



**UNIVERSITY OF SWAZILAND  
FINAL EXAMINATION PAPER**

**PROGRAMME: 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: BOX MATHEMATICAL  
INSTRUMENTS AND GRAPH PAPER**

**INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO  
OTHER QUESTIONS.**

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GRANTED BY THE CHIEF INVIGILATOR**

## SECTION I: COMPULSORY QUESTION

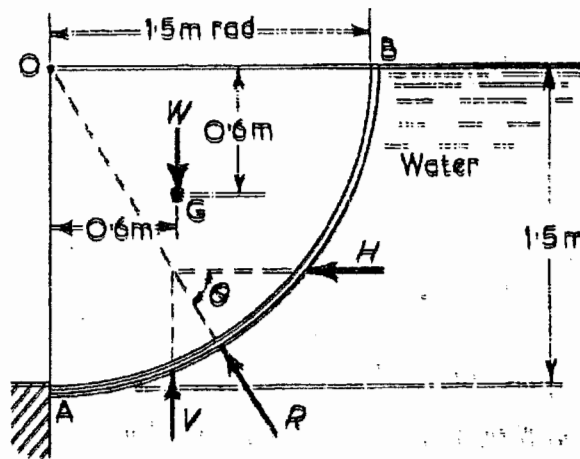
QUESTION 1

(a) Briefly discuss the following properties of fluids:

- |                      |           |
|----------------------|-----------|
| (i) Specific weight; | (5 Marks) |
| (ii) Fluid pressure; | (5 Marks) |
| (iii) Viscosity.     | (5 Marks) |

(b) A sluice gate consists of a quadrant of a circle of radius 1.5m pivoted at its centre O as in the figure below. Its centre of gravity is at G as shown. When the water is level with the pivot O, calculate the magnitude and direction of the resultant pressure on the gate due to the water and the turning moment required to open the gate. The width of the gate is 3m and it has a mass of 6000kg.

(25 Marks)



## SECTION II: ANSWER TWO QUESTIONS FROM THIS SECTION

QUESTION 2

- (a) Define effective stress and comment on its importance in practical soil mechanics problems. (10Marks)
- (b) Briefly discuss tri-axial soil tests. (10 Marks)

**QUESTION 2 (continued)**

- (c) From tri-axial tests with pore-water measurement it is found that the cohesion and angle of internal shearing resistance of a soil, referred to as effective stress, are  $10\text{kN/m}^2$  and  $25^\circ$  respectively. Using Coulomb's equation, find the shearing strength of this soil at a depth of 9m below the ground surface. The soil has an average density of  $1930\text{kg/m}^3$  and the water table is at a depth of 2.7m below the surface.

(10 Marks)

**QUESTION 3**

- (a) The vane test is used in the determination of the shear strength of clay soils *in situ*. Outline the procedure of a vane test.

(5 Marks)

- (b) What difficulties would one anticipate with the results of a vane test?

(5 Marks)

- (c) A vane of length 250mm and diameter 100mm is used to measure the shear strength of a saturated soil. If the torque required to fail the vane is 518Nm calculate the apparent shear strength of the soil.

A test on the same soil was carried out using a vane of 300mm length and diameter 100mm and the torque at failure was 612Nm. Calculate the ratio of shear strength in the vertical plane to shear strength in the horizontal plane.

(20 Marks)

Note: Assume angle of internal shear is zero.

$$T = c_v (\pi dh) \frac{d}{2} + c_H \left( \pi \frac{d^2}{4} \right) \frac{1}{3} \times 2$$

**QUESTION 4**

- (a) Define the following terms with regard to water pumps:

- (i) Pump capacity;
- (ii) System head;
- (iii) Brake power;
- (iv) Demand power

(10 Marks)

**QUESTION 4 (continued)**

(b) Water is being pumped from a reservoir into a 1000-m-long, 25cm-diameter steel pipe and conveyed to an open canal. The water surface in the canal is 15m above the water surface in the reservoir. Determine:

- (i) The total head that the pump must supply;
- (ii) The water power;
- (iii) The brake power;
- (iv) The demand power.

if 5000 l/m is being pumped, the pump speed is 3600 rpm, and the pump and motor efficiencies are 75 and 92 percent, respectively. There are three elbows ( $k = 1.2$ ) in the pipeline and a strainer bucket with a foot valve ( $k = 10$ ) on the pump inlet pipe (i.e., on the suction line).

(20 Marks)