UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: December 2015

Module Number: CE8240 **Module Name: Water Resources Planning and Management**

[Three Hours]

[Answer all questions]

Q1. Briefly discuss three of the followings.

a) Suppose that there is an area where the only source of water is from an aquifer. Briefly discuss how you might develop a plan for its use over time.
b) Effect of climate change on the operation of existing water resources systems and incorporation of climate change in water resources systems planning
c) Stormwater management in coastal urban areas
d) Optimization and simulation in water resources systems modelling

[12.0 Marks]

Q2. Consider a wastewater treatment plant in which it is possible to include five different treatment processes in series. These treatment processes must together remove at least 90% of influent waste. Assuming R_i is the amount of waste removed by process i, the following conditions must hold:

$$20 \leq R_1 \leq 30$$
$$0 \leq R_2 \leq 30$$
$$0 \leq R_3 \leq 10$$
$$0 \leq R_4 \leq 20$$
$$0 \leq R_5 \leq 30$$

The cost of various discrete sizes of each unit process i depend upon the waste entering the process i as well as the amount of waste removed, as indicated in Table Q2.

a) Formulate the problem as a dynamic programming problem to find the least-cost path. Clearly indicate the state, stage, constraints, and objective.

[2.0 Marks]

b) Draw the dynamic programming network. Indicate the calculations required to find the least-cost path using backward-moving procedure.

[6.0 Marks]

c) Will the solution change under following conditions?

(i) $R_4 = 0$ if $R_3 = 0$ or

(ii) $R_3 = 0$ if $R_2 \leq 20$

[4.0 Marks]

Table Q2: Waste removal and associated cost in each process

Process		1	2	3	4	5
Influent I_i	Waste Removal R_i	Annual cost (C_i)				
100	20	5				
100	30	10				
80	10		3	3	1	
80	20		9		2	
80	30		13			
70	10		4	5	2	
70	20		10		3	
70	30		15			
60	10			6	2	3
60	20				4	6
60	30					9
50	10			7	3	4
50	20				5	8
50	30					10
40	10			8	5	5
40	20				7	12
40	30					18
30	10				8	8
30	20				10	12
20	10					8

Q3. Three alternative flood protection schemes are being considered for reducing the damages incurred by a local community. The capital costs for alternatives A, B, and C are \$600,000, \$800,000, and \$1000,000, respectively. The corresponding annual operation and maintenance costs are \$ 50,000, \$80,000, and \$ 200,000. It is estimated that the annual reduction in flood damages associated with alternatives A, B, and C are \$150,000, \$240,000, and \$350,000, respectively. The planning period is 10 years and the discount rate is 10%.
Compound interest factors are given in page 4.

a) Which alternative would you recommend based on discounted payback period?

[4.0 Marks]

b) Which alternative would you recommend based on benefit-cost analysis?

[6.0 Marks]

c) What will be the best option, if the planning period is 20 years?

[2.0 Marks]

Q4. A proposed micro-hydro scheme will supply power for electrical lighting, milling, battery charging, and cooking. The net head is 20 m and efficiency of the plant is 80%. Irrigation requires 10 m^3/day and the area has 500 ha of irrigable land. The annual average flow variation of the river is shown in Figure Q4 while power demands are given in Table Q4.

