TED (15) – 5013

(REVISION — 2015)

Reg. No...

Signature ....

DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/ MANAGEMENT/COMMERCIAL PRACTICE — OCTOBER, 2018

GEOTECHNICAL ENGINEERING

[*Time* : 3 hours

(Maximum marks : 100)

PART — A

(Maximum marks : 10)

Marks

I Answer *all* questions in one or two sentences. Each question carries 2 marks.

1. Identify residual and transported soil.
2. Define plasticity index.
3. State Darcy's law.
4. List the two geophysical methods of soil exploration.
5. Describe proportioning of footings. (5×2 = 10)

PART — B

(Maximum marks : 30)

II Answer any *five* of the following questions. Each question carries 6 marks.

1. Analyze soil as a three phase system.
2. Discuss the importance of effective stress in the engineering behavior of soil.
3. Explain the procedure for finding out coefficient of permeability by variable head permeability test.
4. Identify the objectives of soil investigation.
5. Explain general and local shear failure.
6. Prepare the plan of a rectangular combined footing and list the circumstances under which it is essential.
7. Compile the precautions to be taken to avoid tilts and shifts during well sinking.

(5×6 = 30)

Marks

PART — C

(Maximum marks : 60)

(Answer *one* full question from each unit. Each full question carries 15 marks.)

UNIT — I

III (a) Derive a relationship between voids ratio, water content, specific gravity and degree of saturation. 7

(b) Explain the corrections to be applied to hydrometer. 8

OR

IV (a) A soil specimen has a water content of 10% and a wet unit weight of 20 kN/m^3. If the specific gravity of the solid is 2.7, determine the dry unit weight, voids ratio and degree of saturation. Take $\gamma_w = 10$ kN/m^3. 8

(b) Explain the three Atterberg's limit. 7

UNIT — II

V (a) Explain the difference between seepage velocity and discharge velocity. 7

(b) Discuss the factors affecting compaction. 8

OR

VI (a) Define the terms free water, adsorbed water and capillary water. 6

(b) Plot the results of Standard Proctor Test in a graph and explain the features optimum moisture content, maximum dry density and zero air voids line. 9

UNIT — III

VII (a) Distinguish between disturbed and undisturbed soil samples. 6

(b) Describe the limitations of Plate Load Test. 9

OR

VIII (a) Explain the wash boring method of soil exploration. 8

(b) Describe the Split Spoon Sampler and its use. 7

UNIT — IV

IX (a) Compile the objectives of foundation. 6

(b) Explain the classification of piles. 9

OR

X (a) Distinguish between shallow and deep foundation. 6

(b) Describe the parts of well foundation. 9

(17) 1

SCHEME OF VALUATION

(Scoring Indicators)

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	PART A			
I 1,	Residual soil: The soil stays at the place of its formation just near the parent rock.	1		
	Transported soil: The soil deposited at a place away from the place of its origin	1	2	
2,	The plasticity index is defined as the numerical difference between the liquid limit and plastic limit of soil i.e: $I_P = W_L - W_P$	2	2	
3,	For laminar flow conditions in a saturated soil mass, the rate of flow or discharge is proportional to the hydraulic gradient i.e: $Q = k i A$ $Q \Rightarrow$ discharge, $k \Rightarrow$ Coeff of permeability, $i \Rightarrow$ hydraulic gradient, $A \Rightarrow$ C/s area	2	2	
4,	(i) Seismic refraction method	1		
	(ii) Electrical resistivity method	1	2	
5,	To reduce the differential settlement due to live load variations for footings on fine grained soils, all the footings are designed in such a proportion that they have equal pressure under the service loads. Thus all the footings would settle by equal amounts		2	10
	PART B			
II	The three constituents in a soil mass are (i) Solid particle (ii) air (iii) water. These are blended			

