KATHMANDU UNIVERSITY
End Semester Examination
February, 2025

Level : B.E.
Year : II
Time : 2 hrs. 30mins.

20 FEB 2025

Course : CHEG 212
Semester : II
F. M. : 40

SECTION "B"

Assume suitable data if missing.

1. Determine the density, specific gravity, and mass of the air in a room whose dimensions are 4 m × 5 m × 6 m at 100 kPa and 25°C. [2]

2. The pressure difference between an oil pipe and water pipe is measured by a double-fluid manometer, as shown in Fig. 1. For the given fluid heights and specific gravities, calculate the pressure difference $\Delta P = P_B - P_A$ [4]

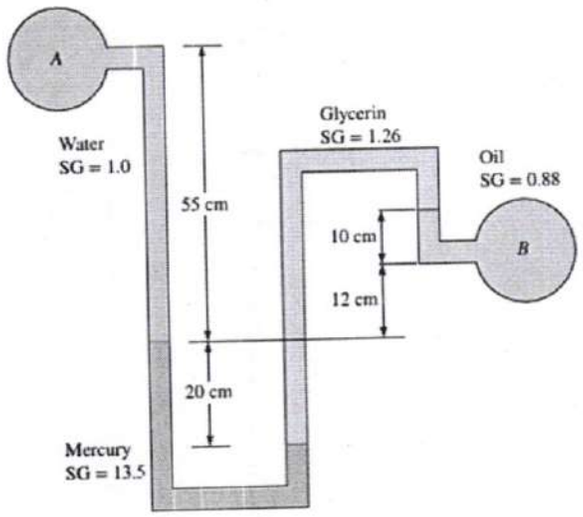

Figure 1

3. Write a general form of the mass balance. A cylindrical tank 3 m in diameter, with axis vertical, has an inflow line of 0.1 m inside diameter and an outflow line of 0.2 m inside diameter. Water is flowing in the inflow line at a velocity of 2 m/s and leaving by the outflow line at a velocity of 1 m/s. Is the level in the tank rising or falling? How fast? [1+4]

4. Derive the governing equation for a boundary layer flow over a flat plate. Find the boundary layer thickness and local and wall-averaged shear stresses associated with the downstream position. Also find total drag force for the flow condition given. The water flows on the two sides of the flat plate of thickness 0.5 mm and length 20 cm with free stream velocity 0.6 cm/s. The kinematic viscosity is 0.00894 cm^2/s. [4+3]

5. Derive a Poiseuille's equation for a flow between two parallel plates. [4]

P.T.O.

6. What is the minimum diameter at section (1) to avoid cavitation at that point? Take D_2 = 15 cm [4]

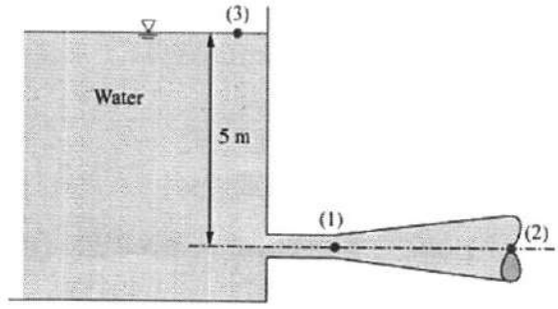

Figure 2

7. The pipe bend in Fig.3 is attached to the rest of the piping system by two flexible hoses, which transmit no forces. Water enters in the +x direction and leaves in the —y direction. The flow rate is 500 kg/s, and the cross-sectional area of the pipe is constant = 0.1 m^2. The pressure throughout the pipe is 200 kPa gauge. Calculate the x and y components of the force in the pipe support. [4]

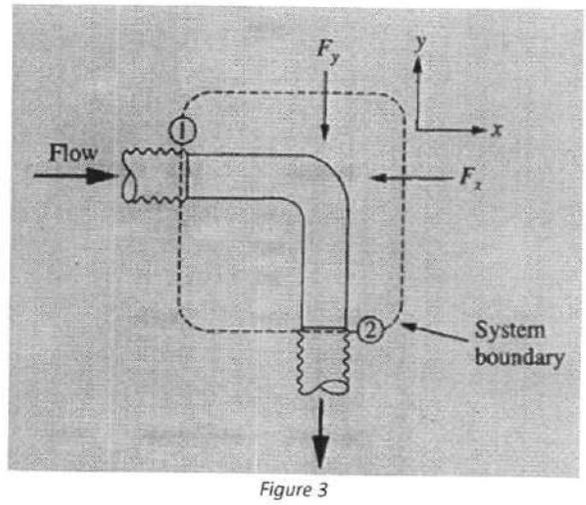

Figure 3

8. A mixing tank with D_i = 3 ft and $D_{impeller}$ = 1ft. has the dimension ratios (H = T). The impeller corresponds to Curve 1 in Fig. and has N = 300 rpm. The fluid has the same properties as water. Estimate the power input to the impeller. (Kinematic viscosity of water = 1.002×10^{-6} ,1 feet = 0.3048 meter) H= height of liquid, D = impeller diameter T= Tank diameter. [2]

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9. Write various types of Non-Newtonian fluids with their definition. A student team is to design a human-powered submarine for a design competition. The overall length of the prototype submarine is 4.85 m, and its student designers hope that it can travel fully submerged through water at 0.440 m/s. The water is freshwater (a lake) at T = 15°C. The design team builds a one-fifth scale model to test in their university's wind tunnel (Fig.). A shield surrounds the drag balance strut so that the aerodynamic drag of the strut itself does not influence the measured drag. The air in the wind tunnel is at 25°C and at one standard atmosphere pressure. At what air speed do they need to run the wind tunnel in order to achieve similarity? [1+2]