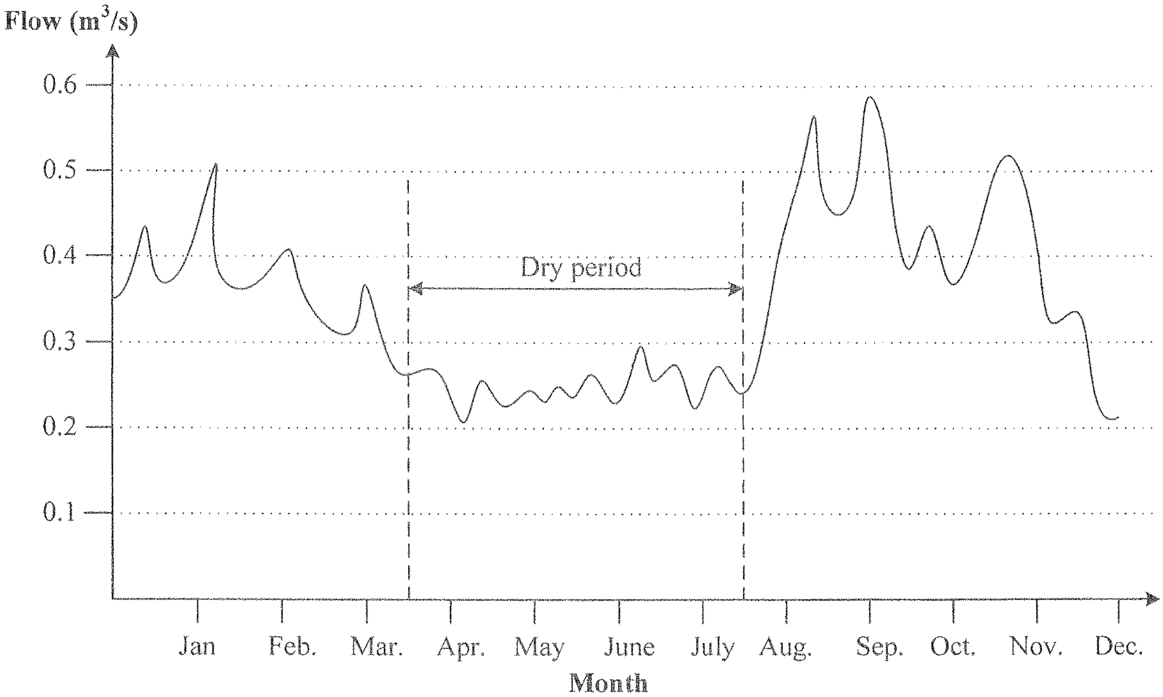

Figure Q4: Annual hydrograph

Table Q4: Power demand

Type	Demand (kW)	Daily requirement
Lighting	30	6 p.m-12 p.m
Milling	10	8 a.m -4 p.m
Battery charging	3	Throughout the day
Cooking	2	Throughout the day

a) If the priority is given for the irrigation, lighting, and milling, prepare a demand/supply graph for a typical day.

[6.0 Marks]

b) Calculate the plant factor considering primary loads.

[3.0 Marks]

c) Calculate the plant factor with the addition of cooking and battery charging.

[3.0 Marks]

Q5. a) Briefly distinguish between "conveyance approach" and "infiltration approach" used in stormwater management. Use stormwater management hierarchy to elaborate your explanation.

[6.0 Marks]

b) Write short notes on stormwater best management practices (BMPs) available for different elements in a watershed?

[3.0 Marks]

c) If you are assigned to plan a stormwater management system for a particular area, list the procedure that you may carry out?

[3.0 Marks]

10% — **Compound Interest Factors** — **10%**

	Single Payment		Uniform Payment Series				Arithmetic Gradient		
n	Compound Amount Factor Find *F* Given *P* *F/P*	Present Worth Factor Find *P* Given *F* *P/F*	Sinking Fund Factor Find *A* Given *F* *A/F*	Capital Recovery Factor Find *A* Given *P* *A/P*	Compound Amount Factor Find *F* Given *A* *F/A*	Present Worth Factor Find *P* Given *A* *P/A*	Gradient Uniform Series Find *A* Given *G* *A/G*	Gradient Present Worth Find *P* Given *G* *P/G*	*n*
1	1.100	.9091	1.0000	1.1000	1.000	0.909	0	0	1
2	1.210	.8264	.4762	.5762	2.100	1.736	0.476	0.826	2
3	1.331	.7513	.3021	.4021	3.310	2.487	0.937	2.329	3
4	1.464	.6830	.2155	.3155	4.641	3.170	1.381	4.378	4
5	1.611	.6209	.1638	.2638	6.105	3.791	1.810	6.862	5
6	1.772	.5645	.1296	.2296	7.716	4.355	2.224	9.684	6
7	1.949	.5132	.1054	.2054	9.487	4.868	2.622	12.763	7
8	2.144	.4665	.0874	.1874	11.436	5.335	3.004	16.029	8
9	2.358	.4241	.0736	.1736	13.579	5.759	3.372	19.421	9
10	2.594	.3855	.0627	.1627	15.937	6.145	3.725	22.891	10
11	2.853	.3505	.0540	.1540	18.531	6.495	4.064	26.396	11
12	3.138	.3186	.0468	.1468	21.384	6.814	4.388	29.901	12
13	3.452	.2897	.0408	.1408	24.523	7.103	4.699	33.377	13
14	3.797	.2633	.0357	.1357	27.975	7.367	4.996	36.801	14
15	4.177	.2394	.0315	.1315	31.772	7.606	5.279	40.152	15
16	4.595	.2176	.0278	.1278	35.950	7.824	5.549	43.416	16
17	5.054	.1978	.0247	.1247	40.545	8.022	5.807	46.582	17
18	5.560	.1799	.0219	.1219	45.599	8.201	6.053	49.640	18
19	6.116	.1635	.0195	.1195	51.159	8.365	6.286	52.583	19
20	6.728	.1486	.0175	.1175	57.275	8.514	6.508	55.407	20