INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal,Hyderabad-500043

CIVIL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**GEOTECHNICAL ENGINEERING**
Course Code	:	**ACE006**
Class	:	B. Tech IV Semester
Branch	:	Civil Engineering
Year	:	2018-19
Course Coordinator	:	Ms. J. Hymavathi, Assistant Professor, Department of Civil Engineering.
Course Faculty	:	Mrs. J. Hymavathi, Assistant Professor, Department of Civil Engineering. Mr. Y. Ravi Kumar, Assistant Professor, Department of Civil Engineering.

COURSE OBJECTIVES:

The course should enable the students to:

I	Identify the type of soil based on index properties of soils, soil formation & its structure
II	Recognize the importance of permeability for calculating the seepage through soils. Find out the coefficient of permeability using various laboratory & field tests
III	Analyze the stress at any point below the ground surface due to self weight and externally applied load. Interpret the importance of consolidation and compaction on the settlement of footing.
IV	Recognise the importance of shear strength in load carrying capacity of soil. Calculate the shear strength of soil using various laboratory tests.

COURSELEARNING OUTCOMES:

Students, who complete the course, will have demonstrated the ability to do the following:

CACE006.01	Calculate the unit weights in various field conditions using different relationships.
CACE006.02	Examine water content, specific gravity, bulk density and dry densities of a soil using various laboratory and field tests.
CACE006.03	Identify the type of soil present in the site by using particle size distribution curve & other index properties of soils as per IS soil classification system.
CACE006.04	Find the Atterberg limits of soils which is used in classifying the fine grained soils.
CACE006.05	Understand the permeability of soil & find out the range of coefficient of permeability in various soil types.
CACE006.06	Explain the importance of permeability in calculation of seepage through earthen dams, amount of water to be pumped when the soil is excavated below ground water table.
CACE006.07	Evaluate the coefficient of permeability using falling head tests and constant head tests.
CACE006.08	Evaluate the coefficient of permeability using pumping in and pumping out tests.
CACE006.09	Calculate the stresses beneath the ground level due to self weight of soil.
CACE006.10	Analyze the importance of total, neutral and effective stress in load carrying capacity of soil.
CACE006.11	Sketch the total, neutral and effective stress distribution diagram for various field conditions.
CACE006.12	Explain quick sand condition, its occurrence and its significance.
CACE006.13	Understand the importance of flow net in calculating seepage loss, uplift pressure, exit hydraulic gradient.
CACE006.14	Calculate the stress below the ground due to externally applied load using Boussinesq's theory.

CACE006.15	Calculate stress due to load using Westergaard's and approximate method of stress distribution.
CACE006.16	Importance of compaction in reducing the immediate settlement, improving the load carrying capacity.
CACE006.17	Determining themaximum dry density and optimum moisture content of soil using standard proctor test soil. List the various field equipments used for compacting the different types of soils.
CACE006.18	Recognize the importance of consolidation in settlement calculation& calculate the consolidation settlementespecially inclayey soils.
CACE006.19	Determination of consolidation parameters of a soil using laboratory test such as using square root of time fitting method, logarithmic square method and height of solids method.
CACE006.20	Understand the shear failure criteria proposed by Mohr-coulombband shear parameters of soil
CACE006.21	Determination of shear strength of soil using direct shear test and tri-axial test in various drainage conditions.
CACE006.22	Recognize the behaviour of soil in normal, over and under consolidated soil. Understand the concept of dilatancy in sandy soil.
CACE006.23	Posses the Knowledge and Skills for employability and to succeed in national and international level competitive examinations.

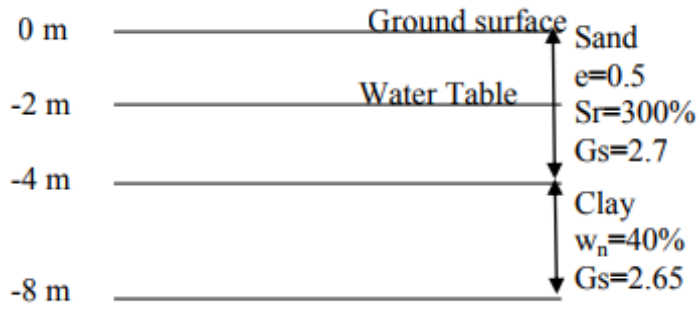
S.No	QUESTIONS	Blooms taxonomy level	Course Learning Outcomes
UNIT I			
INTRODUCTION AND INDEX PROPERTIES OF SOILS			
Part - A (Short Answer Questions)			
1	Sketch the process of soil formation.	Remember	CACE006.01
2	Name common clay minerals.	Understand	CACE006.01
3	Define void ratio, porosity.	Understand	CACE006.01
4	What are the various types of structures present in soil?	Remember	CACE006.02
5	Define degree of saturation, % air voids.	Understand	CACE006.02
6	Define water content and name the laboratory tests used for determining water content.	Remember	CACE006.02
7	Define saturated unit weight, submerged unit weight, what is the relationship between saturated and submerged unit weight.	Remember	CACE006.02
8	What is the relationship between void ratio, specific gravity and water content?	Understand	CACE006.02
9	Define relative density & explain its significance.	Remember	CACE006.03
10	Draw two phase & three phase diagram.	Understand	CACE006.03
11	What is the principle of hydrometer & write its expression?	Understand	CACE006.03
12	Define liquid limit & plastic limit .	Remember	CACE006.03
13	Define Shrinkage limit.	Remember	CACE006.03
14	Define Consistency limits.	Understand	CACE006.03
15	What is the classification of the soil based on particle sizes?	Understand	CACE006.04
16	Write the expression for toughness index.	Remember	CACE006.04
17	Draw plasticity chart proposed by IS soil classification system.	Remember	CACE006.04
18	Define specific gravity & name the laboratory test used for determining specific gravity of soil.	Understand	CACE006.04
19	Sketch Particle size distribution curve & explain its significance.	Remember	CACE006.04
20	What is the relationship between void ratio and porosity?	Remember	CACE006.05
21	Define Sensitivity.	Understand	CACE006.05
22	Define Thixotropy.	Remember	CACE006.05
23	Define Activity.	Understand	CACE006.05
25	Define coefficient of curvature and coefficient of uniformity.	Remember	CACE006.05
26	Classify the soils based on transportation agency.	Remember	CACE006.05

