Model Answer: Winter 2017

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

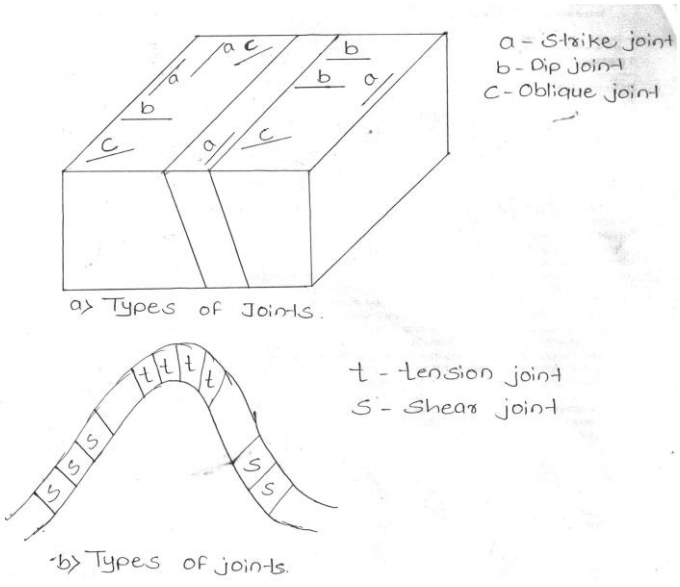
Important Instructions to examiners:

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) i) Ans.**	**Attempt any SIX of the following:** **State any Four importance of Geology.** 1. It is used to study different properties of rocks. 2. For any heavy construction project study of geology is required. 3. Geology provides a systematic knowledge of construction materials, their structure and properties. 4. The knowledge of erosion, transportation and deposition of surface water helps in soil conservation, river control, coastal and harbor works. 5. The knowledge about the nature of the rocks is very necessary in tunneling, constructing roads and in determining the stability of cuts and slopes. 6. The foundation problems of dams, bridges and buildings are directly related with geology of the area where they are to be built.	**½ mark each (any four)**	**(12M)** **2M**

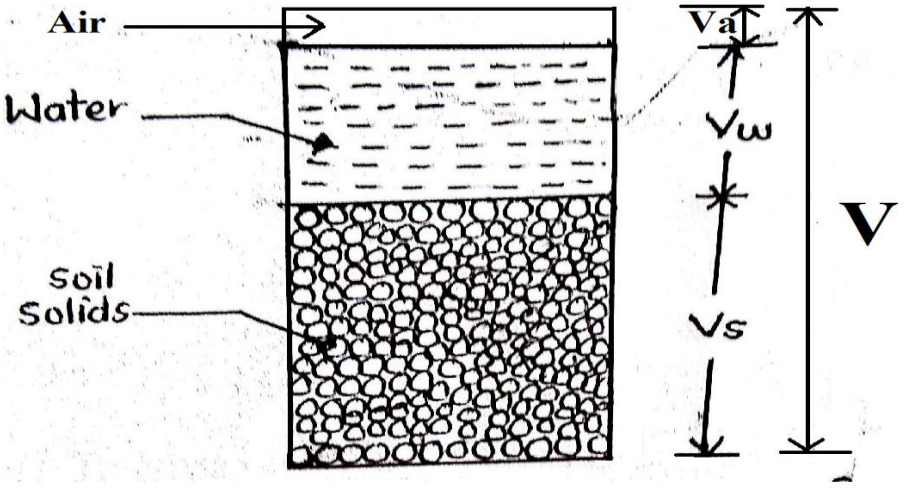
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**(a) ii) Ans.**	**Define dip and folds.** **Dip –** It is the inclination of bedding plane of rock with horizontal is called as Dip**.** **Fold –** It is the bends or curvatures in rock formed due to action of compressive forces on horizontal layers called as fold**.**	**1M** **1M**	**2M**
	iii) Ans.	**Define focus and epicenter** **Focus-** The place or point of origin of an earth quake below ground surface is termed as focus or hypocenter of earthquake. **Epicentre –**The place or point on ground surface , where seismic waves reaches firstly causing major damage is known as epicenter.	**1M** **1M**	**2M**
	iv) Ans.	**State any four importance of soil in civil engineering**. 1. Soil is more suitable in embankment fills and retaining pond beds after their construction. 2. Soil is also suitable for foundation but require compactions as without compaction structure may collapse. 3. Soil provides the moderate support for all types of foundations. 4. Improper study of soil may lead to failure of structure. 5. For plinth filling soil can be used as a construction material. 6. Soil cement mixture can be used for sub grades. 7. Pervious and impervious soil can be used in earthen dams. 8. For Water bound macadam roads soil is used as a binder material.	**½ mark each (any four)**	**2M**
	v) Ans.	**Define voids ratio and porosity.** **Voids ratio –** It is the ratio of volume of voids to volume of solids called as voids ratio. **Porosity-** It is the ratio of volume of voids to the total volume of soil, measured in percentage is called as porosity	**1M** **1M**	**2M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**(a)**			
	vi)	**Define permeability and Phreatic Line.**		
	Ans.	**Permeability**		
		"It is defined as the properly of soli which permits the seepage of fluid through interconnecting voids under gravity	**1M**	**2M**
		Phreatic Line:		
		The topmost seepage line in an earthen dam at which hydrostatic pressure is zero, is called as Phreatic line.	**1M**	
	vii)	**Define safe bearing capacity and allowable bearing pressure.**		
	Ans.	**Safe bearing capacity (q_s):** It is the maximum pressure which the soil can carry without risk of shear failure is called as safe bearing capacity. **OR**	**1M**	
		Sometimes the safe bearing capacity is also referred to as the ultimate bearing capacity q_u divided by factor of safety. $q_u = q_s / FOS$		**2M**
		Allowable bearing pressure:		
		The net loading intensity at which neither the soil fails in shear nor there is excessive settlement of structure, is called as Allowable bearing pressure.	**1M**	
	viii)	**State any two purpose of compaction.**		
	Ans.	**Purpose of compaction**		
		1. To increase density and thereby shear strength and bearing capacity of soil, this is required in case of slope stability improvement. 2.To decrease the permeability of soil, this is required for earth dam 3. To reduce settlement of structure after the construction. 4. To reduce danger of piping, this is required for seepage control of earth dam. 5. To increase resistance towards erosion of soil by rain and other causes.	**1 Mark each (any two)**	**2M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**(b)**	**Attempt any <u>TWO</u> of the following:**		**(8M)**
	(i)	**State physical properties of minerals depending on light and state of aggregates.**		
	Ans.	**Properties of minerals depending on light:** **i)** Luster **ii)** Streak **iii)** Transparency **iv)** Fluorescence	**½ mark each**	
		Properties of minerals depending on State of aggregates: **i)** Colour **ii)** Hardness **iii)** Cleavage **iv)** Fracture **v)** Tenacity **vi)** Structure (form) **vii)** Specific gravity	**½ mark each (any Four)**	**4M**
	(ii)	**List types of joints with sketches.**		
	Ans.	**Types of joints are-** 1. Strike Joint 2. Dip Joint 3. Oblique Joint 4. Tension Joint 5. Shear Joint 	**1 mark each (any four)**	**4M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**(iii)**	**List any four field applications of Geotechnical Engineering.**		
	Ans.	Field applications of Geo Tech Engineering are as follows: 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.	**1 mark each (any four)**	**4M**
Q.2		**Attempt any <u>FOUR</u> of the following:**		**(16M)**
	(a)	**Explain classification of rock based on mode of origin(genesis).**		
	Ans.	**<u>Classification of rock based on mode of origin(genesis)</u>** **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 infact ,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.	**4M**	**4M**
	(b)	**Define fault and list its types.**		
	Ans.	**<u>Fault:</u>** It is defined as the rupture / fracture along which there is a relative movement of beds. The movement may vary from few centimeters to many km. depending upon nature and magnitude of stresses and resistance offered by rock. **<u>Types of fault :</u>** 1) Based on position of fault plane. (a) Normal Fault (b) Reverse Fault	**2M**	

