Full Marks: 100

Time: 3 hours

Attempt any FOUR questions
Assume reasonable value for any data not supplied

1. (a) Classify concrete piles on the basis of their mode of installation.
   (b) Describe, with a sketch, the installation process of a vibro pile. In what field conditions is it used?
   (c) Determine the safe load that can be carried by a precast RCC pile of 300 mm diameter and an embedded length of 22 m from the following data:

> weight of hammer = 20 kN
> height of free fall = 910 mm
> efficiency of hammer blows = 75%
> average penetration in the last 5 blows = 10 mm
> co-efficient of restitution = 0.55

Use modified Hiley's formula. Assume a factor of safety of 3.

[5+8+12=25]

2. (a) Distinguish between a test pile and a working pile.
   (b) What is an uplift pile? Give examples of two filed conditions where such piles are required.
   (c) Determine the ultimate load-carrying capacity of a single pile of length 20 m and diameter 300 mm that is to be installed in a deep deposit of sand having the following properties:

$$\gamma = 18 \text{ kN/m}^3, \gamma_{sat} = 18.7 \text{ kN/m}^3, c=0, \phi=30°.$$

The water table is at 3 m below GL and the cut-off level pile is 1.5 m below GL. Given, for D_f/B=6.7 and ϕ=30°, N_q=17.5. The following average values of soil properties may be used:
co-efficient of earth pressure=0.6, angle of friction between pile and soil=22°.

[3+7+15=25]

3. (a) 'A pile installed in a dense sand stratum may undergo a local, or even a punching shear failure.' – State giving reasons, whether the above statement is true or not.
   (b) A pile group consists of three rows of piles. The first row consists of vertical piles, while the second and third rows consist of batter piles having batter angles of +θ and –θ respectively. The pile cap is subjected to an inclined static force with an eccentricity e. Describe, with the help of a neat sketch, how you would determine the axial forces in various piles. State the assumptions therein.
   (c) Draw a neat sketch of a doubly under-reamed pile. Why is it considered to have a better performance than other piles in a black cotton soils? Can it be used in alluvial deposits?

[5+10+10=25]

4. (a) Derive, from first principles, an expression for the skin friction resistance of a single pile installed in a sand deposit.
   (b) Describe, with neat sketches, the methods of determination of the following:
       (i) Ultimate load carrying capacity from the results of a maintained load test
       (ii) Skin friction resistance from the results of a cyclic load test.

[9+16=25]

5. A raft carrying a *udl* of 24 kN/m², is to be supported by a pile group. The plan area of the raft is 25 m x 25 m. The subsoil conditions at the site are shown in the following table:

No. of stratum	Depth (m)		Type of soil	Average properties
	From	To		
1	0.0	1.2	filling	$\gamma=16$ kN/m^2
2	1.2	9.0	Soft clay	$\gamma=18$ N/m^2, $\gamma_{sat}=19$ kN/m^2, $q_u=45$ kN/m^2, $\alpha=0.9$
3	9.0	25.5	Stiff clay	$\gamma_{sat}=20$ kN/m^2, $q_u=120$ N/m^2, $\alpha=0.55$
4	>25		Medium sand	$\gamma_{sat}=20$ kN/m^2, $c=0$, $\phi=33°$, $K_s=0.6$, $\delta=25°$

Design a suitable pile group to support the raft with respect to a minimum factor of safety of 3.0.

[25]

6. In a piled raft foundation, the pile group consists of 144 piles arranged in a square formation. The diameter and length of each pile are 400 mm and 16 m respectively, while their spacing is 1.6 m c/c. The raft is founded at a depth of 1.5 m below GL and carries a gross vertical stress of 100 kN/m^2. The projection of raft on all sides beyond the outer edges of the piles is 0.8 m. The subsoil consists of a 22 m thick layer of soft clay, which is underlain by a sand stratum. The water table is at the GL. The properties of the clay are as follows:

$$w = 32\%, G = 2.72; LL = 41\%$$

Estimate the probable consolidation settlement of the pile group. The soil layer undergoing consolidation should be divided into 3 sub-layers of equal thickness.

[25]