Model Answer: Winter-2019

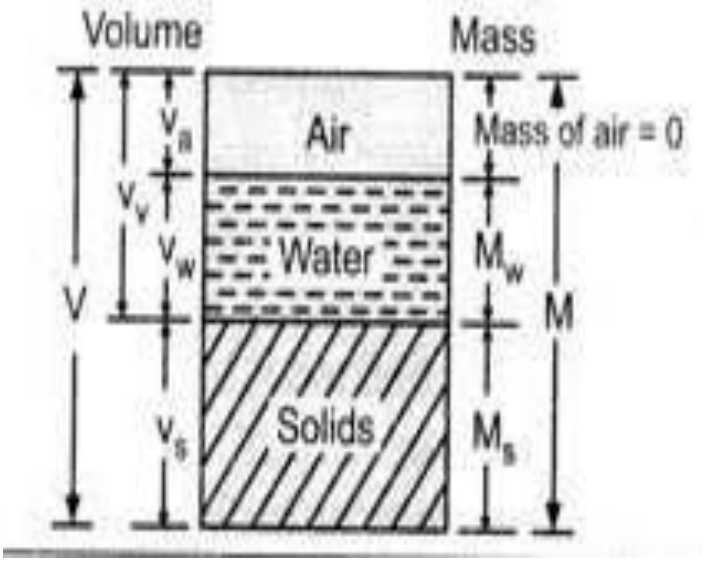
Subject: Geotechnical Engineering

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)**	**Answer any SIX of the following:**		**12**
	i)	**Define mineralogy**		
	Ans.	Mineralogy is that branch of geology, which deals with formation, occurrence, aggregation, properties, and uses of minerals. Mineralogy sometimes itself divided into specific sub-branches such as crystallography, optical mineralogy and descriptive mineralogy and so on.	**2**	**2**
	ii)	**State any two engineering uses of igneous rock.**		
	Ans.	**Uses of Igneous rock:** 1. As it is strongest rock, can be used to manufacture the aggregates, gravels for concrete work of building. 2. It is useful to use it as boulders for road construction work. 3. It is also useful in the form of ballast in the railway tracks. 4. It plays a strong support for various foundations of number of civil engineering structures.	**1 each (any two)**	**2**
	iii)	**Define dip and strike.**		
	Ans.	**1. Dip:** It is the inclination of bedding plane of rock with horizontal is called as dip**.** **2. Strike:** It is the geographic direction in which bed, fault or joint plane of rock occurs called as strike**.**	**1** **1**	**2**

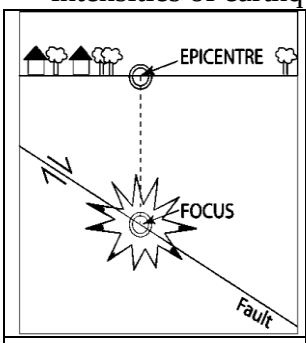
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	iv)	**Define faults and state any two types of fault.**		
	Ans.	**Fault:** It is defined as the rupture / fracture along which there is a relative movement of beds of rocks, called as fault.	1	
		Types of fault: 1. Translational fault 2. Rotational fault 3. Normal or gravity fault 4. Reverse or thrust fault 5. Dextral fault 6. Sinistral fault 7. Strike fault 8. Dip fault 9. Oblique fault 10. Radial fault 11. Enechelon fault 12. Accurate or peripheral fault	½ each (any two)	2
	v)	**Draw three phase diagram for partially saturated soil.**		
	Ans.	 **Figure : Three Phase Diagram for Partially Saturated Soil**	2	2
	vi)	**Define soil as per IS.**		
	Ans.	**Definition of soil as per IS: 2809-1972:** Soil is the sediment or other unconsolidated accumulation of solid particles produced by physical and chemical disintegration of rock.	2	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	**vii)**	**State two uses of soil.**		
	Ans.	**Uses of soil:** 1. Soil is used as construction material to manufacturing of clay bricks for masonry. 2. The murum is used for plinth filling in the building construction. 3. Natural soil is also used as sub grade soil for pavement. 4. Soil becomes embankment for road side, bridge abutment, and retaining wall. 5. Soil is also used as foundation material in the form of supporting soil for various civil engineering structures like building, road, bridge etc.	**1 each (any two)**	**2**
	vii)	**Define voids ratio and porosity.**		
	Ans.	1. **Voids ratio:** It is the ratio of volume of voids to volume of solids called as voids ratio. 2. **Porosity:** It is the ratio of volume of voids to the total volume of soil; called as porosity.	**1** **1**	**2**