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.2</td><td>(b)</td><td>2) Based on their genesis
a) Gravity fault
b) Thrust fault
c) Strike / slip fault
3)Horst and Graben
4)Step fault
5)Bedding fault
6)Dip fault
7)Strike fault</td><td>½ mark each (any four)</td><td>4M</td></tr>
<tr><td></td><td>(c) Ans.</td><td>Give salient features of earthen dam in Maharashtra (any two).
<u>Salient features of earthen dam in Maharashtra:</u>
<table>
<tr><th rowspan="2">Sr.No</th><th rowspan="2">Features</th><th colspan="3">Name of the Dam</th></tr>
<tr><th>Panshet</th><th>Chaskaman</th><th>Urmodi</th></tr>
<tr><td>1</td><td>River</td><td>Ambi</td><td>Bhima</td><td>Urmodi</td></tr>
<tr><td>2</td><td>Nearest City</td><td>Velhe</td><td>Khed</td><td>Satara</td></tr>
<tr><td>3</td><td>Height above lowest foundation (m)</td><td>63.56</td><td>46.28</td><td>32.00</td></tr>
<tr><td>4</td><td>Length of dam(m)</td><td>1039</td><td>1045</td><td>1575</td></tr>
<tr><td>5</td><td>Volume content of dam(10^3 m^3)</td><td>4190</td><td>2903</td><td>1283</td></tr>
<tr><td>6</td><td>Gross storage capacity(10^3 m^3)</td><td>303000</td><td>318.17</td><td>82.94</td></tr>
<tr><td>7</td><td>Reservoir area (10^3 m^3)</td><td>15645</td><td>18218</td><td>26</td></tr>
<tr><td>8</td><td>Effective storage capacity(10^3 m^3)</td><td>294000</td><td>210.99</td><td>76.72</td></tr>
<tr><td>9</td><td>Purpose</td><td>Irrigation & water supply</td><td>Irrigation & power generation</td><td>Irrigation</td></tr>
</table></td><td>2 Mark each (any two)</td><td>4M</td></tr>
</table>

