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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024**

- COURSE NAME : ENGINEERING ECONOMICS
- COURSE CODE : BFC 44602
- PROGRAMME CODE : BFF
- EXAMINATION DATE : JULY 2024
- DURATION : 2 HOURS
- INSTRUCTION :
1. ANSWER ALL QUESTIONS
 2. THIS FINAL EXAMINATION IS CONDUCTED VIA
 - Open book
 - Closed book
 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

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- Q1** (a) Engineering economy involves a systematic evaluation of the economic merits of proposed solutions to engineering problems. Consider yourself as an engineer, give an example of situation that requires economic judgement in construction project by systematically applying the **SEVEN (7)** decision making process of engineering economy. (14 marks)
- (b) There are a variety of costs to be considered in an engineering economic analysis. These costs differ in their frequency of occurrence, relative magnitude, and degree of impact on the study. Explain any **FOUR (4)** type of costs associated with products or services in construction activities. (4 marks)
- (c) Last year, your company, classified as a G1 contractor, invested RM 500,000 in construction machinery with a life cycle of approximately five years. Typically, the company opts to replace machinery after this period to minimize operational and maintenance costs. The annual depreciation rates are detailed in **Table Q1**. Please select **ONE (1)** year within the machinery's life span for resale and calculate the sunk cost for that year. (7 marks)

Table Q1.1 Percent of Depreciation Value and Sold Price

Year	Percent of Depreciation Value (per year)	Sold Price (RM)
2	6%	210000
3	8%	195000
4	10%	175000
5	12%	150000

- Q2** (a) In 2024, your company has been selected to design and construct a new residential building in a growing area of the city. The building will have 20 floors and will house 200 apartments. The previous residential building that your company constructed in the same area had 10 floors and housed 100 apartments which costed RM700,000. The cost index was 120 in 2018 and is projected to be 130 in 2024. The cost capacity factor for a similar building is 0.9. You are required to improve the earthwork and it will cost RM 31,000. Your company has been tasked with improving the energy efficiency of the building by incorporating sustainable design elements. This will cost an additional RM 50,000, but the investment will pay off in the long run with lower energy bills for the residents.



For the external works, your company has decided to partner with a reputable construction firm, Greenway Construction. They have completed similar projects in the area within two years with high levels of customer satisfaction. Greenway Construction has a 95% learning curve and is expected to reduce labor requirements. In their previous project, they completed the external works in 500 hours. For this project, external works labor will be charged to your company at RM 70 per hour and materials will cost RM 500,000.

- (i) Calculate the associated cost with constructing the new building.
(6 marks)
- (ii) Calculate the required labor time and cost for the external earthwork.
(3 marks)
- (iii) Compute the overall projected expenditure for new residential building in 2024.
(4 marks)

- (b) Your company has appointed you to manage a project involving the construction of a two-floor office building, each floor measuring 15,000 gross square feet. As the project manager, you are responsible for coordinating all project efforts from the initial decision to proceed with the design and construction of the building through to its initial occupancy. Develop the first three levels of a planning diagram, incorporating 15 work activities, including main tasks and sub-tasks.
(12 marks)

- Q3** (a) An Excavation Contractor purchased a bulldozer four years ago for RM70,000 estimating that it would have an economic life of 8 years with no salvage value. Present salvage value (book value) of the existing machine is RM10,000. Out-of-pocket disbursements for operation and maintenance are about RM20,000 per year, and in addition because of repeated breakdowns, the company has had to rent another bulldozer for 45 days each year at RM500 per day.
- The company is planning to buy a new bulldozer at a cost of RM80,000. The economic life of the new bulldozer is 5 years with no salvage value. Operation and maintenance costs for the new machine would be the same as the old machine. The purchase of a new machine would eliminate the need for renting a bulldozer for 4 years necessitating the rental of an extra bulldozer only on the 5th year.

