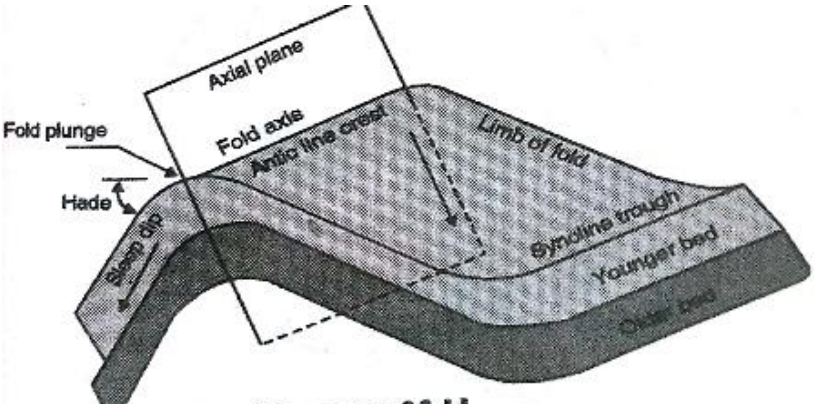
MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

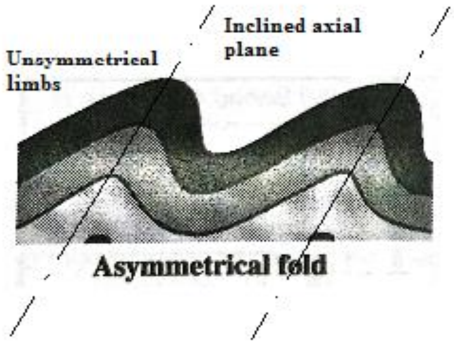
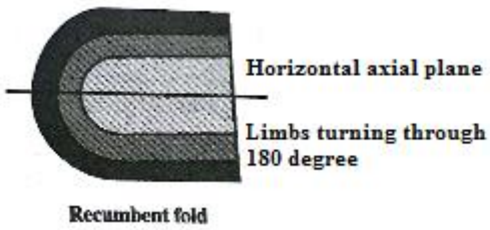
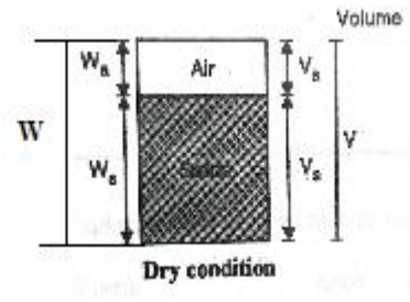
Model Answer: Summer 2018

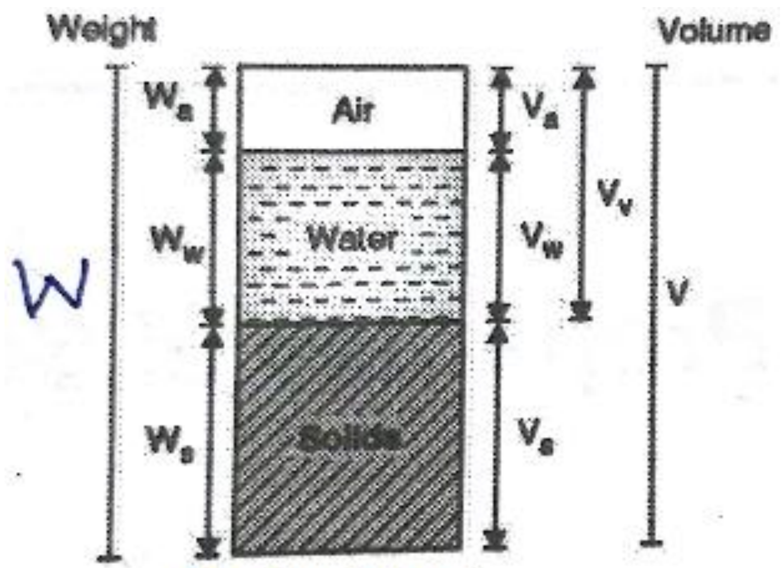
Subject: Geotechnical Engineering **Sub. Code: 17420**

