06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Differentiate between residual and transported soils. What would be a solution of different soil engineering problem? [2]

2. a) How does Index property of a soil differ from its Engineering property?
   b) Mention Index tests those are generally done to find the properties of individual soil grains and soil mass as a whole.
   c) Draw stress strain behaviour of different consistency states of soils.
   d) An embankment is made by compacting the soil. For compaction, 1,00,000 m3 of the soil is excavated from the borrow pit having void ratio equal to 0.8. Calculate the volume of the embankment if its void ratio after compaction is 0.6. [1+2+2+3]

3. How is the plasticity chart useful for classifying fine-grained soils? a soil has the following characteristics:
   a) Percentage of soil passing No. 200 sieve = 55
   b) Percentage of coarse fraction passing No.4 sieve = 60
   c) Liquid limit = 68%
   d) Plastic limit = 22%

   Classify given soil according to ISSCS. [2+6]

4. a) Describe basic structural units of clay minerals. Point out the difference between Silica sheet, Gibbsite sheet and Brucite sheet.
   b) Briefly Describe flocculated and dispersed structures of soils in regard with compaction. [2+2]

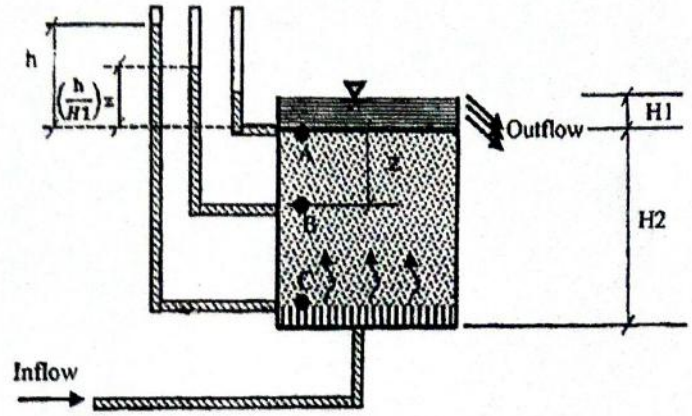
5. In the construction of a road, the compaction specification required was 95% of Proctor maximum dry density at a field moisture content within 2% of the optimum moisture content. The maximum dry density and optimum moisture content obtained in the laboratory from the Standard Proctor test were 1.95 Mg/m^3 and 13.5% respectively. A site engineer conducted sand cone test a two locations and obtained the following results.

Location No.	Mass of soil removed (gm)		Mass of sand used (gm)
	Wet	Dry	
1	43.86	38.46	39.51
2	37.38	32.21	32.39

   The density of sand used was 1.86 Mg/m^3. Check whether the specification was satisfied or not. [6]

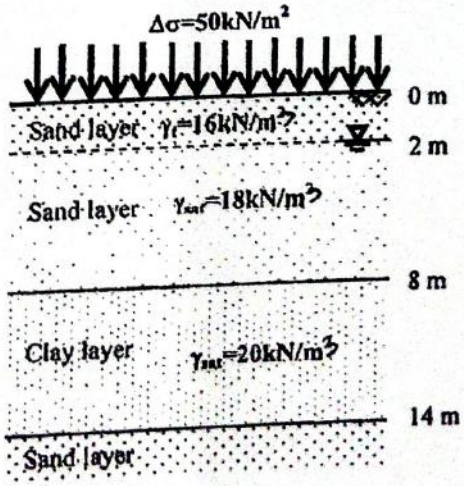
6. a) Explain the variation of effective stress due to the flow of water through the soil mass in downward and upward directions. What is discharge velocity? [2+1]
   b) In a variable head permeability test on a soil of length L_1, the head of water in the standpipe takes 5 seconds to fall from 900 to 135 mm above the tail water level. When another soil of length L_2 = 60 mm is placed above the first soil, the time taken for the head to fall between the same limits is 150 seconds. The permeameter has a cross sectional area of 4560 mm^2 and a standpipe area of 130 mm^2. Calculate the permeability of the second soil. [7]

7. a) What do you understand by Flow net in regard with seepage through soils?
   b) Derive a Laplace equation for Two-dimensional flow in the soil.
   c) In the figure below, upward seepage is shown. The rate of water supply from the bottom is kept constant. The total loss of head during upward seepage between points B and A is h. Keeping in mind the total stress at any point in the soil is solely determined by the weight of the soil and the water above it, draw the variation of total stress, pore water pressure and effective stress with depth. Take points A, B and C as reference. [1+4+3]



8. What is Isobar Diagram? Draw Isobar Diagram of 0.1Q. What is the limitation of Boussinesq's theory ? [1+5+2]

9. a) What is compressibility and what are the possible causes of compression in the soil?
   b) Define consolidation settlement, preconsolidation pressure (maximum overburden pressure), degree of consolidation and coefficient of consolidation?
   c) A soil profile is shown in below figure. If a uniformly distributed load 50 kPa is applied on the ground surface having preconsolidtion pressure, compression index and recompression index are 125 kPa, 0.36 and 0.06, respectively. Calculate the amount of settlement of the clay layer due to primary consolidation. Take γ_w = 10 kN/m^3.
   d) How can you accelerate consolidation settlement? [2+3+4+1]



10. What is stress path? What are the limitations of direct shear test? A specimen of fine dry sand, when subjected to a triaxial compression test failed at a deviator stress of 500 KN/m^2. It failed with a pronounced failure plane with an angle of 25° to the axis of sample. Compute the lateral pressure (σ_3) to which the specimen would have been subjected. [1+2+7]

11. What are the causes of the failure of earth slopes? A slope of very large extent of soil with properties c' = 0, e = 0.7, G = 2.7 and ϕ = 35° is likely to be subjected to seepage parallel to the slope with water level at the surface. Determine the maximum angle of slope for a factor of safety of 2.0. What will be the factor of safety if the water level were to come down well below the surface for this angle of slope? [2+4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What do you understand by soil mechanics and why do you need to study this? What would be a solution of different soil Engineering problem? [2]

