VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF CIVIL ENGINEERING

QUESTION BANK

IV SEMESTER

CE6405–SOIL MECHANICS

Regulation – 2013

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(As per Anna University 2013 Regulation)

SUBJECT CODE/NAME: CE6405- SOIL MECHANICS

SEM/YEAR: IV/II

UNIT 1- SOIL CLASSIFICATION AND COMPACTION			
Nature of soil – phase relationships – Soil description and classification for engineering purposes, their significance – Index properties of soils - BIS Classification system – Soil compaction – Theory, comparison of laboratory and field compaction methods – Factors influencing compaction behavior of soils.			
PART A			
Q.NO	**QUESTIONS**	**BT LEVEL**	**COMPETENCE**
1.	Define degree of saturation and shrinkage ratio	BT-1	Remember
2.	What are the Atterberg's limits? List its types.	BT-1	Remember
3.	If the volume of voids is equal to the volume of solids in a given soil sample, Find void ratio and porosity.	BT-1	Remember
4.	Define air content and percentage air content in soil	BT-1	Remember
5.	Define compaction.List various factors affecting compaction.	BT-1	Remember
6.	Mention the classification of soil system.	BT-1	Remember
7.	Define plasticity index and flow index.	BT-2	Understand
8.	Discuss about water content of a soil mass and define liquid limit	BT-2	Understand
9.	Differentiate between plasticity and consistency.	BT-2	Understand
10.	The natural water content of an excavated soil from the borrow pit is 35%. Its liquid limit is 65% and plasticity limit is 25%. Determine the Liquidity Index of the soil and comment about the consistency of the soil.	BT-2	Understand
11.	A compacted sample of soil with a bulk unit weight of 19.62kN/m^3 has a water content of 15 percent. Calculate its dry density, degree of saturation and air content? Assume G = 2.65.	BT-3	Apply
12.	What is a zero air voids line? Draw a compaction curve and show the zero air voids line.	BT-3	Apply

13.	Derive the relationship between void ratio and porosity.	BT-3	Apply
14.	State whether the following statement is true or false and justify your answer. The efficiency of compaction improves with increase in compactive effort.	BT-4	Analyse
15.	List any four equipment/ methods for field compaction of soil	BT-4	Analyse
16.	Explain the term optimum moisture content of soil.	BT-4	Analyse
17.	Compose a relation for γ_{sat} with G, γ_w and e.	BT-5	Evaluate
18.	A dry clay has a mass of 30g and volume of 15cc, What will be the shrinkage limit if the specific gravity of solids is 2.65	BT-5	Evaluate
19.	Draw the phase diagram for completely dry and fully saturated soil mass.	BT-6	Create
20.	Two clay samples A and B have the following properties: **Soil properties** / **Clay A** / **Clay B** **Liquid limit** / 44% / 55% **Plastic limit** / 29% / 35% **Natural water content** / 30% / 50% Which of the clays A or B would experience larger settlement under identical loads? Conclude with your comments.	BT-6	Create

Soil properties	Clay A	Clay B
Liquid limit	44%	55%
Plastic limit	29%	35%
Natural water content	30%	50%

Part B

1.	Describe the procedure for determining water content and specific gravity of a given soil in the laboratory by using a pycnometer.	BT – 1	Remember
2.	By three phase soil system, show that the degree of saturation S (as ratio) in terms of mass unit weight(γ), void ratio (e),specific gravity of soil grains(G) and unit weight of water (γ_w) is given by the expression: $$\gamma = \frac{(G + eS)\gamma_w}{1 + e}$$	BT – 1	Remember
3.	In an earth dam under construction, the bulk unit weight is 16.5 kN/m^3 at water content 11%. If the water content has to be increased to 15%, compute the quantity of water to be added per cu.m of soil. Assume no change in void ratio. Determine the degree of saturation at this water content. Take G = 2.7.	BT – 1	Remember
4.	(i) A partially saturated soil from an earth fill has a natural water content of 22% and a bulk unit weight of 19 kN/m^3. Assuming the specific gravity of soil solids as 2.65, compute the degree of saturation and void ratio. If subsequently the soil gets saturated, determine the dry density, buoyant unit weight and saturated unit weight. (8) (ii) Explain Indian Standard soil classification system for classifying coarse grained soil. (5)	BT – 2	Understand

