



MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR DEGREE IN

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 301 SOIL MECHANICS I

DATE: 13/6/2017

TIME: 8:30 – 10:30 AM

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) With aid of a well labeled diagram, briefly describe the formation and the characteristics of the following types of rocks, giving examples in each (6 marks)
- Igneous rocks
 - Metamorphic rocks
 - Sedimentary rocks
- b) List any four factors that influence the conversion process of rocks into soils (2 marks)
- c) Explain briefly any three general importance of soils in the field of civil engineering (3 marks)
- d) Describe briefly any four properties of clay minerals that are of importance in civil engineering context (4 marks)
- e) With aid of sketches or equations, where necessary, differentiate the following pairs of terms as used in soil mechanics (4 marks)
- Well graded soils and uniformly graded soils
 - Plastic limit and shrinkage limit
 - Water content and saturation
 - Vadose water and phreatic water

- f) A core cutter cylinder of internal diameter 100 mm and length 125 mm was used to obtain a sample of damp sand from a trial hole. After trimming the ends, the total mass of the cylinder and soil was 3508 g; the mass of the empty cylinder was 1525 g. after oven-drying, the soil on its own weighed 1633 g. if the specific gravity was also found to be 2.71, determine parameters for the sample (5 marks)
- Bulk density
 - Dry density
 - Water content
 - Void ratio
 - Air voids
- g) The plastic limit of a soil is 25% and its plasticity index is 8%. When the soil is dried from its state at plastic limit, the volume change is 25% of its volume of plastic limit. Similarly, the corresponding volume change from the liquid limit to the dry state is 34% of its volume at liquid limit. Determine (6 marks)
- The shrinkage limit
 - The shrinkage ratio

QUESTION TWO (20 MARKS)

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

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

Determine:-

- The phreatic line for the dam (10 marks)
- The discharge passing through the dam (10 marks)

QUESTION THREE (20 MARKS)

The following data were recorded during a laboratory compaction test:

Water content (%)	5	8	10	13	16	19
Mass of wet soil in mould (kg)	1.777	1.938	2.024	2.090	2.052	1.986
Soil grain specific gravity	= 2.70					
Volume of mould	= 950 litres					

- By graphical method determine the maximum dry density and optimum water content (10 marks)
- On the same graph in (a), plot the zero and five percent air-voids content (5 marks)
- Estimate the air-void, void ratio and degree of saturation at the optimum water content (1 mark)
- Indicate on the graph, the range of dry density that may be expected from the field compaction, if the field air-voids are allowed to vary by ± 1.5 percent and the optimum water content by ± 2.0 percent of the laboratory optimum values (4 marks)

QUESTION FOUR (20 MARKS)

The following data were recorded during a soil particle size analysis test in the laboratory

Stage 1: wet and dry sieving on sample of 574.5g

Gravel fractions:	sieve size (mm)	14	10	6.3	5.0	3.35	2.0
	Mass retained (g)	0	4.6	14.9	4.5	14.5	24

Stage 2: wet and dry sieving on 160 g of the sample passing 2.0 mm in stage 1

Sand fractions:	Sieve size (mm)	1.18	0.6	0.425	0.3	0.212	0.15	0.063
	Mass retained (g)	27.2	14.2	4.0	3.3	3.1	2.1	7.6

Stage 3: sedimentation analysis on 71 g of the sub-sample passing 63 μ m in stage 2

Silt and clay fractions:	size (μ m)	40	20	10	6	2
	% coarse than	13	17	25	12	21

- Plot the grading curve (15 marks)

- b) Determine the following characteristics of the soil (5 marks)
- i. Characteristic sizes: d_{10} mm, d_{30} mm, and d_{60} mm
 - ii. Uniformity coefficient, C_u
 - iii. Coefficient of gradation, C_g

QUESTION FIVE (20 MARKS)

- a) With the aid of a well labeled sketch, derive an equation for a steady flow in an unconfined aquifer (6 marks)
- b) A horizontal layer of sand of 20 m average thickness is overlain by a layer of clay with a horizontal surface of 30 m thickness. A testy well of 0.5 m diameter and two observation wells at distances of 10 m and 60 m from the test well are drilled through the aquifer. After pumping at a rate of 0.1 m³/s to steady-state conditions, the drawdown in the observation wells were 4m in the first well (at 10 m) and 3m in the second well (at 60m). Determine (14 marks)
- i. The coefficient of permeability
 - ii. The transmissivity constant
 - iii. The drawdown in the test well
 - iv. The radius of the cone of depression