UNIVERSITY OF SWAZILAND

MAIN EXAMINATION PAPER

PROGRAMMES: BSc. ABE 3, and BSc LWM 3 OLD (T)

COURSE CODE: ABE 303

TITLE OF PAPER: FLUID AND SOIL MECHANICS

TIME ALLOWED: TWO (2) HOURS

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS

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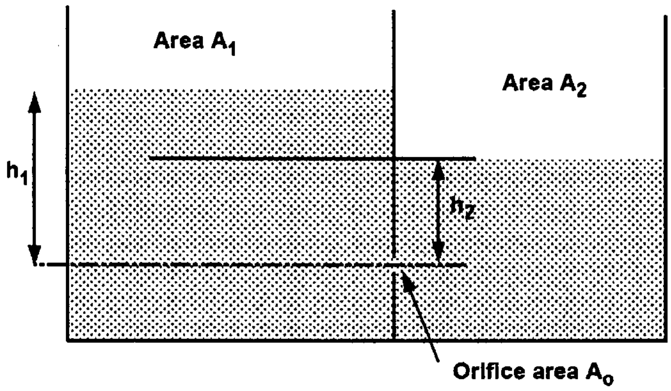
QUESTION 1

a. Two vertical cylindrical tanks of 5.0 *m* and 3.0 *m* diameter contain water. They are joined near their bases by a pipe of diameter 5cm which is short enough to be considered an orifice with C_d of 0.6. If the 3.0 *m* diameter tank initially has a level 2.0 *m* higher than the other, calculate how long it will take for the levels to become equal in each tank.



i. Determine the *ideal velocity* at point *2* (at the centre of the orifice). **[5 marks]**

ii. Calculate the *actual discharge* at point *2* **[5 marks]**

iii. Calculate how long it will take for the levels to become equal in each tank **[10 marks]**

b. Define effective stress and state its significance in practical soil mechanics problems. **[10 marks]**

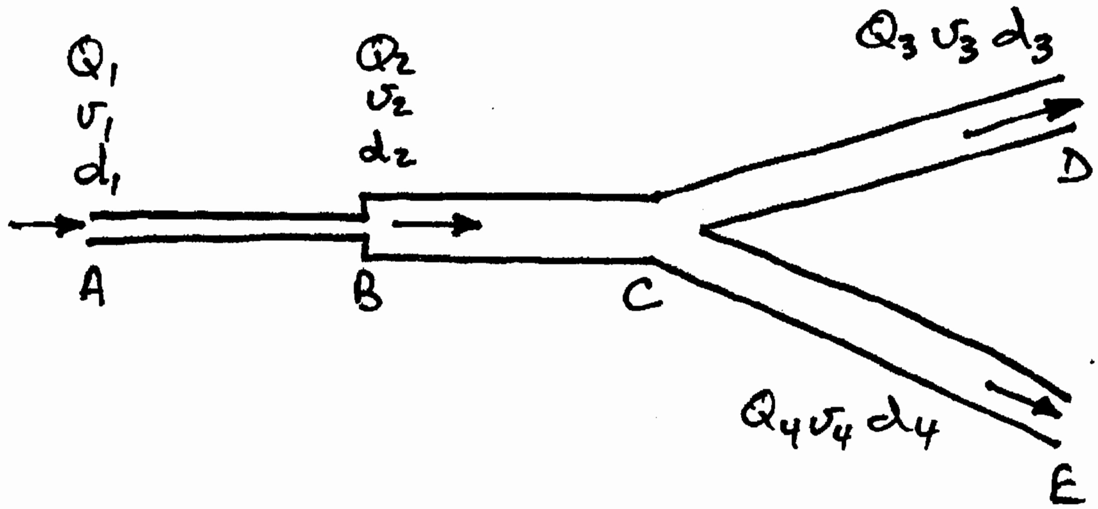
c. Outline the role of the Proctor test in civil engineering works such as embankments or earth dams. **[10 marks]**

QUESTION 2

a. A certain town receives its water directly from a water tower. If the top of the water in the tower is 26.0 *m* above the water faucet in a house, what should be the water pressure at the faucet? (Neglect the effects of other users). **[10 marks]**

b. Outline the Mohr- Coulomb failure criterion **[10 marks]**

c. Water flows from point *A* to points *D* and *E* as shown in the figure below. Some of the flow parameters are known as shown in the Table. Determine the unknown parameters.