<table>
<tr><td>5.</td><td>Discuss about the grain size distribution of soil by
i) sieve analysis.
ii) sedimentation analysis</td><td>BT – 2</td><td>Understand</td></tr>
<tr><td>6.</td><td>Sandy soil in a borrow pit has unit weight of solids as 25.8kN/m^3, water content equal to11% and bulk unit weight equal to 16.4kN/m^3. How many cubic meter of compacted fill could be constructed of 3500m^3 of sand excavated from the borrow pit, if the required value of porosity in the compacted fill is 30%. Also calculate the change in degree of saturation.</td><td>BT -3</td><td>Apply</td></tr>
<tr><td>7.</td><td>(i) Discuss in detail the engineering significance of the consistency limits of soil. (6)
(ii) Explain the IS soil classification system for classifying fine grained soil. (7)</td><td>BT- 4</td><td>Analyse</td></tr>
<tr><td>8.</td><td>(i) Discuss the effect of compaction on various engineering properties of soils. (5)
(ii) A soil sample is found to have the following properties. Classify the soil according to IS classification system. Passing 75μ sieve = 10%; passing 4.75 mm sieve = 70%; Uniformity coefficient =8; coefficient of curvature = 2.8; Plasticity index = 4%. (8)</td><td>BT – 4</td><td>Analyse</td></tr>
<tr><td>9.</td><td>A laboratory compaction test on soil having G= 2.67 gave a maximum dry unit weight of 17.8 KN/m3 and a water content of 15%. Determine the degree of saturation, air content and percentage air voids at the maximum dry unit weight. What would be theoretical maximum dry unit weight corresponding to zero air voids at the optimum water content?</td><td>BT- 5</td><td>Evaluate</td></tr>
<tr><td>10.</td><td>The following data on consistency limits are available for two soils A and B.
<table>
<tr><th>S.No.</th><th>Index</th><th>Soil A</th><th>Soil B</th></tr>
<tr><td>1</td><td>Plastic limit</td><td>16%</td><td>19%</td></tr>
<tr><td>2</td><td>Liquid limit</td><td>30%</td><td>52%</td></tr>
<tr><td>3</td><td>Flow index</td><td>11</td><td>06</td></tr>
<tr><td>4</td><td>Natural water content</td><td>32%</td><td>40%</td></tr>
</table>
indicate which soil is
(i) Better foundation material on remoulding.
(ii) Better shear strength as function of water content.
(iii) Better shear strength at plastic limit.
(iv) More plastic
Classify the soil as per IS classification system. Do those soils have organic matter?</td><td>BT- 6</td><td>Create</td></tr>
<tr><td>11.</td><td>In its natural condition, a soil sample has a mass of 22.9 N and a volume of 1.15 x 10^{-3} m^3. After being completely dried in the oven sample weighs 20.35 N. Find bulk density, water content, void ratio, porosity, degree of saturation, air content, dry density and percentage air voids.</td><td>BT – 1</td><td>Remember</td></tr>
</table>

12.	(i) Derive the relationship between porosity and void ratio. (5) (ii) A partially saturated sample from a borrow pit has a natural moisture content of 15% and bulk unit weight of 1.9 g/cc. G = 2.7. Determine the degree of saturation and void ratio. What will be the unit weight of the soil if it gets saturated. (8)	BT – 2	Understand
13.	(i) Describe the proctor compaction test in detail. (7) (ii) Draw the diagram for the three Atterberg Limits of a soil and mark the various soil phases. (3) (iii) Define Sensitivity and Thixotropy for a soil. (3)	BT – 3	Apply
14.	(i) A partially saturated soil samples collected from a pit has a natural moisture content of 18% and bulk unit weight of 20 kN/m^3. G = 2.68. Estimate the void ratio and degree of saturation. What will be the unit weight of the soil sample on saturation? (8) (ii) Discuss the engineering behaviour of compacted cohesive soils. (7)	BT – 4	Analyse

Part-C

<table>
<tr><td>1.</td><td>A soil mass in its natural state is partially saturated having a water content of 17.5 percent and void ratio of 0.87. Determine the degree of saturation, total unit weight, dry unit weight what is the weight of water required to make a mass of 10 m^3 volume to get saturated assume G = 2.69.</td><td>BT-1</td><td>Remember</td></tr>
<tr><td>2.</td><td>500 gms of dry soil was used for sieve analysis the masses of soil retained on each sieve is given below:
<table>
<tr><td>I.S. sieve</td><td>2mm</td><td>1.4mm</td><td>1mm</td><td>500μ</td><td>250μ</td><td>125μ</td><td>75μ</td></tr>
<tr><td>Mass in gms</td><td>10</td><td>18</td><td>60</td><td>135</td><td>145</td><td>56</td><td>45</td></tr>
</table>
Plot the grain size distribution curve and compute the following:
a) Percentage of gravel, coarse sand, medium sand, fine sand and silt as per I.S 1498
b) Uniformity coefficient
c) Coefficient of curvature, classify the soil.</td><td>BT – 3</td><td>Apply</td></tr>
<tr><td>3.</td><td>A soil sample consisting of particles of size ranging from 0.6mm to 0.01mm is put on the surface of still water tank. state the time of settlement of the coarsest and finest particle of the sample through a depth of 1.2m. Assume specific gravity of soil particle as 2.65 and viscosity of water as 0.01 poise.</td><td>BT-2</td><td>Understand</td></tr>
<tr><td>4.</td><td>A sample of sand above water table was found to have a natural moisture content of 15% and an unit weight of 18.84 KN/m^3 laboratory test on a dried sample. Indicates value of e_{max} =0.85 and e_{min}=0.5 in loosest and densest state respectively. compute degree of saturation and relative density .Assume G=2.65</td><td>BT-2</td><td>Understand</td></tr>
</table>

