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Name.....

Reg. No.....

FIFTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, NOVEMBER 2013

ME 09 501—HEAT AND MASS TRANSFER

Time : Three Hours Maximum : 70 Marks

I. Answer *all* the questions :

1 Define fin effectiveness. When is the use of fins not justified ?

2 What do you mean by a radiation shield ? Where is it used ?

3 What is film temperature and its significance ?

4 What do you mean by fouling factor ? What are the causes of fouling ?

5 Define Fourier number and Biot number of mass transfer.

(5 × 2 =10 marks)

II. Answer any *four* questions :

II. (a) Derive an expression for three dimensional heat conduction equations in cylindrical coordinates.

(b) State and prove Kirchhoff of law of radiation.

(c) Derive an expression for turbulent boundary layer thickness over a flat plate.

(d) State the assumptions made in deriving Nusselt's equation for film condensation.

(e) Discuss briefly the effect of turbulence on boundary layers.

(f) Explain briefly three modes of mass transfer.

(4 × 5 = 20 marks)

III. (a) Fins, twelve in number, having k = 75 W/mK. and 0.75 mm thickness protrude 25 mm from a cylindrical surface of 50 mm diameter and 1 m length placed in an atmosphere of 40°C. If the cylindrical surface is maintained at 150° C and the heat transfer coefficient in 23 W/m^2K, calculate :

(a) the rate of heat transfer ;

(b) the percentage increase in heat transfer due to fins ;

(c) the temperature at the center of fins ; and

(d) the fin efficiency and the fin effectiveness.

Or

(b) A truncated cone has top and bottom diameters of 50 cm and 50 cm respectively and a height of 50 cm Calculate the shape factor between the top surface and side (conical surface) and also the shape factor between the side and itself. The fraction of radiation leaving the top surface which is intercepted by the bottom surface is 0.12.

Turn over

IV. (a) A plate of length 750 mm and width 250 mm has been placed longitudinally in a stream of crude oil which flows with a velocity of 5m/s. If the oil has a specific gravity of 0.8 and kinematic viscosity of 1 stoke, calculate (a) boundary layer thickness at the middle of plate ; (b) shear stress at the middle of plate ; and (c) friction drag on one side of the plate.

Or

(b) Explain the Prandtl mixing length concept to describe turbulent flow over a surface.

V. (a) (i) A metal clad heating element of 5 mm diameter and emissivity 0.9 is horizontally immersed in a water bath. The surface temperature of the metal is 260°C under steady state boiling conditions. Estimate the power distribution per unit length of heater.

(ii) State the assumptions made in deriving Nusselt's equation for film condensation.

Or

(b) (i) Derive an expression for logarithmic mean temperature difference of the counter flow heat exchanger.

(ii) Write the procedure for designing of compact heat exchanger.

VI. (a) Air at one atmosphere and at 25° C, containing small quantities of iodine, flows with a velocity of 6.2 m/s inside a 35 mm diameter tube. Calculate mass transfer coefficient for iodine. The thermo physical properties of air are : $\upsilon = 15.5 \times 10^{-6}$ m^2 / s ; D = 0.82×10^{-5} m^2/s.

Or

(b) The molecular weights of the two components A and B of a gas mixture are 24 and 28 respectively. The molecular weight of a gas mixture is found to be 30. If the mass concentration of the mixture is 1.3 kg m^3, determine the following :—

(i) Density of component A and B ;

(ii) Molar fractions ;

(iii) Mass fractions ; and

(iv) Total pressure if the temperature of the mixture is 290 K.

(4 × 10 = 40 marks)