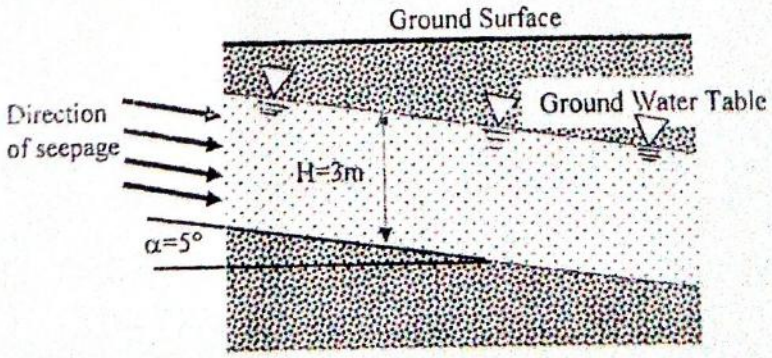
2. A relative density test conducted on a sandy soil obtained the following results: maximum void ratio = 1.25, minimum void ratio = 0.45, relative density = 40% and G = 2.65. Find the dry density of the soil in the present state. If a 3 m thickness of this stratum is densified to a relative density of 60%, how much will the soil reduce in thickness? What will be the new density in dry and saturated conditions? [8]

3. a) How do you identify fine grain soils in the field?
   b) Write down the types of soil classifications.
   c) For finding the suitability of soils as subgrade for highways, which soil classification is generally used? Write down the name of each group according to that classification. Show the general rating of those groups as a suitability of subgrade.
   d) Draw the plasticity chart in corporated in an USCS and give the group symbols of the various region in the chart. [1+2+2+3]

4. What is specific surface area and what is its effect on fine grained soil? [3+1]

5. a) What is Zero Airvoid (ZAv)?
   b) Write down the factors that affect soil compaction.
   c) The maximum dry unit weight of a compacted soil mass is found to be 18 kN/m^3 with optimum water content being 15%. Find the values of porosity and degree of saturation of this compacted soil. Also, find the value of the maximum dry unit weight on the zero air void line at that optimum water content? Take specific gravity of soil solid as 2.7. [1+2+3]

6. a) Define the meaning of capillarity in regard with normal soil ground. Also, explain the effect of water table variation on the effective stress.
   b) As shown in below figure, an inclined permeable soil layer is underlain by an impervious layer. The coefficient of permeability of the permeable soil layer is equal to 4.8×10^{-5} m/sec. If seepage of water in this soil layer occurs in the direction shown in the figure below, then calculate (i) Hydraulic gradient and (ii) rate of water flow (seepage) for that soil layer. Take the thickness of soil layer, H =3 m and the angle of inclination of that soil layer, $\alpha = 5°$. Assume any other necessary conditions.



c) Write down the names of testing method for determining coefficient of permeability in the laboratory and field.

d) Differentiate between discharge velocity and seepage velocity. [2+4+2+2]

7. What are the properties of flow net? Prove that flow lines intersect the equipotential line at right angles. [2+6]

8. a) Vertical stress due to a point load can be calculated based on Boussinesq's and Westergaard's solutions. What is the basic difference between these two solutions?

b) Briefly explain Newmark's Influence Chart. What is the main use of this Chart?

c) Describe approximate stress distribution methods for loaded areas. [2+3+3]

9. a) What are the methods of accelerating consolidation settlement? What are the different causes of preconsolidation of soil? [1+2]

b) Derive a governing differential equation for one dimensional consolidation theory by Terzaghi? [7]

10. a) Write down the names of shear strength tests that can be performed in the laboratory? How do you calculate shear strength in direct shear test?

b) If direct shear is conducted for loose and dense sands, then plot graphs of Shear stress and Change in height of specimen versus Shear displacement.

c) Unconfined compression test is a special type of unconsolidated undrained triaxial test. Why?

d) Derive an expression for principal stresses at failure conditions. [2+2+1+5]

11. a) Explain finite slope and infinite slopes in regard with slope stability.

b) Find Factor of Safety of slope using $\phi = 0$ analysis method. Assume necessary conditions. [2+4]

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.06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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- ✓ *Assume suitable data if necessary.*

1. What are the various field of application of soil mechanics? Write the factors that determine the characteristics of a residual soil. [1+1]

2. Define thixotropy and flow index. A sample of saturated clay has a volume of 97 cm^3 and mass of 202 gm. When completely dried, its volume is 87 cm^3 and mass of 167 gm. Determine: [2+6]
   i) Initial water content
   ii) Specific gravity of soil solids
   iii) Shrinkage limit

3. Classify the following soils a, b and c as per unified soil classification system: [3+3+2]
   i) Soil passing form 75μ sieve = 4%, soil passing from 4.75mm sieve (Coarse fraction) = 62%, coefficient of uniformity = 5, coefficient of curvature = 2.6
   ii) Soil passing from 75μ sieve = 62%, liquid limit = 54%, plastic limit = 23%
   iii) Soil passing from 75μ sieve = 39%, liquid limit = 33%, plastic limit = 18%

4. What is isomorphous substitution? Compare between 1:1 and 2:1 minerals. [1+3]

5. a) Draw compaction curve for a soil showing maximum dry density, optimum water content, zero-air void line, dry side and wet side of optimum water content.
   b) Compare the compaction characteristic curve for sand and clay. [3+3]

6. What are the factors that influence the height of capillary rise in soils? Establish the relationship between seepage velocity and superficial velocity. A soil stratum having thickness of 1.15 m, porosity = 30% and G = 2.7 is subjected to an upward seepage head of 1.95 m. Determine the thickness of coarse material required above the soil stratum to provide a factor of safety of 2 against piping assuming that the coarse material has the same specific gravity and porosity as the soil and head loss in the coarse material is negligible. [1+3+6]

7. a) Derive the relationship for the seepage discharge through anisotropic soil.
   b) If the upstream and downstream heads of an impervious dam are 8 m and 1 m repectively, then find the seepage discharge when seepage of water takes place from upstream to downstream via the isotropic soil lying below the impervious dam. Take total number of flow channels and equipotential drops as 9 and 12, respectively. Also, take coefficient of permeability of the soil layer, $k = 3\times10^{-4}$ cm/s. [4+4]

8. What is Newmarks influence chart? A water tank is supported by a ring foundation having outer diameter of 10 m and inner diameter of 7.5 m. The ring foundation transmits uniform load intensity of 160kN/m^2. Compute the maximum vertical stress induced at a depth of 4 m below the foundation using Boussinesq's theory. [2+6]