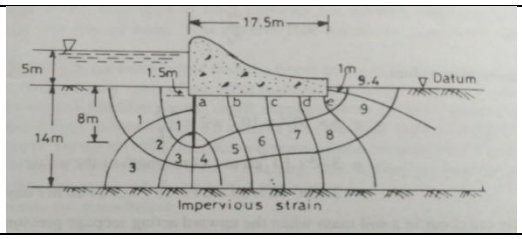
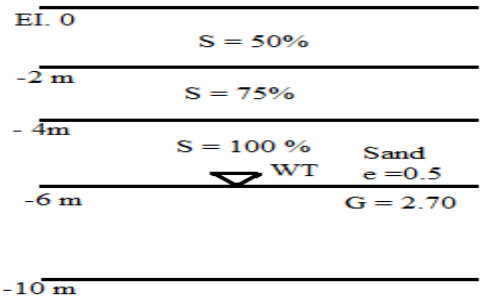
Part - B (Long Answer Questions)			
1	Explain the clay mineralogy in detail with their schematic representation?	Remember	CACE006.01
2	Starting from three phase representation of soil mass, derive the relationship between bulk unit weight, specific gravity, void ratio and degree of saturation.	Understand	CACE006.01
3	With the help of three phase diagram, define the following: (i) Voids ratio (ii) Porosity (iii) Degree of saturation (iv) Water content (v) Absolute/true specific gravity (vi) Apparent specific gravity (vii) Air content (viii) Percentage of air voids and (ix) Relative density.	Understand	CACE006.01
4	Explain in detail the procedure for Sieve analysis and discuss how you can plot grain size distribution curve from sieve analysis.	Remember	CACE006.02
5	$1m^3$ of wet soil weighs 20 kN. Its dry weight is 18 kN, specific gravity is 2.67. Determine the water content, porosity, void ratio, degree of saturation. Draw phase diagram.	Understand	CACE006.02
6	An undisturbed sample of soil has a volume 100 cm3 & mass 200 g on oven drying for 24 hrs, the mass is reduced to 170 g. If G=2.68, determine void ratio, water content & degree of saturation.	Understand	CACE006.02
7	What are the various types of soils based on the method of formation, explain them briefly?	Remember	CACE006.03
8	Explain briefly the various clay minerals.	Remember	CACE006.03
9	Explain the laboratory procedure for determining the liquid limit & plastic limit of soil.	Remember	CACE006.04
10	Explain IS soil classification system for classifying the soil.	Remember	
11	Derive the relationship between saturated unit weight, specific gravity, void ratio and unit weight of water?	Understand	CACE006.04
12	What is the relationship between bulk unit weight, specific gravity, unit weight of water, water content and void ratio. 1 m^3 of soil weighs 18 kN, has a water content of 22%. The specific gravity of soil particles is 2.68. Determine void ratio and porosity.	Understand	CACE006.04
13	Name various field tests used in determining the in-situ unit weight of soil, explain them briefly?	Remember	CACE006.05
14	Derive the relationship between dry unit weight, unit weight of water, % air voids, specific gravity and water content?	Understand	CACE006.05
15	Explain in detail Stoke's law along with its assumptions & limitations?	Remember	CACE006.05
Part – C (Problem Solving and Critical Thinking)			
1	A sample of fully saturated soil has a water content of 25% and a bulk unit weight of $20kN/m^3$. Determine the (i) dry unit weight (ii) void ratio (ii) specific gravity of the soil. What would be the bulk unit weight of the soil if the soil is compacted for the same void ratio but with a degree of saturation 90%.	Remember	CACE006.01
2	A sample of soil compacted according to standard proctor test has a unit weight of $20.58kN/m^3$ at 100% compaction and at optimum water content of 14%. What is the dry unit weight? What is the dry unit weight at zero air voids? If voids become filled with water what would be the saturated unit weight? Assume G=2.7.	Understand	CACE006.01
3	Earth is required to be excavated from borrow pits for building an embankment. The wet unit weight of undisturbed soil is 18 kN/m^3 and its water content is 8%. In order to build a 4 m high embankment with top width 2 m and side slopes 1:1, estimate the quantity of earth required to be excavated per meter length of embankment. The dry unit weight required in the embankment is 15 kN/m^3 with a moisture content of 10%. Assume the specific gravity of solids as 2.67. Also determine the void ratios and the degree of saturation of the soil in both the undisturbed and remoulded states.	Remember	CACE006.01

<table>
<tr><td>4</td><td>A sample of sand above the water table was found to have a natural moisture content of 15% and a unit weight of 18.84 kN/m^3. Laboratory tests on a dried sample indicated values of e_{min} = 0.50 and e_{max} = 0.85 for the densest and loosest states respectively. Compute the degree of saturation and the relative density. Assume G_s = 2.65.</td><td>Understand</td><td>CACE006.02</td></tr>
<tr><td>5</td><td>An undisturbed saturated specimen of clay has a volume of 18.9 cm3 and a mass of 30.2g. On oven drying the mass reduces to 18 g. The volume of dry specimen as determined by displacement of mercury is 9.9 cm^2. Determine the shrinkage limit, volumetric shrinkage, specific gravity, shrinkage ratio.</td><td>Understand</td><td>CACE006.02</td></tr>
<tr><td>6</td><td>A soil has a liquid limit and plastic limit of 47% and 33% respectively. If the volumetric shrinkage at the liquid limit and plastic limit are 44% and 29%. Determine the shrinkage limit& shrinkage ratio.</td><td>Understand</td><td>CACE006.02</td></tr>
<tr><td>7</td><td>The laboratory test on sample of soil gave the following results:
Natural moisture content =24%, liquid limit =62%, plastic limit =28%, percentage of particles less than 2µ =23%. Determine (a) liquidity index (b) activity number (c) consistency and nature of soil.</td><td>Understand</td><td>CACE006.03</td></tr>
<tr><td>8</td><td>The plastic limit of soil is 25% and its plasticity index is 8%. When the soil is dried from its state at plastic limit, the volume change is 25% of its volume at plastic limit. Similarly the corresponding volume change for the liquid limit to the dry state is 34% of its volume at liquid limit. Determine the shrinkage limit and shrinkage ratio.</td><td>Remember</td><td>CACE006.03</td></tr>
<tr><td>9</td><td>500g of dry soil was used for sieve analysis. The masses of soil retained on each sieve is given below:
<table>
<tr><td>IS sieve</td><td>Mass in g</td><td>IS sieve</td><td>Mass in g</td></tr>
<tr><td>2.0mm</td><td>10</td><td>250 µ</td><td>145</td></tr>
<tr><td>1.4mm</td><td>18</td><td>125 µ</td><td>56</td></tr>
<tr><td>1.0mm</td><td>60</td><td>75µ</td><td>45</td></tr>
<tr><td>500µ</td><td>135</td><td></td><td></td></tr>
</table>
Plot a grain distribution curve and compute the following the % of gravel, coarse sand, medium sand, fine and silt as per IS:1498-1959. Find the uniformity coefficient, and coefficient of curvature.</td><td>Understand</td><td>CACE006.04</td></tr>
<tr><td>10</td><td>A partially saturated soil collected from borrow pit has a natural moisture content of 15% and bulk unit weight of 1.9 g/cc, The G of soil is 2.70. Determine degree of saturation and void ratio. What will be the unit weight of sample on complete saturation?</td><td>Remember</td><td></td></tr>
<tr><td>11</td><td>A 1000cc core cutter weighing 946.80 g was used to found out the in-situ unit weight of an embankment, the weight of core cutter filled with soil was noted to be 2770.60 g. Laboratory tests on the sample indicated that the w/c is 10.45% and specific gravity of solids is 2.65. Determine the bulk unit weight, dry unit weight, void ratio and degree of saturation of sample.</td><td>Understand</td><td>CACE006.04</td></tr>
<tr><td>12</td><td>Two soils were tested for their consistency limits in the laboratory. The following data were obtained
<table>
<tr><td colspan="2">Soil A</td><td colspan="2">Soil B</td></tr>
<tr><td>No of blows, N</td><td>w %</td><td>No of blows, N</td><td>w %</td></tr>
<tr><td>8</td><td>43</td><td>5</td><td>65</td></tr>
<tr><td>20</td><td>39</td><td>15</td><td>61</td></tr>
<tr><td>30</td><td>37</td><td>30</td><td>59</td></tr>
<tr><td>45</td><td>35</td><td>40</td><td>58</td></tr>
<tr><td colspan="2">Plastic Limit = 35%</td><td colspan="2">Plastic Limit = 30%</td></tr>
</table>
The natural moisture contents of soils A and B were measured in the field and were found to be 40 % and 50 % respectively.
a) Which soil has greater plasticity?
b) Which soil will be a better foundation material upon remoulding?</td><td>Remember</td><td>CACE006.04</td></tr>
</table>