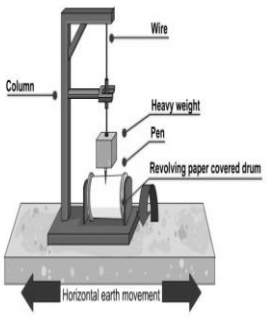
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	**b)**	**Answer any TWO of the following:**		**8**
	i)	**Explain any four field applications of geotechnical engineering knowledge.**		
	Ans.	**Field applications of Geotechnical Engineering:** **1. Design of foundation for various structures:** Foundation 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 structure 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 permeable 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**
	ii)	**Define any four types of folds and explain any one.**		
	Ans.	**Types of folds:** 1. Symmetrical folds 2. Asymmetrical folds 3. Overturned folds 4. Fan folds 5. Recumbent fold 6. Isoclinal folds	**½ each (any four)**	
		Symmetrical 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**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	**b) iii)** **Ans.**	**Explain the classification of rock based on mode of origin.** **Classification of rock based on mode of origin (genesis)**: Based on mode of origin, the rocks are classified in to three categories described below. **1. Igneous Rock:** Igneous rocks are of volcanic origin and are formed as a result of solidification of molten mass lying below or above the earth's surface .The inner layer of the earth are at a high temperature causing the masses of silicates to melt. This molten mass called magma is forced up as volcanic eruption and spreads over the surface of the earth where it solidifies forming basalt and trap. If the magma solidifies below the surface of earth the solid crystalline rock is formed. **2. Sedimentary Rock:** Sedimentary rocks are formed by the deposition and consolidation of new sediments in layers over the preexisting rocks. The new sediments are intact, eroded away from some old rocks by weathering and are then transported by agents like wind, water, ice etc. These eroded sediments after travelling some distance may get deposited over some existing rocks which on consolidation will result in the formation of what are known as sedimentary rocks. **3. Metamorphic Rock:** Metamorphic rocks are formed from igneous or sedimentary rocks as a result of the action of the earth movements, temperature changes and liquid pressure.	**4**	**4**

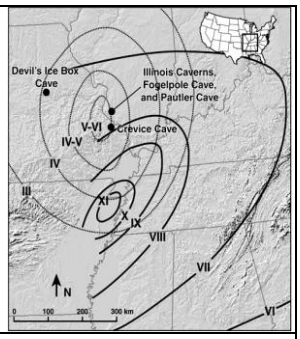
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2		**Answer any FOUR of the following:**		**16**
	a)	**Explain the formation process of soil and state any two types of soil in India.**		
	Ans.	**Soil formation:** Soil formation mainly takes place due to mechanical disintegration or chemical decomposition of rocks whenever rock get exposed to atmosphere, it is acted by various weathering agencies and it gets transported, eroded and deposited in to small particles and then it is converted soil. **Types of soil available in India.** 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** **1 each (any two)**	**4**
	b)	**Define focus, epicenter, seismograph and isoseismic line with sketch.**		
	Ans.	**1. Focus:** The place or point of origin of an earth quake below ground surface is termed as focus or hypocenter of earthquake. **2. Epicenter:** The place or point on ground surface, where seismic waves reaches firstly causing major damage is known as epicenter. **3. Seismograph:** The energy released during faulting, produces seismic waves, which can be detected by sensitive and delicate instruments, called seismograph. **4. Isoseismic line:** The imaginary line joining the points of equal intensities of earthquake on ground is known as isoseismic lines.	**2** **2**	**4**



