UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOR CIVIL ENGINEERING
SUBJECT	:	**GEOTECHNICAL ENGINEERING 3A11**
CODE	:	**GTG3A11**
DATE	:	EXAMINATION AUGUST 2018
DURATION	:	08:00 - 11:00
WEIGHT	:	50: 50
TOTAL MARKS	:	100

ASSESSOR	:	DR. M. FERENTINOU
MODERATOR	:	PROF. F. N. OKONTA.
NUMBER OF PAGES	:	3 PAGES, GRAPH PAPER,

INSTRUCTIONS	:	ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED. QUESTIONS PAPERS MUST BE HANDED IN. ANSWER ALL QUESTIONS. COMPLETE THE FRONT PAGE OF THE EXAMINATION BOOKLET CORRECTLY WITH RESPECT TO DETAILS CONCERNING YOUR, STUDENT NUMBER, DATE, AND QUESTIONS ANSWERED.

Note: You are required to show how your answers are obtained graphically by means of either neat approximate plots and analytically derived answers, or scaled plots and graphical constructions.

QUESTION 1 Soil Physical Characteristic **(15 MARKS)**

Results from a compaction test are given in the table below:

Soil 1

Test No.	1	2	3	4	5	6	7
Mass of dry soil (kg)	3.69	4.15	4.49	4.61	4.49	4.61	3.92
Mass of wet soil (kg)	3.80	4.36	4.80	5.02	4.98	5.21	4.51

Volume of mould = 2305 cm^3
Soil specific gravity = 2.60

$$\rho_d = \frac{\rho}{1+w}, \quad \rho_{do} = \frac{G_s}{1+wG_s}\rho_w$$

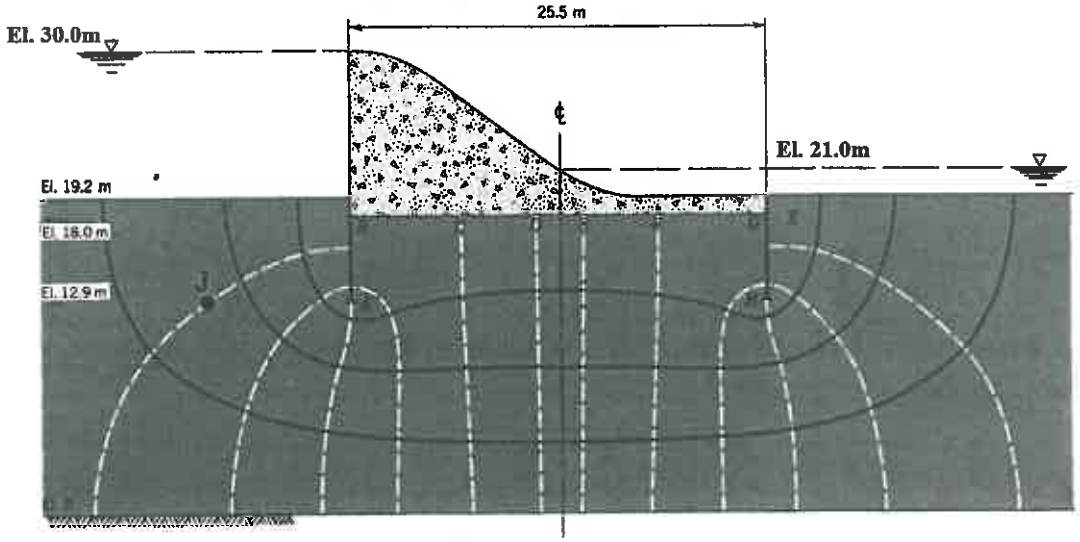
It is suspected that some of the compaction points may be wrong. By appropriately plotting the data, determine whether this is the case and identify any suspicious data points.

QUESTION 2 Seepage in 2D Flow net **(20 MARKS)**

The flow net in the figure below illustrates the seepage that takes place under a dam that has two cut-offs. The flow net consists of four flow channels (N_f = 4) and 12.6 equipotential drops (N_d = 12.6). The incomplete head drop is defined by the equipotential lines on either side of the centre line. Note: For parts *a* and *b* you may indicate your answer on the figure.

Identify the maximum equipotential line and indicate its total head. [2]
Identify the minimum equipotential line and indicate its total head. [2]
Assuming that the vertical and horizontal scale of the figure are the same, is this soil isotropic or anisotropic? Justify your answer. [2]
If the soil has a permeability of k = 0.05 cm/s, what is the flow per unit depth (perpendicular to the plane of the drawing)? [3]
What is the head drop between adjacent equipotentials? [3]
Given the elevation heads indicated in the figure, calculate the total head at points A, C, F, and H. Note: Points A and H are at the bottom of the cut-offs. [4]
Compute the vertical effective stress at point J. Assume the soil has a total unit weight of 20 kN/m^3, and that point J is at an elevation 12.9 m. Ignore the weight of the dam. [4]

Note: $Q/L = kH(N_f/N_d)$



QUESTION 3 Geostatic Stress **(30 MARKS)**

The strata in the flat bottom of a valley consist of 2m of coarse gravel overlying 10m of clay. Beneath the clay is fissured sandstone of relatively high permeability (hydraulic conductivity). The water table in the gravel is 0.5m below ground level. The water in the sandstone is under artesian pressure corresponding to a stand – pipe level of 5m above ground level.

The unit weights of the soil are:

Gravel: above water table 16kN/m^3, below water table (saturated) 20kN/m^3, Clay saturated 22kN/m^3

Plot total stresses, pore water pressures and effective vertical stresses against depth.

a) With initial ground water levels [10]

b) Assuming that the water level in the gravel is lowered 2m, by pumping, but the water pressure in the sandstone is unchanged. [10]

c) Assuming that the relief wells are then pumped to reduce the water level in the sandstone to 15m below ground level. [10]

QUESTION 4 Consolidation Settlement **(35 MARKS)**

The following results were obtained from an oedometer test on a specimen of saturated clay:

Pressure (kN/m^2)	32	59	112	219	434	219	112	59
Void ratio	1.259	1.233	1.16	1.084	1.01	1.017	1.028	1.04

A layer of this clay 6m thick lies below a 4m depth of sand, the water table being at the surface. The saturated unit weight for both soils is 19kN/m^3. A 5m depth of fill of unit weight 21kN/m^3 is placed on the sand over an extensive area. Determine the final settlement due to consolidation of the clay. If the fill were to be removed some time after the completion of consolidation, what heave would eventually take place due to swelling of the clay?

$$s_c = \frac{e_0 - e_1}{1 + e_0} H$$