UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, MAY 2018

COURSE NO: MN 254
COURSE NAME: **SOIL MECHANICS**
CLASS: MN II) TIME: 3 HOURS

Name**:** _____Index Number: _____

SECTION A

Answer all questions in this section in the answer booklet (2 marks each)

1. In soil mechanics deals with the following engineering problems except
   a) Consolidation and settlement
   b) Compaction
   c) Seepage
   d) Soil fertility
2. Soil particles between 0.06 mm and 2.00 mm is
   a) Clay
   b) Silt
   c) Gravel
   d) Sand
3. Soils formed from chemical decomposition are generally
   a) Fine-grained and cohesive
   b) Coarse-grained and cohesionless
   c) Quick
   d) Fine-grained and cohesionless
4. Rock crushed and milled to clay-size fraction will not have the properties of clay because…….
5. Soil properties used for soil classification are
   a) Consolidation and settlement
   b) Compaction and dry density
   c) Particle size and plasticity
   d) Seepage and permeability
6. A full particle size distribution will involve
   a) Sieving and crushing
   b) Sieving and sedimentation
   c) Sieving and compaction
   d) Sieving only
7. A uniformly-graded soil will compact better than a well=graded soil
   a) True
   b) False
8. The Shrinkage Limit is the boundary between
   a) Plastic and Liquid state
   b) Plastic and semi-solid state
   c) Solid and liquid state
   d) Solid and semi-solid state

9. The following are examples of soil used as a construction material **except**
    a) Canal
    b) Embankment
    c) Road
    d) Dam
10. The plasticity index is
    a) The moisture content range within which the soil remains plastic
    b) The moisture content at which the soil ceases to be plastic
    c) The moisture content at which the soil just becomes plastic
    d) The moisture content range within which the soil cannot shrink
11. The plastic limit is the
    a) The moisture range within which the soil remains plastic
    b) The moisture content at which the soil ceases to be plastic
    c) The moisture content at which the soil just becomes plastic
    d) The moisture content range within which the soil is liquid
12. A dry soil is a …… -phase material
    a) One
    b) Two
    c) Three
    d) Four
13. Write the definitions of the following:
    a) Void ratio ……
    b) Moisture content ……
    c) Particle specific gravity ……
    d) Air content ……

Use the following information to answer questions **14** to **20.** A cylindrical specimen of soil is 8.0 cm long , 4.0 cm in diameter and weighs 200g. If the water content is 18% and the specific gravity of the solids is 2.68, determine the following:

14. The bulk density is …… Mg/m^3
15. The dry density is …… Mg/m^3
16. The void ratio is …… (state value in decimals)
17. The porosity is …… %
18. The saturated density is …… Mg/m^3
19. The degree of saturation is …… %
20. The Air content is ……%

The following are familiar equations extensively used in soil mechanics; use the information to answer Questions 21 and 24.

$\tau = \sigma_n \tan \phi = c$ Eqn A

$\sigma_n = \frac{1}{2}(\sigma_1 + \sigma_3) + \frac{1}{2}(\sigma_1 - \sigma_3)cos2\theta$ Eqn B

$\tau = \frac{1}{2}(\sigma_1 - \sigma_3)sin2\theta$ Eqn C

$\sigma_1 = \left(\frac{1+sin\varphi}{1-sin\varphi}\right)\sigma_3 + \left(\frac{2c\ cos\varphi}{1-sin\varphi}\right)$ Eqn D