	c) Which soil is more compressible? d) Which soil shows a higher rate of loss in shear strength upon increase in water content? e) Which soil has a higher strength at plastic limit? f) Is there a likelihood of organic matter present in these soils?		
13	A sample of sand with the specific gravity of solids as 2.65 has a porosity of 40%. Find out the dry unit weight, unit weight of the sample when fully saturated, submerged unit weight and bulk unit weight when the degree of saturation is 50%.	Remember	CACE006.05
14	A sample of sand from a natural deposit has a porosity of 35%. For a volume of 495 cc, the dry weight in the densest and loosest states is 950 and 700 g, respectively. Compute the relative density of sand assuming the specific gravity of solids to be 2.65.	Understand	CACE006.05
15	In a liquid limit test, specimens of a certain sample of clay at water content of 31.93, 27.62, 25.51 and 23.30% required 5, 16, 23 and 42 blows, respectively to close the standard groove. The plastic limit of the clay is 13%. Natural water content is 18%. Determine the liquid limit, plasticity index, consistency index, flow index and toughness index of the soil.	Remember	CACE006.05
UNIT 2			
PERMEABILITY, EFFECTIVE STRESS AND SEEPAGE THROUGH SOILS			
Part – A (Short Answer Questions)			
1	State Darcy's Law.	Remember	CACE006.06
2	Define Permeability.	Understand	CACE006.06
3	What are the factors affecting permeability of soil?	Remember	CACE006.06
4	What is the range of coefficient of permeability for gravel, sand, silt and clayey soils?	Understand	CACE006.06
5	Enumerate the laboratory tests for determining the coefficient of permeability?	Remember	CACE006.06
6	Define total stress & neutral stress.	Understand	CACE006.06
7	Define effective stress &explain its significance.	Remember	CACE006.07
8	Write the expression for vertical coefficient of permeability in layered soils.	Understand	CACE006.07
9	Define flow net & uses of flow net.	Remember	CACE006.07
10	What are the characteristics of flow net.	Understand	CACE006.07
11	Explain quick sand condition.	Remember	CACE006.07
12	Define flow line.	Understand	CACE006.08
13	Define equipotential line.	Remember	CACE006.08
14	Sketch flow channel and field.	Understand	CACE006.08
15	Differentiate between absorbed and capillary water in soils.	Remember	CACE006.08
16	Write the expression for horizontal coefficient of permeability in layered soils.	Understand	CACE006.08
17	Write the expression for height of capillary rise in soils.	Remember	CACE006.09
18	What is capillary fringe?	Understand	CACE006.09
19	Write the expressions for finding out the coefficient of permeability using falling head and constant head test.	Remember	CACE006.09
20	Name the field tests to find the coefficient of permeability.	Understand	CACE006.09
Part - B (Long Answer Questions)			
1	Explain the laboratory procedure for determining the coefficient of permeability for fine grained soils i.e., silts and clay?	Remember	CACE006.06
2	Explain the laboratory procedure for determining the coefficient of permeability using constant head permeability test?	Understand	CACE006.06
3	Explain in detail flow net with neat sketch? Discuss in detail properties and applications of flow net?	Remember	CACE006.06

4	Explain about Darcy's law. Explain its validity in soil.	Remember	CACE006.06
5	Explain quick sand phenomenon.		CACE006.07
6	Discuss pumping-out method for the determination of the coefficient of permeability in the field.	Remember	CACE006.07
7	Discuss pumping-in method for the determination of the coefficient of permeability in the field.	Remember	CACE006.07
8	Derive expressions for average permeability of stratified soil when flow is parallel and perpendicular to the direction of stratification.	Understand	CACE006.07
9	Define coefficient of permeability and explain factors affecting permeability.	Remember	CACE006.08
10	Differentiate between absorbed and capillary water in soils? Write the expression for determining height of capillary rise in small diameter pipe and in soils respectively.	Remember	CACE006.08
11	Draw the total, neutral and effective stress distribution diagram up to a depth of z m for a soil below a water body.	Understand	CACE006.08
12	Calculate the total, neutral and effective stresses in case of upward seepage condition and sketch its stress distribution diagrams.	Remember	CACE006.09
13	Sketch the total, neutral and effective stress distribution diagrams when there is a downward seepage of water through the soil.	Understand	CACE006.09
14	Derive the expression for calculating the seepage quantity using flow net.	Remember	CACE006.09
15	Explain the following terms? a) Flow lines and equipotential lines b) Uplift pressure c) Exit gradient d) Piping failure e) Elementary squares.	Understand	CACE006.09
	Part – C (Problem Solving and Critical Thinking)		
1	A sand sample of 35 cm^2 cross sectional area and 20 cm long was tested in a constant head permeameter. Under a head of 60 cm, the discharge was 120 ml in 6 min. The dry weight of sand used for the test was 1120 g, and Gs = 2.68. Determine (a) the hydraulic conductivity in cm/sec, (b) the discharge velocity, and (c) the seepage velocity.	Remember	CACE006.06
2	Determine the average coefficient of permeability in directions parallel and perpendicular to the planes of a stratified deposit of soil consisting of 3 layers of total thickness 3 m. The top and bottom layers are 0.5 m and 0.8 m thick. The values of K for top, middle, and bottom layers are 2×10^{-4} cm/s, 3×10^{-3} cm/s, 1×10^{-2} cm/s respectively.	Understand	CACE006.06
3	The following data were recorded in a constant head permeability test. Internal diameter of Permeameter = 7.5 cm, head lost over a sample length of 18 cm = 24.7 cm, quantity of water collected in 60 s = 626 ml, porosity of the soil sample was 44%. Calculate the coefficient of permeability of the soil. Also determine the discharge velocity and the seepage velocity during the test. If the test was carried out at a temperature of 25^0 C, estimate the permeability of the soil for a porosity of 39% and at 20^0 C.	Remember	CACE006.06
4	The water table in a certain area is at a depth of 4m below the ground surface. To a depth of 12m the soil consists of very fine sand having an average void ratio of 0.65. Above the water table the sand has an average degree of saturation of 50%. Calculate the effective pressure on a horizontal plane at a depth 10m below the earth surface. Assume specific gravity of soil is 2.6.	Understand	CACE006.06

