Important Instruction to Examiners:-

1) The answers should be examined by key words & not as word to word as given in the model answers scheme.

2) The model answers & answers written by the candidate may vary but the examiner may try to access the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more importance.

4) While assessing figures, examiners, may give credit for principle components indicated in the figure.

5) The figures drawn by candidate & model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credit may be given step wise for numerical problems. In some cases, the assumed contact values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding.

7) For programming language papers, credit may be given to any other programme based on equivalent concept.

Important notes to examiner

1) Q No-4(a) in this numerical data is insufficient hence Students may assume appropriate data and numerical can be solved.

1. a) Attempt any SIX of the following	12M
i) Define petrology and mineralogy.	
i) Petrology: Formation of various types of rocks, their mode of occurrence, composition, texture and structures, geological and geographical distribution on the earth are all studied under petrology. It is one of the important subdivisions of geology and is further subdivided into distinct branches: Igneous petrography, Sedimentary petrology and metamorphic petrology.	1M
ii) Mineralogy: 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.	1M
ii) Define outcrop and strike.	
i) Out crop: The dip and strike of beds can be easily measured in the field from their exposures called outcrops	1M
ii) Strike: The horizontal distance perpendicular to the fault plane is called as strike.	1M
iii) What is seismograph?	
Seismograph: The energy released during faulting, produces seismic waves, which can be detected by sensitive and delicate instruments, called seismograph.	2M
iv) What do you understood by the term: **1) Epicenter and** **2) Richter scale.**	
i) Epicenter: The point or line on the Earth's surface immediately above the focus is called Epicenter	1M
ii) Richter scale: It is a quantitative base-10 logarithmic scale. It is also called as local magnitude scale(M_L) a simple numerical scale to describe the relative sized of earthquakes. At the same distance seismograms (records of earthquakes ground vibration) of larger earthquakes have bigger wave amplitude than those at close distances.	1M
v) Give the IS Definition of soil.	
As per Indian standards 2809-1972: Soil is the sediment or other unconsolidated accumulation of solid particles produced by physical and chemical disintegration of rock.	2M

vi)	**Define :** **1) Ultimate Bearing Capacity** **2) Safe Bearing Capacity.**	
i)	Ultimate bearing capacity: The ultimate bearing capacity is the gross pressure at the base of the foundation at which the soil fails in shear. This is also sometimes called as ultimate bearing value or ultimate bearing pressure.	1M
ii)	Safe bearing capacity: The maximum pressure which the soil can carry without risk of failure is called safe bearing capacity $Q_s = \frac{\text{Ultimate Bearing capacity}}{\text{Factor of safety}}$	1M
	OR	
i)	Ultimate bearing capacity (q_u): It is the gross pressure at the base of the foundation at which the soil fails in shear is called as ultimate bearing capacity.	1M
ii)	Safe Bearing Capacity (q_s):- The maximum pressure the soil can carry safely without risk of shear failure is called the safe bearing capacity. It is equal to the net safe bearing capacity plus the original overburden pressure. Sometimes the safe bearing capacity is also referred to as the ultimate bearing capacity $\mathbf{q_u}$ divided by factor of safety **F.**	1M
vii) Define Co-efficient of earth pressure.		
i)	Co-efficient of earth pressure is the ratio of the horizontal stress to the vertical stress $K_o = \frac{\sigma 0}{\sigma v}$	2M
viii) Define: **1) Degree of saturation and** **2) Air content.**		
i)	Degree of saturation: The degree saturation is a ratio of the volume of water in the voids to the volume of voids. It is expressed as per cent $S = \frac{Vw}{Vv} \times 100\%$	1M
ii)	Air content: When soil mass is completely dry the voids present in the soil mass are completely filled only with air. The liquid phase remains absent in such case $V_a = V_v$ Air content is defined as ratio of volume of air to volume of voids, i.e ac =Va/Vv	1M

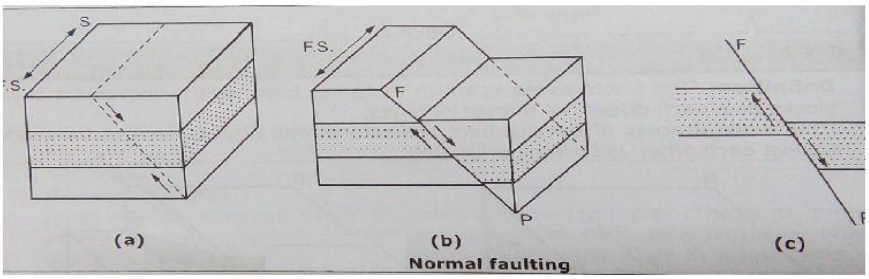
b)Attempt any TWO of the following	8
i) State and briefly explain any four physical properties of minerals.	
Minerals have distinguishing physical properties that in most cases can be use to determine the identity of the mineral. Among the various properties crystal, habit, cleavage, hardness, density, luster, streak color, tenacity, magnetism and taste.	1M
Individual Crystals:	
i) Cubic: cube shapes	
ii) Octahedral: shaped likes octahedrons,	
iii) Tabular: rectangular shapes examples – feldspar	
iv) Equant: a term used to describe minerals that have all of boundaries of approximately equal length.	
v) Acicular: long slender needle like crystals, example – natrolite	1/2Me
vi) Prismatic: Abundance of prism faces	ach
vii) Bladed: like a wedge or knife blade example – kyanite	any
Cleavage: Crystals often contain planes of atoms along which the bonding between the atoms is weaker than along other planes.	six
Parting: parting is also a plane of weakness in the crystal structure but it is along planes that are weakened by some applied force.	
Fracture: If the mineral contains no planes of weakness it will break along random directions called fracture several different kinds of fracture patterns are observed:	
i) Conchoidal fracture	
ii) Fabrous and splintery	
iii) Hackly	
iv) Even or regular	
v) Uneven or Irregular	
Hardness: hardness is determined by scratching the mineral with a mineral or substance of known hardness.	
Tenacity: Tenacity is the resistance of a mineral to breaking, crushing, or bending.	
i) Brittle: breaks or powder	
ii) Malleable : can be hammered into thin sheet	
iii) Sectile: can be cut into thin sheeting with knife.	
iv) Ductile: bends easily and does not return to its original shapes.	