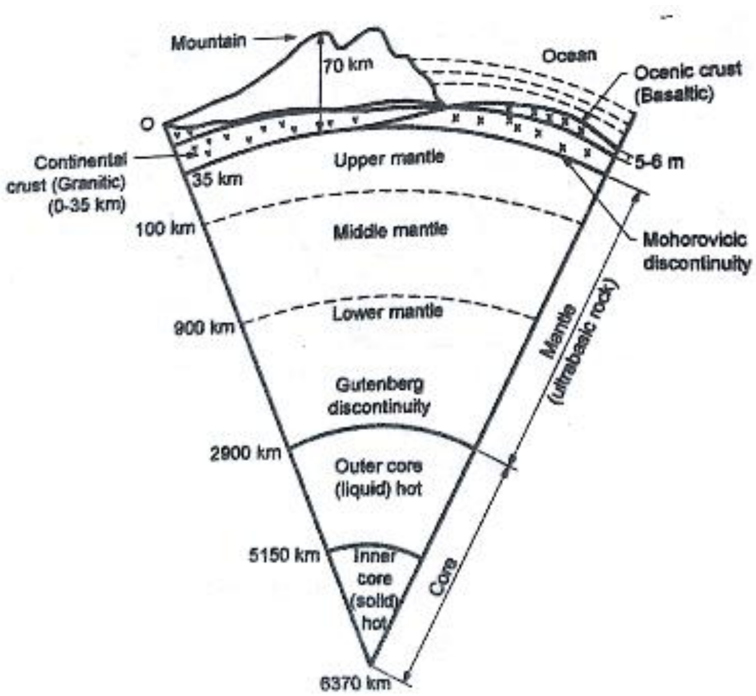
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by the candidate and those in the model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	**(A)**	**Attempt any SIX:**		**12**
	(a)	**Define the following branches of Geology.** **(i) Stratigraphy** **(ii) Rock Mechanics**		
	Ans.	**(i) Stratigraphy:** This branch deals with the study in the geologic history of an area, origin, composition, proper sequence and correlation of the rock strata of sedimentary rocks.	1	2
		(ii)Rock Mechanics: Petrology is study of formation of various types of rocks, their mode of occurrence, composition, texture and structures, distribution on the earth.	1	
	(b)	**Give the most common classification of the Metamorphic Rocks based on the basis of foliation.**		
	Ans.	i) Foliated rocks ii) Non Foliated rocks	**1 each**	**2**
	(c) **Ans.**	**With a neat labelled sketch show any four elements of fold of rock.**  **Elements of fold**	**2**	**2**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	**(d)** **Ans.**	**Define with neat labeled sketches the following.** **(i) Asymmetrical Fold (ii) Recumbent Fold** **(i) Asymmetrical Fold:** The fold in which the axial plane is not vertical but it is inclined is called as asymmetrical fold.  **(ii) Recumbent Fold:** These are extreme type of overturned folds in which the axial plane acquires an almost horizontal position in such folds one limb lies vertically above the other. 	**1** **1**	**2**
	(e) **Ans.**	**Draw three phase diagram for Dry Conditions with neat labelled diagrams and explain all the notations used therein.**  W_a= Weight of air V_a= Volume of air W_s= Weight of soil solids V_s= Volume of Soil solids W= Total weight of soil V= Total Volume of Soil	**1** **1**	**2**
	(f) **Ans.**	**Define (i) Denundation (ii) Deflation.** **(i) Denundation:** Denudation involves the processes that cause the wearing away of the earth's surface by moving water, by ice, by wind and by waves, leading to a reduction in elevation and in relief of landforms and of landscapes. **(ii) Deflation:** Deflation is erosion by wind of loose material from flat areas of dry, uncemented sediments such as those occurring in deserts, dry lake beds, floodplains, and glacial outwash plains.	**1** **1**	**2**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	(g) Ans.	**State any four field applications of Geotechnical Engineering.** **Field of applications of Geotechnical Engineering -** i. Design of foundation ii. Design of pavement iii. Design of Earth retaining structures iv. Design of water retaining structure v. Design of abutment vi. Design of underground structures	½ each (any four)	2
	(h) Ans.	**Soil is called as three phase system, why? Explain with a neat sketch with the meanings of all notations used therein.**  Three phase System of Soil	½	2
		As natural soil contains solid soil particles and water and air present in its voids such complex nature of soil sample is difficult to analyze its physical properties hence it is simplified and presented in its equivalent three phase diagram as shown in the figure above. Therefore it is called as three phase system.	1	
		W_a= Weight of air V_a= Volume of air W_s= Weight of soil solids V_s= Volume of Soil solids W_w= Weight of water V_w= Volume of water W= Total weight of soil V= Total Volume of Soil	½	

