5013 (2)

N19-00184

TED (15) – 5013 Reg. No. ....

(REVISION — 2015) Signature ....

DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/ MANAGEMENT/COMMERCIAL PRACTICE — OCTOBER, 2019

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. Define the term percentage of air voids.
2. Differentiate the residual and transported soil.
3. Differentiate free water and held water.
4. Define ultimate bearing capacity of soil.
5. List the classification of pile foundation based on mode of transfer of loads. (5×2 = 10)

PART — B

(Maximum marks : 30)

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

1. List the importance of Soil Engineering.
2. Describe the determination of water content of soil by oven drying.
3. Explain effective pressure, pore pressure and neutral pressure.
4. List the factors affecting permeability.
5. Describe the method of wash boring soil exploration.
6. Explain the need of general exploration and detailed exploration.
7. Explain combined footing of spread foundation with sketches. (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 the functional relationship between e, G, w and Sr. 6

(b) Explain in detail the method of sieve analysis of coarse grained soil. 9

OR

IV (a) A compacted soil sample with a bulk unit weight of 19.62 KN/m^3 has a water content(w) of 15%. If the specific gravity of soil is 2.65, determine the dry density, voids ratio and degree of saturation (Sr). 6

(b) Describe the procedure of core cutter method for find out the field density of soil. 9

UNIT — II

V (a) State Darcy's Law. 6

(b) Describe constant head method for finding coefficient of permeability of soil. 9

OR

VI (a) Explain the factors affecting compaction. 6

(b) Describe the procedure of standard proctor test. 9

UNIT — III

VII (a) Explain effect of water table in bearing capacity of soil. 6

(b) Describe the method of standard penetration test. 9

OR

VIII (a) List the limitations of plate load test. 6

(b) Explain seismic refraction method. 9

UNIT — IV

IX (a) Distinguish shallow and deep foundation. Give two examples of each. 6

(b) Describe pile erection methods. 9

OR

X (a) Draw the section and mark the component parts of well foundation. 6

(b) Describe the rectification of tilt and shift with the sketch. 9

SCHEME OF VALUATION

Revision – 2015

Course Title :- Geotechnical Engineering

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Course Code : 5013

Qst. No	Scoring Indicator	Split up score	Sub total	Total
	PART – A			
I 1.	Percentage of air voids is defined as the ratio of the volume of air voids to the total volume of the soil mass. $n_a = \frac{V_a}{V} \times 100$.			
2.	When the soil stays at a place ~~away from the place~~ of its formation just above the parent rock, it is known as residual soil. When the soil deposited at a place away from the place of its origin it is called transported soil.			
3.	Water that is free to move through a soil mass under the influence of gravity is known free water. Held water is the water that is held within a soil mass by soil particles.			
4.	Ultimate bearing capacity is the pressure at the base of foundation at which the soil fails in shear.			
5.	(1) End bearing pile (2) Friction pile (3) Combined end bearing and friction piles.			

Qst. No	Scoring Indicator	Split up score	Sub total	Total
	PART - B			
II 1.	(a) Foundation design and construction (b) Retaining structures: (c) Pavement design (d) Design of earth dam. (e) Design of embankment and excavation (f) Design of underground structures:– tunnels, shaft and conduits etc.			
2.	(i) Weigh an evaporating dish. (W_1) (ii) Place about 30gm of wet soil sample in the dish and weigh. (W_2) (iii) Place the dish with the wet soil in the oven, allow it to dry for 24 hours at 105° to 110°C. (iv) Remove the dish and dry soil from the oven, allow it to cool in desiccator and find out the weight (W_3) (v) Water content $w = \frac{W_w}{W_d}$ W_w = wt of water $= W_2 - W_3$ W_d = wt of oven dry soil $= W_3 - W_1$ $w = \frac{W_2 - W_3}{W_3 - W_1} \times 100$			

Qst. No	Scoring Indicator	Split up score	Sub total	Total
3.	Effective pressure :- is the pressure transmitted from particle to particle through their points of conduct through the soil mass above the plane. This pressure also known as intergranular pressure. This pressure is effective in decreasing the voids ratio of the soil mass and mobilising its shear strength. Pore pressure or neutral pressure :- is the pressure transmitted through the pore fluid. This pressure equal to water load per unit area above the plane. This pressure does not have any measurable influence on the voids ratio or any other mechanical property of the soil, such as the shearing resistance.			
4.	(i) Effect of size and shape of particle (ii) Effect of properties of pore fluid (iii) Effect of voids ratio (iv) Effect of structural arrangement of particle and stratification. (v) Effect of ~~structural arrangement of particle and~~ degree of saturation and other foreign matter (vi) Effect of absorbed water.			

