UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: November 2017

Module Number: CE8253

Module Name: Water Resources Planning and Management

[Three Hours]

[Answer all questions]

Q1. a) Briefly describe the hill climbing search technique

b) Describe "Conveyance - approach" and "infiltration approach" used in stormwater management

c) Sketch a mini hydropower plant indicating the main components

[4.0 Marks for each]

Q2. a) Explain a water resources planning situation that needs the combined optimization simulation analysis in order to identify the best alternative solutions.

[4.0 Marks]

b) An industrial company is planning to construct a treatment facility to treat a toxic waste generated by the manufacturing of their products. It is estimated that toxic wastewater generation rate is 300 m^3/day with a concentration of 1500 mg/L. According to the regulations, maximum permissible discharge limit of the toxic waste is 30 kg/day. A feasibility study indicated that there are two treatment methods to achieve the required effluent quality. Method 1 has a cost of $300X^{0.85}$ in \$/day, where X is the amount of toxic waste in m^3/day. This method has a treatment efficiency of 95%. Method 2 has a cost of \$130/m^3 of toxic waste treated. The treatment efficiency achievable by this method is $(1 - 0.002X)$, where X is the amount of toxic waste (m^3/day) treated. If the combination of the two methods is used to remove the toxic waste, formulate an optimization model that could be used to determine how best the discharge limit could be achieved.

[8.0 Marks]

Q3. a) A contractor purchased a construction equipment for a cost of 1 million Rs. A local bank is offering an interest rate of 5% compounded daily to purchase the machine. If the contractor will pay the principal plus the interest at the end of 5 years, what is the total interest to be paid? If another bank offers a rate of 5.4% compound semi-annually, is it worth to go with the new offer?

[6.0 Marks]

b) Two alternative water supply projects are considered to supply the water requirement of an industry. Associated cost estimations of the project are given in Table Q3. If the schemes will have a 20 year life span and the interest rate is 10%, determine the annual cost of the projects and state which the best alternative is. What are the additional factors that you may consider in making the decision?

Compound interest factors are given in Page 4.

Table Q3

Project No	Construction cost (Million Rs)	Annual operational and maintenance cost (Million Rs)
1	.6	0.4 0.6 (10 years onwards)
2	3	1.5 1.7 (10 years onwards)

[6.0 Marks]

Q4. Figure Q4 shows a drainage basin upstream of a proposed culvert which has an area of 15 hectares. There appear to be two flow paths converging in the lower land area. The existing drainage area is reasonably homogeneous having a runoff coefficient of 0.25. There is a likely development in the area of 5 ha closer to the road and runoff coefficient in the developed area will be 0.6. A 10-year design check is required for the proposed culvert. Rainfall intensity (mm/hr) for 10 year return period is given by; $I_{10} = \frac{1980}{(t_c+8.6)^{0.776}}$, where t_c is the time of concentration in minutes. Consider that 2 year 24 hour rainfall as 3 in. Table Q4 provides the characteristics of the flow paths AC, BC, and CD. Find the peak discharge for the developed condition.

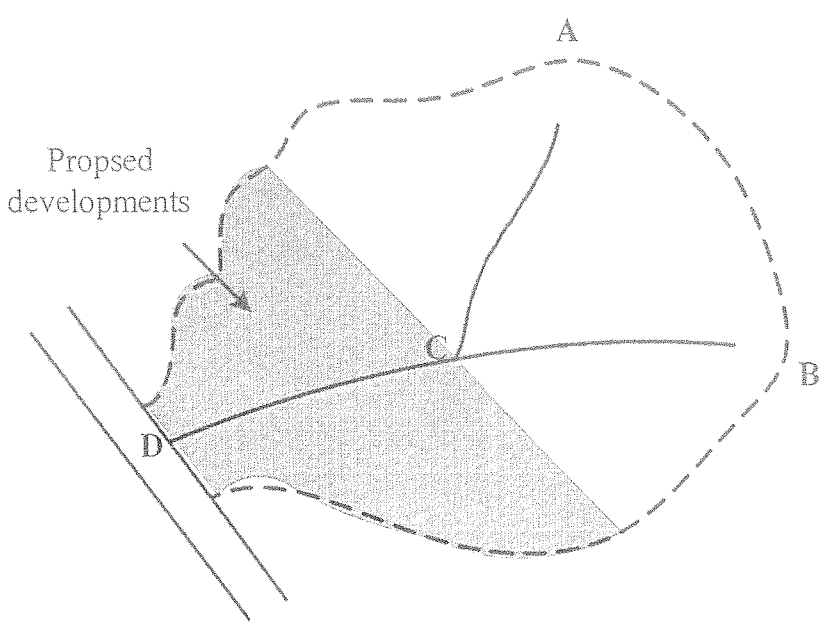

Figure Q4

Table Q4

	AC	BC	CD
Length (ft)	980	1300	700
Slope (%)	0.8%	0.6%	1%
Surface characteristics	grassed waterway Manning coefficient =0.24	grassed waterway Manning coefficient =0.24	Developed condition: Lined channel Manning coefficient =0.015