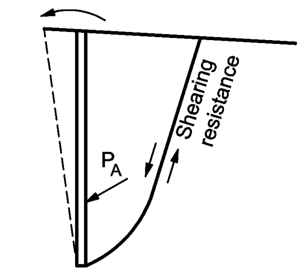
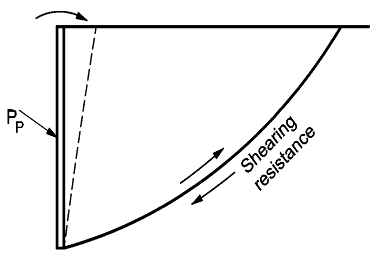
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	**(B)**	**Attempt any Two:**		**8**
	(a) **Ans.**	**Draw neat labelled internal structure of Earth.**  ***(Note : 3 marks for sketch and 1 mark for labeling)***	**4**	**4**
	(b) **Ans.**	**State two types of folds and joints each and explain any one fold.** Types of folds are as follows: i. Symmetrical folds ii. Asymmetrical folds iii. Overturned folds iv. Fan folds v. Recumbent fold vi. Isoclinal folds	**½ each (any two)**	
		Types of joints are as follows: i. Strike Joint ii. Dip Joint iii. Oblique Joint iv. Tension Joint v. Shear Joint	**½ each (any two)**	**4**
		i. Asymmetrical Fold: The fold in which the axial plane is not vertical but it is inclined is called as asymmetrical fold. The ascending and descending limb of asymmetrical fold are not parallel about the axial plane. ***(Note:- Explanation of any one of the above should be considered)***	**2**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	(c)	**State any four applications of soil as construction material and foundation bed.**		
	Ans.	**Applications of soil as construction material are as follows:** i. Soil is more suitable in embankment fills and retaining pond beds after their construction. ii. For plinth filling soil can be used as a construction material. iii. Pervious and impervious soil can be used in earthen dams. iv. Soil is used for brick manufacturing and these bricks are used for building construction.	½ each	4
		Applications of soil as foundation bed are as follows: i. Soil is also suitable for foundation but require compactions as without compaction structure may collapse ii. Soil provides the moderate support for all types of foundations. iii. Soil cement mixture can be used for sub grades. iv. For Water Bound Macadam roads soil is used as a binder material.	½ each	
Q. 2		**Attempt any FOUR:**		16
	(a)	**State any four effects of weathering on rocks.**		
	Ans.	Effects of weathering on rocks are as follows: 1. The rock surface is disintegrated into many smaller pieces due to weathering. 2. By the chemical change of decomposition, new rocks are formed whose chemical composition is different. 3. Due to weathering, erosion of bed rock takes place depending upon rock structure. 4. Due to weathering disintegrated loose particles get transported and deposited in the form of soil.	1 each	4
	(b)	**State particle size classification of soils.**		
	Ans.	Particle size classification of soils: i. Clay: less than 2 micron ii. Silt: 2 micron to 75 micron iii. Sand: 75 micron to 4.75 mm iv. Gravel: 4.75 mm to 80 mm v. Pebbles: 80 mm to 300 mm vi. Boulders: more than 300 mm	4	4
	(c)	**Describe Seismic Waves.**		
	Ans.	**Seismic Waves:** During each earthquake the elastic waves are generated which are travel in each directions are termed as seismic waves. Types of seismic waves are as follows: 1. Primary or Longitudinal Waves 2. Secondary or Traverse waves 3. Long or surface waves-Rayleigh waves and love waves		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2		**1. Primary Waves (P - wave):** These waves propagates in longitudinal direction and capable to pass through solids, liquid and gases .These are fastest waves among all with speed of travel 8-13 km/s and hence reach first to recording station on ground . These waves gives push or pull or to and fro moment to particles of ground. **2. Secondary or Traverse waves (S - wave):** These waves move in perpendicular direction to direction of propagation of waves. It passes through only solids .These waves has slow speed about 5 –7 km/s. When secondary or shear waves moves horizontally during propagation, then it is known as SH waves. But when it moves in vertical plane, then it is SV waves. **3. Long waves (L - wave):** These waves travel along the surface or earth's crust to pass through solids and liquids. These surface waves are slower with speed of 4-5 km/s confined to earth layers. These waves give major destruction during earthquake. These waves are complex in nature having large amplitude.	**4**	**4**
	(d) **Ans.**	**State any four effects of earthquake.** **Effects of earthquake are as follows:** i. Destruction of various Civil Engineering structures. ii. Formation of irregularities (unevenness) on ground. iii. Sudden landslides along hill slopes. iv. Change in river course. v. Formation of new lakes springs. vi. Generation of high ocean tidal waves. vii. Fire exposure due to short circuiting. viii. Loss of human life and property.	**1 each (any four)**	**4**
	(e) **Ans.**	**Explain any two types of weathering.** **1. Mechanical Weathering:** In this process the rock surface is broken into smaller pieces without any chemical change. The smaller broken rock pieces are deposited at and over the parent rock on the flat surface and these are accumulated at the end of sloping surface. The main agents of physical weather in are ice, water wind and temperature. **2. Chemical Weathering:** In this process the rock surface is broken into smaller pieces by chemical decay of minerals it is chemical reaction between the atmospheric gases and the surface of rock. The main agencies are responsible for chemical weathering is oxidation, hydration and carbonation.	**2 each (any two)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2		**3. Spheroidal Weathering:** If joints and fractures in rock beneath the surface form a 3D network the rock will be broken into cube like pieces separated by the fractures. **4. Biological Weathering:** Plants and animals play an important role in the breakdown and decay of rock, indeed their part in soil formation is of major significance.		
	(f) Ans.	**Explain Determination of dry density by core cutter method.** **Procedure:** 1. Measure the internal dimension of core cutter and calculate its volume (V) in cm^3. 2. Take weight of empty core cutter without dolly as W_1 gm. 3. Clean the ground by removing loose soil if any and keep the core cutter vertically on ground with sharp edge at bottom. 4. Now, drive the core cutter into the ground using 13.5 – 14 kg hammer, so that half of dolly will remain above the ground. 5. Remove the soil around the core cutter using pick axe and shape take out the core cutter using pick axe and spade and take out the core cutter safely filled with soil. 6. Remove the dolly and excess soil from top of core cutter. 7. Take weight of core cutter completely filled with soil as W_2 gm. 8. Calculate the bulk unit weight of field soil as $\gamma = (W_2 - W_1) / V$ in gm $/cm^3$. 9. Now, take the soil specimen from the core cutter and determine its water content by oven drying method. 10. Calculate the dry unit weight of field as 11. $\gamma_d = \gamma / (1+w)$ in gm $/cm^3$. 12. Repeat above steps two more times to calculate average dry unit weight of soil.	4	4
Q. 3		**Attempt any Four:**		16
	(a) Ans.	**Calculate the coefficient of uniformity (C_u) and coefficient of curvature (C_C) for a soil sample for which,** **(i) D_{10} = 0.0019 mm (ii) D_{30} = 0.030 mm (iii) D_{60} = 0.49 mm** Coefficient of uniformity $C_u = \frac{D_{60}}{D_{10}} = \frac{0.49}{0.0019}$ $\boxed{C_u = 257.89}$ Coefficient of curvature $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(0.030)^2}{0.0019 \times 0.49}$ $\boxed{C_c = 0.966}$	2 2	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3	(b) Ans.	**State any four factors affecting the permeability of soil.** Following are the factors which affect the permeability of soil. i. Grain size ii. Shape of particles iii. Properties of pore fluid iv. Temperature v. Void ratio vi. Stratification of soil vii. Entrapped air and organic impurities viii. Degree of saturation	1 each (any four)	4
	(c)	**In a falling head permeability test on a sample 12.2 cm length and 44.41 cm^2 in cross-sectional area, the water level in stand pipe of 6.25 mm internal diameter dropped from a height of 75 cm through 24.7 cm in 15 minutes. Find the coefficient of permeability.**		
	Ans.	Area of stand pipe , $a = \frac{\pi}{4} \times (0.625)^2 = 0.307\ cm^2$, $t_2 - t_1 = t = 15$ minutes $= 15 \times 60 = 900$ sec. $h_1 = 75$ cm, $h_2 = (75 - 24.7) = 50.3$	1	4
		Co-efficient of permeability , $\therefore K = 2.303 \frac{aL}{At} \log_{10} \frac{h_1}{h_2}$ $K = 2.303 \times \frac{0.307 \times 12.2}{44.41 \times 900} \log_{10}\left(\frac{75}{50.3}\right)$	1	
		$\boxed{K = 3.74 \times 10^{-5} cm/sec}$	2	
	(d) Ans.	**State any two advantages and disadvantages each of direct shear test of soil.** **Advantages of direct shear test:** 1. Test is simple and convenient. The sample preparation is easy. 2. Drainage is quick due to less thickness of sample and pore water pressure dissipates very rapidly. 3. It is suitable for conducting drained test on a cohesionless soil.	1 each (any two)	4
		Disadvantages of direct shear test: 1. Failure of soil specimen is always along a horizontal plane, which may not be very realistic. 2. If any large soil particles or stones etc. are present at failure plane, it will give wrong results. 3. The stress distribution on failure plane is not uniform. 4. Measurement of pore pressure is not possible.	1 each (any two)	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3	(e) Ans.	**State any four characteristic of flownet.** 1. In a flow-net, flow lines and equipotential lines intersect each other at right angles. 2. The quantity of water flowing through each flow channel is the same. 3. The drop of head, or the potential drop between any two successive equipotential lines is the same. 4. The fields are approximately squares.	1 each	4
	(f) Ans.	**Explain different types of earth pressure with the help of neat labeled sketches.** **(a) Lateral earth pressure:** Soil in contact with any vertical or inclined face of structure exerts force on structure which is known as lateral earth pressure.	1	
		(b) Active earth pressure: Active earth pressures defined as pressure exerted on retaining wall resulting from slight movement of wall away from filling.  	1 ½	4
		(c) Passive earth pressure : Passive earth pressure is pressure when the movement of the sretaining wall is such that the soil tends to compress horizontally.  	1 ½	
Q. 4		**Attempt any Four:**		16
	(a) Ans.	**State and explain factors affecting bearing capacity of soil. (any four)** Following are the factors which affecting bearing capacity of soil i. Soil type. ii. Grain size. iii. Degree of compaction.		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		iv. Stratification of soil. v. Presence of water table. vi. Types of foundation. i. **Soil type:** soil type and its values of cohesion 'c' and internal friction or angle of internal friction 'ϕ' will play an important role in the bearing capacity. Any ordinary soil resists the load by a combination of internal friction and cohesion. ii. **Grain size:** The bearing capacity generally decreases as the grain size increases. Fine grained soils have more bearing capacity. iii. **Degree of compaction:** The amount of compaction also affects the bearing capacity. As compared to rammer, rollers give more degree of compaction. Therefore more density achieved using rollers, thus bearing capacity increased. iv. **Stratification of soil:** If the stratification is perpendicular to the direction of load coming on the soil, the bearing capacity is maximum. v. **Presence of water table:** The bearing capacity for soils decreases with the presence of water table. Higher the water table, lesser is the bearing capacity vi. **Types of foundation:** Bearing capacity of soil for shallow foundations is less than that of deep foundations.	**1 each (any four)**	**4**
	(b) Ans.	**State any four assumptions made by Rankine's theory of earth pressure.** **Assumptions of the Rankine's theory:** i. The soil mass is semi infinite, homogeneous dry and cohesionless. ii. The ground surface is plane which may be horizontal or inclined. iii. The back of wall is vertical is smooth. iv. The wall yields about the base thus satisfies deformation condition for plastic equilibrium. v. The soil element is in state of plastic equilibrium i.e. on verge of failure.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4	(c) Ans.	**Differentiate on any four points between compaction and consolidation.**	1 each (any four)	4

