UNIVERSITY OF FORT HARE

AGS422

SUPPLEMENTARY EXAMINATION

January 2019

TIME: 3 Hours

SUBJECT: SOIL SCIENCE **MARKS:** 100

PAPER: SOIL PHYSICS

THIS PAPER CONSISTS OF:

- 3 pages (including cover page)

INTERNAL EXAMINERS	EXTERNAL EXAMINER
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Answer all questions

Question 1 (10 mark)

Explain the difference between the following terms:

i. Soil stress and soil strain [5]

ii. Thermal conductivity and Thermal diffusivity [5]

Question 2 (10 mark)

a. Discuss the causes and effects of soil compaction in agricultural soils [5]

b. Discuss the use of a soil penetrometer in assessing soil strength and the factors that must be considered when taking such measurements. [5]

Question 3 (20 mark)

a. Calculate the approximate specific surface area per unit weight of a sand composed of the following array of particle sizes: [3]

Average diameter	1 mm	0.5 mm	0.2 mm	0.1 mm
Percent by mass	50%	40%	30%	10%

b. A droplet of water mist ($\rho = 1000$ kg m^{-3}) has a radius of 4.8 microns. What is its terminal velocity as it falls through air? [5]

c. The Stoke's law is given as: $v = d^2 (\rho_s - \rho_w)\, g/ 18\eta$ for terminal velocity of particles falling in a viscous fluid by their own weight due to gravity where v is terminal velocity of particles, d is diameter of particles, ρ_w is density of water, ρ_s is density of particles and η is viscosity of water.
Using Stoke's law, calculate the time needed for all the clay (>0.0002 mm) to settle to a 30 cm depth in an aqueous suspension at 20°C. Given that the acceleration due to gravity is 981 cm s^{-2}, viscosity is 0.01002 Pascal-second (i.e. g/ cm-second), the mean particle density is 2.65 g cm^{-3} and density of water is 1 g cm^{-3}. [5]

d. A fine grained soil is found to have a liquid limit of 80% and a plasticity index of 50. The natural water content is 30%.

i. Determine the liquid index. [2]

ii. Indicate the probable consistency of the natural soil. [3]

Question 4 (20 mark)

a. A sample of moist soil having a wet mass of 1.0 kg and a volume of 0.64 liter (6.4×10^{-4} m^3) was dried in the oven and found to have a dry mass of 0.8 kg. Assuming the typical value of particle density for a mineral soil (2650 kg/m^3), calculate the:

i. void ratio [2]

ii. volume wetness θ [2]

iii. degree of saturation [2]

iv. air-filled porosity [4]

b. Describe the various structural types found in the soil and indicate their significance in terms of aeration, water movement and root development. [5]

c. Describe the method used to measure particle density [2]

d. Water can flow from low soil water content to high soil water content soil profiles. Explain why? [3]

Question 5 (20 mark)

a. Soil water acquires potential energy when work is done against the major forces in the soil. Give a detailed account of the four major forces in the soil. [4]

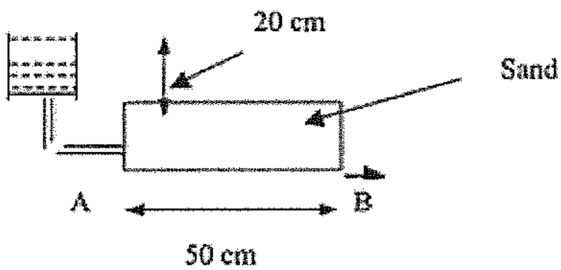
b. Consider the soil column given in the following figure. Horizontal flow is taking place. The saturated hydraulic conductivity of sand inside the column is 5×10^{-3} cm sec^{-1}. Use the data shown in the figure. Make necessary assumptions.

i. Calculate the difference in hydraulic head across the soil length. [2]

ii. Calculate the hydraulic head gradient. [3]

iii. Calculate the water flux through the column. [5]

iv. Calculate the volume of water collected at the outlet during 12 hr if the cross-sectional area of the column was 1000 mm^2. [5]



Question 6 (20 mark)

a. Sketch a graph to illustrate the relationship between the soil water content and suction in soils with compacted and aggregated soils [5]

b. Give a detailed account of the factors that control the rate of water infiltration into the soil. [5]

c. With aid of a clearly defined equation, state the following laws:

i. Fick's Law of Diffusion. [5]

ii. Fourier's Law of Heat. [5]