BANGLADESH UNIVERSITY OF PROFESSIONALS
Military Institute of Science and Technology
B.Sc. in Environmental, Water Resources, and Coastal Engineering, Term Final (Fall) Examination 2024: April 2025
Student Group: 36<Earned Credit Hours ≤ 72
Subject: EWCE 261, Fluid Mechanics

Time: 3.00 hours **Full Marks: 180**

INSTRUCTIONS:

a. Use **SEPARATE** answer scripts for each section.
b. **Question-1**in **Section-A** and **Question-5** in **Section-B** are compulsory.
c. Answer any other **TWO** out of the remaining **THREE** questions from each section.
d. Figures in the margin indicate full **marks**.
e. Assume reasonable data if necessary.
f. **Symbols** and **abbreviations** used have their usual meanings.

SECTION-A

Question 1 (Compulsory)

a. For the complete analysis of the fluid motion, two methods are generally used. Explain those methods. **04**

b. Define – **09**
(i) Steady flow and unsteady flow.
(ii) Laminar flow and turbulent flow.
(iii) Stream line and path line.

c. A two dimensional fluid flow, the velocity vector is given by v = 2yi + xj. Find the velocity and acceleration of fluid particle at point (3.5, 1.2). **06**

d. Explain reasons of using the kinetic energy coefficient and the momentum coefficient in a fluid flow. **04**

e. The diameter of a pipe of section 1 and 2 are 10 cm and 15 cm, respectively. Find the discharge through the pipe, if the velocity of liquid flowing thorough section 1 is 5 m/s. If the relative density of liquid is 0.86, find the mass flow rate and weight flow rate. What will be the velocity through section 2. **07**

Question 2

a. A pipeline with a pump leads to nozzle as shown in figure 1. Find the flow rate, when the pump develops a head of 30 m (at point C). Assume that the head loss in the 15 cm diameter pipe may be expressed by $h_L = \frac{5v_1^2}{2g}$, while the head loss in the 10 cm diameter pipe is $h_L = \frac{12v_1^2}{2g}$. **18**
Also sketch the energy line and hydraulic grade line and find the pressure head at the suction of the pump.

b. The horizontal wye fitting in figure 2 splits Q_L into two equal flow rates. At section 1, Q_1 = 4 ft^3/s and P_1 = 20 psig. Neglect losses. Compute pressure P_2 and P_3. **12**

Question 3

a. Determine the magnitude and direction of the resultant force exerted on the double nozzle. Both nozzle jets have a velocity of 10 m/s. The axes of the pipe and both nozzles lie in a horizontal plane. Assume $\gamma = 9.81\ kN/m^3$. Neglect friction. (Figure 3) **20**

b. A capillary tube of inside diameter 6 mm connects a tank A and open container B (Figure 4). The liquid in A, B and capillary CD is water having specific weight 9.78 kN/m^3 and a viscosity of 0.0008 kg/(m-s). The pressure P_A = 34.5 kPa gage. What is the flow rate used in which direction the water will flow? **10**

Question 4

a. A 50° reducing bend is connected in a pipeline, the diameters at the inlet and outlet of the bend being 700 mm and 350 mm, respectively. Find the force exerted by the water on the bend, if the intensity of pressure at inlet to bend is 10 N/cm^2 and flow rate of water is 700 l/sec. Also find the angle made by the resultant force with the horizontal direction. Assume the system including the reducing bend is in the horizontal plane (Figure 5). **15**

b. A 5 cm diameter water jet with a velocity of 30 m/s impringes on a single vane moving in the same direction at a velocity of 18 m/s (Figure 6). The friction losses over the vane are such that $v_2 = 0.9\, v_1$. Compute the force exerted by the water on the vane. **15**

SECTION-B

Question 5 (Compulsory)

a. Briefly discuss about the followings: **06**
   (i) Viscosity
   (ii) Capillarity
   (iii) Center of pressure
   (iv) Laminar sublayer

b. Using Hardy cross method, find the magnitude and direction of flow in all the pipes of the network as shown in Figure 7, after two sets of corrections. Use n = 2. Start by assuming initial flows as 9 cfs in pipe ab and cd, 6 cfs in pipe ac and bd, 3 cfs in pipe bc. **18**

c. Show that for a constant rate of discharge and a constant value of friction factor, f, frictional head loss in a pipe varies inversely as the fifth power of diameter. **06**