9. Distinguish between normally consolidated and over consolidated soil deposits. A 5 m thick saturated soil layer has a compression index of 0.25 and coefficient of permeability 3.2×10^{-3} mm/s. If the void ratio is 1.9 at vertical stress of 0.15 N/mm^2, calculate the void ratio when the vertical stress is increased to 0.2 N/mm^2. Also calculate settlement due to above stress increase and time required for 65% consolidation. [2+8]

10. a) Write down the names of shear strength tests. [2]

b) Consolidated undrained triaxial test was performed for a normally consolidated saturated clay and cell pressure, $\sigma_3 = 200\text{kN/m}^2$, axial stress, $\sigma_1 = 550\text{kN/m}^2$ and pore water pressure, $u_w = 80\text{kN/m}^2$ were measured. Answer the followings: [2+2+2+2]

i) Plot the Mohr circle of stresses in regard with Total stress.

ii) Plot the Mohr circle of stresses in regard with effective stress.

iii) Assume the condition of normal consolidation and c'=0. Then obtain the value of ϕ'.

iv) If Mohr-Coulomb's failure criterion is assumed to be valid, then determine the direction of failure plane that might occur within the specimen

11. An infinite slope is made of clay with the following properties: [6]

$\gamma_t = 18\text{kN/m}^3$, $\gamma' = 9\text{kN/m}^3$, $c = 25\text{kN/m}^2$ and $\Phi' = 28°$. If the slope has an inclination of 35° and height equal to 12m, determine the stability of the slope, when (a) the slope is submerged and (b) there is seepage parallel to the slope.

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What are the different civil engineering problems related to soils? What would be a solution of such problems? [2+1]

2. a) Draw a graph showing different states of consistency of soil in reference to stress strain behavior.

   b) An embankment of 1,00,000 m^3 volume has to be constructed by compacting the soil brought from excavation site. After the compaction, dry unit weight of compacted soil (embankment) will be 16 kN/m^3. Also, bulk unit weight and water content of the soil at the excavation site are 12 kN/m^3 and 15%, respectively. Find the volume and weight of soil to be excavated from the excavation site. Take specific gravity of soil solid as 2.70. [3+5]

3. Give the grain size ranges of different soil types according to (MIT). Explain the different field identification methods for fine-grained soils. [3+5]

4. Explain double diffuse layer. Among Kaolinite, Montmorillonite and Illite clay minerals, which one swells the most and why? [4]

5. The following results were obtained from a standard compaction test. [6]

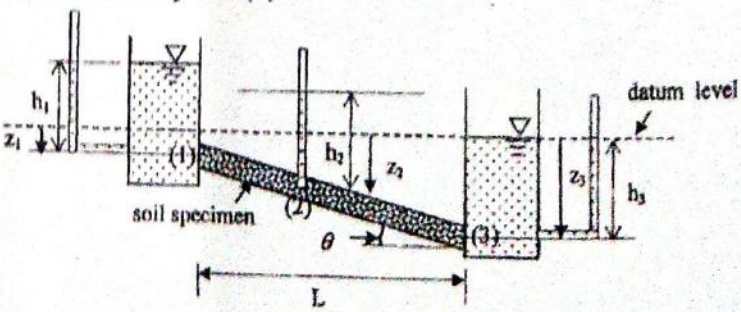
Test No.	1	2	3	4	5	6
Water content (%)	11.0	12.1	12.8	13.6	14.6	16.3
Mass of compacted soil (gm)	1920.5	2051.5	2138.5	2147.0	2120.0	2081.5

The specific gravity of solids is 2.7 and volume of the compaction mould is 1000 cm^3. A field compacted soil sample showed water content of 35% and unit weight of 2.318 Mg/m^3.

i) Draw compaction curve and determine the maximum dry unit weight and OMC.
ii) Find the relative compaction (RC)
iii) Find the degree of saturation at the maximum dry unit weight

6. a) In the figure below, water flows from point (1) to point (3) via the soil specimen which is inclined at an angle θ. Piezometers inserted at points 1, 2 and 3 show piezometric heights h_1, h_2 and h_3 respectively. In the figure below z_1, z_2 and z_3 represent the distance of points 1, 2 and 3 from datum level. [4+1]

   i) Find total heads at points 1, 2 and 3 from datum level.
   ii) Find the hydraulic gradient for this case when water enters the specimen from point (1) and exits from point (3).

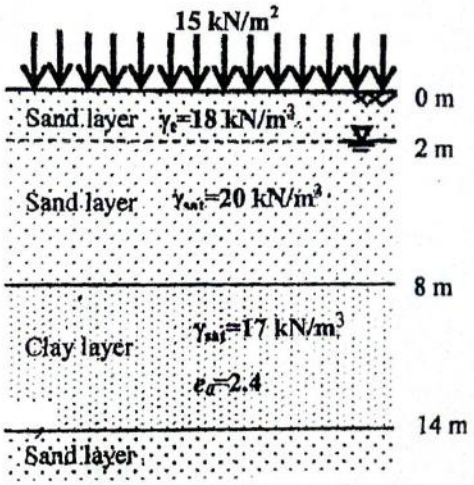


   b) Obtain the expression for the critical hydraulic gradient necessary for quick condition to develop. Why there is more likelihood of quick conditions in sand than in clay? [4+1]

7. What are the basic requirements for the design of protective filters? Is the flow through an earth dam confined flow or unconfined flow? Prove that flow lines intersect the equipotential line at right angle. [2+1+5]

8. State the assumptions of Boussinesq's equation. A water tower has circular foundation of diameter 10 m. Total weight of tower including foundation is 1800 tonnes. A very weak stratum having bearing capacity of 10 t/m^2 lies 3 m below the foundation level. Calculate the stress due to foundation load at the top of the weak stratum and as certain whether it will be safe to construct the water tower at that place with given foundation size.

9. a) A surcharge load of 15 kPa was applied on the ground surface having the soil profile as shown in figure below Consolidation settlement took place in the clay layer. Consolidation test was done for the clay layer and following results were obtained: Coefficient of consolidation, $c_v = 3.25\times10^{-7}$ m^2/s, Compression index, $C_c = 1.2$ and Coefficient of permeability, $k = 3.5\times10^{-9}$ m/s. Assume that the consolidation of clay layer is solely due to the change in stress at the center of the clay layer. Also, consider that there is no change in ground water level before and after the consolidation Take $\gamma_w = 10$ kN/m^3.