UNIT II- SOIL WATER AND WATER FLOW			
Soil water – static pressure in water - Effective stress concepts in soils – capillary stress – Permeability measurement in the laboratory and field pumping in pumping out tests – factors influencing permeability of soils – Seepage – introduction to flow nets – Simple problems. (Sheet pile and weir).			
PART A			
Q.NO	**QUESTIONS**	**BT LEVEL**	**COMPETENCE**
1.	List the various types of soil water.	BT-1	Remember
2.	State capillary rise and surface tension.	BT-1	Remember
3.	Define Critical hydraulic gradient.	BT-1	Remember
4.	Explain Darcy's law of permeability of soil.	BT-2	Understand
5.	Distinguish between total stress, neutral stress and effective stress.	BT-2	Understand
6.	Show the relationship between total, neutral and effective stresses.	BT-3	Apply
7.	Differentiate seepage velocity from discharge velocity.	BT-4	Analyze
8.	Compare Capillarity with Permeability.	BT-4	Analyze
9.	Say true or false and justify your answer: In fine-grained soils the capillary rise is less compared to coarse grained soils.	BT-5	Evaluate
10.	Write typical range of co-efficient of permeability for gravel, sand, silt and clay.	BT-6	Create
11.	List out the methods of drawing flow net.	BT-1	Remember
12.	Write the various types of field permeability test.	BT-1	Remember
13.	Define flow net. Draw a neat sketch.	BT-1	Remember
14.	What is Quick sand condition? Under what circumstances can it occur?	BT-2	Understand
15.	Explain the terms: seepage pressure and flow net.	BT-2	Understand
16.	For a homogeneous earth dam 52m high and 2m freeboard, a flow net was constructed and following results were obtained: Number of potential drops= 25; Number of flow channels =4 Calculate the discharge per metre length of the dam, if the coefficient of permeability of the dam material is 3 x 10^{-5}m/sec.	BT-3	Apply
17.	Illustrate the various uses of Flow net in Engineering practices.	BT-3	Apply
18.	Distinguish between the factors that affect hydraulic conductivity?	BT-4	Analyze
19.	State the assumptions in construction of flow net.	BT-5	Evaluate
20.	What are the factors affecting permeability?	BT-6	Create

PART B			
1.	The water table in a deposit of sand 8m thick is at a depth of 3m below ground surface. Above the water table, the sand is saturated with capillary water. The bulk density of sand is 19.62 KN/m^3. Give the effective pressure at 1m, 3m, and 8m below the ground surface. Hence plot the variation of total, neutral and effective stress over the depth of 8m.	BT – 1	Remember
2.	A clay layer 3 m thick is having water content 45%, and specific gravity of solids 2.7. This clay layer is lying below another layer which is 5m thick sand layer. The sand layer lying at the top is having void ratio 0.6 and with Degree of saturation 40% and Gs=2.65. The water table is at a depth of 3m below. Determine the Total stress, Pore Pressure and Effective Stress at various levels and draw the corresponding diagrams.	BT – 5	Evaluate
3.	Calculate the effective stress at a depth of 2m, 4m, 6m, 8m & 10m in a soil mass having Υ_s = 21 KN/m^3. In water table there is a capillary rise up to ground surface. Also draw the total stress diagram up to 10 m.	BT -3	Apply
4.	A soil deposit consists of a sand layer of 5m thick followed by clay layer. The water table is at a depth of 2m from ground level and dry & saturated unit weight is 16 KN/m^3 &20 KN/m^3 respectively. Draw the variation of total, neutral and effective stress variation in sand layer. If there is a sudden pore water pressure of 20 KN/m^2 at the bottom of sand layer, what will be the change do you expect in effective stress in the sand layer?	BT -4	Analyze
5.	In a constant head permeameter test, the following observations were taken: Distance between piezometer tappings =15cm, Difference of water levels in piezometers = 40cm. Diameter of the test sample = 5cm, Quantity of water collected = 500ml, Duration of the test = 900 sec. Determine the coefficient of permeability of the soil. If the dry mass of the 15cm long sample is 486g and specific gravity of the solids is 2.65. Determine seepage velocity of water during the test.	BT- 1	Remember
6.	In a falling head permeability test the length and area of cross section of soil specimen are 0.17 m and 21.8 x 10^{-4} m^2 respectively. Calculate the time required for the head to drop from 0.25 m to 0.10 m. The area of cross section of stand pipe is 2.0 x 10^{-4} m^2. The sample has three layers with permeabilities 3 x 10^{-5} m/sec for first 0.06 m, 4 x 10^{-5} m/sec for second 0.06 m and 6 x 10^{-5} m/sec for the third 0.05 m thickness. Assume the flow is taking place perpendicular to the bedding plane.	BT – 4	Analyze
7.	The falling head permeability test was conducted on a soil sample of 4cm diameter and 18cm length. The head fell from 1.0m to 0.40m in 20 minutes. If the cross-sectional area of the stand pipe was $1cm^2$, determine the coefficient of permeability.	BT – 1	Remember

