Model Answer: Winter-2018

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

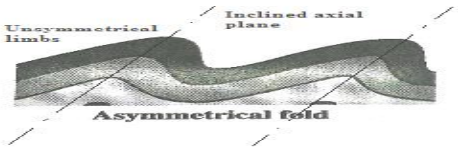
Important Instructions to examiners:

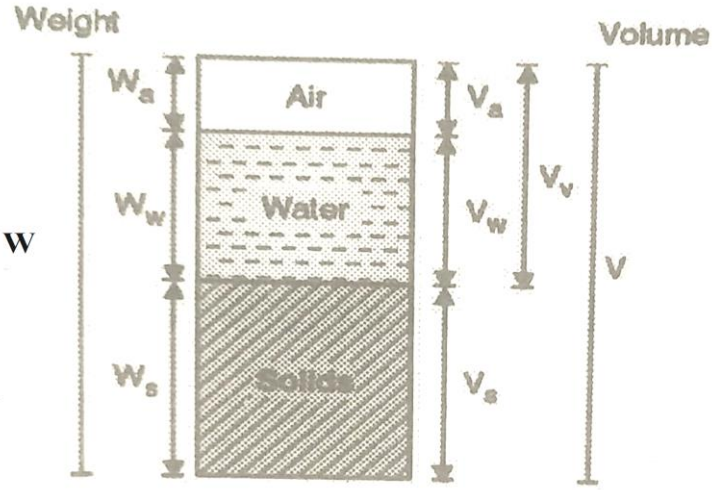
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 Answer	Marks	Total Marks
Q.1	**(A)**	**Attempt any SIX of the following:**		**(12)**
	(a) Ans.	**State four branches of Geology.** 1. Physical Geology 2. Geomorphology 3. Mineralogy 4. Petrology 5. Structural geology 6. Stratigraphy 7. Palaeontology	**½ each (any four)**	**2**
	(b) Ans.	**State types of rocks based on their genesis (mode of origin).** 1. Igneous Rocks 2. Sedimentary Rocks 3. Metamorphic Rocks	**2**	**2**
	(c) Ans.	**Define faults and state any two types of it.** **Fault:** It is defined as the rupture / fracture along which there is a relative movement of beds.	**1**	
		Types of fault : 1. Based on position of fault plane. i. Normal Fault ii. Reverse Fault 2. Based on their genesis. i. Gravity fault ii. Thrust fault iii. Strike / slip fault	**½ each (any two)**	**2**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	**(c)**	3. Horst and Graben 4. Step fault 5. Bedding fault 6. Dip fault 7. Strike fault		
	(d)	**Define :** **i. Void ratio** **ii. Water content.**		
	Ans.	i. **Void Ratio:** It is the ratio of volume of voids to the volume of solids. ii. **Water content:** It is the ratio of the weight of water (W_w) to the weight of solids (W_s).	**1** **1**	**2**
	(e)	**Define soil as per IS.**		
	Ans	Soil is the sediment or other unconsolidated accumulation of solid particles produced by physical and chemical disintegration of rock.	**2**	**2**
	(f)	**State any two situations where knowledge of soil mechanics is required.**		
	Ans.	1. Design of foundation for various structures. 2. Design of pavement for various roads. 3. Design of earth retaining structures i.e. retaining wall, sheet pile. 4. Design of water retaining structures i.e. dam, weir etc. 5. Design of abutments of bridge. 6. Design of underground structures i.e. pipeline, tunnels etc.	**½ each (any four)**	**2**
	(g)	**Define permeability.**		
	Ans.	**Permeability:** It is defined as the property of soil which permits the seepage of fluid through interconnecting voids under gravity.	**2**	**2**
	(h)	**Define weathering of rocks.**		
	Ans.	**Weathering of rock :** The process, by which the rock is decayed, disintegrated and decomposition with the action of the distractive mechanical or chemical action of the physical agent of atmosphere like wind, water and ice is called a Weathering.	**2**	**2**