Focus and Epicenter



Seismograph

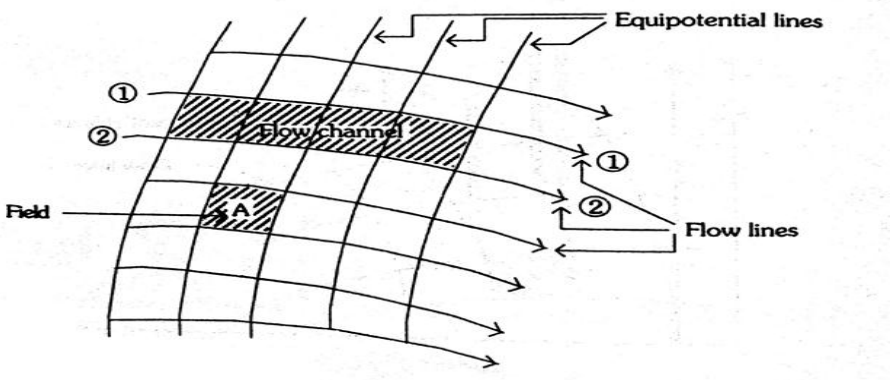


Isoseismic Lines

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	c)	**State any four causes of earthquake.**		
	Ans.	**Causes of earthquake:** 1. Movement of tectonic plates 2. Volcanic eruption 3. Anthropogenic sources 4. Dams 5. Use of explosives 6. Sport games 7. Injection and Extraction of fluids 8. Removal of natural gases	**1 each (any four)**	**4**
	d)	**State any four effects of earthquake.**		
	Ans.	**Effect of earthquake:** 1. Destruction of various Civil Engineering structures 2. Formation of irregularities (unevenness) on ground 3. Sudden landslides along hill slopes 4. Change in river course 5. Formation of new lakes springs 6. Generation of high ocean tidal waves 7. Fire exposure due to short circuiting 8. Loss of human life and property	**1 each (any four)**	**4**
	e)	**State any four considerations to construct earthquake resistant structures.**		
	Ans.	**Considerations to construct earthquake resistant structures:** 1. The foundation should be provided over the hard rock with no sign of faults. 2. The building should be symmetrical and rectangular in plan. 3. The reinforcement bar should be minimum 16 mm in diameter used for all structural members of RCC buildings. 4. Doubly reinforced sections should be provided in case of RCC elements of building. 5. High ductile materials should be used to construct the RCC parts. 6. Masonry part with stone or brick should be avoided as far as possible. 7. Reinforcing bars of 12 mm should be provided at all corners and junction of walls of load bearing structures 8. The wall thickness of load bearing structures should be minimum 230 mm. 9. The column should be short or made up of steel material as far as possible.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	**f)** **Ans.**	**Explain the determination of plastic limit of soil.** **Procedure for determination of plastic limit of soil:** 1. Take 20-25 gm air dried soil sample passing through 425 micron IS sieve. 2. Add distilled water in soil and mix it thoroughly for 10-15 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.) 3. 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. Continue the rolling process till soil starts crumbling and it resembles a uniform thread. 5. Compare the prepared soil thread with metal rod of same diameter, and then stop the rolling; where soil thread crumbles into different parts. 6. Determine the water content of crumbled soil parts by oven drying method as w %. 7. Repeat all above steps two more tones to get average water content as plastic limit (W_P) given soil sample.	**4**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		**Answer any <u>FOUR</u> of the following:**		**16**
	a)	**Explain the mechanical sieve analysis test carried out on soil sample to classify it.**		
	Ans.	**Procedure of mechanical sieve analysis test:** 1. Initially keep the given soil sample in rapid moisture meter for 2-3 hours to get oven dried soil. Break the visible lumps present in soil using fingers with light pressure. 2. Arrange the set of IS sieves mentioned above in the descending order with coarser sieve at top and finer sieve at bottom. 3. Take the soil sample about 500-1000 gm and put it on topmost sieve. Place lid and pan at top and bottom of IS sieve set respectively. 4. Keep this assembly on Mechanical Sieve Shaker for sieving. Continue the shaking the sieve set for minimum10-15 minutes as recommended. 5. Take out the soil from each sieve using steel brush. Measure the weight of soil fraction retained on each sieve separately. Record the same in observation table. 6. Calculate the cumulative percentage finer using tabular format give below. 7. Draw the Particle Size Distribution Curve (PSDC) on semi logarithmic graph as particle size as abscissa (log scale) versus cumulative percentage finer as ordinate (natural scale). 8. From nature of PSDC, classify the given soil in the categories given below. Well graded soil, poorly graded soil, uniformly graded soil, fine grained soil, coarse grained soil.	**4**	**4**

