

**B.E. CIVIL ENGINEERING SECOND YEAR
SECOND SEMESTER EXAM 2025
SUBJECT: GEOTECHNICAL ENGINEERING I**

Time: Three hours**Full Marks =100**

(40 marks for part I and 30 Marks for part II and part III)

Use a same Answer-Script for each part**Part - I**

- **Answer any 14 MCQ (in Group A) only from the available 14 MCQs. Each MCQ is carrying 1 mark.**
- **Some MCQ question may have more than one correct alternative, so examine each alternative of each MCQ before giving your choice of the concerned MCQ.**
- **Giving all alternatives of any MCQ as your choices as correct answers of the concerned MCQ, will lead to zero marks for the concerned MCQ.**
- **Questions which belong to Group B (apart from the MCQ questions in Group A), have to be answered following the instructions given in Group B.**
- **If someone answers more questions than the required number of questions (as directed in Group B), then the answers to the first and successive questions in Group B (which jointly will make the required number of questions that have to be answered in Group B) will be evaluated only.**
- Assume reasonable data if it is not supplied.
- Maintain neatness.
- All drawings-must be drawn by pencil.
- All the notations used here for their conventional meanings.
- No code etc. will be needed to answer the questions of this part.

Instructions (with examples) for giving answers to MCQ in this part:

Suppose you have to answer following MCQ in your answer script:

MCQ 1) Name of the present prime minister of the India

- a) Jawaharlal Nehru,
- b) Narendra Modi,
- c) Manmohan Singh,
- d) None of the above.

MCQ 2) Virat Kohli is

- a) Captain of the Indian Cricket team,
- b) Husband of Anuska Sharma,
- c) President of the BCCI,
- d) All of the above.

MCQ 3) Within the last few months

- a) Trump has won,
- b) Biden left himself away from the presidential election,
- c) China attacked India,
- d) All of the above.

Then during giving answer in your answer scripts, you have to give the answers of the above MCQ in the following style only:

Part -II

Answer to MCQ 1) : b) Narendra Modi,

Answer to MCQ 2) : b) Husband of Anuska Sharma,

Answer to MCQ 3) : a) Trump has won,

b) Biden left himself away from the presidential election,

Note:

(A) In MCQ 2, if anyone give alternative "a)" as one of the correct alternative, he/ she is wrong as Virat Kohli was (not "is") Captain of the Indian Cricket team. So, read each word of the alternatives very carefully before giving your answer.

(B) In MCQ 3, if anybody either alternative "a)" or alternative "b)" as the correct alternative, he/ she will get 0.5 marks as there were two correct alternatives.

(C) There is no negative marking for choosing wrong alternative as your choice in any MCQ.

[Turn over

Form A: Paper-setting Blank

Ref No. Ex/CE/PC/B/T/223/2025

**B.E. CIVIL ENGINEERING SECOND YEAR
SECOND SEMESTER EXAM 2025
SUBJECT: GEOTECHNICAL ENGINEERING I**

Time: Three hours**Full Marks =100**

(40 marks for part I and 30 Marks for part II and part III)

Use a same Answer-Script for each part**Part - I****Group- A****Choose the correct alternative/ alternatives for any 14 MCQ from the following 14 MCQ:**

Question	CO	Marks
1) Clay mineralogy is the science dealing with (A) the structure of clay minerals (B) the study of the mineralogical composition (C) electrical properties of the clay particles (D) all of the above (E) (A) and (B) above	CO1	1
2) In montmorillonite clay, the link is due to (A) natural attraction for the cations in the intervening space (B) natural attraction for the anions in the intervening space (C) Vander Waal forces (D) all of the above (E) (A) and (C) above	CO1	1
3) All of these clay minerals have _____ basic atomic sheets. The most appropriate word to fill the blank, is: (A) two (B) three (C) four (D) depends on the situation	CO1	1
4) The water layer with thickness of ____ is called adsorbed water layer. The most appropriate words to fill the blanks, are: (A) 5 angstroms, (B) 10 angstroms, (C) 15 angstroms, (D) None of the above	CO1	1
5) The capillary water rises against gravity and is held by the (A) adhesion (B) friction (C) surface tension (D) all of the above	CO2	1
6) when an external load is applied on a saturated soil mass, the pressure is immediately transferred to (A) the inter-granular contact surface areas (B) the pore water (C) expel some water from the voids (D) all of the above	CO2	1
7) In free water, the hydrostatic pressure distribution is (A) parabolic (B) initially parabolic, then linear (C) linear (D) Initially linear, then parabolic	CO2	1
8) The shear strength of a soil is governed by the: (A) effective stress, (B) the pore water pressure, (C) the percentage of air present within the voids, (D) Both (A) and (B)	CO2	1
9) The combination of stream lines and flow lines in the proper flow domain is called (A) a flow-channel	CO2	1

