UNIVERSITY OF SWAZILAND
SUPPLEMENTARY EXAMINATION PAPER

PROGRAMMES: BSc. Agric 3 (LWM)

COURSE CODE: LUM 303 (NEW PROGRAMME)

TITLE OF PAPER: FLUID AND SOIL MECHANICS

TIME ALLOWED: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: MATHEMATICAL BOX OF INSTRUMENTS AND GRAPH PAPER

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS

DO NOT OPEN THIS PAPER UNTIL PERMISION HAS BEEN GRANTED BY THE CHIEF INVIGILATOR

SECTION 1: COMPULSORY

QUESTION 1

(a) With the aid of sketches explain the difference between active and passive soil failure. [15 marks]

(b) A series of direct shear box tests is performed on a moist silt soil. The shear box is a square single ring device with a sample length and width of 5.08×5.08cm. At soil failure, the following shear forces, T, were recorded for different vertical forces, N. Find the cohesion and angle of internal friction of the soil. [20 marks]

N (N)	20	40	80	160	360
T (N)	31	40	59	100	175

(c) Define permeability [5 marks]

SECTION 2: ANSWER ANY TWO QUESTIONS

QUESTION 2

(a) A 3000kW track laying tractor with a mass of 50 tonnes and a 4.8m blade cuts the soil at a 400mm depth. Given that the mass of the blade, excluding the arms is 4 tonnes, calculate;

(i) The effective soil force, P. [15 marks]

(ii) The draft, H. [5 marks]

(iii) The vertical force, V. [5 marks]

Given that, $\alpha = 53^o$, $\gamma = 19.6kN/m^3$, $\phi = 30^o$, $\delta = 20^o$, $c = 20kPa$, and $c_a = 4kPa$

(b) State the Bernoulli's theorem and discuss its significance in fluid dynamics. [5 marks]

QUESTION 3

(a) Define the following terms and outline their significance with regard to fluid mechanics;

(i) Specific weight [5 marks]

(ii) Fluid pressure [5 marks]

(iii) Viscosity [5 marks]

(iv) Flow nets [5 marks]

(b) A rectangular channel conveys water at 6.0 m^3/s. Find the critical depth, y_c, and critical velocity, v_c, for the following widths:

(i) Four meters [5 marks]

(ii) Three meters [5 marks]

QUESTION 4

(a) Define effective stress and comment on its importance in practical soil mechanics. [10 marks]

(b) A 1m diameter new cast iron pipe (C=130) is 845m long and has a loss of 1.11m. Find the discharge capacity of the pipe according to the Hazen-Williams formula. [10 marks]

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

APPENDIX

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

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

$$\cot\beta = \frac{\sqrt{\frac{\sin(\alpha+\delta)\sin(\delta+\phi)}{\sin\alpha\sin\phi}} - \cos(\alpha+\delta+\phi)}{\sin(\alpha+\delta+\phi)}$$

$$k_p = \frac{(\cot\alpha + \cot\beta)\sin(\beta+\phi)}{2\sin(\alpha+\beta+\delta+\phi)}$$

$$k_{ca} = \frac{-\cos(\alpha+\beta+\phi)}{\sin\alpha\sin(\alpha+\beta+\delta+\phi)}$$

$$P = \left(\gamma h^2 k_p + chk_c + c_a hk_{ca}\right)w$$

$$H = P\sin(\alpha+\delta) + c_a hw\cot\alpha$$

$$V = P\cos(\alpha+\delta) - c_a hw + W$$

The Hazen-Williams formula is given by;

$$V = 0.8492CR^{0.63}S^{0.54}$$