B.E. (Civil) Part II Final Examinations April-May, 2013
4th Semester Civil Engineering
GEOTECHNICAL ENGINEERING I
(CE 402)

Full Marks: 70 Time: Three hours

FIRST HALF

Attempt *Q. No.* 1 and *any two* from the rest

1.(a) Draw the three-phase diagram of a partly saturated soil mass and label it. Hence derive an expression for the bulk density of the soil in terms of its degree of saturation, specific gravity of solids, water content and the unit weight of water.

(b) The Atterberg limits of a given clay sample are as follows:
Liquid limit = 49%
Plastic limit = 26%
Shrinkage limit = 14%
Draw a neat sketch of the plasticity chart (IS: 1498) and classify the given soil with the help of it.

(c) A concentrated load of 100 kN is applied at a point on the ground surface. Draw the isobar for a stress intensity of 10 kN/m^2 due to this load. (6+4+5 = 15)

2.(a) Distinguish between the following (any three):

(i) Single-grained structure and honeycombed structure
(ii) Residual soil and transported soil
(iii) Well-graded soil and poorly graded soil
(iv) Alluvial soil and aeolian soil
(v) Silty clay and clayey silt.

(b) The volume of a saturated soil sample is 28 cc. The sample is dried in oven and the weight of the dry soil pat is found to be 48.86 g. Draw a three-phase diagram to represent the initial state of the soil. Hence determine from first principles the void ratio, moisture content, saturated density and dry density of the sample. Given, G = 2.68. (3x2+4=10)

3.(a) What do you understand by the *consistency* of a soil?

(b) A shrinkage limit test was performed in the laboratory on a clay sample. The initial and final volumes of the sample were V_0 and V_d, while W_0 and W_d were the corresponding weights. Derive an expression for the shrinkage limit of the soil.

(c) The void ratios of a sand sample in its densest and loosest states are 0.97 and 0.65 respectively. The in-situ density of the sand is 1.85 g/cc and its natural moisture content is 23%. Determine the relative density of the sand. Given, G = 2.68. (2+5+3=10)

4.(a) What do you understand by *flocculent structure* of a soil ? Explain with a sketch.

(b) State Stoke's law. What, in your opinion, is the biggest limitation of this law with reference to its application in the hydrometer test?

(c) The diameter of a spherical soil particle is 0.05 mm. The particle is allowed to fall freely from the surface of a liquid having a unit weight of 0.99 g/cc. The viscosity of the liquid is 9.1×10^{-6} g-s/cm^2. Determine the terminal velocity of the particle. Given, specific gravity of soil solids = 2.70. (3+3+4=10)

5.(a) Plot the distribution of vertical stress intensity due to a concentrated force of 300 kN, applied on the ground surface, on a vertical plane located at a horizontal distance of 3 m from the line of action of the force. Use Boussinesq's equation.

(b) The stress increment at a depth z due to uniformly distributed load of intensity q, acting over a circular area of radius r, is given by:

$$\Delta\sigma_z = q\left[1 - \left\{\frac{1}{1+(r/z)^2}\right\}^{3/2}\right]$$

Using the above equation, draw a Newmark's chart for an influence value of 0.005. (4+6=10)

SECOND HALF

Answer any three questions.
(Two marks are reserved for neatness.)

6.(a) Classify water in soils as free water and held water, and further classify the latter.

(b) Define total pressure, effective pressure and neutral pressure and state their relationship.

(c) The subsoil strata at a site consists of a stratum of fine sand 1.6 m thick overlying a stratum of clay 1.4 m thick. Under the clay stratum lies a deposit of coarse sand extending to a considerable depth. The water table is 1.5 m below the ground surface. Assuming the top fine sand to be saturated by capillary water, calculate and plot the variation of total pressures, neutral pressures and effective pressures at ground surface and at depths of 1.6, 3.0 and 5.0 metres below the ground surface. Assume for fine sand G = 2.65, e=0.6; for clay G=2.75, e=0.8;,and for coarse sand G=2.66, e=0.5. (2+3+6)

7.(a) State Darcy's Law for flow through soils and hence define the coefficient of permeability.

(b) Enumerate the factors governing the permeability of a soil. Briefly discuss the effect of each of them.

(c) Determine the average coefficient of permeability in directions parallel and normal to bedding planes of a stratified deposit of soil consisting of 3 layers of total thickness of 2.0 m. The top and bottom layers are each 0.5 m thick. The respective coefficients of permeability for the top, middle and bottom layers are $2x10^{-4}$, $3x10^{-3}$ and $1x10^{-2}$ cm/sec. (2x3+5)

8.(a) Give expressions for the commonly used compressibility parameters of soils.

(b) Define the phenomenon called consolidation of soils and state Terzaghi's consolidation equation.

(c) A 2 m thick layer of saturated clay exists at a depth of 5m below the ground surface. Above and below the clay layer is dense coarse sand whose porosity is 30% and specific gravity of 2.66. Depth of water table is 3 m below the ground surface. Degree of saturation above the water table is 30% . The clay has a natural water content of 40% and specific gravity of 2.74. Due to the construction of a building at the site the average pressure increment at the mid-depth of the clay layer has been estimated as 0.85 kg/cm^2.

An undisturbed specimen of this clay, 2 cm thick, when tested in the laboratory, is found to have a C_c of 0.45.
(i) Estimate the ultimate settlement due to consolidation.
(ii) If it is observed that the specimen reaches 50% consolidation in the first 30 minutes, how much time will the clay layer at site take to undergo the same degree of consolidation? (3+2+6)

9.(a) Enumerate the types of shear tests commonly used in the laboratory as well as in the field.

(b) With reference to the Triaxial Compression Test, state the different test conditions and briefly describe them.

(c) A sample of cohesionless soil in a direct shear test fails under a shear stress of 1.7 kg/cm^2 when the normal stress is 2.0 kg/cm^2. Find the angle of shearing resistance, the principal stresses at failure and the principal planes. (2+3+6)

10. Write short notes on any three of the following: (3x11/3)

(i) Capillarity and height of capillary rise in soils
(ii) Determination of coefficient of consolidation
(iii) Preconsolidation pressure and its determination
(iv) Relationship between principal stresses at failure
(v) Quick sand and critical hydraulic gradient
(vi) Inclination of failure surface