(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

FOURTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: CSE 454

COURSE TITLE: IRRIGATION ENGINEERING I

DATE: 7TH OCTOBER **TIME: 9 – 11 A.M**

Instructions to candidates

1. This paper consists of **FIVE (5)** questions
2. Answer question **ONE (Compulsorily)** and **ANY** other **THREE (3)** questions
3. Candidates are not allowed to write anywhere on the question paper
4. All symbols have their usual meanings unless otherwise stated
5. Necessary table and figure is attached
6. Time allowed is **TWO (2)** hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 5 Printed Pages. Please Turn Over.

Question ONE {Compulsory (25 marks)}

a) Briefly explain the following terms used in irrigation
   i. Available moisture
   ii. Crop water requirement
   iii. Irrigation water requirements (3 marks)

b) Briefly explain the following terms used in furrow irrigation system
   i. Intake opportunity time
   ii. Advance stream
   iii. Cut back stream (3 marks)

c) Explain the functions of the following irrigation structures: (5 marks)
   i. Weir
   ii. Canal head regular
   iii. Scouring sluice
   iv. Guide wall
   v. Apron

d) Briefly explain the design factors/criteria for basin irrigation system. (6 marks)

e) A stream of 135 litres per second was diverted from a canal and 100 litres per second were delivered to the field. An area of 1.6 hectares was irrigated in 8 hours. The effective depth of root zone was 1.8cm. The run-off in the field was 432 m3. The depth of water penetration varied linearly from 1.8m at the head end of the field to 1.2m at the tail end. The available moisture holding capacity of the soil is 20cm/m depth of soil. Irrigation was started at moisture extraction level of 50% of the available moisture. Determine:
   i. The conveyance efficiency (2 marks)
   ii. The water application efficiency (2 marks)
   iii. The water storage efficiency (2marks)
   iv. The water distribution efficiency (2 marks)

Question TWO (15 marks)

a) An area of 20 hectares is to be irrigated by a pump working for 12 hours a day. The available moisture holding capacity of soil is 16cm/m and the depth of root zone is 1m. Irrigation is to be done when 50% of available moisture in the root zone is depleted. Water application efficiency is 70%. Peak rate of moisture use by crops is 4mm. losses in water conveyance are negligible. Determine:
   i. Net depth of water application (2 marks)
   ii. Irrigation period (2 marks)
   iii. Depth of water pumped per application (2 mark)
   iv. The required capacity of the irrigation system in hectare-cm/day (1 mark)
   v. The required capacity of the irrigation system in litres/second (1 mark)

b) Determine the required capacity of a sprinkler system to apply water at the rate of 1.25 cm/hr. Two 186 metres long sprinkler lines and sixteen sprinklers spaced at 12m interval on each line are required. The spacing between lines is 18m
   (2 marks)

c) Allowing 1 hour for moving each of 186m sprinkler line describe in (a) above:
   i. How many hours would be required to apply 5cm irrigation to a square field of 16 hectares? (2 marks)
   ii. How many days are required assuming 10 hours/day? (2 marks)

Question THREE (15 marks)

a) A pump discharges water at the rate of $11m^3$ per hour and works for 8 hours per day. Estimate the area commanded by the pump if the average depth of irrigation is 8cm and irrigation interval is 15 days. (5 marks)

b) The following data were obtained in determining the soil moisture content at successive depths in the root zone prior to applying irrigation water:

Depth of sampling (cm)	*Weight of moist soil (g)*	*Weight of dry soil (g)*
0 - 25	134.60	126.82
25 - 50	136.28	127.95
50 - 75	122.95	115.32
75 - 100	110.92	102.64

The average bulk density of the soil in the root zone was 1.50 g/cm^3. The available moisture holding capacity of the soil was 17.8 cm/m. Determine:

i. The moisture content (% db) at the different depths in the root zone (4 marks)

ii. The total moisture content (depth) in the root zone at the time of irrigation (4 marks)

iii. The net depth of water to be applied to bring the moisture content to field capacity (1 mark)

iv. The gross irrigation requirement at an estimated field irrigation efficiency of 70% (1 mark)

Question FOUR (15 marks)

a) Highlight FOUR advantages and TWO disadvantages of drip irrigation system in its operations (3 marks)

b) Furrows of length 90m and spaced 75cm apart are irrigated by and initial stream of 2 litres per second. The initial stream reached the lower end of the field in 50minutes. The size on stream was reduced to 0.5 litres per second. The cut back stream continued for 1 hour. Determine the depth of irrigation (6 marks)

c) An irrigation stream of 27 litres per second is diverted to a border check basin of size 12m by 10m. The water holding capacity of the soil is 14%. The average soil moisture content in the crop root zone prior to applying water is 6.5%. The average depth of crop root zone is 1.2m. The specific gravity of root zone soil is 1.5. Determine:

i. The net irrigation requirement (2 marks)

ii. Total volume of water required in check basin (2 marks)

iii. Required duration of irrigation to replenish the root zone moisture (2 mark)

