



MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN
BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 301: SOIL MECHANICS I

DATE: 13TH JANUARY, 2025

TIME: 11.00 AM – 1.00 PM

INSTRUCTIONS:

*Answer question **ONE (Compulsory)** and **any other TWO** questions*

Necessary tables and charts are provided in the appendix at the end of the questions

Take specific gravity of soil as 2.70

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Define the term soil mechanics. (3 Marks)
- b) Explain the importance of the knowledge of soil mechanics in civil engineering. (4 Marks)
- c) Discuss the contributions made by Albert Mauritz Atterberg in civil engineering. (3 Marks)
- d) Briefly describe the laboratory procedure for classifying fine soils by sedimentation method. (5 Marks)
- e) Describe the laboratory procedure for determining the maximum dry density –water content relationship of a soil. (5 Marks)
- f) Describe the laboratory procedure for determining the permeability coefficient of coarse soils. (5 Marks)
- g) From first principles derive the relationship between total stress and effective pore water pressure. (5 Marks)

QUESTION TWO (20 MARKS)

The data in Tables Q2.1 and Q2.2 were recorded during particle size analysis test in the laboratory on a 575 g sample of soil.

Table Q2.1 Stage 1: Wet and dry sieving

Sieve size (mm)	14	10	6.3	5	3.35	2	1.18
Mass retained (g)	0	4.6	14.9	14.8	47.8	79.2	89.8

Table Q2.1 (Continues)

Sieve size (mm or μm)	600	425	300	212	150	63
Mass retained (g)	46.5	13.2	10.9	10.2	6.9	25

Table Q2.2 Stage 2: Sedimentation analysis on 71.7 g passing 63 μm in Stage 1

Size (μm)	40	20	10	6	2
% coarser than	15.1	17.9	25.4	12.0	20.8

- (i) Plot the grading curve for the soil. (11 Marks)
- (ii) Determine the grading characteristics. (6 Marks)
- (iii) Classify the soil according to the British Standards Classification System. (3 Marks)

QUESTION THREE (20 MARKS)

The data in Table Q3 were recorded during a BS compaction test.

Table Q1

Mass of wet soil in mould (Kg)	1.682	1.786	1.833	1.843	1.758	1.663
Water content (%)	5	8	10	13	16	19

Volume of mould was $945 \times 10^3 \text{ cm}^3$

- (i) Plot the curve of dry density against water content. (8 Marks)
- (ii) Determine the maximum dry density (MDD) and optimum water content (OWC) for the compacted soil. (2 Marks)
- (iii) Under field conditions variations in the applied compactive effort may cause the air-voids content to vary by ± 2 percent. Also, the field water content may vary above and below the optimum value by 2 per cent. Calculate and indicate, on the axis in (i) above, the range of dry densities that may be found after compaction in the field. (10 Marks)

QUESTION FOUR (20 MARKS)

An earth dam made of a homogeneous material has the following data:

Coefficient of permeability of dam material	$= 5 \times 10^{-4}$ cm/sec
Level of top of dam	= 200.0 m
Level of deepest river bed	= 178.0 m
Highest flood level of reservoir	= 197.5 m
Width of top of dam	= 4.5 m
Upstream slope	= 3H: 1V
Downstream slope	= 2H: 1V

Determine the phreatic line for the dam section and the discharge passing through the dam.

QUESTION FIVE (20 MARKS)

An impervious paved area is to be constructed on a base of clayey silt during the wet season. Observations indicate that the water table will stabilize at 1.7 m below formation level. Using the data given in Table Q5, prepare an equilibrium water content profile and compare it with in situ water contents.

Data:

WL = 66%, Wp = 35%, average unit weight = 18.7 kN/m³.

Contact pressure at formation level = 7.5 kPa

Wetting curve (pF = 1.0 to 4.0): Equilibrium water content = 48 – 9.0 pF

Table Q5

Depth below formation (m)	0.1	0.5	1.5	2.5	4.0	5.0	6.0
In-situ water content before construction (%)	24.7	25.3	25.8	25.0	24.5	24.0	23.8