TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY
Department of BUILDING & Civil engineering
UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING
TCV4212: SOIL MECHANICS I
END OF SEMESTER EXAMINATIONS
SERIES: AUGUST, 2024
TIME: 2 HOURS

INSTRUCTIONS TO THE CANDIDATE:

1. You should have the following for this examination:
   - **Answer booklet.**
   - **Mathematical Table/Pocket Calculator.**
2. This paper consists of **FOUR** questions.
3. Answer question **ONE (Compulsory)** and any other **TWO** questions.
4. This paper consists of **FIVE** printed pages.
5. **Do not write on the question paper.**

Question ONE: Soil Physics:

(a) The expression below is used in calculations of unit weights of soils:

$$\gamma_b = \left\{ \frac{G_s + e\,S_r}{1+e} \right\} \gamma_w$$

Where γ_b = bulk unit weight, γ_w = unit weight of water, G_s = specific gravity of the soil grains and e = void ratio. Derive the expression from the basic principles.

(10 marks)

(b) A soil sample in its natural state has a mass of 2.29 kg and a volume of 1.15×10^{-3} m^3. In an oven dried state, the dry mass of the sample is 2.035 kg and the specific gravity G_s of the solids is 2.68.
Determine:

(i) The bulk density,
(ii) The bulk unit weight,
(iii) Water content,
(iv) The dry unit weight,
(v) Void ratio,
(vi) Saturated unit weight,
(vii) Sub-merged unit weight,
(viii) Porosity,
(ix) Degree of saturation,
(x) Air voids ratio.

(20 marks)

Question TWO: Soil Classification

Determine the plasticity index of a soil from the following test data:
Liquid limit test:
Table 2.1: Cone penetrometer test results

Cone penetration (mm)	15.5	17.3	19.6	22.4	23.9
Moisture content (%)	47	51	56	63	66

Plastic limit test:
Table 2.2: Results

Test number	1	2
Mass of moisture (g)	1.52	1.67
Mass of dry soil threads (g)	4.61	4.77

(20 marks)

Question THREE: Soil Compaction

A standard compaction test was carried out in a mould of volume 0.001 m^3 .

Test results are tabulated below:

Table 3.1: Results of compaction test

Moisture content (%)	12.8	14.5	15.6	16.8	19.2
Mass of wet soil and mould (g)	2010	2092	2114	2100	2055

Specific gravity of solids Gs = 2.67

Determine the:

(a) Maximum dry density,
(b) Optimum moisture content,
(c) Saturation line
(d) 5% air voids lines,
(e) Air content at maximum dry density.

Hint:

Moisture content		%					
		Decimal (w)					
Mass of soil (g)							
Bulk density $\rho_b = \frac{mass\ of\ soil}{vol.\ of\ mould}$ (kg/m^3)							
Dry density (kg/m^3)	$\rho_d = \frac{\rho_b}{1+w}$						
	$\rho_d = \frac{G_s(1-A_r)}{1+wG_s}\rho_w$	For saturation line, $A_r = 0$					
		For 5% air voids, $A_r = 0.05$					

(20 marks)

Question FOUR: Permeability in Soils

(a) In a constant head permeameter test the following results were obtained:
Duration of test (t) ----------4.0 minutes,
Quantity of water collected (q) ----------300 ml,
Head difference in manometer (h) ---------- 50 mm,
Distance between manometer tappings (l) ----------100 mm,
Diameter of test sample ---------- 100 mm.
Determine the coefficient of permeability k(mm/s).

(10 marks)

(b) A field test to determine the coefficient of permeability was carried out. Results were:

Pumping out rate from central well (q)----------7.5 m^3/day,
Water table height above bedrock during pumping:

(i) At observation well, 15 m (r_1) from the central casingZ_1, ----------5.5 m,

(ii) At observation well, 30 m (r_2) from the central casing, Z_2----------6.5 m.

If the soil stratum was unconfined, calculate the coefficient of permeability (m/day).

(10 marks)