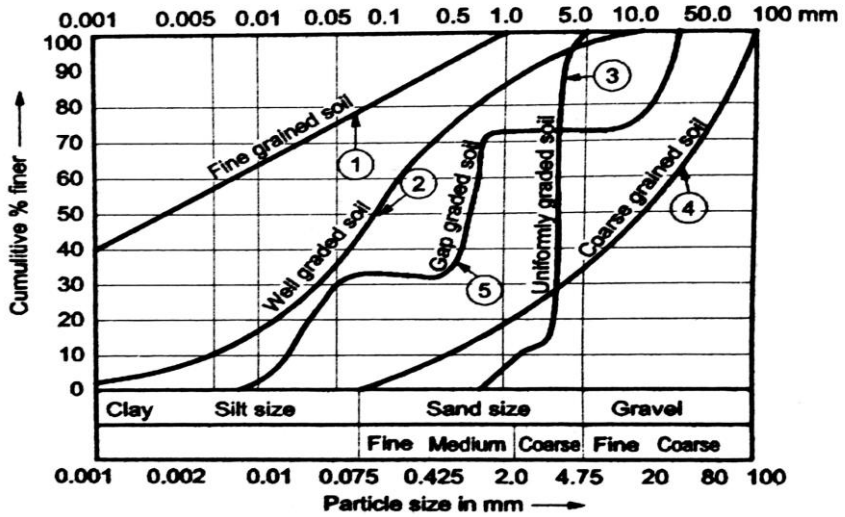
<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answer</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.1</td><td>(i)
Ans.</td><td>Define Liquid limit.
Liquid limit (W_L): It is minimum water content at which two separated grooved soil parts mixed together under 25 blows of casagrande's liquid limit apparatus; is called as liquid limit.</td><td>2</td><td>2</td></tr>
<tr><td></td><td>(B)</td><td>Attempt any <u>TWO</u> of the following:</td><td></td><td>(8)</td></tr>
<tr><td></td><td>(a)
Ans.</td><td>State any four types of minerals with properties depending on light and state of aggregation.
<table><tr><th></th><th>Minerals</th><th>Gypsum</th><th>Kyanite</th><th>Talc</th><th>Quartzc</th></tr><tr><td rowspan="3">State of aggregation</td><td>Colour</td><td>White, Yellow, Dark, Grey.</td><td>White, Pale, Blue, Grey</td><td>Brown, White, Green</td><td>Red, Green, Blue, Colourless</td></tr><tr><td>Lustre</td><td>Vitreous silky</td><td>Vitreous silky</td><td>Greasy pearly</td><td>Vitreous silky</td></tr><tr><td>Fracture</td><td>Conchoidal</td><td>Uneven</td><td>Uneven</td><td>Conchoidal</td></tr><tr><td>Light</td><td>Streak</td><td>White</td><td>White</td><td>White</td><td>White</td></tr></table></td><td>4</td><td>4</td></tr>
<tr><td></td><td>(b)
Ans.</td><td>State any four types of folds and explain any one.
Types of Folds:
1. Based on appearance in cross section.
i. Anticline fold
ii. Syncline fold
2. Based on position of axial plane.
i. Symmetrical fold
ii. Asymmetrical fold
iii. Overturned fold
iv. Isoclinal fold
v. Recumbent fold
3. Based on mode of occurrence.
i. Anticlinorium fold
ii. Synclinorium fold
iii. Dome fold
iv. Basin fold
4. Based on Degree of compression.
i. Open fold
ii. Closed fold
5. Based on position of axis.
i. Non plunging fold
ii. Plunging fold</td><td>½ each (any four)</td><td>4</td></tr>
</table>