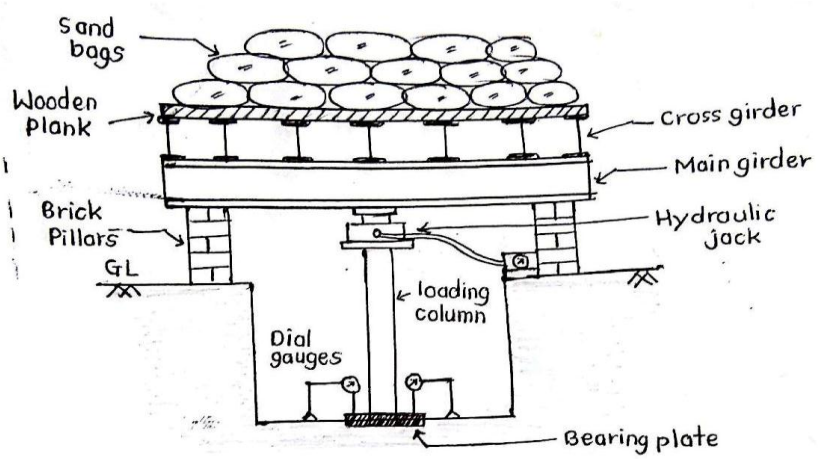
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	**(d)**	**Explain with sketch soil as a three phase system.**		
	Ans.		**2M**	**4M**
		3 phase diagram of soil		
		As natural soil contains solid soil particles and water and air present in its voids such complex nature of soil sample is difficult to analyze its physical properties hence it is simplify and presented in its equivalent 3 phase diagram as shown in fig. Depending upon three phase diagram of soil its 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.	**2M**	
	(e)	**Explain practical procedure of determining water content by oven drying method.**		
	Ans.	**<u>Procedure for determination of water content of soil by oven drying method-</u>** **1.** Take container with lid, measure the empty weight of container with lid as W_1 gm. **2.** Put sufficient quantity of moist soil sample in the container and take the weight of container, lid and moist soil as W_2 gm. **3.** Keep this assembly in the thermostat oven at a temperature 105^0c to110^0c for 24 hrs. with lid at bottom; so that water should be evaporated completely to give us dry soil . **4.** Take out container from oven and cool it in dessicator .Then take weight of container, lid and dry soil as W_3 gm. **5.**Calculate the percentage water content of given soil as- $W = (W_2 - W_3)/(W_3 - W_1) \times 100$ **6.** Repeat above steps two more times to determine average water content of given soil sample.	**4M**	**4M**

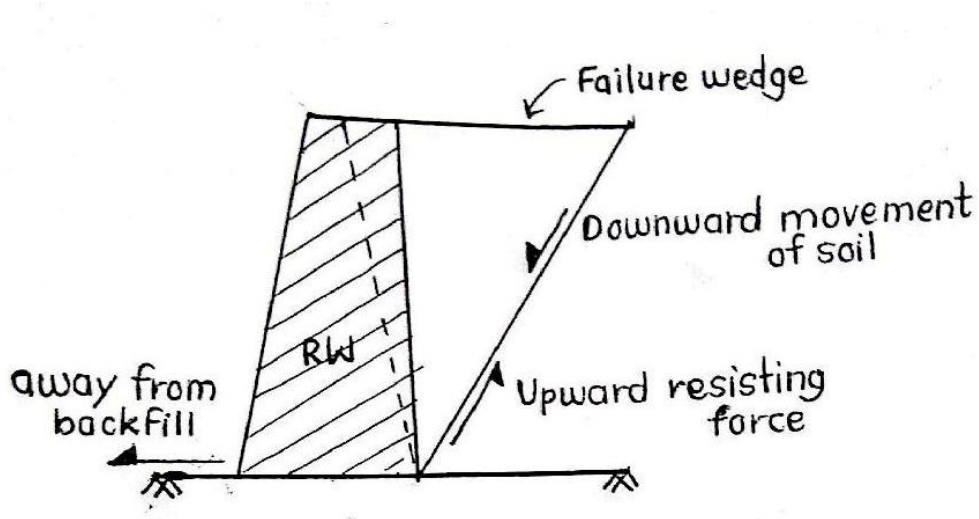
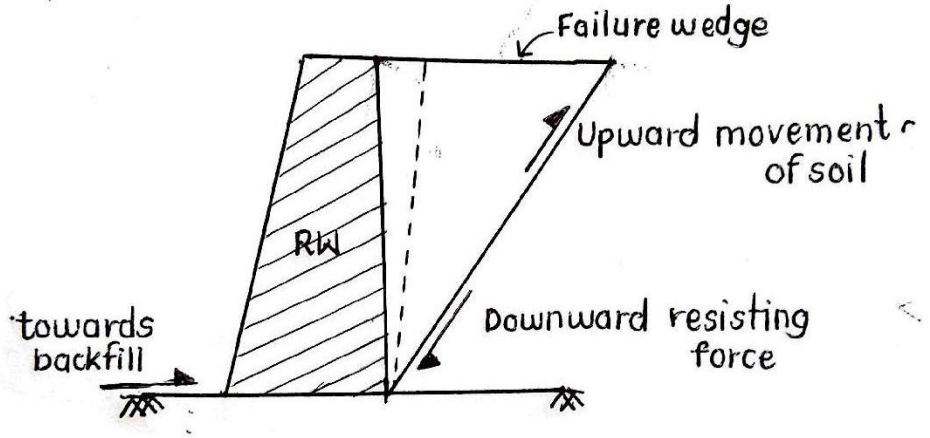
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	**(f)**	**List assumptions made by Terzaghi's analysis for soils bearing capacity.**		
	Ans.	Assumptions of Terzaghi's bearing capacity theory: 1. Soil behaves like ideally plastic material. 2.Soil is homogeneous , isotropic and its shear strength is represented by coloumbs 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 $\psi = \varphi$.	**1 mark each (any four)**	**4M**
Q.3		**Attempt any <u>FOUR</u> of the following:**		**(16M)**
	(a)	**State Information and classification of soils.**		
	Ans.	**Soil –** The hard parenting rock undergoes weathering and produces unconsolidated granular particles of varying sizes , such formation is known as Soil.	**1M**	
		<u>Classification of soil</u>- The soil is classified using most simplest geological classification. In this soil is classified in two categories-		
		1. **Residual soil –** The soils which are resting on its parent rock without ant transportation, is termed as residual soils. These soils does not have any stratification, but it shows well distinguished soil profile. Example. Red soil, Black soil	**1½ M**	**4M**
		2. **Transported soils-**The soils which are transported and get deposited in depressions on ground, is known as transported soils. Due to high velocity winds or water flow, loose soil particles transported along with organic and inorganic impurities. finally deposition of soil gives variety of transported soils. Example. Colluvial soils , Alluvial soils, Glacial soils, Eolian soils.	**1½ M**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**b)** **Ans.**	**State method of construction of earth quake resisting structure.** In addition to safety factor, some general precaution has to be followed to minimize the danger of collapse / failure of bldg. **a)The foundation :** i) Should rest on hard solid bed ii) Should be withstanding shock when constructed on loose soil. iii) Foundation should be provided at some level throughout the bldg. iv)Keys should be provided at base. **b) The body of structure** i) Lighter walls & possible RCC ii) Continuing of the cross walls iii)Keys should be provided at walls junction iv)Minimum openings in wall **c)The roof of structure** i) Flat roof are greater resistance against shocks ii) Light wt. material iii)Avoid projections / overhanging iv)Uniform mass **d)General** a. Ties at various levels of constant b. uniform height of component c. Symmetrical plan d. Provide expansion joints at discontinuity e. Equal loading on floors f. Provide shear walls g. Avoid stilt floor h. Ductile detailing of steel reinforcement RCC components.	**1 mark each (any four)**	**4M**

