

National University of Lesotho

Department of Soil Science and Resource Conservation

SSR 3503 -12: Soil Physics

FINAL EXAM

3 hours

Total Marks: 100

January, 2024

Instructions:

The question paper has Five (5) questions and all questions carry equal marks (25 marks).

Answer FOUR (4) Questions ONLY

Question 1 (25 marks)

- a) Mention one (1) soil **physical** property and one (1) soil physical function or process affected by the mentioned agricultural practices (*Do not mention the same property for more than once*) **(10 marks)**

Agricultural practices	Soil Properties	Soil Functions/process
i. Tillage		
ii. Conservation agriculture		
iii. Mulching		
iv. Addition of organic manure		
v. Surface drainage		

- b) Calculate gravimetric water content (ϑ_{wt}), moisture percentage (**Moisture %**) and volumetric water (ϑ_v) content given soil sample weights in the Table below **(15 marks)**

Time of measurements	Mean wet weight (g)	Mean dry weight (g)	ϑ_{wt}	Moisture %	Bulk density g.cm^{-3}	ϑ_v
Two weeks before planting	55.5	45.4			1.45	
At harvest	50.5	45.3			1.44	

- c) Show the relationship between total porosity, particle and bulk density. **(5 marks)**

Question 2 (25 marks)

- a) **True or False (10 marks)**

- i. In the textural triangle a silt loam is higher clay content than that of a silty clay loam
- ii. Total pore space is higher in soil with finer particles than a sandy soil.
- iii. In sandy soils macropores occupy more than 70% of the pore space hence have higher total pore space than clay.
- iv. A clayey soil has high bulk density than a sandy soil.
- v. Specific surface area of clay is higher and has higher water holding capacity.
- vi. Sandy soils release most of the water at higher potentials, while clayey soils, with adhesive and osmotic binding, will release water at lower potentials.

- vii. Clay soil with a large proportion of fine pores shows poor hydraulic conductivity as compared to sandy soil with higher proportion of larger pores.
- viii. Water and mineral salts first enter through the cell wall and cell membrane of the root hair cell by osmosis
- ix. In the absence of transpiration, plants absorb water from the soil by the osmotic mechanism
- x. Immediately after rain or irrigation, the entire pore space or the voids in between the solids are completely filled with water, and the soil is saturated

b) Match the correct word and fill in the blanks with words given below (10 marks)

Pressure potential (Ψ_p); Adhesion; Soil moisture characteristic curve; plastic limit; Field capacity; Transpiration pull; Osmotic potential; Vacuoles; Soil water potential; Darcy's law; Cohesion; Hysteresis; Fick's law; Osmotic difference; wilting point; cell wall; cuticles, Root hairs.

- i. It is referred to as turgor potential in plant cells, can be either negative or positive
- ii. It is the difference between the energy states of soil water and pure free water
- iii. It describes water movement as affected by saturated hydraulic conductivity of the soil and the hydraulic head difference.
- iv. They have salts, which speed up water absorption from soil water
- v. They prevent water absorption
- vi. The available water content for the plants is determined as the difference between _____ and _____.
- vii. Two forces responsible for water retention in the soil are _____ and _____.
- viii. _____ is influenced by solute concentration.
- ix. Water enter the plant through the cell wall and cell membrane of the root hair cell.
- x. _____ have a total surface area of several hundred square meters for water absorption.

c) Explain Dispersion and Fractionation (Stokes law) in determining soil texture or particle size analysis (5 Marks):

Question 3 (25 marks)

a) Define the following soil physical properties (16 marks)

- i. Soil aeration
- ii. Anaerobiosis
- iii. Bulk density
- iv. Soil structure
- v. Soil consistency
- vi. Hydraulic conductivity
- vii. Pf curve.
- viii. Leaching requirement

d) Short answer questions (9 marks)

- i. What is the importance of a good soil structure?
- ii. How does mulching improve soil physical properties
- iii. What is the difference between infiltration and percolation

Question 4 (25 marks)

a) Describe the following components of soil water potentials: **(15 marks)**

- i. Matric potential
- ii. Osmotic potential
- iii. Pressure potential

b) Show with illustration of a graph, Compare soil moisture characteristic curve of a clay soil and a sandy soil. **(10 marks)**

Question 5 (25 marks)

a) What is capillarity? (5 marks)

b) What is hydraulic conductivity? (5 marks)

c) Explain the components of the Darcy's equation - $\frac{Q}{t} = AK_{sat} \frac{\Delta\psi}{L}$ (5 marks)

d) Describe soil water storage **(5 marks)**

e) What is crop water requirement? **(5 marks)**