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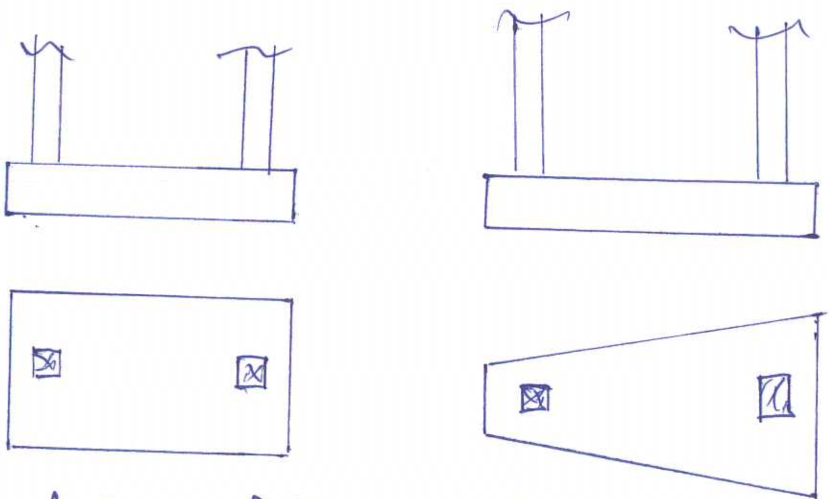
Qst. No	Scoring Indicator	Split up score	Sub total	Total
6	The aim of general exploration is to determine the depth, thickness, extent and composition of each soil stratum at the site. The depth of the bed rock and the ground water table is also determined. The preliminary explorations are generally in the form of a few boring or test pits. Tests are conducted with cone penetrometers and sounding rods to obtain information about the strength and compressibility of soils. Detailed Exploration :- The purpose of detailed explorations is to determine the engineering properties of the soil in different strata. It include an extensive boring programme, sampling and testing of the sample in a laboratory.			
7.	 A common footing constructed for two or more columns is called combined footing. It may be rectangular in shape if both the columns carry equal loads, or can be trapezoidal if there is limitations and they carry unequal loads. Generally they are constructed of reinforced concrete.			

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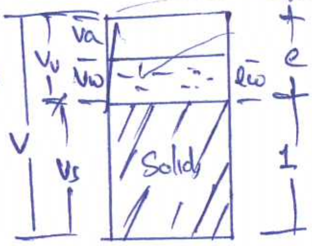
Qst. No	Scoring Indicator	Split up score	Sub total	Total
III (a)	(see below)			6

PART - C

UNIT - I

III (a) Relationship b/w e, G, w and Sr.

In fig e_w represent Vol. of water, e represent the Vol. voids and the Vol. of solid is equal to unity.



Now $S_r = \frac{V_w}{V_v} = \frac{e_w}{e}$

$\therefore e_w = e S_r$ ——— (I)

The term 'e_w' is known as the water voids ratio.

For fully saturated soil $e_w = e$

Now $w = \frac{W_w}{W_d} = \frac{V_w \cdot \gamma_w}{V_s \gamma_s} = \frac{e_w \cdot \gamma_w}{1 \cdot \gamma_s}$

But $G = \frac{\gamma_s}{\gamma_w}$ or $\gamma_s = G \gamma_w$

$\therefore w = \frac{e_w \cdot \gamma_w}{G \cdot \gamma_w} = \frac{e_w}{G}$

$e_w = wG$ ——— (2)