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1		**Asymmetrical Fold:** The fold in which the axial plane is not vertical but it is inclined is called as asymmetrical fold. Due to unequal compressive forces the older rock beds bends about its axial plane showing unsymmetrical nature. The angle of both limbs may be 60^0 and 30^0 with horizontal indicating asymmetrical fold.  ***(Note: Explanation of any other method from above should be considered.)***	**1** **1**	
	(c) **Ans.**	**State and explain any four field applications of Geotechnical Engineering.** **Field applications of Geotechnical Engineering are as follows:** **1. Design of foundation for various structures:** Foundation is required to transfer the load of super structure to foundation soil and to give stability to the super structure. The size and type of foundation is affected by the bearing capacity of soil. The GTE helps in design of foundation by investigating bearing capacity of soil. **2. Design of pavement for various roads:** A pavement constructed with various material placing in layer in compact, dense form which support to vehicle wheel loads. The wheel load is repetitive and varying in magnitude. The thickness of each layer for type road, nature, climate condition and bearing capacity of soil on which pavement is constructed is varying. The GTE is applicable in pavement layer design i.e. thickness. **3. Design of earth retaining structures i.e. retaining wall, sheet pile:** The sloping ground is to be leveled by constructing earth retaining st. and Filling natural soil behind it.The GTE is helpful to ensure stability of such structure by studying earth pressure. **4. Design of water retaining structures i.e. Dam, weir etc.** The construction of earthen dam requires permealile and impermeable soil. The position each soil, their function is different. The section of dam should be stable against water pressure, seepage pressure, which can be studied under GTE. **5. Design of underground structures i.e. Pipeline, tunnels etc.** The shape of tunnel depends on the type of soil, geological stability of beds. GTE is necessary to study shear strength, permeability of soil for such structure.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2		**Attempt any FOUR of the following:**		**(16)**
	(a) Ans.	**Explain three phase system of soil.**		
			**2**	
		Fig. Three Phase System of Soil		**4**
		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 simplify and presented in its equivalent three phase diagram as shown in figure above. Depending upon three phase diagram of soil is classified in three categories. 1. Dry soil 2. Partially saturated soil 3. Fully saturated soil. However if we take a dry soil mass, the voids are filled with air only. In case of perfectly saturated soil the voids are filled completely with water. In case of partially saturated soil, both air and water are present in the voids.	**2**	
	(b) Ans.	**Explain the causes of an earthquake.** **Causes of earthquake:** **1. Volcanic eruption:** Earthquakes may also occur in volcanic regions and are caused by the movement of magma in volcanoes. **2. Tectonic movements:** Most naturally occurring earthquakes are related to the tectonic nature of the earth. Such earthquakes are called tectonic earthquakes. **3. Natural disaster like landslide, tsunami:** Some earthquakes have anthropogenic sources such as extraction of minerals and fossil fuel from the earth's crust the removal or injection of fluids into the crust, reservoirs induced seismicity, massive explosion and collapse of large buildings.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2		**4. Massive civil structures like dams, reservoirs:** A rare few earthquakes have been associated with the buildup of large masses of water behind dams. **5. High water flows:** With the injection or extraction of fluids into the earth's crust. **6. Manmade explosions:** The detonation of powerful explosives such as nuclear explosions can cause low magnitude ground shaking.		
	(c)	**Explain formation process of soil and any two types of soil in India.**		
	Ans.	**Soil formation:** Soil formation mainly takes place due to mechanical disintegration or chemical decomposition of rocks whenever rock get exposed to atmosphere, it is acted by various weathering agencies and it gets transportated,eroded and deposited in to small particles and then it is converted soil.	**2**	
		Types of soil available in India.		**4**
		1. Residual soil: i. Red soil ii. Laterite soil		
		2. Transported soil: i. Colluvial soil ii. Alluvial soil iii. Glacial soil iv. Lacustrine soil v. Eolian soil	**2**	
	(d)	**Classification of earthquake based on origin and focus.**		
	Ans.	**Classification of earthquake based on focus:** i. Shallow earthquake: Focus depth less than 60 km. is taken as shallow earthquake. ii. Intermediate earthquake**:** Origin of earthquake is at a depth in between 60 km. to 300 km. called as intermediate earthquake. iii. Deep earthquake: Focus is at depth in range of 300 km. to 700 km. such earthquake.	**2**	
		Classification of earthquake based on origin: i. Tectonic Earthquake: This occurs due to movement of tectonic plates. ii. Volcanic Earthquake: This occurs due to volcanic eruption. iii. Collapse Earthquake: This occurs due to seismic waves produced by explosion of rock on the surface.	**2**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2		iv. Explosion Earthquake: This occurs due to detonation of nuclear or chemical elements.		
	(e)	**Define** **i. Seismology** **ii. Focus** **iii. Epicenter** **iv. Intensity**		
	Ans.	**i. Seismology:** A branch of geophysical science dealing with to study the causes and effects of the earthquakes and to make predictions of their occurrence in the future.	**1**	
		ii. Focus: It is a point within the earth where earthquake originates. Focus may be point or zone of disturbances.	**1**	**4**
		iii. Epicenter: This is the point on the earth's surface which is vertically above the focus.	**1**	
		iv. Intensity: It is a quantitative measure of the actual shaking at the location during an earthquake and is assigned as Roman capital letters.	**1**	
	(f)	**Explain procedure for determination of plastic limit of soil.**		
	Ans.	i. Take 20 to 25 gm. air dried soil sample passing through 425 micron IS sieve.		
		ii. Add distilled water in soil and mix it thoroughly for 10 to 15 minutes till soil becomes plastic enough, so that it can be moldable. (It is recommended to keep clayey soils about 24 hours for its maturity.)		
		iii. Make the balls of soil paste and roll it on non-porous glass or marble plate using figure pressure till it becomes soil thread of 3mm diameter.	**4**	**4**
		iv. Continue the rolling process till soil starts crumbling and it resembles a uniform thread.		
		v. Compare the prepared soil thread with metal rod of same diameter and then stop the rolling; where soil thread crumbles into different parts.		
		vi. Determine the water content of crumbled soil parts by oven drying method as w %.		
		vii. Repeat all above steps two more times to get average water content as plastic limit (W_P) given soil sample.		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		**Attempt any <u>FOUR</u> of the following:**		**(16)**
	(a)	**Explain with neat sketch particle size distribution curve.**		
	Ans.		**2**	
		Fig. Particle Size Distribution Curve		
		Particle size distribution curve (PSDC) is the semi log graph drawn as sieve size versus % finer of given soil sample. The PSDC is useful for grading of soil i.e. classification of soil based on its particle sizes available. Thus the outcome of sieve analysis is PSDC gives following types of soil as shown in figure above. From above graph soil is classified based on grading curves as follows.	**2**	**4**
		1. **Fine grained soil:** When line cuts Y-axis indicate more amount of fine particles. 2. **Well graded soil:** When PSDC is S-shaped indicates soil contains all particle sizes. 3. **Uniformly graded soil:** When line is almost vertical indicates particles of same sizes. 4. **Coarse grained soil:** When line cuts X-axis indicates more amount coarse particles available. 5. **Gap graded soil:** When graph is of wavy nature indicating particles of only specific size and deficiency of other sizes.		
	(b)	**Explain determination of coefficient of permeability by constant head method.**		
	Ans.	**Procedure** i. Take 2.5 Kg air dried soil sample passing through 9.5mm IS sieve. ii. Add the water in soil equals to its optimum moisture content (OMC) to get required density.		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		iii. Apply grease to inside surface of mould, base plate and collar. Clamp the base plate with extension collar. iv. Fill the prepared soil sample in permeameter in three different layers. Compact each layer using 25 blows using rammer. v. Remove the collar and trim the excess soil for mould. Remove compaction base plate. vi. Cover the soil with filter paper and porous stones on both sides. vii. Place the mould assembly in the drainage base. Fix the top cap on it using rubber sealing gasket. viii. Open air vent at top of permeameter mould to remove air from soil. ix. Immerse the mould with soil specimen in water tank for saturating it about 24 hours. x. Connect the inlet nozzle of permeameter to outlet of constant head water tank. Close the air vent of mould. xi. Open outlet of permeameter and allow water to flow in the bottom water tank. Wait for some time to establish steady flow. xii. Measure head causing flow 'h'. Collect quantity of water (Q) in the measuring cylinder for suitable time interval (t). xiii. Calculate the coefficient of permeability of soil as $K = \frac{Q \times L}{A \times h \times t}$ cm/s. xiv. Repeat all above steps two more times to get average coefficient of permeability of given soil sample.	**3** **1**	**4**