- (i) Determine the value for both of the bulldozer if a MARR is 10% per year using the proper cash flow diagram. (10 marks)
 - (ii) Justify if the machine should be replaced or not. Give your reason. (5 marks)
- (b) Ali is planning for an education fund for his new born daughter. He is only able to invest in a fixed saving account starting on her fourth birthday. He planned to withdraw RM4000 a year on her 18th, 19th, 20th and 21st birthday, make the total of RM16000 for her college funding. Assume bank interest is 5%. Draw the cash flow diagram for the above scenario. Considering Ali will deposit consistent amount of money every year, calculate his annual investment starting from her 4th birthday until her 17th birthday to make sure his plan success. (10 marks)
- Q4** (a) SNS Corporation is considering a new project to construct new railway sand managing the High-Speed Rail (HSR) trains from Kuala Lumpur station to Singapore. The land acquisition is estimated to be RM62 million. Construction cost for the railways and other facilities including the high-speed trains is expected to be RM208 million with an additional annual maintenance cost of RM22 million. Finally, the projected increase in public transport travelers will require an additional railways traffic controller costing RM20 millions with an annual cost of RM8 million. Annual benefits of the railways have been estimated as in **Table Q4.1**. Apply the B-C ratio method for both conventional and modified cases using PW and AW methods with the study period of 20 years and a MARR of 12% per year to determine whether the SNS Corporation should proceed with the HSR project. (10 marks)

Table Q4.1 Annual benefits of the railways

Descriptions	RM (million)
Tickets collected	36
Rental of shop lots receipts from entrepreneurs	16
Parking lots charges to visitors	14
Convenience benefit to the local community	16
Additional tourism income to the state of Johor	12

- (b) The state government of Johor is planning to build a new dam for hydroelectric. Instead of generating power, the dam also will be equipped with tourism facility and flood control. The government identified three suitable locations X, Y and Z. The estimated benefits and costs that are expected to be derived from the three

locations under consideration are shown in **Table Q4.2**. The interest rate is 6% and the life span of each project is 40 years. Calculate the benefits and disbenefits for each project using present worth (PW) method and propose the justifiable project based on the benefit cost analysis.

(15 marks)

Table Q4.2 benefits and costs

Cost and benefit (RM Million)	project		
	X	Y	Z
Initial cost	150	175	215
Power sales per year	1.9	1.5	2.1
Flood control saving per year	2.3	3.5	5.5
Irrigation benefit per year	8.1	5.5	7
Recreation benefit per year	5.2	1.5	3.5
Environmental impact per year	5.2	2	3.5
Operation and maintenance cost per year	1.5	2	2.2