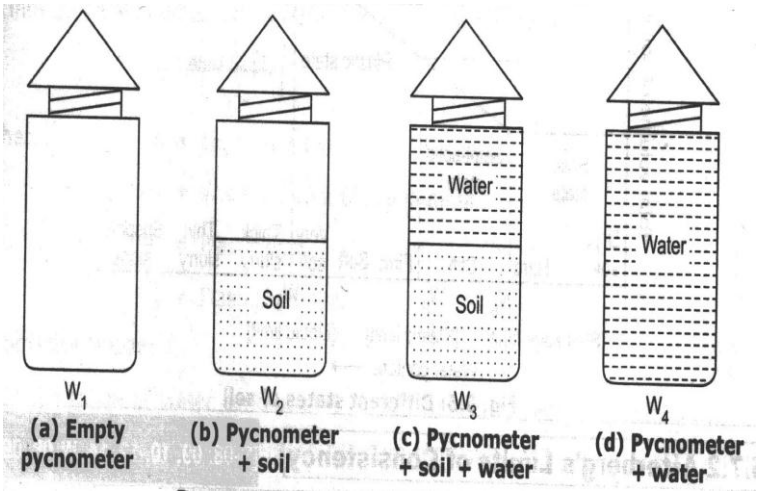
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**c)**	**Given, D_{10} =160 µ, D_{30} = 4.75mm and D_{60} = 20 mm , find coefficient of curvature of soil and coefficient of uniformity.**		
	Ans.	Given :- D_{10} =160µ = 0.16mm D_{30} =4.75mm D_{60} =20mm To find: Cc=? Cu=? Solution :-		
		Co-efficient of curvature $Cc= \frac{(D_{30})2}{D_{60} \times D_{10}}$	**1M**	
		$= (4.75)^2/ (20 \times 0.16)$	**1M**	
		Cc = 7.05		**4M**
		Co-efficient of uniformity $Cu= \frac{D_{60}}{D_{10}}$	**1M**	
		$= 20/0.16$		
		Cu = 125	**1M**	
	d)	**A saturated clayey soil weighing 1600 gms weights 1200 gms after oven drying. if its dry density in 1350kg/m^3. Determine its water content, void ratio, porosity and degree of saturation.** **Assume G =2.50 and Υ_w = 12 kN/m^3**		
	Ans.	Given W= 1600 gm Ws=1200 gm Υ_d = 1350 kg/m^3 = 1.35 gm/cc G= 2.50 Υ_w = 12 kN/m^3 = 1.2 gm/cc To find W =? e =? η =? S or S_r =? $W = W_W / W_s = (W - W_s) / W_s$ $= (1600-1200) / 1200 = 0.3333$ $= 0.3333 \times 100 =$ **33.33%** **OR**		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**d)**	$\Upsilon d = \frac{W_s}{V}$ $V = \frac{1200}{1.35}$ V=888.89 cc $\Upsilon = \frac{W}{V}$ $= \frac{1600}{888.89}$ **Υ= 1.80 gm/cc** Now, $\Upsilon_d = \frac{\Upsilon}{1+w}$ $1.35 = \frac{1.80}{1+w}$ $w = \frac{1.80}{1.35} - 1$ **w** = 0.333 = 0.3333 x 100 = **33.33 %** using $\Upsilon_d = \frac{G.\Upsilon_w}{1+e}$ $1.35 = \frac{2.50\ x\ 1.2}{1+e}$ $e = \frac{2.50\ x\ 1.2}{1.35} - 1$ **e = 1.22** we know that, $\eta = \frac{e}{e+1}$ η = 1.22 / (1.22 + 1) **η** = 0.5495 X 100 = **54.95%** S or $S_r = \frac{G.w}{e}$ S_r = 2.5 X 33.33) / 1.22 **S_r = 0.6829 = 68.29 %**	**1M** **1M** **1M** **1M**	**4M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**e) Ans.**	**Explain with sketch plate load test.**  **Fig. Plate load test** **Procedure-** i) Excavate a pit of depth equal to 5 times to that of breath of proposed footing. ii) 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 fig. no.8. above. iii) 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. iv) Note down the settlements after 1,5,10,20,40,60 minutes at corresponding applied loads. v) Loading should be continued till 25mm total settlement or soil failure, whichever is achieved earlier. vi) Finally plot a graph of load vs. settlement to find out load before failure as bearing capacity of soil.	**2M** **2M**	**4M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**f)**	**Define with sketch active and passive earth pressure.**		
	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.	**1M**	**4M**
		Diagram of Active earth pressure-	**1M**	
		 **Active earth pressure**		
		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.	**1M**	
		Diagram of Passive earth pressure –	**1M**	
		 **Passive earth pressure**		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4		**Attempt any <u>FOUR</u> of the following:**		**(16M)**
	a) Ans.	**Define dry unit weight and saturated unit weight with formulas.** **<u>Dry Unit Weight :</u>** The dry unit weight (Υ_d) is defined as the weight of the solids per unit volume. $$\Upsilon d = \frac{W_s}{V}$$ **<u>Saturated Unit Weight :</u>** The saturated unit weight (Υ_{sat}) is the bulk unit weight per unit volume when the soil is fully saturated. **Or** It is define as weight of fully saturated soil per unit volume. $\Upsilon_{sat} = W_{sat} / V$	**1M** **1M** **1M** **1M**	**4M**