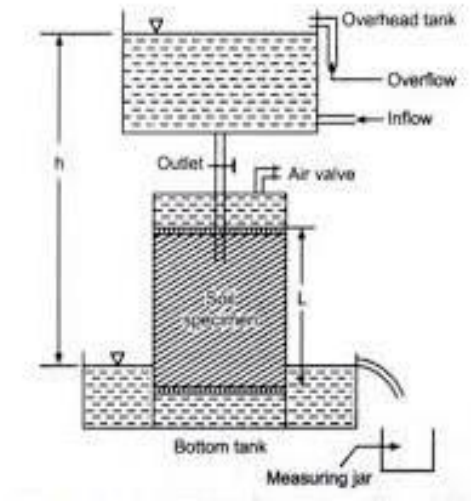


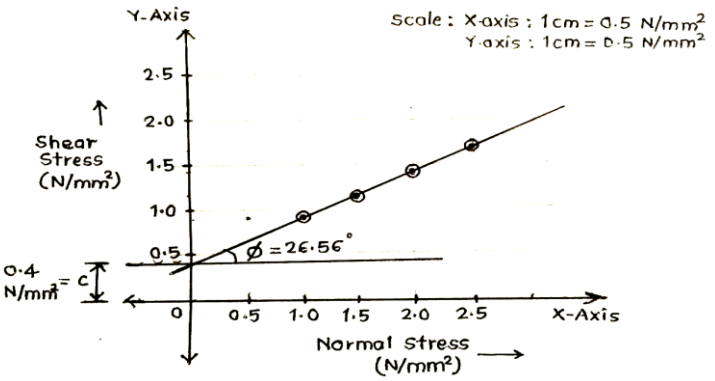
Fig. Constant Head Method

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	**(c)**	In direct shear test following observation were recorded at the failure of the specimen:		

Normal stress (N/mm^2)	1.0	1.5	2.0	2.5
Shear stress (N/mm^2)	0.9	1.15	1.4	1.65

Plot failure envelop and find value of angle of shearing resistance and cohesion.

Ans.



2

Angle of shearing resistance: $\phi = 26.56^o$

Cohesion $C = 0.4N/mm^2$

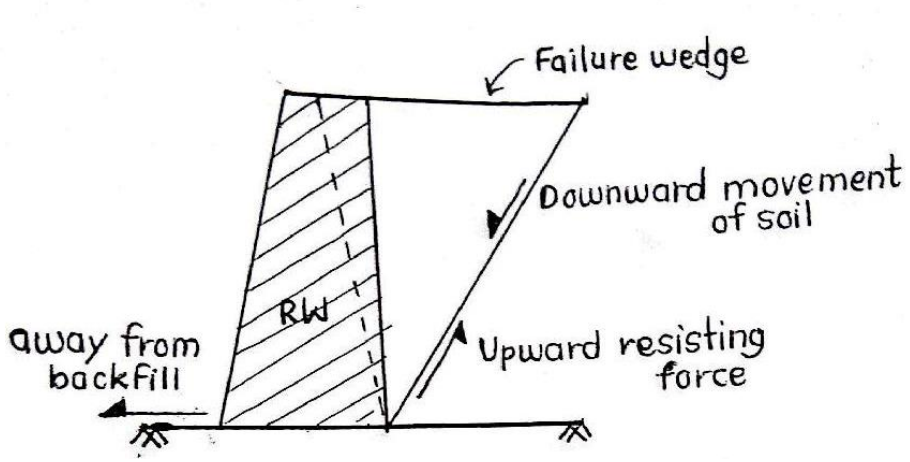
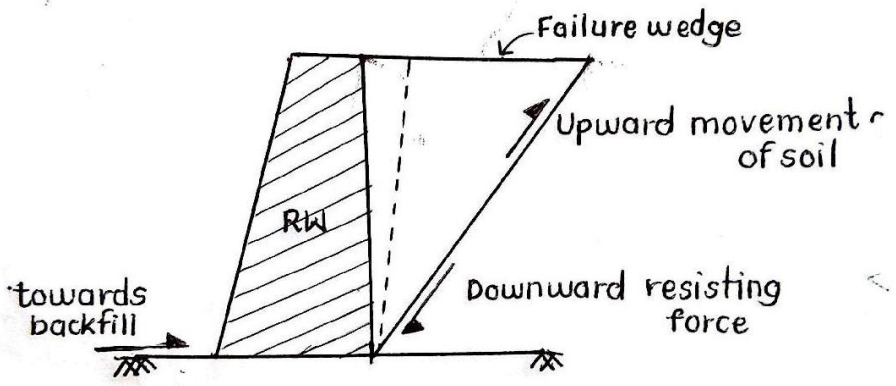
2

