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.

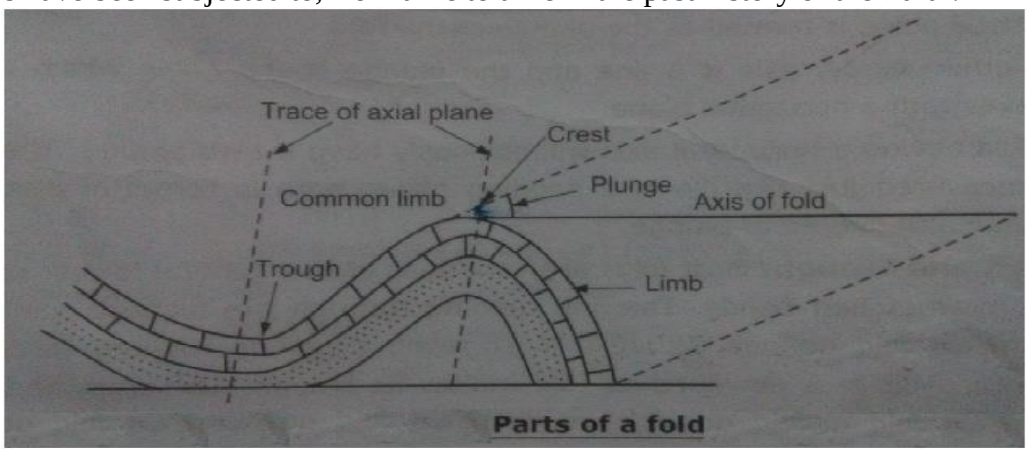
Important notes to examiner

Q .NO	SOLUTION	MARKS
Q1) a)	**Attempt any SIX of the following**	**12 M**
i)	**Define geology and state its branches.**	**02 M**
	Geology: Geology is the science of study of the solid matter that constitutes the Earth. Encompassing such things as rocks, soil, gemstones, geology studies, the composition, structure, physical properties, history, and the processes that shape Earth's components. Branches of geology: i. Physical geology ii. Geomorphology iii. mineralogy iv. Petrology v. Structural geology vi. Stratigraphy vii. palaeontology viii. Historical geology ix. Applied geology x. Hydrology xi. Indian geology **xii.** photo-geology	**1M** **1/4 Mark Each Any Four**
ii)	**Define petrology and rock.**	**02 M**
	a. **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 uner petrology. It is one of the important subdivisions of geology and is further subdivided into distinct branches: Igneous petrography, Sedimentary petrology and metamorphic petrology. b. **Rock:** A rock is an aggregate of minerals it may be made up of one mineral i.e. monomineralic or it may consist of different minerals i.e. polymineralic	1M 1M
iii)	**State classification of rocks based on their genesis.**	**02 M**
	Rocks on the basis of their origin are broadly divided into three major classes 1) Igneous rock. 2) Sedimentary rock. 3) Metamorphic rock.	**02 M**
iv)	**Define outcrop and faults.**	**02 M**
	i) Out crop: The dip and strike of beds can be easily measured in the field from their exposures called outcrops. ii) 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.	**1M** **1M**
v)	**Define joints and state their classification.**	**02 M**
	Joints: joint are defined as a fracture in rock where there has been no lateral movement in the plane of the fracture (up, down or sideway) of one side relative to the other. **Classification of joints:** a) Spatial joints i) Systematic joints (regular joints) ii) Non- systematic (irregular) joint b) Geometry i) strike joints, ii) Dip joints, iii) Oblique joints. c) Origin i) Tension joints, ii) Shear joints, iii) Compression joints	**1M** **1/2M Each Any Two**

