Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ENGINEERING ECONOMY
COURSE CODE	:	BNR 36502 / BPK 30902
PROGRAMME CODE	:	BNE / BND / BNF / BNB
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWERS **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) The principles of Engineering Economy can be divided into **SEVEN (7)** parts which provides a complete implementation of the regulations. List ALL the **SEVEN (7)** principles of Engineering Economy.

(7 marks)

(b) Explain the difference between Explicit Cost and Implicit Cost. To assist your explanation, you may use some examples.

(4 marks)

(c) A MNC company in Malaysia owned 2 machines, named Machine A and Machine B. The capital investment associated with the machines is about the same. However, the differences between those machines are their production capacities (production rate x available production hours) and their reject rates (percentage of parts produced that cannot be sold). The data has been shown in **Table Q1(c)** below;

Table Q1(c): Production Capacities

	Machine A	**Machine B**
Production rate	100 parts / hour	130 parts / hour
Hours available for production	7 hours / day	6 hours / day
Percent parts rejected	3%	10%

The material cost is RM6.00 per part, and all defect-free parts produced can be sold for RM12.00 each. (Rejected parts have negligible scrap value.) For both machines, the operator cost is RM15.00 per hour and the variable overhead rate for traceable costs is RM5.00 per hour. Determine:

(i) Profit from Machine A, and

(4 marks)

(ii) Profit from Machine B

(4 marks)

(d) Mr A is thinking of chartering a bus to take a group of people for a holiday. After made few assumptions, he predicted the following expenses per person; bus rental RM80.00, event ticket RM12.50, gas expenses is RM75.00, and refreshment charge is RM7.50 per person. Other costs are fuels at RM20.00 and the bus driver allowance at RM50.00.

(i) Calculate the total fixed costs and total variable costs.

(2 marks)

(ii) Develop a formula for the total cost and evaluate the potential possibilities to make money from the trip. Mr. A believes that he could attract 30 peoples at RM35.00 per ticket.

(4 marks)

Q2 (a) Site work activities associated with constructing a small bridge are shown in the **Table Q2 (a)** below. The table includes the quantity of each activity, the unit of measurement associated with each activity, and the unit cost of each activity.

Table Q2 (a): Site work activities

Activity	Quantity	Unit of measurement	Labor unit cost (RM)	Equipment cost (RM)	Material unit cost (RM)
Excavation, unclassified	1667	*cy*	1.35	1.43	0
Excavation, structural	120	*cy*	21.31	5.00	0
Backfill, compacted	340	*cy*	7.78	1.72	0
Pile-driving rig	job	*ls*	5688	6420	300
Piling, steel, driving	2240	*lf*	3.13	2.93	16.57

cy =cubic yard; ls=lump sum; lf= linear foot

Calculate;

(i) The total cost for structural excavation,

(2 marks)

(ii) The total cost for the pile-driving rig, and

(2 marks)

(iii) The total labor cost for the site work.

(4 marks)

(b) Tenaga Nasional Berhad plans to build a new 900-MW hydroelectric power plant. It is known that a 250-MW plant cost RM1.2 billion 10 years ago with a cost index of 200. The cost capacity factor for a hydroelectric power plant is 0.85. Calculate;

(i) The current cost of 250-MW hydroelectric power plant if the cost index now is 900, and

(4 marks)

(ii) The cost to build a 900-MW hydroelectric plant.

(4 marks)

(c) **Table Q2(c)** shows the prices and weightage for different grade of ready mix concrete from the year 2017 to year 2019. Year 2018 is the reference year having index value as 110.6. Determine;

(i) The weighted index for the price of ready mix concrete in year 2019.
(4 marks)

(ii) The corresponding year 2020 prices of ready mix concrete from year 2019 if 111.4 is the index value in year 2020.
(5 marks)

Q3 (a) A new machine is proposed by a consultant company to upgrade the power quality measurement at PQ meters. The investment cost is RM 45,000 with salvage value of RM 5,000 after 5 years. The revenue generated from the installation of the equipment minus the operating and maintenance cost of the equipment is RM 7,500 per year. The MARR is 15% per year. Outline the cash flow diagram.
(4 marks)