v) Flexible: bend s somewhat and does not return to its original shape. vi) Elastic: bends but does return to its original shape. **Specific Gravity (Density)**: It is the mass per unit volume. It is also the relative density(weight of substance divided by the weight of an equal volume of water) **Colour**: color is sometimes an extremely diagnostic property of mineral	
ii) State any four causes of earthquakes.	
Possible cause of an earthquake are classified into below categories 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 **Movement of tectonic plates**: The tectonic earthquakes are perhaps caused by the slippage or movement of the rock masses along the rupture or break. The non tectonic type of earthquakes includes earthquakes caused by a number of easily understandable processes such as volcanic eruption superficial movement like landslides. These are generally very severe and area affected is often very large. All such processes may introduce vibrations into the ground by jerk **Volcanic eruption:** Earthquakes may also occur in volcanic regions And are caused by the movement of magma in volcanoes. Such earthquakes can be an early warning eruption. **Anthropogenic sources:** Some earthquakes have anthropogenic sources such as extraction of minerals and fossil fuel the Earth's crust reservoir-included seismicity massive explosions and collapse of large building. **Dams:** A rare few earthquakes have been associated with the build-up of large masses of water behind dams. **Use of explosives:** The detonation of powerful explosives such as nuclear explosions can cause low-magnitude ground shaking nuclear bomb also produce the seismic shock so powerful that it was measurable even on third passage around the Earth**.** **Sport games:** Sports games have been known to inadvertently produce micro earthquakes in which the effect register on the campus seismograph. **Injection and Extraction of fluids:** With injection or extraction of fluids into the earth's crust (e.g. at certain geothermal power plants and at the Rocky Mountain Arsenal) such earthquakes occur because the strength of the earth's crust can be modified by fluid pressure.	1M each any four
ii) What is meant by geologic cycle? State the types of weathering and explain brief.	
Geologic cycle: The most important of these begins with molten magma from within the earth crystallizing into rock then continues with the rock being broken down into soil and that soil then being converted back into rock, This process repeats itself over and over again through geologic time.	

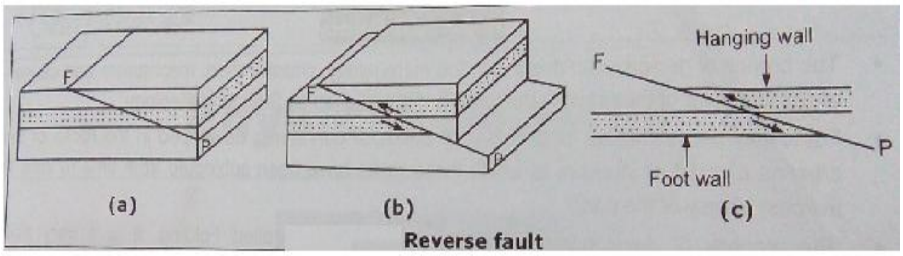
Types of weathering: i) Mechanical weathering ii) Chemical weathering iii) Spheroidal weathering iv) Biological weathering **Mechanical weathering:** It is also termed as physical weathering in this process the rock surface is broken into smaller pieces without any chemical change. The smaller broken rock pieces are deposited at and over the present rock on the flat surface and these are accumulated at the end of slopping surface. It is slow process with water and temprature **Chemical weathering:** In this process the rock surface is broken into small pieces by chemical decay of minerals. It is chemical reaction between the atmospheric gases and surface of rockweathering are oxidation, hydration, carbonation and solution. **Spheroidal weathering:** If joints and fractures in rock beneath the surface form a 3-dimentional network the rock will be broken into cube like pieces separated by fracture water can penetrate more easily along these fracture and each of the cube like begin to weather inward **Biological weathering :**Plants and animals play an important role in the break down and decay of rock indeed their part in soil formation is of major significance	1M 1M each any three
Q.2 Attempt any FOUR of the following :	**16M**
a) Define a fault and state its classification.	
Fault: The fractures along which there has been relative movement of the blocks past each other. The entire process of development of fractures and displacement of the blocks against each other is termed as faulting. Following factors are more considered important in classification of faults: i) The apparent movement of the disrupted blocks along the fault plane. ii) The direction of slip. iii) The relation of fault attitude with the attitude of the attitude of the displaced beds. iv) The amount of dip of the fault. v) Mode of occurrence. The apparent movement of the disrupted blocks along the fault plane in two types i) Normal faults: Such a fault in which hanging wall has apparently moved down with	1M 1M each any three

respect to foot wall classified as a normal fault.

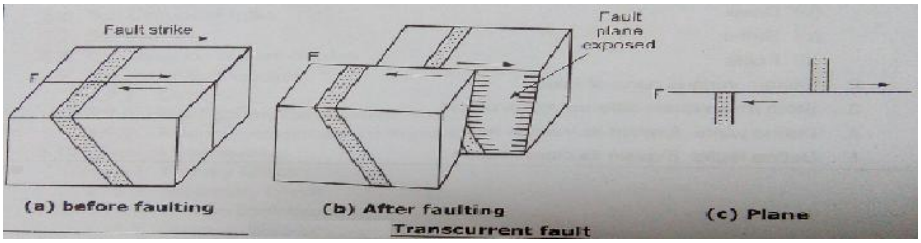
Normal faults are also often termed as gravity faults especially when it is established that the hanging wall has actually moved down with respect to the foot wall.



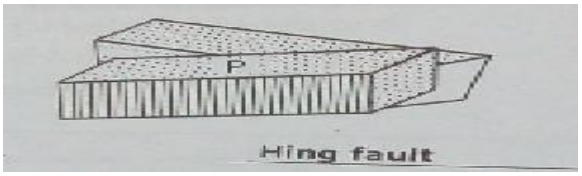
ii) Reversed faults: It is a type of fault in which the hanging wall appears to have moved up with respect to the foot wall. In reversed faults the fault plane is generally inclined between horizontal and 45^0 although reversed faults with steeply inclined fault surface have been also encountered by virtue of their inclination and direction of movement reverse faulting involves shortening of the earth.

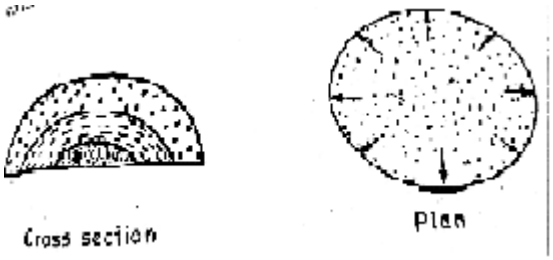
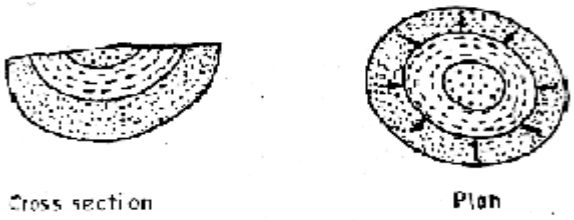


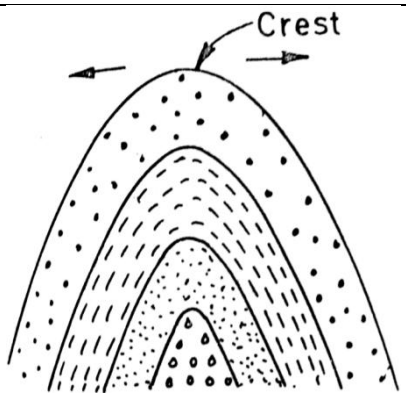
iii) Strike- slip faults: This is the third major category of faults known to occur in nature and on a very large scale these may be defined as faults in which faulted blocks have been moved against each other in an essentially horizontal direction.



