



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 301 SOIL MECHANICS 1

DATE: 26/8/2022

TIME: 8.30-10.30 AM

INSTRUCTIONS:

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Define the following terminologies as applied to a 3-phase system in soil mechanics
- Porosity
 - Void ratio
 - Degree of saturation
 - Dry unit weight
 - Saturated unit weight (7.5 marks)
- 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: (15 marks)
- Moisture content
 - Bulk unit weight
 - Dry unit weight
 - Saturated unit weight
 - Submerged unit weight
- c) The following data were obtained in a standard laboratory Proctor compaction test on a soil sample. Plot the compaction curve and determine the optimum moisture content and maximum dry density if the volume of the container is 944 cm^3 . If it is proposed to secure a

95% relative compaction in the field, what would be the range of moisture contents allowed?
(7.5 marks)

QUESTION TWO (20 MARKS)

Moisture content (%) (w)	5.02	8.81	11.25	13.05	14.4	19.25
Weight of compacted soil (N)	16.02	17.52	19.54	20.22	20.29	19.29
Bulk density (kNm^{-3})						
Dry Density (kNm^{-3})						

- 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 μm		54
212 μm		47
63 μm		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)
- Consistency of a soil
 - Liquid limit
 - Plastic limit
 - Plasticity index
 - 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)

- i. The liquid limit
- ii. 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 groundwater. (3 marks)
 - i. Aquifer
 - ii. Unconfined aquifer
 - iii. Confined aquifer
- b) Derive from first principles an expression for coefficient of permeability for an unconfined aquifer. (10 marks)
- c) An unconfined aquifer is 32m thick below the water table. A constant discharge of $2\text{m}^3/\text{min}$ is pumped out of the aquifer through a central well till the water level in the central well becomes steady. Two observation wells at distances of 15m and 70m from the central well show falls of 3m and 0.7m respectively from their static levels. Find the permeability of the aquifer. (7 marks)

QUESTION FIVE (20 MARKS)

In a deposit of fine sand the water table is 3.5m below the surface but sand to a height of 1.0m above the water table is saturated by capillary water; above this height the sand may be assumed to be dry. The saturated and dry unit weights, respectively, are 20 and 16 kN/m^3 . Calculate the effective vertical stress in the sand 8m below the surface.