5	The water table in a deposit of sand 8m thick is at a depth of 3m below the surface. Above the water table the sand is saturated with capillary water for a 2m height. The saturated and dry density of sample is 19.62kN/$m^3$and 18 kN/m^3respectively. Calculate the effective pressure at 1m, 3m, and 8m below the surface. Hence plot the variation of total pressure, neutral pressure and effective pressure at the depth of 8m.	Understand	CACE006.07
6	A 5m thick sand layer with specific gravity 2.67 and void ratio 0.6 is underlain by a bed of 4m clay having saturated unit weight 20 kN/m^3. Plot the total, neutral & effective stress distribution diagram up to the bottom of clay layer, when 1) Water table is at 2m below Ground surface (S = 50% above WT) 2) Water table is at ground surface 3) The water table is 2m above ground surface.	Understand	CACE006.07
7	a) A masonry dam has pervious sand as foundation. Determine the maximum permissible upward gradient, if a FOS of 4 is required against boiling? For the sand, n = 45% and G = 2.65. b) What is the theoretical height of capillary rise and capillary pressure in a fine grained soil with effective size of 0.002 mm?	Remember	CACE006.07
8	In a falling head permeability test on a sample 12.2 cm high and 441 cm2 in cross-sectional area, the water level in a standpipe of 6.25 mm internal diameter dropped from a height of 75 cm to 24.7 cm in 15 minutes. Find the coefficient of permeability?	Understand	CACE006.07
9	For the subsoil condition shown below, draw the total, neutral and effective stress diagrams up to a depth of 8 m. Neglect capillary flows. 	Remember	CACE006.08
10	For a field pumping test, a well was sunk through a horizontal stratum of sand 14.5 m thick underlain by a clay stratum. Two observation wells were sunk at a horizontal distance of 16 m and 34 m respectively from the pumping well. The initial position of WT was 2.2 m below GL. At a steady-state pumping rate of 925lt/min, the drawdown in the observation wells was found to be 2.45 m and 1.20 m respectively. Calculate the coefficient of permeability of the sand.	Understand	CACE006.08
11	The flow for a concrete dam of 17.5 m base width which retains 5m of water is shown below. The base of the dam is 1.5 m below the ground surface. Compute the seepage flow below the dam per meter length of the dam, uplift pressure along the base of dam and exit gradient.	Remember	CACE006.08

			
12	For the soil profile shown below , plot total stress, neutral stress and effective stress from EI 0 to EI -10 m. 	Remember	CACE006.09
13	A clay structure of thickness 8 m is located at a depth of 6 m below the ground surface, it is overlaid by fine sand, the water table is located at a depth of 2 m below the ground surface. For fine sand submerged unit weight is 10.2kN/m^3. The moist unit weight of sand located above the water table is 16kN/m^3. For clay layer, G=2.76 and water content is 25%. Compute the effective stress at the middle of the clay layer.	Understand	CACE006.09
14	A stratified layer of soil consists of 4 layers of equal thickness the coefficient of permeability of second, third and fourth layers are respectively ½, 1/3 and twice of the permeability of the top layer. Compute the average permeability of the deposit, parallel and perpendicular to the direction of stratification in terms of permeability of top layer.	Remember	CACE006.09
15	a) The end of a clean glass tube is inserted in pure water. What is the height of capillary rise, if the tube is (a) 0.1 mm, and (b) 0.001 mm in diameter? b) Calculate the approx height of capillary rise in a soil having e = 0.75, D_{10} = 0.05 mm. (C = 25).	Understand	CACE006.09
UNIT – III STRESS DISTRIBUTION IN SOILS AND COMPACTION			
Part – A (Short Answer Questions)			
1	Define Pressure bulb & explain its significance.	Understand	CACE006.10
2	State the Boussinesq's expression for the vertical stressdistribution in case of point load.	Remember	CACE006.10
3	What are the assumptions of Boussinesq's stress distribution theory?	Remember	CACE006.10
4	What is the difference between Boussinesq's & Westergaard's theory	Remember	CACE006.10
5	Sketch the variation of vertical stress distribution along vertical and horizontal plane.	Understand	CACE006.10
6	Explain the approximate method of stress distribution insoils.	Remember	CACE006.10
7	Sketch Newmark's Influence chart & innumerate its uses.	Understand	CACE006.11
8	State Westergaard's equation for vertical stress at a pointdue to point load.	Remember	CACE006.11
9	Write a short note on isobar.	Understand	CACE006.11
10	State Newmark's equation for vertical stress below thecorner of a uniformly loaded rectangular area.	Remember	CACE006.11

