INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)

Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

QUESTION BANK

Course Name	**GEOTECHNICAL ENGINEERING**			
Course Code	A50120			
Class	III – B. Tech I- Semester			
Branch	Civil Engineering			
Academic Year	2017 – 2018			
Course Structure	**Lectures**	**Tutorials**	**Practical's**	**Credits**
	4	-	-	4
Course Coordinator	Ms.J.Hymavathi, Ms.B.Navya. Assistant Professor, Civil Engineering Dept.			
Course Faculty	Ms.J.Hymavathi, Ms.B.Navya, Assistant Professor, Civil Engineering Dept.			

COURSE OVERVIEW

It is the branch of civil engineering concerned with the design and construction of foundations, slopes, retaining walls, embankments, tunnels, levees, wharves, landfills and similar facilities; and with the engineering characterization and behavior of the ground and its constituent materialsPlays a key role in all civil engineering projects built on or in the ground. Is vital for the assessment of natural hazards such as earthquakes, liquefaction, sinkholes, rock falls and landslides.

S. No	Question	Blooms Taxonomy Level	Program Outcome
	UNIT – I		
Part - A (Short Answer Questions)			
1	Name different types of soil based on transportation agency	Understand	1
2	Define Void Ratio.	Remember	2
3	Define specific gravity of particles.	Remember	2
4	Define degree of saturation.	Remember	2
5	Define dry density.	Remember	2
6	Define water content.	Remember	2
7	Define porosity.	Remember	2
8	Define saturated unit weight & submerged unit weight?	Remember	2
9	Explain Sensitivity & Activity?	Remember	2
10	Draw three phase & two phase diagram? Explain its use?	Remember	2
11	Explain the significance of a grain size distribution curve.	Understand	2
12	Define consistency limits.	Understand	3

13	Write the expression for toughness index.	Remember	3
14	Write the expression for flow index.	Remember	3
15	Draw plasticity chart.	Remember	3
16	What is IS classification of soil and the principle of soil classification.	Understand	2
17	A sample weighing 18kN/m^3 and has water content of 30%. The specific gravity of soil particles is 2.68. Determine void ratio and porosity.	Understand	3
18	Differentiate between saturated density and bulk density.	Remember	2
19	What are clay minerals explain it with neat sketch?	Understand	
20	Differentiate between void ratio and porosity.	Understand	
Part - B (Long Answer Questions)			
1	Explain soil formation & soil types?	Understand	1
2	Explain in detail the laboratory methods for grain size distribution of fine and coarse soil.	Remember	1
3	Starting from three phase representation of soil mass, derive the relationship between bulk unit weight, specific gravity, void ratio and degree of saturation	Understand	1
4	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.	Remember	2
5	Explain the principle of hydrometer method.	Remember	
6	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%.	Understand	1
7	Explain laboratory tests to determine the (i) specific gravity of soil (ii) water content of soil.	Understand	1
8	A sample weighing 20kN/m^3 and has water content of 20%. The specific gravity of soil particles is 2.68. Determine void ratio and porosity. Derive the equation for calculating void ratio, e in terms of w, G & γ	Understand	2
9	Discuss the importance of Atterberg's limits of soil. What are the main index properties of fine grained soils? How are these determined in laboratory?	Remember	2
10	Discuss the method for determination of shrinkage limit of soil.	Understand	2
11	What do you understand by index properties? What is their importance? What are the main index properties of a coarse grained soil? How are these determined?	Remember	2
12	Explain in detail about three clay minerals?	Remember	2
13	What are the uses of consistency limits? What are their limitations?	Remember	2
14	What is the use of classification of soils? Discuss the Indian standard classification system?	Understand	2

