BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

AGC 403

Department of Crop Science

Bachelor of Agricultural Science (Honours) Degree in Crop Science

Irrigation and Water Management

3 hours (100 Marks)

Instructions:

1. This paper contains 6 questions
2. Answer any **FOUR** questions, each of which carries 25 marks

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Question 1

a) Define the following key concepts for irrigation planning:
   i. Application rate (AR) [3 Marks]
   ii. Distribution uniformity (DU) [3 Marks]
   iii. Daily water use (ET) [3 Marks]
   iv. Irrigation efficiency (IE) [3 Marks]
   v. Soil moisture depletion (SMD) [3 Marks]

b) A soil sample was taken from a field a few days after an irrigation and the following information was established.
   - Mass of wet sample = 825 g
   - Mass of oven dry soil = 700 g
   - Volume of cylinder used to collect sample = 500 cm^3

   i. Calculate the percentage gravimetric soil moisture, [4 marks]
   ii. The percentage volumetric moisture content, [4 marks]
   iii. The water depth in mm/m. [2 marks]

Question 2

a) With the aid of a diagram explain how evapotranspiration varies with the stage of growth of a crop. [5 marks]

c) An area of 25 ha will be irrigated by a pump working 10 hours a day for 5 days. Irrigation is desired at 50% soil water depletion. The available water holding capacity of the soil is 20 cm per m depth of soil root zone depth is 75 cm. the conveyance and water application efficiency are 75 % and 80 % respectively. The mean consumptive use rate of the crops is 5 mm/day. Work out the:

i. Net irrigation requirement [5 marks]
ii. Gross irrigation requirement [5 marks]
iii. Irrigation frequency [5 marks]
iv. Required capacity of the system [5 marks]

Question 3

a) Discuss how the following factors influence evapotranspiration:

i. Air temperature, [3 marks]
ii. Relative humidity, [3 marks]
iii. Solar radiation, [3 marks]
iv. Wind velocity, and [3 marks]
v. Canopy cover. [3 marks]

b) Given the data in table 1 and using the dependable rain formula to estimate effective precipitation (Pe). Complete table 1 and estimate the seasonal water needs for the crop. [10 marks]

Table 1

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)						
IWR net (mm/day)						

Question 4

a) Explain the moisture extraction pattern characteristics in soils by plants. [8 marks]

b) 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 5

a) Discuss the implications of excessive groundwater withdrawal in farms. [10 marks]

b) Given a 12 m x 18 m sprinkler system with individual sprinkler discharge of 2.2 m^3/hr with 4.0 mm nozzles and operating at 350 kPa pressure. Deduce:

i. The spacing between laterals, [2 marks]
ii. Spacing between sprinklers,and [1 mark]
iii. The application rate. [3 marks]
iv. Maximum allowable pressure drop along the lateral (kPa). [2 marks]

c) 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 [4 marks]
ii. The distribution uniformity (DU) [3 marks]

Question 6

a) Explain some of the best practices pump users can employ to prevent cavitation in irrigation pumps. [10 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 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]

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]