Sr. No.	Compaction	Consolidation
i.	Takes place before building of structure.	Takes place after building of structure
ii.	Fast process	Very slow process.
iii.	Settlement is prevented due to compaction.	Settlement takes place due to consolidation
iv.	Artificial process.	Natural process.
v.	Does not go on indefinitely.	Goes on indefinitely.
vi.	It takes places due to dynamic loading.	It occurs due to static loading.

(d) Ans.

Explain standard Proctor test to obtain OMC and MDD values for given soil.

Standard Proctor test procedure :

(1) Clean the mould and take weigh of it as W_1 gm.
(2) Apply grease to inside of mould, base plate and collar.
(3) Assemble the mould and base plate together on the floor.
(4) Take one part of sample and fill the mould in 3 layers giving 25 blows to each layer with the 2.6 kg hammer dropping from 310 mm.
(5) Scratch with spatula each layer before putting in the next layer.
(6) Remove the collar and trim the compacted soil flush with the top of mould with a straight edge.
(7) Weigh the mould with the soil as W_2 gm. Extract the soil from mould with the extruder.
(8) Middle part soil sample is taken for water content determination.
(9) Determine the water content by oven drying method as w%.
(10) Calculate bulk density.

$$\gamma = \frac{W_2 - W_1}{V} \text{ in gm/cc,}$$

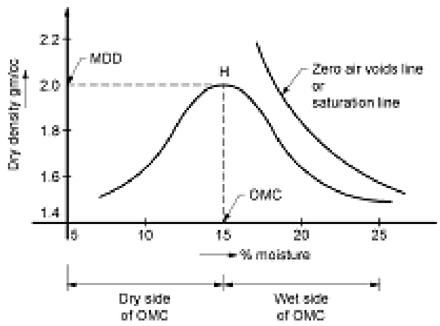
Where, V = Volume of proctor mould.