4

	(d)	**State characteristics of flow-net.**		
	Ans.	**Characteristics of flow net are as follows:** i. The flow lines and equipotential lines in the flow net intersect each other orthogonally. ii. The area or field formed due to intersection of these lines are approximately square. iii. The quantity of water flowing through each channel is almost same. iv. Smaller dimensions of the field indicate greater hydraulic gradient and more velocity of flow. v. The potential drop between two adjacent equipotential lines is same.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	**(e) Ans.**	**Explain briefly direct shear test of shear strength of soil.** **Procedure** 1. Take 2.5 Kg. air dried soil sample passing through 4.75 mm and retained on 2.36mm IS sieve. 2. Measure the internal dimensions of the shear box. Also determine the average thickness of the grid plates. 3. Fix the upper part of the box to the lower part using the locking screws. Attach the base plate to the lower part. 4. For performing a UU test, plain toothed grids (without perforations) are used at the top and bottom faces of samples. Shear force is applied immediately after applying the normal load. Place the grid plate in the shear box keeping the serrations of the grid at right angles to the direction of shear. Place the porous stone over the grid plate. 5. Weigh the shear box with base plate, grid plate and porous stone. 6. Place the soil specimen in the box. Tamp it directly in the shear box at the required density. When the soil in the top half of the shear box is filled. 7. Weigh the box with soil specimen. 8. Weigh the box inside the box contained and fix the loading pad on the box. Mount the box contained on the loading frame. 9. Bring the upper half of the box in contact with the proving ring. Check the contact by giving a slight movement. 10. Fill the container with water if the soil is to be saturated, otherwise omit this step. 11. Mount the loading yoke on the ball placed on the loading pad. 12. Mount the dial gauge on the loading yoke to record the vertical displacement and another dial gauge on the container to record the horizontal displacement. 13. Place the weights on the loading yoke to apply a normal stress. Allow the sample to consolidate under the applied normal stress. Note the reading of the vertical displacement dial gauge. 14. Remove the locking screws. Using the spacing screws, raise the upper part slightly above the lower part such that the gap is slightly larger than the maximum particle size. Remove the spacing screws.	**4**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		15. Adjust all the dial gauges to read zero. The proving ring should also read zero. 16. Apply the horizontal shear load at a constant rate of strain of 0.2mm/minute. 17. Record the reading of the proving ring, the vertical displacement dial gauge and the horizontal displacement dial gauge at regular time intervals. Take the first few readings at closer intervals. 18. Continue the test till the specimen fails or till a strain of 20% is reached. 19. At the end of the test, remove the specimen from the box and take a representative sample for water content determination. 20. Repeat the test on identical specimens under the normal stresses of 50, 100, 200, 400 kN/mm^2 etc. (The range of stresses selected should correspond to the actual field stress conditions.) 21. Plot the graph by taking the value normal stress as abscissa and the maximum shearing stress as ordinate to find shear strength as $\tau = c + \sigma \tan\phi$		
	(f) Ans.	**Explain effect of water table on bearing capacity of soil.** **Effect of water table on bearing capacity of soil:** i. The rise in water table from below the foundation results in decrease in granular soil. ii. When the water table reaches the ground where the depth is greater footing the bearing capacity is reduced by 50% or more. iii. The bearing capacity is not affected for purely cohesive soil. iv. The bearing capacity for non-granular soil decreases with presence of water table. v. Presence of water table for shallow depth give poor bearing capacity as compared for larger depth foundation. vi. When water table is above base of footing-submerged weight of soil should be considered for bearing capacity. vii. When water table is somewhat below the base of footing-elastic wedge is partially saturated soil should be considered. viii. When water table is at a depth D equal to width of footing below the base of footing-a linear interpolation in reduction factor should be made for bearing capacity calculations. ix. As ground water table rises accordingly bearing capacity of soil decreases.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		**Attempt any <u>FOUR</u> of the following:**		**(16)**
	(a)	**Explain with sketch active and passive earth pressure of soil.**		
	Ans.	**Active earth pressure:**		
		The minimum earth pressure on retaining wall which is developed due to movement of wall away from backfill is called as active earth pressure.	**1**	
			**1**	
		Fig. Active Earth Pressure		**4**
		Passive earth pressure:		
		The maximum earth pressure on retaining wall which is developed due to movement of wall towards backfill is called as passive earth pressure.	**1**	
			**1**	
		Fig. Passive Earth Pressure		
	(b)	**State assumption made in Rankine's theory of earth pressure for non-cohesive soils.**		
	Ans.	**Assumption of Rankines Theory:**		
		i. The soil is semi-infinite, homogenous, dry and cohesion less. ii. The soil element is in the state of plastic equilibrium. iii. The ground surface is plane which may be horizontal or inclined. iv. The back of is vertical and smooth. v. The wall yield about the base thus satisfies deformation condition for plastic equilibrium.	**1 each (any four)**	**4**