15	Explain different types of soil structures with neat figures?	Remember	2
Part - C (Problem Solving and Critical Thinking Questions)			
1	Explain the terms porosity, void ratio and degree of saturation? 1 m3 of wet soil weighs 20 kN. Its dry weight is 18 kN. Specific Gravity of solids is 2.67. Determine the water content, porosity, void ratio and degree of saturation. Draw a Phase diagram.	Understand	1
2	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.	Understand	3
3	An undisturbed sample of soil has a volume 100cm3 and mass 200g. on oven drying for 24 hours, the mass is reduced to 170g. If G= 2.68. Determine the (i) void ratio (ii) water content and (iii) degree of saturation of soil.	Understand	2
4	A cylindrical specimen of cohesive soil 10cm dia and 20cm length is prepared in a mould. If the wet weight is 2.25 kg and water content is 15%. Determine the dry unit weight and the void ratio. If G=2.7 determine the degree of saturation of the sample.	Understand	2
5	A partially saturated samples from a borrow pit has a natural moisture content of 15% and bulk unit weight of 1.9 g/cc. The specific gravity of solids is 2.70. Determine the degree of saturation & void ratio. What will be the unit weight of the sample on saturation?	Understand	2
6	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.	Understand	2
7	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.	Understand	3
8	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.	Understand	2
9	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	Understand	2

<table>
<tr><td>10</td><td>The moisture content of an undisturbed sample of clay belonging to a volcanic region is 265% under 100% saturation. The specific gravity of the solids is 2.5. The dry unit weight is 21 kN/m^3. Determine (i) the saturated unit weight, (ii) the submerged unit weight, and (iii) void ratio.</td><td>Understand</td><td>2</td></tr>
<tr><td>11</td><td>The void ratio of a clay sample is 0.5 and the degree of saturation is 70%. Compute the water content, dry and wet unit weights of soil. Assume G=2.7</td><td>Understand</td><td>2</td></tr>
<tr><td>12</td><td>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</td><td>Understand</td><td>2</td></tr>
<tr><td>13</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>3</td></tr>
<tr><td>14</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>2</td></tr>
<tr><td>15</td><td>The natural moisture content of an excavated soil is 32%. Its liquid limit is 60% and plastic limit is 27%. Determine the plasticity index of soil and comment about the nature of soil.</td><td>Understand</td><td>2</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">UNIT 2</td></tr>
<tr><td colspan="4">Part - A (Short Answer Questions)</td></tr>
<tr><td>1</td><td>State Darcy’s law.</td><td>Remember</td><td>4</td></tr>
<tr><td>2</td><td>What are the limitations of Darcy’s law?</td><td>Remember</td><td>4</td></tr>
<tr><td>3</td><td>Define permeability.</td><td>Understand</td><td>4</td></tr>
<tr><td>4</td><td>Explain the factors affecting the permeability of soil.</td><td>Understand</td><td>4</td></tr>
<tr><td>5</td><td>Define effective, neutral and total stress.</td><td>Understand</td><td>5</td></tr>
<tr><td>6</td><td>What is a flow net?</td><td>Remember</td><td>5</td></tr>
<tr><td>7</td><td>What is the standard temperature to report permeability?</td><td>Understand</td><td>5</td></tr>
<tr><td>8</td><td>Describe applications of flow net?</td><td>Understand</td><td>5</td></tr>
<tr><td>9</td><td>What are the uses of flow nets?</td><td>Remember</td><td>5</td></tr>
<tr><td>10</td><td>Explain quick sand condition?</td><td>Understand</td><td>5</td></tr>
<tr><td>11</td><td>What are the salient characteristics of a flow net?</td><td>Remember</td><td>5</td></tr>
<tr><td>12</td><td>What is seepage?</td><td>Understand</td><td>5</td></tr>
<tr><td>13</td><td>What is Flow line?</td><td>Understand</td><td>5</td></tr>
<tr><td>14</td><td>What is Equipotential line?</td><td>Understand</td><td>5</td></tr>
</table>

