D 30986 (Pages : 2) Name.....................

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FIFTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION OCTOBER 2012

ME 09 501—HEAT AND MASS TRANSFER

Time : Three Hours Maximum : 70 Marks

Answer **all** *the questions.*

I. (a) Define thermal diffusivity.

(b) What is shape factor ?

(c) Define Reynolds number.

(d) What is the Stefan-Boltzmann law ?

(e) Define Fick's first and second law of diffusion. ($5 \times 2 = 10$ marks)

Answer any **four** *questions.*

II. (a) Discuss the different modes by which heat be transferred. Give suitable example.

(b) Derive an expression for heat transfer rate through a composite cylinder with 2 layers.

(c) Air at 20°C flows over a flat plate at 60°C at a velocity of 60 m/s. Determine the value of average convective heat transfer co-efficient up to a Reynolds number of 10^7. Considering the laminar region.

(d) Explain about radiation shields in detail.

(e) How much water can be heated per hour in a double tube heat exchanger with counter flow if superheated steam enters the inner tube at 250°C and leaves at 190°C with water entering the outer tube at 25°C and leaving at 140°C. The heat exchanger area is 0.2 sq.m. and the overall heat transfer coefficient from steam to water is 730 W/m^{2}K.

(f) Derive an expression for the Logarithmic Mean Temperature Difference for the flow in a counter flow heat exchanger.

($4 \times 5 = 20$ marks)

Answer **all** *questions.*

III. (a) Derive the Fourier rate equation for heat transfer by conduction. Give the units and physical significance of each term appearing in this equation.

Or

(b) Determine the heat transfer rate through a spherical copper shell of thermal conductivity 386 W/mK, inner radius 2 mm and outer radius 60 mm. The inner surface and outer surface temperatures are 200°C and 100°C respectively.

IV. (a) A wall consists of three layers of 0.2 m concrete, 0.08 m of fibre glass insulation and 0.015 m gypsum board (0.04 W/mK). The convective heat transfer coefficients at inside and outside surface are 15 and 45 W/m^{2}K respectively. The inside and outside surface temperatures are 25°C and –10°C respectively. Calculate the overall heat transfer coefficients for the wall and heat loss per unit area.

Or

(b) Explain the general equation for the rate of heat transfer by convection. List the various factors on which the value of this coefficient depends.

Turn over

V. (a) Two rectangles 0.8 × 0.8 m are placed perpendicularly with a common edge. One surface has $T_1 = 1000$ K $\varepsilon_1 = 0.6$, while the other surface is insulated and in radiant balance with a large surrounding room at 300 K. Determine the temperature of the insulated surface and the heat lost by the surface at 1000 K.

Or

(b) (i) Explain the following :

(1) Absorptivity.

(2) Reflectivity.

(3) Transmissivity.

(ii) Differentiate between specular and diffuse reflections.

(iii) Derive Stefan-Boltzmann's law from Planck's law.

VI. (a) Two identical counter flow type heat exchangers are available. Water (C_p = 4.2 KJ/kg-K) at the rate of 1 kg/sec and at 30°C is heated by cooling an oil (C_p = 2.1 kJ/kg-K at 90°C. The oil flow rate is 0.75 kg/sec. The heat transfer area in each heat exchanger is $4m^2$. The heat exchangers are connected in series on water side and in parallel on the oil side. The oil flow rate is split in the ratio 2 : 1 as 0.5 kg/sec in the first and 0.25 kg/sec in the second exchanger. Water enters the first heat exchangers at 30°C. Calculate the final water and oil temperature. Overall heat transfer coefficient in each heat exchanger is 300 W/m^2K.

Or

(b) The molecular weight of the two components A and B of a gas mixture are 24 and 28. The molecular weight of gas mixture is 30. The mass concentration of the mixture is 1.2 kg m^3. Find :

(i) Molar fractions ;

(ii) Mass fractions ; and

(iii) Total pressure if the temperature of mixture is 2900 K.

(4 × 10 = 40 marks)