equating the eqn $e_w = e \cdot S_r$ and $e_w = wG$, we get

$e \cdot S_r = wG$

$e = \frac{wG}{S_r}$

6

6

Qst. No	Scoring Indicator	Split up score	Sub total	Total
II (b)	Theory :- The Soil is sieved through a set of Seives. The material retained on different Sieves is determined. The percentage of material retained on any Sieve is given by $P_n = \frac{M_n}{M} \times 100$ where M_n = Mass of soil retained on sieve 'n' M = Total mass of the Sample. The Cumulative percentage of the material retained, $C_n = P_1 + P_2 + \cdots P_n$ Where P_1, P_2 etc are the percentages retained on Sieves 1', 2' etc. which are Coarser than Sieve 'n'. The Percentage finer than the Sieve 'n' $N_n = 100 - C_n$ Procedure :- 1) A Soil sample of about 1000gm may be taken, dried and Cooled and should be then passed through the set of Sieves starting with the largest. 2) Sieving can be done using mechanical Sieve shaker or manually. 3) On Completion of Sieving the material retained on each Sieve shall be weighed on a balance. 4) The percentage weight retained on each Sieve may calculated. 5) Determine the cumulative percentage retained and the percentage finer.			9

S. No.	I.S Sieve	Particle size	Mass retained	% retained	Cumulative % retained	Percentage of finer (N)

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Qst. No	Scoring Indicator	Split up score	Sub total	Total
	OR			
IV(a)	Bulk unit weight $\gamma = 19.62\ kN/m^3$ water content $w = 15\% = 0.15$ $G = 2.65$ $\gamma_w = 10\ kN/m^3$ (i) Dry density $\gamma_d = \frac{\gamma}{1+w} = \frac{19.62}{1+0.15} = \underline{17.06}$ (ii) $1+e = \frac{G\gamma_w}{\gamma_d} = \frac{2.65\times10}{17.06}$ $1+e = 1.55$ $e = \underline{0.55}$ (iii) degree of saturation $S = \frac{wG}{e}$ $= \frac{0.15\times2.65}{0.55} = \underline{0.72}$			
IV(b)	Theory:- A cylinderical core cutter is a seamless steel tube. for determination of the ~~dry~~ density of the soil, the cutter is pressed into the soil mass so that it is filled with the soil. The cutter filled with the soil is lifted up. The mass of the soil in the cutter is determined. Then the dry density is obtained as $\gamma_d = \frac{\gamma}{1+w} = \frac{M/V}{1+w}$ Where M = Mass of the wet soil in the cutter V = Internal volume of the cutter. w = water content. Procedure: 1. Determine the ~~mass~~ internal diameter and height of the core cutter.			

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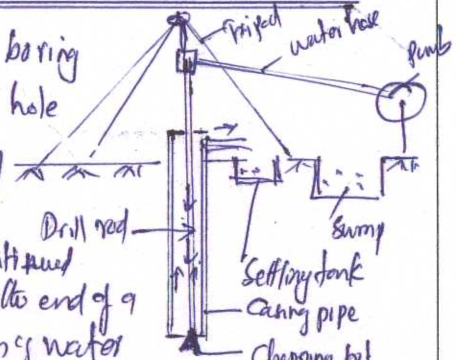
Qst. No	Scoring Indicator	Split up score	Sub total	Total
	(ii) Determine the weight (mass) (m) of the cutter. (iii) Level the surface of area of the soil mass to be tested (iv) Place the dolley over the top of the core cutter and press the core cutter in to the soil mass using the rammer. Stop the process of pressing when about 15mm of the dolley protrudes above the soil surface. (v) Remove the soil surrounding the core cutter and take out the core cutter (vi) Remove the dolley. Trim the top and bottom surface of the core cutter using a straight edge. (vii) weigh the core cutter filled with soil. (m_2) (viii) Remove the ~~core cutter of the~~ soil from the core cutter. Take a representative sample for the water content determination.			
II (b)	Wash boring is commonly used for boring in difficult soil. To start with the hole is advanced a short depth (2 to 3m) by auger and then casing pipe is pushed to prevent the sides. The hole is then continued by the use of a chopping bit fixed at the end of a string at a hollow drill rod. A stream of water under pressure is forced through the rod with bit, which loose the soil as the water flows up around the pipe. The soil water slurry is discharged in to a tub. The soil particle settle down in the tub and the clean water flows in to a sump which is re-used for circulation.  			