Q.4 (c) Ans. **Distinguish between compaction and consolidation of soil (any four points).**

Sr. No.	Compaction	Consolidation
1	Instant compression of soil under dynamic load is called compaction.	Gradual compression of soil under steady load is called consolidation.
2	It is fast process.	It is very slow process.
3	It is artificial process.	It is natural process.
4	It is done to improve soil properties like bearing capacity, shear strength, impermeability etc.	It takes place due to structural load which does not improve soil properties.
5	Settlement is prevented due to compaction.	Settlement takes place due to compaction.
6	Compaction is done before construction of structure.	Consolidation takes place after construction of structure.
7	Pore water pressure is not important in compaction.	Pore water pressure is very important in compaction.
8	Compaction does not go indefinitely.	Consolidation goes indefinitely.

Marks: **1 each (any four)** — Total Marks: **4**

(d) Ans. **State any four methods of soil stabilization. Explain any one.**

Methods of soil stabilization:

1. Mechanical Stabilization
2. Lime Stabilization
3. Cement Stabilization
4. Bitumen Stabilization
5. Fly ash Stabilization
6. Stabilization by chemicals
7. Stabilization by heating
8. Stabilization by grouting

Marks: **2**

Mechanical Stabilization:

In this method, stabilization of soil is done without adding any chemicals or admixtures. The procedure of mechanical stabilization is described below.

i. Initially the soil is excavated using excavator and then it is ground to finer particles using pulveriser.

ii. In this pulverized soil, well graded aggregates are spread and mixed till homogeneous mixture will form.

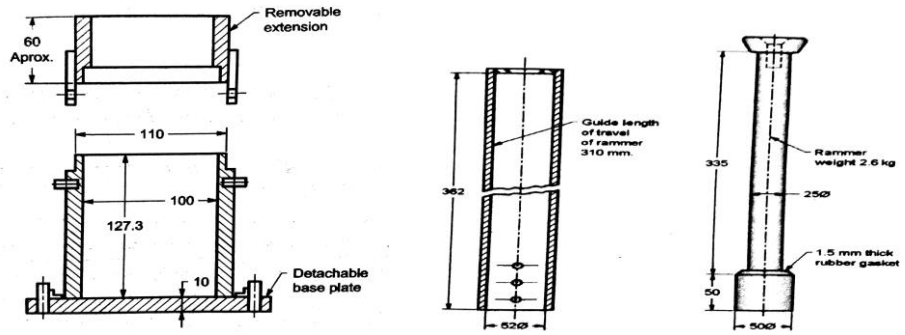
iii. Then water is sprinkled which is optimum moisture content i.e. OMC for getting maximum dry density i.e. MDD.

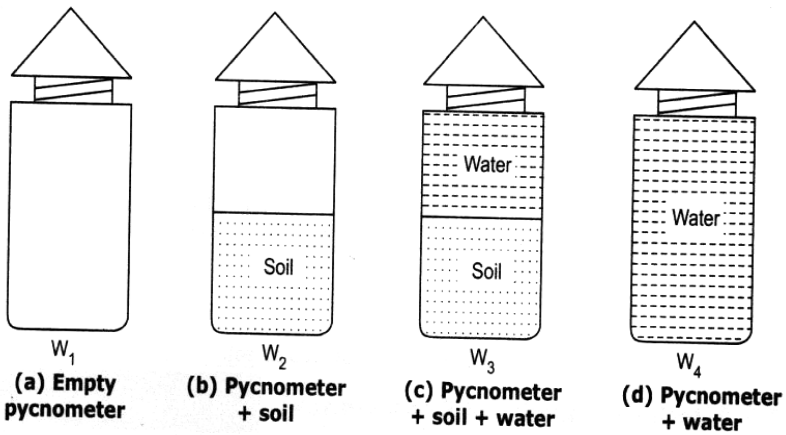
iv. The heavy roller (8 to10 tone capacity) is used to compact soil 15 to 20 cm thickness as per type of soil available.