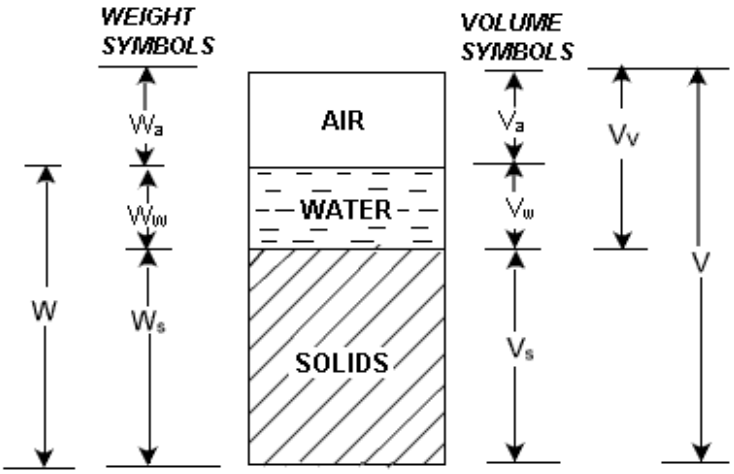
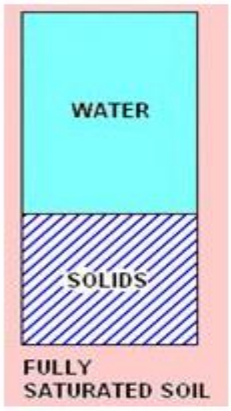
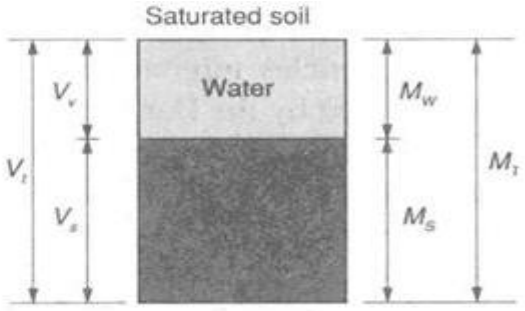
Q .NO	SOLUTION	MARKS
vi)	**Define earthquake and intensity.**	**02 M**
	i. Earthquake: It is define as vibrations induced in the earth's crust due to internal or external causes that virtually shake up a part of the crust and all the structures and living and non-living things existing on it. **ii. Intensity:** It is a qualitative measure of the actual shaking at the location during an earthquake and is assigned as Roman Capital Numerical.	**1M** **1M**
vii)	**Define soil as per I.S.**	**02 M**
	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**
	viii) State objectives of Geotechnical Engineering.	**02 M**
	Following are the objectives of geotechnical engineering: 1) To perform soil investigation and to develop methods for soil sampling. 2) To classify soil properties in the light of soil engineering product. 3) To apply the result and soil investigation and sampling, so as to use soil as construction material economically.	**1M** **Mark Each Any Two**
	ix) State Darcy's Law of permeability.	**02 M**
	It states that for laminar flow, the rate of flow or discharge per unit time is directly proportional to hydraulic gradient. q= KiA or V= q/A = Ki Where q= discharge per unit time. , A= total cross-sectional area of soil mass, perpendicular to the direction of flow, i= hydraulic gradient = h/L, K = Darcy's coefficient in permeability, v= velocity of flow, h= differential head of water = h_1-h_2, L= length of soil sample.	**1M** **1M**
b)	**Attempt any TWO of the following**	**8 M**
	i) Define the following terms: **1) Focus** **2) Epicenter** **3) Seismograph** **4) Isoseismic lines**	**04 M**
	i) **Focus:** The focus is the place beneath the Earth's surface from where an earthquake originates. ii) **Epicenter:** The point or line on the Earth's surface immediately above the focus is called Epicenter iii) **Seismograph:** The energy released during faulting, produces seismic waves, which can be detected by sensitive and delicate instruments, called seismograph. iv) **Isoseismic lines:** It is the line joining the places with equqal seismic intensity i.e. lines joining points where similar ground motion were experienced they are assessed by examining the damage done.	1M 1M 1M 1M

Q .NO	SOLUTION	MARKS
ii)	**State any four causes and two effects of earthquake**	**04 M**
	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. **Possible effect of an earthquake :** i) Shaking and ground rupture. ii) Landslides and Avalanches iii) Fires iv) Soil liquefaction v) Tsunamis	**1/2M Each Any Four** **1/2 Mark Each Any Four**
	iii) Define minerals and state any six properties of minerals.	**4 M**
	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**

Q .NO	SOLUTION	MARKS
	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 vi) Prismatic: Abundance of prism faces vii) Bladed: like a wedge or knife blade example – kyanite **Cleavage**: Crystals often contain planes of atoms along which the bonding between the atoms is weaker than along other planes. **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	**½ M each any six**

Q .NO	SOLUTION	MARKS
Q-2)	**Attempt any four of the following**	**16 M**
a)	**Define folds and draw neat sketch of a fold and label its different parts.**	**04 M**
	Fold: Folds may be defined as undulations or bends that are developed in the rock of the Earth's crust, as a result of stresses (commonly lateral compression) To which these rocks have been subjected to, from time to time in the past history of the Earth.  **Parts of a fold**	2M 1M Mark Diag. 1 Mark Labeling
b)	**State formation and classification of soil.**	**04 M**
	Soils are formed by numerous process of weathering both physical and chemical. A boulder pried loose from the side of mountain by rapidly flowing water of river and came along with the water ay has result of abrasive impact forces converted into sandy soil similarly due to other physical weathering process and environmental conditions. **Type of soil available :** Gravel ii) sand iii) silt iv) clay v) organic vi) peat **Classification of soil :** i) **Residual soils:** Those soil have suffered very little or no transport during or after their formation a) Thickness b) Stratification c) Chemical composition d) Leaching ii) **Transported soil:** This group includes all those soils that have been deposited at places far from their parent rocks. a) Colluvial soil b) Alluvial soil c) Glacial soil d) Eolian soil	1M 1M 1 Mark Each Any Two 1 Mark Each Any Two
c)	**Classify earthquakes based on focus and origin.**	**04 M**
	Earthquakes based on focus distributed in three general depth ranges: i) Shallow earthquakes originate within about 60 kilometers of the surfaces ii) Intermediate earthquakes have foci between 60 to 300 kilometers down iii) Deep seated earthquakes originate at depths below 300 kilometers	2 Mark Any Two