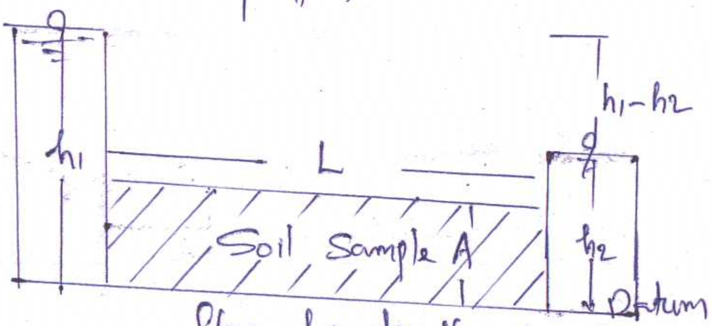
Qst. No	Scoring Indicator	Split up score	Sub total	Total
V(a)	Darcy's law			

The flow of water through soil is governed by Darcy's law. On the basis of experiments Darcy found that the velocity of flow is proportional to the hydraulic gradient for laminar flow in saturated soil.

$$v \propto i \quad \text{or} \quad v = ki$$

$$v = \frac{q}{A} = ki \quad \therefore \quad q = kiA$$

Where q = discharge per unit time = Q/t
A = Total c/s area of soil mass
i = hydraulic gradient = h/L
k = Darcy's coefficient of permeability
v = Velocity of flow



Flow of water through soil

If the soil sample of length 'L' and c/s area 'A' is subjected to differential head of water, $h_1 - h_2$, the hydraulic gradient 'i' will be equal to $\frac{h_1 - h_2}{L}$ and we have

$$q = k\left(\frac{h_1 - h_2}{L}\right)A$$

(b)

1. Take about 2.5 kg of representative specimen of soil and raise its water content to the OMC. Leave the soil mix in an air tight container for some time.
(2) Assemble the permeameter with compaction base in bottom and weigh accurate to 1 g. Put the 6cm' collar for the top end.

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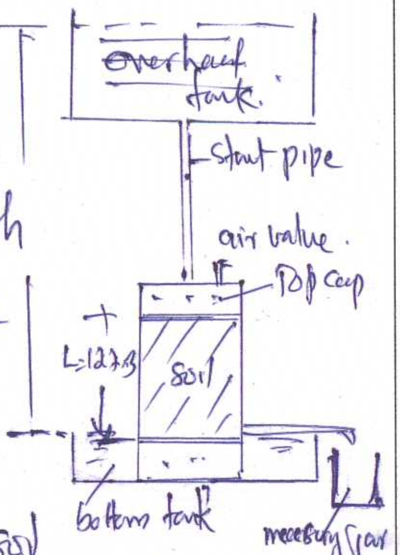
Qst. No	Scoring Indicator	Split up score	Sub total	Total
	(3) Compact the wet soil mix in two layers, with 15 blows of 2.5 kg dynamic ramming tool. Remove the collar and trim off the excess soil. weigh the mould assembly with soil. The difference of two weight taken would give the weight (w) of the soil compacted)  (4) Take small specimen of the soil in a container to the water content determination. (5) Place filter paper on the top of soil specimen and fix the perforated base plate on to it. (6) Turn the assembly upside down and remove the compaction plate. Place the top perforated plate on the top of the soil specimen and fix the top cap on to it after inserting the sealing gasket. (7) Place the mould assembly in the bottom tank and fill the bottom tank with water upto its outlet. (8) Connect the outlet tube of the constant head tank to the inlet nozzle of the permeameter. Adjust the hydraulic head. (9) Start the stop watch. Measure the quantity of water collected in the beaker under the outlet of the bottom tank during the convenient time interval. (10) Repeat the test twice more under the same interval. The constant hydraulic gradient 'i' is the head 'h' devided by the Length 'L' of the Sample. If the Length of the Sample is large the head lost over a Length of specimen is measured by inserting piezometric tubes. If Q is the total qty of flow in time interval 't' we have from Darcy's law, $q = Q/t = kiA$ $k = \frac{Q}{t} \cdot \frac{1}{iA} = \frac{Q}{t} \cdot \frac{L}{h} \cdot \frac{1}{A}$ $\therefore$ $k = \frac{QL}{Aht}$			

