B.Tech Sem – V (2007 Course) (Mechanical Engg.) : WINTER - 2018

SUBJECT: HEAT TRANSFER

Day: Tuesday
Date: 27/11/2018

W-2018-2819

Time: 02.30 PM TO 05.30 PM
Max. Marks: 80

N.B.:

1) **Q. 1** and **Q. 5** are **COMPULSORY** and attempt **ANY TWO** questions from the remaining questions in both the sections.
2) Answer to both sections should be written in **SEPARATE** answer books.
3) Figures to the right indicate **FULL** marks.
4) Assume suitable data wherever **necessary**.
5) Use non –programmable **CALCULATOR** is allowed.

SECTION-I

Q.1 **a)** What is Newton's Law of Cooling? **(04)**

b) For a particular material if thermal conductivity varies according to the relation $k = k_0(1+\beta T)$, at different values of β, show variation in temperature profile when heat flows through a plane slab. **(05)**

c) What is efficiency and effectiveness of fins? **(05)**

Q.2 **a)** Calculate the rate of heat flow per m^2 through a furnace wall consisting of 200 mm thick inner layer of chrome brick, a center layer of kaolin brick 100 mm thick and an outer layer of masonry brick 100 mm thick. The unit surface conductance at the inner surface is 74 $W/m^2°C$ and the outer surface temperature is 70 °C. The temperature of the gases inside the furnace is 1670 °C. What temperatures prevail at the inner and outer surfaces of the center layer? **(08)**
Take k_{CB} = 1.25 W/m°C, k_{KB} = 0.074 W/m°C, k_{MB} = 0.555 W/m°C

b) What is thermal diffusivity? State its significance. **(05)**

Q.3 **a)** A plane wall is 1 m thick and it has one surface (x = 0) insulated while the other surface (x = L) is maintained at a constant temperature of 350 °C. The thermal conductivity of wall is 25 W/m°C and a uniform heat generation per unit volume of 500 W/m^3 exists throughout the wall. Determine the maximum temperature in the wall and location of the plane where it occurs. **(08)**

b) Explain the concept of critical thickness of insulation. **(05)**

Q.4 **a)** A motor body is 300 mm in diameter (outside) and 200 mm long. Its surface temperature should not exceed 50 °C when dissipating 150 W. Longitudinal fins of 12 mm thickness and 30 mm height are proposed. The convection coefficient is 40 $W/m^2°C$. Determine the number of fins required. Atmospheric temperature is 35 °C. **(08)**

b) Stat physical significance of Biot number and Fourier number. **(05)**

P.T.O.

SECTION - II

Q.5 **a)** What is Prandtl number? How it is related with hydrodynamic and thermal boundary layers? **(05)**

b) Define the terms absorptivity, reflectivity and transmissivity. **(05)**

c) What is difference between film and drop-wise condensation? **(04)**

Q.6 3.8 kg of oil per second is heated from 20 °C to 40 °C by passing through a circular annulus with a velocity of 0.3 m/s. The hot gases at 400 °C are passed through the inside tube of 100 mm diameter and are cooled to 100 °C. Find the length of the pipe required for the above heat transfer process assuming the gases are flowing in opposite direction to the oil? **(13)**
Take following properties of oil and gases at mean temperature:

Property	Oil	Gases
Density (kg/m^3)	800.00	0.8
Kinematic viscosity (m^2/s)	8×10^{-6}	32.8×10^{-6}
Specific heat at constant pressure (Cp) (J/kgK)	3350	1050
Thermal conductivity (W/m°C)	0.2	0.035

Use the correlation: $Nu = 0.023\ Re^{0.8} Pr^{0.4}$

Q.7 **a)** State and explain Plank's law. **(08)**

b) A filament of a 75 W light bulb may be considered as a black body radiating into a black enclosure at 70 °C. The filament diameter is 0.10 mm and length is 5 cm. Considering the radiation, determine the filament temperature. **(05)**

Q.8 **a)** Differentiate between pool boiling and forced convection boiling. **(05)**

b) A rectangular tube, 30 mm × 50 mm, carries water at a rate of 2 kg/s. Determine the length required to heat water from 30 °C to 50 °C. if the wall temperature is maintained at 90 °C. **(08)**
Use following properties of water at 40°C:
ρ = 992.2 kg/s, k = 0.634 W/m°C, Cp = 4.174 kJ/kg°C, $\mu = 6.551 \times 10^{-4}$ Ns/m^2

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