UNIVERSITY OF FORT HARE

PRINCIPLES OF IRRIGATION
AGC321

DEGREE EXAMINATIONS

NOVEMBER

2018

.....

Time: 3 HOURS

Subject: AGC321

Marks: 100

This paper consists of 5 pages including the cover page

Internal Examiners
R MOYO

External Examiners

INSTRUCTIONS

ANSWER ANY FIVE (5) QUESTION

ANSWER ANY 5 QUESTION

1. A small irrigation system has a diesel engine pump which pumps water to impact sprinklers

   Number of sprinklers 9 Discharge rate of each sprinkler 1.4 m3/h
   Spacing between sprinklers 12m Spacing between sets 12 m
   Irrigation efficiency 75%
   Fuel consumption of the pump 1.6L/h Cost of Diesel R11.50/L
   Cost of maintenance 20% of fuel cost Labour cost 1% of fuel cost
   Water license fee 11 cents per kiloliter used

   Calculate the variable cost of net irrigation per mm depth per ha of crop. (20)

   Gross depth of irrigation per mm net application = $\frac{Net\ application(mm) x\ 100}{\%\ efficiency}$

   Gross water per ha per mm of net application = Gross depth of irrigation(mm) x 10 (kL/ha.mm)

   Volume of water pumped per hour = Discharge rate per sprinkler x number of sprinklers

   Diesel consumption per m3 water pumped = $\frac{Diesel\ consumption/hour}{Vol.water\ pumped\ /hour}$

2. a. i. Define PAWC. (2)

   ii. Explain why PAWC is important in irrigated crop production (8)

   b. Using Tables 1 and 2, calculate the maximum depletion for potatoes with a rooting depth of 600 mm growing in a soil with 22 %. (10)

Table 1: Crop sensitivity to water stress

Crop category	Types of crops	% depletion of water holding capacity before irrigation. (%WHC)
Low tolerance	Lucerne, potato, beetroot, many horticulture crops, crops where the vegetative part is the economic yield (cabbage, tobacco)	15% – 25%
Medium tolerance	Most field crops	50% -- 75%
High tolerance	Wheat, sorghum, salt tolerant crops	Can survive >100%, normally irrigate at 75%

Table 1: Soil water guide for different soil types (AWC is for medium tolerance crops)

Soil type	Sand	Loam	Clay –loam	Clay
% clay	5 –15	15 –25	25 – 40	>40
Water holding capacity (to oven dry)	60 mm/m	90 mm/m	120 mm/m	150 mm/m
Available water capacity (% WHC)	80	70	60	50
Available water capacity	48 mm/m	63 mm/m	72 mm/m	75 mm/m

3. a. Calculate the water content of the soil profile over a depth of 1.5 m given the following information. (10)

Soil depth (mm)	Soil dry bulk density (kg/m3)	Sample mass before drying(g)	Sample mass after drying (g)
0-150	1150	58.7	56
150-300	1220	55	52
300-600	1290	64.4	61
600-1500	1410	57.7	54

b. i. Calculate how much net irrigation will have to be applied to wet the soil to field capacity and to provide for a leaching requirement ratio 0.125. The soil water content at field capacity is 12 mm/100 mm over the profile depth. (6)

ii. Calculate the gross volume of water required to bring this soil to field capacity and allow for leaching. The area is 5 ha and irrigation efficiency is expected to be 70 %. (4)

4. Irrigation water supply for a scheme has an EC of 2.35 dS/m at 25ooC. Wheat and cotton will be grown in ratio. Wheat will be grown in winter when negligible rainfall is expected and net crop water requirement is 480 mm. Cotton will be grown in summer when mean rainfall is 420 mm, and supplementary crop water requirement is 260 mm. Calculate the Net Requirement for both crops using the following information:
$EC_{w(ab)}$ = [EC_{wa} x proportion water a] + [EC_{wb} x proportion water b], EC rain water = 0.05 dS/m (20)

Table 4 CROP TOLERANCE AND YIELD POTENTIAL OF SELECTED CROPS AS INFLUENCED BY IRRIGATION WATER SALINITY (EC_W) OR SOIL SALINITY (EC_e) (dS/m)
YIELD POTENTIAL

FIELD CROPS	*100%*		*90%*		*75%*		*50%*		*"maximum"*	
	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w
Cotton *(Gossypium hirsutum)*	7.7	5.1	9.6	6.4	13	8.4	17	12	27	18
Sorghum *(Sorghum bicolor)*	6.8	4.5	7.4	5.0	8.4	5.6	9.9	6.7	13	8.7
Wheat *(Triticum aestivum)*	6.0	4.0	7.4	4.9	9.5	6.3	13	8.7	20	13

5. a. A 60 ha irrigation is designed for maximum class A pan evaporation rate of 5.5 mm/day and the crop factor of 1.1. The whole area will be growing the same crop and water will be supplied by one pump. Actual operating time of the overhead sprinklers is planned for 22 hours per day. Assuming the standard application efficiency, calculate the pump system capacity required. (10)