– END OF QUESTIONS –

APPENDIX A

5%

Compound Interest Factors

5%

n	Single Payment		Uniform Payment Series				Arithmetic Gradient		n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	Gradient Uniform Series	Gradient Present Worth	
	Find F Given P F/P	Find P Given F P/F	Find A Given F A/F	Find A Given P A/P	Find F Given A F/A	Find P Given A P/A	Find A Given G A/G	Find P Given G P/G	
1	1.050	.9524	1.0000	1.0500	1.000	0.952	0	0	1
2	1.102	.9070	.4878	.5378	2.050	1.859	0.488	0.907	2
3	1.158	.8638	.3172	.3672	3.152	2.723	0.967	2.635	3
4	1.216	.8227	.2320	.2820	4.310	3.546	1.439	5.103	4
5	1.276	.7835	.1810	.2310	5.526	4.329	1.902	8.237	5
6	1.340	.7462	.1470	.1970	6.802	5.076	2.358	11.968	6
7	1.407	.7107	.1228	.1728	8.142	5.786	2.805	16.232	7
8	1.477	.6768	.1047	.1547	9.549	6.463	3.244	20.970	8
9	1.551	.6446	.0907	.1407	11.027	7.108	3.676	26.127	9
10	1.629	.6139	.0795	.1295	12.578	7.722	4.099	31.652	10
11	1.710	.5847	.0704	.1204	14.207	8.306	4.514	37.499	11
12	1.796	.5568	.0628	.1128	15.917	8.863	4.922	43.624	12
13	1.886	.5303	.0565	.1065	17.713	9.394	5.321	49.988	13
14	1.980	.5051	.0510	.1010	19.599	9.899	5.713	56.553	14
15	2.079	.4810	.0463	.0963	21.579	10.380	6.097	63.288	15
16	2.183	.4581	.0423	.0923	23.657	10.838	6.474	70.159	16
17	2.292	.4363	.0387	.0887	25.840	11.274	6.842	77.140	17
18	2.407	.4155	.0355	.0855	28.132	11.690	7.203	84.204	18
19	2.527	.3957	.0327	.0827	30.539	12.085	7.557	91.327	19
20	2.653	.3769	.0302	.0802	33.066	12.462	7.903	98.488	20
21	2.786	.3589	.0280	.0780	35.719	12.821	8.242	105.667	21
22	2.925	.3419	.0260	.0760	38.505	13.163	8.573	112.846	22
23	3.072	.3256	.0241	.0741	41.430	13.489	8.897	120.008	23
24	3.225	.3101	.0225	.0725	44.502	13.799	9.214	127.140	24
25	3.386	.2953	.0210	.0710	47.727	14.094	9.524	134.227	25
26	3.556	.2812	.0196	.0696	51.113	14.375	9.827	141.258	26
27	3.733	.2678	.0183	.0683	54.669	14.643	10.122	148.222	27
28	3.920	.2551	.0171	.0671	58.402	14.898	10.411	155.110	28
29	4.116	.2429	.0160	.0660	62.323	15.141	10.694	161.912	29
30	4.322	.2314	.0151	.0651	66.439	15.372	10.969	168.622	30
31	4.538	.2204	.0141	.0641	70.761	15.593	11.238	175.233	31
32	4.765	.2099	.0133	.0633	75.299	15.803	11.501	181.739	32
33	5.003	.1999	.0125	.0625	80.063	16.003	11.757	188.135	33
34	5.253	.1904	.0118	.0618	85.067	16.193	12.006	194.416	34
35	5.516	.1813	.0111	.0611	90.320	16.374	12.250	200.580	35
40	7.040	.1420	.00828	.0583	120.799	17.159	13.377	229.545	40
45	8.985	.1113	.00626	.0563	159.699	17.774	14.364	255.314	45
50	11.467	.0872	.00478	.0548	209.347	18.256	15.223	277.914	50
55	14.636	.0683	.00367	.0537	272.711	18.633	15.966	297.510	55
60	18.679	.0535	.00283	.0528	353.582	18.929	16.606	314.343	60
65	23.840	.0419	.00219	.0522	456.795	19.161	17.154	328.691	65
70	30.426	.0329	.00170	.0517	588.525	19.343	17.621	340.841	70
75	38.832	.0258	.00132	.0513	756.649	19.485	18.018	351.072	75
80	49.561	.0202	.00103	.0510	971.222	19.596	18.353	359.646	80
85	63.254	.0158	.00080	.0508	1245.1	19.684	18.635	366.800	85
90	80.730	.0124	.00063	.0506	1594.6	19.752	18.871	372.749	90
95	103.034	.00971	.00049	.0505	2040.7	19.806	19.069	377.677	95
100	131.500	.00760	.00038	.0504	2610.0	19.848	19.234	381.749	100



