

National University of Lesotho
Faculty of Agriculture – Department of Soil Science

Final Examination

SSR 316 – Soil Physics

Programmes: BSc Agriculture (Soil Science)

Year 3

December 2017

100 Marks

Time: 3 Hours

Instructions

Answer any Five (5) Questions

Question 1

Define the subject matter of soil physics and outline its general applications in agriculture (20 marks)

Question 2

- a) Briefly describe dispersed soil systems (10 marks)
- b) Briefly discuss the conceptual complexities of studying soil physical properties (5 marks)
- c) Briefly describe the meaning and implications of the dynamic steady state in soil systems (5 marks)

Question 3

Discuss in detail the concept of a physical soil system (20 marks)

Question 4

Briefly discuss the following:

- a) Discuss one function of soils in agriculture (5 marks)
- b) What properties make the role mentioned in (a) above possible? (5 marks)
- c) With reference to (a) and (b) above, what physical processes must occur in soils to make this possible? (10 marks)

Question 5

a) Answer True (T) or False (F) – (1 marks each)

- i) A physical property is a quantifiable attribute which characterizes either the amount of mass or energy or the ability of a soil to transmit mass, energy or momentum.
- ii) Soil properties may characterize equilibrium states i.e. state properties and may describe non-equilibrium characteristics such as the transport properties or ability of a soil to transmit water.
- iii) Properties which change with the size of a homogeneous system are called extensive e.g. mass, volume and heat.
- iv) Properties which do not change with the size of a homogeneous system are called intensive
- v) If you study one soil system and feel confident your knowledge can be used to predict the response of a second soil system, then we must ensure that the properties are identical for the two systems

b) Fill in the blanks and do not re-write the question statements (1 marks each)

- i) _____ states that it is necessary but not sufficient to deal with a small set of soil properties. It is also necessary that small changes in the value of any independent variable do not result in large variations in a response variable. This is called smoothness & allows us to avoid concerns about abrupt transitions
- ii) _____ states that for two soil systems to behave similarly, only a small subset of all properties need be specified. The maximum # is a function of df while the minimum depends on the processes considered or problem to be analyzed.
- iii) _____ means that the state of a system is unambiguously determined when a special set of properties which are independent of the history of the system have definite values.
- iv) _____ soil has properties which may change from point to point in a non-random fashion e.g. Cracks in a soil represent systematic variations; Banded fertilizer also represent systematic variations across a field
- v) _____ soil is one whose properties do not change from point to point within the soil system except in an uncorrelated fashion.
- c) A Crop Science student wishes to determine the amount of water she must apply to saturate 25 cm of soil initially at a volumetric moisture content of 0.20 cm^3 of water per volume of soil and a bulk density of 1.0 Mg m^{-3} ?
- i) Calculate the porosity of the soil and interpret this value to the crop science student in the context of the question. (5 marks)
- ii) Calculate the air filled porosity of the soil and interpret this value to the crop science student in the context of the question. (2.5 marks)
- iii) Calculate the depth of water required to saturate the soil and interpret this value to the crop science student in the context of the question. (2.5 marks)

Question 6

- a) Demonstrate whether the dimensional homogeneity of the law of capillary rise: $h = 2\sigma \cos\theta / r\rho g$, is dimensionally correct (5 marks)
- b) Soil A has water flowing through it, such that a Reynolds Number of 20 is calculated. Soil B has a characteristic pore size of 0.20mm and the water has a density of 1.0 Mg m^{-3} and a viscosity of 1.0 g per m-sec. What velocity does the water have to flow through soil B for the flow to be similar? (5 marks)

$$R_B = \frac{V r \rho}{\eta}$$

- c) Assume density of water is 0.997 Mg m^{-3} and viscosity is 0.9804 cp at 25°C . How long does a particle of diameter 0.1 mm take to fall 10 m in water at 25°C ? (10 marks)

Question 7

- a) Soil samples are collected in 20g metal ring which are 5.0 cm high and 7.0 cm inside diameter. The Oven dry sample including the ring weighs 310 g .
- Calculate the bulk density of the sample (5 marks)
 - Calculate the porosity of the sample (5 marks)
- b) The gravimetric moisture content of a sand is determined to be $\theta_m = 0.05$. If 55.0 g sample is taken:
- How much oven dry soil is present? (2.5 marks)
 - How much water is present? (2.5 marks)
 - Estimate the volumetric moisture content. (2.5 marks)
 - How much water should be added to bring the sample to a gravimetric moisture content of 0.15 . (2.5 marks)