Indian Institute of Engineering Science and Technology, Shibpur
ME (Civil) Second Semester Examinations, April-May, 2014
Theoretical Soil Mechanics (CE-1011)

Time: 3 hours Full Marks: 70

Answer any five Questions

1.(a) For determination of the principal stresses at a point in a soil mass, derive the characteristic equation $\sigma_n^3 - I_1 \sigma_n^2 + I_2 \sigma_n - I_3 = 0$
(b) Show also that the principal stresses are mutually orthogonal. (2x7)

2.(a) Derive the matrix equation $S' = ASA^T$ relating the change in stress components under the state of rotation of axes system about the origin.
(b) Derive expressions for the octahedral normal and shear stresses. (2x7)

3.(a) On an arbitrary plane in any elementary region of the soil body, enumerate the components by which the states of stress and strain are completely specified and categorize and list the equations relating these components.
(b) Derive the compatibility equation for plane strain condition. in terms of stress components (2x7)

4. Starting with the assumptions, derive the Boussinesq equation for vertical stress due to point load acting on the surface of a semi-infinite elastic and istropic medium. (14)

5.(a) Establish the equations of equilibrium in terms of total stresses.
(b) Develop the bi-harmonic equation in cartesian coordinates. (6+8)

6. (a) Explain the principle of Dubrova's approach to account for the effect of wall movement on the lateral earth pressure magnitude and distribution against the wall.
(b) How does Dubrova's solution compare with Coulomb's solution? (12+2)

7.(a) Show that the system of equations defining stability of soil structures is statically determinate.
(b) Prove that in plane problems at the limiting equilibrium,

$$\sigma_x = \sigma (1 + \sin \phi \cos 2\theta) - \psi$$
$$\sigma_z = \sigma (1 - \sin \phi \cos 2\theta) - \psi$$
$$\tau_{xz} = \sigma \sin \phi \sin 2\theta$$

in which, $\sigma = (\sigma_x + \sigma_z)/2 + \psi$, $\psi = c \cot \phi$, ϕ = angle of internal friction, and, θ = angle between the major principal stress direction and the x-axis. (4+10)

8.(a) State the basic equations of Sokolovsky's method of characteristics
(b) What are the different kinds of boundary value problems encountered in geotechnical engineering that can be solved by the method of characteristics? Discuss the solution procedure of these problems. (4+10)