UNIVERSITY OF SWAZILAND

FINAL EXAMINATION PAPER

PROGRAMMES: BSc. LWM 3

COURSE CODE: LUM 303

TITLE OF PAPER: FLUID AND SOIL MECHANICS

TIME ALLOWED: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: NONE

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS

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QUESTION 1

a. Starting from the Bernoulli equation, develop the equation shown below for discharge over a sharp edged rectangular weir. State **all** assumptions made.

$$Q_{actual} = c_d \frac{2}{3} B\sqrt{2g}H^{\frac{3}{2}}$$ **[15 marks]**

b At the end of a channel is a sharp edged rectangular weir with a width of 400mm and a coefficient of discharge, c_d , of 0.65. The water is flowing at a depth 0.16m above the base of the weir. If this weir is replaced by a 90° V-notch weir with the same coefficient of discharge, what will be the necessary upstream depth of water to achieve the same discharge as the rectangular weir. **[15 marks]**

c. Define the following terms and outline their significance with regard to soil mechanics;

(i) shear strength **[5 marks]**

(ii) Mohr-Coulomb failure criterion **[5 marks]**

QUESTION 2

a. A retaining wall 5m high supports a backfill consisting of 2m of sandy clay overlying 3m of sand. The gravimetric water level water level coincides with the upper surface of the sand. Given that the soil constants are;

Sandy clay	**sand**
$\rho = 1840kg/m^3$	$\rho = 1930kg/m^3$
$c = 11.5kN/m^2$	$c = 0kN/m^2$
$\phi = 10^o$	$\phi = 35^o$

(i) Determine the total active thrust on the retaining wall and its point of action, assuming tension cracks have developed. **[10 marks]**

(ii) If it were possible to lower the water level by 2m, without altering the soil properties, what then would be the active thrust on the wall? Again, assume tension cracks would develop. **[10 marks]**

b. Write short notes on pump performance (characteristics) curves. **[10 marks]**

QUESTION 3

Water flows horizontally along a 220mm pipeline fitted with a 90° bend that moves the water vertically upwards. The diameter at the outlet of the bend is 150mm and it is 0.5m above the centerline of the inlet. If the flow through the bend is 150 liters/s and assuming no losses due to friction, calculate the magnitude and direction of the resultant force the bend support must withstand. The volume of the bend is $0.02m^3$ and the pressure at the inlet is 100 kN/m^2. **[25 marks]**

c. What do "total strength parameters" and "effective strength parameters" designate? **[5 marks]**

QUESTION 4

a. Derive an expression for the bulk density of a partially saturated soil in terms of specific gravity of the particle, G_s, the void ratio, e, the degree of saturation, S_r, and the density of water, ρ_w. **[10 marks]**

b. Define permeability **[5 marks]**

c. A venturimeter is used to measure the flow of water in a pipe of diameter 100mm. The throat diameter of the venturimeter is 60mm and it has a coefficient of discharge of 0.9.

When a flow of 100 liters/s is flowing the attached manometer shows a head difference of 60cm, what is the density of the manometric fluid of the manometer? **[15 marks]**

APPENDIX

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

$$p_a = k_a \gamma z$$

$$k_a = \frac{1-\sin\phi}{1+\sin\phi} = \tan^2\left(45-\frac{\phi}{2}\right)$$

$$p_a = k_a \gamma' z$$

$$p_a = k_a \gamma z - 2c\sqrt{k_a}$$

$$p_a = \gamma z \frac{1}{N_\varphi} - 2c\frac{\sqrt{N_\varphi}}{N_\varphi}$$

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