8.	Explain in detail with neat sketches, the field determination of permeability.	BT- 2	Understand
9.	Describe the Unconfined Pumping Out Flow and determine the coefficient of permeability of soil. Also explain Draw Down Curve.	BT- 2	Understand
10.	(i) Write a short note on quick sand conditions in soil. (5) (ii) Explain briefly about the applications of flow net. (8)	BT – 3	Analyze
11.	A field pumping test has been carried out in a well was sunk through a horizontal stratum of sand 15 m thick and underlain by a clay stratum. Two observation wells were sunk at horizontal distances of 18 m and 35 m respectively from the pumping well. The initial position of the water table was 2.5 m below the ground level. At a steady state pumping rate of 925 litres/min. The drawdown curves in the observation wells were found to be 2.50 m and 1.50 m respectively. Estimate the coefficient of permeability of the sand.	BT – 4	Analyze
12.	(i) Explain about various factors affecting Co-efficient of permeability. (5) (ii) Explain any four methods of obtaining flow nets. (8)	BT- 2	Understand
13.	Calculate the ratio of average permeability in horizontal direction to that in the vertical direction for a soil deposit consisting of three Horizontal layers, if the thickness and permeability of second layer are twice of those of the first and those of the third layer twice those of second?	BT – 6	Create
14.	i. For a homogenous earth dam of 52 m height and 2 m free board, the flow net has 22 potential drops and 5 flow channels. Calculate the discharge per metre length of the dam, given k = 22 x 10^{-6} m/sec, and exit hydraulic gradient. (7) ii. List the characteristics of flow nets. (6)	BT- 1	Remember
	PART C		
1.	The sub soil strata at a site consist of fine sand 1.8m thick overlying a stratum of clay 1.6m thick. Under the clay stratum lies a deposit of coarse sand extending to a considerable depth. The water table is 1.5m below the ground surface. Assuming the top fine sand to be saturated by capillary water, calculate the effective pressures at ground surface and at depths of 1.8m, 3.4 m and 5.0m below the ground surface. Assume for fine sand G=2.65, e=0.8 and for coarse sand G=2.66, e=0.5.What will be the change in effective pressure at depth 3.4m, if no capillary water is assumed to be present in the fine sand and its bulk unit weight is assumed to be16.68kN/m^3.The unit weight of clay may be assumed as 19.32 kN/m^3.	BT -2	Understand
2.	Describe in detail with neat sketches, the laboratory determination of permeability methods.	BT – 1	Remember
3.	(i) Classify the various applications of flow net? (8) (ii) List out the uses of flow net. (7)	BT – 4	Analyze

4.	(i) A drainage pipe beneath a dam has become clogged with sand; coefficient of permeability of the sand is 7.5 m/day. The average difference in head water and tail water elevation is 21 m and it has been observed that there is a flow of 160 litres per day through the pipe. The pipe is 97 m long and has a cross-sectional area of $0.02m^2$. Find out up to what length of the pipe is filled with sand? (7) (ii) A flow net analysis was performed for estimating the seepage loss through the foundation of a coffer dam, results of the flow net analysis gave a number of flow line 'N_f'=6 and number of drops 'N_d'=16. The head of water lost during seepage was 5m. Assume the co-efficient of permeability of the soil is 'k'=$4x10^{-5}$ m/min. Estimate the seepage loss per meter length of the coffer dam per day. Also estimate the exit gradient if the average length of the last flow field is 0.9m. (8)	BT-3	Apply

UNIT 3-STRESS DISTRIBUTION AND SETTLEMENT

Stress distribution - soil media – Boussinesq theory - Use of Newmarks influence chart –Components of settlement — immediate and consolidation settlement – Terzaghi's one dimensional consolidation theory – computation of rate of settlement. - √t and log t methods– e-log p relationship - Factors influencing compression behaviour of soils.

PART A

Q.NO	QUESTIONS	BT LEVEL	COMPETENCE
1.	Define stress isobar or pressure bulb.	BT-1	Remember
2.	Write the Westergaard's equation for the vertical stress for a point load.	BT-1	Remember
3.	Define primary and secondary consolidation.	BT-1	Remember
4.	What are the stages of consolidation?	BT-1	Remember
5.	Define coefficient of consolidation and compression index.	BT-1	Remember
6.	What are the factors that influence the compression behaviour of soils?	BT-1	Remember
7.	Differentiate between coefficient of consolidation and degree of consolidation.	BT-2	Understand
8.	Discuss about the assumptions made in Terzaghi's one dimensional consolidation theory?	BT-2	Understand
9.	State the Boussinesq formula for vertical stress distribution in soil under a point load.	BT-2	Understand
10.	What do you understand by the terms immediate settlement and co-efficient of volume compressibility.	BT-2	Understand
11.	What is the principle behind Newmark's influence chart?	BT-3	Apply
12.	Find the compression index of remoulded soil sample with liquid limit of 40%.	BT-3	Apply

13.	What is the use of consolidation test data?	BT-3	Apply
14.	Compare Boussinessq's and Westerguard analysis for stress distribution.	BT-4	Analyze
15.	Identify the limitations of Terzaghi's analysis in one dimensional consolidation theory.	BT-4	Analyze
16.	How is consolidation different from compaction?	BT-4	Analyze
17.	Compare and differentiate geostatic stress and pre-consolidation pressure?	BT-5	Evaluate
18.	State Drainage path lengths for single and double drainage conditions for a soil layer of height H.	BT-5	Evaluate
19.	Draw a consolidation curve for normally consolidated and over consolidated clay.	BT-6	Create
20.	Draw the Newmark's chart and what is basis of the construction of Newmark's influence chart?	BT-6	Create