	b) Ans.	**Explain with sketch specific gravity determination by pcynometer.** **<u>Determination of specific gravity by pycnometer test:</u>** **Precedure :-** 1. Dry the pycnometer and weigh it with its cap (W_1) 2. Take about 200 g to 300 g of oven dried soil passing through 4.75mm sieve into the pycnometer and weigh again(W_2) 3. Add water to cover the soil and screw on the cap. 4. Shake the pycnometer well and connect it to the vaccum pump to remove entrapped air for about 10 to 20 minutes. 5. After the air has been removed, fill the pycnometer with water and weigh it (W_3). 6. Clean the pycnometer by washing thoroughly. 7. Fill the cleaned pycnometer completely with water up to its top with cap screw on. 8. Weigh the pycnometer after drying it on the outside thoroughly (W_4).	**2M**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**b)**	 $Sp.Gravity\ (G_s) = \frac{(W_2 - W_1)}{[(W_2 - W_1) - (W_3 - W_4)]}$ Where, W_1 = Empty weight of pycnometer W_2 = Weight of pycnometer + oven dry soil W_3 = Weight of pycnometer + oven dry soil + water W_4 = Weight of pycnometer + water full	**2M**	**4M**
	c)	**In falling head permeability test on sample 15 cm high and 45 cm ^{2} in cross section area, the water level in stand pipe of 8 mm internal diameter dropped from a height of 75 cm to 25 cm in 15 min. Find the coefficient of Permeability.**		
	Ans.	Given, L= 15cm A = 45 cm^2 d= 8mm h_1= 75cm h_2= 25 cm t = 15 min = 900 sec. To find:- k=? a = π/ 4 x d^2 = π/ 4 x 0.8^2 = 0.50 $k = 2.303 \frac{a\,X\,L}{A\,X\,t}\ X\ log_{10} \frac{h_1}{h_2}$ $k = 2.303 \frac{0.50\ X\ 15}{45\ X 900}\ X\ log_{10} \frac{75}{25}$ k = 2.034 x 10^{-4} cm/sec	**1M** **1M** **1M** **1M**	**4M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**d) Ans.**	**State the factors affecting permeability.** **Followings are the factors which affect permeability:** 1. Particle Size or diameter of soil particle 2. Impurities in water 3. Void ratio 4. Degree of Saturation 5. Adsorbed water 6. Entrapped air and organic matter 7. Stratification of soil layer 8. Properties of pore fluid i.e. viscosity and temperature 9. Shape of particle	**1 Mark each (any four)**	**4M**
	e) Ans.	**State any four factors affecting compaction with their effect.** **Following the different factors affecting compaction of soil with their effect:** **Water content :** When water content is less i.e. dry soil , compaction is not better , but when water content is excessive , compaction is not possible. Therefore water content should be optimum to get better degree of compaction. **Amount of compaction:** When amount of compaction is more , one can achieve better degree of compaction in soil even with less water content . but when amount of compaction is less , we cannot get MDD even at OMC. **Types of soil :** For the same compactive effort, the MDD of cohesion less soil is more at less OMC. But MDD of cohesive soil is less even at high OMC. **Methods of soil compaction:** When compaction is done manually using rolling, ramming or tamping, then soil gets partially compacted but due to mechanical compaction using various compaction equipment like rollers, vibrators etc. soil can be compacted to higher density. **Use of admixtures :** The compaction of soil can be increased by adding suitable admixtures like lime, fly ash, bitumen, rise husk ash etc. these admixture densify the soil by increasing bonding between soil particles.	**1 Mark each (any Four)**	**4M**