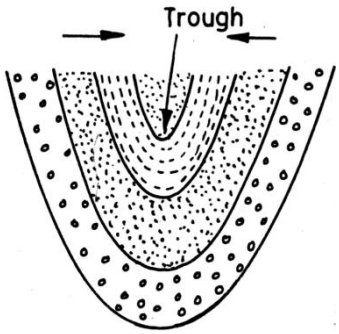
iv) Hinge faults: These are also called pivotal faults or rotational faults a hinge fault is characterized by a movement of the disrupted blocks along a medical poit called the hinge point.



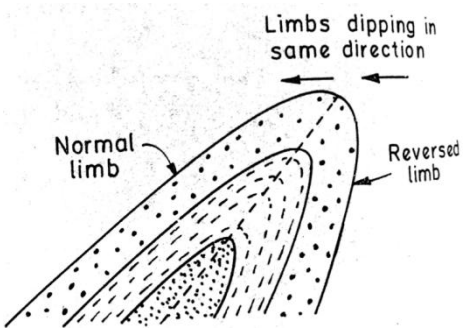
b) What is a fold and state its types ?	
Fold: It is defined as undulations or curvatures developed in the rocks of the crust as a result of stresses to which these rocks have been subjected from time to time in the past history of the earth. Folds generally do not occur singularly but infact they often form a group in which individual members exibit many similarities as well as dissimilarities	1M
i) Anticlinorium: An anticlinorium fold is a large anticline which is further throw into smaller fold 	1M for any three
ii) Synclinorium: Syclinorium is a large syncline further consisting of smaller folds are very large in size	
iii) Domes and Basins: A dome is a special type of anticline in which the beds dip away from the central point in all directions. 	
iv) A Basin is a special type of syncline in which the beds dip towards central point from all directions. In outline, domes and basins are generally oval or nearly circular in shape 	
v) Anticlines: Beds are up folded into arch like structure.	



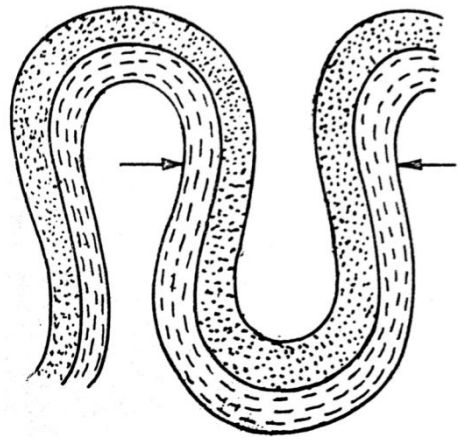
vi) Sydine: Beds are down folded into a trough like structure.



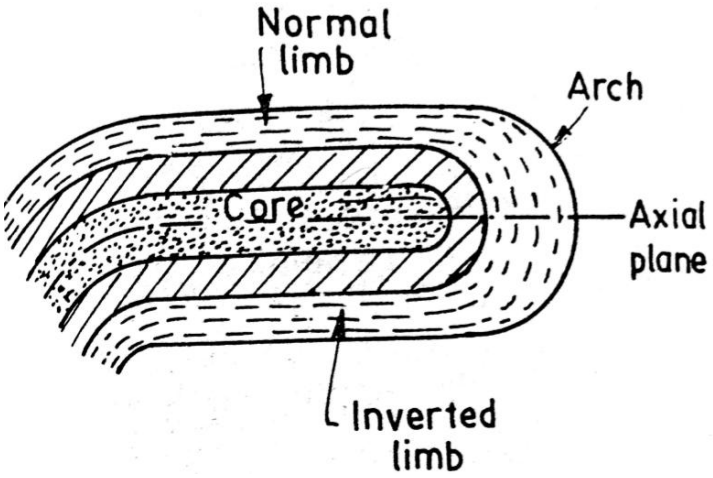
vii) Overturned folds: Both the limbs of afold may get overturned because of very high compression



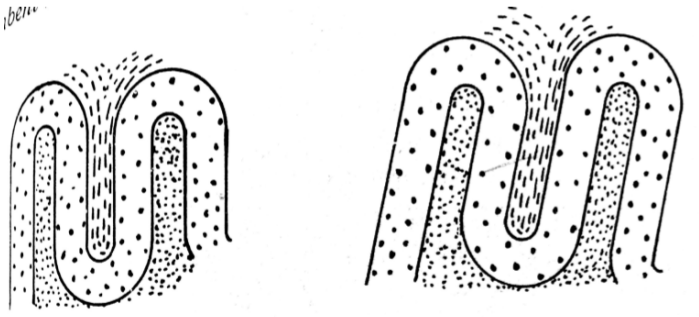
viii) Fan fold: limbs dipping away from each other

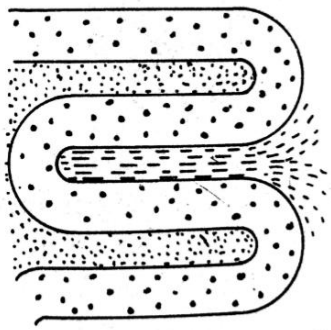


ix) Recumbent Folds: One limb lies vertically above the other.

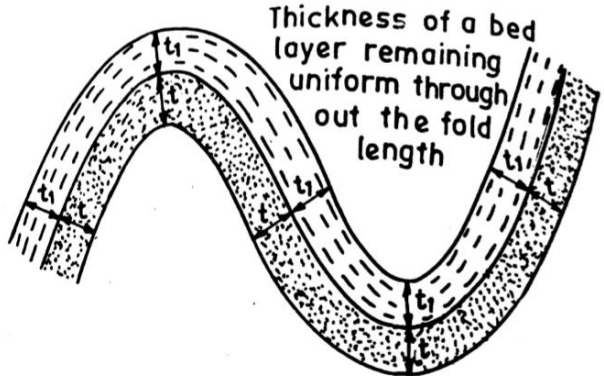


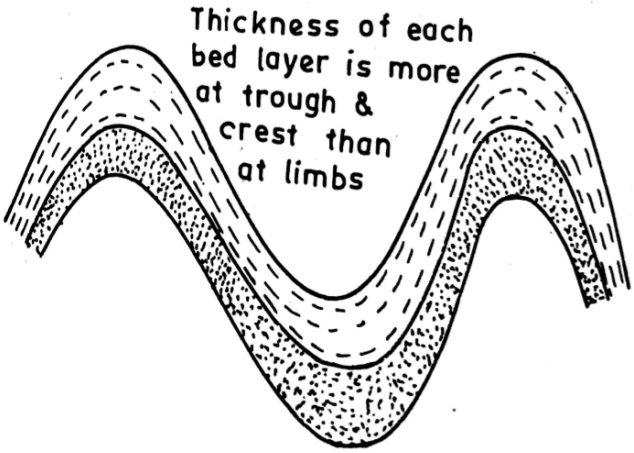
x) Isoclina Folds: These folds may be vertical, inclined or horizontal are called as vertical isoclinal fold, Inclined isoclinal fold, recumbent isoclinal fold.





xi) Open fold and Closed fold: Thickness of bed is same throughout the layer are called as open fold and thickness is more at trough and crest at the limbs is called closed fold.





c) Name any four earthen dams of Maharashtra and sate the name of the river across which they're constructed.

