



MACHAKOS UNIVERSITY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR BACHELOR IN CIVIL ENGINEERING

ECV 301: SOIL MECHANICS I

DATE: 6/3/2023

TIME: 8:30 – 10:00 AM

INSTRUCTIONS

- This paper comprises of five questions. Answer **three** questions
- Question one is **compulsory** and carry 30 marks
- Answer any other **two** questions

QUESTION ONE (30 MARKS)

- a) Define the following terminologies as applied to a 3-phase system in soil mechanics
(10 marks)
- i. Porosity
 - ii. Void ratio
 - iii. Degree of saturation
 - iv. Dry unit weight
 - v. Saturated unit weight
- b) From first principles and in terms of void ratio (e), degree of saturation (S_r), particle specific gravity (G_s), and unit weight of water (γ_w), derive the following expressions:
(10 marks)
- i. Moisture content

- ii. Bulk unit weight
- iii. Dry unit weight
- iv. Saturated unit weight
- v. Submerged unit weight

- c) A dry soil has a void ratio of 0.65 and a grain specific gravity of 2.8. Water is added to the sample so that its degree of saturation is 60% without any change in void ratio. The sample is next wholly immersed in water. Determine **(10 marks)**

- i. Bulk unit weight of the soil
- ii. Dry unit weight
- iii. Moisture content
- iv. Saturated unit weight if degree of saturation is 95%

QUESTION TWO (20 MARKS)

- a) State Stokes law and describe why it is important in soil particle size distribution **(4 marks)**
- b) The results of particle size analysis for a soil sample is shown below. Plot the gradation curve and determine D_{10} , D_{30} , D_{60} , C_u and C_z . **(16 marks)**

Sieve size	Particle size	Percentage smaller
63mm		100
20mm		76
6.3mm		65
2mm		59
600 μ m		54
212 μ m		47
63 μ m		34
	0.020mm	23
	0.006mm	14
	0.002mm	7

QUESTION THREE (20 MARKS)

- a) Define the following terms as applied to cohesive soils **(5 marks)**
- i. Consistency of a soil
 - ii. Liquid limit
 - iii. Plastic limit
 - iv. Plasticity index
 - v. Linear shrinkage

- b) The Cone Penetrometer test results for a soil sample are shown in the table below. If the plastic limit is 24.1%, plot the graph and determine **(15 marks)**
- The liquid limit
 - Plasticity index

Cone penetration (mm)	15.5	18.0	19.4	22.2	24.9
Moisture content (%)	39.3	40.8	42.1	44.6	45.6

QUESTION FOUR (20 MARKS)

- a) Define the following terms as applied to permeability of soil **(3 marks)**
- A phreatic surface
 - A perched water table
- b) The coefficient of permeability may be determined in the laboratory by constant-head and falling-head methods. State the type of soil each method is suitable for. **(3 marks)**
- c) Derive from first principles an expression for the coefficient of permeability determined by the falling-head permeameter **(10 marks)**
- d) In a falling-head permeability test, the head causing flow was initially 50cm and dropped 2 cm in 5 minutes. How much time is required for the head to fall to 25cm? **(4 marks)**

QUESTION FIVE (20 MARKS)

- a) Define the following terms as applied to groundwater. **(6 marks)**
- Seepage
 - Hydraulic gradient
 - A flow line
 - Equipotential line
- b) A deposit of cohesionless soil with a coefficient of permeability of $2 \times 10^{-2} \text{ cm/s}$ has a depth of 12m to an impervious layer. A sheet pile wall is driven into the deposit to a depth of 7.5m. The wall extends above the surface of the soil and a 4.5m depth of water acts on one side. Sketch the flow net and determine the seepage quantity per metre length of wall. **(14 marks)**