11	State Boussinesq's equation for vertical stress at a pointdue to uniformly loaded circular area.	Remember	CACE006.11
12	Define compaction & its use.	Remember	CACE006.12
13	Innumerate the factors affecting compaction.	Remember	CACE006.12
14	Differentiate between compaction and consolidation.	Understand	CACE006.12
15	Differentiate between standard proctor and modified proctor test.	Understand	CACE006.12
16	State zero air voids line equation.	Remember	CACE006.12
17	Name few field compaction equipments for clayey soil.	Understand	CACE006.13
18	What is the field compaction equipment for sandy soil?	Understand	CACE006.13
19	How would you control the compaction quality?	Remember	CACE006.13
20	Define OMC and MDD.	Understand	CACE006.13
Part - B (Long Answer Questions)			
1	What are the assumptions made by Boussinesq's in deriving the expression for vertical stress in soil due to point load? Explain its limitations?	Remember	CACE006.10
2	Explain assumptions & limitations of Westergaard's theory. State the expression for vertical stress in soil due to point load.	Remember	CACE006.10
3	Explain Newmark's influence chart preparation and usage.	Understand	CACE006.10
4	Explain the phenomena of compaction?	Remember	CACE006.10
5	Explain the effect of compaction on properties of soil.	Understand	CACE006.11
6	How compaction of soil is controlled in field?	Remember	CACE006.11
7	List the field compaction equipment and explain them in detail.	Understand	CACE006.11
8	Describe standard proctor test and modified proctor test.	Remember	CACE006.11
9	Explain the laboratory procedure to determine maximum dry density and optimum moisture content by using standard compaction test.	Understand	CACE006.11
10	Discuss briefly on methods of compaction and field compaction method.	Remember	CACE006.12
11	Explain in detail various factors affecting the compaction of soil.	Remember	CACE006.12
12	What are the types of rollers used for compacting different types of soils in the field? How do you decide the compactive effort required for compacting the soil to a desired density in field?	Understand	CACE006.12
13	Discuss how quality control of compacted earth mass is ensured in the in-situ.	Remember	CACE006.13
14	Compare the properties of soil on dry of optimum and wet of optimum.	Understand	CACE006.13
15	Explain the structure and engineering behaviour of compacted soils?	Understand	CACE006.13
Part – C (Problem Solving and Critical Thinking)			
1	A proctor compaction test was conducted on a soil sample and the following observations were made Water content (%): 5.0, 6.5, 8.9, 11.4, 13.6, 15.1 Mass of wet soil (kg): 1.70, 1.90, 2.00, 1.98, 1.95, 1.92 If the volume of the mould used was 950 cc and the specific gravity of soil was 2.65. (i) draw dry density vs moisture content curve (ii) also plot the zero air voids line (iii) Find OMC & MDD of soil (iv) find the degree of saturation at OMC.	Remember	CACE006.10
2	a) A long strip footing of width 2m transmits a pressure of 200kPa to the underlying soil. Using 2 : 1 dispersion method, compute the approximate value of the vertical stress at a depth of 5m below the footing. b) A point load of 100 kN acts on the surface. Determine the intensity of vertical stress at a point 2m below the surface at a distance of 2m from the point of load. Use Boussinesq's theory.	Understand	CACE006.10

<table>
<tr><td>3</td><td>A rectangular area of 2m x 4m carries a uniformly distributed load 80 kN/sq.m at ground surface. Find the vertical pressure at 5m below the centre and corner of the loaded area. Solve the problem by a) dividing the rectangle into four equivalent rectangles, b) 2:1 method.</td><td>Understand</td><td>CACE006.10</td></tr>
<tr><td>4</td><td>A load 500kN acts as a point load at the surface of a soil mass. Estimate the vertical stress at a point 4 m below and 3m away from the point of load using Boussinesq's and Westergaard's theory.</td><td>Remember</td><td>CACE006.11</td></tr>
<tr><td>5</td><td>During a compaction test, a soil attains a maximum dry density of 18 kN/m^3 at a water content of 12%. Determine the degree of saturation and percent air voids at maximum dry density. Also find the theoretical maximum dry density corresponding to zero air voids at OMC. The specific gravity of soils 2.67.</td><td>Remember</td><td>CACE006.11</td></tr>
<tr><td>6</td><td>The maximum dry density of a sample by the light compaction test is 1.78 g/cc at an optimum water content of 15%. Find the air voids and the degree of saturation. G =2.67 what would be the corresponding value of dry density on the zero air void line at O.W.C.</td><td>Understand</td><td>CACE006.11</td></tr>
<tr><td>7</td><td>a) A Concentrated load of 40kN acts on the surface of the soil mass. Estimate the vertical stress at a point directly below beneath the load up to a depth of 10m and draw a plot.
b) A Concentrated load of 40kN acts on the surface of thesoil mass. Estimate the vertical stress due to load onhorizontal planes at a depth of 1m, 2m and 3m up to a horizontal distance of 3m on either side of centre and draw a plot on horizontal plane.</td><td>Remember</td><td>CACE006.11</td></tr>
<tr><td>8</td><td>a) The four legs of a transmission tower form in plan a square of side 4m and together carry a total load of 200kN. Compute the increase in vertical stress at a depth of 3m vertically below a Leg. Use Boussinesq's theory.
b) Find the intensity of vertical pressure at a point 4m directly below 20 kN point load acting at a horizontal ground surface. What will be the vertical pressure at a point 2 m horizontally away from the axis of loading but at the same depth of 4m and directly under the load at a depth of 3 m.</td><td>Remember</td><td>CACE006.11</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>9</td><td>A sample of soil compacted according to the standard Proctor test has a density of 2.06g/cm^3 at 100% compaction and at an optimum water content of 14%. What is the dry unit weight? What is the dry unit weight at zero air voids? If the voids become filled with water what would be the saturated unit weight? Assume G=2.67.</td><td>Remember</td><td>CACE006.12</td></tr>
<tr><td>10</td><td>The records of a soil compaction in the past gave compaction water content of 15% and saturation 85%. What might be the dry density of soil?</td><td>Remember</td><td>CACE006.12</td></tr>
<tr><td>11</td><td>Standard Proctor test conducted on a soil gave the following details:
<table>
<tr><td>Bulk density (kN/m^3)</td><td>18.0</td><td>19.0</td><td>19.6</td><td>20.5</td><td>21.0</td><td>20.5</td><td>20.1</td></tr>
<tr><td>Water content (%)</td><td>9.6</td><td>11.0</td><td>12.5</td><td>14.0</td><td>16.0</td><td>18.0</td><td>19.5</td></tr>
</table>
Find OMC and maximum dry density by plotting compaction curve. Determine degree of saturation at OMC, if G = 2.68</td><td>Understand</td><td>CACE006.12</td></tr>
<tr><td>12</td><td>The in-situ void ratio of a granular soil deposit is 0.50. The maximum and minimum ratios of the soil were determined to be 0.75 and 0.35. G =2.67. Determine the relative density and relative compaction of the deposit.</td><td>Remember</td><td>CACE006.12</td></tr>
<tr><td>13</td><td>The compaction of an embankment is carried out in 300 mm thick lifts. The rammer used for compaction has a foot of area 0.05 sq m. The energy developed per drop of the rammer is 40 kg m. Assuming 50% more energy in each pass over the compacted area due to</td><td>Understand</td><td>CACE006.13</td></tr>
</table>

