The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

0093

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX4343 Soil Mechanics**
Academic Year	: 2024/25
Date	: 22nd February 2026
Time	: 1330-1630hrs
Duration	**: 3 hours**

Index No.: .....

Examination Type: Closed Book

General Instructions

1. This is a Closed Book Test.
2. Read all instructions carefully before answering the questions.
3. This question paper consists of Part A (twelve questions) and Part B (six questions) in **Six (6)** pages.
4. Answer all questions in Part A. All questions carry equal marks. Attach this page, with your answers to Part A, to your answer script. You are advised to spend approximately One (1) hour on Part A (3x12 = 36 points).
5. Answer four questions in Part B. All questions carry equal marks. You are advised to spend approximately 28 minutes per question (16x4 = 64 points).

PART A: Circle the correct response.

Question 1	a	b	c	d	e
Question 2	a	b	c	d	e
Question 3	a	b	c	d	e
Question 4	a	b	c	d	e
Question 5	a	b	c	d	e
Question 6	a	b	c	d	e
Question 7	a	b	c	d	e
Question 8	a	b	c	d	e
Question 9	a	b	c	d	e
Question 10	a	b	c	d	e
Question 11	a	b	c	d	e
Question 12	a	b	c	d	e

PART A: 0093

Answer all questions. All questions carry equal marks.

1. The equation $\rho_d = \frac{G_s}{1+wG_s/S}$ represents a phase relationship of an in-situ engineering soil specimen. Which of the following statements are true?
   A. It is used to compute dry densities representing the Standard Proctor Compaction Curve.
   B. Parameter S takes values 0, 1, and any other in-between value.
   C. The dry density is a function of the specific gravity and the void ratio.
   D. For a given soil matrix, water content is inversely proportional to the degree of saturation.
   a. A and B only. b. B and C only. c. C and D only. d. A and C only. e. B and D only.

2. Which of the following statements are true based on the MIT Soil Classification system?
   A. A coarse grain soil should have less than 5% fines.
   B. A coarse grain soil can be assigned the group symbol GC.
   C. A sandy silt is assigned the group symbol MS.
   D. A GC soil may have a percentage of fines between 12 – 50%.
   a. A and B only. b. B and C only. c. C and D only. d. A and C only. e. B and D only.

3. Fig. A3 shows a state of plane stress acting in the horizontal and vertical directions of a material element. The shear stress acting on the plane inclined at 25 degrees from the positive x direction is:
   a. 13.5 kPa b. 17.5 kPa c. 20.5 kPa d. 24.5 kPa e. 32.0 kPa

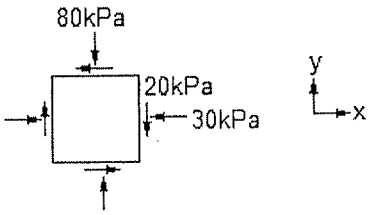

Fig. A3

4. Which of the following statements are true regarding the Hydrometer Test?
   A. The hydrometer reading is measured when forces acting on a particle is in equilibrium.
   B. An increase in the ambient temperature reduces the drag force on solid particles.
   C. The density correction for the dispersing agent affects the computed per cent passing.
   D. The computed per cent passing is based on the mass of soil passing 0.063mm sieve.
   a. A, B, and C only b. B, C, and D only c. A, C, and D only d. A, B, and D only
   e. A, B, C and D

5. Which of the following statements are true regarding the Unconfined Compression (UC) Test performed on a saturated clayey soil?
   A. The measured degree of saturation indicates the reliability of the test result.
   B. The measured cohesion increases with increasing water content.
   C. The measured angle to the failure plane indicates the reliability of the test result.
   D. The test can be used to determine the strength parameters with respect to effective stresses.
   a. A and B only. b. B and C only. c. C and D only. d. A and C only. e. A and D only.

6. A soil has 20% of soil fraction passing 0.063mm sieve size. The soil type could be:
   a. GW b. GP c. SM d. MC e. CH

7. Which of the following statements are true?
   A. Atterberg limit tests are performed on the fraction passing 0.425mm sieve.
   B. Liquid limit is determined when the water content is reduced from the liquid state.
   C. When classifying soils with per cent fines >12, Liquid and Plastic limits are determined.
   D. The MIT Soil Classification system uses clay and silt fractions, from the Hydrometer test.
   a. A, B and C only b. B, C and D only c. A, B and D only d. A, C and D only
   e. A, B, C and D

8. The Angle of repose of a cohesionless granular soil depends on:
   A. Surface roughness of soil grains.
   B. Size distribution of particles in the soil heap.
   C. Shape of soil grains.
   D. Moisture content.
   a. A, B and C only b. A, B and D only c. B, C and D only d. A, C and D only
   e. A, B, C and D.