Question FIVE (15 marks)

a) Discuss factors that may aid in selection of a given irrigation method (8 marks)

b) Given the data below, determine spacing, L between drains, by:

i. Trial and Error method (4 marks)

ii. Nomographs method (3 marks)

$D = 2m$, $K_2 = 1m/day$, $K_1 = 0.5m/day$, $q = 0.005m/day$, $r = 0.10m$ and $h = 0.6m$

APPENDIX B

B(a)

d-VALUES HOOGHOUDT (1940)

$r = 0.10\ m$

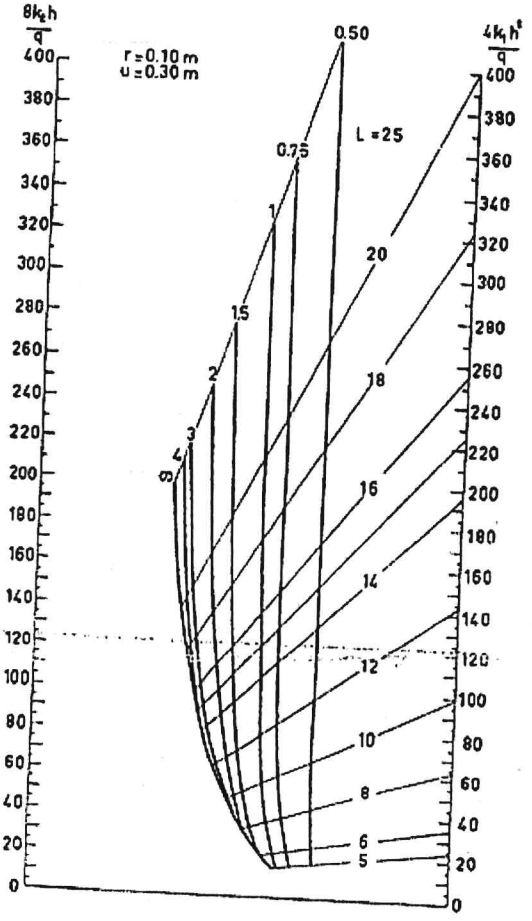
$L \rightarrow$ 5 m	7,5	10	15	20	25	30	35	40	45	50
D										
0.5 m 0,47	0.48	0.49	0.49	0.49	0.50	0:50 →				
0.75 0.60	0.65	0.69	0.71	0.73	0.74	0.75	0.75	0.75	0.76	0.76
1.00 0.67	0.75	0.80	0.86	0.89	0.91	0.93	0.94	0.96	0.96	0.96
1.25 0.70	0.82	0.89	1.00	1.05	1.09	1.12	1.13	1.14	1.14	1.15
1.50	0.88	0.97	1.11	1.19	1.25	1.28	1.31	1.34	1.35	1.36
1.75	0.91	1.02	1.20	1.30	1.39	1.45	1.49	1.52	1.55	1.57
2.00		1.08	1.28	1.41	1.5	1.57	1.62	1.66	1.70	1.72
2.25		1.13	1.34	1.50	1.69	1.69	1.76	1.81	1.84	1.86
2.50			1.38	1.57	1.69	1.79	1.87	1.94	1.99	2.02
2.75			1.42	1.63	1.76	1.88	1.98	2.05	2.12	2.18
3.00			1.45	1.67	1.83	1.97	2.08	2.16	2.23	2.29
3.25			1.48	1.71	1.88	2.04	2.16	2.26	2.35	2.42
3.50			1.50	1.75	1.93	2.11	2.24	2.35	2.45	2.54
3.75			1.52	1.78	1.97	2.17	2.31	2.44	2.54	2.64
4.00				1.81	2.02	2.22	2.37	2.51	2.62	2.71
4.50				1.85	2.08	2.31	2.50	2.63	2.76	2.87
5.00				1.88	2.15	2.38	2.58	2.75	2.89	3.02
5.50					2.20	2.43	2.65	2.84	3.00	3.15
6.00						2.48	2.70	2.92	3.09	3.26
7.00						2.54	2.81	3.03	3.24	3.43
8.00						2.57	2.85	3.13	3.35	3.56
9.00							2.89	3.18	3.43	3.66
10.00							↓	3.23	3.48	3.74
∞ 0.71	0.93	1.14	1.53	1.89	2.24	2.58	2.91	3.24	3.56	3.88

