



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY
DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL DIPLOMA

IN

CIVIL / WATER / IRRIGATION ENGINEERING

SUBJECT: Soil Mechanics

PAPER NO: 578/15/S01

DURATION: 3 Hours

MARCH/APRIL 2021 EXAMINATION

REQUIREMENTS

Scientific calculator

INSTRUCTIONS TO CANDIDATE

- 1. Answer any five (5) questions.**
- 2. Start each question on a fresh page.**

This paper consists of 4 printed pages.

QUESTION 1

- a) What is your understanding of the following properties of soil.
- i) Void ratio (1 mark)
 - ii) Degree of saturation (1 mark)
 - iii) Moisture content (1 mark)
 - iv) Dry density (1 mark)
 - v) Specific gravity (1 mark)
- b) If a soil sample has a dry unit weight of 19.5 kN/m^3 , moisture content of 8% and a specific gravity of solid particles is 2.67. Calculate the following:
- i) Void ratio
 - ii) Unit weight and saturated unit weight
 - iii) The mass of water to be added to 1 m^3 of soil to reach 80% saturation. (15 marks)

QUESTION 2

- a) i) State Stoke's Law. (2 marks)
- ii) What is its use in the sedimentation method of analysis? (1 mark)
- iii) What are its limitations? (3 marks)
- b) An air dried sample of soil weighing 25kg was sieved in laboratory. The results are given below:

Sieve size	Mass retained
(mm)	(g)
2.0	0
1.	2.02
0.6	3.51
0.425	7.53
0.212	8.15
0.150	2.81
0.075	0.90
Pan	0.08

Plot the grain size distribution curve and determine the coefficient of uniformity and coefficient of curvature.

What is the description of the soil. (14 marks)

QUESTION 3

- a) Briefly discuss the factors that affect compaction of a soil.
(8 marks)
- b) The following results are obtained from a standard compaction test:

Mass of compacted soil (g)	Moisture content (%)
1920.5	11.0
2051.5	12.1
2138.5	12.8
2147.0	13.6
2120.0	14.6
2081.5	16.3

The specific gravity of the solids is 2.68 and the volume of the compaction mould is 1000cm³.

Plot the compaction curve and obtain the maximum compaction and optimum moisture content.
(8 marks)

Plot also the 0% and 10% air voids curves.
(2 marks)

If the natural moisture content in the field is 11.8%, what is the possible maximum dry density if the soil is compacted with its natural moisture content?
(2 marks)

QUESTION 4

- a) Discuss the factors that affect the permeability of a soil.
(10 marks)
- b) During a pumping test, a well was sunk through a stratum of dense sand 10m deep overlying an impervious stratum. Observation holes were drilled at 6.75m and 15m from the well. Initially the water level in the well was 2.5m below the ground surface. After pumping until steady conditions had been achieved, the water levels in the observation wells had dropped 1.95m and 0.5m respectively. If the steady discharge was 5 litres, determine the coefficient of permeability.
(10 marks)

QUESTION 5

- a) Describe the three types of tests that can be carried out on a triaxial testing machine. (6 marks)
- b) A series of triaxial tests was conducted on an over consolidated clay and the following results were obtained.

Sample No.	Cell Pressure (kN/m ²)	Deviator stress (kN/m ²)	Pore-water Pressure (kN/m ²)
1	125	510	-70
2	250	620	-10
3	500	850	+120

Plot the strength envelopes in terms of total stresses and effective stresses and hence determine the shear strength parameters. (14 marks)

QUESTION 6

Describe how you would determine the plastic limit of a soil specimen in a laboratory. (20 marks)

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