Thickness of soil layer –

When thickness of soil layer to be compacted is more, then it is difficult to achieve better compaction. Hence lesser thickness of soil layers can be effectively compacted to required density.

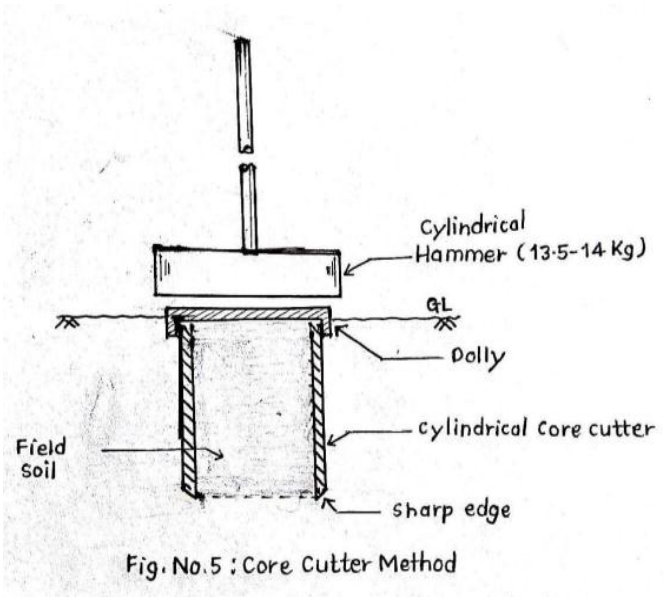
f) Differentiate between compaction and consolidation.(any four points).

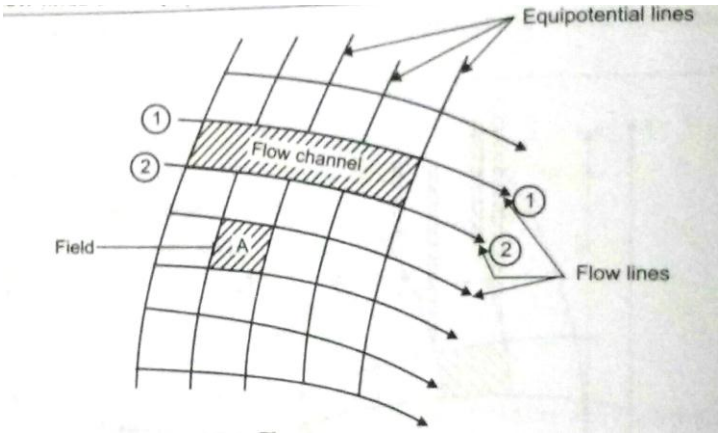
Ans.

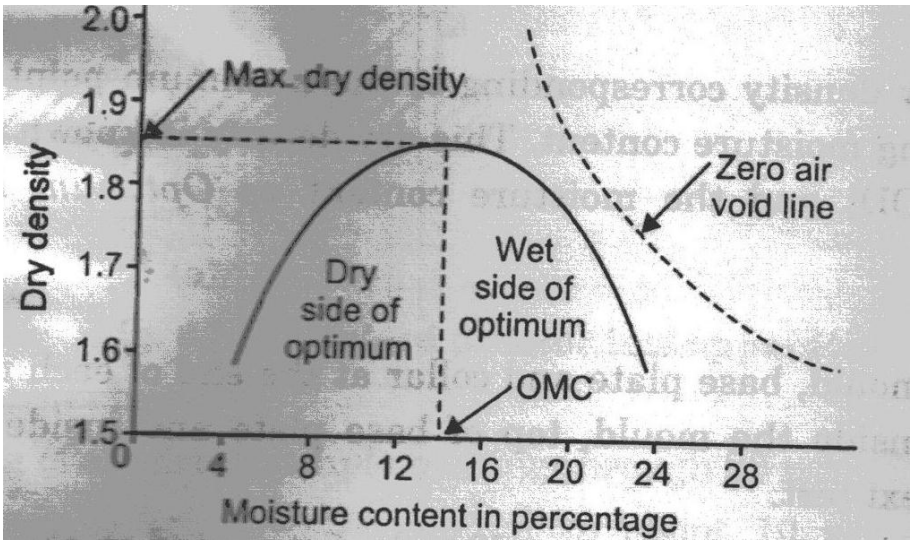
Sr. No	Compaction	Consolidation
1	Instant compression of soil under dynamic load is called compaction.	Gradual compression of soil under steady load is called consolidation.
2	It is fast process.	It is very slow process.
3	It is artificial process.	It is natural process.
4	It is done to improve soil 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 go indefinitely.