Q .NO	SOLUTION	MARKS
	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	2 Mark Any Two
d)	**Stat field applications of geotechnical engineering (any four).**	**04 M**
	The field of geotechnical Engineering includes some important applications as: a) Foundation design b) Pavement Design c) Design of earth retaining structures d) Design of earth dams e) Design of embankments f) Underground structures **a) Foundation design:** Foundation is most important to require transmitting the load of structure to soil safely and efficiently. Bearing capacity of soil is essential to knowledge of stress distribution below the loaded area, settlement of foundation, effect of vibration, effect of ground water. **b) Pavement Design:** A pavement is hard crust placed on soil for the purpose of providing a smooth and strong surface on which vehicles can move. Thickness of pavement depends upon subsoil and its component parts. It is also depend on the effect of repetition of loading intensity of traffic, construction materials, earth fills or cut etc. **c) Design of Earth Retaining Structures:** When sufficient space is not available for a mass of soil to spread and form a slope, structure is required to retain the soil. An earth retaining structure is also required to keep the soil at different levels on it either side. The retaining structure may be a rigid retaining wall or a sheet pile bulkhead which is relatively flexible. The knowledge of the active earth pressure, passive earth pressure, density and moisture content is essential for design of earth retaining structures. The geotechnical engineering gives the theory of earth pressure on retaining structures. **d) Design of Earthen Dams:** In construction of earthen dam, soil is main Constituent, This may be homogeneous and heterogeneous. Therefore, its design requires thorough knowledge of index properties, plasticity characteristics, particle size distribution, specific gravity, permeability, consolidation, compaction and shear Strength etc. Determination of optimum moisture content at which maximum Density will occur is most essential for the design of earthen dam.	**1M Each Write ANY FOUR**

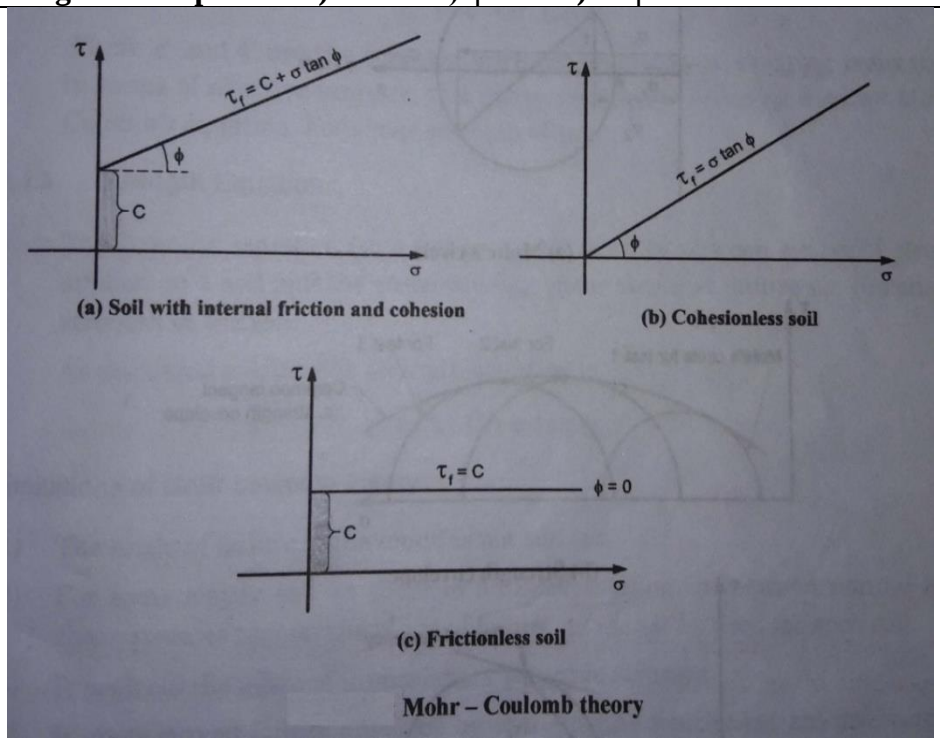
Q .NO	SOLUTION	MARKS
e)	**Draw phase diagram of a soil when soil is :** **(i) Moist** **(ii) Fully saturated and label the diagrams.**	**04 M**
		2 M
	 	2 M
f)	**Define void ratio; porosity; water content and degree of saturation.**	**04 M**
	i) **Voids Ratio:** Voids ratio e of a given soil sample is the ratio of the volume of voids to the volume of soil solids in the given soil mass. e=Vv/Vs ii) **Porosity:** The ratio of volume of voids (V_v)to the volume of soil (V) is called as Porosity (n) n= V_v / V x 100 iii) **Water content:** The water content w, also called as moisture content, is defined as the ratio of weight of water Ww to the weight of solids (Ws or Wd)in a given mass of soil w= Ww/Wd x 100 iv) **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 Each**