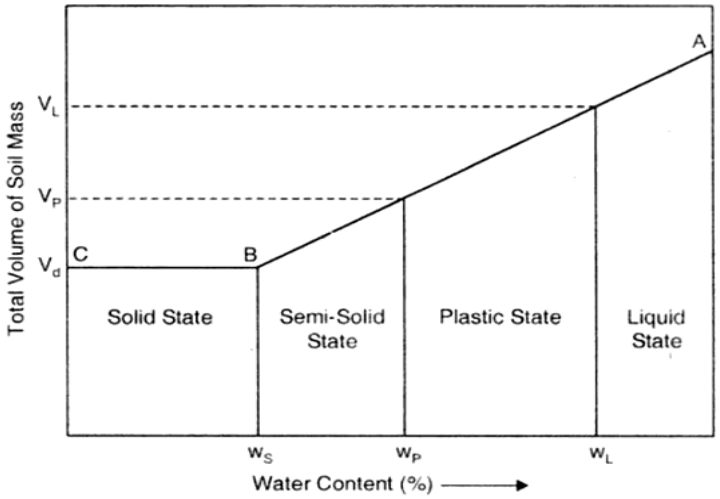
v. The compacted surface is cured sprinkling water on it, followed by compaction. The curing and compaction is done alternatively for seven days.

