(c) Variation of local heat transfer co-efficient along the flow.

4. A tube of 2 m length and 25 mm outer diameter is to be used to condense saturated steam at 100°C while the tube surface is maintained at 92°C. Estimate the average heat transfer coefficient and the rate of condensation of steam if the tube is kept horizontal. The steam condenses on the outside of the tube.

5. (i) Give the classification of heat exchangers.

   (ii) It is desired to use a double pipe counter flow heat exchanger to cool 3 kg/s of oil (Cp = 2.1 kJ/kgK) from 120°C. Cooling water at 20°C enters the heat exchanger at a rate of 10 kg/s. The overall heat transfer coefficient of the heat exchanger is 600 W/m2K and the heat transfer area is 6 m^2. Calculate the exit temperatures of oil and water.