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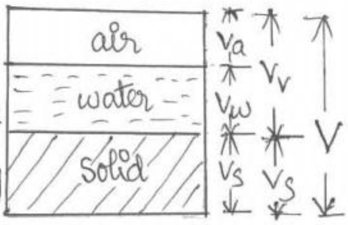
	together to form a complex material. For the purpose analysis, it is convenient to represent the soil mass by a diagram in which the solid particles are segregated and placed in the lower layer is called a three phase diagram  uses (i) To analyse the various properties of soil (ii) To establish the relationship between various properties (iii) To explain compaction, consolidation, drying, saturation etc.	1.5 uses → 1.5 Fig → 3	6	
2.	(i) Compression of soil depend on the effective stress. Compression = $f(\sigma')$ where f is a function & σ' is eff. stress. when σ' increases, compression occurs, and cause settlement of structure. (ii) when effective stress is changed, the shear strength changes. Then the stability of slopes, the earth pressure against retaining structure and the bearing capacity of soil which depends on shear strength will also change. (iii) when eff: stress changes, the voids ratio of soil also changes and the permeability which depends on voids ratio will also change. (iv) For a cohesionless soil, quicksand condition will be developed when effective stress is equal to zero	1.5 1.5 1.5 1.5	6	
3.	This test is used to determine the coefficient of permeability of less permeable soils such as fine sands and silts. Procedure: 1. A cylinder containing the soil sample is placed on a base [Perforated disc] 2. A graduated standpipe of known diameter is connected to the soil sample.			

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	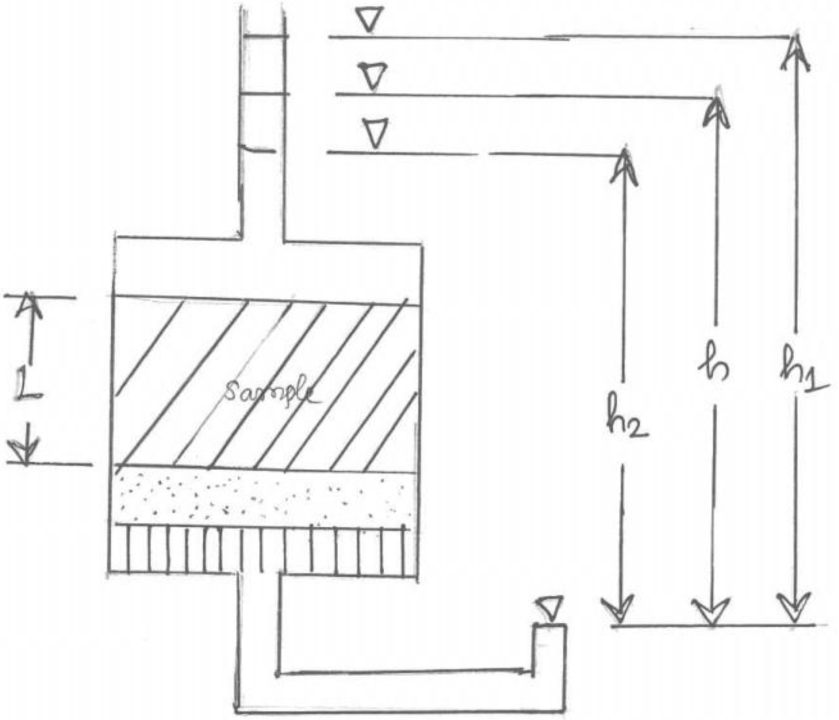	2		
	3. The test is conducted by filling the standpipe with de-aired water and allowing flow to take place through the Sample. 4. During the test, the waterlevel will continuously drop and the height of water in the stand pipe is recorded at several time intervals during the test. 5. Any one pair of measurements, namely the time taken for the head to fall from h_1 to h_2 will yield one value of 'k'	/		
	6. The average value of K can be computed from several such readings. As per Darcy's law $q = KiA = k \cdot \frac{h}{L} \cdot A$ h' – flow head at any time between t_1 & t_2.	3		
	K can be from the eq: $K = 2.303 \frac{aL}{At} \log_{10} h_1/h_2$]	1	6	