6%

Compound Interest Factors

6%

n	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	
1	1.060	.9434	1.0000	1.0600	1.000	0.943	0	0	1
2	1.124	.8900	.4854	.5454	2.060	1.833	0.485	0.890	2
3	1.191	.8396	.3141	.3741	3.184	2.673	0.961	2.569	3
4	1.262	.7921	.2286	.2886	4.375	3.465	1.427	4.945	4
5	1.338	.7473	.1774	.2374	5.637	4.212	1.884	7.934	5
6	1.419	.7050	.1434	.2034	6.975	4.917	2.330	11.459	6
7	1.504	.6651	.1191	.1791	8.394	5.582	2.768	15.450	7
8	1.594	.6274	.1010	.1610	9.897	6.210	3.195	19.841	8
9	1.689	.5919	.0870	.1470	11.491	6.802	3.613	24.577	9
10	1.791	.5584	.0759	.1359	13.181	7.360	4.022	29.602	10
11	1.898	.5268	.0668	.1268	14.972	7.887	4.421	34.870	11
12	2.012	.4970	.0593	.1193	16.870	8.384	4.811	40.337	12
13	2.133	.4688	.0530	.1130	18.882	8.853	5.192	45.963	13
14	2.261	.4423	.0476	.1076	21.015	9.295	5.564	51.713	14
15	2.397	.4173	.0430	.1030	23.276	9.712	5.926	57.554	15
16	2.540	.3936	.0390	.0990	25.672	10.106	6.279	63.459	16
17	2.693	.3714	.0354	.0954	28.213	10.477	6.624	69.401	17
18	2.854	.3503	.0324	.0924	30.906	10.828	6.960	75.357	18
19	3.026	.3305	.0296	.0896	33.760	11.158	7.287	81.306	19
20	3.207	.3118	.0272	.0872	36.786	11.470	7.605	87.230	20
21	3.400	.2942	.0250	.0850	39.993	11.764	7.915	93.113	21
22	3.604	.2775	.0230	.0830	43.392	12.042	8.217	98.941	22
23	3.820	.2618	.0213	.0813	46.996	12.303	8.510	104.700	23
24	4.049	.2470	.0197	.0797	50.815	12.550	8.795	110.381	24
25	4.292	.2330	.0182	.0782	54.864	12.783	9.072	115.973	25
26	4.549	.2198	.0169	.0769	59.156	13.003	9.341	121.468	26
27	4.822	.2074	.0157	.0757	63.706	13.211	9.603	126.860	27
28	5.112	.1956	.0146	.0746	68.528	13.406	9.857	132.142	28
29	5.418	.1846	.0136	.0736	73.640	13.591	10.103	137.309	29
30	5.743	.1741	.0126	.0726	79.058	13.765	10.342	142.359	30
31	6.088	.1643	.0118	.0718	84.801	13.929	10.574	147.286	31
32	6.453	.1550	.0110	.0710	90.890	14.084	10.799	152.090	32
33	6.841	.1462	.0103	.0703	97.343	14.230	11.017	156.768	33
34	7.251	.1379	.00960	.0696	104.184	14.368	11.228	161.319	34
35	7.686	.1301	.00897	.0690	111.435	14.498	11.432	165.743	35
40	10.286	.0972	.00646	.0665	154.762	15.046	12.359	185.957	40
45	13.765	.0727	.00470	.0647	212.743	15.456	13.141	203.109	45
50	18.420	.0543	.00344	.0634	290.335	15.762	13.796	217.457	50
55	24.650	.0406	.00254	.0625	394.171	15.991	14.341	229.322	55
60	32.988	.0303	.00188	.0619	533.126	16.161	14.791	239.043	60
65	44.145	.0227	.00139	.0614	719.080	16.289	15.160	246.945	65
70	59.076	.0169	.00103	.0610	967.928	16.385	15.461	253.327	70
75	79.057	.0126	.00077	.0608	1300.9	16.456	15.706	258.453	75
80	105.796	.00945	.00057	.0606	1746.6	16.509	15.903	262.549	80
85	141.578	.00706	.00043	.0604	2343.0	16.549	16.062	265.810	85
90	189.464	.00528	.00032	.0603	3141.1	16.579	16.189	268.395	90
95	253.545	.00394	.00024	.0602	4209.1	16.601	16.290	270.437	95
100	339.300	.00295	.00018	.0602	5638.3	16.618	16.371	272.047	100