Question 6

a. Briefly explain- **07**
   (i) Effects of temperature on viscosity of fluids.
   (ii) Various types of losses in pipe flow.

b. A double U-tube manometer as shown in Figure 8 is connected between the two horizontal pipelines carrying water and oil (S = 0.9). Neglecting the weight of air, determine – **10**
   (i) Pressure difference between water pipe and oil pipe
   (ii) If the pressure at the oil pipe is 200 kN/m^2, find the pressure at the water pipe.

c. Two reservoirs having difference of water levels of 12 m are **13**

connected by a pipe system as shown in Figure 9. The length of the pipe AB, BC and BD are 1.5 km, each with 300 mm diameter. Find the discharge from one tank to another, if value of f for all the pipes are 0.01.

Question 7

a. Using Buckingham's π- theorem, show that velocity through circular orifice is given by $v = \sqrt{2gH}Q\left[\frac{D}{H}, \frac{\mu}{\rho vH}\right]$, whre H is the head carrying flow, D is the diameter of the orifice, μ is viscosity, ρ is density, g is acceleration due to gravity. **15**

b. Briefly explain about the venture principle. **05**

c. Derive the equation of hydrostatic law of pressure variation in a static fluid. **10**

Question 8

a. Briefly explain- **06**
   (i) Newtonian fluid
   (ii) Froude number
   (iii) Absolute and gauge pressure

b. The plate shown in figure 10 is submerged in oil (S = 0.94) and lies in a vertical plane. Find the magnitude and location of hydrostatic force acting on one side of the plate. **10**

c. Water flows at a 50 cm diameter welded steel pipe at 20°C. If the energy gradient is 0.006, determine the flow rate. Roughness for welded steel pipe is 0.046 mm. **14**

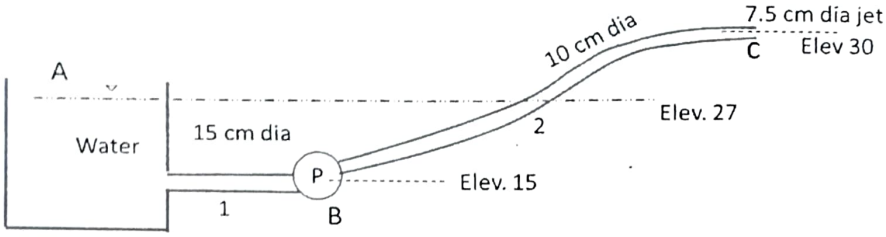


Figure 1 for Question 2(a)

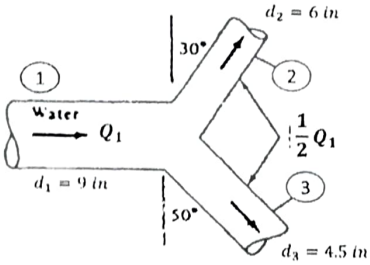


Figure 2 for Question 2(b)

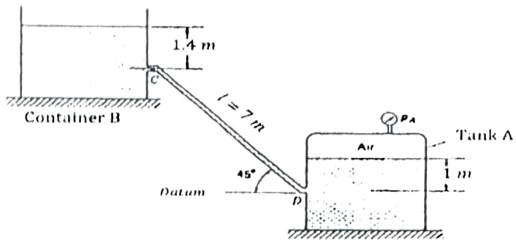


Figure 4 for Question 3(b)

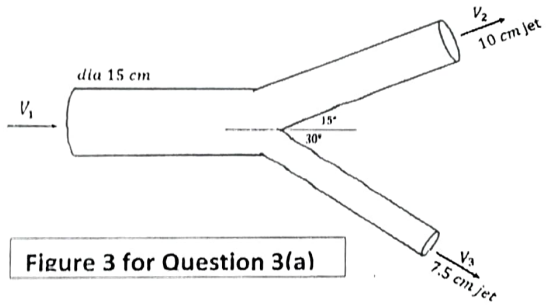


Figure 3 for Question 3(a)