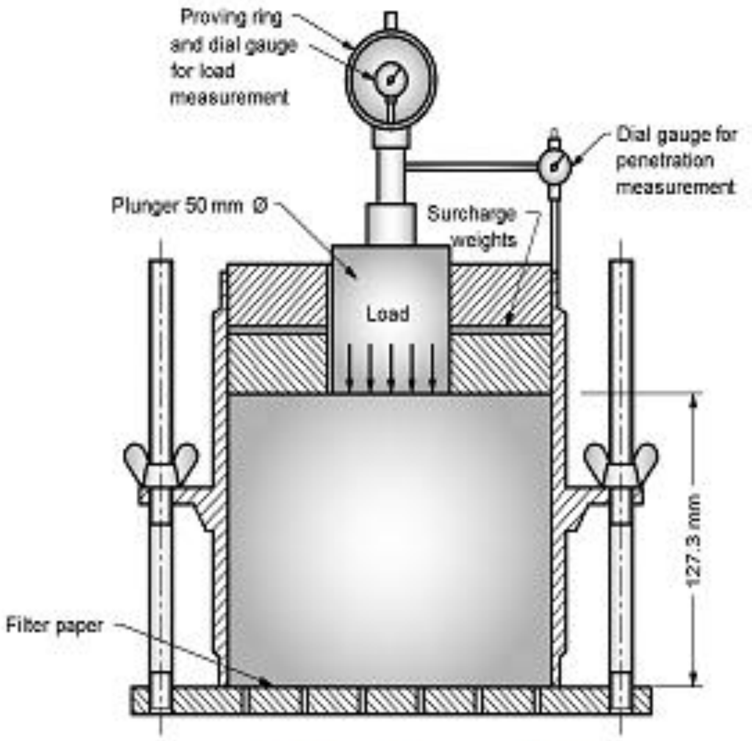
(11) Calculate dry density using following expression,

$$\gamma_d = \frac{\gamma}{1 + w} \text{ in gm/cc}$$

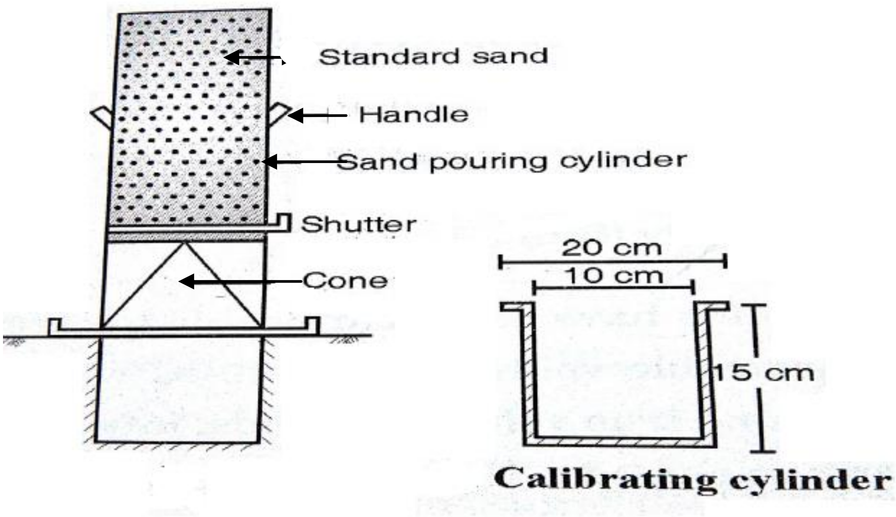
(12) Repeat steps 4 to 11 by taking 2 to 3% more water than preceding test.
(13) For all repetition, record the readings and plot moisture content against corresponding dry density.
(14) From the compaction curve, maximum value of dry density is taken as Maximum Dry Density (MDD) and corresponding water content should be taken as Optimum Moisture Content (OMC).

Marks: 3

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4			1	4
	(e) Ans.	**Enlist methods of soil stabilization and shear failure.** **Methods of soil stabilization:** Following are two methods used for soil stabilization: 1) Without adding admixers (Mechanical stabilization): Mechanical stabilization is done using rammers, tampers, vibrators and rollers 2) With adding admixers : i. Soil-lime stabilization ii. Soil-cement stabilization iii. Soil-bitumen stabilization iv. Soil-fly ash stabilization v. Electrical stabilization vi. Magnetic stabilization vii. Chemical stabilization	2	4
		Methods of soil shear failure : Shear strength of soil can be determine by following test i. General shear failure ii. Local shear failure iii. Punching shear failure	2	
	(f) Ans.	**Define CBR Value and explain the test along with neat sketch.** **Definition of CBR:** It is the ratio of the force per unit area required to penetrate a soil mass with a circular plunger of 50 mm diameter at the rate of 1.25 mm/minute to that required for corresponding penetration in a standard material.	1	
		Test Procedure: i. The CBR test is conducted in the laboratory on a prepared specimen in a mould. ii. CBR mould of 150 mm diameter with a base plate and collar, a loading frame with the cylindrical plunger of 50 mm diameter and dial gauges for measuring penetration values.		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		 CBR Test Apparatus	1	4
		iii. A cylindrical plunger of 50 mm diameter to penetrate in a soil specimen at rate of 1.25 mm/minute. The load values are noted corresponding to penetration values of 0,0.5,1.0,1.5,2.0,2.5,2.5,3.0,3.5,4.0,5,7.5,10.0and 12.5 mm. iv. The load penetration graph is plotted. v. Sometimes curve with initial upward concavity is obtained indicating the necessity of correction. The corrected origin is established by drawing a tangent from the steepest point on the curve. The load values corresponding to 2.5 and 5.0 mm penetration values from the corrected graph are noted as Test load. CBR% = (Test load / Standard load) X 100 Normally the CBR value at 2.5 mm penetration which is higher than that at 5.0 mm penetration recorded.	2	