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10%

Compound Interest Factors

10%

n	Single Payment		Uniform Payment Series				Arithmetic Gradient		n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	Gradient Uniform Series	Gradient Present Worth	
	Find F Given P F/P	Find P Given F P/F	Find A Given F A/F	Find A Given P A/P	Find F Given A F/A	Find P Given A P/A	Find A Given G A/G	Find P Given G P/G	
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
21	7.400	.1351	.0156	.1156	64.003	8.649	6.719	58.110	21
22	8.140	.1228	.0140	.1140	71.403	8.772	6.919	60.689	22
23	8.954	.1117	.0126	.1126	79.543	8.883	7.108	63.146	23
24	9.850	.1015	.0113	.1113	88.497	8.985	7.288	65.481	24
25	10.835	.0923	.0102	.1102	98.347	9.077	7.458	67.696	25
26	11.918	.0839	.00916	.1092	109.182	9.161	7.619	69.794	26
27	13.110	.0763	.00826	.1083	121.100	9.237	7.770	71.777	27
28	14.421	.0693	.00745	.1075	134.210	9.307	7.914	73.650	28
29	15.863	.0630	.00673	.1067	148.631	9.370	8.049	75.415	29
30	17.449	.0573	.00608	.1061	164.494	9.427	8.176	77.077	30
31	19.194	.0521	.00550	.1055	181.944	9.479	8.296	78.640	31
32	21.114	.0474	.00497	.1050	201.138	9.526	8.409	80.108	32
33	23.225	.0431	.00450	.1045	222.252	9.569	8.515	81.486	33
34	25.548	.0391	.00407	.1041	245.477	9.609	8.615	82.777	34
35	28.102	.0356	.00369	.1037	271.025	9.644	8.709	83.987	35
40	45.259	.0221	.00226	.1023	442.593	9.779	9.096	88.953	40
45	72.891	.0137	.00139	.1014	718.905	9.863	9.374	92.454	45
50	117.391	.00852	.00086	.1009	1163.9	9.915	9.570	94.889	50
55	189.059	.00529	.00053	.1005	1880.6	9.947	9.708	96.562	55
60	304.482	.00328	.00033	.1003	3034.8	9.967	9.802	97.701	60
65	490.371	.00204	.00020	.1002	4893.7	9.980	9.867	98.471	65
70	789.748	.00127	.00013	.1001	7887.5	9.987	9.911	98.987	70
75	1271.9	.00079	.00008	.1001	12709.0	9.992	9.941	99.332	75
80	2048.4	.00049	.00005	.1000	20474.0	9.995	9.961	99.561	80
85	3299.0	.00030	.00003	.1000	32979.7	9.997	9.974	99.712	85
90	5313.0	.00019	.00002	.1000	53120.3	9.998	9.983	99.812	90
95	8556.7	.00012	.00001	.1000	85556.9	9.999	9.989	99.877	95
100	13780.6	.00007	.00001	.1000	137796.3	9.999	9.993	99.920	100