PART B

1.	(i) Find intensity of vertical pressure at a point 3 m directly below 25 kN point load acting on a horizontal ground surface. What will be the vertical pressure at a point 2m horizontally away from the axis of loading and at same depth of 3m.? Use Boussinesq's equation (8) (ii) List the Boussinesq's theory assumptions and limitations. (5)	BT-1	Remember
2.	A concentrated point load of 200 kN acts at the ground surface. Find the intensity of vertical pressure at a depth of 10m below the ground surface and situated on the axis of the loading. What will be the vertical pressure at a point at a depth of 5m and at a radial distance of 2m from the axis of loading? Use Boussinesq analysis.	BT-1	Remember
3.	In a laboratory consolidometer test on a 20mm thick sample of saturated clay taken from a site,50% consolidation point was reached in10minutes. Estimate the time required for the clay layer of 5m thickness at the site for 50% compression if there is drainage only towards the top. What is the time required for the clay layer to reach 50% consolidation if the layer has double drainage instead of single drainage.	BT-1	Remember
4.	Discuss the spring analogy for primary consolidation. What are its uses?	BT-1	Remember
5.	(i) A concentrated load 10kN acts on the surface of a soil mass. Using Boussinesq analysis find the vertical stress at points (a) 3m below the surface on the axis of loading and (b) at radial distance of 2m from axis of loading but at same depth of 3m. (8) (ii) Explain Taylor's square root time method for determining co-efficient of consolidation. (5)	BT-2	Understand
6.	(i) Describe Terzaghi's theory of one dimensional consolidation along with the spring analogy. (6) (ii) A clay layer of 8 m thick with single drainage settles by 120 mm in 2 years. The co-efficient of consolidation for this clay was found to be 6 x 10-3 cm^2/sec. Calculate the likely ultimate consolidation	BT-2	Understand

	settlement and find out how long it will take to undergo 90 % of this ultimate settlement. (7)		
7.	The load from a continuous footing of width 2m, which may be considered to be strip load of considerable length, is 200kN/m^2. Determine the maximum principal stress at 1.5m depth below the footing, if the point lies (i) directly below the centre of the footing, (4) (ii) directly below the edge of the footing and (5) (iii) 0.8m away from the edge of the footing (4)	BT-3	Apply
8.	Discuss in detail about the Boussineq's analysis to find vertical stress and horizontal shear stress for point load.	BT-3	Apply
9.	(i) List the different components of settlement? Explain their occurrence with respect to the change in soil systems. (3) (ii) 20 mm thick undisturbed smaple of saturated clay is tested in laboratory with drainage allowed through top and bottom. Sample reaches 50% consolidation in 35 min. If clay layer from which sample was obtained is 3m thick and is free to drain through top and bottom surfaces, calculate the time required for same degree of consolidation in the field. What is the time required if the drainage in the field is only through the top? (10)	BT-4	Analyze
10	(i)A water tank has supported by a circular foundation of diameter 10.5 m is resting on a soil stratum. The total weight of the tank including the foundation is 17,700 kN. Estimate the stress due to the above load at 0.5 m and 2.5 m depth at the center of the water tank. (7) (ii) Explain in detail of the determination of coefficient of consolidation using log t method. (6)	BT-5	Evaluate
11	(i)A layer of soft clay is 6m thick and lies under a newly constructed building. The weight of sand overlying the clay layer produces a pressure of 2.6kg/cm^{2}and the new construction increases the pressureby1.0kg/cm^2. If the compression index is 0.5. Compute the settlement. Water content is 40% and specific gravity of grains is 2.65. (7) (ii) Explain in detail the laboratory determination of co-efficient of consolidation. (6)	BT-6	Create
12	A clay layer of 10 m thickness underlies a sand stratum of 10 m and overlies a pervious layer. The sand layer carries a point load of 10 MN. Assume e =0.7 and G = 2.72, L.L. = 60% and C_v= 25 x 10^{-4} cm^2/sec. the water table is located 5 m above the top of the clay layer. Find how long would the clay take to settle 4.7 cm.	BT-4	Analyzing
13	(i) Write a brief critical note on " the concept of pressure bulb and its use in soil engineering practice".(5) (ii) A 1 cm thick laboratory soil sample reaches 60% consolidation in 33 sec. under double drainage condition. Find how much time will be required for a 10 m thick layer in the field to reach the same degree of consolidation if it has drainage face on one side only? (8)	BT-4	Analyze

14	A 8 m thick clay layer with single drainage settles by 120 mm in 2 years the co-efficient of consolidation of thin clay was found to be 6 x 10^{-3} cm^2/sec. Calculate the likely ultimate consolidation settlement and find how long it will take to undergo 90% of this settlement.	BT-2	Understand
PART C			
1.	Derive the equation for Terzaghi's theory of one dimensional consolidation with a neat sketch.	BT-1	Remember
2.	(i) Describe the Newmark's chart and its application. (5) (ii) A concentrated load of 22.5 kN acts on the surface of a homogeneous soil mass of large extent. Find the stress intensity at a depth of 3m, 6m, 9m, 12m, and 15m directly below the point load; draw the vertical stress distribution diagram along vertical axis. (8)	BT-2	Understand
3.	A 5m thick saturated soil stratum has a compression index of 0.25 and coefficient of permeability 3.2 x10^{-3} mm/sec. If the void ratio is 1.9 m at vertical stress of 0.15 N/mm^2. Compute the void ratio when the vertical stress is increases to 0.2 N/mm^2, also calculate settlement due to above stress increase and time required for 50% consolidation and 90% consolidation.	BT-4	Analyze
4.	A rectangular foundation, 3 x 2.1 m is perfectly flexible and carries a load of 300 kN/m^2. Determine the vertical pressure at a depth of 5 m below a point P at center and corner.	BT-4	Analyze

