

Department Of Engineering and Physics  
 Bachelor of Science (Honours) in Agricultural Engineering  
 Design and Operation of Pressurised Irrigation Systems

3 HOURS (100 MARKS)

**INSTRUCTIONS**

Answer any **FOUR** questions. Each question carries 25 marks.

JUN 2023

**Question 1**

a. Briefly explain the following terms:

- i. Water emitter [2 marks]
- ii. Tensiometer. [2 marks]
- iii. Sodium adsorption rate (SAR). [2 marks]
- iv. Reference crop evapotranspiration (ET<sub>0</sub>). [2 marks]
- v. Net irrigation requirement. [2 marks]
- vi. Leaching requirement. [2 marks]
- vii. Irrigation cycle. [2 marks]

**Table 1**

Type of soil	Light (coarse) texture	Medium texture	Heavy (fine) texture
Saturation capacity (SC) % weight	25-35%	35-45%	55-65%
Field capacity (FC) % weight	8-10%	18-26%	32-42%
Wilting point (WP) % weight	4-5%	10-14%	20-24%
SC/FC	2/1	2/1	2/1
FC/WP	2/1	1.85/1	1.75/1
Bulk density (volume weight)	1.4-1.6 g/cm <sup>3</sup>	1.2-1.4 g/cm <sup>3</sup>	1.0-1.2 g/cm <sup>3</sup>
Soil available water (moisture) by volume (FC-WP x bulk density)	6%	12%	16-20%
Available moisture (Sa) in mm per metre soil depth (FC-WP x bulk density x 10)	60 mm	120 mm	160-200 mm
Soil water tension in bars:			
• at field capacity	0.1	0.2	0.3
• at wilting point	15.0	15.0	15.0
Time required from saturation to field capacity	18-24 h	24-36 h	36-89 h
Infiltration rate	25-75 mm/h	8-16 mm/h	2-6 mm/h

b. Given the soil physical properties in the above table 1, the field capacity (FC) of a 45-cm layer of soil is 18 percent. How much water in cubic metres per hectare does this layer hold?

**Question 2**

With an aid of diagram, describe the main components of a pressurised piped systems

[25 marks]

**Question 3**

Design a drip irrigation for a watermelon plot, given the preliminary data below  
 Area and crop

The plot dimensions are 120 x 83 m (about 1 ha), planted in the open with watermelons in rows 2.20 m apart and spaced along the rows at 0.5 m. The plot is divided into two parts, each with 54 rows 40.5 m long. There are 81 plants per row. Thus, there are 4 374 plants in each part, i.e. 8 748 plants in the whole plot and 108 plant rows.

#### **Soil, water and climate**

Heavy texture soil with low permeability (approximately 6 mm/h) and a high water holding capacity. The source of water is a nearby open water reservoir; it is of good quality but with a high impurity content of organic origin (algae). The crop growing season is from early April to early July; the evaporation pan average maximum readings are 3.3 mm/d in April, 4.64 mm/d in May and 6.13 mm/d in June.

#### **Crop water requirements and irrigation schedule**

The maximum irrigation requirements of the watermelons are during the mid-season stage and the yield formation in late May-early June, when the  $k_c$  value is 1.0. The average reading for the two months is 5.38 mm/d, which multiplied by a correction factor of 0.66 gives an  $ET_o$  of 3.55 mm/d. As  $k_c = 1.0$ ,  $ET_c = 3.55$  mm/d. The system's application efficiency is 90 percent.

Therefore, the daily gross requirements at peak are:

$$3.55 \times 0.90 \div 100 = 3.94 \text{ mm/d} \quad 3.94 \times 10 \times 1 \text{ ha} = 39.4 \text{ m}^3/\text{d}$$

The irrigation scheduling in late May is not arranged at a fixed depletion of the available soil moisture, but at a fixed interval of one day. Therefore, irrigation takes place every day and the dose is  $39.5 \text{ m}^3$ . At the early stages of the growing season, the irrigation interval ranges from 4 to 2 days. [25 marks]

#### **Question 4**

Describe the parameters required and the evaluation criterias to be considered when using reclaimed wastewater for the treatment and reuse for irrigation purposes.

[25 marks]

#### **Question 5**

Outline the minimum engineering investigation requirements for a drip irrigation system to enable the successful planning, designing and implementation at the farm level.

[25 marks]

#### **Question 6**

Provide an example for the tenders for the supply of centre pivot pressurised irrigation equipment.

[25 marks]

End of paper