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12%

Compound Interest Factors

12%

n	Single Payment		Uniform Payment Series				Arithmetic Gradient		n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	Gradient Uniform Series	Gradient Present Worth	
	Find F Given P F/P	Find P Given F P/F	Find A Given F A/F	Find A Given P A/P	Find F Given A F/A	Find P Given A P/A	Find A Given G A/G	Find P Given G P/G	
1	1.120	.8929	1.0000	1.1200	1.000	0.893	0	0	1
2	1.254	.7972	.4717	.5917	2.120	1.690	0.472	0.797	2
3	1.405	.7118	.2963	.4163	3.374	2.402	0.925	2.221	3
4	1.574	.6355	.2092	.3292	4.779	3.037	1.359	4.127	4
5	1.762	.5674	.1574	.2774	6.353	3.605	1.775	6.397	5
6	1.974	.5066	.1232	.2432	8.115	4.111	2.172	8.930	6
7	2.211	.4523	.0991	.2191	10.089	4.564	2.551	11.644	7
8	2.476	.4039	.0813	.2013	12.300	4.968	2.913	14.471	8
9	2.773	.3606	.0677	.1877	14.776	5.328	3.257	17.356	9
10	3.106	.3220	.0570	.1770	17.549	5.650	3.585	20.254	10
11	3.479	.2875	.0484	.1684	20.655	5.938	3.895	23.129	11
12	3.896	.2567	.0414	.1614	24.133	6.194	4.190	25.952	12
13	4.363	.2292	.0357	.1557	28.029	6.424	4.468	28.702	13
14	4.887	.2046	.0309	.1509	32.393	6.628	4.732	31.362	14
15	5.474	.1827	.0268	.1468	37.280	6.811	4.980	33.920	15
16	6.130	.1631	.0234	.1434	42.753	6.974	5.215	36.367	16
17	6.866	.1456	.0205	.1405	48.884	7.120	5.435	38.697	17
18	7.690	.1300	.0179	.1379	55.750	7.250	5.643	40.908	18
19	8.613	.1161	.0158	.1358	63.440	7.366	5.838	42.998	19
20	9.646	.1037	.0139	.1339	72.052	7.469	6.020	44.968	20
21	10.804	.0926	.0122	.1322	81.699	7.562	6.191	46.819	21
22	12.100	.0826	.0108	.1308	92.503	7.645	6.351	48.554	22
23	13.552	.0738	.00956	.1296	104.603	7.718	6.501	50.178	23
24	15.179	.0659	.00846	.1285	118.155	7.784	6.641	51.693	24
25	17.000	.0588	.00750	.1275	133.334	7.843	6.771	53.105	25
26	19.040	.0525	.00665	.1267	150.334	7.896	6.892	54.418	26
27	21.325	.0469	.00590	.1259	169.374	7.943	7.005	55.637	27
28	23.884	.0419	.00524	.1252	190.699	7.984	7.110	56.767	28
29	26.750	.0374	.00466	.1247	214.583	8.022	7.207	57.814	29
30	29.960	.0334	.00414	.1241	241.333	8.055	7.297	58.782	30
31	33.555	.0298	.00369	.1237	271.293	8.085	7.381	59.676	31
32	37.582	.0266	.00328	.1233	304.848	8.112	7.459	60.501	32
33	42.092	.0238	.00292	.1229	342.429	8.135	7.530	61.261	33
34	47.143	.0212	.00260	.1226	384.521	8.157	7.596	61.961	34
35	52.800	.0189	.00232	.1223	431.663	8.176	7.658	62.605	35
40	93.051	.0107	.00130	.1213	767.091	8.244	7.899	65.116	40
45	163.988	.00610	.00074	.1207	1358.2	8.283	8.057	66.734	45
50	289.002	.00346	.00042	.1204	2400.0	8.304	8.160	67.762	50
55	509.321	.00196	.00024	.1202	4236.0	8.317	8.225	68.408	55
60	897.597	.00111	.00013	.1201	7471.6	8.324	8.266	68.810	60
65	1581.9	.00063	.00008	.1201	13173.9	8.328	8.292	69.058	65
70	2787.8	.00036	.00004	.1200	23223.3	8.330	8.308	69.210	70
75	4913.1	.00020	.00002	.1200	40933.8	8.332	8.318	69.303	75
80	8658.5	.00012	.00001	.1200	72145.7	8.332	8.324	69.359	80
85	15259.2	.00007	.00001	.1200	127151.7	8.333	8.328	69.393	85
90	26891.9	.00004		.1200	224091.1	8.333	8.330	69.414	90
95	47392.8	.00002		.1200	394931.4	8.333	8.331	69.426	95
100	83522.3	.00001		.1200	696010.5	8.333	8.332	69.434	100