Determine total, effective and pore water pressure at the center of the clay layer (i) before applying the surcharge load, (ii) immediately after applying the surcharge load and (iii) sufficiently after a long time of applying the surcharge load.

b) What will be the final settlement of the clay layer after the primary consolidation? Also, determine the settlement of clay layer after 0.5 year. [For $U = 70\%$, $T_v = 0.403$, for $U = 80\%$, $T_v = 0.569$, for $U = 90\%$, $T_v = 0.848$] [5+4]

10. How are the drainage conditions adopted in a triaxial shear test realized in the field? Derive the general formula that gives the value of the major principal stress σ_1 as a function of minor principal stress σ_3, the cohesion and angle of internal friction. 3+7]

11. a) What are the probable types of failure of slope?

b) Write down the possible causes of increase in shear stress or decrease in shear strength of soil in regard with slope instability.

c) Explain remedial measures that can be used to prevent slope failure. [2+3+1]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary log-scale and simple graph papers are provided.***
- ✓ *Assume suitable data if necessary.*

1. Explain briefly the different Civil engineering and infrastructure development problem related to soils. [2]
2. Sandy soil in a borrow pit has unit weight of solids as 25.8 kN/m^3, water content equal to 11% and bulk unit weight equal to 16.4 kN/m^3. How many cubic meter of compacted fill could be constructed of 3500 m^3 of sand excavated from borrow pit, if required value of porosity in the compacted fill is 30%. Also calculate the change in degree of saturation. [8]
3. What is the purpose of classifying soils? What are the basic requirements of a soil classification? Draw the plasticity chart incorporate in Indian standard soil classification system and give group symbols of various regions in the chart. [1+2+5]
4. Describe the types of possible soil structures. [4]
5. What are the factors affecting compaction? How will you control the compaction in the field? [2+4]
6. Obtain the expression for the critical hydraulic gradient necessary for a quick condition to develop by using effective stress approach. Why is there more likelihood of quick condition in sands than in clay? For a field pumping test, a well was sunk through a horizontal stratum of sand 14.5 m thick and underline by a clay stratum. Two observation wells were sunk at horizontal distances of 16 m and 34 m respectively from the pumping well. The initial position of the water table was 2.2 m below ground level. At a steady state pumping rate of 925 liters/minute, the drawdowns in the observation wells were found to be 2.45 m and 1.20 m respectively. Calculate the coefficient of permeability of the sand. [3+1+6]
7. What is unconfined flow in seepage flow? Show the process of calculation of uplift force at base of concrete dam due to seepage flow between dam and impervious layer using flow net. [2+6]
8. A water tank is supported by a ring foundation having outer diameter of 10 m and inner diameter of 7.5 m. The ring foundation transmits uniform load intensity of 160 kN/m^2. Compute the vertical stress induced at depth of 4 m, below the center of ring foundation. [8]

9. What is the governing differential equation in one dimensional consolidation theory? [3+3+4]

The results of a laboratory consolidation test on a clay sample are given below:

Pressure P ((kN/m^2)	void ratio, e
23.94	1.112
47.88	1.105
95.76	1.080
191.52	0.985
383.04	0.850
766.08	0.731

i. Draw an e-log p plot.
ii. Determine the pre-consolidation pressure (p_c).
iii Find the compression index (c_c).

(Provide log scale graph paper)

10. Two identical soil specimen were tested in a triaxial apparatus. First specimen failed at a deviator stress of 770 kN/m^2 when the cell pressure was 2000 kN/m^2. Second specimen failed at a deviator stress of 1370 kN/m^2 under a cell pressure of 400 kN/m^2. Determine the value of c and ϕ analytically. If the same soil is tested in a direct shear apparatus with a normal stress of 600 kN/m^2, estimate the shear stress at failure. [10]

11. What types of slope failures are common in soils? What factors provoke slope failure? What methods of analysis are used to estimate the factor of safety of a slope? [1+2+3]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
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Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

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1. In what way does the knowledge of soil mechanics help in civil engineering practice? [2]
2. A project engineer receives a laboratory report with tests performed on central material testing laboratory, IOE, Pulchowk. The engineer suspects that one of the measurements is in error. Are the engineers suspicions correct? If so, which one of these values is wrong and what should be its correct value? [8]

   γ = unit weight of sample = 18.4 kN/m^3
   γ_s = unit weight of solids = 26.1 kN /m^3
   w = water content = 40%
   e = voids ratio = 1.12
   S = degree of saturation = 95%

3. Compare the Plasticity chart provided to classify fine grained soil in USCS, ISSCS and BSCS. [8]
4. What is the effect of increased surface area on the properties of soils? Illustrate by schematic diagrams how the clay minerals Kaolinite, Illite and Montmorillonite are formed. [1+3]
5. An embankment for a highway 30 m wide and 1.5 m compacted thickness is to be constructed from a sandy soil trucked from a borrow pit. The water content of the sandy soil in the borrow pit is 15% and its void ratio is 0.69. The specification requires the embankment be compacted to a dry unit weight of18 KN/m^3. Determine for 1 km length of embankment, the following: [2+2+2]

   i) The weight of sandy soil from the borrow pit required to construct the embankment
   ii) The number of 10 m^3 truck loads of sandy soil required for the construction
   iii) The degree of saturation of the sandy soil in -situ

6. Determine the effective stress at 2m, 4m, 6m 8m and 10m in a soil mass having γ_{sat} = 21 kN/m^3. Water table is 2 m below ground surface. Above water table there is capillary rise up to ground surface. Also draw total stress diagram up to 10.00m. [10]
7. What is a flow net? Describe its properties and uses. Prove that the discharge through an earth mass is given by, $q = K*h*(N_f/N_d)$ [1+2+5]
   K = coefficient of permeability
   h = head
   Nf = number of flow channels
   Nd = Number of equipotential drops

8. An elevated structure with a total weight of 10,000 KN is supported on a tower with 4 legs. The legs rest on piers located at the corners of a square 6 m on a side. What is the vertical stress increment due to this loading at point 7 m beneath the center of the structure? [8]