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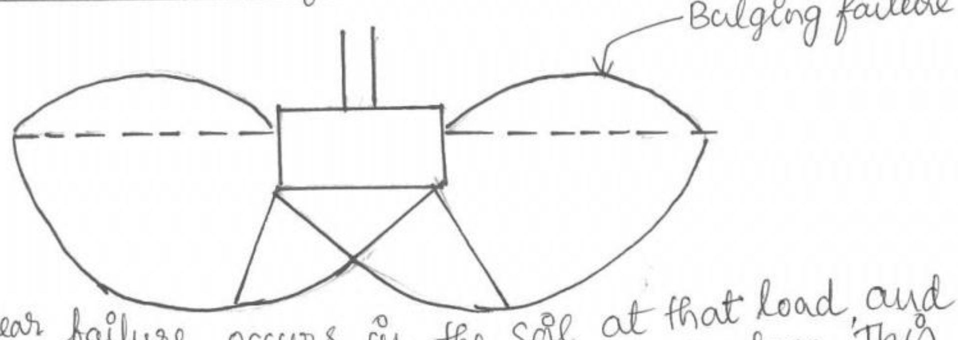
4.	1. To Select the type & depth of foundation for a given structure. 2. To determine the bearing capacity of the soil 3. To estimate the probable maximum and differential settlement. 4. To establish the ground water level & to find properties of water 5. To predict lateral earth pressure against retaining walls & abutments 6. To select suitable construction technique 7. To ascertain the suitability of the soil as a construction material 8. To predict and to solve potential foundation problem 9. To investigate the safety of the existing structures any six	1x6	6	
5.	1. General shear failure  A shear failure occurs in the soil at that load and the failure surfaces extend to the ground surface. This type of failure is general shear failure. (i) This failure takes place abruptly and is catastrophic (ii) A heave on the sides is always observed. (iii) A slight downward movement of footing develop fully plastic zones (iv) If relative density > 70% — general shear failure occurs. eg: dense sand.	1.5		
	2. Local Shear failure Loose soil begins to fail at a load much less than the ultimate bearing capacity.	1.5		

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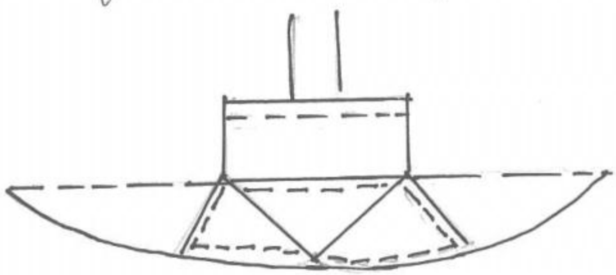
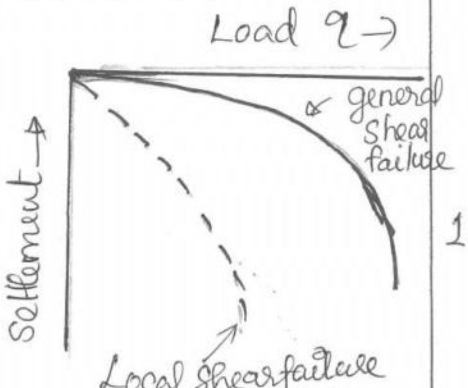
	i) The soil beneath the foundation gets compressed significantly. eg: loose sand or soft clays. (ii) very slight bulging of ground surface adjacent to the foundation is found (iii) well defined pattern of failure is observed only under the foundation and beyond the edges of foundation (iv) when $\phi \leq 29°$, local shear failure is likely to occur (v) If relative density $< 20\%$, local shear failure occur	1.5		
	 	1.5	6	
6.	1) The outer surface of the well curb and steining should be regular and smooth 2) The dia: of curb should be kept about 4 to 8cm larger than the outer dia: of steining, and the well should be symmetrically placed 3) The cutting edge should be of uniform thickness and sharpness 4) Dredging should be done uniformly on all sides in a circular well and in both pockets of a twin well.	4x1.5	6	

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	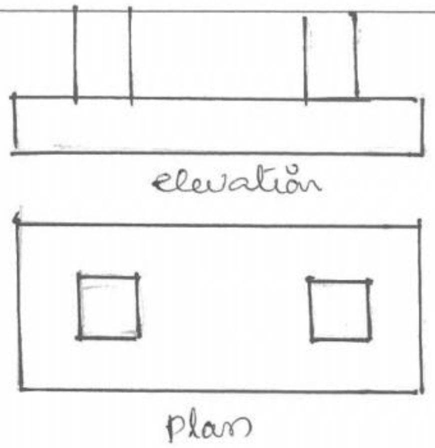 A combined footing supports two columns. May be rectangular or trapezoidal			
	1) It is used when the two columns are so close to each other that their individual footings would overlap	1.5		
	2) It is used when the property line is so close to one column that a spread footing would be eccentrically loaded when kept entirely within the property line	1.5		
		fig: 3	6	30
	PART C			
III a)	voids ratio ⇒ e ; water content ⇒ ω ; Sp. gravity ⇒ G and degree of saturation ⇒ S_r			
	from the definition of water content, $\omega = \frac{M_w}{M_s} = \frac{V_w \rho_w}{V_s \cdot \rho_s}$	2		
	" " " " degree of saturation $= S_r = \frac{V_w}{V_v}$ $\therefore V_w = S_r . V_v$	2		
	" " " Specific gravity $= G = \frac{\rho_s}{\rho_w}$ or $\rho_s = G \rho_w$	2		
	$\therefore$ water content $\omega = \frac{V_w}{V_s} \cdot \frac{\rho_w}{G \rho_w} = \frac{S_r . V_v}{V_s} \cdot \frac{1}{G}$	1		
	ie: $e S_r = G . \omega$		7	