Empirical equations for time of concentration

Sheet flow

$$T_{SF} = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

Where:

T_{SF} = Travel time in hr; n = Manning's roughness coefficient for sheet flow; L = Flow length (ft); P_2 = 2-year, 24 hour rainfall (in); S = land slope

Shallow concentrated flow

$V = 16.1345\sqrt{S}$ (Unpaved)

$V = 20.3282\sqrt{S}$ (Paved)

Where V = average velocity (ft/s); S = watercourse slope

[12.0 Marks]

Q5. a) A storage hydropower plant having a capacity of 40 MW supplies the electric power requirement of a certain community. The average load curve is given in the Figure Q5a. If the net head available is 20 m and the efficiency of the turbine is 85%, determine the flow required from the storage reservoir to supply the demand.

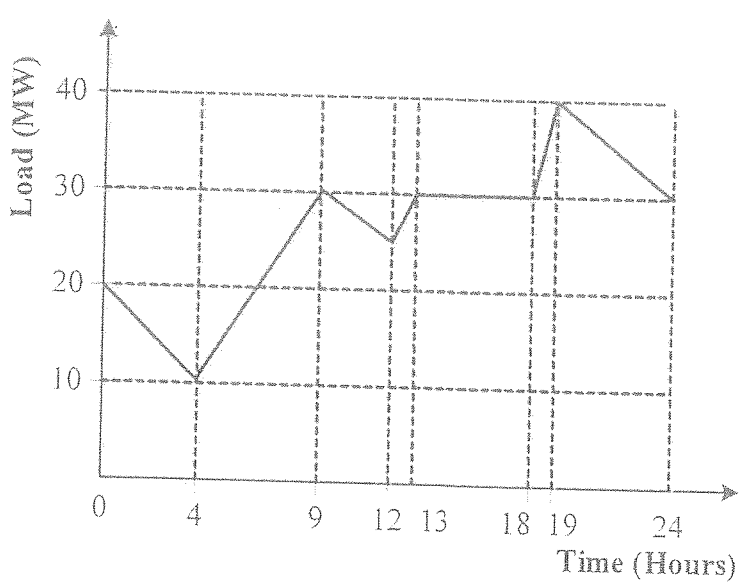

Figure Q5a

[4.0 Marks]

b) In 10 years' time, it is expected that the power requirement increases by twice. Feasibility study indicated that there are two potential hydropower plant sites in the river. Figure Q5b indicates the locations of the hydropower plants. Net head (H) available for hydropower plants and their efficiencies (η) are indicated in the figure. Calculate the required release of water flow rate from the reservoir in order to meet the power requirement in 10 years' time.

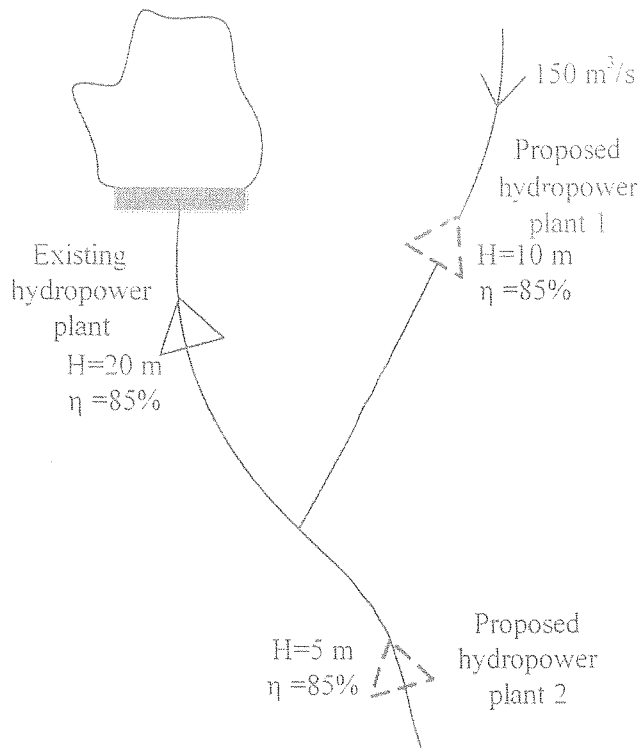

Figure Q5b

[8.0 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