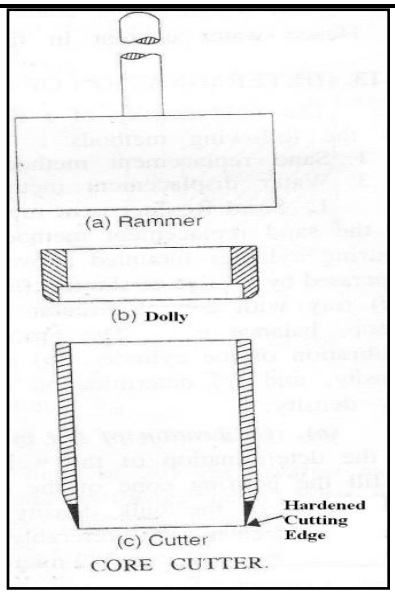
Earthen Dam	River	
Panshet (Tanajisagar)	Ambi	1M
chaskaman	Bhima	1M
Urmodi	Urmodi	1M
Gangapur	Godavari	1M

d) Explain the method of determination in-situ density with a core-cutter.

Dry unit weight of soil (γd) : The dry unit weight (γd) is the weight of solids (Ws) per unit of its total volume (V) (prior to drying) of the soil mass. 1M

$(\gamma d) = Ws/ V$

Procedure for determination of dry density of field soil by core cutter method.

-Measure the inside dimensions (accurate to 0.25 mm) of the core cutter and calculate its volume. Find the mass of core cutter (without dolly) accurate to 1 gm i.e. (W_1) -Expose the soil area, about 30 cm square to be tested and level it. Put the dolly on the top of the core cutter and drive the assembly in to the soil with the help of the rammer until the top of the dolly protrudes about 1.5 cm above the surface. -Dig out the container from the surrounding soil and allow some soil to project from lower end of the cutter. With the help of straight edge, trim flat the end of the cutter. -Find the mass of cutter full of soil i.e. (W_2) -Keep some representative specimen of the soil for water content determination. -Repeat the test at two or three locations nearly and get the average dry density $$\gamma_d = \frac{\gamma}{1+w}$$		1M 1M for diag. 1M
e) In a specific gravity test the following data is obtained at room temperature of 30^0C. **i) Mass of pycnometer =680 gm** **ii) Mass of pycnometer + water = 720.26 gm** **i) Mass of pycnometer + soil solids + water = 750.36 gm** **ii) Mass of pycnometer + soil solids = 727.25 gm** **Determine the specific gravity of soil solids.**		
Given i) Mass of pycnometer (W_1) =680 gm ii) Mass of pycnometer + water (W_4) = 720.26 gm i) Mass of pycnometer + soil solids + water (W_3) = 750.36 gm ii) Mass of pycnometer + soil solids (W_2) = 727.25 gm $G = \frac{(W2-W1)}{(W2-W1)-(W3-W4)}$ $= \frac{(727.25-680)}{(727.25-680)-(750.36-720.26)}$ $= \frac{47.25}{47.25-30.15}$ G =2.75		1M 1M 1M 1M

f) State the procedure for the determination of water content by oven-drying method.

i) This is commonly adopted and simplest method for determination of water content of a soil sample in the laboratory.

ii) The method basically consists of drying a weighed moist sample of soil in an oven at a controlled temperature for a period of twenty four hours after which the dry weight of the sample is taken.

iii) The drying of soil is recommended at a temperature of 105^{o}-110^{o} C as temperature higher than 110^{o} Cmay break the crystalline structure of crystallization thus giving wrong results

iv) A lower temperature of 60^{o} C is recommended for highly organic soils at 110^{o} C oxidation of organic matter may take place.

v) Sand and gravels require less time to dry, i.e. 4 to 6 hours but routine laboratory procedure is for drying for twenty four hours at 105^{o}-110^{o} C.

vi) A clean non-corrodible container is weighed within 0.001 gm accuracy.

vii) About 30-40 gm of moist soil sample is placed in it and weighed accurately.

viii) It is then placed in the oven for drying at 110^{0} C for 24 hours.

ix) After 24 hours, it is taken out allowed to cool and weighed again

The water content is then calculated as shown below:

Let W_1 = Weight of container

W_2 = Weight of container with moist sample

W_3 = Weight of container with dried sample

Weight of water $W_w = W_2 - W_3$

Weight of solids $W_s = W_1 W_1$

$$\text{Water content } W = \frac{W2-W3}{W3-W1} \times 100\%$$

Sr No.	Size of particles more than 90% passing through	Minimum quantity (gm)
1.	425µ -IS sieve	25
2.	2mm	50
3.	4.75mm	200
4.	10mm	300
5.	20mm	500
6.	40mm	1000

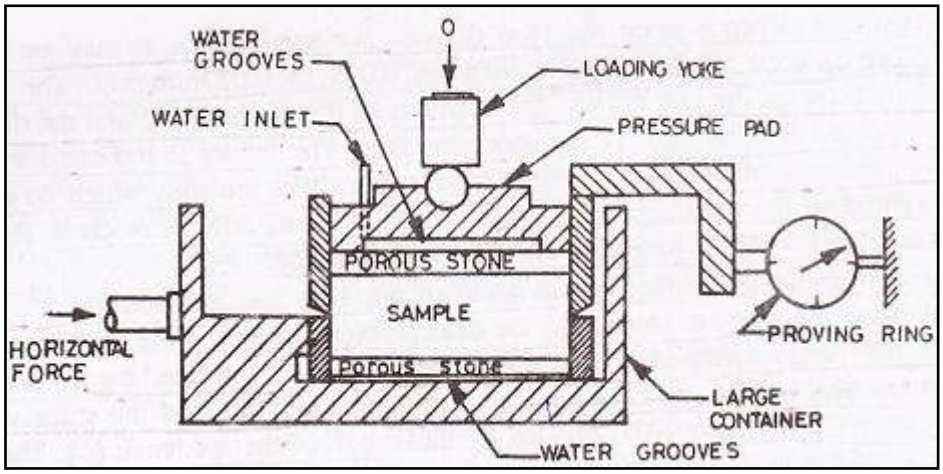
The above table gives the minimum quantity of soil sample to be taken for test.

