"Investing in Africa's Future"

COLLEGE OF HEALTH, AGRICULTURE & NATURAL SCIENCES

NAAE 302: IRRIGATION AND WATER MANAGEMENT

END OF SECOND SEMESTER FINAL EXAMINATIONS

APRIL 2022

LECTURER: MR. W. ZENDERA

DURATION: 3 HOURS

INSTRUCTIONS

Answer any FIVE Questions

Use Answer Sheets Provided

Begin Your Answer for Each Question on a New Page

Credit is Given for Neat Presentation

Question 1

a) Explain the importance of the following terms in irrigation design and irrigation water management.
   i. Infiltration rate, [5 marks]
   ii. Field capacity, and [5 marks]
b) Permanent wilting point. [5 marks]
c) Define the term consumptive use and explain why it is generally taken to be equivalent to evapotranspiration. [5 marks]

Question 2

a) Sketch a graph to show how the crop coefficient (Kc) varies with the stage of growth of a plant. [4 marks]
b) Define the term consumptive use and explain why it is generally taken to be equivalent to evapotranspiration. [4 marks]
c) What do you understand by irrigation scheduling? [2 marks]
d) Explain 5 advantages of irrigation scheduling. [10 marks]

Question 3

a) List for methods of estimating reference evapotranspiration. [4 marks]
b) The following data in table 1 were obtained in determining the soil moisture content at successive depth in the root zone prior to applying irrigation water.

Table 1.

Depth of sampling (mm)	Weight of moist soil sample (g)	Weight of oven dry soil (g)
0 -250	134.60	126.82
250-500	136.28	127.95
500-750	122.95	115.32
750-1000	110.2	102.64

The bulk density of the soil in the root zone was 1.50 g/cm^3. The available moisture holding capacity of the soil was 178 mm/m depth. Determine:

a) The moisture content at the different depth in the root zone, [6 marks]
b) Moisture content in the root zone at the time of irrigation, [5 marks]

c) The net depth of water to be applied to bring the moisture
   content to field capacity, and   [5 marks]
d) The gross irrigation requirement at estimated field efficiency
   of 70 %.   [5 marks]

Question 4

a) Discuss how the following factors influence evapotranspiration:
   i.   Air temperature,   [2 marks]
   ii.   Relative humidity,   [2 marks]
   iii. Solar radiation,   [2 marks]
   iv.   Wind velocity, and   [2 marks]
   v.   Canopy cover.   [2 marks]
b) Determine the net irrigation water needs (IWR net) on a monthly
   basis for the following data in table 2 and conditions. Use the
   dependable rain formula to estimate the effective precipitation. [10 marks]
   Table 2.

Month	Jan	Feb	Mar	Apr	May	Jun
Etc (mm/day)	3.3	5.61	6.2	6	4.3	3
P(mm/month)	80	70	38	20	0	0
Pe (mm/month)						
IWR net (mm/month)						

Question 5
a) Explain some of the best practices pump users can employ to
   prevent cavitation in irrigation pumps.   [7 marks]
b) A centrifugal pump is installed alongside a river, 500 m above sea level to
   pump water at a temperature of 20°C. The suction line losses (friction +
   secondary losses in the suction pipe and foot valve) are 0, 5 m and the object
   in view is to install the pump on the bank, 4,5 m above the minimum water
   level in the river. *(refer to appendix for addition material)*

   i.   Determine whether it is possible to install the pump if the
         required NPSH is 5, 2 m and,   [4 marks]
   ii.   Also what is the maximum static suction head of the pump in

the present instance? [3 marks]

 iii. Given that this pump if to deliver water at a rate of 180 m^3/hr over a head (H) of 40 m, give the specifications of the pump (i.e. pump efficiency, impeller size and power requirements) [6 marks]

Question 6

A permanent sprinkler system with a sprinkler spacing of 18 × 12 m and sprinkler delivery rate of 1. 75 m^3/h must be used to apply 50 kg/ha of nitrogen in the form of water-soluble calcium nitrate in a fruit orchard. The sandy loam soil's easily available water retention ability is 150 mm/m. The nitrogen must be applied to a depth of 300 mm. The effective root depth is 1 m. Twenty sprinklers irrigate simultaneously and the standing time is 12 hours. *Calcium nitrate contains 15.5 % N and a solubility = 1.2 kg/l.*

Calculate:

 i. The area being irrigated [2 marks]
 ii. The amount of calcium nitrate required per set-up. [2 marks]
 iii. The minimum amount of water required to dissolve the fertilizer. [3 marks]
 iv. The fertilizer injection rate if time of injection is 1 hour. [3 marks]
 v. The concentration of the fertilizer in the system. [3 marks]
 vi. Irrigation application depth in 12 hrs. [3 marks]
 vii. Depth of infiltration. [4 marks]
 viii. The time required for nitrogen to penetrate a depth of 300 mm. [5 marks]

Question 7

a) State 3 surface irrigation methods. [3 marks]

b) Explain the management strategies that can be used to minimize water losses in surface irrigation systems. [8 marks]

c) A flow of 100 l/s is diverted from a supply canal and 80 l/s is delivered to the field. A 2 ha field is irrigated in 10 hrs. The soil available water holding capacity is 180 mm/m and the effective root zone depth is 1.2 m. runoff losses from the field are 320 m^3. Irrigation is initiated at 50 % moisture depletion calculate:

    i.   Conveyance efficiency, [3 marks]

    ii.   The application efficiency, [3 marks]

    iii.   The water distribution efficiency, [3 marks]

End of Examination Paper