Question 1

In a Proctor compaction test on a borrow pit soil to construct an embankment, the following data were obtained:

Water content (%)	5	8	10	13	16	19
Bulk unit weight (kN/m^3)	18.7	20.4	21.3	22.0	21.6	20.9
Note 1: $G_s = 2.70$						
Note 2: bulk unit weight is not the dry unit weight.						

The natural bulk unit weight and water content of the soil in the borrow pit are 18 kN/m^3 and 6.0% respectively.

(a) Draw the graph of dry unit weight against water content and from it determine the maximum dry unit weight and optimum water content.

(b) How many cubic metres of borrow pit soil is needed for 1 cubic metre of embankment fill compacted to 95% Proctor compaction?

(c) How many truckloads of soil will be required for the embankment which is 50,000 m^3 in volume? Each truck has a capacity of 10 m^3. (Note: the volume of the embankment is the compacted volume while the soil to be hauled is at its natural volume).

(e) Determine the total cost of the soil for the embankment based on the following:

- ♦ purchase and load soil at the site, haul 2 km round trip and spread with a dozer = \$25/m^3;
- ♦ extra mileage charge for each km (round trip) = \$3.10/m^3;
- ♦ round trip distance = 10 km;
- ♦ compaction = \$1.02/m^3 of the natural soil.

Question 2

A flexible foundation over an existing sewer (Figure 1) is to be designed. The sewer is at 3 m below the bottom of the foundation. The design loads under the semi-circular and rectangular sections are 200 and 100 kPa, respectively. If the pressure increase due to the foundation on the sewer at Point A or B exceeds 70 kPa, the sewer will break. Will the design loading break the sewer? What should the maximum loading intensity in the semi-circular loading section be if the total loading (the rectangular loading remains unchanged) does not break the sewer?

KTL

Question 3

The stress state at a point in a soil mass is given in Figure 2. Determine:

(a) the magnitudes of the major and minor principal stresses (σ_1, σ_3);
(b) the directions of the major and minor principal planes from the horizontal plane ,
(c) the magnitude of the maximum shear stress and its direction from the horizontal plane;
(d) the normal and shear stresses on a plane inclined at 25° clockwise to the major principal plane.

A direct shear box test has been conducted on the soil with following results:

Normal stress (kPa)	110	216	324	432
Peak shear stress (kPa)	66	131	195	261

Determine if the above stress state is possible.

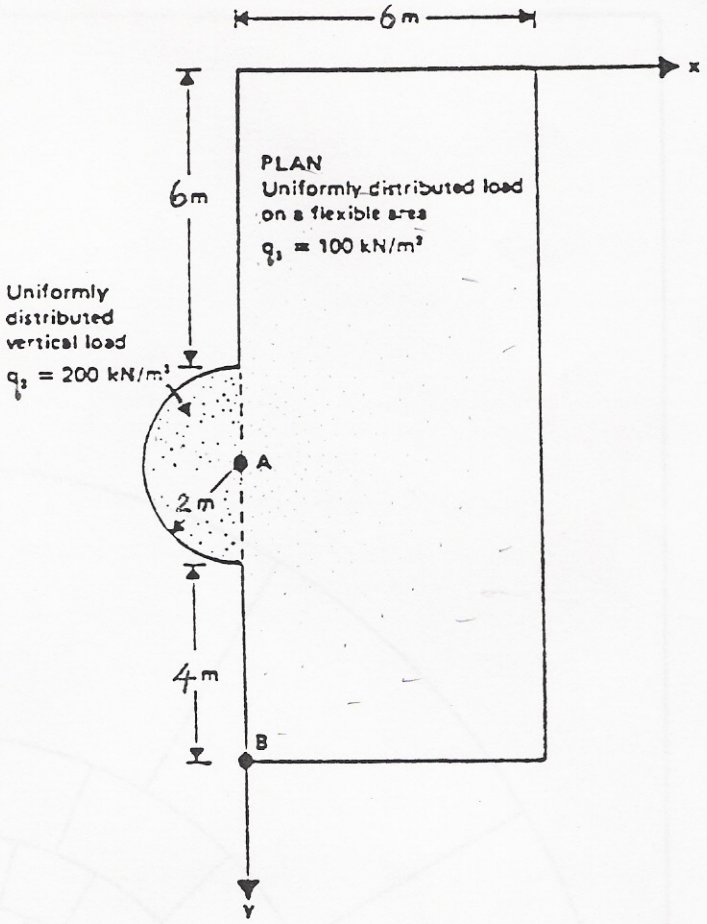
Question 4

A consolidated drained triaxial test was conducted on a normally consolidated clay with the following results at failure:

$\sigma_1 = 276\ \text{kN/m}^2$
$\sigma_1 - \sigma_3 = 276\ \text{kN/m}^2$

Determine
(a) the angle of internal friction, φ;
(b) angle θ that the failure plane makes with the major principal plane;
(c) normal stress, σ, and shear stress, τ, on the failure plane;
(d) the direction of the plane along which the maximum shear stress exists;
(e) the effective normal stress and maximum shear stress on the plane obtained in (d).
(f) Explain why the failure does not occur along the plane obtained in (d).