Q .NO	SOLUTION	MARKS
Q.3	**Attempt any four of the following**	**16 M**
a)	**The density of soil sample is 2000kg/m^3 and its water content is 18%. Determine dry density, void ratio, porosity, and degree of saturation. Assume G=2.72, γ_w=10KN/m^3.**	**04 M**
	Solution:- **γ= 2000Kg/m^3 = 2gm/cc, w=18%, G=2.72, γ_w=10KN/m^3.** **γ_d =? , e=?, η=?, S=?.** $\gamma_d = \frac{\gamma}{1+w} = \frac{2}{1+0.18} = \mathbf{1.694 gm/cc}$ $\gamma_d = \frac{G\gamma_w}{1+e} \quad \therefore 1.694 = \frac{1\ x\ 2.72}{1+e} \quad \therefore \boldsymbol{e = 0.6056}$ $\eta = \frac{e}{1+e} = \frac{0.6056}{1+0.6056} = 0.377 = 0.377\ x\ 100 = \mathbf{37.77}\%$ $S = \frac{Gw}{e} = \frac{2.72\ x\ 0.18}{0.6056} x\ 100 = \mathbf{80.845}\%.$	1M 1M 1M 1M
b)	**Write step by step procedure to determine specific gravity of soil by pycnometer in laboratory.**	**04 M**
	1. Clean the pycnometer and dry it, find the mass of pycnometer, brass cap and washer accurate to 1g. say M1 2. Put about 200gm to 400gm of wet soil sample in pycnometer and find its mass with its cap say M2. 3. Fill the pycnometer with water to its half of its height and mix it thoroughly and more water and stir it and take is mass say M3. 4. Empty the pycnometer clean it and fill it with clean water till it top of cap and find its weight say M4. 5. The specific gravity is calculated by $G = \frac{M_2 - M_1}{(M_2 - M_1) - (M_3 - M_4)}$	1M each for any four points
c)	**Define Liquid Limit, Plastic Limit, Shrinkage Limit and Plasticity Index.**	**04 M**
	1. **Liquid Limit:** The water content at which the soil changes from the liquid state to plastic state is known as liquid limit (LL, w_L). In other wards the liquid limit is the water content at which the soil ceases to be liquid. 2. **Plastic Limit:** The water content at which the soil becomes semisolid is known as the plastic limit. (PL, wp).The plastic limit is the water content at which the soil just fails to behave plastically. Soil begins to crumble when rolled into a thread of 3 mm diameter.The numerical difference between the liquid limit and the plastic limit is known as plasticity index. (PI, Ip), **PI = LL – PL.** 3. **Shrinkage limit:** The water content at which the soil changes from a semisolid state to the solid state is known as the shrinkage limit (SL, w_S). Shrinkage limit is the smallest water content at which a reduction in water content will not cause a decrease in the volume of the soil mass. At this water content the shrinkage ceases. 4. **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). $I_P = W_L - W_p$	

