Elizade University Ilara-Mokin

Department of Civil and Environmental Engineering

Semester: Second Semester **Session: 2018/2019 Session**

Course code: CVE 302 **Course title: Advanced Hydraulics**

Examination time: 3hours **Units: 2**

Instruction: Attempt any five questions

Question 1(20 Marks)

(a) State the general differential form of the continuity equation for fluid flow and reduce this to that of a steady, incompressible fluid flow. (10 Marks).

(b) Assuming ρ (density) in a two-dimensional flow to be constant, do these flows satisfy continuity?

(i) $u = -2y, v = 3x$

(ii) $u = 0, v = 3xy$

(iii) $u = 2x, v = -2y$ (10 Marks)

Question 2 (20 Marks)

A reservoir of carbon tetrachloride (CCl_4) has a mass of 500kg and a volume of 0.315 m^3. Find the carbon tetra-chlorides.

(i) Weight

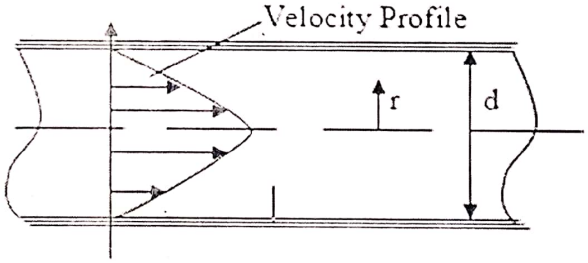
(ii) Mass density

(iii) Specific weight, and

(iv) Specific gravity. (20 Marks)

Question 3 (20 Marks)

Water is moving through a pipe. The velocity profile at the same section is shown in the figure below and is given



Mathematically as $v = \frac{\beta}{4\mu}(\frac{d^2}{4} - r^2)$ where v is the velocity of water at any position, r, β is a constant, μ = viscosity of water, d = pipe diameter and r = radial distance form centerline.

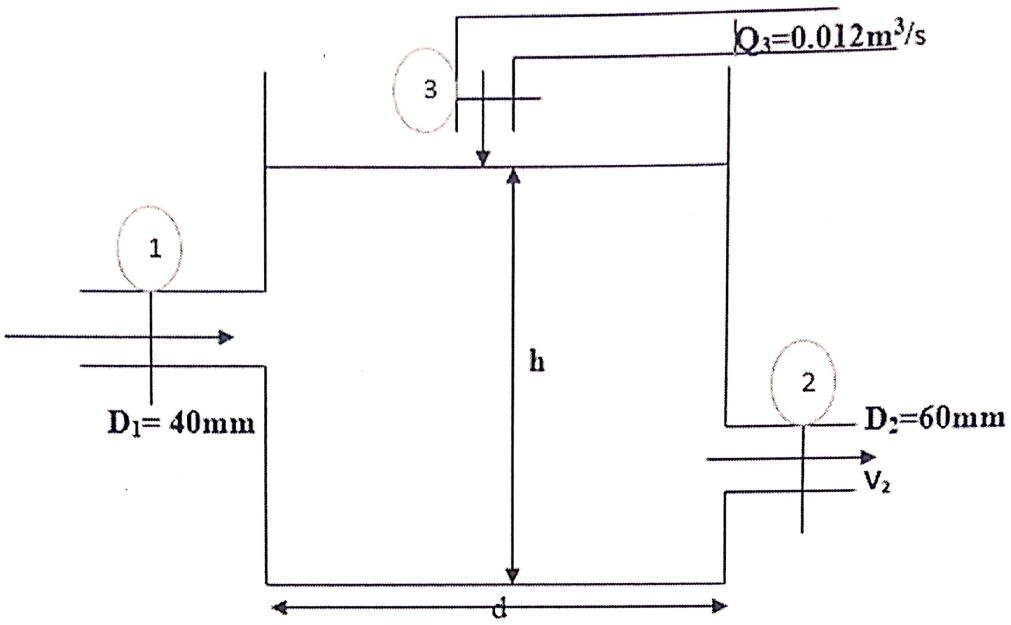
(a) What is the shear stress at the wall of the pipe due to the water? (10 Marks)

(b) What is the shear stress at a position $r = \frac{d}{4}$? (4 Marks)

(c) If the given profile persists a distance L along the pipe, what drag force is induced on the pipe by the water in the direction of flow over this distance? (6 Marks)

Question 4 (20 Marks)

The water tank is being filled through section 1 at $V_1 = 5$ m/s and through section 3 at $Q_3 = 0.02$ m^3/s? (see figure below).



(a) If the water level is constant, determine the exit velocity V_2. (8 Marks)

(b) If the water level in the tank varies and $V_2 = 8$ m/s, $V_1 = 5$ m/s, $Q_3 = 0.012 m^3/s$, find the rate of change of level, $\frac{dh}{dt}$. Assume the diameter of the cylindrical tank d = 1.0m (6 Marks)

(c) For the general case of flow, given Q_1, Q_2, and Q_3, derive an expression for $\frac{dh}{dt}$ in terms of the volume flows Q_1, Q_2, and Q_3 at the three parts.

Question 5 (20 Marks)

(a) By dimensional analysis, determine the dynamic pressure exerted by a flowing in compressible fluid on an immersed object, assuming pressure is a function of the density and velocity. 10 marks

(b) Assuming the power delivered to a pump is a function of the unit weight of the fluid, the flow in m^3/s and the head delivered. Establish an equation by dimensional analysis. (10 Marks).

Question 6 (20 Marks)

(a) On what slope should a 610mm vitrified sewer pipe be laid that 0.17 m^3/s will flow when the sewer is half full? (10 Marks)

(b) What will be the slope if the sewer flow full? (10 Marks)

(use manning's n = 0.013).

Question 7 (20 Marks)

(a) For a given cross-sectional area, determine the best dimensions for a trapezoidal channel. (10 Marks)

(b) Determine the most efficient section of a trapezoidal channel, n = 0.025, to carry 12.74 m^3/s. to prevent scouring, maximum velocity is to be 920mm/s and the side slopes of the trapezoidal channel are 1 vertical to 2 horizontals. What slope S of the channel is required? (10 Marks)