(*UNIVERSITY OF CHOICE*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY SPECIAL/SUPPLEMENTARY EXAMINATIONS 2021/2022 ACADEMIC YEAR

FIFTH YEAR SEMESTER ONE MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: CSE 521

COURSE TITLE: GEOTECHNICAL ENGINEERING

DATE: 3RD OCTOBER   **TIME: 12- 2 P.M**

INSTRUCTIONS:
1. This paper contains **FOUR** questions
2. QUESTION ONE IS COMPULSORY
3. Attempt any other Two questions
4. Marks for each question are indicated in the parenthesis.
5. Graphs Papers SHALL be provided.

Examination duration is **2 Hour**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over.

Question ONE (30 marks)

(a) **Table Q1a** shows the layer thickness of expansive soil with varying degrees of swelling potential. Using the Van Der Merwe method, the total swell was established as 4.14 in. Given that the potential expansion (PE) for; very high, high, medium and low swell potential are 1.00,0.50,0.25 and 0.00 in./ft respectively, determine the swell potential of layer 4 (bottom layer).   **[7 marks]**

(b) Outline **SIX** major factors that contribute to swelling or heaving of the soil footings built on expansive soil

[6 marks]

(c) Describe the formation process, the structure and the properties of the following group of clays;
    i.   Montmorillonite
    ii. Kaolinite   **[8 marks]**

(d) You have been appointed as a design engineer for the construction of a building in kenya. Geotechnical investigation has revealed that the soils are expansive clays. What structural measures will you suggest for mitigating damages caused by the swelling characteristics of these types of soils.   **[6 marks]**

(e) Outline the properties of red coffee soils and black cotton soils   **[3 marks]**

Question TWO (20 marks)

a) You have been appointed as a design engineer for the construction of a building in Nairobi Kenya. Geotechnical investigation has revealed that the soils are collapsible soils. Describe any NINE methods that you will consider for mitigating the collapsible soil problems   **[9 marks]**

b) A footing for a building is founded at 1.5 m below ground level in an expansive clay stratum which extends to a great depth. Swell tests were conducted on three undisturbed samples taken at different depths and the details of the tests are given in **Table Q2b**.
    Required to determine:

    i.   The total swell under structural loadings   **[3 marks]**
    ii. The depth of undercut for an allowable swell of 3 cm   **[3 marks]**

c) What do you understand by underpinning? What are the necessary precautions which must be taken before carrying out this procedure?   **[8 marks]**

Question THREE (20 marks)

a) Describe the installation procedures for the following methods of underpinning. Provide neat sketches.

    i.   Pynford' stool method of underpinning   **[4 marks]**
    ii. Traditional Underpinning   **[4 marks]**

b) A building was constructed in a loessial type normally consolidated collapsible soil with the foundation at a depth of 1 m below ground level. The soil to a depth of 6 m below the foundation was found to be collapsible on flooding. The average overburden pressure was 56 kN/m². Double consolidometer tests were conducted on two undisturbed samples taken at a depth of 4 m below ground level, one with its natural moisture content and the other under soaked conditions. The data in **Table Q3b** were available

Plot the e-log p curves and determine the collapsible settlement for an increase in pressure $\Delta p = 34$ kN/m^2 at the middle of the collapsible stratum. **[12 marks]**

Question FOUR (20 marks)

a) **Figure Q4a** shows a drilled pier with a belled bottom on expansive soils. The details of the pier and soil are given as;

$L_1 = 6$m, $L_2 = 4$m, $L_b = 0.75$m d $= 0.4$m $c_u = 75$ kN/m^2, $p_s = 500$ kN/m^2, $Q = 200$ kN db $= 1.8$m

You are required to determine:

    i.   The total uplift force.

    ii.   The total resisting force

    iii.   Factor of safety for $Q = 0$

    iv.   Factor of safety for $Q = 200$ kN.

    Use Chen's method for computing Q_{up} **[9 marks]**

b) Briefly describe how laterites soils are formed in tropical region and outline FOUR differences between the laterite soils and red soils **[5 marks]**

c) Describe the three categories of red tropical residual soils **[6 marks]**

Table Q1a

Layer number	Layer thickness (fts)	swell potential
1 (top)	3	medium
2	7	high
3	10	very high
4 (bottom)	4	?

Table Q2b

Depth (m) Below GL	2	3.5	5
Swell %	3.5	2.1	0.8

Table Q3b

Applied pressure kN/m^2	10	20	40	100	200	400	800
Void ratio at natural moisture content	0.89	0.79	0.78	0.75	0.725	0.68	0.61

Figure Q4a

Table Q4a : Values of N_c

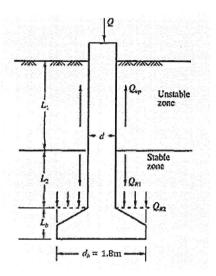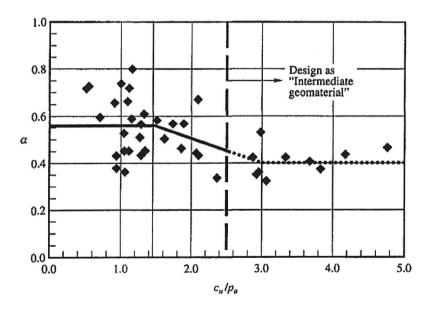| L_2/d_b	N_c
1.7	4
2.5	6
≥ 5.0	9

Figure Q4a (ii): Correlation α and C_u/p_a