9. A building is constructed in site having 4 m thick clay layer. The effective stress in mid of clay layer is 60 KN/m^2. The oedometer test analysis gives preconsolidation pressure of clay is 100 KN/m^2, coefficient of compression 0.32, coefficient of recomprerssion 0.12 and intial void ratio 0.27. Calculate the settlement due to consolidation if [5+5]

   i) Building increase 30 KN/m^2 stress at mid of clay layer
   ii) Building increase 80 KN/m^2 stress at mid of clay layer

10. Draw a typical stress-strain and volume change characteristics curves for loose sands and dense sands from consolidated drained test. An unconfined compression test was carried out on a saturated clay sample. The maximum load the clay sustained was 127 N and the vertical displacement was 0.8 mm. The size of the sample was 38 mm diameter and 76mm long. Determine the undrained shear strength. Draw Mohr's circle of stress for the test and locate undrained shear strength (c_u). [3+7]

11. Define factor of safety. How can you calculate the factor of safety in C-ϕ analysis? [1+5]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Bhadra

Exam.	[illegible]		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. Compare the soil classification criteria for fine soil in Indian standard soil classification system and unified soil classification system. [8]

2. The following results refer to the liquid limit test. [8]

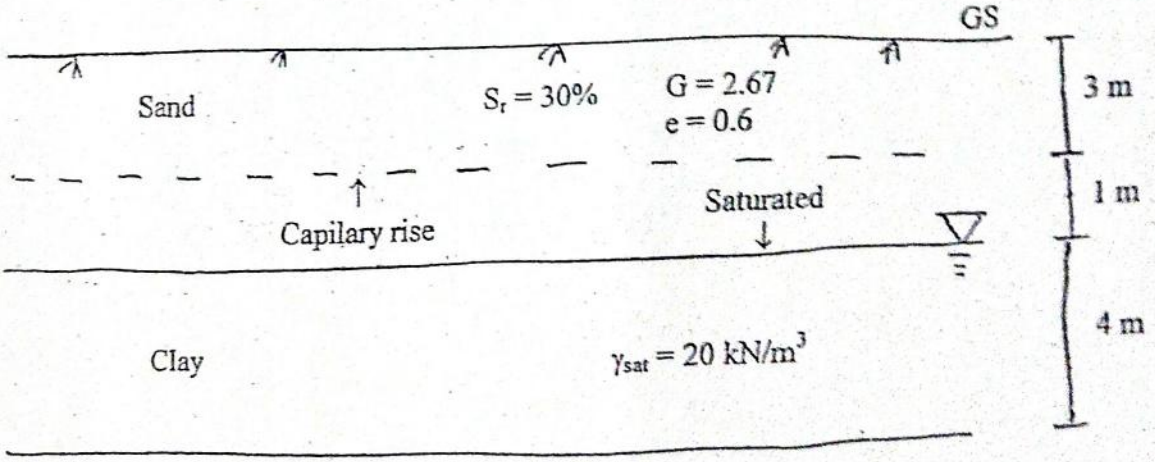
No. of blow	33	23	18	11
Water content (%)	41.5	49.5	51.5	55.6

The plastic limit form two tests were 23% and 24% respectively. Determine the plasticity index and toughness index for the soil.

3. List the types of soil depending on its formation. Describe the possible soil structures in natural soil mass. [2+4]

4. What is the effect of compaction on the engineering properties of the soil? How would you decide whether the soil should be compacted the dry of the optimum or the wet of optimum? [6]

5. For the subsoil conditions as shown in figure below, plot the total, neutral and effective stress distribution up to the bottom of the clay layer. [10]



6. Derive an equation for topmost flow line in case of a homogeneous earth dam. [8]

7. A rectangular area 4 m × 2 m is uniformly loaded with a load intensity of 100 KN/m^2 at a ground surface. Determine the vertical pressure at a depth 3 m below a point within the loaded area 1 m away from the short edge and 0.5 m away from the long edge. Use equivalent point load method. [8]

8. A 25 mm thick clay sample was used in oedometer consolidation test. During test it takes one month for 50% consolidation. If same clay of 5 m thick is in between rock layer and sand layer in site. Calculate the time required for 90% consolidation in site after construction of building in site. [10]

9. A consolidated undrained test was conducted on a clay specimen and the following result were obtained. [10]

Cell pressure (KN/m^2)	200	400	600
Deviator stress (KN/m^2)	118	240	352
Pore water pressure at failure (KN/m^2)	110	220	320

Determine the shear strength parameter with respect to effective stress.

10. An embankment is to be made from a soil with $C_u = 20\ kN/m^2$, $\phi_u = 20°$ and $\gamma = 20\ kN/m^2$. If a factor of safety of 1.5 with respect to shear strength is required for the embankment slope, determine the limiting height of the slope, if built at a slope angle of 25°. [6]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- Candidates are required to give their answers in their own words as far as practicable.
- *Attempt **All** questions.*
- *The figures in the margin indicate **Full Marks***
- *Assume suitable data if necessary.*

1. a) Define Soil Mechanics and write its importance. What type of Geo-technical problems may occur in Civil Engineering and Infrastructure Development, describe in brief. [2+3+3]

   b) A clay sample, containing its natural moisture content, weighs 0.333 N. The specific gravity of solids of this soil is 2.70. After oven-drying, the soil sample weighs 0.2025 N. The volume of the moist sample, before oven-drying, found by displacement of mercury is 24.30 cm^3. Determine the moisture content, void ratio and degree of saturation of the soil. [8]

2. a) What is compaction? Explain the salient features of modified AASHTO compaction test. How will you control the compaction in the field? [1+2+5]

   b) A permeameter of diameter 82.5 mm contains a column of fine sand 460 mm long. When water flows through it under constant head at a rate of 191 ml/min, the loss of head between two points 250 mm apart is 380 mm. Calculate coefficient of permeability. If falling head test is made on same sample using a stand pipe of diameter 30 mm, in what time the water level in stand pipe will fall from 1560 mm to 1060 mm? [4+4]

3. a) Define phreatic line and write down the procedure to construct pheratic line on any Earthen Dam with neat sketch. [8]

   b) A point load of 140 kN is applied at the ground surface. Construct a pressure bulb when the stress imposed becomes 20% of the applied load. [8]

4. a) Define shear strength of soil. Using the result of triaxial test, derive the relation for major principle stress (σ_1) in terms of minor principle stress (σ_3) and shear strength parameters (i.e. c and φ). [8]

   b) An open layer of clay 4 m thick is subjected to loading that increases the average effective vertical stress from 185 kPa to 310 kPa. Given m_v = 0.00025 m^2/KN, C_v = 0.75 m^2/year, determine [8]

   i) the total settlement,
   ii) the settlement at the end of 1 year,
   iii) the time in days for 50% consolidation,
   iv) the time in days for 25 mm of settlement to occur.