1/4M each any eight

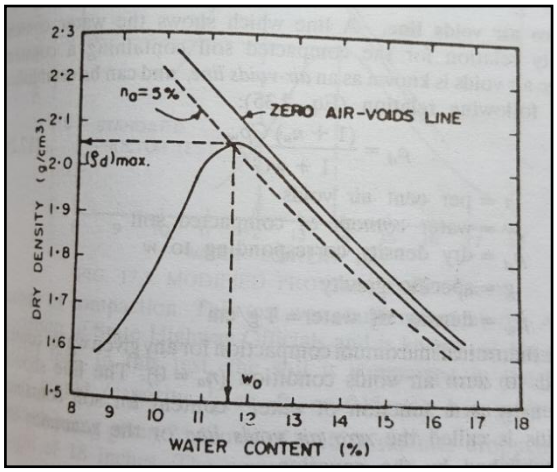
1M

1M

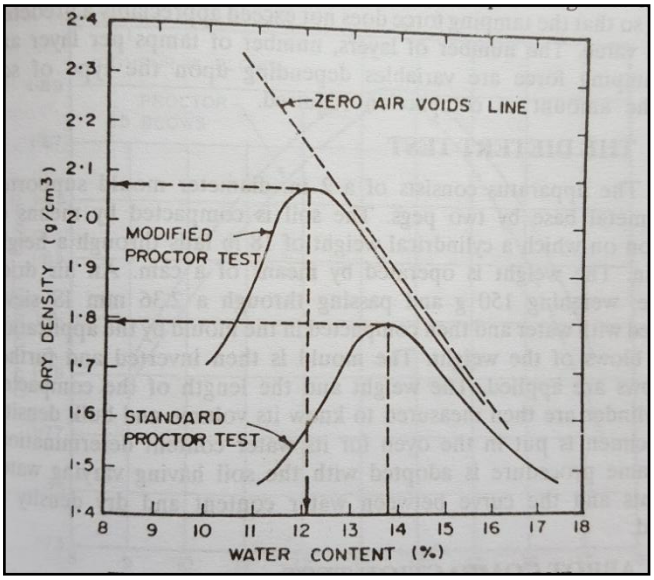
Q No.3	Attempt any Four of the following	16
a)	**Define with formula D_{10}, D_{30},D_{60} with respect to grain size.**	
	Coefficient of uniformity : 1)It is define as the ratio of D_{60} size to D_{10} size for given soil sample. 2) When Soil is uniformly graded the C_u is nearly to unity. 3) $C_u = \frac{D_{60}}{D_{10}}$ Where D_{10} = 10% of particles are finer than that size. D_{60}= means that soil for which the total smaller particles in given soil are 60%. **Coefficient of curvature**: 1)It represents the shape of the particle size distribution curve. 2) $C_c = \frac{{D_{30}}^2}{D_{10}\ x\ D_{60}}$ 3) C_c= 1 to 3 for well graded soil. C_c> 4 for well graded soil. C_c > 6 for well graded sand.	2M 2M
b)	**Define Permeability and Coefficient of Permeability.**	
	a) Permeability (K): - It is defined as the property of soil which permits the seepage of fluid through interconnected voids under gravity. OR **Permeability (K)**:- It also be defined as the speed at which the water flows through under unit head at unit hydraulic gradient. **b) Coefficient of Permeability: -** It is defined as the velocity of flow under a unit hydraulic gradient through a soil. **Mathematically: -** K = $\frac{V}{i}$ Where v = velocity of flow in m/s. And I = hydraulic gradient.	2M 2M
c)	**Describe Direct Shear Test with Neat Sketch.**	
	1. Take 250gm of dry sand in a shear box of 60mm x 60mm x 50mm and fix the upper part and lower part of box by locking screw and attach the base plate to lower part. 2. Place the grid plate above the base plate. 3. Fill the shear box with sand layer compact each layer with tamper. 4. Weight the remaining sand and by the difference find the sand required to fill the box. 5. Calculate the density of sand in the shear box and assemble the two halves of the box. 6. Place the box in the container and the container on the direct shear test apparatus. 7. Place the loading pad on the top and adjust the proving ring dial gauge reading to zero. 8. Mount loading yoke and dial gauge and apply a stress of 0.05N/mm^2 to record vertical and horizontal displacement.	Any 6 points ½ M each

	9. Remove locking screw and using spacing screw raised the upper part slightly above the lower part to create 1mm gap. 10. Remove spacing screw and apply a horizontal shear load of 1.25mm/min and record the reading for shear failure. 11. Plot the graph taking values of maximum shear on Y axis and normal stress on X axis. 12. The angle gives the shearing resistance and the intercept gives cohesion.  	1M for diagram
d)	**At the bottom of bore hole, a vane 120mm long and 80mm in diameter was presented into soft clay. Torque was applied and gradually increased to 57N-m, when failure took place estimate the shear strength of clay.**	
	Given : - H= 120mm D= 80mm T = 57N-m = 57000N-mm Shear Strength $C_u = \frac{T}{\pi d^2 (\frac{H}{2}+\frac{d)}{2}}$ Shear Strength $C_u = \frac{57000}{\pi \times 80^2 (\frac{120}{2}+\frac{80}{2})} = 0.0283 N/mm^2$	2M 2M
e)	**Define flow net and state its properties.**	
	Flow Net: - The grid, mesh or net formed by intersection of equipotential line and flow lines is called as flow net. **Properties of Flow Net: -** i) In a flow net, flow lines and equipotential lines intersect each other at right angles. ii) The quantity of water flowing through each flow channel is the same. iii) The drop of head, or the potential drop between any two successive equipotential lines is the same. iv) The fields are approximately squares. v) The flow net is representative of the flow pattern and dissipation of the hydraulic head.	1 (1M each for any 3 points)

f)	**State the assumptions made in terzaghi's bearing capacity analysis.**	
	Assumptions in Terzaghi's Analysis : - **1.** The soil is homogenous and isotropic and its shear strength is represented by Coulomb's equation. **2.** The strip footing has a rough base and the problem is essentially two dimensional. **3.** The elastic zone has straight boundaries inclined at $\Psi = \emptyset$ to the horizontal and the plastic zone fully developed. **4.** Failure zone do not extend above the horizontal plane through the base of the footing i.e the shear resistance of the soil above the base is neglected and the effect of soil around the footing is considered equivalent to a surcharge $\sigma = \gamma$ x D. **5.** The base of the footing is laid at shallow depth. **6.** General shear failure is assumed to take place and the soil volume is unchanged prior to failure.	(1M each for any four points)
Q No.4	**Attempt any four of the following**	**16 M**
a)	**A strip footing 1.4m wide is laid at a depth of 4.5m in a purely cohesive soil having ϱ = 144KN/m^2 and bulk unit weight = 17.7KN/m^3, calculate ultimate bearing capacity by Terzaghi's analysis (N_c and N_q are 5.7 and 1 respectively)**	**04 M**
	Given: - γ = 17.7 KN/m^3 c = 144KN/m^2 B=1.4m Depth=D=4.5m N_c= 5.7 , N_q= 1 , **N_γ = 0 (assumed)** **Ultimate Bearing Capacity is given by:** $q_f = cN_c + qN_q + \frac{1}{2}\gamma BN_\gamma$ **C=144KN/m^2, N_c=5.7 , q=γD_f = 17.7x4.5= 79.65, N_q= 1, B=1.40m, N_γ= 0** q_f **=(144x 7) + 79.65x1 + 0** $$q_f = 820.80 + 79.65$$ $$q_f = 900.45 KN/m^2$$ **(Note: -Students may assume suitable data and numerical can be solved.)**	**04 M**
b)	**State the effect of water table on bearing capacity. Explain**	
	Effect of water table on bearing capacrty of soil:- 1)The rise in water table from below the foundation results in decrease in granular soil. 2)When the water table reaches the ground where the depth is greater footing the bearing capacity is reduced by 50% or more. 3)The bearing capacity is not affected for purely cohesive soil. 4)The bearing capacity for non-granular soil decreases with presence of water table. 5)Presence of water table for shallow depth give poor bearing capacity as compared for	(1M each for any four points)

