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B.E. (Full Time) DEGREE END SEMESTER EXAMINATION, NOV/DEC 2011

AGRICULTURAL AND IRRIGATION ENGINEERING

SEVENTH SEMESTER - (REGULATION 2008)

AI 9405 – IRRIGATION EQUIPMENT AND DESIGN

Time: 3 hours **Marks: 100**

Part – A **10 x 2 = 20**

1. Answer ALL questions

2. Allowed to use tables and nomograph

1. Write the design advantages and drawbacks of dissimilar pumps in series and parallel
2. What do you mean by iso-efficiency curves?
3. Differentiate between turbine pumps, mixed flow pump and propeller pump
4. Distinguish between jet pump and airlift pump
5. Calculate the operating pressure in an Orifice type point source emitter, if the discharge is 10 lit/sec and k is 0.6.
6. Define the uniformity coefficient in drip irrigation system
7. Determine the required capacity of a sprinkler system to apply water at the rate of 1.25cm/hr. Two 190 m long sprinkler liner are required. Nineteen sprinklers are spaced at 10 m intervals on each line. The spacing between lines is 18m.
8. What is perforated type sprinkler system?
9. Write the necessity of automation in agriculture.
10. Under what circumstance non-return and butterfly valves are used in micro irrigation?

Part - B **5 x 16 = 80**

11. (i) Explain the greenhouse irrigation system with a neat sketch (8)
    (ii) Write the working of Solenoid and Pressure relief valves with diagram (8)

12 (a) (i) A double acting reciprocating pump running at 50 rpm is discharging 1.2 m^3/min. The pump has a storke of 400 mm and diameter of the piston is 200 mm. The delivery and suction heads are 20 m and 5 m respectively. Find the slip of the pump and power required to drive the pump. Take diameter of the piston rod as 20 mm. (10)

(ii) Explain the working of circular two bucket lift and twin treadle pump with suitable sketch (6)

(OR)

(b) (i) A four stage centrifugal pump has four identical impellers, keyed to the same shaft. The shaft is running at 400 rpm and the total manometric head developed by the multistage pump is 40 m. The discharge through the pump is 0.2 m^3/s. The vanes of each impeller are having an outlet angle of 45°. If the width and diameter of each impeller at outlet is 5 cm and 60 cm respectively, find the manometric efficiency. (10)

(ii) Explain the performance and adaptability of common types of indigenous water lift (6)

13. (a) (i) Explain the working principle of airlift pump with a neat sketch (10)

(ii) Explain the criteria and procedure for the selection of irrigation pumps. Also discuss it's characteristic curves. (6)

(OR)

(b) (i) A deep well turbine pump installed in a tube well has a discharge of 22 litres/sec. The discharge pipe is 12.5 cm in diameter. The pumping water level is 24 m below the centre line of the discharge head. The delivery pipe is 15 m long, measured from the end of the discharge head. A sluice valve and two long sweep bends, each of 12.5 cm inside diameter, are fitted on the delivery pipe. The delivery pipe outlet is 4.6 m above the discharge end of the pump. Determine the brake horse power of the directly connected vertical electric motor required to operate the pump if the pump efficiency is 68%. (10)

(ii) Discuss the various pump troubles and remedies in pumps (6)

14. (a) (i) Explain the step by step procedure involved in the design of drip irrigation system (10)

(ii) In an orchard with fully grown trees, determine the number of emitters required per tree if 65% of the area is to be irrigated under the following conditions (i) good quality irrigation water (ii) saline irrigation water. The soil is of medium texture and the soil layers are of low density. The effective depth of root zone is 1.5 m. the tree to tree spacing in the orchard is 4 m and the spacing between laterals is 5 m. (6)

(OR)

(b) Design a drip irrigation system for a 5 hectare orchard crop in Tamil Nadu region. The field is rectangular with a length of 400 m along the head end and a width of 125 m. The field is nearly flat and the soil is sandy loam. The irrigation water source is a river flowing close to the top corner of the field. The crop spacing is 4 m x 5 m. Assume necessary data. (16)

15. (a) (i) Explain the step by step procedure involved in the design of sprinkler irrigation system (10)

(ii) Determine the uniformity coefficient of a sprinkler plot where four sprinklers are place at each corner of the plot. The observed rate of application in the plot is given as 8.9, 7.6, 6.6, 8.1, 7.6, 9.9, 10.2, 8.3, 8.9, 9.1, 9.1, 9.4, 8.9, 9.4, 7.9, 9.1, 8.6, 9.1, 7.9, 6.6, and 6.8. (6)