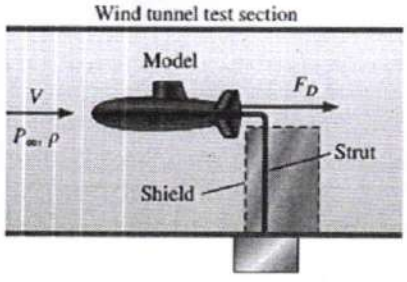

Figure 4

10. Water at 10°C flows from a large reservoir to a smaller one through a 5-cm-diameter cast iron piping system, as shown in Fig.5. Determine the elevation z1 for a flow rate of 6 L/s. The density and dynamic viscosity of water at 10°C are ρ =999.7kg/ m3 and μ=1.307× 10−3 kg/m·s. The roughness of cast iron pipe is ε =0.00026m. [5]

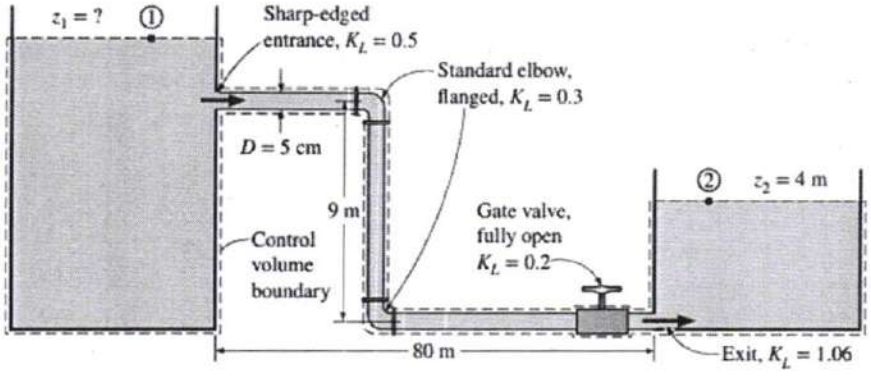

Figure 5

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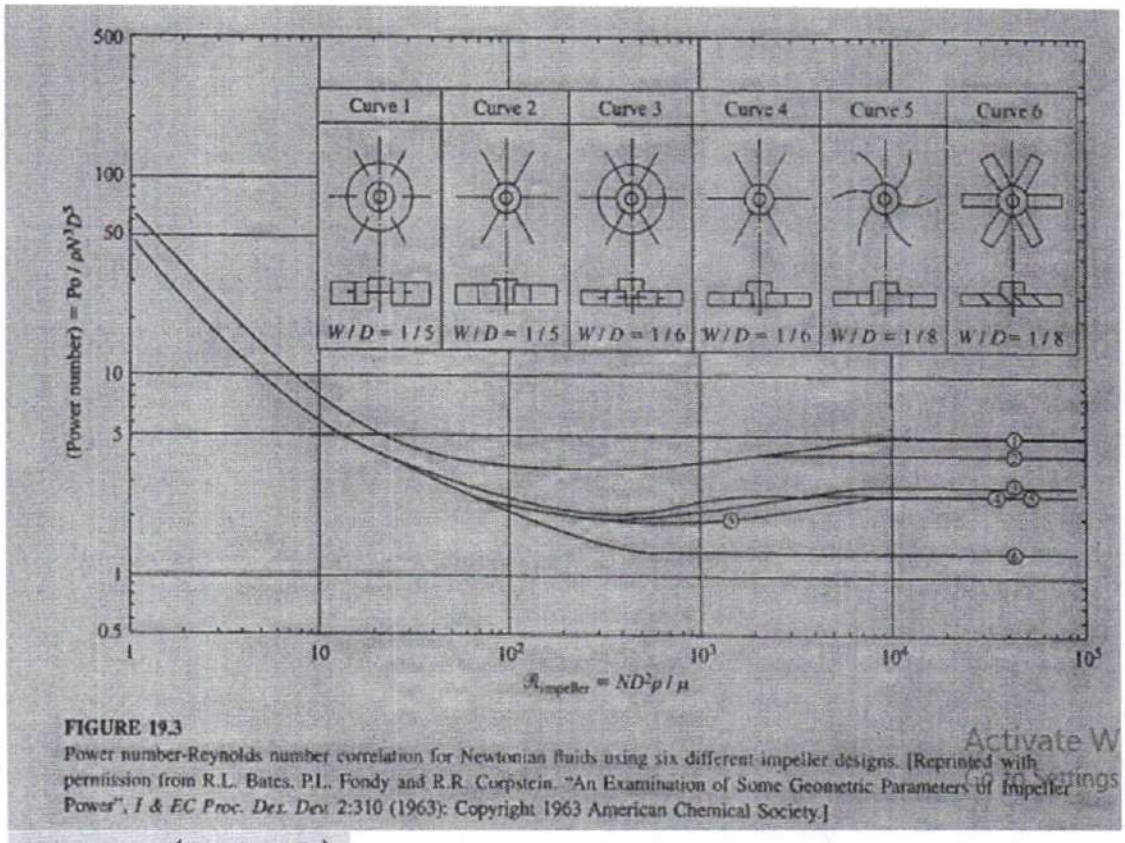

FIGURE 19.3
Power number-Reynolds number correlation for Newtonian fluids using six different impeller designs. [Reprinted with permission from R.L. Bates, P.L. Fondy and R.R. Corpstein, "An Examination of Some Geometric Parameters of Impeller Power", *I & EC Proc. Des. Dev.* 2:310 (1963): Copyright 1963 American Chemical Society.]

$$\frac{1}{\sqrt{f}} = -2.0 \log\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{\mathrm{Re}\sqrt{f}}\right)$$