AFRICA UNIVERSITY
A United Methodist-Related Institution

COLLEGE OF HEALTH, AGRICULTURE & NATURAL SCIENCES

NAAE 302: Irrigation and Water Management
END OF SECOND SEMESTER EXAMINATION
APRIL/MAY 2024
LECTURER: MR. W. ZENDERA
DURATION: 3 HOURS

INSTRUCTIONS

1. Answer any FIVE Questions
2. For calculations refer to relevant figures in the appendices.
3. Credit is Given for Neat Presentation

Question 1

a) With the aid of a diagram explain how the infiltration rate of water in soil varies with time during irrigation. [5 marks]

b) Describe the characteristic moisture extraction pattern in the soil by crops. [5 marks]

c) A loam soil has a field capacity of 22 % and wilting point of 10 %. The bulk density of the soil is 1.5 g/cm^3. Irrigation is to be applied when the moisture content falls to 14 % and irrigation efficiency is 75 %. If the root zone depth is 70 cm, determine:

i. The water holding capacity of the soil. [5 marks]

ii. The water depth required to be applied to the field. [5 marks]

Question 2

Explain what is meant by the following classifications of soil water:

a) Gravitational water, [4 marks]

b) Capillary water, [4 marks]

c) Hygroscopic water, [4 marks]

d) Saturation capacity, [4 marks]

e) Field capacity, and [2 marks]

f) Permanent wilting point. [2 marks]

Question 3

a) Explain the management strategies that can be used to minimize water losses in surface irrigation. [5 marks]

b) With the aid of diagrams, explain the effects of the following poor practices in furrow irrigation systems.

i. A small stream size, [5 marks]

ii. A large stream size, and [5 marks]

iii. Furrow spacing too wide. [5 marks]

Question 4

a) Explain the three steps to working out irrigation needs of your avocado trees. [3 marks]

b) With reference to Avocado explain the following:

i. Water requirements [3 marks]

ii. Critical growth stages [3 marks]

iii. Suitable irrigation methods [3 marks]

c) Given the following information for irrigated avocado

- Recommended dosage = 5 mm/day
- Lateral spacing = 2.5 m (two laterals per row of avocado trees)
- Emmiter spacing = 0.3 m
- Emitter discharge = 1 l/hr

Calculate:

i. The application rate (mm/hr), [3 marks]
ii. The set time (hrs), and [3 marks]
iii. The amount of water needed per ha (m^3/day). [2 marks]

Question 5

a) Given a 12 m x 15 m sprinkler system with individual sprinkler discharge of 2.0 m^3/hr with 4.0 mm nozzles and operating at 350 kPa pressure. Deduce:
   i. The spacing between laterals, [3 marks]
   ii. Spacing between sprinklers, [3 marks]
   iii. The application rate, and [3 marks]
   iv. Maximum allowable pressure drop along the laterals (kPa). [2 marks]

b) The performance of a sprinkler system is determined using the catch can test. The following data (mm depth) were obtained from this test.

40	45	50	43	38	35	30	27	27	26	22	

Calculate:
   i. The Christiansen coefficient (CU), and [5 marks]
   ii. The distribution uniformity (DU) [4 marks]

Question 6

a) Describe some of the best practices a pump user can employ to prevent cavitation. [5 marks]
b) With the aid of a diagram, explain the following pump performance regulating approaches.
   i. Operating two pumps in series, and [5marks]
   ii. Operating two pumps in parallel [5 marks]
c) A pump was set up under the following conditions:
   - Flow rate required = 18 m^3/hr
   - Suction lift = 3 m
   - Static discharge head = 13 m
   - Pipe frictional losses= 6 m
   - Sprinkler operating pressure = 350 kPa

Calculate:

   i. The total dynamic head, and [2 marks]
   ii. The power required to run the pump in (Kw). [3 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