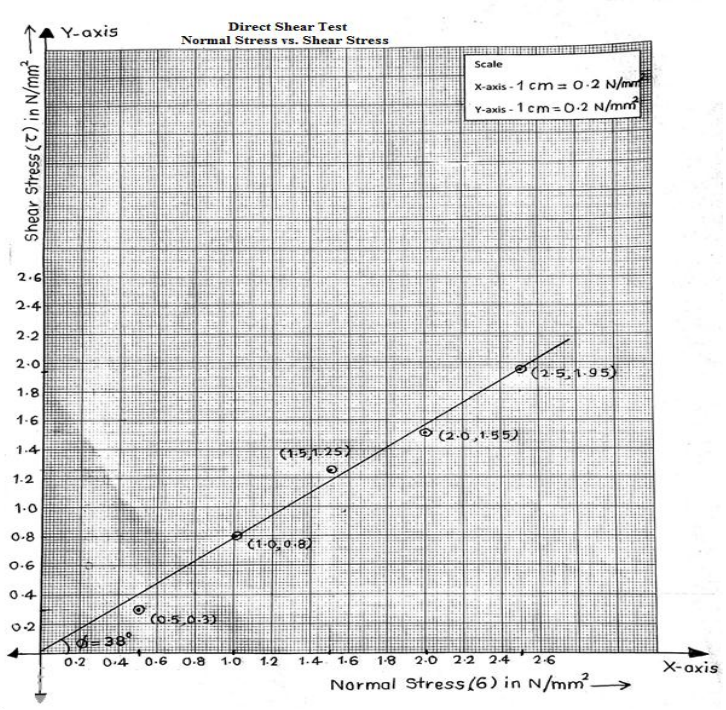
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	b)	**State the Darcy's law of permeability with expression. Hence define coefficient of permeability.**		
	Ans.	**Darcy's law of permeability:** It states that for laminar flow, the rate of flow or discharge per unit time is directly proportional to hydraulic gradient.	1	
		Expression: q = KiA	1	
		q/A = Ki V = Ki V/i = K	1	4
		Where, q = rate of discharge K = coefficient of permabilty A = cross sectional area of soil sample V = average discharge velocity i = hydraulic gradient		
		Coefficient of Permeability: It is defined as the average discharge velocity of flow under a unit hydraulic gradient through a soil. Mathematically: **K = V/i**	1	
	c)	**State any four characteristics of flow net with sketch.**		
	Ans.	**Characteristics of flow net:** 1. The flow lines and equipotential lines in the flow net intersects each other orthogonally 2. The area or field formed due to intersection of these lines is approximately square 3. The quantity of water flowing through each channel is almost same. 4. Smaller dimensions of the field indicate greater hydraulic gradient and more velocity of flow. 5. The potential drop between two adjacent equipotential lines is same.	½ each (any four)	
		 **Figure : Flow Net**	2	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	d)	**Explain the direct shear test to determine shear strength of soil.**		
	Ans.	**Procedure for Direct Shear Test:** 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. Fix the upper part of the box to the lower part using the locking screws. Attach the base plate to the lower part. 3. For performing a undrained test, Plain toothed grids (without perforations) are used at the top and bottom faces of samples. Place the porous stone over the grid plate. 4. Weigh the shear box with base plate, grid plate and porous stone. Place the soil specimen in the box. Tamp it directly in the shear box at the required density. 5. When the soil in the top half of the shear box is filled, weigh the box with soil specimen. Weigh the box inside the box contained and fix the loading pad on the box. Mount the box contained on the loading frame. 6. Bring the upper half of the box in contact with the proving ring. Check the contact by giving a slight movement. 7. Mount the loading yoke on the ball placed on the loading pad. 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. 8. Place the slotted weights of 0.5 N/mm^2 on the loading yoke to apply a normal stress. Note the reading of the vertical displacement dial gauge. 9. 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. 10. Apply the horizontal shear load at a constant rate of strain of 0.2mm/minute till shear failure of soil. Record the reading of the proving ring, the vertical displacement dial gauge and the horizontal displacement dial gauge at regular time intervals to know the shear stress at failure. 11. Repeat the test on identical specimens under the normal stresses of 1.0, 1.5, 2.0 N/mm^2 etc. Plot the graph by taking the value Normal Stress as abscissa and the maximum shearing stress as ordinate to find shear strength of soil.	**4**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	e)	**Determine the value of cohesion and angle of internal friction from the following observation taken during direct shear test.**		

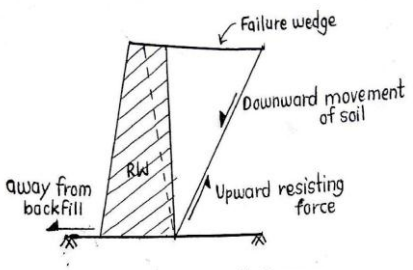
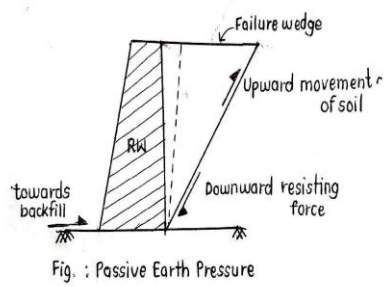
Normal Stress (N/mm^2)	0.5	1.0	1.5	2.0	2.5
Shear Stress (N/mm^2)	0.3	0.8	1.25	1.55	1.95

Ans.