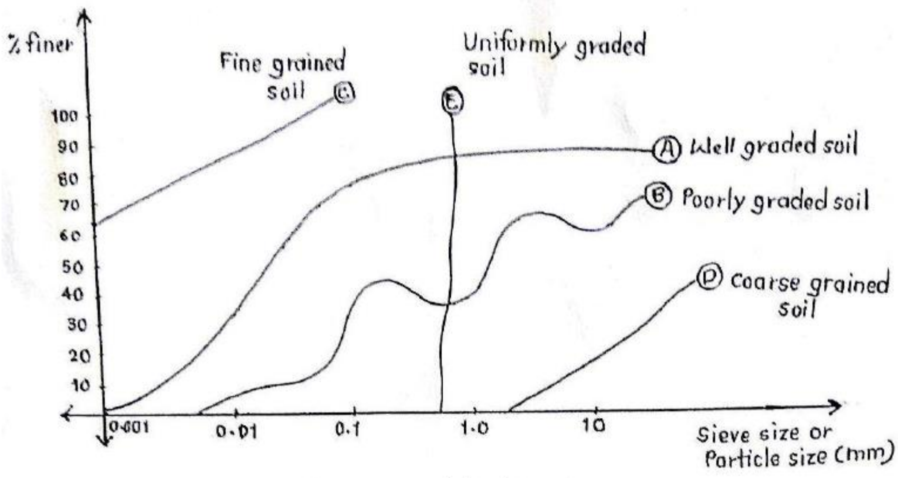
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5		**Attempt any TWO:**		**16**
	(a)	**Calculate void ratio, porosity and degree of saturation for soil mass of bulk density 1.76, specific gravity of soil grains 2.7 and water content as 30%.**		
	Ans.	$\gamma_d = \frac{\gamma}{1+w} = \frac{1.76}{1+\left(\frac{30}{100}\right)} = 1.35\,\text{gm/cc}$	**2**	
		$\gamma_d = \frac{G.\gamma_w}{1+e}$ $1.35 = \frac{2.7\times1}{1+e}$ $1+e = \frac{2.7\times1}{1.35}$ $e = 2-1$ $\boxed{e=1}$	**1** **1**	
		$n = \frac{e}{e+1}$ $n = \frac{1}{1+1}$ $n = 0.5$ $\boxed{n=50\%}$	**1** **1**	**8**
		$S_r = \frac{w.G}{e}$ $S_r = \frac{0.3\times2.7}{1}$ $S_r = 0.81$ $\boxed{S_r = 81\%}$	**1** **1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5	(b) Ans.	**Draw neat labeled sketch to explain stepwise procedure to determine bulk density by sand replacement method.** 	2	
		i. Fill the sand pouring cylinder with clean sand so that the level of the sand in the cylinder is within about 10 mm from the top. Find out the initial weight of the cylinder plus sand (W_1) and this weight should be maintained constant throughout the test for which the calibration is used. ii. Allow the sand of volume equal to that of the calibrating container to run out of the cylinder by opening the shutter, close the shutter and place the cylinder on the glass sand takes place in the cylinder close the shutter and remove the cylinder carefully. Weigh the sand collected on the glass plate. Its weight (W_2) gives the weight of sand filling the cone portion of the sand pouring cylinder. Repeat this step at least three times and take the mean weight (W_2) Put the sand back into the sand pouring cylinder to have the same initial constant weight (W_1). **Determination of Bulk Density of Soil** iii. Determine the volume (V) of the container be filling it with water to the brim. Check this volume by calculating from the measured internal dimensions of the container.	2	8
		iv. Place the sand poring cylinder centrally on the calibrating container making sure that constant weight (W_1) is maintained. Open the shutter and permit the sand to run into the container. When no further movement of sand is seen close the shutter, remove the pouring cylinder and find its weight (W_3). v. The following calculations should be made to determine bulk density of given soil sample: a) The weight of sand (W_a) in gm, required to fill the calibrating container should be calculated from the formula, $W_a = W_1 – W_3 - W_2$	2	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5		b) The bulk density of sand (Υ_s) in kg/m^3 should be calculated from the formula, $\Upsilon_s = (W_a / V) \times 1000$ c) The weight of sand (W_b) in gm, required to fill the excavated hole should be calculated from the formula, $W_b = W_1 - W_4 - W_2$ d) The bulk density (Υ_b), that is, the weight of the weight soil per cubic meter should be calculated from the formula, $\Upsilon_b = (W_w / W_b) \times \Upsilon_s$ kg/m^3	**2**	
	(c)	**Explain Atterberg's limits of consistency and mechanical sieve analysis of soil.**		
	Ans.	The Atterberg's limit is a basic measure of the critical water content of a fine grained soil, by its shrinkage limit, plastic limit and liquid limit. In each state the consistency and behaviour of a soil is different and consequently so its engineering properties.	**1**	
		Types of consistency limit: i. Liquid limit ii. Plastic limit iii. Shrinkage limit		
		i. **Liquid limit:** It is minimum water content at which two separated grooved soil parts mixed together under 25 blows of Casagrande's liquid limit apparatus; is called as liquid limit.	**1**	
		ii. **Plastic limit:** It is minimum water content at which soil begins to crumble into parts when it is rolled into 3 mm diameter thread; is known as plastic limit.	**1**	
		iii. **Shrinkage limit:** It is maximum water content at which there is no reduction in volume of soil due to further decrease in water content is termed as shrinkage limit.	**1**	
		Mechanical sieve analysis: The process of analyzing the particle size present in soil by using mechanical means is known as mechanical sieve analysis. By performing mechanical sieve analysis, a particle size distribution curve is plotted for grading of soil.	**1**	
		Procedure: i) Arrange the set of I.S. sieves in descending order i.e. coarser sieve at top and finer sieve at bottom. The I.S sieve set must include sieves of size 4.75 mm, 2.36 mm, 1.18 mm, 600 μ, 150 μ, 75 μ. ii) Take 500-1000gm oven dried soil sample and put it on topmost sieve. Keep lid and pan at top and bottom respectively. iii) Now, shake this assembly of sieve on mechanical sieve shaker for 10-15 minutes, so that soil sample will be sieved completely.	**2**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5		iv) Take the weight of soil mass retained on each sieve separately in grams. v) Calculate % finer for each sieve using following tabular format.		8

