*"Investing in Africa's Future"*

# COLLEGE OF HEALTH, AGRICULTURE & NATURAL SCIENCES

**NAAE 302: Irrigation and Water Management**

**END OF SECOND SEMESTER EXAMINATIONS**

**APRIL/MAY 2024**

**LECTURER: MR. W. ZENDERA**

**DURATION: 3 HOURS**

---

## *INSTRUCTIONS*

1. Answer any FIVE Questions

2. Use Answer Sheets Provided

Begin the Answer for each question on a new page

Question 1

a) Explain the term effective "root zone depth" [3 marks]
b) Explain why an irrigation manager would be interested in knowing the soil texture. [3 marks]
c) Given the data in table 1 below for a certain field crop:

Table 1

| | |
|---|---|
| Root zone depth | 100 cm |
| Field capacity | 22 % |
| Wilting point | 12 % |
| Bulk Density | 1.5 g/cm$^3$ |
| Evapotranspiration rate | 15 mm/day |
| Irrigation efficiency | 75 % |
| | |

Assuming 10 % moisture depletion of the available water before irrigation calculate:

i. The net depth of application, [5 marks]
ii. Calculate the irrigation frequency. [5 marks]

**Question 2**

a) List the five essential elements necessary for the design of a successful irrigation project. [5 marks]
b) Explain how the following factors influence evapotranspiration rate of field crops.
   i. Relative humidity, [2 marks]
   ii. Solar radiation, [2 marks]
   iii. Wind velocity, [2 marks]
   iv. Canopy cover, [2 marks]
   v. Air temperature. [2 marks]
c) List five methods used for estimating reference crop evapotranspiration. [5 marks]

Question 3

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 4

a) State four aspects that would determine the irrigation frequency of your crop. [5 marks]
b) Explain why the quantification of potential evapotranspiration important in agriculture. [5 marks]
c) Determine the seasonal crop water needs for a maize crop planted in November given the following data in Table 2. [10 marks]

Table 2

| Crop growth stage | Germination and establishment Period | Vegetative period | Tasseling, silking and pollination period. | Kernel development and maturity period |
|---|---|---|---|---|
| Period (days) | 20 | 30 | 40 | 30 |
| Kc | 0.4 | 0.80 | 1.10 | 0.80 |
| ETo mm/day | 3.6 | 4.5 | 5.10 | 5.40 |
| ETc mm/day | | | | |
| ETc mm/stage | | | | |
| Seasonal crop ET | | | | |

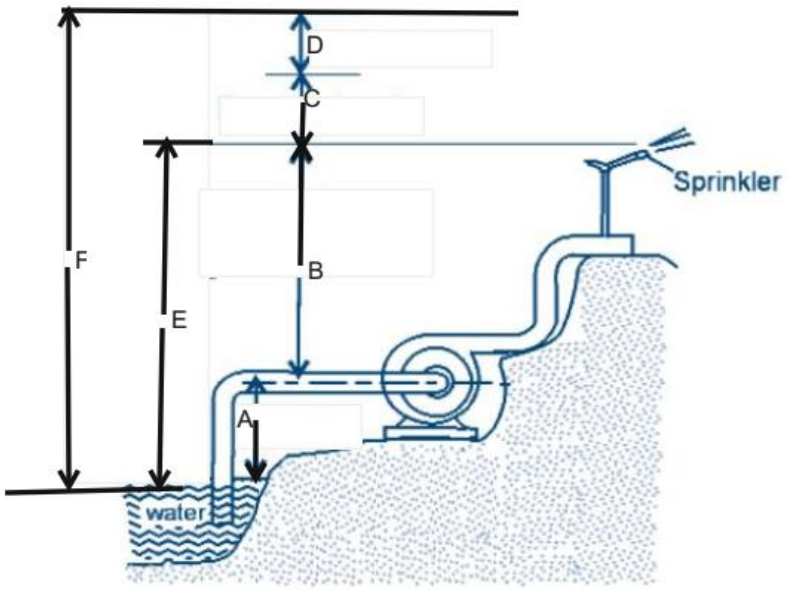
**Question 5**

a) A stream of 140 litres per second was diverted from a canal and 110 litres per second were delivered to the field. An area of 1.65 ha was irrigated in eight hours. The effective depth of rootzone was 1.85 m. the runoff loss in the field was 435 $m^3$. The depth of water penetration varied linearly from 1.85 m at the head end of the field to 1.25 m at the tail end. Available moisture holding capacity of the soil is 25 cm/m depth of soil. Irrigation was started at a moisture extraction level of 50 % of the available moisture. Calculate

i. The water conveyance efficiency, [5 marks]
ii. Water application efficiency, [5 marks]
iii. Water storage efficiency and [5 marks]
iv. Water distribution efficiency. [5 marks]