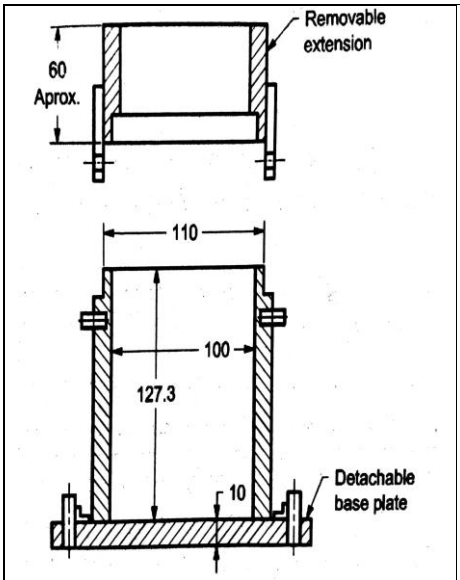
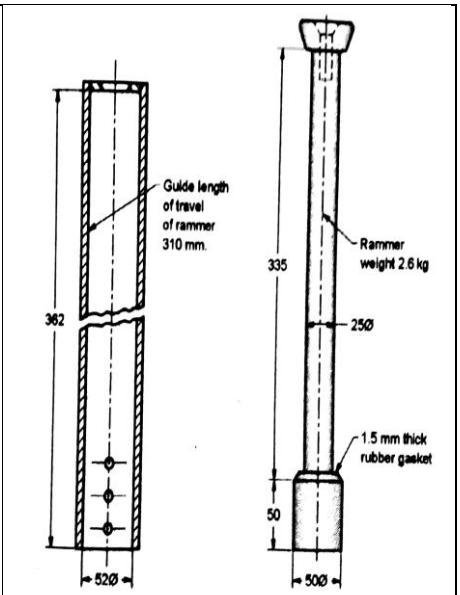
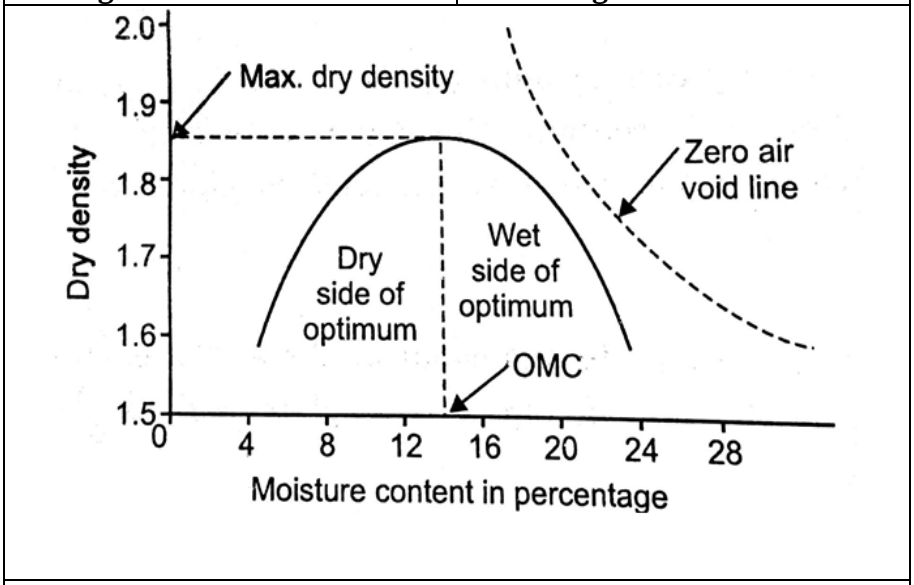
		1. As the straight line passing through maximum points plotted on graph meets origin point; the value of cohesion **C is 0**.	**1**	**4**
		2. The angle made by Y-intercept line with horizontal i.e. angle if shearing resistance $\phi = \tan^{-1}((y_2 - y_1) / (x_2 - x_1)$ $\phi = \tan^{-1}((1.95-0.8) / (2.5-1.0)$ **$\phi = 37.47^0 = 38^0$.**	**1**	
	f)	**State any four assumptions made in Terzaghi's analysis of bearing capacity failure of soil.**		
	Ans.	**Assumptions of Terzaghi's bearing capacity failure theory:** 1. Soil behaves like ideally plastic material. 2. Soil is homogeneous, isotropic and its shear strength is represented by Coloumb's equation. 3. The total load on footing is vertical and uniformly distributed. 4. The footing is long enough with L/B = ∞. 5. The shear strength above base of footing is neglected and taken as uniform surcharge γ_{Df}. 6. The elastic zones developed has straight boundaries inclined at $\psi = \phi$.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		**Answer any FOUR of the following:**		**16**
	a)	**Explain the effect of water table on bearing capacity of soil.**		
	Ans.	**Effect of water table on bearing of capacity of soil:** 1. When the water table reaches the ground where the depth is greater footing the bearing capacity is reduced by 50% or more. 2. The bearing capacity is not affected for purely cohesive soil. 3. The bearing capacity for non-granular soil decreases with presence of water table. 4. Presence of water table for shallow depth give poor bearing capacity as compared for larger depth foundation. 5. When water table is above base of footing-submerged weight of soil should be considered for bearing capacity. 6. When water table is somewhat below the base of footing-elastic wedge is partially saturated soil should be considered. 7. 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. 8. As ground water table rises accordingly bearing capacity of soil decreases.	**1 each (any four)**	**4**
	b)	**Differentiate between active earth pressure and passive earth pressure with sketch.**		
	Ans.	**Difference between active and passive earth pressure:**		

Active Earth Pressure	Passive 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.	The maximum earth pressure on retaining wall which is developed due to movement of wall towards backfill is called as passive earth pressure.
 Fig : Active Earth Pressure	 Fig. : Passive Earth Pressure