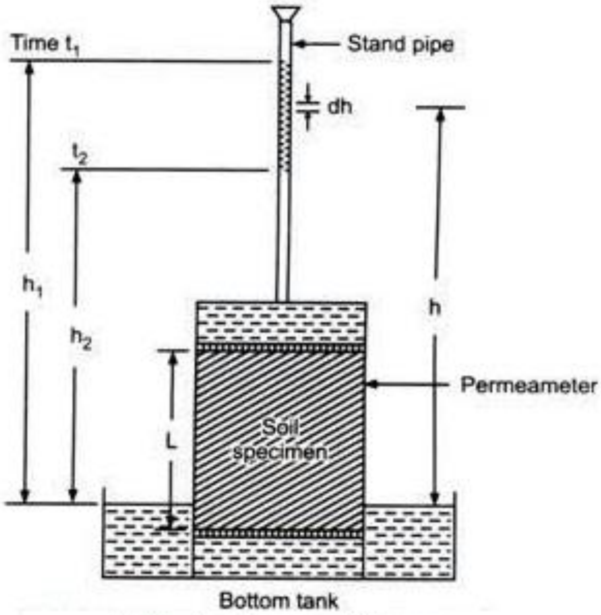
Sieve size (mm)	Mass Retained (gm)	Cumulative mass retained (%)	% Cumulative mass retained (%)	% Finer or passing (%)