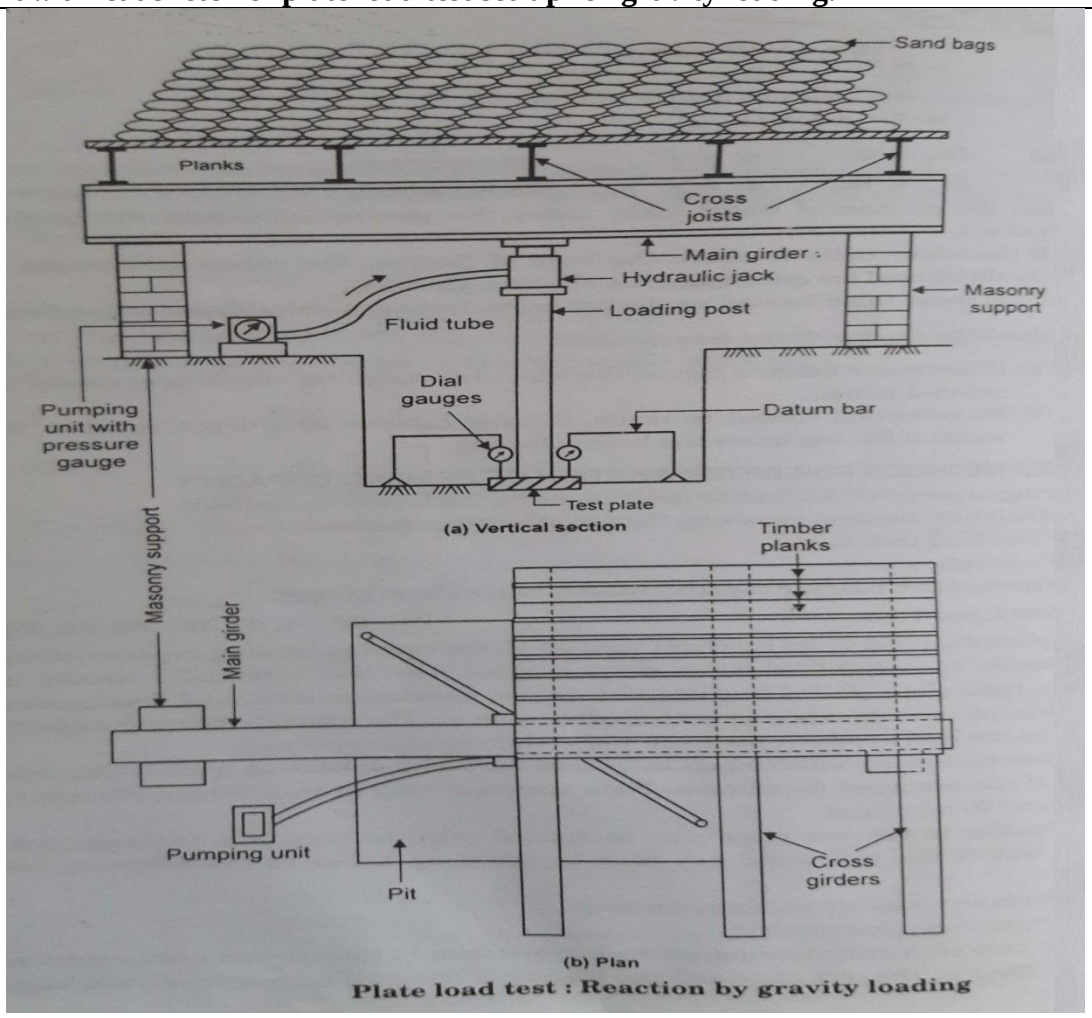
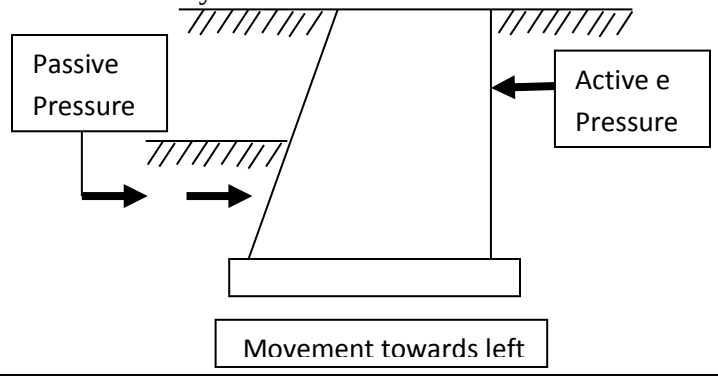
Q .NO	SOLUTION	MARKS
d)	**Write step by step procedure to determine plastic limit in the laboratory.**	**04 M**
	Procedure: 1) Sieve the soil sample through 425 micron IS sieve. 2) Take 20 gm of soil sample and mix it with distilled water till the soil becomes plastic enough to be moulded with fingers. 3) Prepare a ball of uniform diameter of the above wet sample. 4) Roll it on glass plate with just sufficient finger pressure till 3 mm diameter threads are formed. 5) Take a portion of crumbled soil thread and find its moisture content by Where, W= % moisture content W1 = Weight of wet soil thread W2 = Wet of dry soil thread 6) Take three observations and record the average value as the plastic limit of given sample of soil.	**4M**
e)	**What do mean by coarse grain soil and fine grained soil.**	**04 M**
	Coarse Grain Soil:- 1. If more than 50% of soil is retained on sieve 0.075mm it is called as coarse grain soil. 2. A coarse grain soil is called as gravel if 50% or more of the coarse fraction is retained on 4.75mm IS sieve else it is termed as sand. 3. Coarse grain soil contains less 5% fine are called as GW and SW if they are well graded. 4. If they are poorly graded they are graded by symbol GP and SP. 5. If the percentage of fines lie between 5% to 12% coarse grain soil are designated by symbol GW-GM. **Fine Grain Soil:-** **1.** A soil is termed as fine grain soil if more than 50% of soil passes through 0.075mm. **2.** Fine grain soil is sub divided soil in silt, based on their liquid limit and plasticity index. **3.** The fine grain soil are subdivided into soil possessing low or high plasticity when the liquid limit is less than 50% or more than 50% respectively.Organic soil are also included in fine grain soil.	2M for any two points 2M for any two points
f)	**State field identification test on soil and explain any one.**	**04 M**
	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.	2M for any four test ½ M each for any four points

