



**UNIVERSITY OF ESWATINI
FINAL EXAMINATION PAPER**

PROGRAMME: BSC ABE 4

COURSE CODE: ABE402/ABE 403

TITLE OF PAPER: IRRIGATION DESIGN AND MANAGEMENT

TIME ALLOWED: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: NONE

**INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO
OTHER QUESTIONS.**

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GRANTED BY THE CHIEF INVIGILATOR**

SECTION I COMPULSORY

QUESTION 1

a) Explain with examples how the following factors are key in choosing an appropriate irrigation system:

- i) Quality of water
- ii) Available expertise
- iii) Type of crop
- iv) Cost of water
- v) Topography

[20 marks]

b) Given the following:

- Crop – maize
- Climate – Hot
- $ET_{peak} = 7 \text{ mm/d}$
- Centre Pivot irrigation application efficiency, $E_a = 0.87$
- Desired actual irrigation interval for the peak season, $f = 1 \text{ d}$
- Total time to complete an irrigation event, $T = 22 \text{ h}$
- Spacing between sprinklers along the lateral = 5 m
- Impact sprinkler selected with an effective wetted diameter, $D_w = 20 \text{ m}$ (distal sprinkler)
- The leaching requirement (or fraction), $LF = LR < 0.1$
- Length of the centre pivot lateral = 405 m

- i) Calculate the irrigation system capacity (L/s).
- ii) Determine the application rate (mm/h) at 50 m, 100 m, 200 m and 400 m from the centre.

[20 marks]

SECTION II ANSWER ANY TWO QUESTIONS

QUESTION 2

- a) Describe the neutron scattering method (neutron probe) of soil moisture measurement. Also discuss its advantages and disadvantages.

[10 marks]

- b) Explain how the following factors affect the rate of transpiration:
- i) Bulk (leaf layer boundary) resistance
 - ii) Cuticular resistance
 - iii) Temperature
 - iv) Soil moisture content
 - v) Crop height

[20 marks]

QUESTION 3

- a) Describe the following types of sprinkle system:

- (i) Hand move sprinkler
- (ii) Centre pivot
- (iii) Gun type sprinkler
- (iv) Linear move

[16 marks]

- b) A sprinkler system has a gross irrigation requirement of 131 mm. The operating pressure at the sprinkler nozzle is 380 kPa. The area to be irrigated is 20 ha, and the time of operation is 20 hours. The overall pump efficiency is 70 %. At full operation, the pump is taking water from the ground, with the water table 23 m below the sprinkler nozzle. The head losses to the furthest sprinkler from the pump is 7.6 m. Calculate the total pumping head (m) and the system capacity (m^3/s).

[14 marks]

QUESTION 4

- a) Chemigation is defined as the application of chemicals via an irrigation application system. These chemicals may include fertilizers, soil amendments, herbicides, insecticides etc. Discuss the advantages and disadvantages of chemigation. [10 marks]
- b) Describe how one can determine the sprinkler system uniformity using a grid of sprinklers, clearly explaining the equations used in the test. [20 marks]

Useful Equations

$$A_R = 2\pi R S_L$$

Where A_R is the representative area, R is the distance from the pivot; S_L is the local spacing between sprinklers on the pivot lateral.

$$q_R = \frac{2Q_S R S_L}{R_L^2}$$

Where q_R is the sprinkler discharge, Q_S is the total discharge and R_S is the distance from the pivot to irrigated field boundary.