Figure 1



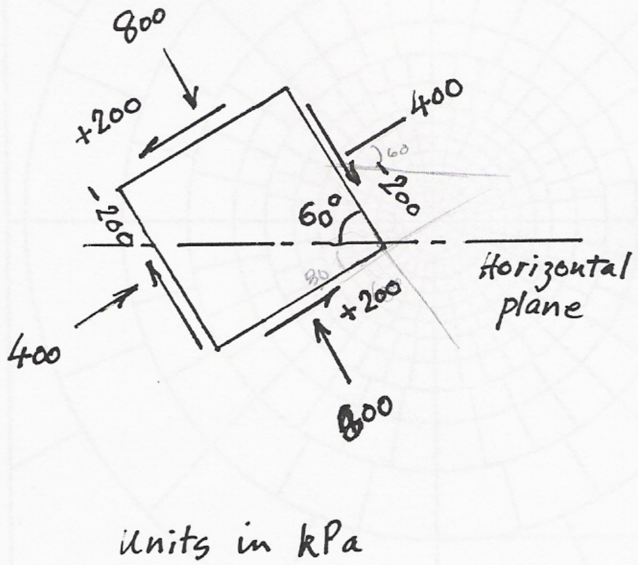
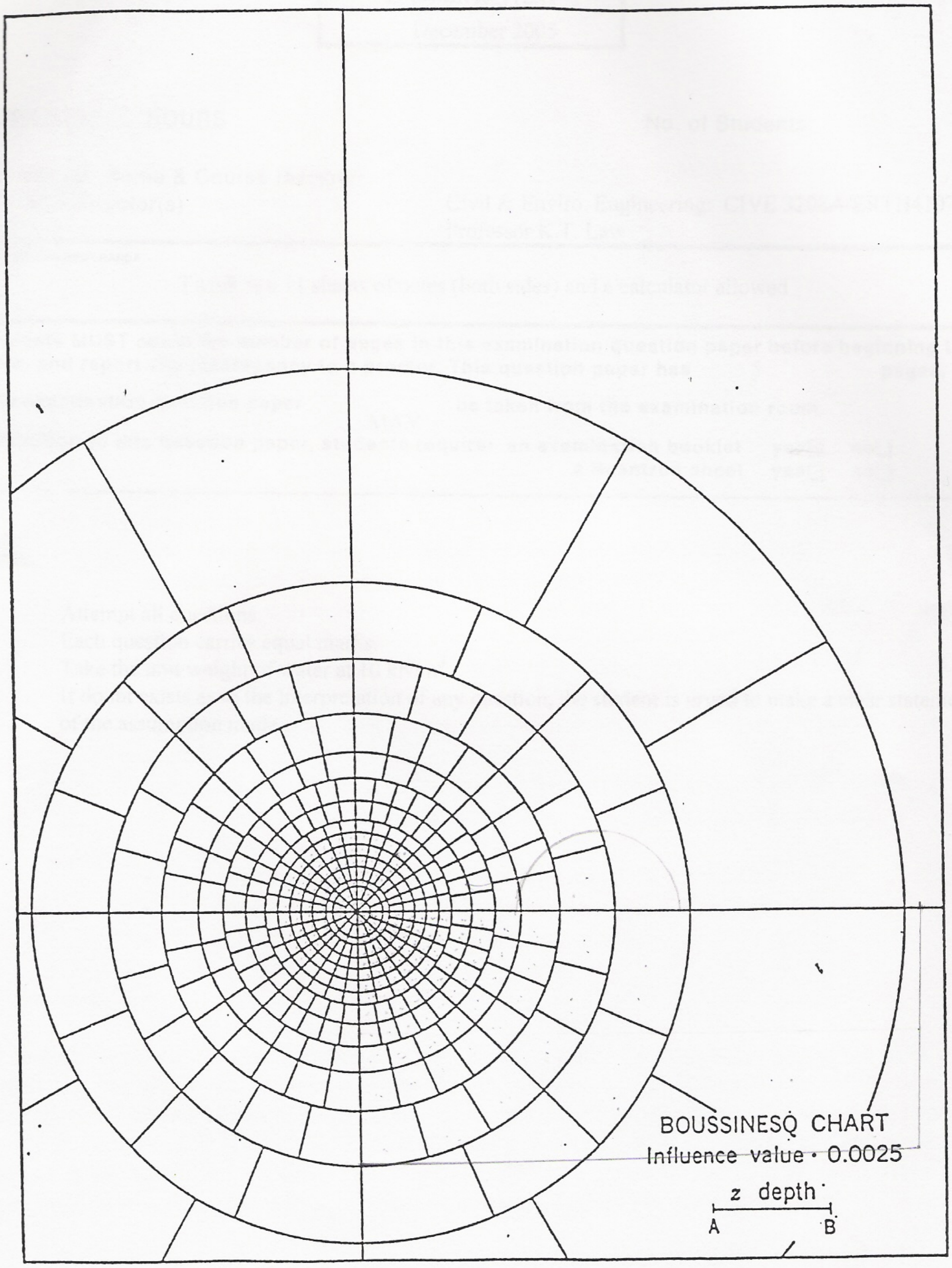


Figure 2

KTL



2cm = 3m.

FIG. 6-14. Influence chart for vertical stresses in a semi-infinite homogeneous isotropic solid—the Boussinesq analysis. [*Adapted from Newmark (35) by Georgia Institute of Technology, Soil Mechanics Laboratory, reproduced by permission.*]