15	Define coefficient of permeability?	Remember	4
16	What is capillary rise?	Remember	4
17	Write the expression of permeability in stratified soils.	Understand	4
18	Differentiate between absorbed and capillary water in soils.	Understand	4
19	What is entry correction of the flow net?	Understand	5
20	What is Phreatic line?	Remember	5
Part - B (Long Answer Questions)			
1	Explain the factors affecting the permeability of soil.	Understand	3
2	Determination of coefficient of permeability in a laboratory and discuss their limitations.	Understand	3
3	What is Darcy's law? What are its limitations?	Remember	4
4	What are the characteristics of flow nets?	Remember	5
5	Discuss the properties and applications of flow nets and explain quick sand phenomenon.	Understand	5
6	Describe the electrical analogy of flow net construction.	Remember	5
7	Describe pumping-out method for the determination of the coefficient of permeability in the field?	Understand	3
8	Describe pumping-in method for the determination of the coefficient of permeability in the field?	Understand	3
9	Differentiate between absorbed and capillary water in soils and what are the advantages and disadvantages of coefficient of permeability.	Understand	3
10	What is seepage velocity, coefficient of percolation and quick sand.	Understand	4
11	What is a flow net? Describe its properties and applications. Describe different methods used to construct the flow net.	Remember	5
12	Explain the uses of flow nets.	Remember	5
13	Define the total stress, neutral stress and effective stress. What is the importance of the effective stress?	Remember	6
14	What is the effect of surcharge and capillary action on the effective stress?	Understand	4
15	What is effective stress principle?	Understand	4
Part - C (Problem Solving and Critical Thinking Questions)			
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 1 120 g, and G_s = 2.68. Determine (a) the hydraulic conductivity in cm/sec, (b) the discharge velocity, and (c) the seepage velocity	Understand	4
2	In a falling head permeameter, the sample used is 20 cm long having a cross-sectional area of 24 cm^2. Calculate the time required for a drop of head from 25 to 12 cm if the cross sectional area of the stand pipe is 2 cm^2. The sample of soil is made of three layers. The thickness of the first layer from the top is 8 cm and has a value of $k_1 = 2 \times 10^{-4}$ cm/sec, the second layer of thickness 8 cm has $k_2 = 5 \times 10^{-4}$ cm/sec and the bottom layer of thickness 4 cm has & $k_3 = 7 \times 10^{-4}$ cm/sec. Assume that the flow is taking place perpendicular to the layers	Understand	4
3	A sand sample of 0.25 m length was subjected to constant head	Understand	3

	permeability in a permeameter having an area of 307 x 10^{-4} m^2. A discharge of 100 cc was obtained in a period of 60 seconds under a head of 0.39 m. Height of dry sand in the sample was 1350 grams and the specific gravity of sand particles was 2.67. determine (i) Coefficient of permeability (ii) Superficial velocity (iii) Seepage velocity		
4	In a falling head permeability test, head causing flow was initially 500 mm and it drops to 20 mm in 5 minutes. Calculate the time required for the head to fall to 250 mm.	Understand	3
5	The following details refer to a test to determine the permeability of the soil: Thickness of specimen =25 mm; diameter of specimen= 75 mm; diameter of standing pipe=10 mm; initial head at start=1000 mm; water level after 3hrs 20 minutes= 800 mm. Determine the permeability of the soil. If voids ratio of the sample is 0.75, what is the permeability of the same soil at a voids ratio of 0.9?	Understand	3
6	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	3
7	A stratifies layer of soils 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.	Understand	3
8	If a falling head permeameter test the initial head is 40 cm. The head drops by 5cm in 10 minutes. Calculate the time required to run the test for the final head to be 20cm. If the sample is 6 cm in height and 50 cm^2 in cross sectional area, calculate the coefficient of permeability taking area of stand pipe = 0.5 cm^2 .	Understand	3
9	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	Understand	4
10	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. The bulk density of sample is 19.62kN/m^3. Calculate the effective pressure at 1m, 3m, 8m below the surface. Hence plot the variation of total pressure, neutral pressure and effective pressure at the depth of 8m.	Understand	4
11	A sand deposit contains three distinct horizontal layers of equal thickness. The coefficient of permeability of the upper and lower layers is 10^{-3} cm/s and that of the middle is 10^{-2}cm/s . What are the values of the horizontal and vertical coefficients of permeability of the three layers and what is their ratio?	Understand	3