	overlap, calculate the number of passes required to develop compactive energy equivalent to IS compaction for each layer.		
14	A compacted fill is to be constructed using one of the two potential borrow areas A and B. The in-situ properties of the soil at these sites are as follows: Borrow area A: e=0.80, w=17.5%, G=2.65 Borrow area B: e=0.68, w=14.0%, G=2.65 The compacted volume of the embankment will be 50,000 m^3, its unit weight 20 kN/m^3 at a placement water content of 20%. Soil from borrow area is to be excavated and transported to the site in trucks of 10 m^3 capacity. During excavation and dumping of soil in the trucks, the soil increases in volume by 10%. At the site, the required additional amount of water is added to the soil and compacted to the desired extent by pneumatic rubber tyred rollers. The cost of excavation, transportation and compaction is Rs 400 per truck for borrow area A and Rs 500 per truck for borrow area B. Water charges per truck is Rs 150. Which of the two borrow areas is more economical?	Understand	CACE006.13
15	Two columns A and B are standing 5m apart. Load transferred through them may be taken as point load. Through column A, a load of 400 kN are acting. Calculate the resultant vertical pressure due to these load on a horizontal plane 2m below the ground surface at points vertically below the column A and B.	Understand	CACE006.13
UNIT 4			
CONSOLIDATION			
Part – A (Short Answer Questions)			
1	Define consolidation.	Remember	CACE006.14
2	What are the different types of settlements in soil.	Understand	CACE006.14
3	Define under consolidated clays.	Remember	CACE006.14
4	Define over consolidated clays.	Understand	CACE006.14
5	Define normally consolidated clays.	Remember	CACE006.15
6	Write the formula to determine the compression index in terms of liquid limit.	Remember	CACE006.15
7	Explain the significance of pre-consolidation pressure.	Understand	CACE006.15
8	List the assumptions of Terzaghi's 1-D consolidation theory.	Remember	CACE006.15
9	Define compression index.	Understand	CACE006.16
10	Define coefficient of consolidation.	Remember	CACE006.16
11	Write the expression for immediate settlement.	Remember	CACE006.16
12	Differentiate between primary consolidation and secondary consolidation.	Understand	CACE006.16
14	Define primary consolidation & write the expression for calculating the consolidation settlement.	Remember	CACE006.17
15	Define recompression index.	Understand	CACE006.17
16	Discuss Terzaghi's theory of consolidation.	Remember	CACE006.17
17	How is consolidation different from compaction?	Remember	CACE006.18
18	Under what conditions secondary consolidation becomes important?	Understand	CACE006.18
19	Differentiate between coefficient of compressibility and coefficient of volume decrease.	Remember	CACE006.18
20	Define degree of consolidation.	Understand	CACE006.18
Part - B (Long Answer Questions)			
1	Discuss Terzaghi's theory of consolidation, stating the various assumptions and their validity.	Remember	CACE006.14
2	Write a brief procedure of consolidation test to determine the coefficient of consolidation by both logarithmic time fitting method.	Remember	CACE006.14

3	Explain the square root of time fitting method of determining the coefficient of consolidation of a clay sample?	Remember	CACE006.14
4	Explain the procedure for determining pre consolidated pressure?	Remember	CACE006.15
5	Explain how you will determine void ratio of the sample by change in void ratio method. Also explain how do you find coefficient volume change?	Understand	CACE006.15
6	What are the different causes of pre consolidation of soils? What is the effect of pre consolidation on the settlement?	Remember	CACE006.15
7	Differentiate between normally consolidated, under consolidated and over consolidated soils. How would you determine the over consolidation pressure.	Understand	CACE006.16
8	Discuss the spring analogy for primary consolidation.	Remember	CACE006.16
9	What is over consolidation soil? Explain briefly with an example.	Understand	CACE006.16
10	Explain briefly the laboratory consolidation test.	Remember	CACE006.17
11	Explain the procedure for determining the total settlement of the footing.	Understand	CACE006.17
12	Define the following terms: (i) Coefficient of compressibility (ii)Coefficient of volume change (iii)Compression index (iv)Expansion index (v) Recompression index.	Remember	CACE006.17
13	Explain graphical method to determine the pre-consolidation pressure.	Understand	CACE006.18
14	Explain the procedure for determining the consolidation settlement.	Remember	CACE006.18
15	Sketch e-p and e-logp curves and explain their significance.	Understand	CACE006.18
Part – C (Problem Solving and Critical Thinking)			
1	A soil sample 20 mm thick takes 20 minutes to reach 20% consolidation. Find the time taken for a clay layer 6 m thick to reach 40% consolidation. Assuming double drainage in both the cases.	Understand	CACE006.14
2	A stratum of normally consolidated clay 7m thick is located at a depth 12m below ground level. The natural moisture content of the clay is 43% and its liquid limit is 48%. The specific gravity of the solid particles is 2.76. The water table is at a depth of 5m below ground surface. The soil is sand above the clay stratum. The submerged unit weight of the sand is 11kN/m^3 and 18 kN/m^3 above the water table. The average increase in pressure at the centre of the clay stratum is 120kN/m^3 due to the weight of the building that will be constructed on the sand above the clay stratum. Estimate the expected settlement of the structure.	Understand	CACE006.14
3	A clay layer of 6m thick is situated with sand on top and impervious rock at the bottom. In a consolidation test conducted in the laboratory on an undisturbed specimen of 20 mm thick clay sample, 90% settlement was reached in 3 hours. Estimate the time in years for the building on this deposit to reach 90% of its final settlement.	Remember	CACE006.14
4	An oedometer test is performed on a 2 cm thick clay sample. After 5 minutes, 50% consolidation is reached. After how long time would the same degree of consolidation is achieved in the field where the clay layer is 3.70 m thick? Assume the sample and the clay layers have the same drainage boundary conditions (double drainage).	Understand	CACE006.15
5	In a consolidation test the pressure on a sample was increased from 150 to 300kN/m^2. The void ratio after 100% consolidation under 150kN/m^2 was 0.945, and that under 300kN/m^2 was 0.812. The coefficient of permeability of the soil was 25 x 10-6 mm/s and the initial height of the sample was 20mm. Determine (i) the coefficient of compressibility, (ii) the coefficient of volume compressibility.	Remember	CACE006.15
6	Saturated soil of 5 m thick lies above an impervious stratum and below a pervious stratum. It has a compression index of 0.25 with k = 3.2×10^{-10} m/sec. Its void ratio at a stress of 147 kN/m^2 is 1.9.	Understand	CACE006.15