9. Figure A9 shows a Mohr's Circle plot. The effective friction angle ϕ' is equal to:
   a. 25.2° b. 26.8° c. 27.6° d. 29° e. 31.2°

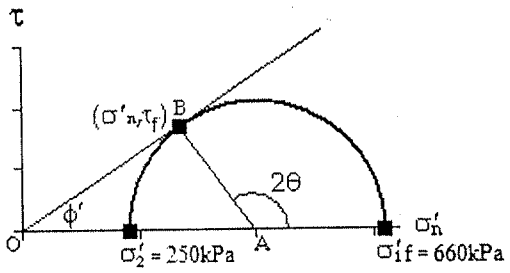

Fig. A9

10. Which of the following statements are true, regarding Constant Head Permeability Test?
   A. The hydraulic gradient across the soil specimen is considered constant.
   B. Increasing temperature of the fluid decreases the hydraulic gradient.
   C. Decreasing void ratio of the specimen increases the hydraulic gradient.
   D. Increasing temperature of the fluid increases the Coefficient of Permeability.
   a. A and B only. b. B and C only. c. C and D only. d. A and C only. e. A and D only.

11. Which of the following statements are true regarding 1-dimensional Consolidation theory?
   A. The compressible layer undergoes vertical and lateral strains.
   B. The excess pore water pressure dissipates vertically only.
   C. The compressible layer is fully saturated.
   D. The imposed load is instantaneously transferred to the skeleton of the soil layer.
   a. A and B only. b. B and C only. c. C and D only. d. A and C only. e. A and D only.

12. Which of the following statements are true regarding 1-dimensional Consolidation?
   A. Parameter U represents the per cent of total settlement occurring during the 24hr period.
   B. Parameter c_v has units kPa^{-1}.
   C. Parameter T is related to U based on 1-dimensional consolidation theory.
   D. Parameter t is obtained from the laboratory test curve, for a given load increment.
   a. A and B only. b. B and C only. c. C and D only. d. A and C only. e. A and D only.

PART B

Answer four questions. All questions carry equal marks.

1. During its formation Kaolinite is made of a Silicon centred tetrahedral layer bonded with an Aluminium centred octahedral layer. Several such silica-alumina sheets are held together with hydrogen bonds, to form Kaolinite mineral particles.

   A. Explain the interaction between Kaolinite particles and pore water. (4 points)

   B. Explain why such an interaction is not present between sand particles and the pore fluid. (3 points)

   C. Explain why Montmorillonite clays possess a higher Specific Surface Area when compared to Kaolin clays. (3 points)

   D. State the Soil description and the Group Symbol of a pure Kaolin soil. (2 points)

   E. If you are requested to perform the standard visual soil classification tests for the soil described in Section D above, state the observations and the observation-based conclusions you may reach. (4 points)

2. Figure B2 schematically represents the contact between two solid particles, subjected to an external load, P; and a pore-water pressure, u.

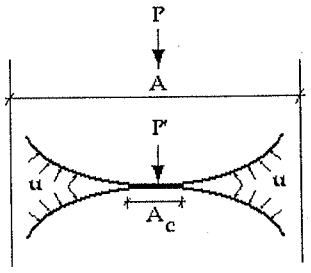

Fig. B2

   A. State the Principle of Effective Stress; define all terms. (3 points)

   B. Define all parameters shown in Fig. B2. (3 points)

   C. Describe the relationship between your responses to questions 2A and 2B. (3 points)

   D. Explain how you would determine parameter u, at a given point. (3 points)

   E. Explain based on your response to Question 2A, why a sandcastle made on the beach would retain its shape, without falling apart. (4 points)

3. The following readings were obtained during a 1-D Consolidation test:

   Before loading:

Mass of the wet soil specimen (g)	= 95.892
Average diameter of ring (mm)	= 50.1
Average height of ring (mm)	= 20.25
Initial settlement dial reading (mm)	= 0.000

   End of test:

Mass of the wet soil specimen (g)	= 91.753
Mass of the dry soil specimen (g)	= 74.895
Final settlement dial reading (mm)	= 2.342

   A. Compute the initial degree of saturation (%) to one decimal place accuracy. (3 points)

   B. Compute the initial void ratio to three decimal place accuracy (3 points)

   C. Explain why the initial degree of saturation is measured, and the importance of this measurement. (3 points)

   D. State the degree of saturation you would expect at the end of the test. (3 points)

   E. Sketch the shapes of the compression curves for a normally consolidated soil and an over-consolidated soil, on the same *e* vs. *log*(p') plot. You may also assume that the specimens are obtained from the same stratum. (4 points)

4. Fig.B4 shows plot of a combined Sieve-Hydrometer test.

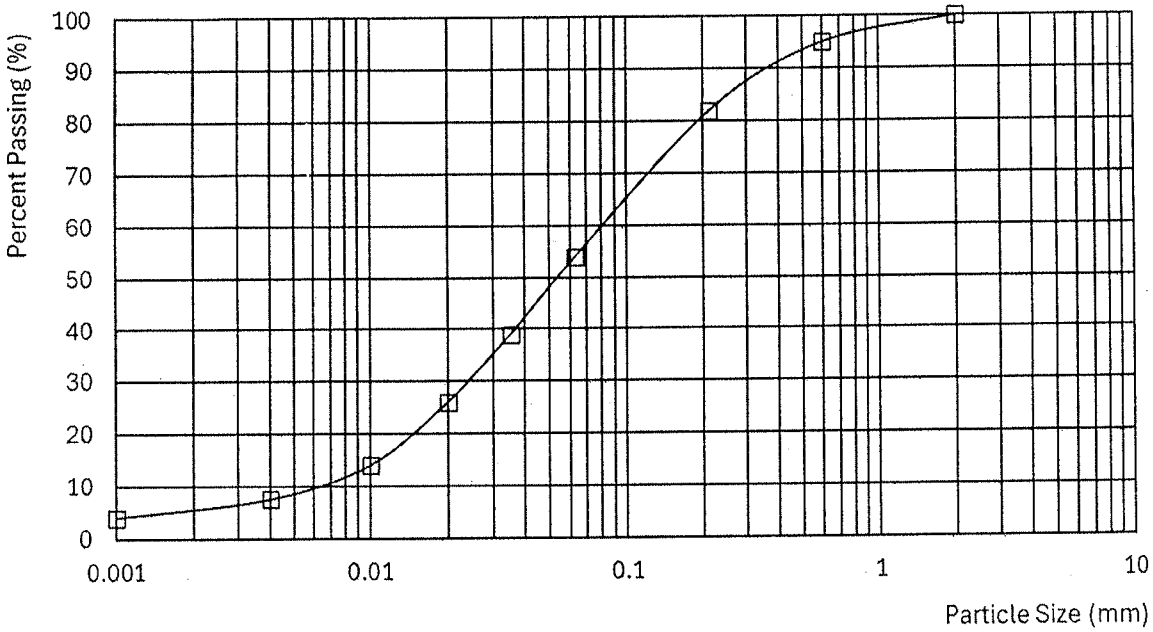

Fig. B4

A. Is this a coarse-grained soil? Explain your answer. (2 points)

B. List the percentage fractions of Gravel, Sand, Silt and Clay. (4 points)

C. State its soil description, based on MIT Soil Classification. (2 points)

D. The Group Symbol as per the MIT Soil Classification, requires performing the Liquid and Plastic Limit tests. Discuss whether you could reasonably conclude its Group Symbol without performing the Liquid and Plastic Limit tests. (4 points)