Section	Diameter (mm)	Flow rate (m^3/s)	Velocity (m/s)
AB	300	?	?
BC	600	?	1.2
CD	?	$Q_3 = 2Q_4$	1.4
CE	150	$Q_4 = 0.5Q_3$	?

[10 marks]

QUESTION 3

a. Estimate the energy head lost along a short length pipe suddenly enlarging from a diameter of 350 *mm* to 700.0 *mm* which discharges 700.0 *l/s* of water. If the pressure at the entrance of the flow is 105.0 N/m^2, find the pressure at the exit. **[10 marks]**

b. A concrete lined channel has base width of 5.0 m and the sides have slopes of 1:2. Manning's n is 0.015 and the beds slope is 1:1000:

i. Determine the discharge, mean velocity and the Reynolds number when the depth of flow is 2.0 *m*. **[10 marks]**

ii. Determine the depth of flow when the discharge is 30.0 m^3/s. **[10 marks]**

QUESTION 4

a. A vane of 250.0 *mm* and diameter 100.0 *mm* is used to measure the shear strength of a saturated soil. If the torque required to fail the vane is 518.0 *Nm*, calculate the apparent shear strength of the soil. **[5 marks]**

A test on the same soil was carried out using a vane of 300.0 *mm* length and diameter 100.0 *mm* and the torque at failure was 612.0 *Nm*. Calculate the ratio of shear strength in the vertical plane to shear strength in the horizontal plane. **[15 marks]**

b. Discuss the use of pump performance (characteristics) curves, outlining clearly how such are used for pump selection. **[10 marks]**

APPENDIX

$$h_L = K'\left(\mathrm{Re}^{e-2}\right)\left(\frac{L}{d}\right)\left(\frac{v^2}{2g}\right) = f\left(\frac{L}{d}\right)\left(\frac{v^2}{2g}\right)$$

$$t = \frac{A_1 A_2}{(A_1 + A_2)C_d A_o \sqrt{2g}}\left[\sqrt{h_{initial}} - \sqrt{h_{final}}\right]$$

$$Q_{actual} = C_d A_1 A_2 \sqrt{\frac{2g\left[\frac{p_1 - p_2}{\rho g} + z_1 - z_2\right]}{A_1^2 - A_2^2}}$$

$$u_1 = \sqrt{\frac{2gh(\rho_{man} - \rho)}{\rho}}$$

$$Q_{actual} = C_d \frac{8}{15} B\sqrt{2g}\tan\left(\frac{\theta}{2}\right)H^{5/2}$$

$$\mathrm{Re} = \frac{vL\rho}{\mu}$$

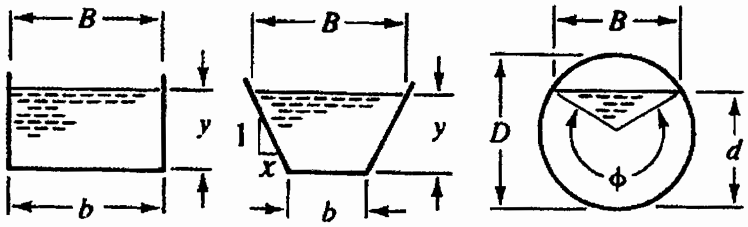
$$T = c_V(\pi dh)\frac{d}{2} + c_H\left(\pi\frac{d^2}{4}\right)\frac{2}{3}$$

$$h_f = \frac{32\mu Lv}{\gamma d^2}$$

$$\mathrm{Re} = \frac{vR\rho}{\mu}$$

$$f = 64/\mathrm{Re}$$

$$Q_{actual} = C_d \frac{2}{3} B\sqrt{2g H^{3/2}}$$



	Rectangle	Trapezoid	Circle
area, A	by	$(b+xy)y$	$\frac{1}{8}(\phi - \sin\phi)D^2$
wetted perimeter, P	$b+2y$	$b+2y\sqrt{1+x^2}$	$\frac{1}{2}\phi D$
top width, B	b	$b+2xy$	$\left(\sin\frac{\phi}{2}\right)D$
hydraulic radius, R	$\frac{by}{b+2y}$	$\frac{(b+xy)y}{b+2y\sqrt{1+x^2}}$	$\frac{1}{4}\left(1-\frac{\sin\phi}{\phi}\right)D$
hydraulic mean depth, D_m	y	$\frac{(b+xy)y}{b+2xy}$	$\frac{1}{8}\left(\frac{\phi-\sin\phi}{\sin(1/2\phi)}\right)D$