	Compute (i) The change in voids ratio due to increase of stress to 196 kN/m^2 (ii) Coefficient of volume compressibility (iii) Coefficient of consolidation (iv) Time required for 50% consolidation.		
7	A 8 m thick clay layer with a single drainage settles by 120 mm in 2 years. The coefficient of consolidation for this clay was found to be 6 $X10^{-3}$ cm^2/sec. Calculate the likely ultimate consolidation settlement and find how long it will take to undergo 90 percent of this settlement.	Remember	CACE006.16
8	A layer of submerged soil 8m thick is drained at its upper surface but is underlain by impermeable shale. The sol is subjected to a uniform vertical stress of 200 kN/m^2 which is produced by the construction of an extensive embankment on the ground surface. If the coefficient of consolidation for the soil is 2 x 10^{-3} cm^2/sec calculate the times when 50% and 90% respectively of the final settlement will take place. Consider T_{50} =0.197.	Understand	CACE006.16
9	A laboratory sample of clay 2cm thick took 15min to attain 60% consolidation under a double drainage condition. What will be the time required to attain the same degree of consolidation for a clay layer 3cm thick under the foundation of a building for a similar loading and drainage condition, What is the value of c_v.	Remember	CACE006.16
10	During a consolidation test, as sample of fully saturated clay 3cm thick is consolidated under a pressure increment of 200kN/m^2. When equilibrium is reached, the sample thickness is reduced to 2.6cm. The pressure is then removed and the sample is allowed to expand and absorb water. The final thickness is observed as 2.8cm and the final moisture content is determined as 24%. If the specific gravity of the soil solids is 2.7, find the void ratio of the sample before and after consolidation.	Understand	CACE006.17
11	A 2.5cm thick sample of clay was taken from the field for predicting the time of settlement for a proposed building which exerts pressure of 100kN/m^2 over the clay stratum. The sample was loaded to 100kN/m^2 and proper drainage allowed from top to bottom. It was seen that 50% of the total settlement occurred in 3minutes. Find the time required for 50% of the total settlement of the building, if it is to be constructed on a 6m thick layer of clay which extends from the ground surface and is underlain by sand.	Understand	CACE006.17
12	A certain clay layer has a thickness of 5 m. After 1 year, when the clay was 50 percent consolidated, 8 cm of settlement occurred. For a similar clay and loading conditions, how much settlement would occur at the end of 1 year and 4 years respectively, if the thickness of this new layer were 25 m.	Remember	CACE006.17
13	The loading period for a new building extended form May 1995 to May 1997. In May 1960, the average measured settlement was found to be 11.43cm. It is known that the ultimate settlement will be about 35.56cm. Estimate the settlement in May 1965. Assume double drainage to occur.	Understand	CACE006.18
14	A sample of layer of silty clay, 5 m thick were tested and the results are as follows: initial void ratio is 0.90, pre-consolidation pressure is 120 kN/m^2,C_r = 0.03 and C_c = 0.27. Estimate consolidation settlement if present overburden pressure is 70kN/m^2 and change in stress is 80 kN/m^2 (ii) when change is stress is 40 kN/m^2.	Remember	CACE006.18
15	A soil has a compression index Cc of 0.28. At a stress of 120kN/m^2, the void ratio was 1.02. Calculate (i) void ratio if the stress on the soil is increased to 180kN/m^2 and (ii) the total settlement of the stratum of 6m thickness.	Understand	CACE006.18

UNIT V			
SHEAR STRENGTH OF SOILS			
Part – A (Short Answer Questions)			
1	Explain importance of shear strength of soils in foundation design.	Remember	CACE006.19
2	Explain about determination of shear strength using vane shear test.	Understand	CACE006.19
3	What are the names of shear tests based on drainage conditions?	Remember	CACE006.19
4	What are the merits of direct shear test?	Understand	CACE006.20
5	What are the different tests for shear strength?	Remember	CACE006.20
6	What are the demerits of direct shear test?	Remember	CACE006.20
7	Define dilatancy.	Understand	CACE006.21
8	What does the Mohr Circle of stress represent?	Remember	CACE006.21
9	What is the meaning of peak and residual shear strength of clay soils?	Understand	CACE006.21
10	How can liquefaction in sands be prevented?	Remember	CACE006.21
11	What are the merits and demerits of tri-axial test?	Understand	CACE006.22
12	What are the merits and demerits of vane shear test.	Remember	CACE006.22
13	What is unconfined compression test?	Remember	CACE006.22
14	What is the difference between angle of repose and angle of internal friction	Understand	CACE006.23
15	Define critical void ratio.	Remember	CACE006.23
16	What are the factors on which critical void ratio depends?	Understand	CACE006.23
17	State Mohr- Coulomb failure theories.	Remember	CACE006.23
18	Describe tri-axial shear test.	Understand	CACE006.23
19	Discuss the shear characteristics of cohesion-less soils.	Remember	CACE006.23
20	Discuss the shear characteristics of cohesive soils.	Understand	CACE006.23
Part - B (Long Answer Questions)			
1	When do you use the following shear tests and give reasons: (a) direct shear test; (b) vane shear test; (c) unconfined compression test.	Remember	CACE006.19
2	Sketch stress strain diagrams for loose sand, dense sand, soft clay and stiff clay and comment.	Understand	CACE006.19
3	Explain the merits and demerits of direct shear test when compared with the other laboratory tests to determine the shear strength of soil.	Remember	CACE006.19
4	Write a note on the laboratory direct shear test.	Understand	CACE006.20
5	What is the Mohr-Coulomb theory of failure?Sketch typical strength envelope for a soft clay, clean sand and a silty clay.	Remember	CACE006.20
6	What are the various drainage conditions and what is the significance of each drainage conditions?	Remember	CACE006.20
7	Classify the shear tests based on drainage conditions. Explain how the pore pressure variation and volume change take place during these tests. Enumerate the field conditions which necessitate each of these tests.	Understand	CACE006.20
8	Discuss modified failure envelope. What are its advantages and disadvantages over the standard failure envelope.	Remember	CACE006.21
9	Explain liquefaction of soils. Discuss various conditions causing liquefaction of sand.	Understand	CACE006.21
10	What is Coulomb's equation for shear strength of soil? Discuss the factors that affect the shear strength parameters of soil.	Remember	CACE006.21
11	For which types of soils will the unconfined compression test give reliable results? Draw a Mohr circle for this test. How do you consider the change in the area of the specimen which takes place during the test in final results?	Remember	CACE006.22
12	What is critical void ratio? How would you determine it in the laboratory?	Remember	CACE006.22
13	Discuss the characteristics of cohesion-less and cohesive soils.	Remember	CACE006.23
14	Explain the phenomena of dilatancy & where it occurs.	Understand	CACE006.23