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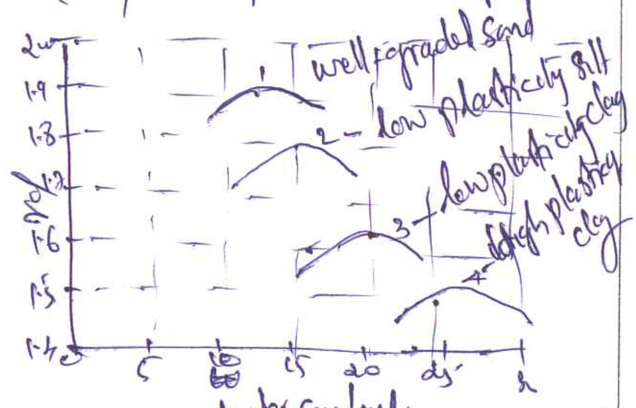
Qst. No	Scoring Indicator	Split up score	Sub total	Total

VI (a) OR **Factors affecting Compaction**

(i) water content :- At low water content, the soil is stiff and offers more resistance to compaction. As the water content is increased, the soil particles get lubricated. The dry density of the soil increases with an increase in the water content till the OMC is reached. . . . . . .

(ii) Amount of Compaction :- The effect of increasing the amount of compactive effort is to increase the maximum dry density and to decrease the OMC.

(iii) Type of Soil :- The dry density achieved depends upon the type of soil.



(iv) Method of Compaction:- Dry density achieved depends not only upon the amount of compactive effort but also on the method of Compaction. For the Same amount of Compaction, the dry density will depends upon whether the method of Compaction utilizes kneading action, dynamic action or static action.

(v) Admixture :- The compaction characteristics of the soils are improved by adding other materials known as admixture ie lime, cement and bitumen.

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Qst. No	Scoring Indicator	Split up score	Sub total	Total
VI(b)	(see below)			

VI(b) (1) The soil which is air dried in sieved through 4.75mm I.S. Sieve is taken (about 3kg)

(2) The soil is then mixed thoroughly with a small amount of water.

(3) The mould is cleaned dried and greased lightly. The mass of the empty mould with base plate but without collar is taken. The collar is then fitted to the mould. The mould is placed on a solid base and filled with the soil in three equal layers. Each layer of the soil is compacted by 25 blows of the rammer with a free fall of 31 cm. The soil surface is scratched with a spatula before the layer is placed.

(4) The collar is then removed and the soil is trimmed to the top of the mould and weighed. The wet weight of the soil is obtained by subtracting the weight of the empty mould from the total weight.

Let M_1 = mass of the mould without soil

M_2 = mass of mould plus soil

V = Volume of mould

Bulk density $\gamma = \frac{M_2 - M_1}{V}$ or $\frac{W_2 - W_1}{V}$ g/cm³

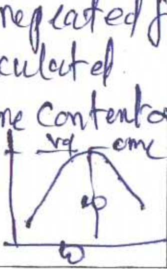
(5) Take the soil sample for the water content determination

$w = \frac{W_w}{W_d} = \frac{\text{wt of water}}{\text{wt of solid}}$

∴ dry density 'γ_d' $= \frac{\gamma}{1+w}$

(6) The soil removed from the mould. More water is added to the soil so as increased the water content by 2 to 3%. It is thoroughly mixed and filled as usual. Test is repeated for five or six times and each time dry density calculated.

(7). Compaction Curve: A graph is drawn b/w moisture content on X-axis and dry density on Y axis. The moisture content at which the max density is reached is the optimum moisture content (OMC)



Qst. No	Scoring Indicator	Split up score	Sub total	Total

UNIT- IV

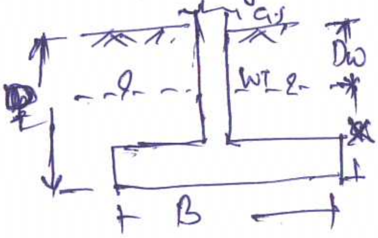
VII (a) The Ultimate bearing capacity has been developed based on the assumption that the water table is located at a great depth

$$q_u = CN_c + \gamma D_f N_q + 0.5 \gamma B N_\gamma$$

If the water table is located close to the foundation, the bearing capacity equation needs modification.