Que. No. Q.4 | Sub. Que. e) | Marks: 1 Mark each (any four) | Total Marks: 4M

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5		**Attempt any FOUR of the following:**		**(16M)**
	a) Ans.	**Give classification of earthquakes based on focus and origin.** **Types of earthquake based on focus -** 1. **Shallow earthquake-** Focus depth less than 60 km is taken as shallow earthquake **2. Intermediate earthquake – O**rigin of earthquake is at a depth in between 60 km to 300 km called as Intermediate earthquake. **3. Deep earthquake –** Focus is at depth in range of 300 km to 700 km such earthquake **Earthquakes based on origin are as follows:** i) Movement of tectonic plates ii) Volcanic eruption iii) Anthropogenic sources iv) Dams v) Use of explosives vi) Sport games vii) Injection and Extraction of fluids viii) Removal of natural gases	**1 mark each (any two)** **1 mark each (any two)**	**4M**
	b) Ans.	**Give any four causes and effects of earthquakes.** **Causes of earthquake -** 1. Volcanic eruption 2. Technical movements 3. Natural disaster like landslide, tsunami 4. Massive civil structures like dams, reservoirs 5. High water flows 6. Manmade explosions **Effects of earthquake -** 1. Destruction of various Civil Engg. 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 mark each (any two)** **1 mark each (any two)**	**4M**