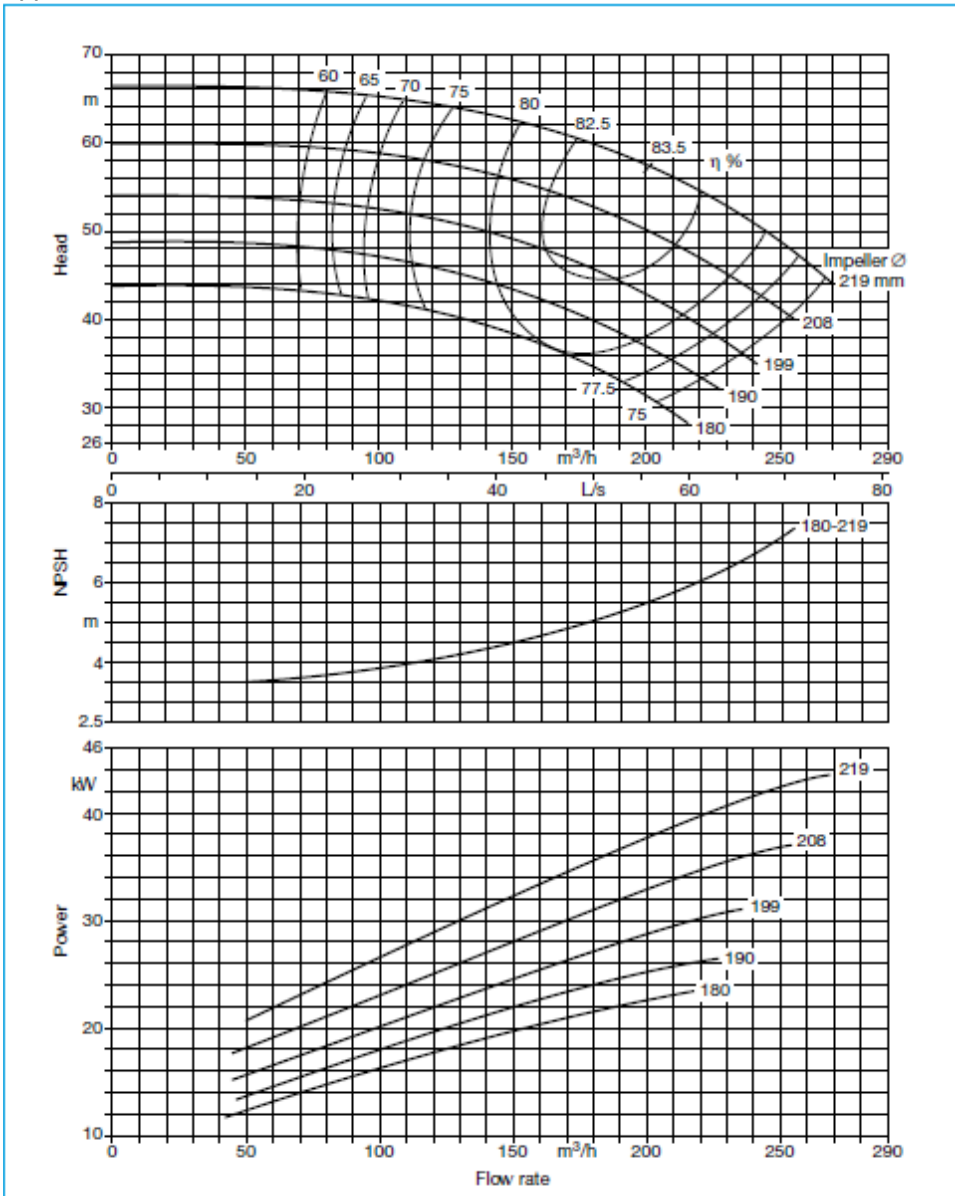

Figure 1: Characteristics of a Centrifugal Pump

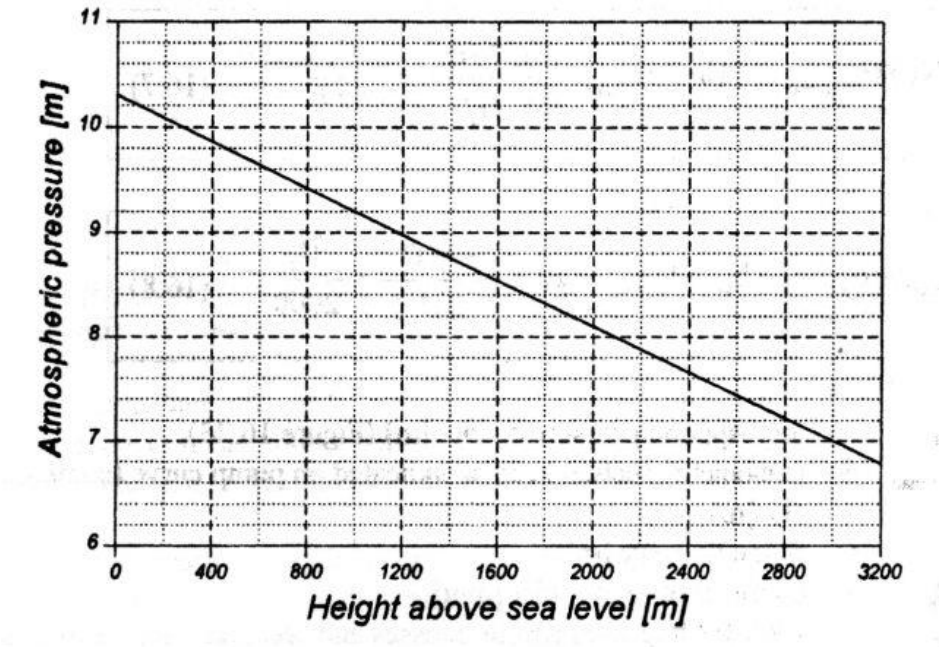