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15%		Compound Interest Factors						15%	
<i>n</i>	Single Payment		Uniform Payment Series				Arithmetic Gradient		<i>n</i>
	Compound Amount Factor Find <i>F</i> Given <i>P</i> <i>F/P</i>	Present Worth Factor Find <i>P</i> Given <i>F</i> <i>P/F</i>	Sinking Fund Factor Find <i>A</i> Given <i>F</i> <i>A/F</i>	Capital Recovery Factor Find <i>A</i> Given <i>P</i> <i>A/P</i>	Compound Amount Factor Find <i>F</i> Given <i>A</i> <i>F/A</i>	Present Worth Factor Find <i>P</i> Given <i>A</i> <i>P/A</i>	Gradient Uniform Series Find <i>A</i> Given <i>G</i> <i>A/G</i>	Gradient Present Worth Find <i>P</i> Given <i>G</i> <i>P/G</i>	
1	1.150	.8696	1.0000	1.1500	1.000	0.870	0	0	1
2	1.322	.7561	.4651	.6151	2.150	1.626	0.465	0.756	2
3	1.521	.6575	.2880	.4380	3.472	2.283	0.907	2.071	3
4	1.749	.5718	.2003	.3503	4.993	2.855	1.326	3.786	4
5	2.011	.4972	.1483	.2983	6.742	3.352	1.723	5.775	5
6	2.313	.4323	.1142	.2642	8.754	3.784	2.097	7.937	6
7	2.660	.3759	.0904	.2404	11.067	4.160	2.450	10.192	7
8	3.059	.3269	.0729	.2229	13.727	4.487	2.781	12.481	8
9	3.518	.2843	.0596	.2096	16.786	4.772	3.092	14.755	9
10	4.046	.2472	.0493	.1993	20.304	5.019	3.383	16.979	10
11	4.652	.2149	.0411	.1911	24.349	5.234	3.655	19.129	11
12	5.350	.1869	.0345	.1845	29.002	5.421	3.908	21.185	12
13	6.153	.1625	.0291	.1791	34.352	5.583	4.144	23.135	13
14	7.076	.1413	.0247	.1747	40.505	5.724	4.362	24.972	14
15	8.137	.1229	.0210	.1710	47.580	5.847	4.565	26.693	15
16	9.358	.1069	.0179	.1679	55.717	5.954	4.752	28.296	16
17	10.761	.0929	.0154	.1654	65.075	6.047	4.925	29.783	17
18	12.375	.0808	.0132	.1632	75.836	6.128	5.084	31.156	18
19	14.232	.0703	.0113	.1613	88.212	6.198	5.231	32.421	19
20	16.367	.0611	.00976	.1598	102.444	6.259	5.365	33.582	20
21	18.822	.0531	.00842	.1584	118.810	6.312	5.488	34.645	21
22	21.645	.0462	.00727	.1573	137.632	6.359	5.601	35.615	22
23	24.891	.0402	.00628	.1563	159.276	6.399	5.704	36.499	23
24	28.625	.0349	.00543	.1554	184.168	6.434	5.798	37.302	24
25	32.919	.0304	.00470	.1547	212.793	6.464	5.883	38.031	25
26	37.857	.0264	.00407	.1541	245.712	6.491	5.961	38.692	26
27	43.535	.0230	.00353	.1535	283.569	6.514	6.032	39.289	27
28	50.066	.0200	.00306	.1531	327.104	6.534	6.096	39.828	28
29	57.575	.0174	.00265	.1527	377.170	6.551	6.154	40.315	29
30	66.212	.0151	.00230	.1523	434.745	6.566	6.207	40.753	30
31	76.144	.0131	.00200	.1520	500.957	6.579	6.254	41.147	31
32	87.565	.0114	.00173	.1517	577.100	6.591	6.297	41.501	32
33	100.700	.00993	.00150	.1515	664.666	6.600	6.336	41.818	33
34	115.805	.00864	.00131	.1513	765.365	6.609	6.371	42.103	34
35	133.176	.00751	.00113	.1511	881.170	6.617	6.402	42.359	35
40	267.864	.00373	.00056	.1506	1779.1	6.642	6.517	43.283	40
45	538.769	.00186	.00028	.1503	3585.1	6.654	6.583	43.805	45
50	1083.7	.00092	.00014	.1501	7217.7	6.661	6.620	44.096	50
55	2179.6	.00046	.00007	.1501	14524.1	6.664	6.641	44.256	55
60	4384.0	.00023	.00003	.1500	29220.0	6.665	6.653	44.343	60
65	8817.8	.00011	.00002	.1500	58778.6	6.666	6.659	44.390	65
70	17735.7	.00006	.00001	.1500	118231.5	6.666	6.663	44.416	70
75	35672.9	.00003		.1500	237812.5	6.666	6.665	44.429	75
80	71750.9	.00001		.1500	478332.6	6.667	6.666	44.436	80
85	144316.7	.00001		.1500	962104.4	6.667	6.666	44.440	85

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APPENDIX B

LIST OF FORMULA

1. $p (1 + i)^n$
2. $C_n = C_k (I_n/I_k)$
3. $Z_u = K(t^n)$
4. $n = \log s / \log 2$
 $W1 (C_{n1}/C_{k2}) + W2 (C_{n2}/C_{k2}) + W... (C_{n...}/C_{k...})$
5. $I_n = \frac{W1 (C_{n1}/C_{k2}) + W2 (C_{n2}/C_{k2}) + W... (C_{n...}/C_{k...})}{W1 + W2 + W...} \times I_k$
6. Conventional B-C ratio with PW
 $B-C = PW(B) \div [(1 - PW(MV)) + PW(O\&M)]$
7. Modified B-C ratio with PW
 $B-C = [PW(B) - PW(O\&M)] \div [1 - PW(MV)]$
8. Conventional B-C ratio with AW
 $B-C = AW(B) \div [CR + AW(O\&M)]$
9. Modified B-C ratio with AW
 $B-C = [AW(B) - AW(O\&M)] \div CR$