	Larger depth foundation.	
c)	**Draw the compaction curves for proctor's light and heavy compaction test. Also state the compactive energy applied in both the cases.**	
	1) Compaction curve for Proctor light test. a) The compactive energy used for this test is 6065Kg-cm per 1000ml of soil or 595KJ/m^3. b) In standard proctor test the weight of hammer is 2.6Kg. c) In Standard Proctor test, 3 layers are made in which the soil is filled in the mould. d) The vertical drop of hammer before striking the soil is 310mm.  	2M 2M

2) Compaction curve for Proctor Heavy Test: -



a) The compactive energy used for this test is 27260Kg-cm per 1000cm^3 or 2674KJ/m^3.

b) In heavy compaction test the weight of hammer is 4.89Kg.

c) In 5 layers soil is filled in the mould.

d) The vertical drop of hammer before striking the soil is 450mm.

d) Define air void line? How it is drawn? State its significance.

1)Zero Air Void Line - 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. — 2M

Or

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.** — 1M

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:- — 1M

The actual dry density with respect to water content cannot reach its theoretical value even after applying heavy compaction.

e) Mention the Suitability of following, methods of compaction

1)Ramming 2) Tamping 3) Rolling

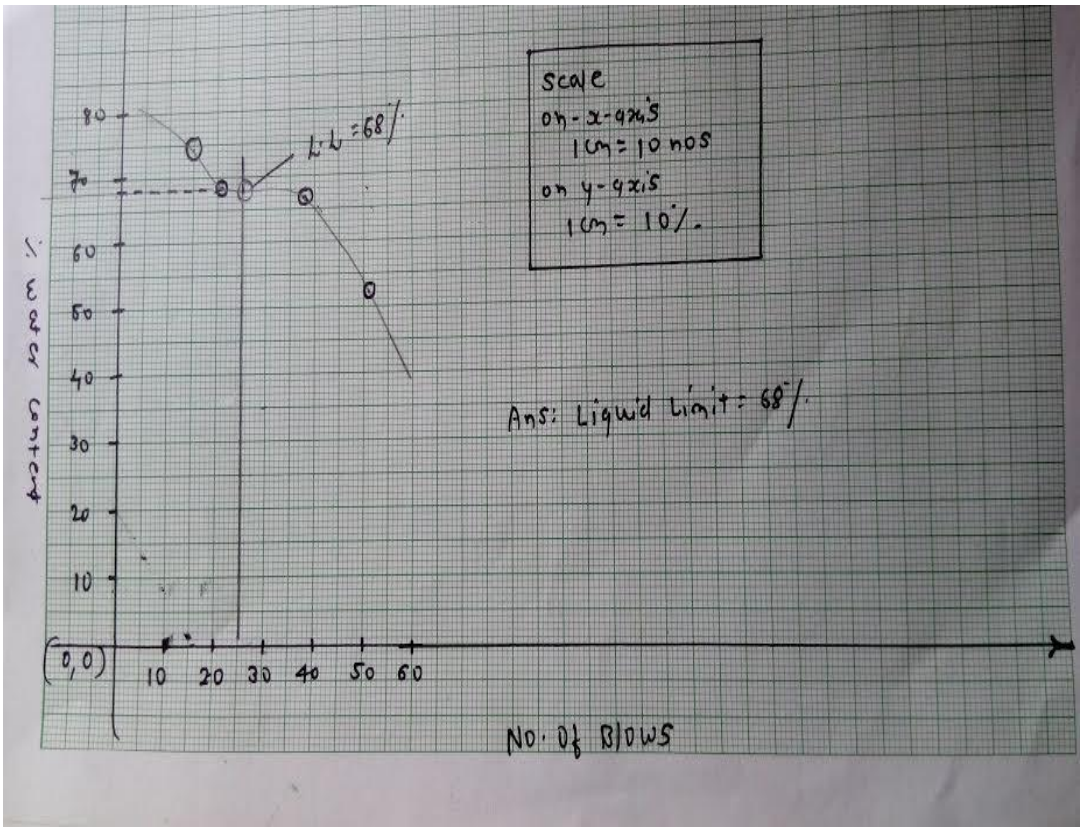
1)Ramming: -

	a) They are used for compacting soil at confined places. b) For light compaction rammers can be used. c)For backfill of abutments of bridges, beds of drainage, trenches etc. **2) Tamping: -** a)For light compaction tamping can be done. b) For small area or where accessibility is difficult for heavy equipments tamping is done. c) For smaller depth's tamping is done. **3) Rolling: -** a) Rollers are used for silty soil, clayey soil sheep foot rollers are used. b) For crushing rocks, gravels, sand smooth wheel rollers are used. c)Pneumatic tiered rollers are used for compacting sand, silt, gravel.	2M 1M 1M
f)	**Compute intensities of P_a and P_b at a depth of 8m in dry cohesionless sand with ϕ= 30° and γ=19KN/m^3.**	
	1)**Coefficient of active earth pressure:** $K_a = \frac{1-sin\emptyset}{1+sin\emptyset}$ $K_a = \frac{1-sin30}{1+sin30} = \frac{1}{3}$ Active Earth Pressure $P_a = K_a \times \gamma \times H$ Active Earth Pressure $P_a = \frac{1}{3} \times 19 \times 8 = 50.667$ KN/m^2. 2)**Coefficient of Passive Earth Pressure: -** $Kp = \frac{1+sin\emptyset}{1-sin\emptyset}$ $K_p = \frac{1+sin30}{1-sin30} = 3$ Passive Earth Pressure $P_b = K_p \times \gamma \times H$ Passive Earth Pressure $P_b = 3 \times 19 \times 8 = 456$KN/m^2	2M 2M