12	Compute the critical hydraulic gradients for the following materials: a) coarse gravel, k=10cm/s, G=2.67, e=0.65 b) Sandy silt, k=10^{-6}cm/s, G=2.67, e=0.80	Understand	3
13	The results of a constant-head permeability test for a fine sand sample having a diameter of 150 mm and a length of 300 mm are as follows: Constant head difference: 500 mm. Time of collection of water : 5 min Volume of water collected : 350 cm. Temperature of water – 24^{o}C Find the hydraulic conductivity for the soil at 20 ^{o}C.	Understand	3
14	For a variable-head permeability test, the following are given: length of specimen = 15 in., area of specimen = 3 sq.in, and k=0.0688 in./min. What should be the area of the stand pipe for the head to drop from 25 to 12 in. in 8 min?	Understand	3
15	The hydraulic conductivity of a clayey soil is 3 x 10^{-7} cm/sec. The viscosity of water at 25^{o}C is 0.0911 x 10^{-4} g . sec/cm^{2}. Calculate the absolute permeability of the soil.	Understand	3
UNIT 3			
Part - A (Short Answer Questions)			
1	State the Boussinesq's equation for vertical stress at a point due to a load on the surface of an elastic medium.	Remember	6
2	Derive as per Boussinesq's theory, expression for vertical stress at any point in a soil mass due to strip load.	Remember	6
3	Derive the Westergaard's solution and limitations of elastic theories.	Remember	6
4	Derive vertical stress under trapezoidal loads, horizontal load, and inclined load.	Remember	6
5	Explain the Newmark's Influence charts and their uses.	Understand	7
6	Describe standard proctor test and the modified proctor test.	Understand	8
7	Write short notes on method on compaction and field compaction method.	Understand	8
8	Discuss the effect of compaction on soil properties.	Understand	8
9	What is the effect of compaction on the engineering properties of the soil? How will you decide if the soil is to be compacted towards the dry of the optimum or the wet of the optimum?	Remember	8
10	What are the different methods of compaction adopted in the field? How would you select the type of roller to be used in the field?	Understand	8
11	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?	Remember	8
12	What are the methods adopted for measuring the density of the compacted soil? Briefly describe the on which will suit all types of soils.	Remember	8
13	Draw an ideal compaction curve and discuss the effect of moisture on the dry unit weight of soil.	Understand	8
14	State the assumptions made in computing stresses below the ground surface due to a point load acting on it. Discuss their validity in practice.	Remember	8
15	What do you understand by geostatic stresses? How are these determined?	Understand	6

UNIT 3 Part - A (Short Answer Questions)			
1	What is pressure bulb?	Understand	6
2	What are the expressions for the Boussinesq's and Westergaard's solution for point load?	Remember	8
3	State Boussinesq's equation for vertical stress at a point due to a load on the surface of an elastic medium.	Understand	8
4	Derive the principle of construction of Newmark's chart and explain its use.	Remember	8
5	A load 1000kN acts as appoint load at the surface of the soil mass. Estimate the stress at a point 2m below 3m away from the point of action of the load by Boussinesq's formula. Compare the value with the result from Westergaard's theory.	Understand	8
6	A circular area on the surface of an elastic mass of great extent carries a uniformly distributed load of 120KN/m^2. The radius of the circle is 3m. Compute the intensity of vertical pressure at a point 5m beneath the centre of the circle using Boussinesq's method.	Understand	8
7	What is compaction?	Understand	6
8	What is the mechanism of compaction?	Understand	6
9	Discuss the effect of compaction on soil properties.	Understand	6
10	Write short notes on field compaction control.	Remember	6
11	Differentiate compaction and consolidation.	Understand	6
12	Differentiate standard proctor and modified proctor test.	Understand	6
13	What is the unit in which compaction is measured?	Understand	
14	Explain 95 % of Proctor Density.	Understand	
15	Explain zero air voids line.	Understand	
Part - B (Long Answer Questions)			
1	State the Boussinesq's equation for vertical stress at a point due to a load on the surface of an elastic medium.	Remember	6
2	Derive as per Boussinesq's theory, expression for vertical stress at any point in a soil mass due to strip load.	Remember	6
3	Derive the Westergaard's solution and limitations of elastic theories.	Remember	6
4	Derive vertical stress under trapezoidal loads, horizontal load, and inclined load.	Remember	6
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10	What are the different methods of compaction adopted in the field? How would you select the type of roller to be used in the field?	Understand	8
11	What are the types of rollers used for compacting different types of soils in the field? How do you decide the compactive effort	Remember	8