UNIT 4- SHEAR STRENGTH			
Shear strength of cohesive and cohesionless soils – Mohr – Coulomb failure theory – Measurement of shear strength, direct shear – Triaxial compression, UCC and Vane shear tests – Pore pressure parameters – cyclic mobility – Liquefaction.			
PART A			
Q.NO	**QUESTIONS**	**BT LEVEL**	**COMPETENCE**
1.	Define sensitivity of soils.	BT-1	Remember
2.	Write down the coulomb's expression for shear strength and list the shear strength parameters.	BT-1	Remember
3.	List out the advantages of direct shear test.	BT-1	Remember
4.	What are the different types of shear test based on drainage conditions?	BT-1	Remember
5.	Define Cohesion and stress path.	BT-1	Remember
6.	List the merits and demerits of triaxial test.	BT-1	Remember
7.	What is the effect of pore pressure on shear strength of soil?	BT-2	Understand
8.	What is shear strength of soil?	BT-2	Understand
9.	State the principle of direct shear test.	BT-2	Understand

10.	What is angle of internal friction?	BT-2	Understand
11.	When is vane shear test adopted? Write the expressions to determine the shear strength of soil.	BT-3	Apply
12.	Explain the Mohr's-Coulomb failure criterion for soils and mention the terms involved.	BT-3	Apply
13.	Discuss about the term Deviator stress.	BT-3	Apply
14.	Why triaxial shear test is considered better than direct shear test?	BT-4	Analyze
15.	What do you understand the term called Liquefaction of soil?	BT-4	Analyze
16.	Classify the methods of determination of shear strength in the laboratory?	BT-4	Analyze
17.	Explain the shear strength parameters?	BT-5	Evaluate
18.	Evaluate the angle made by failure plane with major principle plane using Mohr's circle and strength envelope	BT-5	Evaluate
19.	Sketch the failure envelope for drained triaxial test.	BT-6	Create
20.	Sketch the Mohr's circle for UCC test and mention its salient features.	BT-6	Create
	PART B		
1.	i) The results of a direct shear test on a 60mmx60mm specimen are given below. Determine shear strength parameters. (8) Normal load,N 300 400 500 600 Shear force at failure,N 195 263 324 399 ii) Sketch and discuss the stress-strain and volume change relationship for dense and loose sand. (5)	BT-1	Remember
2.	The results of three consolidated undrainedtriaxial tests on identical specimens of a particular soil are as follows: Test No. 1 2 3 Confining stress, kPa 200 300 400 Deviatoric stress at peak, kPa 244 314 384 Pore water pressure at peak, kPa 55 107 159 Determine the value of effective and total shear strength parameters.	BT-3	Apply
3.	Write down a step by step procedure for determination of cohesion of a given clayey soil by conducting unconfined compression test.	BT-3	Apply
4.	The following table gives data obtained from triaxial compressin test conducted under undrained condition on two specimens of same soil sample. The dia and height are 40mm and 80mm respectively for both samples. Specimen No. 1 2 Cell pressure(kN/m^3) 100 200 Deviator load at failure(N) 637 881 Increase in volume at failure(ml) 1.1 1.5 Axial compression (mm) 5 7 Find Cu and Φu by graphical method.	BT-1	Remember

5.	A saturated specimen of cohesionles ssoil was tested in triaxial compression and the sample failed at a deviator stress of 482kN/$m^2$when the cell pressure was 100kN/m^2under the drained conditions. Find the effective angle of shearing resistance of sand. What would be the deviator stress and the major principal stress at failure for another identical specimen of sand, if it is tested under cell pressure of 200kN/m^2. Use either Mohr's circle method or analytical method	BT-2	Understand
6.	A particular soil failed under a major principal stress of 300kN/m^2 with a corresponding minor principal stress of 100kN/m^2.If for the same soil, the minor principal stress had been 200kN/m^2. What the major principal stress would have been if (i) $\Phi = 30^0$and (ii) $\Phi=0^0$.	BT-4	Analyze
7.	i) Describe the vane shear test in detail and explain the two methods adopted in this test- fully submerged vane and partially submerged vane. (6) ii) An unconfined compression test was conducted on an undisturbed clay sample. The sample had a diameter of 37.5mm and length 80mm. loas at failure measured by proving ring was 28 N and the axial deformation at failure point was 13mm. Determine the unconfined compressive strength and the undrained shear strength of the clay. Plot all the results on a mohrs circle. (7)	BT-2	Understand
8.	A Cylindrical specimen of dry sand was tested in a triaxial test. Failure occurred under a cell pressure of1.2kg/$cm^2$and at a deviator stress of 4.0kg/cm^2. Find (i) Angle of shearing resistance of the soil. (ii) Normal and shear stresses on the failure plane. (iii) The angle made by the plane with the minor principal plane. (iv) The maximum shear stress on any plane in the specimen at the instant of failure.	BT-1	Remember
9.	The following data were obtained in a direct sheartest. Normal pressure 20kN/m^2, Tangential pressure =16kN/m^2, Angle of internal friction = 20^0, Cohesion = 8kN/m^2. Represent the data. (i) By Mohr's circle and compute the principal stresses and the direction of principal planes. (7) (ii) Compare the merits and demerits of triaxial compression test. (6)	BT-1	Remember
10	A vane, 10 cm long and 8cm in diameter, was pressed into soft clay at the bottom of a borehole. Torque was applied and gradually increasedto45 N-m when failure took place. Subsequently, the vane rotated rapidly so as to completely remould the soil. There moulded soil was sheared at a torque of 18N-m. Analyse the cohesion of the clay in the natural and remoulded states and also the value of the sensitivity.	BT-4	Analyze
11.	Derive a relationship between the principal stresses at failure using Mohr-Coulomb failure criterion.	BT-2	Understand
12.	On a failure plane in a cohesionless soil sample, the normal and shear stresses are found as 10 kN/m^2 and 4 kN/m^2. Determine the	BT-4	Analyze