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B)	(i) Meniscus Correction (C_m):- Since the suspension is opaque, the observations are taken at the top of the meniscus. As the marking on the stem increases downwards the correction is positive. It is determined from the readings at the top and bottom of meniscus in the comparison cylinder. Corrected hydrometer reading $= R_h = R_h' + C_m$	2		
	(ii) Temperature Correction (C_t):- The hydrometer is generally calibrated at 27°C. If the temperature of suspension is different from 27°C, temperature correction is to be applied. The temperature correction is obtained from the charts supplied by the manufacturer.	2		
	(iii) Dispersion agent correction (C_d):- Addition of the dispersing agent to the soil specimen causes and increases in the Sp.gravity of the suspension. The dispersing agent correction is always negative. It is determined by noting the hydrometer reading in clear water and again in the same water after adding the dispersing agent.	2		
	$\therefore R = R_h' + C_m \pm C_t - C_d$.	2	8	15
IV a)	Given, water content, $w = 10\% = 0.1$ wet unit weight, $\gamma = 20\ kN/m^3$ Sp.gravity of solids, $G = 2.70$ (i) Dry unit weight, $\gamma_d = \frac{\gamma}{1+w} = \frac{20}{1+0.1} = 18.18\ kN/m^3$	3		

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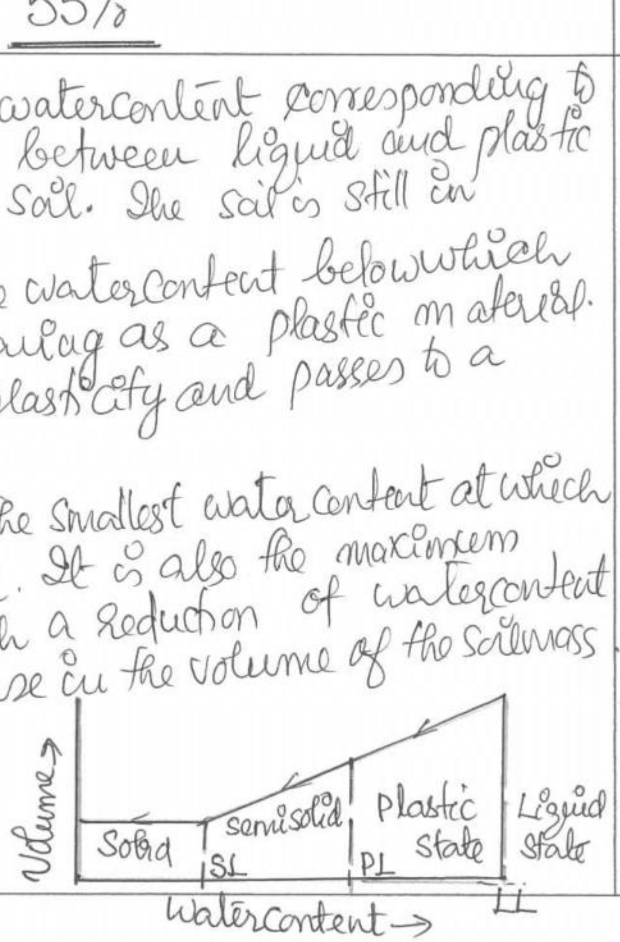
	$\gamma_\omega = 10\ kN/m^3$ (given) $\gamma_d = \frac{G.\gamma_\omega}{1+e}$ or $1+e = \frac{G\gamma_\omega}{\gamma_d} = 2.70 \times \frac{10}{18.18}$ ii). Voids ratio, $e = \frac{2.70\times10}{18.18} - 1 = 0.49$	3		
	iii) Since $eS_r = G\omega$ Degree of Saturation $= S_r = \frac{G\omega}{e} = \frac{2.70\times0.1}{0.49} = 0.551$ $= 55\%$	2	8	
b)	Liquid limit :- It is the water content corresponding to the arbitrary limit between liquid and plastic state of consistency of a soil. The soil is still in liquid state	2		
	Plastic limit :- It is the water content below which the soil stops behaving as a plastic material. The soil loses its plasticity and passes to a semisolid state.	2		
	Shrinkage limit :- It is the smallest water content at which the soil is saturated. It is also the maximum water content at which a reduction of water content will not cause a decrease in the volume of the soil mass.	2		
		1	7	15