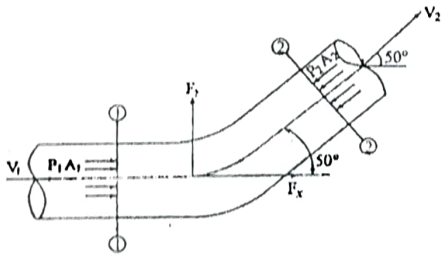


Figure 5 for Question 4(a)

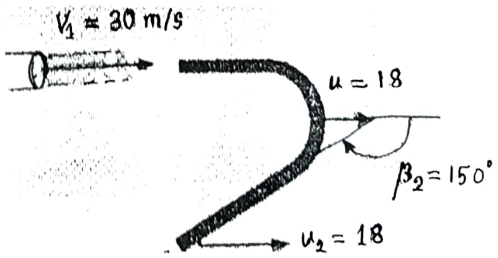
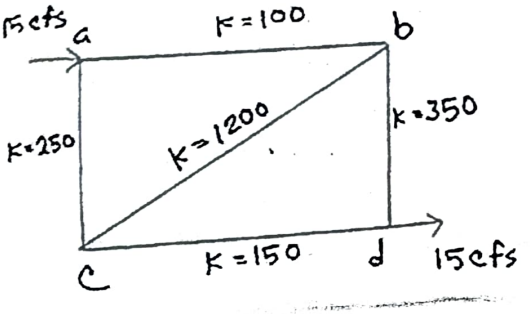
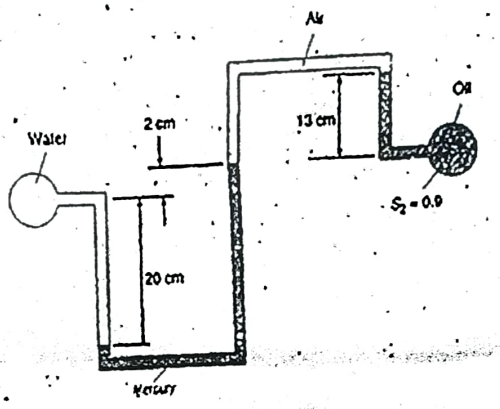


Figure 6 for Question 4(b)



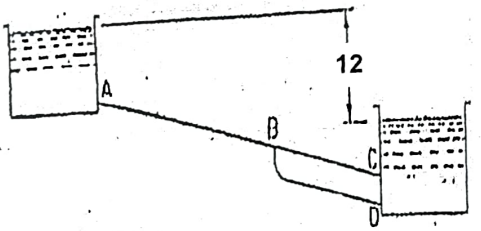
~~Figure 5(b)~~

Figure 7 for Question 5(b)



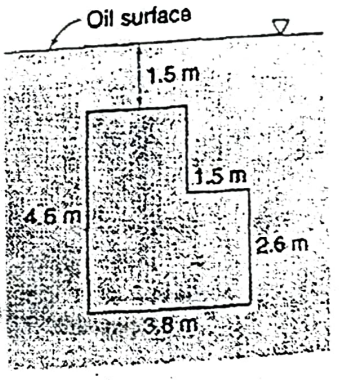
~~Figure 6(b)~~

Figure 8 for Question 6(b)



~~Figure 6(c)~~

Figure 9 for Question 6(c)



~~Figure 8(b)~~

Figure 10 for Question 8(b)

Table: Properties of Water

Tempe-rature $T(^oC)$	Density $\rho(kg/m^3)$	Kinematic viscosity $\nu\ (m^2/s)*10^{\wedge}$	Surface tension σ (N/m)	Bulk modulus of elasticity $K(N/m^2)*10^{\wedge}$
0	999.87	1.787	0.0757	1.98
1	999.93	1.728	0.0755	
2	999.97	1.671	0.0753	
3	999.99	1.618	0.0751	
4	1000.00	1.567	0.0749	
5	999.99	1.519	0.0748	2.03
6	999.97	1.472	0.0747	
8	999.88	1.386	0.0745	
10	999.73	1.307	0.0742	2.09
12	999.52	1.235	0.0740	
14	999.27	1.169	0.0737	2.14
16	998.97	1.109	0.0734	
18	998.62	1.053	0.0731	
20	998.23	1.002	0.0728	2.19
25	997.08	0.890	0.0720	
30	995.68	0.798	0.0712	2.25
35	994.06	0.719	0.0704	
40	992.25	0.653	0.0696	2.26
45	990.25	0.596	0.0689	
50	988.07	0.547	0.0680	2.26
60	983.24	0.467	0.0661	2.25
70	977.81	0.404	0.0643	2.22
80	971.83	0.355	0.0626	2.17
90	965.34	0.315	0.0607	
100	958.38	0.282	0.0589	