Appendix

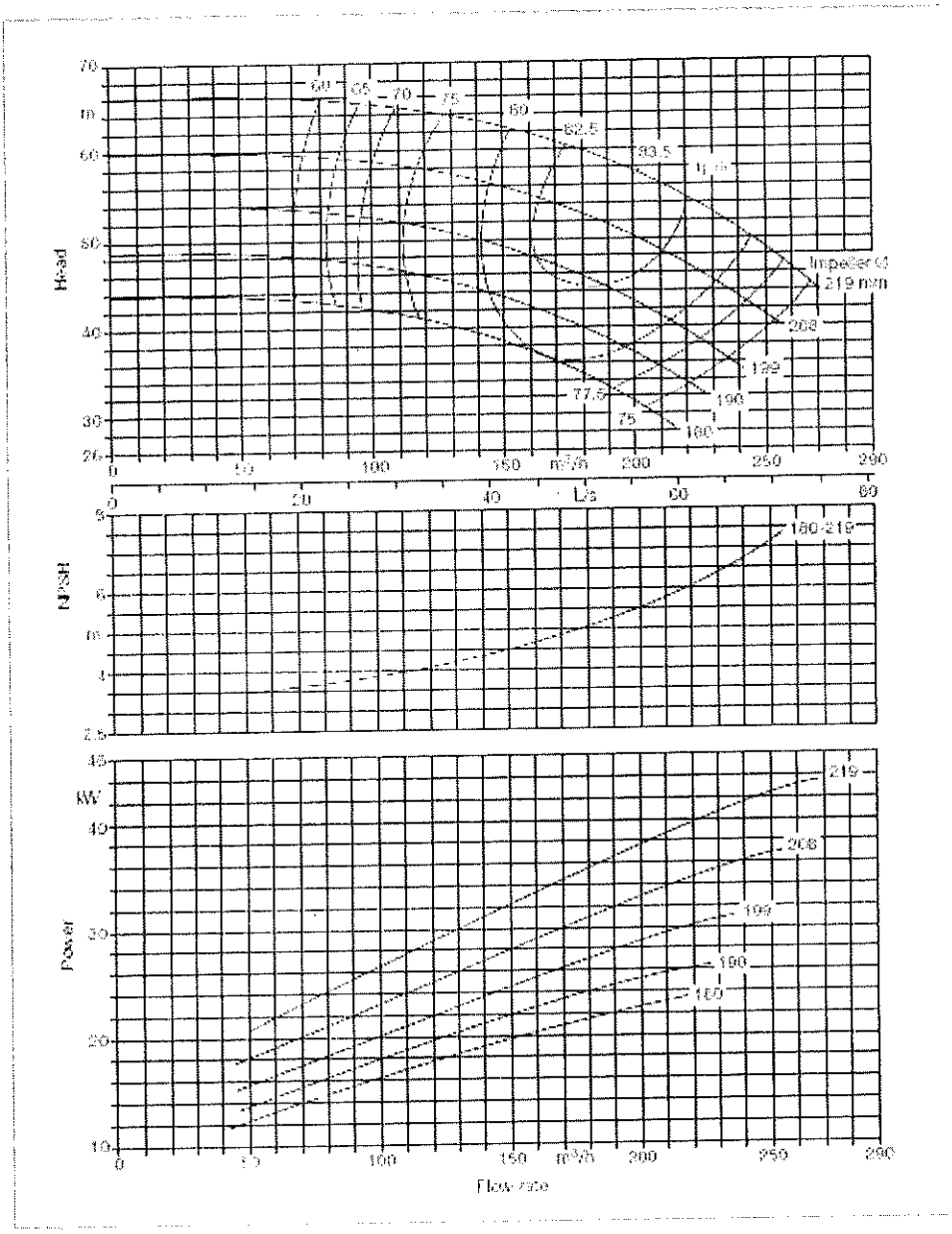

Figure 1: Characteristics of a Centrifugal Pump

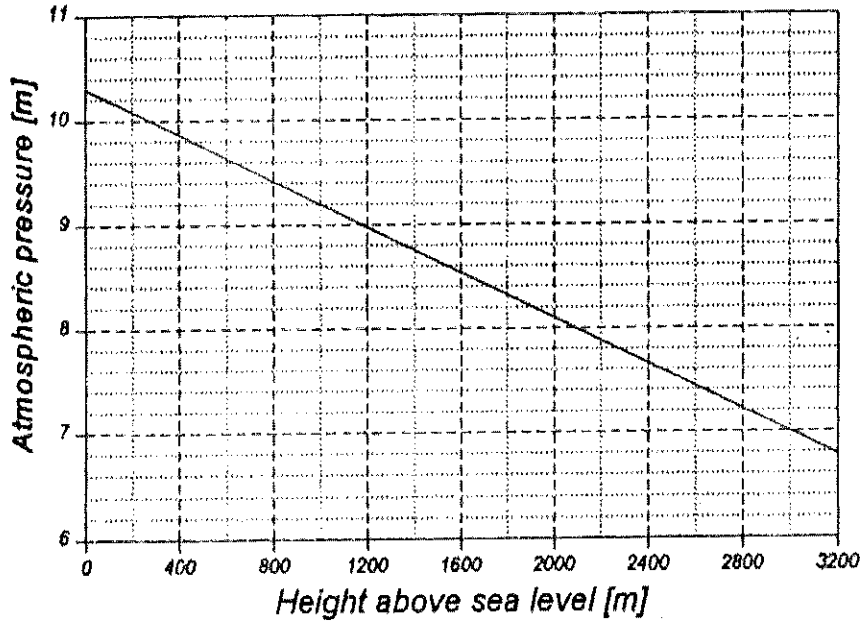

Figure 2. Atmospheric pressure Vs Altitude curve

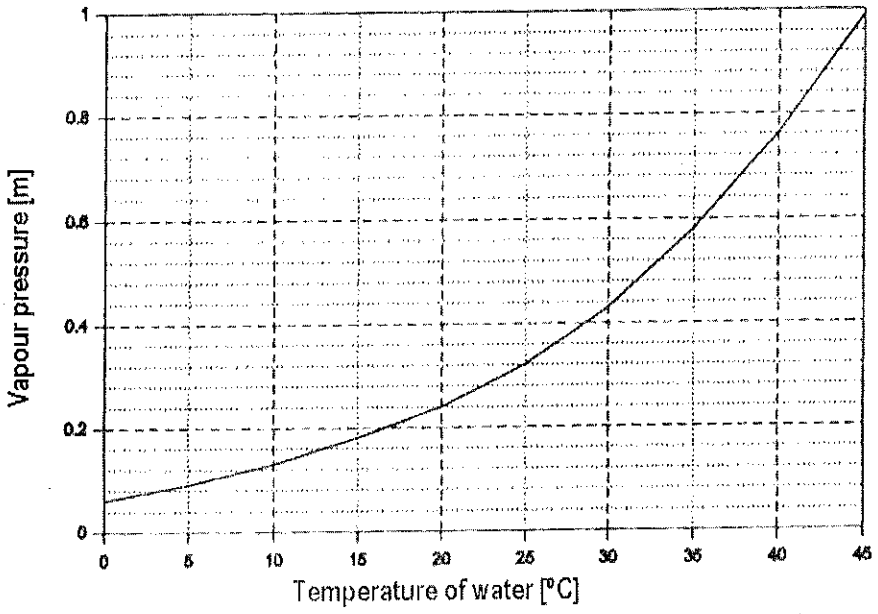

Figure 3. Vapour pressure of water.