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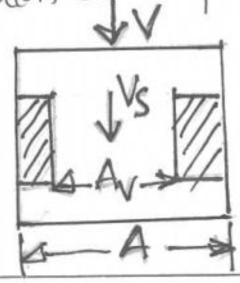
Qst.No		Split up score	Sub Total	Total
V a)	Discharge velocity :- It is a fictitious velocity obtained by dividing the total discharge (Q) by the total cross sectional area (A.) But the total C/s area of soil mass is composed of areas of solids and voids and since flow cannot occur through the sectional areas of solids, discharge velocity is imaginary.	3		
	Seepage velocity: The true or actual velocity with which water percolates through a soil is called the velocity of percolation or seepage velocity.	3		
	$V_S = \frac{Q}{A_V}$ 	1	7	
b)	i) water content :- At low water content, the soil is stiff and offers more resistance to compaction. When water content is increased, the soil mass becomes more workable. Dry density of soil increases with increase in water content till the optimum water content is reached. (ii) Amount of compaction :- As compactive effort increases, dry density will increase and to decrease optimum water content			

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Qst.No		Split up score	Sub Total	Total
	(iii) Type of Soil :- Coarse grained soil can be compacted to higher density than fine grained soils. A well graded sand attains a much higher dry density than a poorly graded soil. Cohesive soils attains a relatively lower maxi: dry density. Heavy clays of very high plasticity have very low dry density (iv) Method of Compaction :- For the same amount of compactive effort, the dry density will depend upon the method of compaction utilizes kneading action, dynamic or static action (v) Admixtures :- To improve compaction characteristics commonly used admixtures are lime, cement and bitumen. any 4 points	2x4	8	15
VI	a) Free water: water which moves in the pores of the soil under the influence of gravity. It flows from one point to the other where there is a difference of total head.	2		
	Adsorbed water :- The water held by electrochemical forces existing on the soil surface. The quantity of adsorbed water depends upon the colloidal fraction in soil. This is important for clayey soils	2		
	Capillary water : The water held in the interstices of soils due to capillary forces. Water rises in small diameter capillary tubes because of adhesion and cohesion.	2	6	

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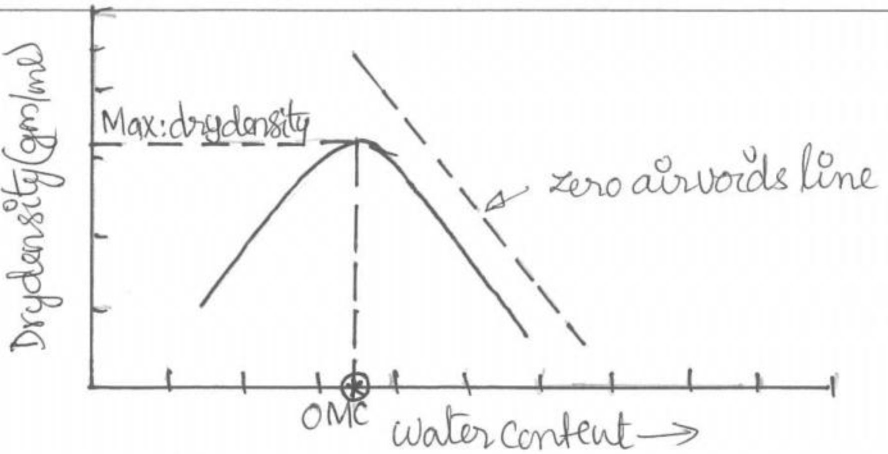
Qst.No		**Split up score**	**Sub Total**	**Total**
b)		3		
	Optimum water content :- The water content corresponding to the maximum drydensity is known as optimum water content or OMC.	2		
	Maxi: dry density :- Dry density initially increases with increase in water content till a maximum value is reached. This is called maxi: dry density with further increase in water content, dry density decreases.	2		
	Zero air voids line :- The line indicating the theoretical maxi: drydensity can be plotted along with the compaction curve. This is called zero air voids line or 100% saturation line.	2	9	15
VII	Disturbed Soil Sample: These are the samples in which the natural structure of the soil gets disturbed during sampling. These samples represent the composition and the mineral content of the soil.			