Figure 2. Atmospheric pressure Vs Altitude curve

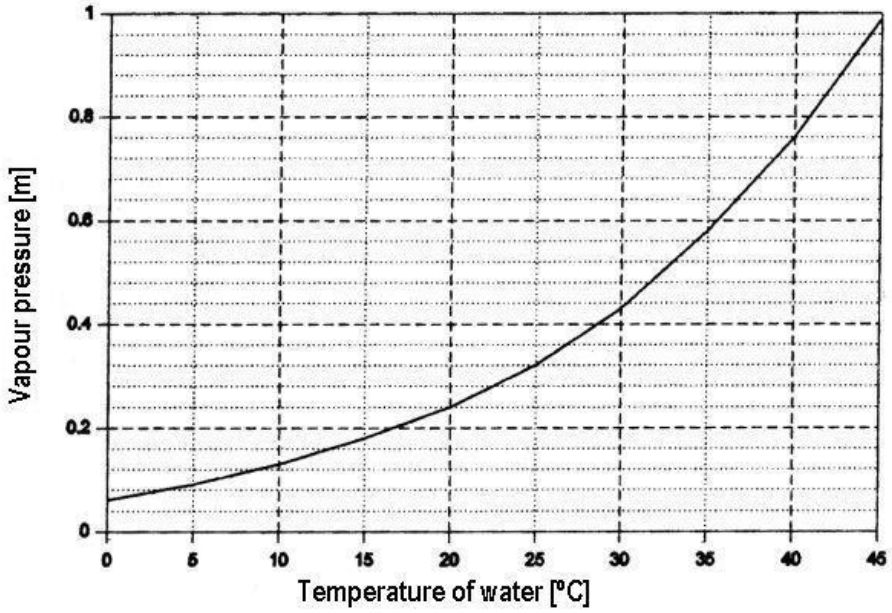

Figure 3. Vapour pressure of water.