<table>
<tr><td>15</td><td>Discuss in detail the laboratory procedure for determining the shear strength of soil using tri-axial test.</td><td>Remember</td><td>CACE006.23</td></tr>
<tr><td colspan="4">Part – C (Problem Solving and Critical Thinking)</td></tr>
<tr><td>1</td><td>The results of two drained triaxial tests on saturated clay are given as
Specimen I : Horizontal confining stress = 70 kN/m^2
Deviator stress = 213 kN/m^2
Specimen II : Horizontal confining stress = 100 kN/m^2
Deviator stress = 250 kN/m^2
Calculate shear strength parameters of the soil.</td><td>Remember</td><td>CACE006.19</td></tr>
<tr><td>2</td><td>Given the following data from a consolidated undrained test with pore water pressure measurement, determine the total and effective stress parameters:
<table>
<tr><td>σ3</td><td>100 kN/m^2</td><td>200 kN/m^2</td></tr>
<tr><td>(σ1 – σ3)</td><td>150 kN/m^2</td><td>192 kN/m^2</td></tr>
<tr><td>uf</td><td>60 kN/m^2</td><td>140 kN/m^2</td></tr>
</table></td><td>Understand</td><td>CACE006.19</td></tr>
<tr><td>3</td><td>The following results were obtained from a triaxial test on two soil specimens. Determine the effective shear strength parameters c’ and φ’ of soil?
<table>
<tr><th>Specimen No.</th><th>Confining Pressure(kPa)</th><th>Deviator Stress at failure(kPa)</th><th>Pore water pressure(kPa)</th></tr>
<tr><td>1</td><td>200</td><td>244</td><td>55</td></tr>
<tr><td>2</td><td>300</td><td>314</td><td>107</td></tr>
</table></td><td>Remember</td><td>CACE006.19</td></tr>
<tr><td>4</td><td>Determine the shear strength in terms of effective stress on a plane within saturated soil mass at a point where the total normal stress is 200 kN/m^2 and the pore water pressure is 80 kN/m^2. The effective stress shear strength parameters for the soil are c’ = 16 kN/m^2 and φ’= 30^0.</td><td>Understand</td><td>CACE006.20</td></tr>
<tr><td>5</td><td>In an in-situ vane shear test on a saturated clay, a torque of 35 Nm was required to shear the soil. The diameter of the vane was 50 mm and length 100 mm. Calculate the undrained shear strength of clay. The vane was then rotated rapidly to cause remoulding of the soil. The torque required to shear the soil in the remoulded state was 5 Nm. Determine the sensitivity of the clay.</td><td>Remember</td><td>CACE006.20</td></tr>
<tr><td>6</td><td>A direct shear test was conducted on a soil, whose results are given below:
<table>
<tr><td>Normal stress, kN/m^2</td><td>150</td><td>250</td></tr>
<tr><td>Shear stress at failure kN/m^2</td><td>110</td><td>120</td></tr>
</table>
Plot the graph and determine the shear strength parameters of the soil. If a triaxial test is conducted on the same soil, what would be the deviator stress at failure when the cell pressure is 150 kN/m^2.</td><td>Understand</td><td>CACE006.20</td></tr>
<tr><td>7</td><td>A series of shear tests was performed on a soil. Each test was carried out until the soil sample sheared and the principal stress for each test are as follows:
<table>
<tr><td>Test</td><td>σ_3(kN/m^2)</td><td>σ_1(kN/m^2)</td></tr>
<tr><td>1</td><td>300</td><td>875</td></tr>
<tr><td>2</td><td>400</td><td>1160</td></tr>
<tr><td>3</td><td>500</td><td>1460</td></tr>
</table>
Plot the Mohr circle of stress and determine strength envelope and angle of internal friction of the soil.</td><td>Understand</td><td>CACE006.20</td></tr>
<tr><td>8</td><td>A direct shear test was performed on a 6cm x 6cm sample of dry sand the normal load was 360N. The failure occurred at a shear load of 180N.Plot the Mohr strength envelope and determine ϕ . Assume c=0</td><td>Understand</td><td>CACE006.21</td></tr>
</table>

	also determine principal stress at failure.		
9	An unconfined compression test was conducted on an undisturbed sample of clay. The sample had a diameter of 37.5 mm and 80 mm long. The load at failure measured by proving ring was 28 N and the axial deformation of the sample at failure was 13mm. Determine the unconfined compressive strength and the undrained shear strength of the clay.	Remember	CACE006.21
10	What is the shear strength of soil along a horizontal plane at a depth 4m in a deposit of sand having the following properties: Angle of internal friction $=35^o$, Dry unit weight $=17kN/m^3$, Specific gravity =2.7. Assume the ground water table is at a depth of 2.5m from the ground surface. Also find the changes in shear strength when the water table rises to ground surface.	Understand	CACE006.21
11	A vane 11.25cm long and 7.5cm in diameter was pressed into soft clay at the bottom of a borehole. Torque was applied to cause failure of soil. The shear strength of clay was found to be $37kN/m^2$. Determine the torque that was applied.	Remember	CACE006.22
12	Determine the shear strength in terms of effective stress on a plane within a saturated soil mass at a point where the total stress is 200 kN/m^2 and the pore water pressure is 80 kN/m^2. The effective stress shear strength parameters for the soil are: c' = 16 kN/m^2 and effective angle of internal friction = 30^o.	Understand	CACE006.22
13	The results obtained from a series of CU tests on a soil gave the following results: $C_{CU}= C'_{CU} = 0$, $\varphi_{CU} = 15^0$, $\varphi'_{CU} = 30^0$. A sample of this soil was tested in a CU test under a cell pressure of 150 kN/m^2. Determine (a) Deviator stress at failure (b) pore water pressure at failure (c) minor principal effective stress at failure and (d) major principal effective stress at failure.	Remember	CACE006.23
14	An unconfined compressive test was conducted on an undisturbed sample of clay. The sample had a diameter of 37.5 mm and was 80 mm long. The load at failure measured by the proving ring was 28N and the axial deformation of the sample at failure was 13mm. Determine the unconfined compressive strength and the un-drained shear strength of clay.	Understand	CACE006.23
15	A drained triaxial test on sand with σ_3' =150 kN/m^2 gave (σ_1'/σ_3') =3.7. Compute (a) σ_{1f}' (b) $(\sigma_1-\sigma_3)_f$ and ϕ'.	Understand	CACE006.23

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