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	These can be used to determine the index properties of the soil such as grain size, plasticity characteristics, specific gravity	3		
	Undisturbed Sample :- These are the sample in which the natural structure of the soil and the water content are retained. It is impossible to get truly undisturbed sample. These are used for determining the engineering properties of soil such as compressibility, shear strength & permeability	3	6	
	b) (i) Size effect :- The results of plate load test reflect the strength and settlement characteristics of the soil within the pressure bulbs. As the pressure bulb depends upon the size of loaded area, it is much deeper for the actual foundation as compared to that of the plate. (ii) Scale effect : The ultimate bearing capacity of saturated clays is independent of the size of the plate but for cohesionless soils, it increases with the size of the plate. To reduce scale effect, the test should be repeated with plates of 2 or 3 diff. sizes (iii) Time effect :- It is a test of short duration ex: for clayey soils, it doesnot give the ultimate settlement. (iv) Interpretation of failure load :- The failure load is not well-defined except in the case of a general shear failure. (v) Reaction load :- It is not practicable to provide a reaction of more than 250 KN.	6x1.5	9	15

(VI) water table :-

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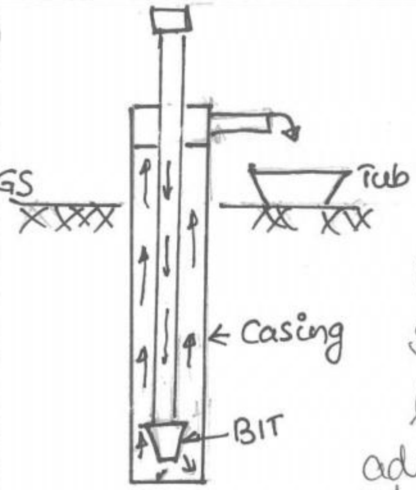
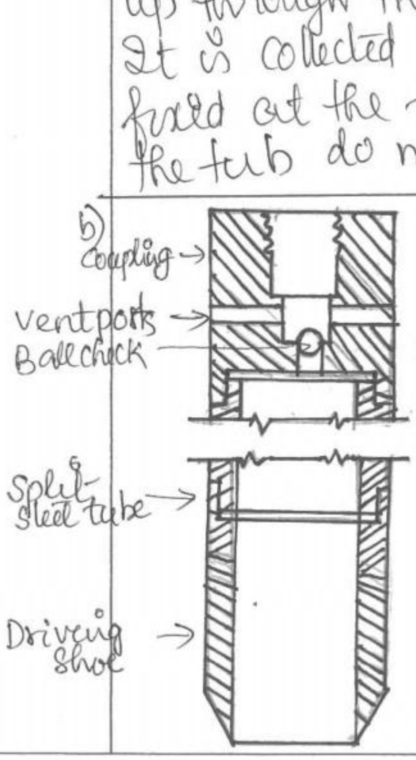
Qst.No	**Scoring Indicators**	**Split up score**	**Sub Total**	**Total**
VIII a)	 A hole is drilled and a casing pipe of 2 to 3m long is fixed. A hollow drill rod is inserted and water under it is pumped in. Water emerges as a strong jet through the chopping bit at bottom. The hole is advanced down by the combined action of chopping and jetting action. The water and disintegrated soil particles are rising up through the annular space around the drill rod. It is collected in a tub through a T-shaped pipe fixed at the top of casing. The soil samples from the tub do not represent the true structure of soil.	fig:3 +5	8	
b)	 Standard Split-Spoon Sampler consist mainly of 3 parts i) Driving shoe, made of tool steel, about 75 mm long ii) Steel tube about 450 mm long split longitudinally in two halves iii) Coupling at the top of tube about 150 mm long (iv) The inside dia of split tube is 38 mm & outside dia 50mm			