(b) A manufacturer of diesel locomotives needs 50,000 hours to produce the first unit and 40,000 hours to produce the second unit. The 4th unit on the other hand, took 32,000 hours to produce. Using the logarithmic model, calculate;

(i) The direct labor required for the 8th unit,
(6 marks)

(ii) The total labor to produce the 8th unit, and
(4 marks)

(iii) The cumulative average number of labor hours per unit for the first 6 units.
(4 marks)

(c) Welsh is a formwork carpenter that specialises in building wooden formwork for concrete columns. The time required for Welsh to build the first wooden formwork for concrete column is 1.5 hours and his learning rate is 0.85. Evaluate;

(i) The time taken to build the 15th wooden framework, and
(4 marks)

(ii) The total time to build the first 15 wooden frameworks.
(3 marks)

Q4 (a) A new train company is planning a project of constructing a new train track between Pagoh and Johor Bahru. This 400 kilometer project is planned to be completed by 2030. The project costs breakdown is as shown in **Table Q4(a).**

(i) Determine the value of Total Cost, Benefit and Not-benefit from the table.
(6 marks)

(ii) By applying the B-C ratio method for both conventional and modified cases using PW and AW methods with the study period of 30 years and a MARR of 20% per year, determine whether the company should proceed with the train project.
(13 marks)

(b) A boy will be starting his tertiary education in five years. He had just informed this to his parents. The cost per year will be RM17, 000 and it's a 4 years program. In order to support him, the parents started investing RM2, 000 per year from five years ago and will continue to do so for coming five more years in future. Evaluate the amount that the parents will have to invest each year for the next five years to have sufficient fund for the boy's education. You may use 10% as the appropriate interest rate for this purpose (discounting or compounding).
(6 marks)

- END OF QUESTIONS -

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Table Q2(c): Prices and weightage for mix concrete

Type of Ready Mix Concrete	Prices RM/m^3			Weightage
	2017 RM/m^3	2018 RM/m^3	2019 RM/m^3	
Grade 15	188.33	190.00	208.73	1
Grade 25	198.33	200.00	219.46	1.5
Grade 35	218.33	220.00	238.54	2

Table Q4(a): Costs breakdown of new train track project

Item	Cost (RM)
Land purchase	26 mil
Cost of construction	72 mil
Yearly rail maintenance	2 mil
Building and equipment	4 mil
Yearly equipment maintenance	1 mil
Train ticket sales	9 mil
Equipment scrap value	13mil
Petrol consumption saving	4 mil
Direct and indirect business revenues	5 mil
Local and state fees	3 mil