2 **4** **2**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	**c)**	**Explain standard proctor test on soil to determine OMC and MDD of soil with sketch.**		
	Ans.	**Procedure of Standard Proctor Test:** 1. Take about 5 Kg. of de-aired soil passing through sieve 20 mm in tray. 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. 2. Note the dimension of proctor mould, collar and base plate. 3. Take the empty weight of the mould (without collar and base plate). Apply a thin film of grease on inside of the mould. Fix the mould to the base plate with the help of wing nuts, place collar on the mould. 4. 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. 5. Remove the collar trim the soil with a straight edge, disconnect the mould from base plate and weigh it. Extrude the compaction soil from the mould. Collect sample from middle of the mould for water content determination. 6. 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. Calculate bulk density of compacted soil for each test. 7. Determine the maximum dry density and optimum moisture content corresponding to the standard proctor compaction by plotting graph water content v/s. dry density.	**3**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	c) Ans.	 **Figure : Proctor Mould**  **Figure : Rammer**  **Figure: Compaction Curve to find OMC and MDD of Soil.**	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	d)	**State the necessity of site investigation. (any four)**		
	Ans.	**Necessity of site investigation:** 1. To verify the suitability of site according to the panned structure. 2. To select the type and depth of foundation for proposed structure based on available substrata. 3. To determine ground water table of site and its probable rise towards proposed foundation. 4. To determine the probable and maximum settlements. 5. To adopt the suitable techniques and equipments for the construction. 6. To predict the lateral earth pressure on retaining wall and abutments of bridge. 7. To investigate the safety of existing structures and to suggest the remedial measures for the same.	**1 each (any four)**	**4**
	e)	**Determine the practical applications of various types of compaction equipments. (any four)**		
	Ans.	**Practical applications of compaction equipments:** **1. Compaction by rolling:** **a) Smooth Wheel Rollers:** These rollers best suitable for subgrade or base coarse compaction of cohesion less soils. **b) Pneumatic Tyred Rollers:** 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:** Suitable only for fine grained soil i.e. cohesive soil. **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. It is suitable for all types of soil. **3. Compaction by Tamping:** Tamping rod is used to compact coarse grained cohesion less soils of lesser thickness. **4. Compaction by Vibratory Compactors:** Dropping weight type and Pulsating hydraulic type vibrators compacts soil by giving vibration, soil particles are packed together and compaction of subgrades and base course of both flexible and rigid pavement. It is suitable for compacting granular soils with no fines in layer up to 1 m.	**1 each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	f)	**State the necessity of soil exploration. What is the criterion for deciding the number of test-pits for site investigation?**		
	Ans.	**Necessity of site exploration:** 1. To know stratification below ground surface. 2. To determining index properties of soil like bulk density, voids ratio, water content, permeability, bearing capacity, compressibility etc. 3. To determine safe bearing capacity for design of foundation of proposed structure. 4. To control the seepage and rise of ground water below surface 5. To decide size, depth and type of foundation for the proposed structure. 6. To know grain size distribution by sampling undistributed soil sample and classify soil accordingly. 7. To decide suitability of soil for proposed structure. **Criterion for deciding the number of test-pits for site investigation:** 1. According to IS: 1892-1979, one test pit at center of plot is sufficient for smaller and less important area. 2. For larger area about 0.4 hectare, four test pit at corners of plot and one at center should be taken. 3. The sounding tests or cone penetration tests should be taken at a spacing 50-100 m in the grid pattern. 4. The test pits should be taken two at edges and one at center for alignment of roadway, runway and railway etc. 5. When the roads are of lesser width, one bore hole at central alignment is sufficient. The spacing varies according to ground variation about 100 m. 6. For dams. The test pits should be taken along top line of upstream side across the abutments with 50 m spacing.	**½ each (any four)** **½ each (any four)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5		**Answer any <u>TWO</u> of the following:**		**16**
	a)	**If the soil sample weighs 180 gm after drying and 200 gm before drying, calculate its water content. The soil sample has specific gravity of 2.7 and porosity 30 %, calculate degree of saturation and voids ratio.**		
	Ans.	Given: W_1 = 200gm W_2 = 180gm G=2.7 η =30% Find: S and e		
		$W = \frac{W_w}{W_s} \times 100 = \frac{(W_1 - W_2)}{W_2} \times 100$	**1**	
		$W = \frac{(200-180)}{180} \times 100$	**1**	
		$\boxed{W = 11.11\%}$	**1**	
		$e = \frac{\eta}{1-\eta} = \frac{\left(\frac{300}{100}\right)}{1-\left(\frac{30}{100}\right)}$	**1**	**8**
		$e = \frac{0.3}{1-0.3}$	**1**	
		$\boxed{e = 0.4286}$	**1**	
		$s \times e = w \times G$	**1**	
		$s = \frac{w \times G}{e} = \frac{11.11 \times 2.7}{0.4286}$		
		$\boxed{s = 70\ \%}$	**1**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	b)	**Explain the determination of liquid limit of soil with neat sketches.**		
	Ans.	**Procedure of Liquid Limit Test:** 1. Take about 120 gm. of air dried soil sample passing through 425 micron IS sieve in metal tray. Add 20 % distilled water to the soil sample to form uniform soil paste. 2. Put this soil paste in the brass cup of Casagrande's apparatus and spread horizontally into portion with few strokes of spatula.Trim the soil up to a depth of 1 cm maximum thickness and remove excess of soil if any. 3. Divide the soil sample in two parts by the firm strokes of the grooving tool along the diameter through the centre of brass cup so that clean sharp groove of proper dimension is formed. 4. Rotate the handle of Casagrande's apparatus at a rate of 2 revolutions per second until two parts of the soil will come in contact with each other for a length of about 12 mm by flow only. 5. Count the number of blows required to close the groove close for about 12 mm as N. 6. Take representative portion of soil for water content determination as w %. 7. Repeat all above steps by changing water in soil sample to get number of blows between10 to 50. Record the number of blows and corresponding water content for various trials. 8. Draw the flow curve i.e. Number of blows required as abscissa (log scale) versus water content determined as ordinate (natural scale) on semi-logarithmic graph paper. 9. Find out the water content corresponding to 25 blows from graph as liquid limit (W_L) of given soil sample.	**6** **2**	**8**

