UNIVERSITY OF SWAZILAND
FINAL 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) Define effective stress and comment on its importance in practical soil mechanics problems. [10 marks]

(b) A pump operating at a speed of 1750rpm discharges water at 4.5461m^3/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 2000rpm; determine:

(i) Discharge [5 marks]

(ii) Head [5 marks]

(iii) Brake power [5 marks]

(iv) $NPSH_r$ [5 marks]

(c) A shear vane is used to determine the shear strength of a clay soil *in situ*. Outline the procedure of a vane test. [10 marks]

SECTION 2: ANSWER ANY TWO QUESTIONS

QUESTION 2

(a) Briefly discuss the tri-axial compression tests. [10 marks]

(b) The following data refer to three tri-axial tests performed on representative undisturbed samples of soil:

Test	**Cell pressure**	**Axial load dial reading (divisions) at failure**
1	50	66
2	150	106
3	250	147

Load dial calibration factor is 1.4N per division. Each sample is 75mm long and 37.5mm diameter. Find, by graphical means, the value of apparent cohesion and angle of internal friction for this soil. [20 marks]

QUESTION 3

(a) Explain the role of the proctor test in civil engineering works such as embankments or earth dams. [10 marks]

(b) In order to measure the *in situ* density of a soil, the following sand replacement test was carried out. 4.56kg of soil was extracted from a hole at the surface of the soil. The hole was then filled with 3.54kg of loose dry sand.

(i) If it took 6.57kg of the same sand to fill a container $0.0042m^3$ in volume, determine the bulk density of the soil. [5 marks]

(ii) In a water-content determination, 24g of the moist soil weighed 20g after drying in an oven at 105°C. If the specific gravity of the particles was 2.68, determine the water content, the dry density, and the degree of saturation of the soil. [15 marks]

QUESTION 4

(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) With the aid of sketches explain the difference between active and passive soil failure. [10 marks]

APPENDIX

AFFINITY LAWS

Impellor performance resulting from changes in pump speed

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

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

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

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

Pump performance due to changes in impellor diameter

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

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

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

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