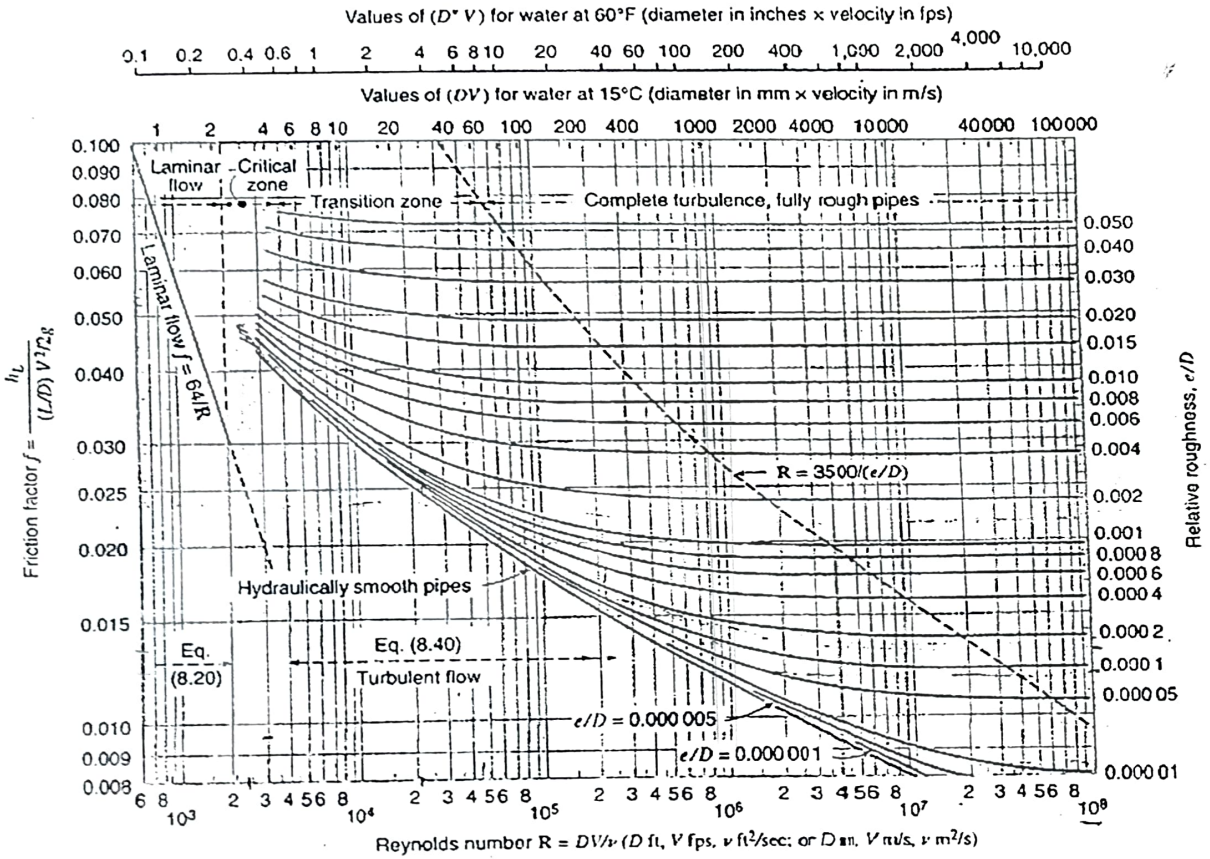


Figure: Moody Chart for Pipe Friction Factor (Stanton Diagram)