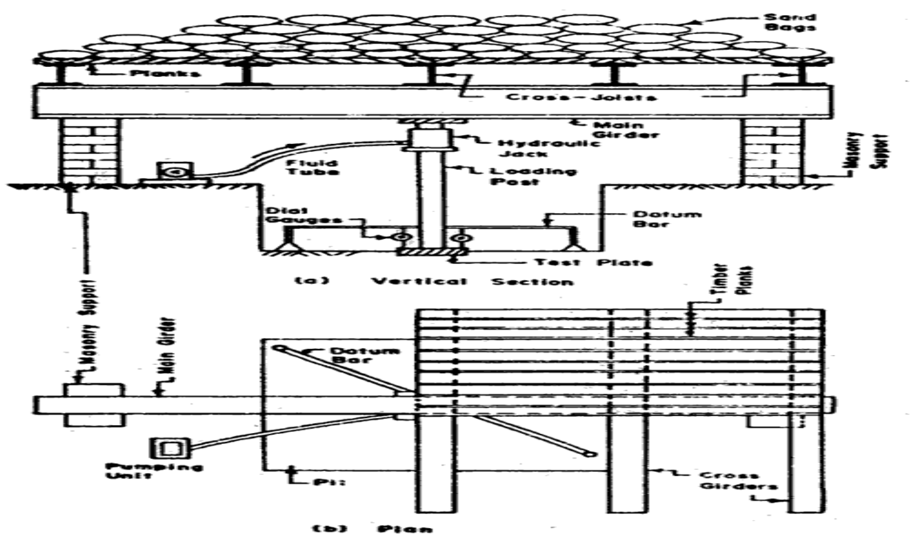


Particle Size Distribution Curve — 1

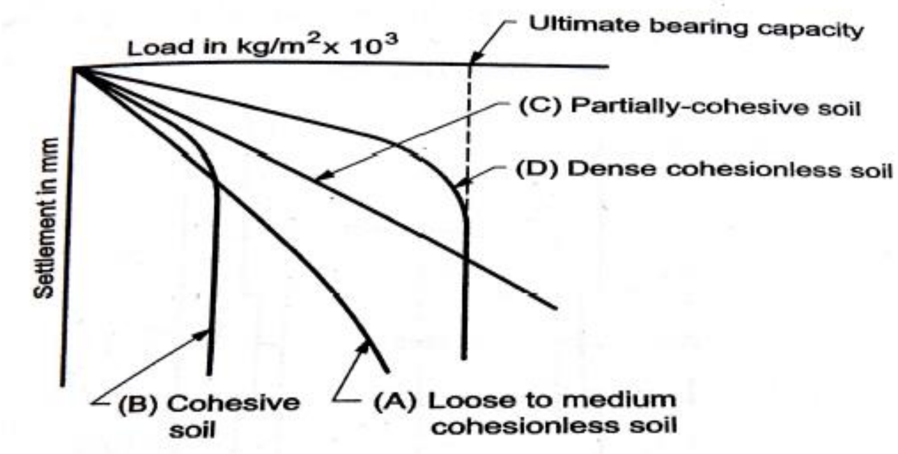
vii) From above graph, soil is classified based on grading curves as follows:

a) Well graded soil
b) Poorly or gap graded soil
c) Fine grained soil
d) Coarse grained soil
e) Uniformly graded soil

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		**Attempt any TWO:**		16
	(a)	**Write step by step procedure for determination of permeability of soil by falling head method permeability test. Explain with neat sketch.**		
	Ans.	Falling head permeability test	2	
		i. Open the valves in the standpipe and the bottom outlet. Ensure that the soil sample is fully saturated without any entrapping of air bubble before starting the test. ii. Fill the standpipe with water keeping the valves V_1 and V_2 open and allow the water to flow out through the outlet pipe for some time and then close the valves. iii. Select in advance the heights h_1 and h_2 for the water to fall and determine the height $\sqrt{h_1h_2}$ and mark this height on the stand pipe. iv. Open the valves and fill the standpipe with water up to height h_1 and start the stopwatch. v. Record the time intervals for water to fall from height h_1 to $\sqrt{h_1h_2}$ and from $\sqrt{h_1h_2}$ to h_2. These two time intervals will be equal if a steady flow condition has been established. vi. Repeat the step (e) at least after changing the heights h_1 and h_2. vii. Calculate the coefficient of permeability of given soil using equation.	4	8
		$$K = 2.303\times\frac{a\times L}{A\times t}\times\log_{10}\times\left(\frac{h_1}{h_2}\right)$$ Where, a = Area of burette pipe L = Length of soil sample	2	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		A = c/s area of soil sample t = Time required to fall water level from h_1 to h_2. h_1 = Initial head h_2 = Final head		
		viii. Repeat all above steps two more times to calculate average coefficient of permeability of given soil.		
	(b)	**Explain with neat sketch plate load test as per IS 1888 by** **1. Gravity loading PLAN** **2. Gravity loading SECTION** **3. Graph to show limitations of plate load test. (any two)**		
	Ans.		1 1	
		Procedure: i) The site where testing is to be done is selected. A test pit, at least 5 times the diameter or width of the plate, and upto the depth of proposed foundation level, is dug. ii) The plate is seated firmly at the centre of the pit. The dead load of all equipment ball and socket, steel plate loading column, jackets is recorded before applying the load increments. iii) A minimum seating pressure of 70 gm/cm^2 is applied and removed before starting the load test. A minimum load is applied to soil, in cumulative increment upto 1kg/cm^2 or $1/5^{th}$ of the estimated ultimate bearing capacity, whichever is lower. iv) The settlement is observed after each load increment at 1, 2.25, 4, 6.25, 9, 16, 30 minutes and thereafter at hourly intervals, and is recorded.	4	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		v) The recording is stopped when the increase in settlement is only 0.02 mm. The procedure is repeated after every increment in load vi) The observation is plotted on a log scale. The settlement in mm is plotted on Y axis and load in kg/m^2 is plotted on X-axis.		



Marks: 1 | Total Marks: 8

vii) From this plot, the ultimate bearing capacity is determined. The plate load test setup is or gravity type of loading.

Limitations of plate load test:
i) Size effect: The actual settlement may vary from the plate weather same pressure is applied.
ii) Time effect: As duration of test is small it does not give the ultimate settlement with respect long time.
iii) Layer effect: If foundation is large accurate result cannot be obtained by test.

Marks: **½ each (any two)**

(c) **State any four equipments used for field compaction giving their suitability for different soils**.

Ans. Types of Compaction Equipment:

1) Compaction by rolling:

a) Smooth wheel rollers :
Suitability: These rollers best suitable for subgrade or base coarse compaction of cohesion less soils.

b) Pneumatic tyred rollers:
Suitability: Pneumatic tyred rollers are effective for compacting cohesive as well as cohesion less soils. Light rollers are effective for compacting soil layers of small thickness.

c) Sheep foot roller:
Suitability: Suitable only for fine grained soil i.e. cohesive soil

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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1		**2) Compaction by Rammers:** Ramming equipments consists of three types: dropping weight type, internal combustion type and pneumatic type. Rammers or tampers are used to compact the soil of light to medium structure i.e. for plinth filling, PCC etc. **Suitability:** Suitable for all types of soil. **3) Compaction by vibratory compactors :** The vibrating equipment, mounted on screeds, plates or rollers are of two types: a) Dropping weight type and b) Pulsating hydraulic type. By giving vibration to soil, soil particles are packed together and compaction of subgrades and base course of both flexible and rigid pavement. **Suitability:** Suitable for compacting granular soils. With no fines in layer up to 1 m. **4) Compaction by Tamping:** Tamping rod is used to compact coarse grained cohesion less soils of lesser thickness. ***(Note : 1 mark for equipment and 1 mark for suitability)***	**8**	**8**