$L \rightarrow$ 50	75	100	150	200	250
D					
0.5 m 0.50 →					
1 0.96	0.97	0.98	0.99	0.99	0.99
2 1.72	1.80	1.85	1.90	1.92	1.94
3 2.29	2.49	2.60	2.72	2.79	2.83
4 2.71	3.04	3.24	3.46	3.58	3.66
5 3.02	3.49	3.78	4.12	4.31	4.43
6 3.23	3.85	4.23	4.70	4.97	5.15
7 3.43	4.14	4.62	5.22	5.57	5.81
8 3.56	4.38	4.95	5.68	6.13	6.43
9 3.66	4.57	5.23	6.09	6.63	7.00
10 3.74	4.74	5.47	6.45	7.09	7.53
12.5	5.02	5.92	7.20	8.06	8.68
15	5.20	6.25	7.77	8.84	9.64
17.5	5.30	6.44	8.20	9.47	10.4
20		6.60	8.54	9.97	11.1
25		6.79	8.99	10.7	12.1
30			9.27	11.3	12.9
35			9.44	11.6	13.4
40				11.8	13.8
45				12.0	13.8
50				12.1	14.3
60				↓	14.6
∞ 3.88	5.38	6.82	9.55	12.2	14.7

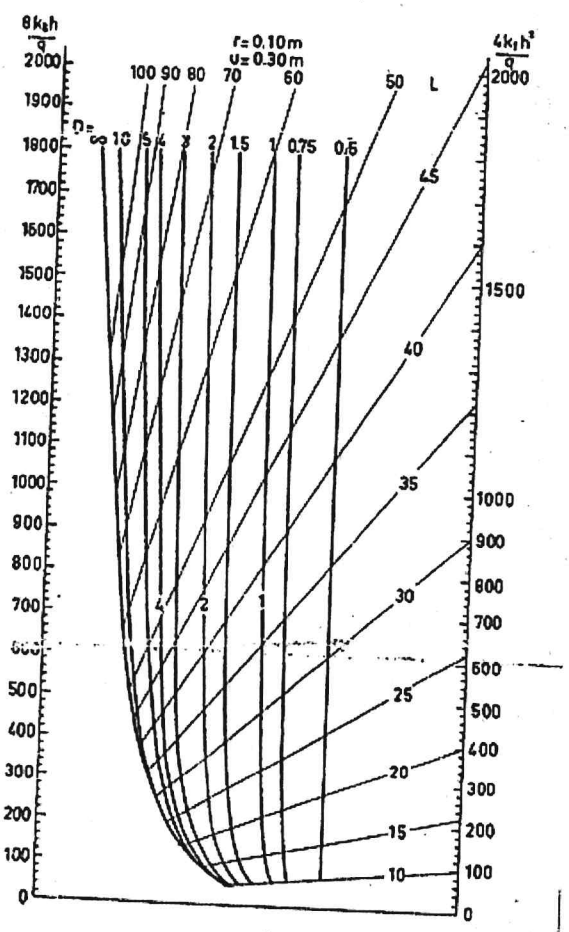
Graph I TILE DRAINS (formula Hooghoudt)

B (b)

Graph Ia: L = 5 — 25 m.



Graph Ib: L = 10 — 100 m.



$\frac{8h}{q}$ (first number) and $\frac{4h^2}{q}$ (second number) for various h- and q-values

h (meters)	q in mm per day									
	1	2	3	4	5	6	7	8	9	10
0.1	800– 40	400– 20	265– 15	200– 10	160– 8	135– 10	115– 5	100– 5	90– 5	80– 5
0.2	1600– 160	800– 80	530– 55	400– 40	320– 32	265– 30	230– 25	200– 20	180– 20	160– 15
0.3	2400– 360	1200– 180	800– 120	600– 90	480– 70	400– 60	345– 50	300– 65	270– 60	240– 35
0.4	3200– 640	1600– 320	1070– 215	800– 160	640– 130	530–110	455– 90	400– 80	360– 70	320– 65
0.5	4000–1000	2000– 500	1340– 335	1000– 250	800– 200	665–165	570–165	500–125	445–110	400–100
0.6	4800–1440	2400– 720	1600– 480	1200– 360	960– 290	800–240	685–205	600–180	535–160	480–145
0.7	5600–1960	2800– 980	1860– 650	1400– 490	1020– 390	930–325	800–280	700–245	620–215	480–145
0.8	6400–2560	3200–1280	2140– 850	1600– 640	1280– 510	1070–425	915–365	800–320	710–285	640–255
0.9	7200–3240	3600–1620	2400–1080	1800– 810	1440– 630	1200–540	1030–460	900–405	800–370	720–325
1.0	8000–4000	4000–2000	2700–1330	2000–1000	1600– 800	1330–665	1140–570	1000–500	890–445	800–400
1.1	8800–4840	4400–2420	2940–1600	2200–1210	1760– 970	1460–805	1260–690	1100–605	980–535	880–485
1.2	9600–5760	4800–2880	3200–1920	2400–1440	1920–1150	1600–960	1370–820	1200–720	1060–640	960–575

Example: h = 0.5 m, q = 7 mm per day: $\frac{8h}{q}$ = 570; $\frac{4h^2}{q}$ = 145

Bulletin no. 8. SOME NOMOGRAPHS FOR THE CALCULATION OF DRAIN SPACINGS
International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands, 1965