



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF CIVIL AND WATER ENGINEERING

Geomechanics / Soil Mechanics

ECW / TCW 2201

Examination Paper

March 2025

This examination paper consists of 6 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: NONE

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INSTRUCTIONS

1. Answer all the questions in Section A and any 3 questions from Section B
2. Each question in Section A carries 1 mark and in Section B 25 marks
3. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
5.	25
TOTAL	100

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Section A

Choose the letter with the right answer

1. Which one of the following soils is formed by wind :
(a) talus (b) loess (c) drift (d) marl
2. Coefficient of a well graded soil is :
(a) less than 1 (b) greater than 6 (c) between 1 and 3
(d) between 3 and 6
3. Plasticity classification of soil is more suitable to :
(a) coarse grained soils (b) fine grained soils (c) both (a) and b
(d) none of the mentioned
4. If the natural water content of a soil mass lies between its liquid limit and plastic limit , the soil is said to be in :
(a) liquid limit (b) plastic state (c) semi-solid state (d) solid state
5. A fully saturated soil sample has a moisture content of 22% . Its plastic limit and liquid limit are found to be 18% and 45% respectively . The plasticity index of the soil is :
(a) 4 % (b) 22 % (c) 23 % (d) 27 %
6. For engineering purposes , a soil is defined as :
(a) a natural aggregate of mineral grains , loose or moderately cohesive , inorganic or organic in nature .
(b) loose mantle at the surface of the earth
(c) a disintegrated rock
(d) none of the above
7. The property of a geological formation which represents its water storage capacity is
(a) permeability (b) porosity (c) both (a) and (b) (d) none of these
8. Which one of the following methods is more suitable for determining the permeability of coarse-grained soils :
(a) constant head permeameter
(b) falling head permeameter
(c) horizontal permeability
(d) none of the above

9. Water wells excavated through confined aquifers are known as :
(a) gravity wells (b) water – table wells (c) non – artesian well
(d) none of the mentioned
10. Water wells excavated through unconfined aquifers are known as :
(a) gravity wells (b) water – table wells (c) non – artesian wells
(d) all of the mentioned
11. Darcy's law is valid when the flow is :
(a) laminar (b) turbulent (c) both (a) and (b) (d) none of these
12. The geological formation which contains and readily yields water to our tubewells is an :
(a) aquifuse (b) aquitard (c) aquiclude (d) aquifer
13. The moisture content of a soil , below which the soil volume becomes constant , is called the :
(a) liquid limit (b) plastic limit (c) shrinkage limit (d) none of the mentioned
14. Which of the following properties of a soil is a measure of particle size range :
(a) effective size (b) uniformity coefficient (c) coefficient of curvature
(d) none of the mentioned
15. For determination of water content , the wet soil is dried in an oven for 24 hours at
(a) 50°C (b) 100°C (c) 105°C (d) 155°C
16. Flow and equipotential lines meet each other at an angle equal to :
(a) 75° (b) 60° (c) 120° (d) 90°
17. The liquid limit of a soil mass is 20 % and its plastic limit is 25 % , then the plasticity index of this soil is :
(a) 5 (b) – 5 (c) 0 (d) none of the mentioned
18. Undisturbed soil samples are best collected by :
(a) thin walled samplers (b) thick walled samplers (c) direct excavation
(d) augers

19. If k_x and k_z are the horizontal and vertical permeability respectively of a stratified deposit, the effective permeability is given by :
- (a) $\sqrt{k_x \cdot k_z}$ (b) $\sqrt{k_x / k_z}$ (c) $\sqrt{k_z / k_x}$ (d) $k_x + k_z / 2$
20. Flow curve is drawn from the test data of :
- (a) permeability test (b) pipette analysis test (c) unconfined compression test (d) liquid limit test
21. The sieve analysis for determining grain size distribution of a soil is valid :
- (a) for silt size to boulder size range
 (b) for silt size to sand size range
 (c) for clay size to boulder size range
 (d) for sand size to boulder size range
22. The water content of a soil which represents the boundary between plastic state and liquid state, is known as :
- (a) liquid limit (b) plastic limit (c) shrinkage limit (d) plasticity index
23. The water level in a confined well :
- (a) increases with the increase in the atmospheric pressure
 (b) decreases with the increase in the atmospheric pressure
 (c) does not undergo any change with the change in the atmospheric pressure
 (d) all of the above are possible
24. The average coefficient of permeability in natural stratified deposits parallel to stratification is :
- (a) always more than that perpendicular to stratification
 (b) always less than that perpendicular to stratification
 (c) always the same as in perpendicular direction
 (d) sometimes more and sometimes less than that in perpendicular direction, depending upon the soil type.
25. In a liquid limit test, a flow curve is drawn, from which the water content corresponding to N number of blows is determined to be the approximate value of liquid limit. What is this value of N ?
- (a) 10 (b) 120 (c) 25 (d) none of the given values

Section B

Question 1

(a) Define the following geo-mechanical terms (1 mark each) , (i) void ratio ,
(ii) porosity , (iii) degree of saturation (iv) air content and (v) dry density

(b) A sample of soil weighing 30,6 kg had a volume of 0,0183 m³ . The sample was dried in an oven and its mass was reduced to 27,2 kg . The specific gravity of the solids was found to be 2,65 . Calculate the following :

- | | |
|-----------------------------------|------------|
| (a) bulk density | (2 marks) |
| (b) dry density | (2 marks) |
| (c) percentage moisture content | (2 marks) |
| (d) saturated density | (4 marks) |
| (e) percentage air voids | (2 marks) |
| (f) void ratio | (2 marks) |
| (g) porosity | (2 marks) |
| (h) degree of saturation | (2 marks) |
| (i) critical hydraulic gradient | (2 marks) |

Question 2

Explain the seismic refraction method for sketching the general ground profile at a proposed bridge site . (25 marks)

Question 3

(a) List five soil factors that affect the permeability of a soil mass . (5 marks)

(b) The specific gravity of the particles of sand is 2,65 . The porosity of the sand in a loose state is 0,52 and in a dense state is 0,37 . Calculate the values of critical hydraulic gradient in these two states . (8 marks)

(c) With the help of well labelled diagrams explain any three ways of stopping seepage on an earth dam . (12 marks)

Question 4

(a) Define the following terms associated with seepage : (1 mark each)

(i) equipotential line , (ii) flow net , (iii) flowline , (iv) flow channel and (v) field

(b) List four parameters that can be calculated using flow nets . (4 marks)

Question 4 continued

(c) Calculate the average horizontal and vertical permeabilities of a soil mass made up of three horizontal layers . The first and second layers have the same thickness of 0,5 m each . The third layer is 1,0 m thick . The coefficients of permeability of the first , second and third layers , respectively are 1×10^{-3} , 2×10^{-2} and 5×10^{-4} cm / sec.
(16 marks)

Question 5

Differentiate between disturbed , undisturbed and non – representative samples and also discuss the uses to which such samples can be put to , respectively . (25 marks)

List of formulae

$$K_x = K_1 d_1 + K_2 d_2 + K_3 d_3 \dots / d_1 + d_2 + d_3 \dots$$

$$K_y = \frac{d_1 + d_2 + d_3}{\frac{d_1}{K_1} + \frac{d_2}{K_2} + \frac{d_3}{K_3}}$$

$$Y = M/V$$

$$m = m_w / m_s$$

$$v_s = m_s / G_s \gamma_w$$

$$i_c = G_s - 1 / 1 + e$$

$$V_a = A_v / V$$

$$e = V_v / V_s$$

$$S_r = V_w / V_v$$