



# MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 308 SOIL MECHANICS II

DATE: 16/5/2019

TIME: 11.00-1.00 PM

Instructions to Candidates

Answer question ONE Any Other TWO questions

## QUESTION ONE (30 MARKS)

- a) Define the following terminologies as applied to shear strength of soils (5 marks)
- Complex stresses
  - Principal plane
  - Principal stress
  - Major principal stress
  - Minor principal stress
- b) From first principles derive the following equations: (10 marks)
- Shear (or tangential) stress,  $\tau = \frac{\sigma_1 - \sigma_3}{2} \sin 2\theta$
  - Normal stress,  $\sigma_n = \sigma_3 + (\sigma_1 - \sigma_3) \cos^2 \theta$
- c) A series of undisturbed samples from normally consolidated clay was subjected to consolidated undrained tests. The results were: (15 marks)

| Cell pressure<br>( $\text{kNm}^{-2}$ ) | Deviator stress<br>at failure ( $\text{kNm}^{-2}$ ) | Pore water<br>pressure ( $\text{kNm}^{-2}$ ) |
|----------------------------------------|-----------------------------------------------------|----------------------------------------------|
| 200                                    | 118                                                 | 110                                          |
| 400                                    | 240                                                 | 220                                          |
| 600                                    | 353                                                 | 320                                          |

Plot in the same graph the strength envelop of the soil

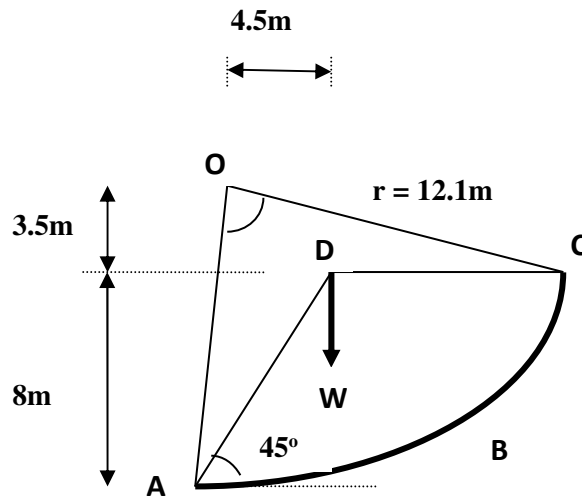
- i. With respect to total stress
- ii. With respect to effective stress

### QUESTION TWO (20 MARKS)

- a) With the aid of sketches describe types of soil in terms of shear strength giving an example of each. (3 marks)
- b) State the factors which affect shearing resistance of a soil (6 marks)
- c) A cylindrical specimen of a saturated soil fails under an axial stress of  $150\text{kNm}^{-2}$  in an unconfined compression test. The failure plane makes an angle of  $52^\circ$  with the horizontal. Calculate the cohesion and angle of shearing resistance of the soil. (11 marks)

### QUESTION THREE (20 MARKS)

- a) Define the following terms as applied to stability of slopes (4 marks)
  - i. Infinite slopes
  - ii. Finite slopes
- b) The figure below shows a  $45^\circ$  slope ABCD of cross sectional area of  $70\text{m}^2$  excavated to a depth of 8m in a deep layer of saturated clay of unit weight  $19\text{kNm}^{-3}$ . If the shear strength parameters, cohesion (C) and angle of internal friction ( $\phi$ ) are  $65\text{kNm}^{-2}$  and  $0^\circ$  respectively if the angle AOC is  $89.5^\circ$ ,
  - i. Determine the factor of safety for the trial failure surface
  - ii. Determine the minimum factor of safety if  $N_s = 0.18$
  - iii. Check that no loss of overall stability will occur according to the limit state approach (16 marks)



#### QUESTION FOUR (20 MARKS)

- What is soil stabilization? (2 marks)
- Describe types of soil stabilization (4 marks)
- What are the effects of lime and cement on soil properties? (4 marks)
- If a cohesive soil and a non-cohesive soil are blended,
  - What type of stabilization is that?
  - With the help of a shear strength envelope describe resulting soil. (10 marks)

#### QUESTION FIVE (20 MARKS)

- With the aid of sketches, describe different types of slope failures. (8 marks)
- An embankment  $10\text{m}$  high is inclined at an angle of  $36^\circ$  to the horizon. A stability analysis by the method of slices gives the sum of shearing forces, normal forces and neutral forces as  $450\text{kN}$ ,  $900\text{kN}$ , and  $216\text{kN}$  respectively. The length of the failure arc is  $27\text{m}$ . If laboratory tests on the soil indicate the effective stress values  $C'$  and  $\phi'$  as  $20\text{kNm}^{-2}$  and  $18^\circ$  respectively, determine the factor of safety with respect to shearing strength and cohesion. (12 marks)