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Interest Table

Years, n	Discrete Compounding; i = 6%					
Factor	Compound Amount Factor	Present Worth Factor	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor
Formula	$F/P = (1+i)^n$	$\frac{P}{F} = \frac{1}{(1+i)^n}$	$\frac{F}{A} = \left[\frac{(1+i)^n - 1}{i}\right]$	$\frac{P}{A} = \left[\frac{(1+i)^n - 1}{i\,(1+i)^n}\right]$	$\frac{A}{F} = \left[\frac{i}{(1+i)^n - 1}\right]$	$\frac{A}{P} = \left[\frac{i\,(1+i)^n}{(1+i)^n - 1}\right]$
Symbol	(F/P)	P/F	F/A	P/A	A/F	A/P
1	1.0600	0.9434	1.0000	0.9434	1.0000	1.0600
2	1.1236	0.8900	2.0600	1.8334	0.4854	0.5454
3	1.1910	0.8396	3.1836	2.6730	0.3141	0.3741
4	1.2625	0.7921	4.3746	3.4651	0.2286	0.2886
5	1.3382	0.7473	5.6371	4.2124	0.1774	0.2374
6	1.4185	0.7050	6.9753	4.9173	0.1434	0.2034
7	1.5036	0.6651	8.3938	5.5824	0.1191	0.1791
8	1.5938	0.6274	9.8975	6.2098	0.1010	0.1610
9	1.6895	0.5919	11.4913	6.8017	0.0870	0.1470
10	1.7908	0.5584	13.1808	7.3601	0.0759	0.1359
11	1.8983	0.5268	14.9716	7.8869	0.0668	0.1268
12	2.0122	0.4970	16.8699	8.3838	0.0593	0.1193
13	2.1329	0.4688	18.8821	8.8527	0.0530	0.1130
14	2.2609	0.4423	21.0151	9.2950	0.0476	0.1076
15	2.3966	0.4173	23.2760	9.7122	0.0430	0.1030
16	2.5404	0.3936	25.6725	10.1059	0.0390	0.0990
17	2.6928	0.3714	28.2129	10.4773	0.0354	0.0954
18	2.8543	0.3503	30.9057	10.8276	0.0324	0.0924
19	3.0256	0.3305	33.7600	11.1581	0.0296	0.0896
20	3.2071	0.3118	36.7856	11.4699	0.0272	0.0872
21	3.3996	0.2942	39.9927	11.7641	0.0250	0.0850
22	3.6035	0.2775	43.3923	12.0416	0.0230	0.0830
23	3.8197	0.2618	46.9958	12.3034	0.0213	0.0813
24	4.0489	0.2470	50.8156	12.5504	0.0197	0.0797
25	4.2919	0.2330	54.8645	12.7834	0.0182	0.0782
26	4.5494	0.2198	59.1564	13.0032	0.0169	0.0769
27	4.8223	0.2074	63.7058	13.2105	0.0157	0.0757
28	5.1117	0.1956	68.5281	13.4062	0.0146	0.0746
29	5.4184	0.1846	73.6398	13.5907	0.0136	0.0736
30	5.7435	0.1741	79.0582	13.7648	0.0126	0.0726
31	6.0881	0.1643	84.8017	13.9291	0.0118	0.0718
32	6.4534	0.1550	90.8898	14.0840	0.0110	0.0710
33	6.8406	0.1462	97.3432	14.2302	0.0103	0.0703
34	7.2510	0.1379	104.1838	14.3681	0.0096	0.0696
35	7.6861	0.1301	111.4348	14.4982	0.0090	0.0690
36	8.1473	0.1227	119.1209	14.6210	0.0084	0.0684
37	8.6361	0.1158	127.2681	14.7368	0.0079	0.0679
38	9.1543	0.1092	135.9042	14.8460	0.0074	0.0674
39	9.7035	0.1031	145.0585	14.9491	0.0069	0.0669
40	10.2857	0.0972	154.7620	15.0463	0.0065	0.0665