<table>
<tr><td></td><td>required for compacting the soil to a desired density in field?</td><td></td><td></td></tr>
<tr><td>12</td><td>What are the methods adopted for measuring the density of the compacted soil? Briefly describe the on which will suit all types of soils.</td><td>Remember</td><td>8</td></tr>
<tr><td>13</td><td>Draw an ideal compaction curve and discuss the effect of moisture on the dry unit weight of soil.</td><td>Understand</td><td>8</td></tr>
<tr><td>14</td><td>State the assumptions made in computing stresses below the ground surface due to a point load acting on it. Discuss their validity in practice.</td><td>Remember</td><td>8</td></tr>
<tr><td>15</td><td>What do you understand by geostatic stresses? How are these determined?</td><td>Understand</td><td>6</td></tr>
<tr><td colspan="4">Part - C (Problem Solving and Critical Thinking Questions)</td></tr>
<tr><td>1</td><td>A rectangular area of 2m X 4m carries u.d.l. of 10 t/m^2 at the ground surface. Estimate the vertical pressure at the depth of 8m vertically below a corner of the loaded area.</td><td>Understand</td><td>6</td></tr>
<tr><td>2</td><td>A circular area is loaded with a uniform load intensity of 100 kN/m^2 at ground surface. Calculate the vertical pressure at a point P so situated on the vertical line through the centre of loaded area that the area subtends an angle 90^O at P. use the Boussinesq analysis.</td><td>Understand</td><td>6</td></tr>
<tr><td>3</td><td>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.</td><td>Understand</td><td>6</td></tr>
<tr><td>4</td><td>A bed of compressible clay 4 m thick has pervious sand on the top and impervious rock at the bottom. In a consolidation test on an undisturbed sample of clay from this deposit, 90% settlement was reached in 4 hours. The sample was 20 mm thick. Estimate the time in years for the building founded over this deposit to reach 90% of its settlement.</td><td>Understand</td><td>6</td></tr>
<tr><td>5</td><td>During a compaction test, a soil attains a maximum dry density o6 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>Understand</td><td>6</td></tr>
<tr><td>6</td><td>Following are the observations of a compaction test
<table>
<tr><td>Water content (%)</td><td>7.7</td><td>11.5</td><td>14.6</td><td>17.5</td><td>19.25</td><td>2.1</td></tr>
<tr><td>Weight of wet soil (N)</td><td>16.67</td><td>18.54</td><td>19.92</td><td>19.52</td><td>19.23</td><td>18.83</td></tr>
</table>
If the volume of the compaction mould is 950 cc, assuming G=2.65.
(i) Draw the compaction curve (ii) Report the maximum dry unit weight and optimum moisture content (iii) Draw 100% saturation line</td><td>Understand</td><td>6</td></tr>
</table>

<table>
<tr><td>7</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>6</td></tr>
<tr><td>9</td><td>The maximum dry density of a sample by the light compaction test is 1.78g/ml 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>8</td></tr>
<tr><td>10</td><td>A cylindrical specimen of a cohesive soil of 10cm diameter and 20cm length was prepared by compaction in a mould. If the wet mass of the specimen weighs 3.25Kg and its water content was 15% determine the dry density and void ratio. If the specific gravity of the particles was 2.70 find the degree of saturation.</td><td>Understand</td><td>8</td></tr>
<tr><td>11</td><td>The following observations were recorded when a sand cone test was conducted for finding the unit weight of a natural soil:
Total density of sand used in the test = 1.4g/cm^3
Mass of the soil excavated from hole =980g
Mass of the sand filling the hole= 700g
Water content of the natural soil =15%
Specific gravity of the soil grains =2.7
Calculate the a) wet unit weight b)dry unit weight c) void ratio d) degree of saturation</td><td>Understand</td><td>8</td></tr>
<tr><td>12</td><td>Old 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>Understand</td><td>8</td></tr>
<tr><td>13</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>Understand</td><td>8</td></tr>
<tr><td>14</td><td>A concentrated load of 200kN is applied at the ground surface. Determine the vertical stress at a point P which is 6m directly below the load. Also calculate the vertical stress at a point R which is at a depth 6m but at a horizontal distance of 5m from the axis of the load.</td><td>Understand</td><td>7</td></tr>
<tr><td>15</td><td>There is a line load of 120kN/m acting on the ground surface along y-axis. Determine the vertical stress at a point P which has x and z co-ordinates as 2m and 3.5m respectively.</td><td>Understand</td><td>7</td></tr>
<tr><td colspan="4">UNIT 4</td></tr>
</table>