Case I :- water table located above the base of footing

The effective surcharge is reduced as the effective weight below water table is equal to submerged unit weight.



$$q = D_w \cdot \gamma + x \cdot \gamma_{sub}$$

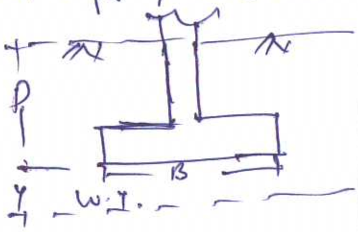
$$x = D - D_w$$

$$q = \gamma_{sub} D + (\gamma - \gamma_{sub}) D_w$$

Thus Ultimate bearing capacity $q_u = CN_c + [\gamma_{sub} \cdot D + (\gamma - \gamma_{sub}) D_w] N_q + 0.5 \gamma_{sub} B \cdot N_\gamma$

Case II When water table is located at depth 'y' below base.

Surcharge term is not affected



unit wt in term is

$$\gamma = \gamma_{sub} + \frac{y}{B}(\gamma - \gamma_{sub})$$

$$q_u = CN_c + \gamma D N_q + 0.5 B \gamma N_\gamma$$

(b) Standard Penetration test (SPT)

The SPT is the most commonly used in situ test on a bore hole. The test is made by making use of split spoon sampler.

The split spoon sampler is connected to a string of drill rod as is lowered into the bottom of the bore hole which was drilled and cleaned in advance. The sampler is driven into the soil strata by making use of a drop weight weighing 63.5 kg. The weight is allowed to fall freely from a height of 750mm @ 30 blows per minute, on to an anvil fixed on the top of the drill rod. - - -

Qst. No	Scoring Indicator	Split up score	Sub total	Total

VII (b) continued — —

The number of blows required to penetrate every successively 150 mm in to the strata up to a maximum total depth of 450 mm is countered. The number of blows required to penetrate from 150 to 450 mm depth is termed as SPT value or N-Value.

The corrected penetration value $N_c = 15 + \frac{1}{2}(N-15)$ where N is recorded value

~~VIII(a) (1) Size~~ ~~UNIT- III~~

VIII(a) (1) Size effect

(2) Scale effect

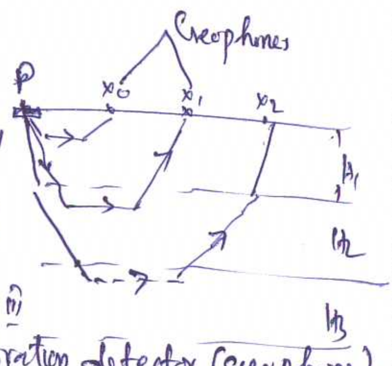
(3) Time effect

(4) Interpretation of failure load

(5) Reaction load

(6) Water table.

(b)



In this method shock waves layer are created in to the soil at their ground level by striking a plate on the soil with hammer. The radiating shock waves are picked up by the vibration detector (geophone), where the time of ~~interval~~ travel gets recorded. Either a number of geophones are arranged along a line.

Some of the waves which travel directly from the shock point along the ground ~~level~~ surface are called primary or direct waves. These primary waves are detected first by the geophone. By knowing the distance b/w the geophone and the shock point and the time by the wave to get refracted to the geophone, the velocity of the wave in the soil layer may calculated and thus the type of underlaying stratum can be ~~assumed~~ assessed.

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Qst. No	Scoring Indicator	Split up score	Sub total	Total
	UNIT - IV			
IX (a)	Shallow foundation :- A shallow foundation transmits the loads to the strata at a shallow depth. According to Terazaghi a foundation is shallow if its depth is equal or less than to its width. Egs: Mat or Raft foundation, (2) Combined footing (3) spread footing (4) Strap footing (5) String footing Deep foundation :- A deep foundation transmits the load at considerable depth below the ground surface. In the case of deep foundation the depth is greater than the width. egs:- Pile foundation, pier foundation, well foundation.			
(b)	(1) Hammer driving: It consist of hoist mechanism, a guiding frame and a hammer device. The hammers used for pile driving are:- i) Drop hammer ii) Single acting hammer iii) Double acting hammer iv) Diesel hammer. (2) Vibratory pile driver:- A vibratory pile driver consist of two weights called exciters, which rotate on opposite direction. The horizontal components of the centrifugal force generated by exciters cancel each other but the vertical components add. Thus a sinusoidal dynamic vertical force is applied to the pile, which forces the pile downward. vibratory pile drivers is useful only for sandy and gravelly soil. (3) Jetting Techniques :- (4) Partial Augering method:-			