Q .NO	SOLUTION	MARKS
	vi) Fine sand and silts possess low dry strength vii) Dry strength test is also known as crushing resistance test. **b)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. **Note: - Any other test explained by student's proportionate marks should be given by examiner.**	
Q.4	**Attempt any Four of the following**	**16M**
a)	**A sieve analysis test was conducted in laboratory and from particle size distribution curve following observations recorded. Calculate coefficient of curvature and coefficient of uniformity. Also classify soil. D10:0.32 mm, D30:1.25 mm, D6o:1.98 mm**	**4 M**
	Find coefficient of curvature for soil particle. $\text{Coefficient of curvature} = C_c = \frac{(D_{30})^2}{(D_{10}) \times (D_{60})}$ $\text{Coefficient of curvature} = C_c = \frac{(1.25)^2}{(0.32) \times (1.98)} = \frac{1.5625}{0.6336} = 2.466$ $\text{Coefficient of Uniformity} = C_v = \frac{(D_{60})}{(D_{10})} = \frac{1.98}{0.32} = 6.1875$	2M 2M
b)	**State the meaning of the symbol GW,GC, SP, SM**	**04 M**
	1. **GW:-** Coarse Grain soil containing less than 5% fine are called as Well graded soil as are designated by the symbol (GW) when 50% or more of coarse fraction is retained on 4.75mm IS sieve. 2. **GP:-** Coarse Grain soil when are poorly graded soil as are designated by the symbol (GP) when 50% or more of coarse fraction is retained on 4.75mm IS sieve. 3. **SP:-** Sand more than 50% of coarse fraction passing through 4.75mm IS sieve is called as poorly graded sand and is designated as (SP). Such sand is clean sand. 4. **SM:-** Sand more than 50% of coarse fraction passing through 4.75mm IS sieve is called as Silty sand with fines present in sand and is designated as (SM).	1M 1M 1M 1M

Q .NO	SOLUTION	MARKS
c)	**Enlist factors affecting permeability.**	**04 M**
	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 for any four factors
d)	**Define Permeability and Pheratic Line.**	**04 M**
	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 is defined as the speed at which the water flows through under unit head at unit hydraulic gradient. **Pheratic Line:-** When flow of water occurs through soil, the top surface of the flow zone is called the phreatic surface, and in section, the top line of flow zone is called the phreatic line.	2M 2M
e)	**Write step by step procedure to determine coefficient of permeability of fine grained soil by falling head method in laboratory.**	**04 M**
	This method is suitable for fine grained soil as quantity of water collected through soil mass is very less and cannot be measured accurately 2. The falling head test is used for relatively less permeable soil where the discharge is small. 3. A stand pipe of know cross sectional area "a" is fitted over permeameter and water is allowed to run down. 4. The water level in the stand pipe constantly falls as water flows. 5. Observations are started after steady state of flow has reached. 6. The head at any time instant "t" is equal to the difference of water level in the stand pipe and the bottom tank. $k = 2.303 \frac{al}{At} log_{10} \frac{h_1}{h_2}$	4M for any four points

Q .NO	SOLUTION	MARKS
f)	**Define Flow Net and state its characteristic**	**04 M**
	Flow Net: - The grid, mesh or net formed by intersection of equipotential line and flow a line is called as flow net. **Characteristic 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 A line 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.	1M 1M each for any three points
Q.5	**Attempt any four of the following**	**16M**
a)	**Define shear strength of soil and state field situations of shear failure.**	**04 M**
	Shear Strength of Soil: Shear strength is a term used in soil mechanics to describe the magnitude of the shear stress that a soil can sustain. . **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.	2M 2M (1/2 M each for any four points.)
b)	**Draw strength envelope for : 1) C-soil 2) φ-soil 3) C-φ soil**	**04 M**
		1M 1M 1M 1M Labeling