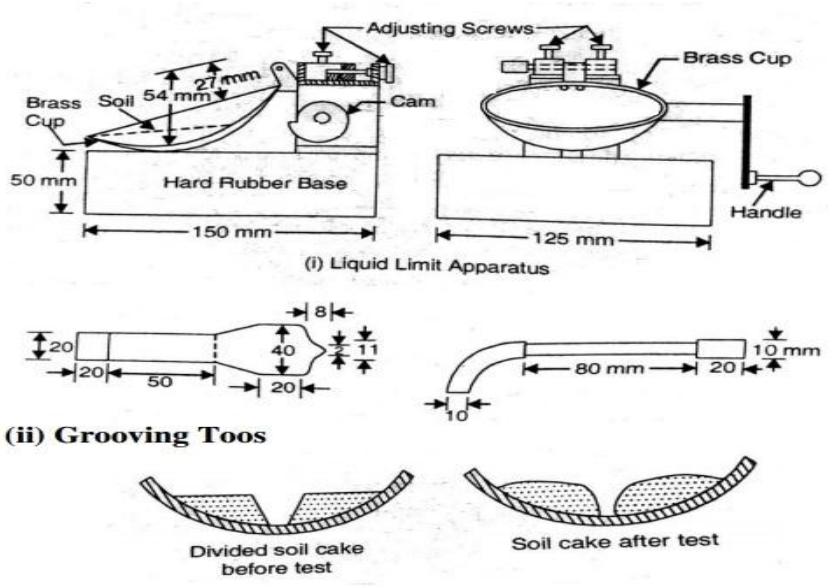
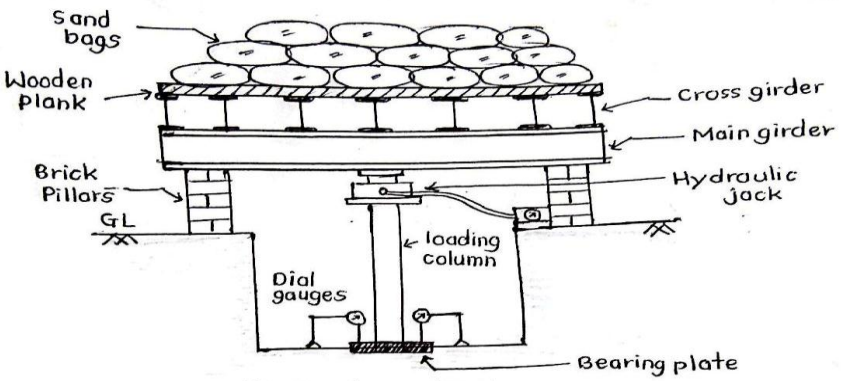
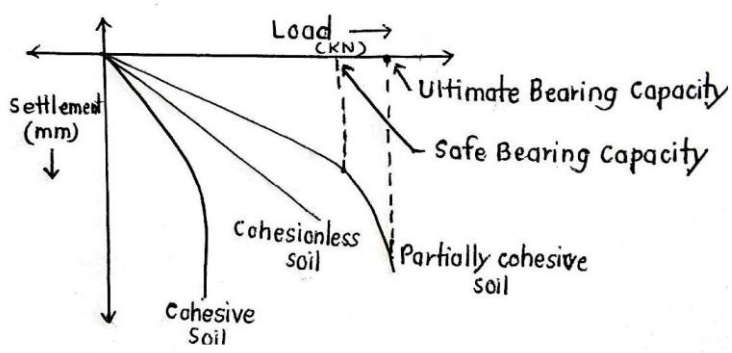
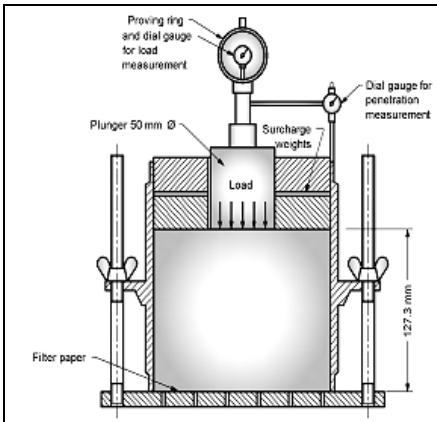
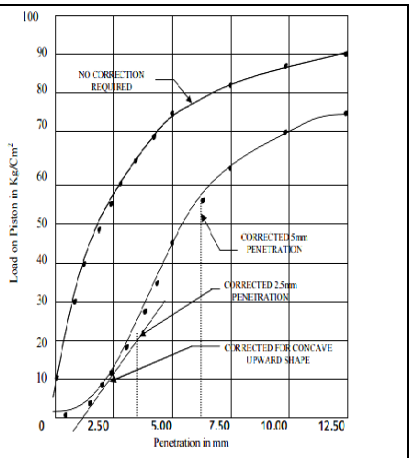