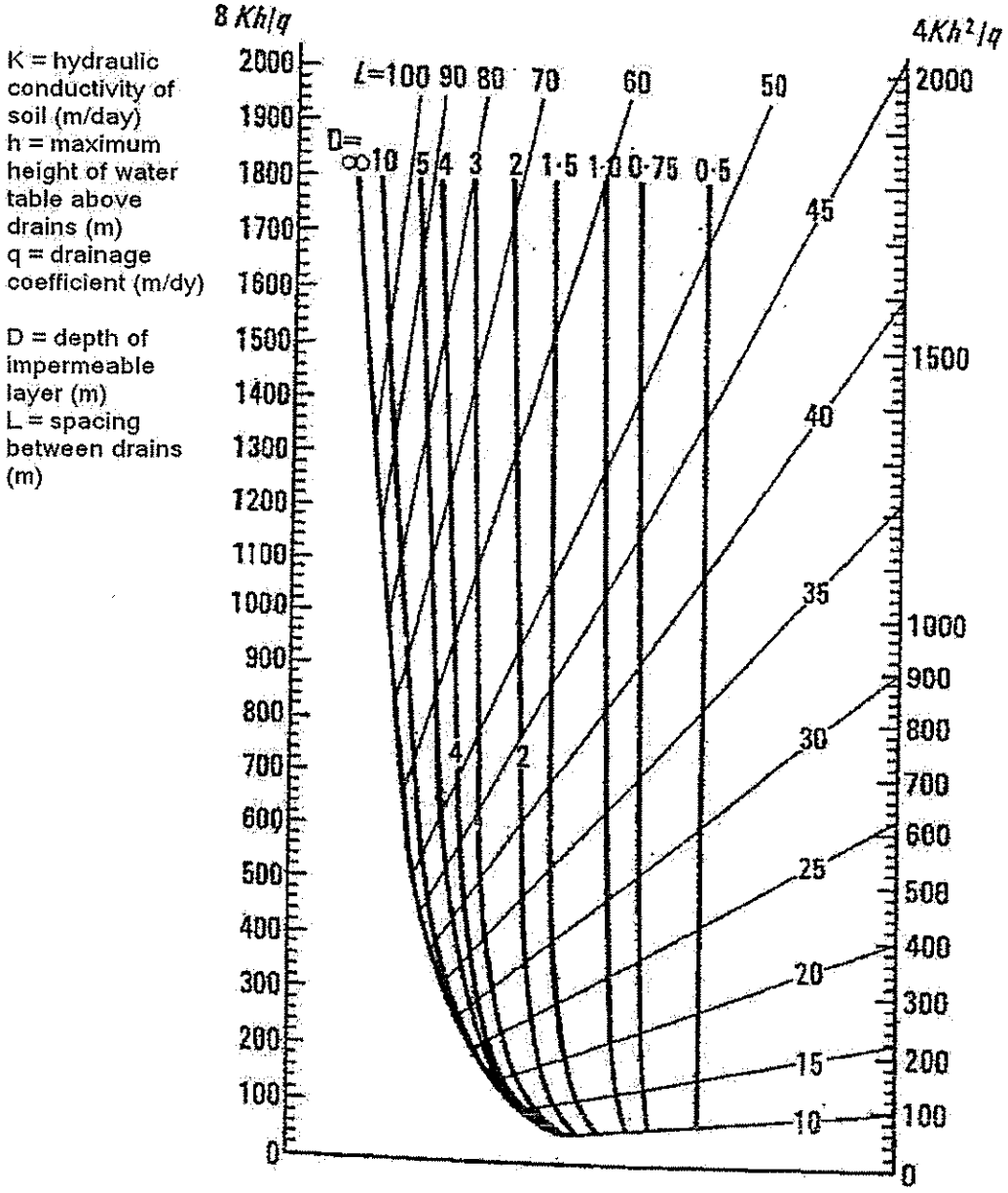
b. Water flow rate at start of canal taking water to an irrigation scheme is 19.3 kl/s. Flow rate at the field edge is 16.8 kl/s. Calculate the transmission efficiency (4)

c. Briefly explain any 3 water management strategies that can be used for furrow irrigation. (6)

6. a. Give two major reasons why an irrigated field may require artificial drainage (5)

b. An irrigation project suffers from waterlogging. Two crops are grown per year. The annual rainfall is 620 mm. The total water requirement for both crops is 1170 mm. There is an impermeable layer at 2.5 m depth. The maximum depth of tube drain can be 1.8 m. The hydraulic conductivity of the soil is 280 mm/day. The crops grown are maize, cotton and wheat. Use the monograph provided to calculate the correct spacing between lateral drains. (15)

Figure 1. A design chart for depth and spacing of tube drains



END OF EXAMINATION