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Interest Table

Discrete Compounding; i = 10%

	Single Payment		Uniform Series				Uniform Gradient		
	Compound Amount Factor	Present Worth Factor	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Gradient Present Worth Factor	Gradient Uniform Series Factor	
N	To Find F Given P F/P	To Find P Given F P/F	To Find F Given A F/A	To Find P Given A P/A	To Find A Given F A/F	To Find A Given P A/P	To Find P Given G P/G	To Find A Given G A/G	N
1	1.1000	0.9091	1.0000	0.9091	1.0000	1.1000	0.000	0.0000	1
2	1.2100	0.8264	2.1000	1.7355	0.4762	0.5762	0.826	0.4762	2
3	1.3310	0.7513	3.3100	2.4869	0.3021	0.4021	2.329	0.9366	3
4	1.4641	0.6830	4.6410	3.1699	0.2155	0.3155	4.378	1.3812	4
5	1.6105	0.6209	6.1051	3.7908	0.1638	0.2638	6.862	1.8101	5
6	1.7716	0.5645	7.7156	4.3553	0.1296	0.2296	9.684	2.2236	6
7	1.9487	0.5132	9.4872	4.8684	0.1054	0.2054	12.763	2.6216	7
8	2.1436	0.4665	11.4359	5.3349	0.0874	0.1874	16.029	3.0045	8
9	2.3579	0.4241	13.5795	5.7590	0.0736	0.1736	19.422	3.3724	9
10	2.5937	0.3855	15.9374	6.1446	0.0627	0.1627	22.891	3.7255	10
11	2.8531	0.3505	18.5312	6.4951	0.0540	0.1540	26.396	4.0641	11
12	3.1384	0.3186	21.3843	6.8137	0.0468	0.1468	29.901	4.3884	12
13	3.4523	0.2897	24.5227	7.1034	0.0408	0.1408	33.377	4.6988	13
14	3.7975	0.2633	27.9750	7.3667	0.0357	0.1357	36.801	4.9955	14
15	4.1772	0.2394	31.7725	7.6061	0.0315	0.1315	40.152	5.2789	15
16	4.5950	0.2176	35.9497	7.8237	0.0278	0.1278	43.416	5.5493	16
17	5.0545	0.1978	40.5447	8.0216	0.0247	0.1247	46.582	5.8071	17
18	5.5599	0.1799	45.5992	8.2014	0.0219	0.1219	49.640	6.0526	18
19	6.1159	0.1635	51.1591	8.3649	0.0195	0.1195	52.583	6.2861	19
20	6.7275	0.1486	57.2750	8.5136	0.0175	0.1175	55.407	6.5081	20
21	7.4002	0.1351	64.0025	8.6487	0.0156	0.1156	58.110	6.7189	21
22	8.1403	0.1228	71.4027	8.7715	0.0140	0.1140	60.689	6.9189	22
23	8.9543	0.1117	79.5430	8.8832	0.0126	0.1126	63.146	7.1085	23
24	9.8497	0.1015	88.4973	8.9847	0.0113	0.1113	65.481	7.2881	24
25	10.8347	0.0923	98.3471	9.0770	0.0102	0.1102	67.696	7.4580	25
30	17.4494	0.0573	164.4940	9.4269	0.0061	0.1061	77.077	8.1762	30
35	28.1024	0.0356	271.0244	9.6442	0.0037	0.1037	83.987	8.7086	35
40	45.2593	0.0221	442.5926	9.7791	0.0023	0.1023	88.953	9.0962	40
45	72.8905	0.0137	718.9048	9.8628	0.0014	0.1014	92.454	9.3740	45
50	117.3909	0.0085	1163.9085	9.9148	0.0009	0.1009	94.889	9.5704	50
60	304.4816	0.0033	3034.8164	9.9672	0.0003	0.1003	97.701	9.8023	60
80	2048.4002	0.0005	20474.0021	9.9951	a	0.1000	99.561	9.9609	80
100	13780.6123	0.0001	137796.1234	9.9993	a	0.1000	99.920	9.9927	100
∞				10.0000		0.1000			∞