Part - A (Short Answer Questions)			
1	Define normally consolidated soil	Remember	7
2	Define under consolidated soil	Remember	7
3	Define over consolidated soils.	Remember	7
4	Explain the significance of pre-consolidation pressure.	Understand	7
5	Explain Terzaghi's assumptions	Understand	7
6	Define compression index	Remember	7
7	Define coefficient of consolidation	Remember	7
8	Differentiate between compaction and consolidation of soils.	Understand	7
9	Define immediate settlement	Understand	7
10	Define primary consolidation	Remember	7
11	Define secondary consolidation.	Remember	7
12	Explain logarithm of time fitting method	Remember	7
13	Differentiate between standard and modified Proctor test	Remember	7
14	Discuss Terzaghi's theory of consolidation.	Understand	7
15	A sand fill compacted to bulk density of 18.84KN/m^3 is to be placed on a compressible saturated marsh deposit 3.5m thick. The height of the sand fill is to be 3m. if the volume compressibility m_v of the deposit is 7 x 10^{-4} m^2/KN, estimate final settlement of the fill.	Understand	7
16	How would you determine over consolidation pressure	Understand	7
17	Define Recompression index	Understand	7
18	Define Expansion index	Remember	7
19	What is field consolidation curve?	Understand	7
20	How would you determine the time- settlement curve in the field?	Understand	7
Part - B (Long Answer Questions)			
1	Explain spring analogy for primary consolidation.	Remember	9
2	Discuss Terzaghi's theory of consolidation, stating the various assumptions and their validity	Remember	9
3	Explain the different e-log p curves for the consolidation.	Remember	9
4	Differentiate between (i) primary consolidation and secondary consolidation (ii) standard and modified Proctor test.	Understand	9
5	How do you determine the pre-consolidation pressure and its determination in soil engineering practice	Remember	9
6	Explain the significance of pre-consolidation pressure. Describe the Casagrande method of determining it	Understand	9
7	Explain with spring analogy, Terzaghi's theory of one dimensional consolidation	Understand	9
8	Write a brief procedure of consolidation test and to determine the coefficient of consolidation by both logarithmic time fitting method and square root of time method.	Understand	9
9	What is over consolidation soil? Explain briefly with an example.	Remember	9
10	Explain the square root of time fitting method of determining the coefficient of consolidation of a clay sample.	Understand	9

11	Explain the phenomena of secondary consolidation. Differentiate between the secondary consolidation index and the coefficient of secondary consolidation.	Understand	9
12	What are the different causes of pre consolidation of soils? What is the effect of pre consolidation on the settlement?	Remember	9
13	Define the following terms: (i) Coefficient of compressibility (ii) Coefficient of volume change (iii) Compression index (iv) Expansion index (v) Recompression index	Remember	9
14	Explain different types of consolidation and their uses.	Understand	9
15	Differentiate between normally consolidated and over consolidated soils. How would you determine the over consolidation pressure?	Understand	9
Part - C (Problem Solving and Critical Thinking Questions)			
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	9
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	9
3	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. Compute (i) The change in voids ratio due to increase of stress to 196 kN/m (ii) Coefficient of volume compressibility (iii) Coefficient of consolidation (iv) Time required for 50% consolidation.	Understand	9
4	A soil has compression index of 0.28. At a stress of 120 kN/m^2 the void ratio is 1.02. Compute (i) void ratio if the stress on the soil is increased to 180 kN/m^2 (ii) total settlement of the stratum of 6 m thickness.	Understand	9
5	A 10m thick submerged clay layer which is drained at both the upper and lower boundaries is subjected to a wide surface pressure of 50kN/m2. The water table is coincident with the top of the clay layer at the ground surface. If the coefficient of consolidation of the clay is 1.16 x 10^{-2} cm^2/sec .Determine the pore pressure at the mid depth of the layer 50 days after the surface pressure was applied. Consider the degree of consolidation= 0.23.	Understand	9