Q No.5	SOLUTION	MARKS
5	**Attempt any four of the following**	
5.a	**State the field application of Geotechnical Engineering (Any Four)** i) In foundation design ii) In pavement design iii) In earth retaining structures iv) In design of earthen dams v) In design of embankments ii) In design of under ground structures	**4M** **(1 M each for any four points.)**
5.b	**Determine Density Index & Comment about the degree of compaction based on the value of Density Index** **Given Data:** i) Field density of sandy Soil = 1800 kg/m^3 = 1.8 gm/cc ii) Water Content = 10% iii) Void ratio at Loosest state = 0.75 iv) Void ratio at Densest t state = 0.47 Solution : Density Index = $I_D = [e_{max} – e] / [e_{max} - e_{min}]$ **γ_d = [(1.8 / (1+0.10)] = 1.64.....** $\gamma_d = (G . \gamma_w) / (1+e)$.....use this equation for finding , 'e' natural $e = [(G . \gamma_w) / \gamma_d] – 1$ e = [(2.67 x1) / 1.64] – 1 ……..(Assume , G = 2.67) **e = 0.62** When soil is loosed state , $e = e_{max}$ ……..Hence $I_D = 0$ When soil is densest state , $e = e_{min}$ ……..Hence $I_D = 1$ Density Index = $I_D = [e_{max} – e] / [e_{max} - e_{min}]$ Density Index = $I_D = [0.75 – 0.62] / [0.75 - 0.47]$ Density Index = $I_D = 0.13 / 0.28$ **Density Index = I_D = 0.46……Ans.** Comment about the degree of compaction based on the value of Density Index As the value of **Density Index = I_D = 0.46, lies in between 0.35 to 0.65 ,** **Hence , the degree of compaction is medium dense**	**1M** **1M** **1M** **1M**

5.c **Plot the flow curve and Find the liquid Limit**

Sr. No	Determination Number	1	2	3	4
1	Number of blows	15	21	38	51
2	Water content %	74.60	68.4	66.7	52.60



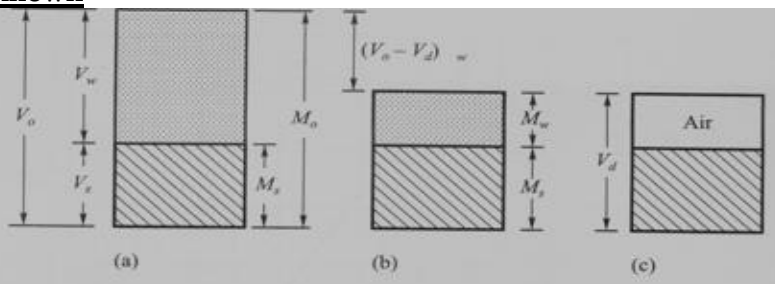
Liquid Limit = 68%

4 M
(Grapgh :3
L.L.:1)

5.d **Derive the expression for Shrinkage Limit :**

4M
(2 M : each Derivation)

When 'G' is unknown



Determination of shrinkage limit

Method I, when G is unknown

Three block diagrams of a sample of soil having the same mass of solids M_s, are given in Fig. Block diagram (a) represents a specimen in the plastic state, which just fills a container of known volume, V_o. The mass of the specimen is M_o. The specimen is then dried gradually, and as it reaches the shrinkage, limit, the specimen is represented by the block diagram (b). The specimen remains saturated up to this limit but reaches a constant volume V_d. When the specimen is completely dried, its mass will be M_s whereas, its volume remains as V_d.

These different states are also represented on Fig. The shrinkage limit can be written as

$$w_s = \frac{M_w}{M_s} \times 100$$

where, $M_w = M_o - M_s - (V_o - V_d)\rho_w$

Therefore, $w_s = \frac{(M_o - M_s) - (V_o - V_d)\rho_w}{M_s} x100\%$

The volume of the dry specimen can be determined by displacement of mercury as explained below.

When 'G' is known

Method II, when G is known

$$w_s = \frac{M_w}{M_s} \times 100 \text{ But, } M_w = (V_d - V_s)\rho_w = \left(V_d - \frac{M_s}{G\rho_o}\right)\rho_w$$

Therefore, $w_s = \frac{\left(V_d - \frac{M_s}{G\rho_o}\right)\rho_w}{M_s} \times 100 = \left[\frac{V_d \rho_w}{M_s} - \frac{\rho_w}{G\rho_o}\right] \times 100$

or $$w_s = \left[\frac{V_d \rho_w}{M_s} - \frac{G_w}{G}\right] \times 100$$

If $\rho_w \approx \rho_o = 1$ gm/cm^3, we have $G_w = 1$ reduces to

$$w_s = \left[\frac{V_d}{M_s} - \frac{1}{G}\right] \times 100$$

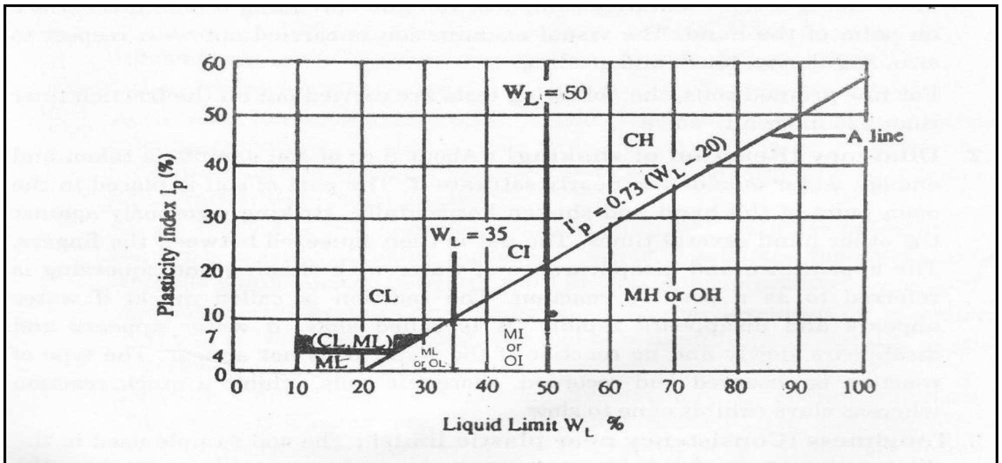
where, G_w = specific gravity of water at room temperature. The specific gravity of solids, G, may be determined

<table>
<tr><td>

5.e

</td><td>

Define plasticity index and classify soil on its basis.
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(W_p).
$$I_P = W_L - W_p$$
Casagrandes plasticity chart with figure and how the soil classification is done according to the chart is given below.



Plasticity chart

Plasticity chart: A Casagrande devised a chart useful for identifying and classifying fine grained soils. The basic of classification is the relationship between liquid limit [W_L] and the plasticity index [I_P]. A line called 'A-line' is drawn diagonally across the chart. The area above the A-line represents inorganic clay and that below A-line represents slit and organic soils. The equation of A-line is: I_P =0.73[W_L -20]
Majority of Indian black cotton soils lie along a band above the A-line. The plot of some of the black cotton soils is also found to lie below the A-line. Care should be taken in classification of such soils.

</td><td>

1M

2M

1M

</td></tr>
<tr><td>

5.f

</td><td>

Describe unified soil classification system
The Unified classification is based on the airfield classification system that was developed by A. Casagrande. The system is based on both , grain size and plasticity properties of the soil, and is therefore applicable to any use.
a) Coarse grained soils : i) Gravel ii) Sand
- Well graded clean (W)
- Well graded with excellent clay binder (C)
- Poorly graded , fairly clean (P)
- Not covered in other groups
b) Fine grained soils : i) Inorganic silt an very fine sands (M)
ii) Inorganic clay (C) iii) Organic silt and clay (O)
c) Highly organic soils and other miscellaneous soil matter: These soils contain large percentages of fibrous organic matter such as peat and the particles of decomposed vegetation. In addition, certain soils containing shells, concretions, cinders and other non-soil material in sufficient quantities are also grouped in this division.