	resultant stress on the plane of failure, the angle of shearing resistance and the inclination of failure plane to the major principal plane.		
13.	Two identical soil specimens were tested in a triaxial apparatus. First specimen failed at a deviator stress of 770kN/m^2 when the cell pressure was 2000kN/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 600kN/m^2, estimate the shear stress at failure.	BT-5	Evaluate
14.	In a triaxial test, a soil specimen was consolidated under a cell pressure of 200 kPa and simultaneously a back pressure of 100 kPa is applied to saturate the specimen. Thereafter, with drainage prevented, the cell pressure was raised to 250 kPa resulting in an increased pore pressure of 149 kPa. Maintaining the same cell pressure of 250kPa, now the deviator stress was increased to 170 kPa and a pore pressure of 220 kPa was observed. Calculate the pore pressure parameters A and B.	BT-6	Create
PART C			
1.	Explain the triaxial shear tests based on drainage and their applicability.	BT-2	Understand
2.	i) What is the shear strength in terms of effective stress on a plane within a saturated soil mass at a point where the total normal stress is 295 kN/m^2 and the pore water pressure is 120 kN/m^2? The effective stress parameters for the soil are c' = 12 kN/m^2 and Φ' = 30^0 . (8) ii) Write the advantages, disadvantages and limitations of direct shear test. (7)	BT-3	Apply
3.	i) An embankment is constructed of soil, with c' = 50 kN/m^2 and Φ' = 20^{0}and unit weight 16 kN/m^3. Determine the pore water pressure, effective stress, shear strength of the soil at the base of embankment just after the fill has been raised form 3m to 6 m. Take pore pressure coefficients A and B as 0.5 and 0.8, respectively, and the lateral pressure as on-half of the vertical pressure. (8) ii) Draw the mohr-coulomb failure envelopes of CU, CD and UU tests sandy soils and comment on shear strength parameters. (7)	BT-5	Evaluate
4.	In vane shear test conducted in a soft clay deposit failure occurred at torque of 42N-m afterwards. The vane was allowed to rotate rapidly and test was repeated in the remoulded soil. The torque at failure in the remoulded soil was 17N-m. Calculate the sensitivity of soil. In both cases the vane was pushed completely inside soil. The height of vane and diameter across blades are 100 mm and 80 mm respectively. What will be the change in the above results if top of the vane is not in contact with soil.	BT-6	Create

UNIT 5- SLOPE STABILITY			
Slope failure mechanisms – Types - infinite slopes – finite slopes – Total stress analysis for saturated clay – Fellenius method - Friction circle method – Use of stability number - slope protection measures.			
PART A			
Q.NO	**QUESTIONS**	**BT LEVEL**	**COMPETENCE**
1.	List out the different types of slope failure with figure.	BT-1	Remember
2.	What is the effect of depth of failure surface on the stability of infinite slope in cohesionless soil?	BT-1	Remember
3.	Define finite slope.	BT-1	Remember
4.	Define factor of safety and critical depth.	BT-1	Remember
5.	What is a slide?	BT-1	Remember
6.	State the basic types of failure occurring in finite slopes.	BT-1	Remember
7.	Discuss about the three critical conditions for which the stability analysis of an earth dam is carried out.	BT-2	Understand
8.	Compare stability number and Taylor's stability number.	BT-2	Understand
9.	When and where the circular failure surface is mobilized? Why?	BT-2	Understand
10.	Sketch the slip circle for a failure plane in a slope and show the forces involved.	BT-2	Understand
11.	Sketch any one of the slope protection measures neatly.	BT-3	Apply
12.	Write the expression for FOS of an infinite slope in case of cohesionless soil.	BT-3	Apply
13	Illustrate the different factor of safety used in the stability of slope.	BT-3	Apply
14.	Differentiate between finite slope and infinite slope.	BT-4	Analyse
15.	Classify the slope protection measures.	BT-4	Analyse
16.	Explain in brief about base failure. When does it occur?	BT-4	Analyse
17.	A cuffing is to be made in clay for which the cohesion is 350 kN/m^2, bulk unit weight is 20 kN/m^3. Find the maximum depth for a cutting of side slope 1.5 to 1. Factor of safety to be 1.5. take the stability number as 0.17.	BT-5	Evaluate
18.	Evaluate the maximum depth of soil having undrained cohesion is $50kN/m^2$. Unit weight of soil is $19kN/m^3$. Stability number is 0.20.	BT-5	Evaluate
19.	Show how does tension crack influence stability analysis?	BT-6	Create
20.	Write short note on critical surface of failure.	BT-6	Create
PART B			
1.	List out the various methods to protect slopes from failure and explain it in detail.	BT-1	Remember
2.	Describe in detail the Swedish slip circle method.	BT-2	Understand
3.	i. Brief Taylor's stability number. (6) ii. State the use of Taylor's charts and its applicability. (7)	BT-1	Remember