E. State the group symbol you would assign to this soil. (2 points)

F. Describe the soil condition of the stratum where the specimen was collected. (2 points)

5. Fig. B5 plots the variation of Degree of Consolidation, U, with the Time Factor, T_v

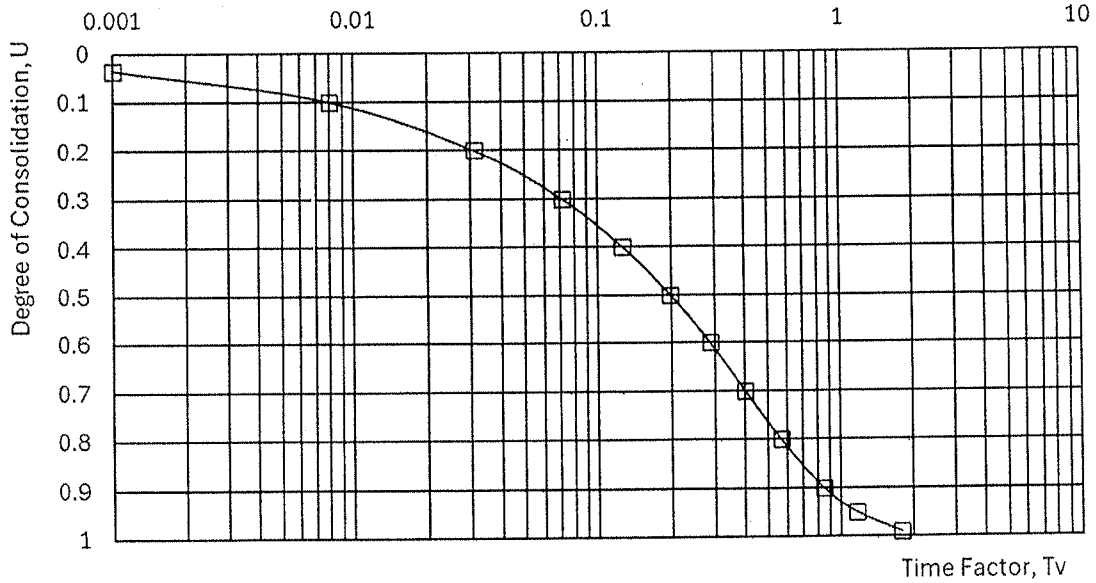

Fig. B5

A. Define the term Degree of Consolidation, U, in-terms of settlement, for a given load increment. (3 points)

B. Explain how you would compute the settlement at U = 0.5. (3 points)

C. As per Fig. B5, describe how Terzarghi's one-dimensional consolidation Theory considers the consolidation settlement to occur with time, for a particular load increment. (3 points)

D. Explain how you would obtain the Coefficient of Consolidation, c_v, using Fig. B5, for a given load increment, during the one-dimensional consolidation test. (3 points)

E. A normally consolidated clay layer is 6m thick and is subject to double drainage. The coefficient of consolidation of the clay is 0.003 m²/day, and the total primary consolidation settlement has been estimated as 120 mm. Using one-dimensional consolidation theory, determine the settlement that will occur after 3 years. (4 points)

6.

A. A constant-head permeability test was performed on a saturated soil sample using water at 30°C. The measured hydraulic conductivity at this temperature was $k_{30} = 4.5 \times 10^{-4}$ m/s. Hydraulic conductivity k is related to intrinsic permeability K by $k = K\rho g/\mu$, where ρ is the density of water, μ is the dynamic viscosity, and g is the acceleration due to gravity. Assuming the intrinsic permeability of the soil remains constant, determine the hydraulic conductivity k_{20} at 20°C.

Given:

Dynamic viscosity of water at 30°C: $\mu_{30} = 0.798 \times 10^{-3}$ Pa.s.; at 20°C; $\mu_{20} = 1.002 \times 10^{-3}$ Pa.s.

Density of water at 30 °C: $\rho_{30} = 995.7$ kg/m^3; at 20 °C: $\rho_{20} = 998.2$ kg/m^3 (5 points)

B. A laboratory Standard Proctor compaction test was performed on a clayey soil and yielded a maximum dry unit weight of 18.5 kN/m^3 at an optimum moisture content of 14%. During field compaction, a sand-cone test was conducted for the same soil. The sand-cone test yielded a wet unit weight of 19.8 kN/m^3 and a water content of 12%. Compute the Relative Compaction. (5 points)

C. A cylindrical soil specimen is tested in an Unconfined Compression Test. The specimen has an initial diameter of 38mm and an initial length of 76mm. During the test, the axial load is applied gradually and measured using a proving ring. At a certain stage of loading, the following observations are recorded:

Change in load dial reading = 22 divisions

Proving ring calibration factor = 0.025N per division

Axial settlement of the specimen = 6 mm

Assuming uniform deformation and constant volume during loading:

i. Calculate the corrected cross-sectional area of the specimen at this stage. (2 points)

ii. Determine the axial load applied to the specimen. (2 points)

iii. Compute the axial stress corresponding to this settlement. (2 points)