(OR)

(b) Design a sprinkler irrigation system for a rectangular 0.1 km^2 field to irrigate the entire area with 5 days period. Not more than 16 hours/day are available for moving the pipe and sprinkling. The required depth of irrigation is 5 cm and the water application rate is not to exceed 0.75 cm/hr. A 30 m deep well located in the centre of the field will provide the following discharge – drawdown relationship: 10.5 lit/sec at 14 m and 16.5 lit/sec at 23 m. Design the system for an average pressure of 3.5 kg/cm^2 at the sprinkler nozzle. The highest point in the field is 1.25 m above the well site and 1 m risers are needed for the sprinklers. Assume pump efficiency as 60% and motor efficiency as 70 %. (16)

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Table F-3. Friction loss in metres per 100 metres in main lines of portable aluminium pipes with couplings

(Based on Scobey's formulae, K_s 0.40 and 9 metres pipe lengths)

[Adapted from Hurd (1969)]

Flow litres/sec.	*Diameter of pipe*						
	7.5 cm	*10.0 cm*	*12.5 cm*	*15.0 cm*	*17.5 cm*	*20.0 cm*	*25.0 cm*
2.52	0.658	0.157					
3.15	1.006	0.239					
3.79	1.423	0.339					
4.42	1.906	0.449	0.150				
5.05	2.457	0.584	0.193				
5.68	3.073	0.731	0.242				
6.31	3.754	0.893	0.295	0.120			
7.57	5.307	1.263	0.417	0.170			
8.83	7.113	1.693	0.560	0.227			
10.10	9.169	2.182	0.721	0.293			
11.36	11.47	2.729	0.967	0.366			
12.62	14.01	3.333	1.102	0.448	0.209		
13.88	16.79	3.996	1.321	0.537	0.251		
15.14	19.81	4.713	1.558	0.633	0.296		
16.41	23.06	5.488	1.814	0.737	0.344		
17.67	26.55	6.316	2.089	0.849	0.397		
18.93	30.27	7.203	2.381	0.967	0.452	0.235	
20.19	34.22	8.142	2.092	1.094	0.511	0.265	
21.45	38.39	9.133	3.020	1.227	0.573	0.298	
22.72	42.80	10.18	3.366	1.368	0.639	0.332	
23.98	47.43	11.29	3.731	1.516	0.708	0.368	
25.24	52.28	12.44	4.113	1.671	0.781	0.399	0.136
26.50		13.65	4.513	1.833	0.857	0.445	0.149
27.76		14.57	4.930	1.988	0.936	0.486	0.163
29.03		16.23	5.364	2.179	1.019	0.529	0.177
30.29		17.59	5.815	2.363	1.104	0.573	0.192
31.55		19.01	6.284	2.554	1.193	0.620	0.208
34.70		22.79	7.532	3.060	1.430	0.742	0.249
37.86		26.88	8.886	3.611	1.687	0.876	0.294
41.01		31.30	10.35	4.204	1.965	1.020	0.342
44.17		36.04	11.91	4.839	2.262	1.174	0.394
47.32		41.08	13.58	5.517	2.520	1.339	0.449
50.48			15.35	6.237	2.915	1.513	0.507
53.63			17.22	6.999	3.271	1.698	0.569
56.79			19.20	7.801	3.666	1.893	0.635
59.94			21.28	8.645	4.041	2.097	0.703
63.10			23.45	9.530	4.454	2.312	0.775
69.49			28.11	11.42	5.338	2.771	0.929
75.72			31.75	13.58	6.298	3.269	1.096
82.03				15.69	7.333	3.886	1.277
88.34				18.06	8.441	4.382	1.470
94.65				20.59	9.624	4.996	1.675
101.0				23.28	10.88	5.648	1.894
107.0				26.12	12.21	6.337	2.125
114.0					13.63	7.064	2.369
120.0					15.08	7.829	2.625
126.0					16.62	8.630	2.894

(***Note***: Where 6.1 m sections of pipes are used, *increase* values shown in table by 7.0 per cent. Where 12.2 m sections of pipe are used, *decrease* values shown in the table by .0 per cent.)