4.	i. A slope of very large extent of soil with properties c'= 0 and $\phi = 32^{\circ}$ 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 FOS is 1.5 treating it as an infinite slope. For this angle of slope what will be the FOS if the water level were to come down well below the surface? The saturated unit weight of the soil is 20 kN/m^3. (8) ii. Discuss about various slope protection measures. (5)	BT-4	Analyse
5.	i. Brief total stress method of analysis of stability of slopes. (6) ii. Describe any four techniques for slope protection with clear sketch. (7)	BT-1	Remember
6.	i. An infinitely long slope having an inclination of 26^o in an area underlined by firm cohesive soil (G = 2.72 and e = 0.50). There is a thin , weak layer of soil 6m below and parallel to the slope surface (c = 25 kN/m^2, ϕ'=16^o. Compute the FOS when the slope is dry. (7) ii. If the ground water flow could occur parallel to the slope on ground surface, what FOS would result- Solve. (6)	BT-5	Evaluate
7.	Outline the FOS of a finite slope possessing both cohesion and friction(c - ϕ) by method of slices.	BT-2	Understand
8.	An embankment 10 m high is inclined at 35^0 to the horizontal. A stability analysis by the method of slices gave the following forces: total normal force = 900 kN, total tangential force = 420 kN, total neutral force = 200 kN. If the length of the failure arc is 23 m, find the factor of safety with respect to shear strength. The soil has c = 20 kN/m^2 and $\phi = 15^o$.	BT-3	Apply
9.	i. A 45° slope has been excavated to a depth of 8 m in a saturated clay, which has following properties: C_u = 60kN/m^2, ϕ_u = 0 and unit weight = 20 kN/m^3 . Determine the factor of safety for the trial failure surface whose radius is 12 m and arc length is 18.84 m. The area of the total wedge is 70m^2 and center of gravity of the trial wedge is 4.5 m away from the center of the failure surface. (7) ii. Illustrate the technique used to improve the stability of slopes. (6)	BT-3	Apply
10	Discuss in detail with neat sketches the Bishop's method of stability analysis.	BT-2	Understand
11	Derive from the first principles, the FOS of an infinite slope a. Cohesionless soil b. c- ϕ soil.	BT-1	Remember
12	Analyse the stability of soil using friction circle method.	BT-4	Analyse

13	A canal is to be excavated to a depth of 6 m below ground level through a soil having the following characteristics c = 15 kN/m^2, ϕ=20°, e=0.9 and G=2.67. The slope of the banks is 1in1.Determine the factor of safety with respect to cohesion when the canal runs full. Evaluate the factor of safety if the canal is rapidly emptied completely?	BT-4	Analyse
14	Write about the analysis of infinite slopes.	BT-6	Create
PART C			
1.	Describe in detail about method of slices.	BT-1	Remember
2.	Briefly explain about the method of analysis of finite slopes.	BT-2	Understand
3.	i. An infinite slope made of soil with c' = 20kPa, ϕ = 20° e = 0.65 and G = 2.7 is 10 m high. The slope angle is 25°. Find the factor of safety with respect to height for the following conditions : a. When the soil is dry b. When the slope is submerged. (8) ii. Explain in detail about the Fellenius circle method of analysing the stability of slopes. (7)	BT-4	Analyse
4.	A cut 9 m deep is to be made in clay with a unit weight of 18 kN/m^3 and cohesion of 27 kN/m^2. A hard Stratum exists at a depth of 18 m below the ground surface. Determine from Taylor's charts if a 300 slope is Safe. If a factor of safety of 1.50 is desired, examine the safe angle of slope?	BT-3	Apply

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CE6405- SOIL MECHANICS

Unit No.		BT-1	BT-2	BT-3	BT-4	BT-5	BT-6	Total No. of Questions
I	Part-A	6	4	3	3	2	2	20
	Part-B	4	3	2	3	1	1	14
	Part-C	1	2	1	-	-	-	4
II	Part-A	6	4	3	3	2	2	20
	Part-B	4	3	2	3	1	1	14
	Part-C	1	1	1	1	-	-	4
III	Part-A	6	4	3	3	2	2	20
	Part-B	4	3	2	3	1	1	14
	Part-C	1	1	-	2	-	-	4
IV	Part-A	6	4	3	3	2	2	20
	Part-B	4	3	2	3	1	1	14
	Part-C	-	1	1	-	1	1	4
V	Part-A	6	4	3	3	2	2	20
	Part-B	4	3	2	3	1	1	14
	Part-C	1	1	1	1	-	-	4

TOTAL NO.OF QUESTIONS IN EACH PART

PART A	100
PART B	70
PART C	20
TOTAL	190