</td><td>

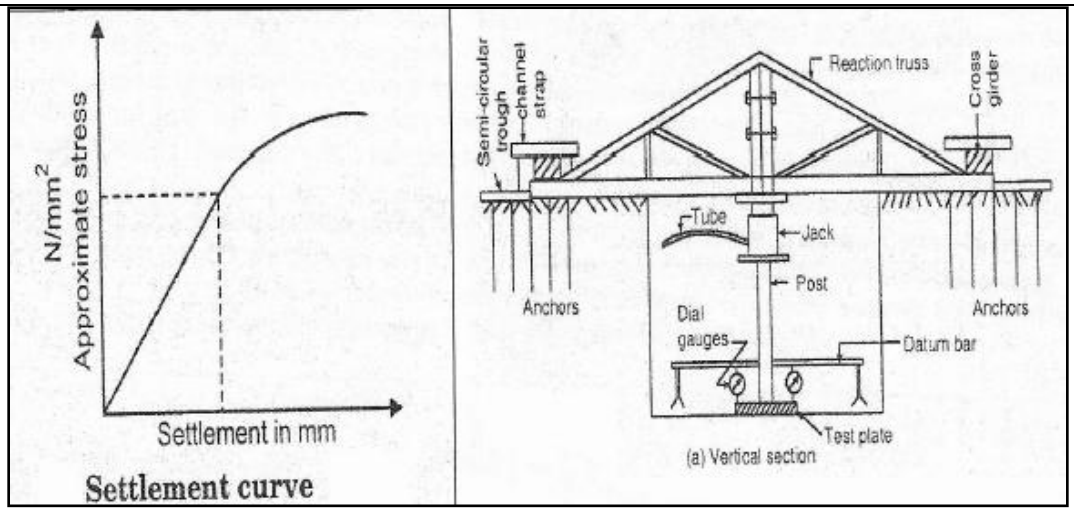
1M

1M

1M

1M

</td></tr>
</table>

Q No.6	Attempt any four of the following	
6.a	**Factors affecting Permeability of Soil:-** **1. Grain Size: -** Permeability varies approximately as the square of the grain size. The permeability of coarse grain soil is more than fine grained soil. The permeability can be expressed as $k=CD_{10}^2$. Where 'k' is coefficient of permeability in (cm/sec) & D_{10} is the effective grain size of soil. **2. Effect of properties of Pore Fluids:-** The permeability is directly proportional to unit weight of water and inversely proportional to its viscosity. The unit weight of water does not change much with change in temperature but viscosity changes with change in temperature. **3. Effect of void ratio:-** Increase in void ratio increases the area available for flow hence permeability increases for critical condition.. **4. Effect of structural arrangement of particles and stratification: -** The structural arrangement of particle may vary at the same void ratio depending upon the method of compacting of soil mass. The structure may be entirely different for a disturbed sample as compared to undisturbed sample. **5. Effect of Degree of Saturation: -** The permeability is reduced if air is entrapped in the voids thus reducing its degree of saturation. Organic foreign matter has a tendency to move towards critical flow channel and choke them up thus decreasing the permeability. **6. Effect of absorbed water:-**The absorbed water surrounding the fine soil particles is not free to move and reduces the effective pore spaces available for the passage of water.	**4M (1 M each for any four points.)**
6.b	**Find Coefficient of permeability =?** $A=3000\ mm^2$ Length of sample = 200 mm Constant head = 1000 mm Quantity of discharge = 25 ml = $25x1000=25000\ mm^3$ Time period = 20 minutes = 20 x 60 = 1200 seconds K = (Q/t) x (1/A) x (L/h) K = [25x1000/ 1200] x [1/3000] x [200/1000] K= 20.83x 0.00033x 0.20 K = 0.0014mm/sec	**1 M** **1 M** **1 M** **1M**
6.c	 **Plate Load Diagramme (Reaction Truss or Gravity loading) any One Dia.**	**4M (Suitable Diagram with names)**

6.d	**Assumptions of Rankines Theory: -** 1. The soil is semi infinite, homogenous, dry and cohesion less. 2. The soil element is in the state of plastic equilibrium. 3. The ground surface is plane which may be horizontal or inclined 4. The back of is vertical and smooth. 5. The wall yield about the base thus satisfies deformation condition for plastic equilibrium.	**4M** **(1mark each)**
6.e	**Criteria for deciding the location and number of test pits and bores :** i) Single stroey buildigs : Building covering an area of four hectare, require atleast five bore holes. One at ii) Multi stroey buildigs : for Multi stroey buildig the bore holes should be at all the corners and also at an important locations. The spacing between bore hole is between 10 to 15 meters. iii) Earthen dam: Boring may be made at 30 to 60 meters, spacing along the top of the up stream face of the dam and across one or both abutments. iv) Concrete Dam: For concrete dams bore hole should be in between 40 to 80 meters. v) Highway : In highway , bore holes are usually made along the proposed center line of the road and spacing may be about 300 to 350 meters. vi) Airport: In case of air ports , boring should be along the center line and along each edge of the runway. Spacing between bore holes should be 25 to 30 meters. vii) Borrow pits : Spacing netween holes should be in case of borrow pits 25 to 30 meters.	**4M** **(1 M each for any four points.)**
6.f	**Field Identification test on soil:-** 1) Dry Strength Test 2) Dilatancy Test 3) Toughness Test 4) Organic content and colour test 5) Visual examination. 6) Other identification test. **a) Dry Strength Test: -** i) The sample is prepared by completely drying in sun or by air drying. It strength is tested by breaking lumps between the fingers. ii) If the dry samples can easily powered it is said to have low dry strength. iii) If considerable finger pressure is required to break the lump the sample has medium strength. iv) If the lump cannot be powered by fingers it has high dry strength. v) Inorganic silts have very less dry strength. vi) Fine sand and silts possess low dry strength vii) Dry strength test is also known as crushing resistance test. **Dilatancy test :** i) This is simple test for fine fractions of soil ii) Militancy means reaction to shaking. About 5 cc soil sample is taken and enough water is added to nearly saturate it. iii) The pat of soil is placed in the open palm of the hand and shaken horizontally by striking vigorously against the other hand several times. The pat is then squeezed between the fingers. iv) The appearance and disappearance of water with shaking and squeezing is called a positive reaction. This reaction is called quick, if water appears and disappears rapidly, slow if water appears and disappears slowly and no reaction if water condition does not appear to change. v) The type of reaction is observed and recorded. Inorganic silts show a quick reaction where as clays shows no reaction or slow reaction.	**4M** **(2 M each Explaination)**