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Interest Table

Discrete Compounding; i = 20%

	Single Payment		Uniform Series				Uniform Gradient		
	Compound Amount Factor	Present Worth Factor	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Gradient Present Worth Factor	Gradient Uniform Series Factor	
N	To Find *F* Given *P* *F/P*	To Find *P* Given *F* *P/F*	To Find *F* Given *A* *F/A*	To Find *P* Given *A* *P/A*	To Find *A* Given *F* *A/F*	To Find *A* Given *P* *A/P*	To Find *P* Given *G* *P/G*	To Find *A* Given *G* *A/G*	*N*
1	1.2000	0.8333	1.0000	0.8333	1.0000	1.2000	0.000	0.0000	1
2	1.4400	0.6944	2.2000	1.5278	0.4545	0.6545	0.694	0.4545	2
3	1.7280	0.5787	3.6400	2.1065	0.2747	0.4747	1.852	0.8791	3
4	2.0736	0.4823	5.3680	2.5887	0.1863	0.3863	3.299	1.2742	4
5	2.4883	0.4019	7.4416	2.9906	0.1344	0.3344	4.906	1.6405	5
6	2.9860	0.3349	9.9299	3.3255	0.1007	0.3007	6.581	1.9788	6
7	3.5832	0.2791	12.9159	3.6046	0.0774	0.2774	8.255	2.2902	7
8	4.2998	0.2326	16.4991	3.8372	0.0606	0.2606	9.883	2.5756	8
9	5.1598	0.1938	20.7989	4.0310	0.0481	0.2481	11.434	2.8364	9
10	6.1917	0.1615	25.9587	4.1925	0.0385	0.2385	12.887	3.0739	10
11	7.4301	0.1346	32.1504	4.3271	0.0311	0.2311	14.233	3.2893	11
12	8.9161	0.1122	39.5805	4.4392	0.0253	0.2253	15.467	3.4841	12
13	10.6993	0.0935	48.4966	4.5327	0.0206	0.2206	16.588	3.6597	13
14	12.8392	0.0779	59.1959	4.6106	0.0169	0.2169	17.601	3.8175	14
15	15.4070	0.0649	72.0351	4.6755	0.0139	0.2139	18.510	3.9588	15
16	18.4884	0.0541	87.4421	4.7296	0.0114	0.2114	19.321	4.0851	16
17	22.1861	0.0451	105.9306	4.7746	0.0094	0.2094	20.042	4.1976	17
18	26.6233	0.0376	128.1167	4.8122	0.0078	0.2078	20.681	4.2975	18
19	31.9480	0.0313	154.7400	4.8435	0.0065	0.2065	21.244	4.3861	19
20	38.3376	0.0261	186.6880	4.8696	0.0054	0.2054	21.740	4.4643	20
21	46.0051	0.0217	225.0256	4.8913	0.0044	0.2044	22.174	4.5334	21
22	55.2061	0.0181	271.0307	4.9094	0.0037	0.2037	22.555	4.5941	22
23	66.2474	0.0151	326.2369	4.9245	0.0031	0.2031	22.887	4.6475	23
24	79.4968	0.0126	392.4842	4.9371	0.0025	0.2025	23.176	4.6943	24
25	95.3962	0.0105	471.9811	4.9476	0.0021	0.2021	23.428	4.7352	25
30	237.3763	0.0042	1181.8816	4.9789	0.0008	0.2008	24.263	4.8731	30
35	590.6682	0.0017	2948.3411	4.9915	0.0003	0.2003	24.661	4.9406	35
40	1469.7716	0.0007	7343.8578	4.9966	0.0001	0.2001	24.847	4.9728	40
45	3657.2620	0.0003	18281.3099	4.9986	0.0001	0.2001	24.932	4.9877	45
50	9100.4382	0.0001	45497.1908	4.9995	*a*	0.2000	24.970	4.9945	50
60	56347.5144	*a*	281732.5718	4.9999	*a*	0.2000	24.994	4.9989	60
80	2160228.4620	*a*	10801137.3101	5.0000	*a*	0.2000	25.000	5.0000	80
∞				5.0000		0.2000			∞

