

D 30986

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Name.....

Reg. No.....

**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 × 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  $730 \text{ W/m}^2\text{K}$ .  
(f) Derive an expression for the Logarithmic Mean Temperature Difference for the flow in a counter flow heat exchanger.

(4 × 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  $386 \text{ W/mK}$ , 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 ( $0.04 \text{ W/mK}$ ). The convective heat transfer coefficients at inside and outside surface are 15 and  $45 \text{ W/m}^2\text{K}$  respectively. The inside and outside surface temperatures are 25°C and  $-10^\circ\text{C}$  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  $0.8 \times 0.8$  m are placed perpendicularly with a common edge. One surface has  $T_1 = 1000$  K  $\epsilon_1 = 0.6$ , 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  $30^\circ\text{C}$  is heated by cooling an oil ( $C_p = 2.1$  kJ/kg-K at  $90^\circ\text{C}$ ). The oil flow rate is 0.75 kg/sec. The heat transfer area in each heat exchanger is  $4\text{m}^2$ . 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  $30^\circ\text{C}$ . Calculate the final water and oil temperature. Overall heat transfer coefficient in each heat exchanger is  $300\text{ W/m}^2\text{K}$ .

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  $1.2\text{ kg m}^3$ . Find :
- (i) Molar fractions ;
  - (ii) Mass fractions ; and
  - (iii) Total pressure if the temperature of mixture is 2900 K.

(4 × 10 = 40 marks)