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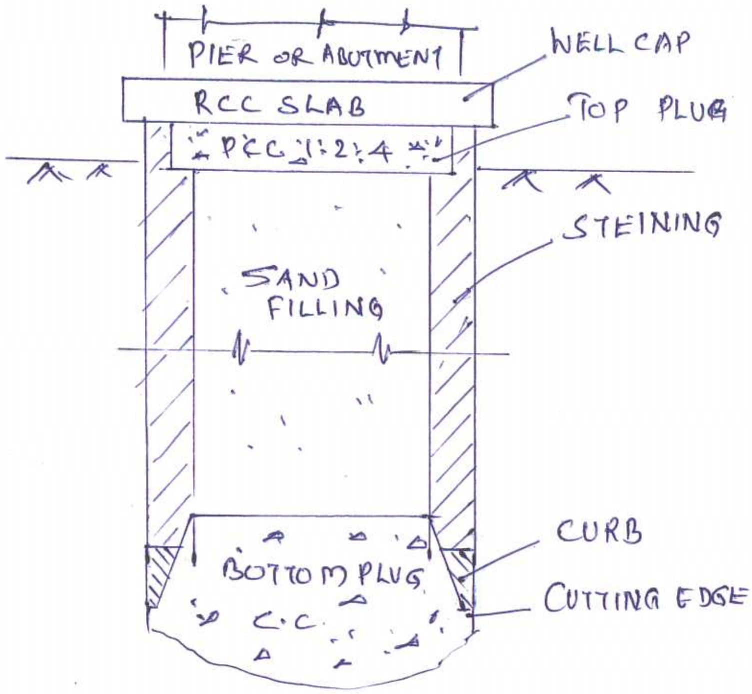
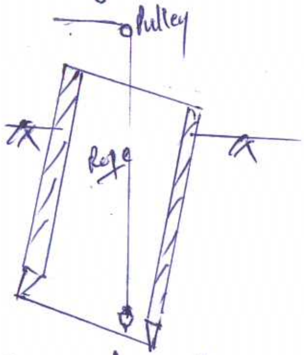
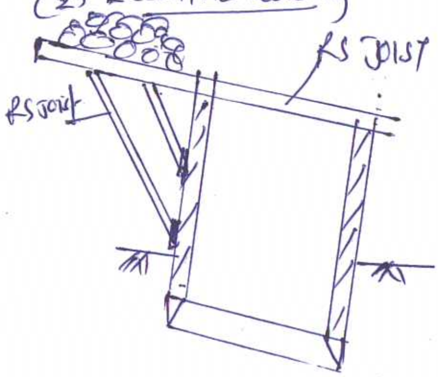
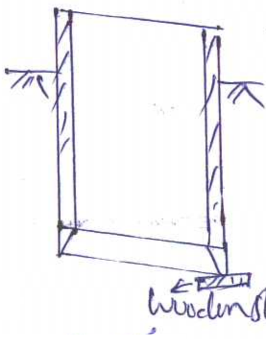
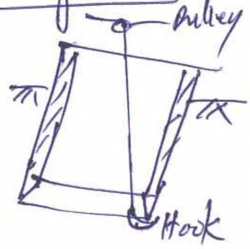
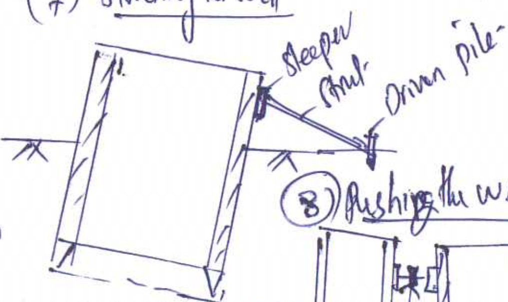
Qst. No	Scoring Indicator	Split up score	Sub total	Total
X(a)				
(b)	(1) Regulation of Grabbing  (2) Eccentric loading  (3) Water jetting (4) Excavation under cutting (5) Inserting wooden Sleeper  (6) Pulling the well  (7) Strutting the well  (8) Pushing the well by Jacks