Marks: **2** — Total Marks: **4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		vi. Then the stabilized portion is allowed for its further use. ***(Note: Explanation of any other method from above should be considered.)***		
	(e)	**Explain modified proctor test with sketch.**		
	Ans.	**Procedure:** i. Take about 5 Kg. of de-aired soil passing through sieve 20 mm in tray. ii. Add about 4% water (approximately 120 ml.) to the soil and mix thoroughly with trowel and cover it with moist cloth for 24 hours to ensure thorough mixing of water with soil. iii. Note the dimension of proctor mould, collar and base plate. iv. Take the empty weight of the mould (without collar and base plate). v. Apply a thin film of grease on inside of the mould. vi. Fix the mould to the base plate with the help of wing nuts, place collar on the mould. vii. To determine the Proctor density till the soil in mould in three equal layers and give 25 blows to each layer using standard hammer. Scrap the top surface of compacted layer before placing the next layer of a soil. Ensure that after compaction of the third layer, the level of compacted soil slightly above the top of the mould. viii. Remove the collar trim the soil with a straight edge, disconnect the mould from base plate and weigh it. ix. Extrude the compaction soil from the mould. x. Collect sample from middle of the mould for water content determination. xi. Repeat step 5 to 10 taking fresh sample of same soil with addition of 3 to 4 % more water than previously added water. Repeat these steps for no. of times till a decrease in the weight of a soil is observed for at least two successive reading. xii. Calculate bulk density of compacted soil for each test. xiii. Determine the maximum dry density and optimum moisture content corresponding to the standard proctor compaction by plotting graph water content v/s. dry density. Also plot constant degree of saturation lines for 100%, 90%, 80% degree of saturation on same graph. Calculate the degree of saturation corresponding to the maximum dry density as OMC and MDD of given soil sample.	**3**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	**(e)**	 **Mould** **Rammer** **Fig. Modified Proctor Test**	**1**	
	(f)	**Explain the necessity of sub-soil exploration.**		
	Ans.	**Necessity of sub-soil exploration:** i. To know stratification below ground surface. ii. To determining index properties of soil like bulk density, voids ratio, water content, permeability, bearing capacity, compressibility etc. iii. To determine safe bearing capacity for design of foundation of proposed structure. iv. To control the seepage and rise of ground water below surface v. To decide size, depth and type of foundation for the proposed structure. vi. To know grain size distribution by sampling undistributed soil sample and classify soil accordingly. vii. To decide suitability of soil for proposed structure.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5		**Attempt any <u>TWO</u> of the following:**		**(16)**
	(a)	**Define specific gravity of soil. Explain the stepwise procedure of determination of specific gravity of soil by pycnometer.**		
	Ans.	**Specific Gravity:** It is ratio of unit weight in air of a given volume of soil solids at a specific temperature to unit weight in air of an equal volume of distilled water at same temperature.	**2**	
		Determination of specific gravity by pycnometer test:		
		Procedure:		
		i. Clean the pycnometer bottle and dry it. Take the weight of empty pycnometer with conical cap as 'W_1' gm.		
		ii. Oven dry the given soil sample passing through 4.75 mm and retained on 75 micron IS sieve, in oven at temperature 105-110^{0}C for 24 hours to get dry soil.		
		iii. Place this soil sample about 150-200 gms in the pycnometer and take its weight as 'W_2' gm.	**4**	**8**
		iv. Now add the distilled water to half of height of pycnometer and stirrer it using glass rod, so that entrapped air will be removed from soil.		
		v. Fill the distilled water up to top of conical cap using pipette.		
		vi. Take the weight of pycnometer filled with distilled water as 'W_3' gm.		
		vii. Remove all content from the pycnometer bottle. Wash and clean it with water.		
		viii. Fill the pycnometer bottle with distilled water only up to top of conical cap.		
		ix. Take the weight of pycnometer completely filled with water as W_4 gm.		
		x. Calculate the specific gravity G, as $G = \frac{(W_2 - W_1)}{[(W_4 - W_1) - (W_3 - W_2)]}$	**1**	
		xi. Repeat all above steps two more times to calculate average specific gravity of given soil sample.		
			**1**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	**(b)**	**Explain Atterberg's limits of consistency with neat sketch.**		
	Ans.	**Atterberg's Limit of consistency:**		
		Liquid limit (W_L): 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.	**2**	
		Plastic limit (W_p): 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.	**2**	
		Shrinkage limit (W_s): 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.	**2**	**8**
			**2**	
		CONSISTENCY LIMITS		
	(c)	**Explain I.S. classification of soil.**		
	Ans.	**I.S. classification of soil:**		
		The soils are classified by Indian standard code i.e. IS 1498:1970 into three categories.		
		1. Coarse grained soil:		
		In these soils, more than half of total soil by weight is larger than 75 micron I S. sieve size.		
		The coarse grained soil is further classified as follows.	**4**	**8**
		i. Boulders having particle size more than 300 mm.		
		ii. Cobble having particle size between 80mm to 300mm.		
		iii. Coarse gravel having size 20mm to 80 mm.		
		iv. Fine gravel having size 4.75mm to 20 mm.		
		v. Coarse sand having size 2mm to 4.7mm.		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	**(c)**	vi. Medium sand having size 425 micron to 2mm. vii. Fine sand having size 75 to 425 micron. **2. Fine grained soil:** In these soils, more than half of total soil by weight is smaller than 75 micron I.S sieve size. The fine grained soil is further classified as follows. i. Silt having particle size 2 to 75 micron. ii. Clay having particle size less than 2 micron. **3. Highly organic soil:** These soils contain large percentage of fibrous organic matter such as peat and particles of decomposed vegetation. In addition, certain soils containing shells, concretions, cinders and other non-soil materials in sufficient quantities are grouped under this category.	**2** **2**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**Attempt any TWO of the following:**		**(16)**
	(a)	**A soil sample 12cm in diameter and 18 cm long is tested in falling head permeameter.The initial head was 45 cm, which was dropped to 20 cm in 15 minutes .The diameter of burette pipe was 0.5cm. Find coefficient of permeability in meter/day.**		
	Ans.	**Given data:** L= 18cm, D = 12 cm, d= 0.5cm, h_1=45cm, h_2= 20 cm, t = 15 min = 900 sec. **To find:** k = ?		
		$A = \pi/4 \times D^2 = \pi/4 \times (12)^2 = 113.097\ cm^2$	**1**	
		$a = \pi/4 \times d^2 = \pi/4 \times (0.5)^2 = 0.196\ cm^2$	**1**	
		$K = 2.303\left(\frac{a \times L}{A \times t}\right) \times \log_{10}\left(\frac{h_1}{h_2}\right)$	**1**	
		$K = 2.303\left(\frac{0.196 \times 18}{113.097 \times 15}\right) \times \log_{10}\left(\frac{45}{20}\right)$	**1**	**8**
		$K=1.686 \times 10^{-3}$ cm/min.	**1**	
		1 m =100 cm 1 day = 24 X 60 min.	**1**	
		$K=1.686 \times 10^{-3} \times (24 \times 60/100)$	**1**	
		K=0.02427 meter/day.	**1**	
	(b)	**Explain method of improving bearing capacity of soil and state typical values for SBC for Black Cotton soil and Hard Moorum.**		
	Ans.	**Methods of improving bearing capacity of soil.** **i. By increasing depth of foundation:** At deeper depths the over burden pressure on soil is higher hence soil is more compacted at deeper depth. As a result it shows higher bearing capacity. **ii. By draining sub soil water:** With increase in percentage of water content of soil the bearing capacity decreases. **iii. By compacting soil:** If we compact soil using appropriate method then there will be increase in its density and shear strength. As a result bearing capacity also increases. **iv. By increasing width of foundation:** By increasing width of foundation the intensity of load is decreases and on the same soil can take more loads. **v. By confining soil:** In this method soils are enclosed with the help of sheet piles. This confined soil is further compacted to get more strength.	**8**	**8**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
		vi. By replacing poor soil: In this method poor soil first removed and then the gap is filled up by superior material such as sand, stone, gravel or any other hard material. **vii. By using grouting material:** In this method poor soil bearing strata is hardened by injecting the cement grout under pressure. **Typical values of SBC for following soils are as follows.** i. Block cotton soil: 130 to 160 kN/m^2 ii. Hard moorum: 880 kN/m^2		
	(c)	**State the factors affecting compaction. State four equipments used for field methods of compaction. Also state its suitability.**		
	Ans.	**Factors affecting compaction:** i) Type of soil ii) Amount of compaction iii) Water content iv) Admixtures v) Method of compaction **Equipment used for compaction with suitability.** **i) 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. **ii) Compaction by Rammers:** **Suitability:** Suitable for all types of soil. **iii) Compaction by vibratory compactors:** The vibrating equipment, mounted on screeds, plates or rollers are of two types. **a) Dropping weight type.** **b) Pulsating hydraulic type.** **Suitability:** Suitable for compacting granular soils with no fines in layer up to 1 m thickness. ***(Note: 4 marks equipment and 2 marks suitability.)***	**½ each (any four)** **6**	**8**