UNIVERSITY OF SWAZILAND
FINAL EXAMINATION PAPER

PROGRAMME: BSC AGRIC 4 (LWM)

COURSE CODE: LUM 407

TITLE OF PAPER: FLUID AND SOIL MECHANICS

TIME ALLOWED: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: BOX MATHEMATICAL INSTRUMENTS AND GRAPH PAPER

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS.

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SECTION I: COMPULSORY QUESTION

QUESTION 1

(a) Explain the role of the Proctor test in civil engineering works such as embankments or earth dams.

(10 Marks)

(b) Standard Proctor compaction tests carried out on a sample of sandy clay yielded the following results:

Bulk density (kg/m³)	2070	2139	2187	2212	2228	2211	2193
Moisture content (%)	6.8	8.5	9.4	10.2	11.3	12.5	13.6

Plot the curve of dry density against moisture content and hence find the maximum dry density and the optimum moisture content.

(20 Marks)

(c) A rectangular channel conveys water at 6.0m³/s. Find the critical depth y_c and critical velocity v_c for the following widths:

(i) Four metres;
(ii) Three metres. (10 Marks)

SECTION II: ANSWER TWO QUESTIONS FROM THIS SECTION

QUESTION 2

(a) Write short notes on pump performance (characteristics) curves.

(10 Marks)

(b) A pump operating at a speed of 1750 rpm discharges water at 4.5461m³/min at a head of 91.5m with a net positive suction head ($NPSH_r$) of 39.344m and required a brake power of 74.6kW. The speed of the pump is changed to 2000 rpm; determine the:

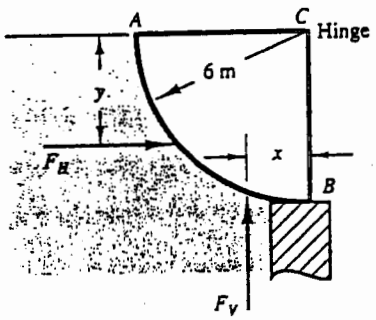
(i) Discharge;
(ii) Head;
(iii) Brake power; and
(iv) $NPSH_r$. (20 Marks)

QUESTION 3

(a) At the foot of a mountain a mercury barometer reads 740mm and a similar barometer at the top of the mountain reads 590mm. What is the approximate height of the mountain, assuming that the density of air is constant and equal to 1.225kg/m^3? (10 marks)

(b) Determine the components of the force due to the water acting on curved area AB per metre length.

(10 Marks)



(c) Write short notes on hydraulic jump. (10 Marks)

QUESTION 4

(a) Define effective stress and comment on its importance in practical soil mechanics problems.

(10 Marks)

(b) From tri-axial tests with pore-water pressure measurement it is found that the cohesion and angle of internal shearing resistance of a soil, referred to as effective stress, are 10kN/m^2 and 23° respectively. Using Coulomb's equation find the shearing strength of this soil at a depth of 8m below the ground surface. The soil has an average density of 1930kg/m^3 and the water table is at a depth of 2.5m below the surface.

(20 Marks)

APPENDIX

$$y_c = \sqrt[3]{\frac{q^2}{g}}$$

$$q = \frac{Q}{w}$$

AFFINITY LWAS

Impeller performance resulting from changes in pump speed

$$Q_2 = Q_1\left(\frac{N_2}{N_1}\right)$$

$$H_2 = H_1\left(\frac{N_2}{N_1}\right)^2$$

$$BP_2 = BP_1\left(\frac{N_2}{N_1}\right)^3$$

$$(NPSH_r)_2 = (NPSH_r)_1\left(\frac{N_2}{N_1}\right)^2$$

Pump performance due to changes in impeller diameter

$$Q_2 = Q_1\left(\frac{D_2}{D_1}\right)$$

$$H_2 = H_1\left(\frac{D_2}{D_1}\right)^2$$

$$BP_2 = BP_1\left(\frac{D_2}{D_1}\right)^3$$

$$(NPSH_r)_2 = (NPSH_r)_1\left(\frac{D_2}{D_1}\right)^2$$