**Question 6**

a) Label the following bump heads marked A-F in figure 2. [6 marks]




b) Explain some of the best practices pump users can employ to prevent cavitation in irrigation pumps. [5 marks]

c) 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 additional material)*

   i. Determine whether it is possible to install the pump if the required NPSH is 5, 2 m and, [5 marks]

   ii. Calculate the maximum static suction head of the pump in the present instance. [4 marks]

Question 7

a) Define fertigation. [3 marks]

b) List the advantages of fertigation. [5 marks]

c) Describe the methods that can be used to inject chemicals into the irrigation system. [7 marks]

d) Calculate the injection rate for chlorine solution into a drip system with a capacity of 20 $m^3$/hr when you wish to achieve a 2 ppm chlorine content in the irrigation water, and the chlorine solution has 12 ml/l available active chlorine. [5 marks]

Appendix

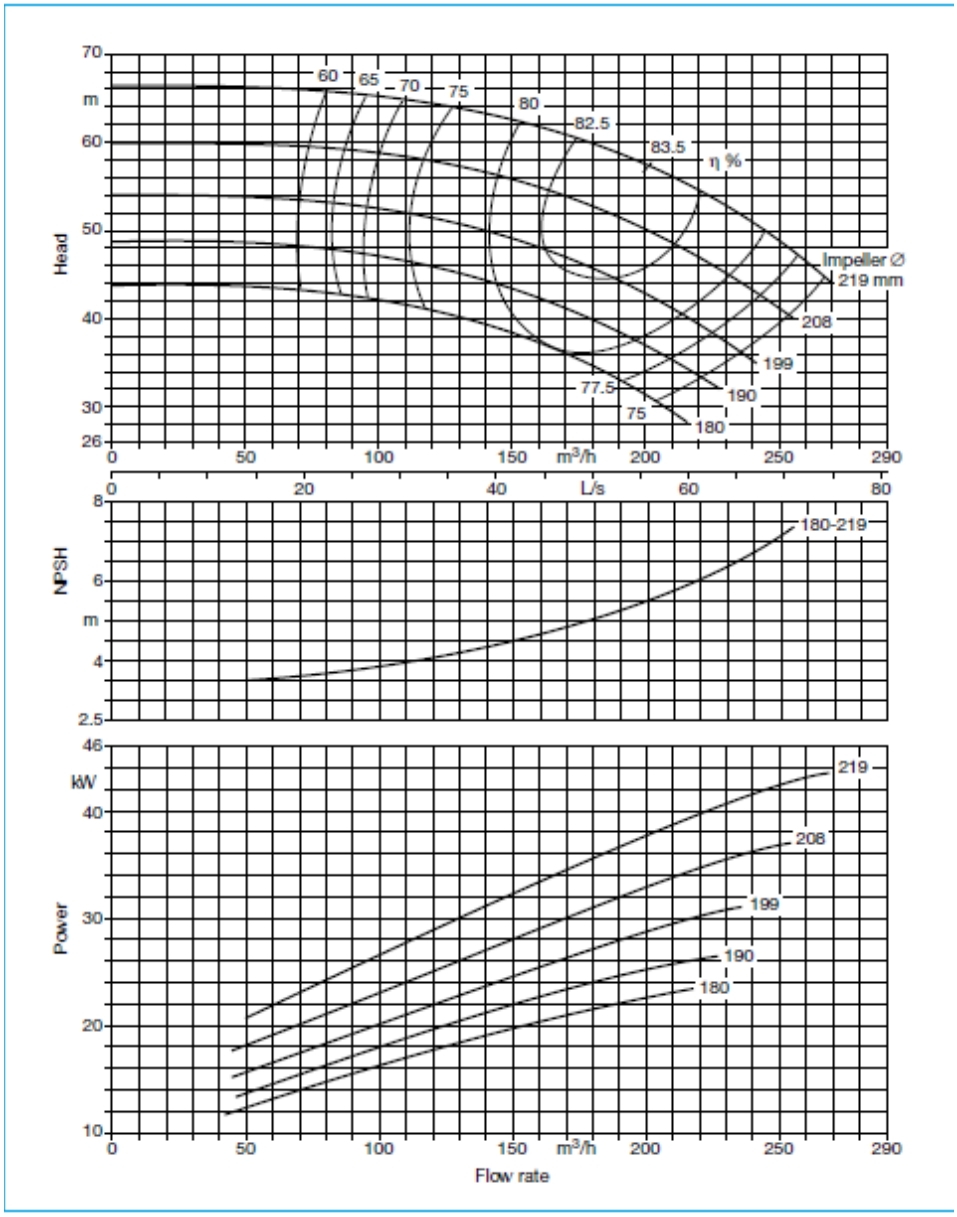



**Figure 1:** Characteristics of a Centrifugal Pump

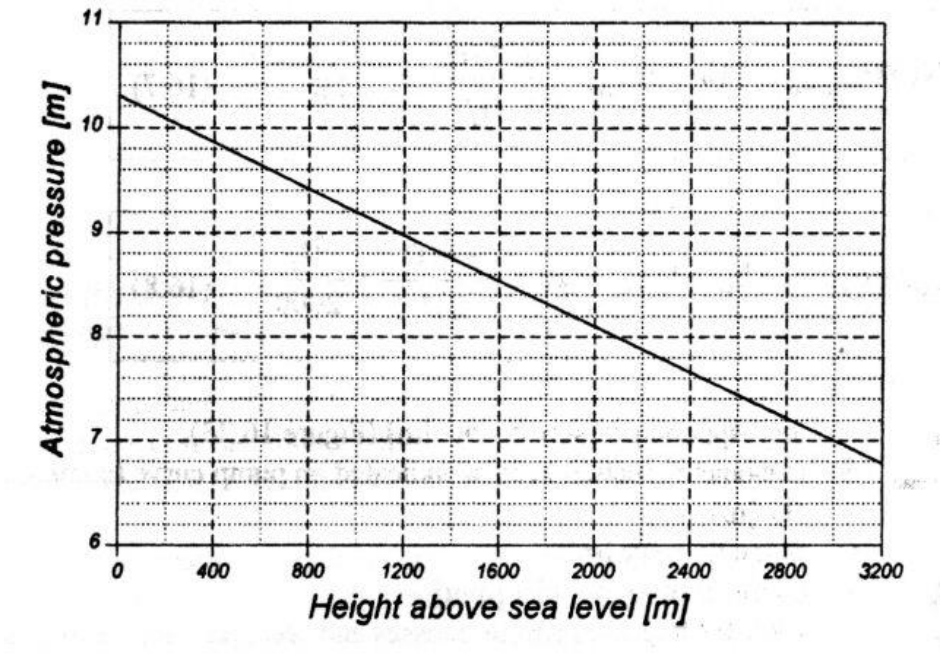



**Figure 2**. Atmospheric pressure Vs Altitude curve

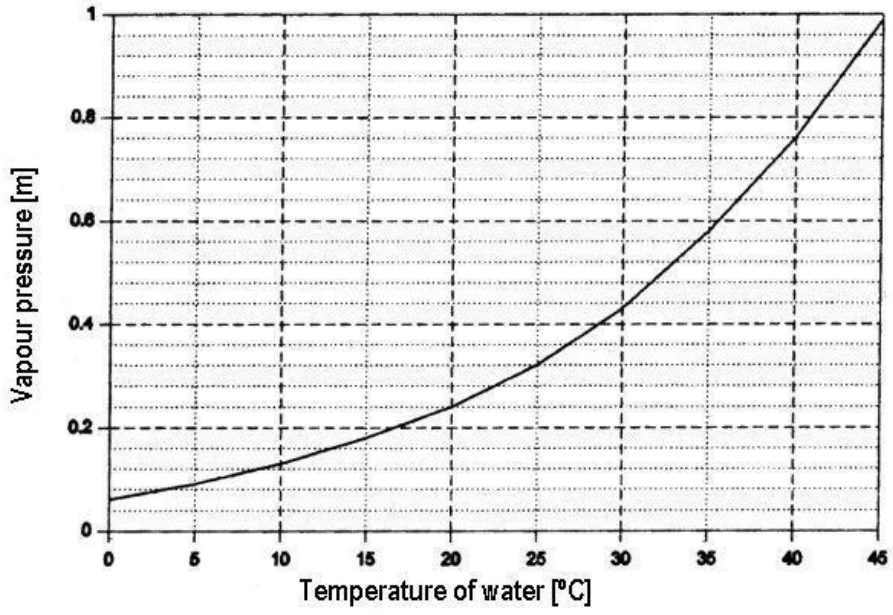



**Figure 3.** Vapour pressure of water.