6	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 which is produced by the construction of an extensive embankment on the ground surface. If the coefficient of consolidation for the soil is 2×10^{-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	9
7	A laboratory sample of lay 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.	Understand	9
8	A oedometer test is performed on a 2cm thick clay sample. After 5min, 50% consolidation is reached. After how long a time would the same degree of consolidation is achieved in the field where the clay layer is 3.7m thick? Assume the sample and the clay layer has the same drainage boundary conditions (double drainage).	Understand	9
9	A recently completed fill was 10m thick and its initial average void ratio was 1.0. The fill was loaded on the surface by constructing an embankment covering a large area of the fill. Some months after the embankment was constructed, measurements of the fill indicated an average void ratio of 0.8. Estimate the compaction of the fill.	Understand	9
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	9
11	A soil sample has a compression index of 0.3. If the void ratio at stress of 1.4kg/m^2 is 0.5, compute (i) the void ratio if the stress is increased to 2kg/m^2 and (ii) the settlement of a soil stratum 4m thick.	Understand	9
12	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/m2 over the clay stratum. The sample was loaded to 100kN/m2 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	9
13	Soil investigation at a site gave the following information. Fine sand exists to a depth of 10.6m and below this lies a soft clay layer 7.6m thick. The water table is at 4.6m below the ground surface. The submerged unit weight of sand is 10.4 kN/m^3 and the unit weight above the water table is 17.6kN/m^3. The water	Understand	9

	content of the normally consolidated clay is 40%, its liquid limit is 45% and the specific gravity of the solid particles is 2.78. The proposed construction will transmit a net stress of 120kN/m^3 at the centre of the clay layer. Find the average settlement of the clay layer.		
14	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	9
15	A stratum of normally consolidated clay of thickness 3m is drained on one side only. It has the hydraulic conductivity of k= 5x 10-8 cm/s and a coefficient of volume compressibility m_v.	Understand	9
UNIT 5			
Part - A (Short Answer Questions)			
1	What are the important characteristics of Mohr's circle?	Understand	8
2	What are the merits of direct shear test?	Remember	8
3	What are the different tests for shear strength?	Remember	8
4	What are the demerits of direct shear test?	Understand	8
5	Define Dilatancy.	Remember	8
6	Define Critical void ratio.	Understand	8
7	Define liquefaction.	Remember	8
8	Define Shear strength of clays.	Remember	8
9	State Mohr- Coulomb failure theories.	Remember	8
10	How can liquefaction in sands be prevented?	Understand	8
11	What are the merits and demerits of triaxial test?	Remember	8
12	What are the merits and demerits of vane shear test.	Remember	8
13	What is stress path?	Understand	8
14	Describe triaxial shear test	Remember	8
15	What is unconfined compression test?	Remember	8
16	Discuss the shear characteristics of cohesionless soils	Understand	8
17	Discuss the shear characteristics of cohesive soils	Understand	8
18	A series of direct shear test was conducted on soil each test was carried out till the same sample failed. The following results were obtained. Determine cohesion intercept and angle of shearing resistance Sample no | Normal stress (KN/m^2) | Shear stresses (KN/m^2) 1 | 15 | 18 2 | 30 | 25 3 | 45 | 32	Understand	8
19	Write revised Mohr-coulomb equation	Remember	8
20	What are the advantages of tri axial shear test over the Direct shear test	Understand	8
Part - B (Long Answer Questions)			
1	Explain Mohr-Coulomb theory of shear strength. Sketch typical strength envelope for a soft clay, clean sand and a silty clay	Remember	10