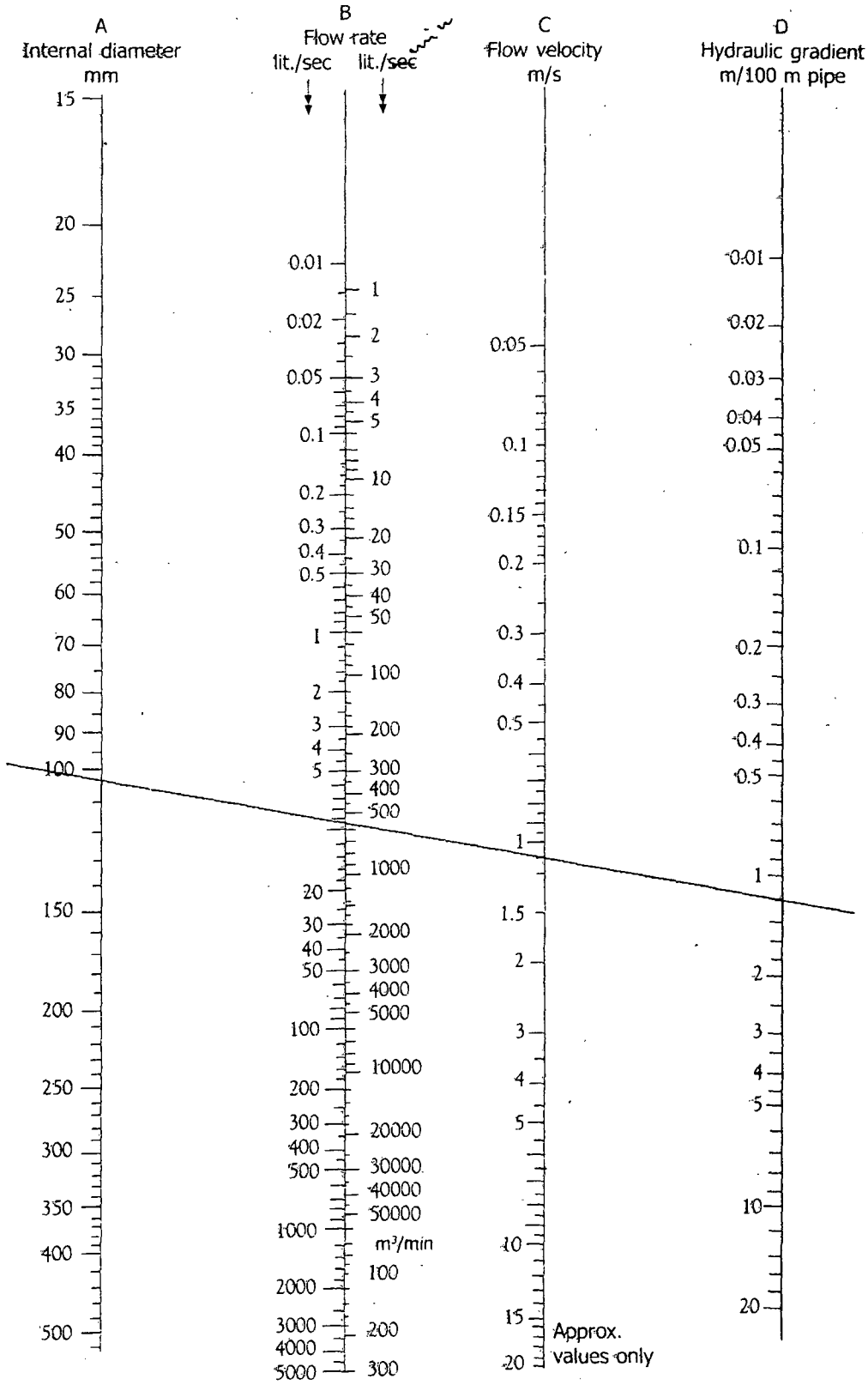

Fig. 13.77. Flow nomograph for polyethylene pipes. *Note:* To use the flow nomograph, at least two values out of **A, B, C and D should be** known. Joining the two values on the lines and extending the line formed by the two points will provide **the desired values.**
(*Example :* Flow 10 lit/sec, pipe size 110 mm outer dia. (104 mm inner dia.),
velocity 1.2 m/sec., hydraulic gradient 1.2 m/100 m. *See the darkened line in the nomograph*)
[***Source:*** Jain Irrigation Systems Ltd. (2005 a)]

APPENDIX F

Friction head loss in irrigation pipes

Table F-1. Friction loss in metres per 100 metres in lateral line of portable aluminium pipe with couplings

(Based on Scobey's formula and 9 metres pipe length)

[Adapted from Hurd (1969)]

