Ref No: EX/MET/ES/B/ChE/T/214/2023

BACHELOR OF METALLURGICAL ENGG.EXAMINATION, 2023

(2nd Year, 1st Semester)

FLUID FLOW & HEAT TRANSFER

Time: Three hours Full Marks:100

Answer any five questions.
Assume any data missing

1. **(a)** 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 immerged in the oil. What is the viscosity of the oil, if the steady state velocity of the rod is0.1m/s. **10**

   (b) Explain rate of strain or shear rate or rate of shear deformation of the fluids. **06**

   (c) Differentiate laminar and turbulent flow. **04**

2. Evaluate the expressions of shear stress, discharge and average velocity of fluid when flowing over a flat plate considering all usual notations. **20**

3. **(a)** Derive Hagen- Poiseuille's equation using all usual notations. **12**

   (b) Show that f= 16/Re for laminar flow in smooth pipe. **08**

4. It is planned to install a steel pipeline with inside diameter of 202mm to transport 3800m^3 of oil per day. The pipeline is to be 32km long and delivery end is to be 30m higher than intake. If the fractional pressure drop in pipeline is 5.3Mpa and overall efficiency of the pump motor set is 60%, Calculate the power requirement of the pump motor set using density and viscosity of oil 897kg/m^3 and 50mPa.s **20**

[Turn over

5. When the Reynold's number is less than about 10^5, the velocity profile in turbulent flow through a small pipe is well represented by $\frac{U}{U_0} = 8.7(\frac{U_*.y}{\nu})^{1/7}$. Using this formula (i) show that the friction factor is, f= 0.31/ $(\frac{V.d}{\nu})0.25$ where V is average velocity. Also (ii) show that the shear at the wall may be given by $\tau_0 = 0.0272.u_{max}{}^2 /(\frac{u_{max}{}^2.r_0}{\nu})^{0.25}$

20

6. For turbulent flow of an incompressible fluid through a circular pipe of radius r, the velocity distribution is given by $U = U_0(1-\frac{r}{r_0})^{1/7}$ where U is the velocity at radius r and U_0 is the velocity at the pipe axis. Calculate the total kinetic energy of flow in terms of discharge Q, radius r_0, specific weight γ and gravity g. Compare the kinetic energy with the kinetic energy when the flow in the pipe is completely laminar and the quantity of fluid flowing is constant at Q. **20**

7. (a). Discuss about the mechanism of condensation and boiling het transfer.
(b) Determine the heat transfer area and length required to cool 6.93kg/s of 95% ethyl alcohol solution (Cp=3810 J/kgK) from 67^{0}C to 40^{0}C using 6.30 kg/s water (Cp=4187 J/kg K) at 15^{0}C taking U_0= 568w/m^{2}K. for parallel and counter flow heat exchanger.

(4+4)+12=20

8. Write short notes on any <u>two</u> **10X2 =20**

a) Bernouille's Equation
b) Derive the expression of LMTD.
c) Prandtl's mixing length theory.