Addis Ababa University
Addis Ababa Institute of Technology
School of Civil and Environmental Engineering

Fundamentals of Geotechnical Engineering II (CEng2142)
Test 3 - Examination Paper Set

Name	
ID No.	
Signature	
Section	
Exam Date:	08.06.2019

Instruction:

1) This examination is closed book and constitutes 5% of your final grade.
2) The time allowed for this exam is 1 hour.
3) Please read the questions carefully and make sure you understand the facts before you begin answering. Write as legibly and concisely as possible.
4) Use the provided space properly to present you answer.

Question #	**Weight** [marks]	**Score** [marks]
1	10	
2	30	
3	30	
4	30	

QUESTION 1: On Fundamentals of Stress and Strain

1.1 Define the following terms briefly and adequately? (4%)

Stress	
Strain	
Stiffness	
Strength	

1.2 What exactly do we mean when we refer to soil as homogeneous and isotropic? (2%)

Homogeneous soil	Isotropic soil

1.3 A cylindrical soil, 75 mm in diameter and 150 mm long, is axially compressed. The length decreases to 147 mm and the radius increases by 0.3 mm.
Calculate: a) axial and radial strains; b) volumetric strains; c) Poisson's ratio (4%)

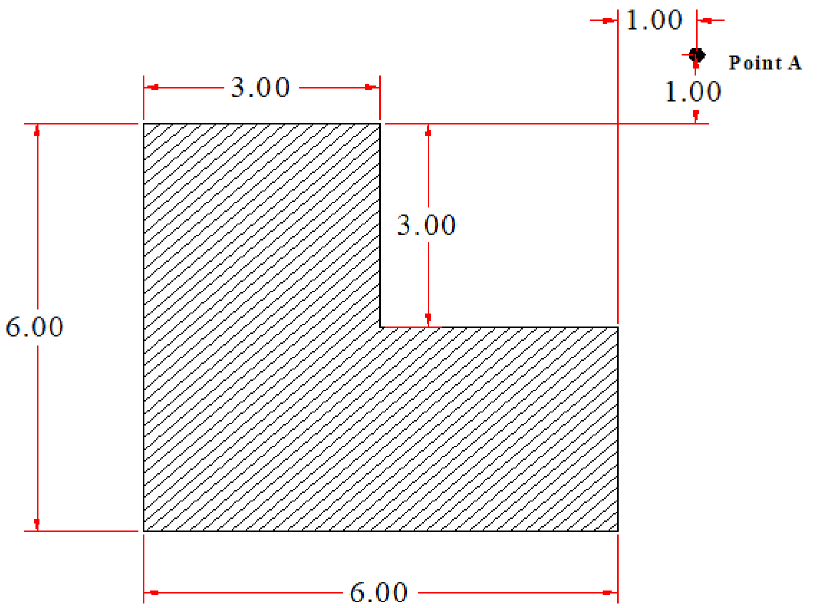
1.4 Soils are not homogeneous, elastic, rigid bodies. Why do we then use elastic methods of analysis to calculate the stress distribution within a soil mass? (5%)

QUESTION 2: On Geostatic and Additional Stresses

2.1 At what depth would the vertical effective stress in a deep deposit of clay be 100 kPa, if e = 1.1? The groundwater level is at 1 m below ground surface and S = 95% above the groundwater level. Neglect pore air pressure. (10%)

2.2 As shown in figure below, An L shape structure exerts a contact pressure of 100 kN/m². Find the stress at a point 5 m depth below point A due to this load. (20%)

$$I_z = \frac{1}{4\pi}\left[\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+-m^2n^2+1}\left(\frac{m^2+n^2+2}{m^2+n^2+1}\right)+\tan^{-1}\left(\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2-m^2n^2+1}\right)\right]$$