Figure: Liquid Limit Test

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	c)	**Define coefficient of uniformity and coefficient of curvature. Calculate Cu and Cc if D_{10} = 0.90 mm, D_{30} = 1.18 mm, D_{60} = 2.30 mm.**		
	Ans.	**Coefficient of uniformity:** It is the ratio of D_{60} to D_{10} values of soil from particle size distribution curve, called as coefficient of uniformity.	**2**	
		Coefficient of curvature: It is the ratio of square of D_{30} to product of D_{10} and D_{60} values of coefficient of curvature.	**2**	
		Coefficient of uniformity C_u:	**1**	**8**
		$C_u = D_{60}/ D_{10} = 2.30 / 0.90$	**1**	
		C_u = 2.555		
		Coefficient of curvature C_c:		
		$C_c = D_{30}^2 / (D_{10} \times D_{60}) = 1.18^2 / (0.90 \times 2.30)$	**1**	
		C_c = 1.886	**1**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**Answer any TWO of the following:**		**16**
	a)	**A soil sample 15 cm long and 10 cm in dia. Is tested in falling head permeameter, having diameter of burette pipe 0.5 cm. If the initial head of 65 cm is dropped to 35 cm in 12minutes, find the coefficient of permeability of soil in meter/day.**		
	Ans.	Area of burette pipe , $a = \frac{\pi}{4} \times (0.5)^2 = 0.196\ cm^2$,	**1**	
		Area of soil sample , $A = \frac{\pi}{4} \times (10)^2 = 78.539\ cm^2$,	**1**	
		$t = 12$ minutes $= 12 \times 60 = 720$ sec. $L = 15$ cm, $h_1 = 65$ cm, $h_2 = 35$ cm	**1**	
		Co-efficient of permeability,		
		$K=2.303\frac{aL}{At}\log_{10}\left(\frac{h_1}{h_2}\right)$	**1**	**8**
		$K=2.303\times\frac{0.196\times15}{78.539\times720}\log_{10}\left(\frac{65}{35}\right)$	**1**	
		$K=3.219\times10^{-5}$ cm/s	**1**	
		$K=3.219\times10^{-5}\times\frac{24\times60\times60}{100}$	**1**	
		$\boxed{K=0.0278\ m/day}$	**1**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	(b)	**Explain plate load test with neat sketch to determine bearing capacity of soil.**		
	Ans.	**Procedure of plate load test:** 1. Excavate a pit of depth equal to 5 times to that of breath of proposed footing. 2. Keep the suitable bearing plate of specified size (30, 45, 60, 75cm square in plan) on soil. Arrange the loading column on it as shown in figure below. 3. Now apply the load on test plate above soil using sand bags or reaction truss loading at a rate of $(1/5)^{th}$ to $(1/10)^{th}$ of total estimated load. 4. Note down the settlements after 1,5,10,20,40,60 minutes at corresponding applied loads. 5. Loading should be continued till 25mm total settlement or soil failure, whichever is achieved earlier. 6. Finally plot a graph of load vs. settlement as shown in figure below to find out load before failure as bearing capacity of soil.	**4**	**8**
		 Fig : Plate load Test	**2**	
		 Fig : Load Settlement Curve	**2**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	(c)	**Explain California bearing Ratio Test with neat sketch to determine % CBR of given soil sample.**		
	Ans.	**Procedure of California Bearing Ratio Test:** 1. Take a given soil; sample and add water equal to OMC of soil to prepare wet mix soil. 2. Take the CBR mould of 150 mm diameter and 175 mm height. Keep it inverted fashion and put the spacer disc of 50 mm thick at its bottom. 3. Fill the prepared wet soil in it within number of layers by properly compacting with rammer. Fill it completely and trim excess soil if any. 4. Now make the CBR mould in regular fashion and remove the space disc. Put the one or two surcharge weights of 2.5 kg each on the soil. 5. Keep it over loading platform of CBR test apparatus as shown in figure 6(c) below. 6. Insert the plunger of 5 cm dia. In the slotted weight and apply the compressive load at a rate of 1.25 mm per minute constantly. 7. Note down the load at each 0.5 mm penetration. Continue the loading till failure of soil or 12.5 mm maximum penetration. 8. Draw the graph i.e. load penetration curve to find the test load. The load values corresponding to 2.5 and 5.0 mm penetration values from the corrected graph are noted as Test load. Normally the CBR value at 2.5 mm penetration which is higher than that at 5.0 mm penetration recorded. 9. Calculate the California Bearing Ratio of given soil as % CBR = (Test load / Standard load) X 100.	**4**	**8**
		 **Figure : CBR Test Apparatus**	**4**	
		 **Figure : Load Penetration Curve**		