Ref No:Ex/Met/ES/B/ChE/T/214/2024(S)

B.E. METALLURGICAL AND MATERIAL ENGG. SECOND YEAR
FIRST SEMESTER SUPPLEMENTARY EXAMINATION 2024

FLUID FLOW AND HEAT TRANSFER

Time:three hours Full marks 100

Answer any five questions
All question carry equal marks.
Assume any data missing

8+(4+4+4)=20

1 (a) For laminar flow when fluid is flowing though smooth pipe show that $f = 16/R_e$

(b) The velocity profile for laminar flow in a circular tube is given by $u = U[1-(r/R)^2]$ where U= constant; r = radial distance from centerline of the tube and R= radius of the tube.

I)What is average velocity?

II)Show that the velocity gradient varies linearly with radius.

III)What is the velocity gradient at the centerline?

8+12=20

2.(a) For hydrostatic equilibrium show that the pressure of static fluid is constant in any cross section parallel to the earth surface but varies from height to height.

(b) A 15cm long cylindrical metal rod slides inside a tube filled with oil. The inner diameter of the tube is 5cm and clearance is 0.05mm. The mass of the bar is 0.5kg when immersed in the oil. What is the viscosity of the oil if the steady state-state velocity of the rod is 0.1m/s.

[Turn over

10+10=20

3.(a) Find the expressions of velocity and discharge of an incompressible fluid when flowing through an annulus taking all usual notations.

(b) For turbulent flow of an incompressible fluid through a circular pipe of radius r, the velocity distribution is given by $u= U_o (1 - r/r_o)^{1/7}$ where u is the velocity at radius r and U_o is the velocity at the pipe axis. Calculate the total kinetic energy in terms of discharge Q, radius r_o, Sp. Wt. γ and gravity g.

10+10=20

4. (a) Derive Bernoulli's equation.

(b) It is planned to install a steel pipeline with an inside diameter of 204 mm to transport 3800m^3 of oil per day. The pipeline is to be 32 km long and delivery end is to be 30m higher than intake. If the frictional pressure drop in the pipeline is estimated to be 5.3 MPa and overall efficiency of the pump-motor set is 65%, Calculate the power requirement of the pump-motor set. The density and viscosity of oil are 897 kg/m^3 and 50mPa.s respectively.

12+8=20

5.(a)An artificial spherical Satellite is launched on the day light side and moves round the earth. The absorptivity of the satellite surface with respect to incident radiation is α (0.2) and emissivity of this surface is ε (0.1). Determine the temperature of the satellite's surface. Take $R= 7.1X10^{10}$cm ; $l =1.5x10^{13}$ cm and $T_s= 5973K$

(a) For thermal equilibrium, show that emissivity equals absorptivity.

12+8=20

6. (a)Hot water at 98°C flows through a 50-mm schedule 40 horizontal steel pipe [K= 54 M/m °C] and is exposed to atmospheric air at 20°C. The water velocity is 0.25 m/s. Calculate the heat transfer co-efficient for this situation. Given ID=0.0525 OD= 0.0603 and properties of water at 98°C

ρ= 960 kg/m^3; $\mu = 2.82x\ 10^{-4}$kg/m.s ; K=0.68 W/m°C; $P_r = 1.76$

(b) Derive an expression for LMTD