



**UNIVERSITY OF SWAZILAND
MAIN EXAMINATION PAPER**

**PROGRAMME: BSC IN LAND AND WATER MANAGEMENT
YEAR 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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GRANTED BY THE CHIEF INVIGILATOR**

QUESTION 1

a) Discuss the three main types of roto-dynamic pumps, and describe the way water flows through them. **[15 marks]**

b) A pump supplies water to a large reservoir through a 2000 m long pipeline, 400 mm diameter. If the difference in water level between the sump and the reservoir is 20 m and the friction factor of the pipeline is λ being 0.03, calculate the pressure and power output required to deliver a discharge of $0.35\text{m}^3/\text{s}$. **[10 marks]**

c) Make suggestions on what could be done to increase the discharge if such a need would arise. **[5 marks]**

c) Discuss each of these phenomena, i.e. cavitation and water hammer, discussing their causes and the possible damage they may cause. **[10 marks]**

QUESTION 2

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

i) If it took 6.57 kg of the same sand to fill a container 0.0042 m^3 in volume, determine the bulk density of the soil. **[7 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. **[8 marks]**

b) i) Define plasticity as used in soil mechanics. **[6 marks]**

ii) Also discuss the three consistency limits which are; liquid, plastic and shrinkage. **[9 marks]**

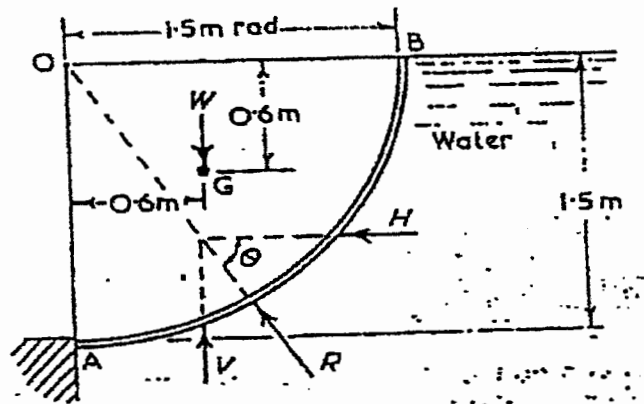
QUESTION 3

- a) Explain the relationship between relative saturation of soils and hydraulic conductivity; illustrate your explanation in a diagram. Also explain how soil texture would affect the hydraulic conductivity. [15 marks]

- b) Explain the theory of consolidation in soil mechanics. Also make mention and briefly discuss the assumptions on which this theory is based. [15 marks]

QUESTION 4

- a) A sluice gate consists of a quadrant of a circle of radius 1.5 m 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.



[15 marks]

- b) Using a pitot tube, it is possible to calculate the mainstream velocity by creating a stagnation point and measuring p_1 and p_s , where p_1 is the general pressure in pipe, and p_s is the stagnation pressure. Elaborate on the concept, and show how the Bernoulli equation can be simplified to equation below which can then be easily used to determine the velocity of flow.

$$v_1 = \sqrt{2 \left(\frac{p_s - p_1}{\rho} \right)}$$

[15 marks]