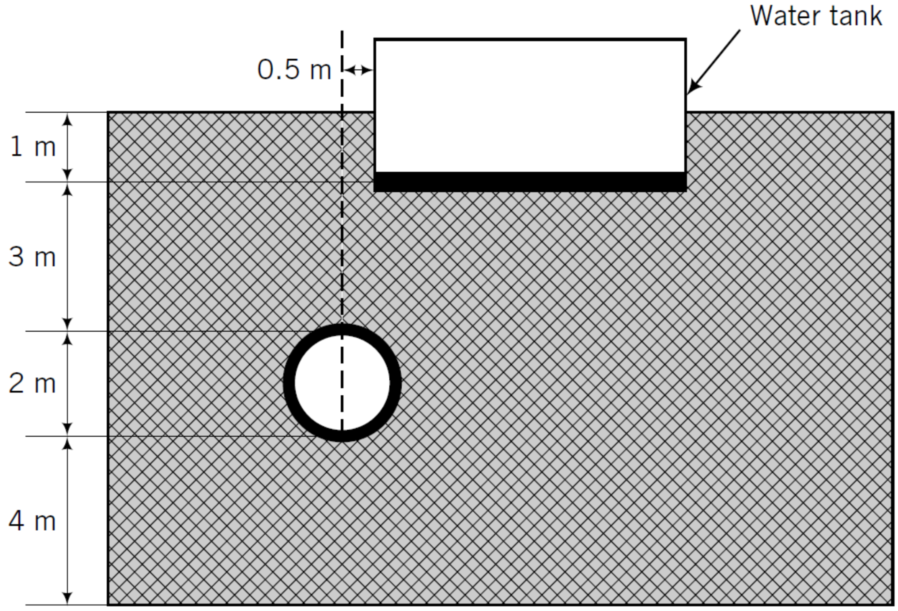
QUESTION 3: On Isobars and Contact Pressure

3.1 A water tank, 15 m in diameter and 10 m high, is proposed for a site where there is an existing pipeline. Plot the distribution of vertical and lateral stress increases imposed by the water tank on the pipeline along one-half the circumference nearest to the tank.

The empty tank's weight (deal load) is 350 kN. Assume the water tank is filled to its capacity.

Construct an isobar for 20% of the contact pressure. (30%)

$$\Delta\sigma_z = q_s\left[1-\left(\frac{1}{1+(r_o/z)^2}\right)^{3/2}\right] = q_s I_c;\ \Delta\sigma_r = \Delta\sigma_\theta = \frac{q_s}{2}\left[(1+2v) - \frac{4(1+v)}{[1+(r_o/z)^2]^{1/2}} + \frac{1}{[1+(r_o/z)^2]^{3/2}}\right]$$



QUESTION 4: On Stress State and Stress Path

4.1 The initial principal stresses at a certain depth in a clay soil are 100 kPa on the horizontal plane and 50 kPa on the vertical plane. Construction of a surface foundation induces additional stresses consisting of a vertical stress of 45 kPa, a lateral stress of 20 kPa, and a counterclockwise (with respect to the horizontal plane) shear stress of 40 kPa.

Plot Mohr's circle

(1) for the initial state of the soil and (2) after construction of the foundation.

Determine

(a) the change in magnitude of the principal stresses,

(b) the change in maximum shear stress, and

(c) the change in orientation of the principal stress plane resulting from the construction of the foundation.

(15%)

4.2 A square foundation (a slab of concrete), 4 m x 4 m, is required to support one of the column loads from a three story building. The foundation base is located at ground surface and weighs 160 kN. Each story applies a load of 720 kN. The soil is a stiff, saturated, over-consolidated clay with a saturated unit weight of 20 kN/m^3 and Ko = 1. Groundwater is at 10 m below the surface. The building was to be constructed rapidly, but after the second story was nearly completed, work stopped for a period of 1 year. A transducer at a depth 5 m below the center of the foundation measured the porewater pressure. When work resumed after the 1-year hiatus, the excess porewater pressure developed during construction dissipated by 50%. Assume the stiff clay behaves like an isotropic, linear elastic material.

For the soil element at 5 m:

(a) Plot the total and effective stress paths in (p, q) space before construction stopped.

(b) Predict the excess porewater pressures just before construction stopped.

(c) Plot the total and effective stress paths in (p, q) space after construction resumed.

(d) Predict the excess porewater pressures after construction resumed.

(15%)