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Interest Fund

JADUAL 19 - Aliran Tunai Diskret: Faktor Faedah Kompaun i = 15%

n	Single Payments		Uniform Series Payments				Arithmetic Gradients	
	Compound Amount F/P	Present Worth P/F	Sinking Fund A/F	Compound Amount F/A	Capital Recovery A/P	Present Worth P/A	Gradient Present Worth P/G	Gradient Uniform Series A/G
1	1.1500	0.8696	1.00000	1.0000	1.15000	0.8696		
2	1.3225	0.7561	0.46512	2.1500	0.61512	1.6257	0.7561	0.4651
3	1.5209	0.6575	0.28798	3.4725	0.43798	2.2832	2.0712	0.9071
4	1.7490	0.5718	0.20027	4.9934	0.35027	2.8550	3.7864	1.3263
5	2.0114	0.4972	0.14832	6.7424	0.29832	3.3522	5.7751	1.7228
6	2.3131	0.4323	0.11424	8.7537	0.26424	3.7845	7.9368	2.0972
7	2.6600	0.3759	0.09036	11.0665	0.24036	4.1604	10.1924	2.4498
8	3.0590	0.3269	0.07285	13.7268	0.22285	4.4873	12.4807	2.7813
9	3.5179	0.2843	0.05957	16.7858	0.20957	4.7716	14.7548	3.0922
10	4.0456	0.2472	0.04925	20.3037	0.19925	5.0188	16.9795	3.3832
11	4.6524	0.2149	0.04107	24.3493	0.19107	5.2337	19.1289	3.6549
12	5.3503	0.1869	0.03448	29.0017	0.18448	5.4206	21.1849	3.9082
13	6.1528	0.1625	0.02911	34.3519	0.17911	5.5831	23.1352	4.1438
14	7.0757	0.1413	0.02469	40.5047	0.17469	5.7245	24.9725	4.3624
15	8.1371	0.1229	0.02102	47.5804	0.17102	5.8474	26.6930	4.5650
16	9.3576	0.1069	0.01795	55.7175	0.16795	5.9542	28.2960	4.7522
17	10.7613	0.0929	0.01537	65.0751	0.16537	6.0472	29.7828	4.9251
18	12.3755	0.0808	0.01319	75.8364	0.16319	6.1280	31.1565	5.0843
19	14.2318	0.0703	0.01134	88.2118	0.16134	6.1982	32.4213	5.2307
20	16.3665	0.0611	0.00976	102.4436	0.15976	6.2593	33.5822	5.3651
21	18.8215	0.0531	0.00842	118.8101	0.15842	6.3125	34.6448	5.4883
22	21.6447	0.0462	0.00727	137.6316	0.15727	6.3587	35.6150	5.6010
23	24.8915	0.0402	0.00628	159.2764	0.15628	6.3988	36.4988	5.7040
24	28.6252	0.0349	0.00543	184.1678	0.15543	6.4338	37.3023	5.7979
25	32.9190	0.0304	0.00470	212.7930	0.15470	6.4641	38.0314	5.8834
26	37.8568	0.0264	0.00407	245.7120	0.15407	6.4906	38.6918	5.9612
27	43.5353	0.0230	0.00353	283.5688	0.15353	6.5135	39.2890	6.0319
28	50.0656	0.0200	0.00306	327.1041	0.15306	6.5335	39.8283	6.0960
29	57.5755	0.0174	0.00265	377.1697	0.15265	6.5509	40.3146	6.1541
30	66.2118	0.0151	0.00230	434.7451	0.15230	6.5660	40.7526	6.2066
31	76.1435	0.0131	0.00200	500.9569	0.15200	6.5791	41.1466	6.2541
32	87.5651	0.0114	0.00173	577.1005	0.15173	6.5905	41.5006	6.2970
33	100.6998	0.0099	0.00150	664.6655	0.15150	6.6005	41.8184	6.3357
34	115.8048	0.0086	0.00131	765.3654	0.15131	6.6091	42.1033	6.3705
35	133.1755	0.0075	0.00113	881.1702	0.15113	6.6166	42.3586	6.4019
40	267.8635	0.0037	0.00056	1779.09	0.15056	6.6418	43.2830	6.5168
45	538.7693	0.0019	0.00028	3585.13	0.15028	6.6543	43.8051	6.5830
50	1083.66	0.0009	0.00014	7217.72	0.15014	6.6605	44.0958	6.6205
55	2179.62	0.0005	0.00007	14524	0.15007	6.6636	44.2558	6.6414
60	4384.00	0.0002	0.00003	29220	0.15003	6.6651	44.3431	6.6530
65	8817.79	0.0001	0.00002	58779	0.15002	6.6659	44.3903	6.6593
70	17736	0.0001	0.00001		0.15001	6.6663	44.4156	6.6623
75	35673				0.15000	6.6665	44.4292	6.6646
80	71751				0.15000	6.6666	44.4364	6.6656
85					0.15000	6.6666	44.4402	6.6661

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME: ECONOMY ENGINEERING

PROGRAMME CODE: BNE/BND/BNF/BNB
COURSE CODE : BNR 36502 / BPK 30902

LIST OF FORMULA

1	$C_n = C_k \left(\frac{I_n}{I_k}\right)$	6	Conventional B-C ratio B-C = PW(B) ÷ [(1 – PW(MV)) +PW(O&M)] B-C = AW(B) ÷ [CR + AW(O&M)]
2	$C_A = C_B \left(\frac{S_A}{S_B}\right)^x$	7	Modified B-C ratio with PW B-C = [PW(B) – PW(O&M)] ÷ [1 – PW(MV)] B-C = [AW(B) – AW(O&M)] ÷ CR
3	$Z_u = K(u^{\left(\frac{Log\, s}{Log\, 2}\right)})$	8	$I_{effective} = \left(1 + \frac{r}{m}\right)^m - 1$
4	$p\,(1 + i)^n$		
5	$I_n = \frac{W1\,(C_{n1}/C_{k2}) + W2\,(C_{n2}/C_{k2}) + W\ldots\,(C_{n\ldots}/C_{k\ldots})}{W1 + W2 + W\ldots\ldots} \times I_k$		