21. If the normal stress in 10 kN/m^2, and the shear strength parameters are c = 25 kN/m^2 and ϕ = 30^o then the shear strength is
    a) 15.37 kN/m^2
    b) 58.34 kN/m^2
    c) 28.36 kN/m^2
    d) 30.77 kN/m^2
22. If the major and minor principal stresses are 100 kN/m^2 and 50 kN/m^2 respectively, what is the induced normal stress on a plane inclined at 40^o to the horizontal?
    a) 79.34 kN/m^2
    b) 26.35 kN/m^2
    c) 58.34 kN/m^2
    d) 15.37 kN/m^2
23. What is the induced shear stress on the plane in Question 22?
    a) 24.26 kN/m^2
    b) 26.24 kN/m^2
    c) 24.62 kN/m^2
    d) 64.26 kN/m^2
24. Using the shear strength parameters in Question 21, what will be the major principal stress at failure if the minor principal stress is 80 kN/m^2?
    a) 134.23 kN/m^2
    b) 326.60 kN/m^2
    c) 183.26 kN/m^2
    d) 425.32 kN/m^2
25. One of the main objectives of the compaction of soils **is**
    a) To reduce porosity
    b) To increase the density
    c) To expel water from the soil
    d) To increase the permeability
26. If the bulk mass of a soil is 2614g and the moisture content is 12% its dry mass will be
    a) 1964.7 g
    b) 1690.5 g
    c) 1785.7 g
    d) 1833.0 g
27. In Darcy's Law the velocity of a fluid passing through soil per unit time is proportional to the
    a) Total head
    b) Atmospheric pressure and gauge pressue
    c) Hydraulic gradient
    d) Particle size and porosity of the soil
28. A particle size distribution that has an almost horizontal section means
    a) Particle sizes in that range form a large proportion of the soil
    b) Particle sizes in that range have almost uniform size
    c) Particle sizes in that range can cause failure
    d) Particle sizes in that range form a tiny proportion of the soil
29. A retaining wall must be safe against
    a) Sliding and bearing failure only

b) Sliding, overturning and bearing failure
c) Overturning and settlement
d) Bearing failure and erosion

30. Relative compaction refers to
    a) Laboratory density/Moisture content
    b) Field density/Laboratory density
    c) Field dry density/laboratory maximum dry density
    d) Laboratory maximum dry density/field dry density

SECTION B
ANSWER ANY TWO QUESTIONS

31. In a pumping test in an unconfined sandy soil, water level in two observation wells sited at 15 m and 30 m from a pumping well were measured until a steady state was reached. Under that condition, the ground water level originally at 4m from the ground surface, dropped by 3m in the nearer observation well, and 1.5 in the farther one. If the thickness of the sandy soil is 35m, and the pumping rate was 0.15 m^3/sec,
    a. What is the permeability of the sandy soil? **(8 marks)**
    b. How far will the water level be from the ground surface at 20m from the pumping well? **(6 marks)**
    c. What will be the drawdown at 40 from the pumping well **(6 marks)**

32. A strip footing 1.50 m wide is located at a depth of 0.8 m in sand, the shear strength parameters to be used in design being c'= 0 and ϕ' = 38°, for which the bearing capacity factors are N_c = 61.4, N_q = 48.9 and N_γ = 67.4. Water can rise to the base of the footing. The unit weight of the sand above the water table is 17 kN/m^3 and the saturated unit weight is 20 kN/m^3.
    a) Determine the ultimate bearing capacity
    b) Calculate the allowable bearing capacity if a factor of safety of 3 is to be used
    c) If the wall supports a design load of 500 kN/m, what will be the factor of safety against bearing failure? (Note: safety factor is based on net values)
    d) At what depth will the factor of safety in (c) be equal to 3? **(20 marks)**

33. a. Describe the direct shear test and state two main differences between the direct shear test and the triaxial test. **(10 marks)**

b. Show three different ways you can obtain the shear strength parameters, c and ϕ from the triaxial laboratory results. **(10 marks)**

Some formulas you might need.

$$\rho_b = \frac{(G_s + eS_r)}{1 + e}\rho_w$$

$wGs = eS_r$

$A = n(1 - S_r)$

$$n = \frac{e}{1 + e}$$

$$q_u = cN_c + \frac{1}{2}\gamma BN_\gamma + \gamma DN_q$$

$T = (\sigma_n - u) \tan \phi + c$

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