2	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	10
3	What types of field tests are necessary for determining the shear strength parameters of sensitive clays?	Remember	10
4	What are the advantages and disadvantages of a triaxial compression test in comparison with a direct shear test	Remember	10
5	What are the advantages and disadvantages of direct shear test over triaxial test?	Remember	10
6	Explain about triaxial compression test	Understand	10
7	Discuss the characteristics of cohesionless and cohesive soils.	Understand	10
8	Discuss modified failure envelope. What are its advantages and disadvantages over the standard failure envelope?	Remember	10
9	Derive the relation between the principle stresses at failure using Mohr-Coulomb failure criterion.	Remember	10
10	Explain liquefaction of soils.	Understand	10
11	What is Coulomb's equation for shear strength of soil? Discuss the factors that affect the shear strength parameters of soil.	Understand	10
12	Enlist the features of a triaxial compression test apparatus and describe them briefly.	Remember	10
13	What are the advantages and disadvantages of triaxial compression test in comparison to direct shear test?	Understand	10
14	What is critical void ratio? How would you determine it in the laboratory? Also explain the conditions causing liquefaction of sand.	Understand	10
15	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?	Understand	10
Part - C (Problem Solving and Critical Thinking Questions)			
1	A soil specimen when tasted in unconfined compression test fails at axial test of 120kN/m^2 the same sample tested in tri-axial compression test. The failure occurs at cell pressure of 40kN/m^2 and axial deviator stress of 160kN/m^2. Determine shear strength parameter.	Understand	10
2	A UU test is carried out on a saturated normally consolidated clay sample at a confining pressure of 3 kg/cm^2. .The deviator stress at failure is 1 kg/cm^2.	Understand	10
3	Two samples were tested in a triaxial machine. The all found pressure maintained further first sample was 2kg/cm^2 and 20kg/cm^2 and the failure occurred at additional axial stress of 7.7 kg/cm^2,while for the second the values were 5.0 kg/cm^2 and 13.7 kg/m^2 resp. Find c and ¢ of the soil.	Understand	10
4	A cylindrical specimen of a saturated soil fails at an axial stress of 180 kN/m^2 in an unconfined compression test. The failure plane makes an angle of 54º with horizontal. Calculate the shear	Understand	10

<table>
<tr><td></td><td>strength parameters of soil.</td><td></td><td></td></tr>
<tr><td>5</td><td>A remoulded specimen of soil prepared by compaction to standard proctor maximum dry unit weight at optimum moisture content is used for consolidated-undrained triaxial test with pore pressure measurements. The test results are given below:
<table>
<tr><td>Test No</td><td>Cell pressure (kN/m^2)</td><td>Deviator stress at failures (kN/m^2)</td><td>Pore pressure (kN/m^2)</td></tr>
<tr><td>1</td><td>40</td><td>300</td><td>05</td></tr>
<tr><td>2</td><td>100</td><td>443</td><td>10</td></tr>
<tr><td>3</td><td>165</td><td>615</td><td>12</td></tr>
</table>
Determine the values of effective shear stress parameters by
(i) Drawing Mohr envelope (ii) Drawing modified envelope</td><td>Understand</td><td>10</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 of 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>10</td></tr>
<tr><td>7</td><td>A vane 11.25 cm long and 7.5 cm 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 37 kN/m^2. Determine the torque that was applied.</td><td>Understand</td><td>10</td></tr>
<tr><td>8</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>$\sigma_3(kN/m^2)$</td><td>$\sigma_1(kN/m^2)$</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>10</td></tr>
<tr><td>9</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 also determine principal stress at failure.</td><td>Understand</td><td>10</td></tr>
<tr><td>10</td><td>A series of direct shear test was conducted on soil each test was carried out till the same sample failed. The following results were obtained. Determine cohesion intercept and angle of shearing resistance and plot the Mohr circle
<table>
<tr><td>Sample no</td><td>Normal stress (kN/m^2)</td><td>Shear stresses (kN/m^2)</td></tr>
<tr><td>1
2
3</td><td>15
30
45</td><td>20
25
30</td></tr>
</table></td><td>Understand</td><td>10</td></tr>
</table>

11	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 change ins hear strength when the water table rises to ground surface.	Understand	10
12	A consolidated drained triaxial test was conducted on a granular soil. At failure σ_1'/σ_3' =4.0. The effective minor principal stress at failure was 100kN/m^2. Compute ϕ' and the principal stress difference at failure.	Understand	10
13	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	10
14	At a depth of 6m below the ground surface at a site, a vane shear tests gave a torque value of 6040N-cm. The vane was 10cm high and 7cm across the blades. Estimate the shear strength of the soil.	Understand	10
15	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.	Understand	10

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