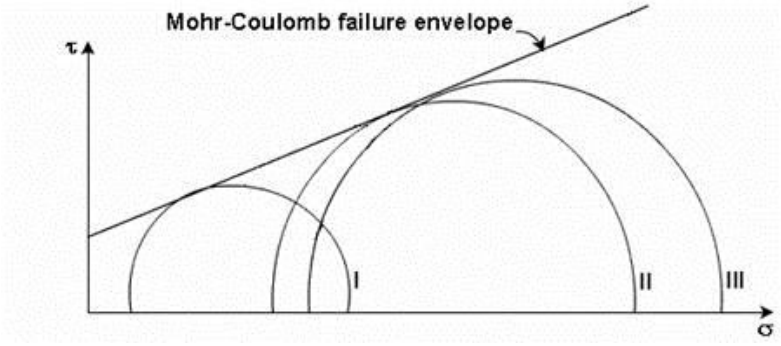
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**c) Ans.**	**Explain with sketch core cutter method test.** **Procedure-** 1. Measure the internal dimension of core cutter and calculate its volume V in cm^3. 2. Take weight of empty core cutter without dolly as W_1 gm. 3. Clean the ground by removing 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 as w. 10. Calculate the dry unit weight of field as $\gamma_d = \gamma / (1+w)$ in gm /cm^3. 11. Repeat above steps two more times to calculate average dry unit weight of soil.  Fig. No.5 : Core Cutter Method	**3M** **1M**	**4M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**d)**	**Define Liquid limit, Plastic Limit, Shrinkage limit and Plasticity index.**		
	Ans.	**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.	**1M**	
		Plastic limit (Wp)– 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.	**1M**	**4M**
		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.	**1M**	
		Plasticity index (I_P): It is the range of water content over which a soil exhibits plasticity. It is the numerical difference between the liquid limit (W_L) and plastic limit (Wp).		
		$I_P = W_L – Wp$		
	e)	**Explain with sketch flow net**		
	Ans.	**Flow Net:** The grid, mesh or net formed by intersection of equipotential line and flow lines is called as flow net.		
		In a flow net, flow lines and equipotential lines intersect each other at right angles. The quantity of water flowing through each flow channel is the same. The drop of head, or the potential drop between any two successive equipotential lines is the same. The fields are approximately squares. The flow net is representative of the flow pattern and dissipation of the hydraulic head.	**2M**	**4M**
			**2M**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**f)**	**State any four Field situations of shear failure .**		
	Ans.	**Field situations where shear failure occurs:** 1) Upstream slope of earth dam , especially during sudden draw down 2)Earth behind retaining wall, especially surcharge 3)Under foundation along planes of maximum shear 4) Sub grades of road. 5) Embankment of road 6) Abutment of bridges	**1 Mark each (Any four)**	**4M**
Q.6		**Attempt any FOUR of the following:**		**(16M)**
	a)	**Explain with sketch concept of zero air voids line.**		
	Ans.	**Zero Air Void Line:** If the soil is assumed to be 100% saturated and different dry densities are calculated for 100% saturation, then the resulting line on the compaction curve is called the 100% saturation line or zero air void line.	**2M**	
		OR The line which shows the relation between water content – dry density for the compacted soil having a constant percentage of air voids is knows as zero air void line. 2) The zero air void line is drawn across compaction curve and gives direct indication of percentage air voids or degree of saturation existing at different points of curve.		
		Significance of Zero Air Void Line:- The actual dry density with respect to water content cannot reach its theoretical value even after applying heavy compaction.	**1M**	**4M**
			**1M**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**b) Ans.**	**Give suitability of any four compaction equipments.** **i) Smooth wheel rollers :** **Suitability:** These rollers best suitable for 5ubgrade or base coarse compaction of cohesion less soils. , **ii) 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 **iii) Sheep foot roller :** **Suitability :** Suitable only for fine grained cohesive soil **iv) Compaction by Rammers :** **Suitability:** Suitable for all types of soil having less thickness i.e. less important works. **v) Compaction by vibratory compactors :** **Suitability:** Suitable for compacting granular soils. with no fines in layer up to 1 m thickness.	**1 Mark Each (any four)**	**4M**
	c) Ans.	**State any four methods of soil stabilization and explain any one.** **<u>Methods of soil stabilization –</u>** 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 **<u>Mechanical Stabilization-</u>** In this method, stabilization of soil is done without adding any chemicals or admixtures. The procedure of mechanical stabilization is described below- **1.** Initially the soil is excavated using excavator and then it is ground to finer particles using pulveriser. **2.** In this pulverized soil , well graded aggregates are spread and mixed till homogeneous mixture will form. **3.** Then water is sprinkled which is optimum moisture content i.e. OMC for getting maximum dry density i.e. MDD **4.** The heavy roller (8-10 tonne capacity) is used to compact soil 15-20 cm thickness as per type of soil available. **5.** The compacted surface is cured by sprinkling water on it , followed by compaction . The curing and compaction is done alternatively for 7 days. Then the stabilized portion is allowed for its further use. **(Note- Explanation of any other method from above should be considered.)**	**½ mark each (any four)** **2M**	**4M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**d) Ans.**	**Give necessity of site investigation and sub soil explorations.** **Necessity of Site investigation –** 1. To determine bearing capacity of soil 2. To select suitable construction techniques 3.To select the type and depth of foundation for given structure 4.To investigate safety of existing structures and to suggest the remedial measures 5. To predict lateral earth pressure against retaining walls & foundation of abutments 6. To establish ground water level and to determine the properties of water. **Necessity of sub-soil 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.	**1 mark each (any two)** **1 mark each (any two)**	**4M**
	e) Ans.	**Explain with sketch Mohr-Coulomb failure theory.** Mohr presented a theory for rupture in materials. The failure along a plane in a material occurs by a critical combination of normal and shear stresses, and not by normal or shear stress alone. The functional relation between normal and shear stress on the failure plane can be given by $S=f(\sigma)$……(1) Coulomb defined the function as $S=C+\sigma \tan\Phi$ ……..(2) Where c is cohesion and Φ is the angle of friction of the soil equation 2) is generally referred to as the Mohr-Coulomb failure criteria. If data from several tests, carried out on different samples up to failure is available, a series of Mohr circles can be plotted. It is convenient to show only the upper half of the Mohr circle. A line tangential to the Mohr circles can be drawn, and is called the Mohr-Coulomb failure envelope.	**3M**	**4M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**e)**		**1M**	**4M**
	f) Ans.	**Explain with sketch mechanical sieve analysis.** **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. **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 4.75mm, 2.36mm, 1.18mm, 600µ,150µ,75µ. 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. iv) Take the weight of soil mass retained on each sieve separately in gms. v) Calculate % finer for each sieve using following tabular format.	**1M** **2M**	

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

vi) Finally, plot the particular size distribution curve on a semi log graph paper as sieve size versus % finer of soil to classify soil as shown in Fig.6(b)
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	**f)**		**1M**	

0.002 0.075 0.425 2mm 4.75mm 20 mm 80 mm 300 mm

Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	Cobble	Boulder
		sand			Gravel			

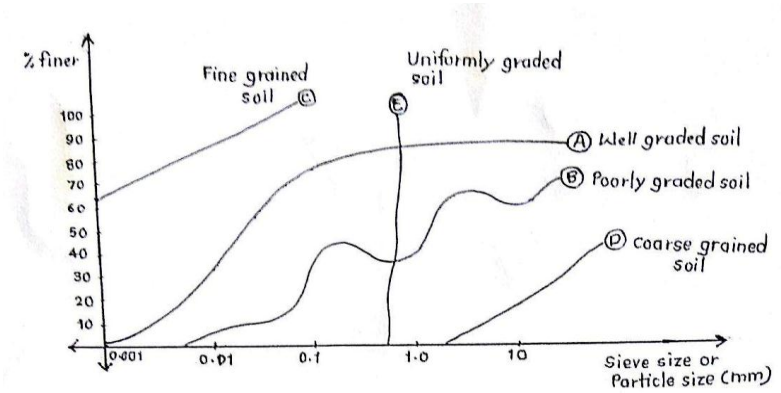


Fig.No.6-b : Particle Size Distribution Curve