5. a) Draw the void ratio effective stress diagram and define coefficient of compressibility and compression Index. Define Normally Consolidated and Over Consolidated Clay. [3+2+3]

   b) An infinite slope has an inclination of 26° with the horizontal. It is underlain by a firm cohesive soil having Gs = 2.72 and e = 0.52. There is a thin weak layer 6 m below and parallel to the slope (c' = 25 kPa, ϕ' = 16°). Compute the factors of safety when (i) the slope is dry, and (ii) ground water flows parallel to the slope at the slope level. [8]

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07 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define soil and soil mechanics. Also define flow index and toughness index of soil. [2+2]

   b) A sample of soil with liquid limit of 72.8% was found to have a liquidity index of 1.21 and water content of 81.3%. What are its plastic limit and plasticity index? [6]

2. A sample of inorganic soil has the following grain size characteristics. [8]

Size (mm)	Percent passing
0.075 (No. 200)	55

   The liquid limit is 50% and plastic limit 40%.

   Classify the soil according to the AASHTO classification system.

3. What are soil structure and fabrics? Explain electrical charges on clay minerals. [4]

4. Enlist the reasons for the maximum dry density obtained in field not being equal to that obtained in the laboratory. Also prove that the energy applied in the modified proctor test is 4.56 times greater than that of the standard proctor test. [4+2]

5. a) Mention the effect of the seepage flow on the effective stress. [4]

   b) A tube well is driven in a confined aquifer of 24 m thick. The aquifer is met 25 m below ground level. The static water table is 15 m below ground level. The discharge of tube well is found to be 6000 m^3/day when the draw down in the well is 12.25 m. Find the diameter of the tube well when the radius of the circle of influence (R) is 300 m. Take the permeability 24.5 m/day. [6]

6. Derive an equation for topmost flow line in case of a homogeneous earth dam with horizontal filter at the base. [8]

7. What is significant depth? Draw the stress contour for the significant depth for a single concentrated load of 1000 kN acting at the ground surface. [2+6]

8. a) Explain the factors that affect the degree of consolidation. [4]

   b) A stratum of clay is 2 m thick and has an initial overburden pressure of 50 KN/m^2 at its middle. Determine the final settlement due to an increase in pressure of 40 KN/m^2 at the middle of the clay layer. The clay is over consolidated, with a pre-consolidation pressure of 75 KN/m^2. The values of the coefficients of recompression and compression index are 0.05 and 0.25 respectively. Take the initial void ratio as 1.40. [6]

9. a) Explain Mohr Coulomb failure criterion. State major principle plane, intermediate plane and minor principle plane. [5]

   b) Explain with figure the procedure of triaxial shear test. [5]

10. a) Explain the various types of factor of safety related in stability of slope. Write differences between finite and infinite slope. [2+1]

    b) Explain friction circle method of stability of slope. [3]

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Tribhuvan University
Institute of Engineering
Examination Control Division
2070 Magh

Exam.	New Back (2065 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics (CE552)

- Candidates are required to give their answers in their own words as far as practicable.
- *Attempt **All** questions.*
- *The figures in the margin indicate **Full Marks**.*
- *Assume suitable data if necessary.*

1. a) Explain the types of problems that geotechnical engineer faces. What are the types of clay minerals of engineering interest? [2+4]

   b) The following results refer to the liquid limit test [8]

No of blows	33	23	18	11
Water content (%)	41.5	49.5	51.5	55.6

   The plastic limit from two tests were 23% and 24% respectively. Determine the plasticity index and toughness index for the soil.

2. How do you identify the fine grain soil in the field? Explain the process of the classification of the fine soil with the help of plasticity chart. [4+4]

3. a) What is difference between compaction and consolidation? [3]

   b) How will engineering properties of soil be improved by compaction. [3]

4. State quick sand condition. A sand deposit consists of two layers the top layer is 3 m thick (ρ=1800 kg/m^3) and the bottom layer is 3.5 m thick (ρsat = 2500 kg/m^3). The water table is at a depth of 4 m from the surface and zone of capillary saturation is 1 m above the water table. Draw the diagram showing the variation of total stress, neutral stress and effective stress. [2+8]

5. State the flow net in a non-homogeneous soil mass. Prove that the stream function satisfies the laplace equation. Explain the protective filters for prevention of erosion. [2+4+2]

6. a) Mention the process of the drawing the pressure bulb. [4]

   b) A strip footing of width 2 m carries a load of 400 KN/m. Calculate the maximum stress at a depth of 5 m below the center line of the footing. Compare the results with 2:1 distribution method. [2+2]

7. Drive the general equation for the calculation of settlement from one-dimensional primary consolidation. How can you differentiate log time method with square root of time method? [6+4]

8. a) State the Mohr failure theory and derive the Mohr Coulomb equation. [4]

   b) In a CD test, a specimen of saturated sand fails under an additional stress of 250 KN/m^2 when the cell pressure was 100 KN/m^2. Draw the Mohr circle and determine: [6]

      i) Angle of shearing resistance
      ii) Inclination of failure plane with the horizontal
      iii) Values of shear and normal stress on the Failure plane.