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	The coupling head may be provided with check valve and 4 venting ports of 10mm dia to improve sample recovery. This sampler is used in Standard Penetration test. After the bore hole has been made, the sampler is attached to the drilling rod and lowered into the hole. The sample is collected by forcing the sampler into the soil by repeated blows of a drop hammer. The sampler is then withdrawn.	fig: 3 + 4	7	15
IX a)	i) To transfer the load of superstructure to the soil below ii) To distribute the load evenly to the capacity of soil iii) To make a levelled surface for further construction iv) To control the settlement and preventing the unequal settlement v) To give stability to structure.	4x1.5	6	
b)	1) According to material used: 1. Steel pile 2. Concrete pile 3. Timber pile 4. Composite pile	2		
	2) According to mode of Transfer of loads: 1. End bearing pile 2. Friction pile 3. Combined end bearing & friction	2		
	3 According to method of installation: 1. Driven pile 2. Driven & cast in situ 3. Bored & " 4. Screw pile 5. Jacked pile	2		

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	4. Classification based on use: Load bearing pile, Compaction pile, Tension pile, Sheet pile, Fender pile, Anchor pile	2		
	5. Classification based on displacement of soil: Displacement piles, Non displacement piles	1	9	15
X a)	Shallow foundation:- It transmits the load to the Strata at a shallow depth. A foundation is said to be shallow, if it is laid at a depth equal to or less than its width. eg: Strip footing, Raft foundn, Strap footing etc.	3		
	Deep foundn:- A foundation which transmits the load at considerable depth below the ground surface. These are suggested when the soil at or near the ground surface is not capable of supporting a structure and Surface soil is unsuitable for Shallow foundation. This is costlier than shallow foundn. eg: piles, piers, Caissons	3	6	

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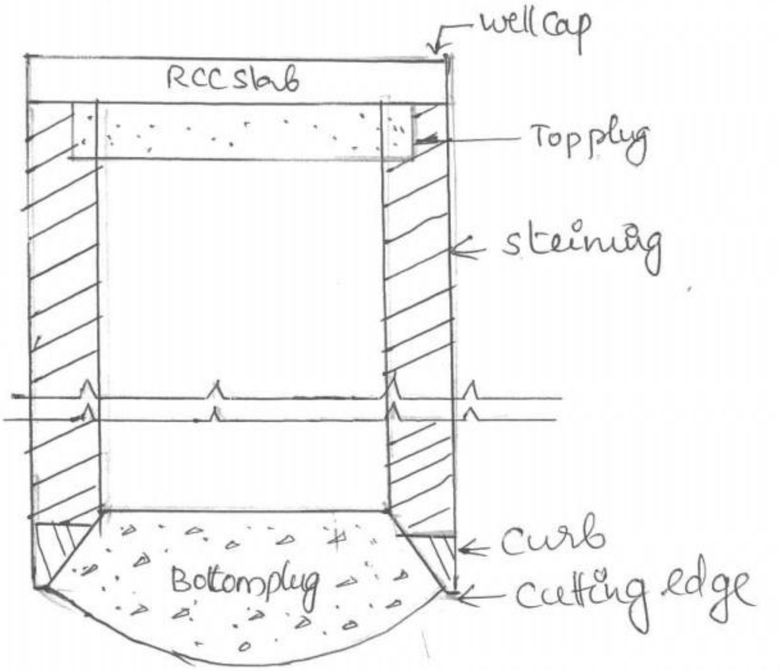
b)	 1. well curb :- This is for supporting the weight of well with partial support at the bottom of the cutting edge. It has also to withstand stress due to sand blows, as well as due to light blasting required when boulder obstruct well sinking 2. Cutting edge :- The cutting edge should have as sharp an angle as practicable for knifing into the soil An angle of slope 1 horizontal to 2 vertical The lower portion is strapped with 12 mm steel plates	3		

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	3 well steining: – The walls of the well are known as steining. It is made of brick masonry stone masonry, PCC or RCC. Later it became an integral part of structure. It should be heavy enough to overcome frictional resistance during sinking. 4 Bottom plug: – The bottom plug of concrete to be designed for an upward load equal to the soil pressure minus self wt of bottom plug and filling. The bottom plug is made bowl shaped so as to have inverted arch action. No 2ft because of underwater concreting. 5 well cap: – RCC well cap is provided at the top to transmit the load of the superstructure. 6. Top plug: – It is formed by concreting	1x6	9	15