Q .NO	SOLUTION	MARKS
c)	**A constant head permeameater gives discharge of 350 ml in 270 seconds under a constant head of 1050mm. Determine coefficient of permeability in m/day, if the soil sample was 150 mm long and 78.50 cm2 in c/s area**	**04 M**
	$A=78.50cm^2 = 7850\ mm^2$ Length of sample = 150 mm Constant head = 1050 mm Quantity of discharge = 350 ml = 350x1000=350000 mm^3 Time period = 270 seconds K = (Q/t) x (1/A) x (L/h) K = [350x1000/ 270] x [1/7850] x [150/1050] K= 1296.29x 0.000127x 0.143 K = 0.0235mm/sec	1 M 1 M 1 M 1M
d)	**Define ultimate bearing capacity and safe bearing capacity.**	**04 M**
	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. **Safe bearing capacity (q_s)** : It is the maximum pressure which the soil can carry without risk of failure is called as safe bearing capacity **OR** **Ultimate Bearing Capacity (q_u):-** The Ultimate bearing capacity of soil is defined as the minimum gross pressure intensity at the base of the foundation at which the soil fails in shear. **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.**	2 M 2 M **or** 2 M 2 M
e)	**State any four assumptions in the theory of Terzaghi's analysis of bearing capacity.**	**04 M**
	Assumptions in Terzaghis analysis 1. The soil is homogeneous and isotropic and its shear strength is represents by Coulomb's equation. 2. The strip footing has rough base and the problem in essentially two dimensional. 3. The shear strength of soil above the base of footing is neglected. The soil above the base is replaced by a uniformity surcharge γD_f 4. The load on the footing is vertical and is uniformly distributed. 5. The footing is long i.e. L/B ratio is infinite, where B is the width and L is the length of footing. 6. The elastic zone has straight boundaries inclined at $\psi = \varphi$ to the horizontal, and the plastic zones fully developed.	Any Four 1M each

Q .NO	SOLUTION	MARKS
f)	**Draw a neat sketch of plate load test set-up for gravity loading.**	**04 M**
	 **Plate load test : Reaction by gravity loading**	**02M Section** **02M Plan**
Q.6	**Attempt any four of the following**	**16 M**
a)	**Define active earth pressure and passive earth pressure. Draw sketches for each.**	**04 M**
	Active Earth Pressure: - It is pressure exerted on retaining wall resulting from slight movement of wall away from filling. **Passive Earth Pressure: -** when the movement of the retaining wall is such that the soil tends to compress horizontally. 	1 M 1M 2 M (fig)

Q .NO	SOLUTION	MARKS
b)	**Compute the intensity of active and passive earth pressure at depth 8.7 m in dry cohesion less sand with angle of internal friction of 28° and unit weight of 18 kN/m^3.Also calculate total earth pressure and its line of action**	**04 M**

Q.6 b] Given

$H = 8.7\,m$ in dry cohesionless sand

$\phi = 28°$

$\gamma = 18\ kN/m^3$

To find :- 1) intensity of active pressure
2) intensity of passive pressure
3) Total active pressure
4) line of action

1) Intensity of active pressure, $P_a = K_a \cdot \gamma \cdot H$ — 1 M

coeff. of active earth pressure, $K_a = \frac{1-\sin\phi}{1+\sin\phi} = \frac{1-\sin 28}{1+\sin 28}$

$\boxed{K_a = 0.36}$

$\therefore P_a = 0.36 \times 18 \times 8.7$

$\boxed{P_a = 56.376\ kN/m^2}$

2) Intensity of passive pressure, $P_p = K_p \cdot \gamma \cdot H$ — 1 M

coeff. of passive earth pressure, $K_p = \frac{1+\sin\phi}{1-\sin\phi} = \frac{1+\sin 28}{1-\sin 28}$

$\boxed{K_p = 2.76}$

$\therefore P_p = 2.76 \times 18 \times 8.7$

$\boxed{P_p = 432.216\ kN/m^2}$

3) Total active pressure per unit length — 1 M

$P_a = \frac{1}{2} \cdot K_a \cdot \gamma \cdot H^2 \times 1$

$= \frac{1}{2} \times 0.36 \times 18 \times 8.7^2 \times 1$

$\boxed{P_a = 245.23\ kN}$

4) Line of action

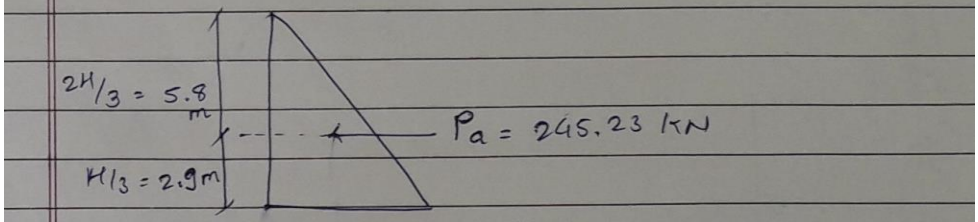
The total pressure 'Pa' is acting at $H/3$ from base