**B.E. CIVIL ENGINEERING SECOND YEAR
SECOND SEMESTER EXAM 2025
SUBJECT: GEOTECHNICAL ENGINEERING I**

Time: Three hours**Full Marks =100****(40 marks for part I and 30 Marks for part II and part III)****Use a same Answer-Script for each part****Part - I**

- (B) a flow-cell
(C) a flow-net
(D) (A) and (B) above

10) The first scientific study of soil mechanics was undertaken by

CO6 1

- (A) Rankine
(B) Coulomb
(C) Terzaghi
(D) none of the above

11) During preliminary investigation, following/s is/ are useful guide/s:

CO6 1

- (A) geophysical method
(B) tests with cone penetrometer
(C) sounding rods
(D) all of the above

12) Wash boring is suitable for

CO6 1

- (A) soft clayey soils
(B) stiff clayey soils
(C) loose sands
(D) all of the above
(E) (A) and (B) above

13) the displacement caused to the natural soil during collection of the soil sample, is influenced by

CO6 1

- (A) the outside clearance
(B) the wall thickness of the sampler
(C) the inside clearance
(D) all of the above

14) Rotary samples can be used for collection of undisturbed samples in

CO6 1

- (A) stiff-to-hard clays
(B) silts and soft rock
(C) sands with some cementation
(D) all of the above

Group- B**Answer following three questions.****Answer any three from 15 (a), 15 (b), 15 (c) and 15 (d)**

- | | | | | |
|----|---|---|-----|-------|
| 15 | a | How many types of clay minerals are there?
Write short notes on any one of available basic atomic sheets those are seen in microstructures of clay minerals. | CO1 | 2+2=4 |
| 15 | b | Classify the clay water system with a tree structure. Discuss on any soil structure available among all the soil structures. | CO1 | 4 |
| 15 | c | Write short notes on any one of the followings:
i) Kaolinite clay,
ii) Montmorillonite clay
iii) Illite clay. | CO1 | 4 |
| 15 | d | Give a comparison between clay and sand in tabular form. | CO1 | 4 |

Answer any three from 16 (a), 16 (b), 16 (c) and 16 (d)

- | | | | | |
|----|---|---|-----|-------|
| 16 | a | What is "capillarity"?
If h_c represents the maximum height of capillary rise of the water in a capillary tube with diameter d , show that (mentioning the meanings of α , T_s and γ_w)
$h_c = (4 T_s \cos \alpha) / d \gamma_w$ | CO2 | 2+2=4 |
| 16 | b | What is meant by total, effective and neutral stress in a three-phase soil system? Explain. | CO2 | 4 |

[Turn over

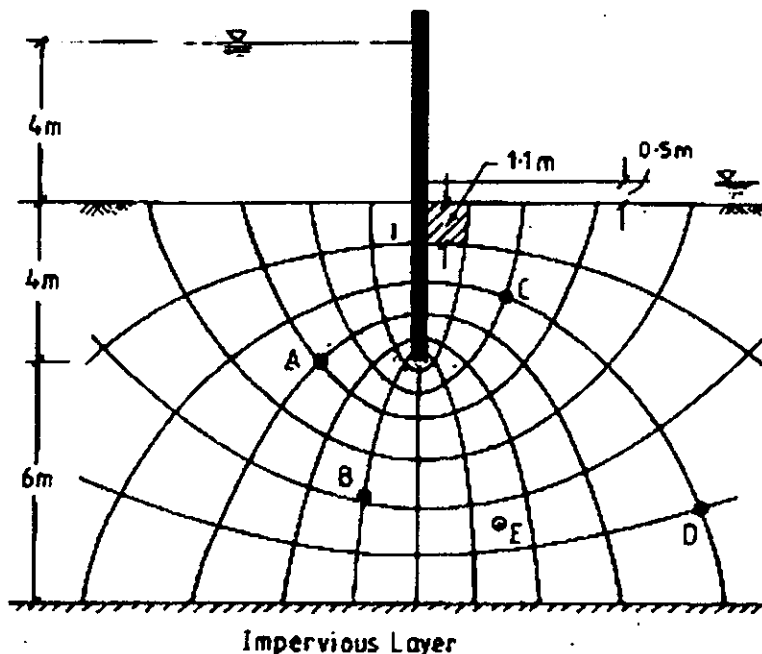
Form A: Paper-setting Blank

Ref No. Ex/CE/PC/B/T/223/2025

**B.E. CIVIL ENGINEERING SECOND YEAR
SECOND SEMESTER EXAM 2025
SUBJECT: GEOTECHNICAL ENGINEERING I**

Time: Three hours**Full Marks =100****(40 marks for part I and 30 Marks for part II and part III)****Use a same Answer-Script for each part****Part - I**

- 16 c A single row of sheet piles is driven up to a depth of 4 m in a bed of clean sand having a co-efficient of permeability of 0.002 cm/sec. An impermeable layer of very stiff clay exists at a depth of 10 m below the G.L. The sheet pile wall has to retain water up to 4 m above G.L. The height of water level on the downstream side is 0.5 m. The concerned flow-net is being shown here:



Determine the following using the above figure:

- The piezometric heads at the points A, B, C, D and E.
- The exit gradient
- Factor of safety against piping. Given, $G = 2.67$, $e = 0.95$

- 16 d The subsoil at a site consists of a fine sand layer lying in between a clay layer at top and a silt layer at bottom. The co-efficient of permeability of the sand is 100 times that of clay and 20 times that of silt, while the thickness of the sand layer is one-tenth that of clay and one third that of silt. Find out the equivalent co-efficient of permeability of the deposit in directions parallel and perpendicular to the bedding planes, in terms of the co-efficient of permeability of the clay layer.