9. A granular soil has Υ_{sat} = 19 KN/m^3, ϕ=35°. A slope has to be made of this material. If a factor of safety of 1.30 is needed against the failure, determine the safe angle of the slope. [6]

   i) When the slope is dry
   ii) If the seepage occurs at and parallel to the surface of the slope

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Bhadra

Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. a) What is soil fabric? Why are the space between mineral particles important for geotechnical engineers and what is it called? [4]

   b) The results of a particle size analysis are shown in the table below:

Sieve size, (mm)	63	37.5	19	13.2	9.5	6.7	4.75	2.36	1.18	0.6	0.212	0.075
Mass retained, (g)	0	26	28	18	20	49	50	137	46	31	34	30

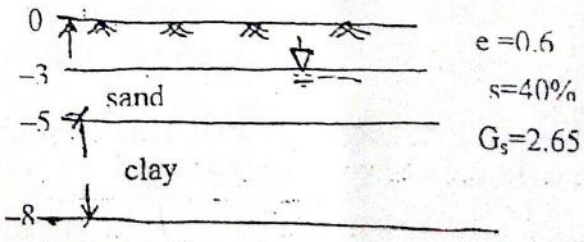
   The total mass was 469g. Plot the particle size distribution curve and determine the coefficient of uniformity, coefficient of curvature and soil description as per BSCS and AASHTO. [8]

2. a) What are different types of soil structure which can occur in nature? Describe in brief. [4]

   b) The moisture content of a specimen of a clay is 22%. The specific gravity of solid is 2.70. (i) Plot the variation of void ratio with degree of saturation and calculate the void ratio and wet densities at 50% saturation. (ii) A sample of this soil with initial degree of saturation of 50% is isotropically compressed to achieve a void ratio of 0.55. Calculate the volume change in terms of percentage of the initial volume. How much of this volume change is due to the outward flow of water from the sample? [8]

3. a) How would you check whether the desired compaction is achieved in the field? [6]

   b) For the subsoil conditions shown in figure below draw the total, neutral and effective stress diagram up to a depth of 8m. Neglect capilary flow. [10]



4. a) What are the basic assumptions in Boussinesq's theory of stress distribution in soils? Determine vertical pressure distribution on a horizontal plane at given depth below the ground surface due to point load applied at the ground surface. [8]

   b) A flow net for seepage under the sheet piling is shown in figure below. Estimate approximately the quantity of seepage in cum/day/m length of the piling, if the permeability of the sand is 5×10^{-3}cm/s. If the saturated unit weight of sand is 19kN/m^3, what is the factor of safety against piping in front of the piles. [8]

07 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Poush

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define the term 'soil' and 'soil mechanics'. Write down its importance. [2]

   b) A sample of clay was coated with paraffin wax and its mass, including the mass of wax was found to be 697.5gm. The sample was immersed in water and the volume of the water displaced was found to be 355 ml. The mass of the sample without wax was 690.0 gm, and the water content representative specimen was 18%. Determine the bulk density, dry density, void ratio and the degree of saturation. The specific gravity of the solids was 2.70 and that of wax was 0.89. [8]

2. a) Differentiate the standard and modified proctor test. Explain the role of water in the compaction. [4+2]

   b) A fine sand deposit is located between the ground surface to a depth of 10m. The soil has an average void ratio of 0.70 and specific gravity of solids of 2.65. The water table is found at a depth of 4m below the ground level. Above the water table the degree of saturation of sand is 55%. Determine the total stress, pore water pressure and effective stress at a depth of 8 m below the ground surface. Calculate also the change in the effective stress if the soil gets saturated up to a height of 1m above the water table due to capillary action. [5+5]

3. a) How can the soil be classified by the textural soil classification system? Explain it with neat diagrams. [8]

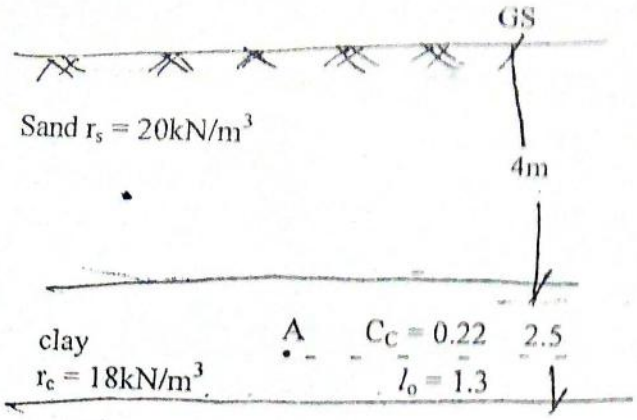
   b) What are the various minearls in the clay soil? Describe them. [4]

4. a) Describe the properties of flow nets. Explain the process of flow net construction in an earthen dam. [3+5]

   b) An elevated structure with a total weight of 10,000 kN is supported on a tower with 4 legs. The legs rest on piers located at the corners of a square 6 m on a side. What is the vertical stress increment due to this loading at a point 7 m beneath the centre of the structure. [8]

5. a) Discuss Terzahi's theory of consolidation, stating the various assumption and their validity. [4]

   b) Calculate the final settlement of the clay layer shown in figure due to an increase of pressure of 30 kN/m^2 at mid-height of the layer. Take γ_w = 10kN/m^3. [6]



6. a) What is Mohr's strength theory for soils? Sketch typical strength envelops for a clean sand. [4]

b) A series of direct shear test was conducted on a soil, each test carried out till the sample failed. The following results were obtained. [6]

Sample no.	Normal stress (kN/m^2)	Shear stress kN/m^2
1	15	18
2	30	25
3	45	32

Determine the cohesion intercept and the angle of shearing resistance.

7. What are the assumption that are generally made in the analysis of slopes? Discuss briefly their validity. [6]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Bhadra

Exam.		Regular	
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics

- Candidates are required to give their answers in their own words as far as practicable.
- *Attempt All questions.*
- *The figures in the margin indicate Full Marks.*
- *Semi-log graph paper will be provided.*
- *All notations are as usual.*
- *Assume suitable data if necessary.*

1. a) Explain the different modes of soil formation. Differentiate between 'residual' and 'transported' soils. What is clay mineral? Mention the types of clay minerals and explain any one of it with neat sketch. [8]

   b) Two soils A and B are mixed dry in proportion of 30%:70% by mass. The specific gravity of soil A and B are 2.60 and 2.70 respectively. If the bulk density of mixed soil is 1.8 gm/cc at 15% water content, determine void ratio and degree of saturation. [8]