i.e. $\frac{8.7}{3} = 2.9\,m$ from base — 1M

OR

The total pressure Pa is acting at $2H/3$

i.e. $\frac{8.7 \times 2}{3} = 5.8\,m$ from top surface



pressure distribution diagram

Q .NO	SOLUTION	MARKS
c)	**Define compaction and state purpose of compaction.**	**04 M**
	Define Compaction : Instant compression of soil under dynamic load is called compaction **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 increase the permeability of soil, this is required for earth dam 3.To reduce settlement of structure after the contruction. 4. To reduce danger of piping , this is required for seepage control of earth dam. 5.To increase resistance towards erossion of soil by rain and other causes.	2M 2M
d)	**State suitability of following compaction equipments (i) Smooth wheel roller (ii) Sheep foot roller, (iii) Rammer and (iv) Vibrator**	**04 M**
	Types of Compaction Equipment: - **i) Compaction by Rolling: -** **a) Smooth wheel rollers :** **Suitability:** These rollers best suitable for 5ubgrade or base coarse compaction of cohesion less soils. , **b) Pneumatic tyred rollers:** **Suitability:** Pneumatic tyred rollers are effective for compacting cohesive as well as cohesion less soils. Light rollers are effective for compacting soil layers of small thickness **c) Sheep foot roller :** **Suitability :** Suitable only for fine grained soil **ii) Compaction by Rammers:** Rammers or tampers are mainly two types, hand operated and mechanical rammer. A hand operated rammer consists of a block of iron or stone about 3 to 5 kg in mass, attached to a wooden rod. The tamper is lifted for about 0.3 m and dropped on the soil to be compacted. A mechanical rammer is operated by compressed air or gasoline power. It is much heavier, about 30 to 50 kg. Ramming equipment's consists of three types: dropping weight type, internal combustion type and pneumatic type. Rammers or tampers are used to compact the soil. **Suitability:** Suitable for all types of soil **iii) Compaction by vibratory compactors :** The vibrating equipment, mounted on screeds, plates or rollers are of two Types: a) Dropping weight type and b) Pulsating hydraulic type. By giving vibration to Soil, soil particles are packed together and compaction of soil is achieved. **Suitability:** Suitable for compacting granular soils. with no fines in layer up to 1 m thickness	**1M Mark each**

e) State difference between compaction and consolidation (any four points). — **04 M**

Sr.No.	Compaction	Consolidation
1	Instant compression of soil under dynamic load is called as compaction	Gradual compression under steady load is called as consolidation.
2	The settlement of structure of prevented due to compaction.	The settlement of structure takes place due to consolidation.
3	Compaction is carried out for improving properties of soil.	Consolidation occurs naturally due to structural load and it does not improve properties of soil.
4	Compaction is an artificial process.	Consolidation is a natural process.
5	Compaction is done before constructing any structure.	Consolidation takes place after constructing the structure.

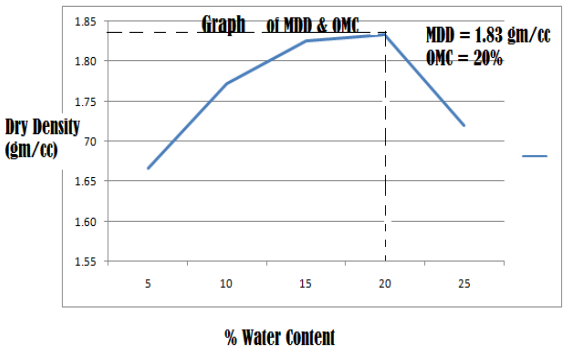
Write Any Four 1Mark each

f) Following observations were made using standard proctor test on a soil sample. — **04 M**

Bulk density (gm/cc)	**1.75**	**1.95**	**2.10**	**2.20**	**2.15**	**2.05**
Water content (%)	**5**	**10**	**15**	**20**	**25**	**30**

Determine OMC and MDD by plotting compaction curve.

Sr. No.	Bulk Density (gm/cc)	Water Content (%)	Dry Density
1	1.75	5	1.670
2	1.95	10	1.770
3	2.1	15	1.826
4	2.2	**20**	**1.833**
5	2.15	25	1.720
6	2.05	30	1.580



(2M:MDD 2M :OMC)