UNIVERSITY OF SWAZILAND
SUPPLEMENTARY 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: NONE

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS.

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SECTION I: COMPULSORY QUESTION

QUESTION 1

(a)   Write short notes on the following:
     (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)
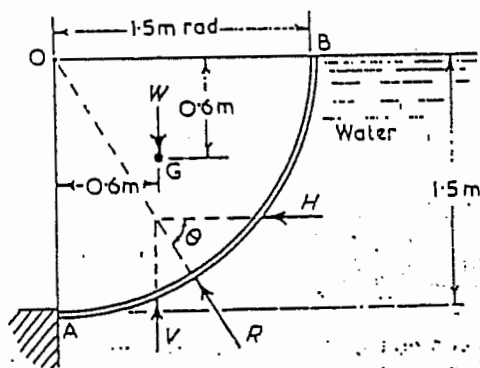
SECTION II: ANSWER TWO QUESTIONS FROM THIS SECTION

QUESTION 2

(a)   Define effective stress and comment on its importance in practical soil mechanics
problems.   (10 Marks)

(a)   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
$10kN/m^2$ and $25°$ 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 $1930kg/m^3$ and the water table is at a depth of 2.7m below the
surface.   (20 Marks)

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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.

$$\text{Torque} = c_v(\pi dh)(d/2) + c_H \frac{(\pi d^2)}{4}(1/3)d \times 2$$

QUESTION 4

(a)   Define permeability.   (5 Marks)

(b)   A well-point lowering scheme is carried out on a site and after steady conditions have been obtained, the readings in observation wells are as shown in the figure below. If the rate of pumping is 100litres/minute, estimate the coefficient of permeability of the sand stratum.   (25 Marks)

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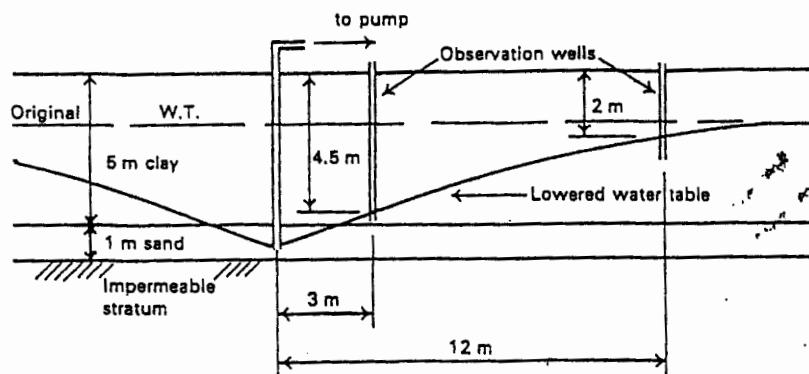
APPENDIX

$$k = \frac{(Q/t)\ln(r_2/r_1)}{\pi(z_2^2 - z_1^2)}$$

Q/t = rate of flow