Flow	*Diameter of pipe*				
(litres/sec)	*5.0 cm*	*7.5 cm*	*10.0 cm*	*12.5 cm*	*15.0 cm*
	Ks 0.34	*Ks 0.33*	*Ks 0.32*	*Ks 0.32*	*Ks 0.32*
1.26	0.32				
1.89	2.53				
2.52	4.49	0.565	0.130		
3.15	6.85	0.858	0.198		
3.79	9.67	1.21	0.280		
4.42	12.9	1.63	0.376	0.122	
5.05	16.7	2.10	0.484	0.157	
5.68	20.8	2.63	0.605	0.196	
6.31	25.4	3.20	0.738	0.240	0.099
7.57		4.54	1.04	0.339	0.140
8.83		6.09	1.40	0.454	0.188
10.10		7.85	1.80	0.590	0.242
11.36		9.82	2.26	0.733	0.302
12.62		12.0	2.76	0.896	0.370
13.88		14.4	3.30	1.07	0.443
15.14		16.9	3.90	1.26	0.522
16.41		19.7	4.54	1.47	0.608
17.67		22.8	5.22	1.70	0.700
18.93		25.9	5.96	1.93	0.798
20.19		29.3	6.74	2.18	0.904
21.45		32.8	7.56	2.45	1.02
22.72		36.6	8.40	2.74	1.13
23.98		40.6	9.36	3.03	1.26
25.24		44.7	10.3	3.34	1.38
26.50			11.3	3.66	1.51
27.76			12.3	4.00	1.66
29.03			13.4	4.35	1.80
30.29			14.6	4.72	1.95
31.55			15.8	5.10	2.12
34.70			18.9	6.12	2.52
37.86			22.2	7.22	2.98
41.01			25.9	8.40	3.46
44.17			29.8	9.68	3.99
47.32			33.8	11.0	4.54
50.48				12.5	5.15
53.63				14.0	5.78
56.79				15.6	6.44
59.94				17.3	7.14
63.10				19.0	7.86

(***Note***: For 6 metres pipe length, *increase* values in the Table by 7.0 per cent and for 12 metres length *decrease* values by 3.0 per cent.)

Normal monthly pan evaporation data.

Month	*All India (average) mm*	*Delhi*
January	99.2	82.9
February	119.6	114.2
March	176.3	202.8
April	210.2	272.1
May	245.4	365.3
June	198.8	312.9
July	145.6	211.3
August	134.6	237.1
September	134.6	222.7
October	144.6	161.2
November	112.2	109.7
December	94.4	87.8

[*Source*: Rajput, T.B.S. and Neelam Patel, 2001 (based on IMD data)]

Estimated maximum diameter of the wetted circle formed by an emission point in a drip irrigation system comprising point source drip outlets at a discharge rate of 4 lit./hr.,

(*Note*: For line source application, the values should be multiplied by a factor of 0.8.)

Depth of root zone and soil texture	*Homogeneous soil layers*	*Soil profiles of varying textural groups*	
		Mostly of low density	*Mostly of moderate density*
	m	*m*	*m*
Root zone depth, 0.75 m:			
Coarse soil	0.45	0.75	1.05
Medium soil	0.90	1.20	1.50
Fine soiil	1.05	1.50	1.80
Root zone depth, 1.5 m:			
Coarse soil	0.75	1.40	1.80
Medium soil	1.20	2.10	2.70
Fine soil	1.50	2.00	2.40

[*Source*: Adapted from United States Soil Cons. Service, (1984).]

Correction factor 'F' for friction losses in aluminium pipes with multiple outlets.

No. of sprinklers on lateral	*1st sprinkler is one sprinkler interval from main*	*1st sprinkler is 1/2 sprinkler interval from main*	*No. of sprinklers on lateral*	*1st sprinkler is one sprinkler interval from main*	*1st sprinkler is 1/2 sprinkler interval from main*
1	1.000	1.000	16	0.365	0.345
2	0.625	0.500	17	0363	0.344
3	0.518	0.422	18	0.361	0.343
4	0.469	0393	19	0.360	0.343
5	0.440	0.378	20	0.359	0.342
6	0.421	0.369	22	0.357	0.341
7	0.408	0.363	24	0.355	0.341
8	0398	0.358	26	0.353	0.340
9	0.391	0.355	28	0.351	0.340
10	0.385	0.353	30	0.350	0.339
11	0.380	0.351	35	0.347	0.338
12	0.376	0.349	40	0.345	0.338
13	0.373	0.348	50	0.343	0.337
14	0.370	0.347	100	0.338	0.337
15	0.367	0.346	> 100	0.335	0.335