Answer any three from 17 (a), 17 (b), 17 (c) and 17 (d)

- | | | | | |
|----|---|---|-----|-------|
| 17 | a | What are the purpose and objective of "soil exploration"? | CO6 | 2+2=4 |
| 17 | b | Write short notes on planning of soil exploration. | CO6 | 4 |
| 17 | c | Write short notes on the precautions taken during Standard Penetration Test. | CO6 | 4 |
| 17 | d | Write short notes on the sounding methods. | CO6 | 4 |

End of the questions

B.E. CIVIL ENGINEERING SECOND YEAR SECOND SEMESTER – 2025**SUBJECT: GEOTECHNICAL ENGINEERING I****Time: 3 HOURS Full Marks : 100****PART II (30 MARKS)****Assume reasonable values of data not supplied****CO1**

1. The unit weight of a soil is 14.9 kN/m^3 . The moisture content of this soil is 17% when degree of saturation is 60%. Determine saturated unit weight, void ratio and specific gravity of soil solids. 6
2. For an inorganic soil % finer for 75micron (0.075mm) is 80% and liquid limit and plastic limit are 60 and 25 respectively. Classify the soil as per IS classification system using plasticity chart. 6
3. Draw the effective stress diagram for a uniform clay deposit below a lake bed with water depth of 2.0m. Bulk density of soil below lake bed = 18.0 kN/m^3 . 4

CO4

4. Draw the shear strength failure envelope for saturated clay, partially saturated compacted clay. Also draw deviator stress vs. axial strain diagram for stiff clay, medium clay and soft clay from unconsolidated undrained triaxial tests. 3+4=7

CO5

5. Derive the expression for Rankine's active earth pressure for a c-phi soil with a neat sketch. Also give the expression for depth of tension crack for the same soil. 6+1=7

[Turn over

**B.E. CIVIL ENGINEERING SECOND YEAR SECOND
SEMESTER EXAM -2025
GEOTECHNICAL ENGINEERING I
[PART-III]**

Full Marks 100
(30 marks for this part)

Question No.	(Answer all the questions.) [Assume any data reasonably if necessary]	Marks																		
1. (a) (b) [CO3]	Discuss in brief about the factors that affect compaction. The maximum and minimum dry densities of sand were determined in the laboratory to be 1682 kg/m ³ and 1510 kg/m ³ , respectively. In the field, if the relative density of compaction of the same sand is 70%, what are its relative compaction (%) and dry density (kg/m ³)?	[5+4]																		
2. (a) (b) [CO3]	Mention and define the non-dimensional parameters that represent the solution of the Terzaghi's 1D consolidation equation with a neat sketch. The followings are the results of a laboratory consolidation test: Dry mass of the specimen = 128g; Initial height of the specimen = 2.54cm; $G_s = 2.75$, and cross section area of the specimen = 30.68 cm ² . <table><tr><th>Pressure, σ', (kN/m²)</th><th>Height of the specimen at the end of consolidation (cm)</th></tr><tr><td>0</td><td>2.540</td></tr><tr><td>54</td><td>2.488</td></tr><tr><td>108</td><td>2.465</td></tr><tr><td>216</td><td>2.431</td></tr><tr><td>432</td><td>2.389</td></tr><tr><td>864</td><td>2.324</td></tr><tr><td>1728</td><td>2.225</td></tr><tr><td>3456</td><td>2.115</td></tr></table> (i) Plot $e - \log \sigma'$ curve (ii) Determine the preconsolidation pressure (iii) Calculate the Compression Index, C_c	Pressure, σ' , (kN/m ²)	Height of the specimen at the end of consolidation (cm)	0	2.540	54	2.488	108	2.465	216	2.431	432	2.389	864	2.324	1728	2.225	3456	2.115	[4+8]
Pressure, σ' , (kN/m ²)	Height of the specimen at the end of consolidation (cm)																			
0	2.540																			
54	2.488																			
108	2.465																			
216	2.431																			
432	2.389																			
864	2.324																			
1728	2.225																			
3456	2.115																			
3. (a) (b) [CO5]	Derive an expression of factor of safety of an infinite slope with cohesionless soil. Briefly discuss different modes of failure of finite slope with neat sketches.	[5+4]																		