2. a) Why classification of soil is required in Civil Engineering? What are common classification systems? How do you classify a soil by the B.S. classification system? Explain with neat sketch. [8]

   b) A pumping test was made in a medium sand having depth of saturation 20m, where a bed of clay was encountered. The normal ground water level was at the surface. Observation wells were located at 4m and 10m from the pumping well. At a discharge of $2m^3$/min from the pumping well, a steady state was attained in 24 hours. The draw down at 4mtr well was 1mtr and at 10 mtr was 0.5mtr. Draw neat sketch and compute the permeability of soil. If draw down is 6m in the main well and dia of tube-well is 30cm then what is the distance between center of well and zero draw down. [4+4]

3. a) Define Flow net, write its characteristics and derive the expression for seepage discharge through any earten structure in terms of N_d (Number of potential drop) and N_f (Number of flow channel), k (coeff. of permeability) and H (head of water). [2+2+4]

   b) The following results were obtained from a standard compaction test: [8]

Mass of compacted soil, g	1920.5	2051.5	2138.5	2147.0	2120	2081.5
Density, kg/m^3	11.0	12.1	12.8	13.6	14.6	16.3

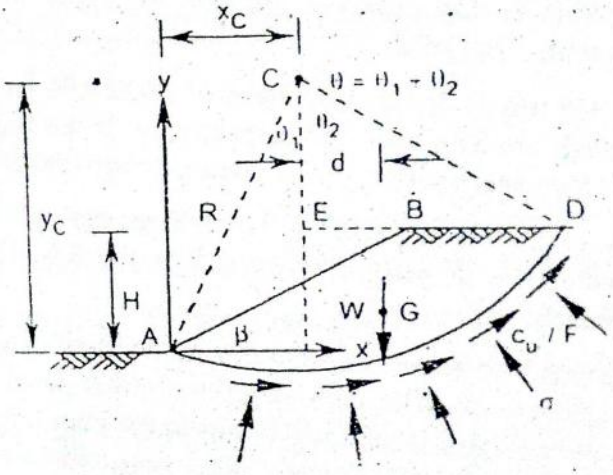
The specific gravity of the solids is 2.68, and the volume of the compaction mould is $1000cm^3$. Plot the compaction curve and obtain the maximum dry density and optimum moisture content. Plot also the 0%, 5% and 10% air voids curves. At the maximum dry density, calculate the void ratio, degree of saturation and air content. If the natural moisture content in the field is 11.8%, what will be the possible maximum dry density if the soil is compacted with its natural moisture content?

4. a) What are the different standard triaxial shear tests with respect to drainage conditions? Explain with reasons the situations for which each test is preferred. Explain the Mohr-Coulomb strength envelope. Sketch and explain the stress-strain relationship for dense and loose sand. [8]

b) A raft foundation of 8m diameter is placed on the ground surface and carries a load of 10000kN including self weight. A 2m thick soft clay layer exists 5m below the ground surface. Take $m_v = 3*10^{-4}\ m^2/kN$. Compute (i) The vertical stress increment at the centre of clay layer using Boussinq's theory, (ii) Consolidation settlement of clay layer. Take $\gamma = 15kN/m^3$. [4+4]

3. a) Derive the expression to obtain consolidation settlement of any cohesive soil deposit having initial thickness Ho, initial void ratio, e_o, initial overburden pressure, σ_o, compression index (Cc), if there is increase in effective stress of $\Delta\sigma$ due to the construction of building. [3]

b) Determine the factor of safety for a 1 vertical to 2 horizontal slope 5m high using a trial toe circle for which $X_c = 4.5m$ and $Y_c = 8m$ as shown in the figure below. The cross sectional area of the sliding mass is $40.22m^2$ and its centroid is located 2.96m to the right of the center of the trial circle. The soil properties are: $C_u = 18kPa$, $\phi_u = 0$ and
$\gamma = 18kN/m^3$. [8]



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07 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Magh

Exam.	New Back (2066 & Later Batch)	Full Marks	80
Level	BE	Pass Marks	32
Programme	BCE	Time	3 hrs.
Year / Part	II / II		

Subject: - Soil Mechanics

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the different types of soil based on its formation? What is a compaction curve? Draw a compaction curve and describe its salient features. [2+2+4]

   b) A natural soil deposit has a bulk unit weight of $17kN/m^3$ and water content of 10%. Determine the amount of water required to be added to $1m^3$ of soil to raise the water content to 15%. Assume void ratio to remain constant. [8]

2. a) What are the different types of clay minerals? How do they affect soil structure? Write down the capilarity in soil. [2+2+4]

   b) In a falling head permeability test, head causing flow was initially 50cm and it was dropped by 2 cm in 5 min. How much time is required for head to fall to 25cm. [8]

3. a) Describe the procedure to draw phreatic line on an earthen dam and derive the expression for seepage discharge through it. [4+4]

   b) A sand deposit consists of two layers. The top layer is 3.5m thick ($\gamma = 18kN/m^3$) and bottom layer is 4.0m thick ($\gamma_{sat} = 20kN/m^3$). The water table is at the depth of 4.5m below the ground level and the zone of capillary saturation is 1m above the water table. Draw the stress diagram showing the variation of total stress, pore water pressure and effective stress. [8]

4. a) Derive the expression for vertical stress at a point laying at depth "Z", radial distance "r" and at polar radial distance "R" due to point load "Q" acting at ground surface. [8]

   b) A Cohesion less soil is tested in lab where normal stress is 100KPa and horizontal stress of 75 KPa. Determine: (i) angle of internal friction (ii) major and minor principle stresses. Use Mohr's circle. [8]

5. a) Derive the relation for consolidation settlement of clayey soil having initial thickness (Ho), initial void ratio (e_o), initial effective stress (σo) and compression index (Cc) due to increase in effective stress ($\Delta\sigma'$). [8]

   b) Analyse the slope made up of clay having $c' = 30kpa$, $\varphi' = 20°$, $e = 0.65$ and $G = 2.7$ under the following different conditions (i) when the soil is dry and (ii) when the slope is submerged. [4+4]

6. a) A compressible layer whose total settlement under a given loading is expected to 20cm, settles 4 cm at the end of 2 months. How many months will be required to reach a settlement of 10cm. Assume double drainage. [8]

   b) Write short notes on: (any two) [2x4]

      i) Stress path
      ii) Field identification of soil
      iii) Index properties of soil

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