Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	ENGINEERING ECONOMY
COURSE CODE	:	BNQ 21002
PROGRAMME CODE	:	BNN
EXAMINATION DATE	:	JUNE /JULY 2019
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) A new machine is proposed by Hakim Engineering Consultant 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. Draw the cash flow diagram.

(4 marks)

(b) A remotely located air sampling station can be powered by solar cells or by running an above ground electric line to the site and using conventional power. Solar cells will cost RM 15,000 to install and will have a useful life of 5 years with no salvage value. Annual costs for inspection, cleaning, maintenance and part replacement are expected to be RM 4,000. A new power line will cost RM 40,000 to install, with power costs expected to be RM 1,000 per year. Since the air sampling project will end in 10 years, the salvage value of the line is considered to be zero. At an interest rate of 6% per year compounded monthly,

(i) Calculate the effective interest rate per year.

(4 marks)

(ii) Determine which alternative should be selected on the basis of an present worth analysis.

(10 marks)

(iii) Determine the initial cost of the above ground line to make the two alternatives equally attractive economically.

(7 marks)

Q2 You are appointed as a contractor for Senai-Desaru Highway project. One of your tasks is to set up the asphalt-mixing plant equipment which has a choice of three sites. Three sites available are Cahaya Baru, Ulu Tiram and Tebrau. You estimate that it will cost RM 5.40 per cubic yard mile (yd^3-mile) to haul the asphalt-paving material from the mixing plant to the job location. Refer to the **Table Q2** below for the factors relating to these three sites. The job requires 50,000 yd^3 of mixed-asphalt-paving material. You are given by your client to complete in five months (25 weeks of 6 working days per week). The delivered of paving material is paid for RM 29 per yd^3.

a) Identify fixed cost and variable cost from the cost factor listed in the table.

(3 marks)

b) Calculate total costs for all three sites (Cahaya Baru, Ulu Tiram and Tebrau). Based on obtained total costs, identify the desired site.

(16 marks)

c) Based on your answer from (b), calculate the volume of asphalt in cubic yard (yd^3) that have to be delivered before gaining profits.

(4 marks)

d) For every site (i.e. Cahaya Baru, Ulu Tiram and Tebrau), express the total cost (TC) equation correspond to the site.

(2 marks)

Q3 (a) Define *Engineering Economy*.

(1 mark)

(b) State **FOUR (4)** importances of Engineering Economy to engineers/engineering technologists.

(4 marks)

(c) **Table Q3 (c)** below shows the past price of Standard Malaysia Rubber (SMR) since 2012, whereby 2013 is the reference year having 246 as an index value. The weight place on SMR CV is one (1) time, SMP L is one and half (1.5) times and SMR 5 is two (2) times.

(i) Calculate a weighted index for the price of a kg of SMR in 2014.

(4 marks)

(ii) Calculate the corresponding 2015 prices of SMR from 2014 if 218 is the index value in 2015.

(6 marks)

(d) Ten years ago, a 180 kW electric generator set cost RM 80,000. The cost index for this class of equipment ten years ago was 180 and is now 200. The cost-capacity factor is 0.5. The plant engineering staff is considering a 220 kW unit of the same general design to power a small isolated plant. Assume a pre-compressor is to be added, which (when isolated and estimated separately) currently costs RM 20,000. Determine the total cost of the 220 kW unit.

(5 marks)

(e) In a learning curve application, 658.5 work hours are required for the third production unit and 615.7 work hours are required for the fourth production unit. Determine the value of learning curve (s).

(5 marks)

Q4 (a) Identify each of the following cash flows to indicate whether it is a benefit, a dis-benefit, or a cost. Justify your answer.

(i) RM 700, 000 per year maintenance by Port Klang authority.
(ii) Expenditure of RM 45 million for tunnel construction on East-West Highway.

(iii) Reduction of RM 375, 000 per year in car accident repairs because of improved lighting.

(iv) RM 700, 000 per year loss of revenue by farmers because of highway right-of-way purchases.

(v) RM 500, 000 saving in toll gate payment for new federal road.

(10 marks)

(b) A high speed train company is considering a project of constructing a new bullet train railway from Muar to Johor Bahru. The 400 kilometer project will be started with purchasing of land from local owner and state government costing about RM 26 million. Cost of construction is estimated to be RM 72 million and yearly maintenance is about RM 2 million. A traffic control building and sophisticated equipment should also be considered with a cost of RM 4 million and RM 1 million per year maintenance expenditures. Some construction equipments will be sold at the end of construction period at the market value of RM 13 million. In addition, yearly speed train ticket fees will be collected amounting to RM 9 million, petrol consumptions save by the road users for RM 4 million, revenues received through the direct and indirect businesses of RM 5 million, and fees collected by the local and state authorities of RM 3 million. The project costs breakdown is shown in **Table Q4(c).**

(i) Determine the value of Total Cost, Benefit and Disbenefit from the above statement. (3 marks)

(ii) Apply 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 bullet train railway project.

(12 marks)

- END OF QUESTIONS –

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Table Q2: Factors relating to Cahaya Baru, Ulu Tiram and Tebrau

Cost Factor ***(Faktor Kos)***	**Cahaya Baru**	**Ulu Tiram**	**Tebrau**
Average hauling distance	7 miles	4 miles	3.3 miles
Monthly rental of site	RM 3,600	RM 10,000	RM 9,000
Cost to set up & remove Equipment	RM 54,000	RM 89,000	RM 75,000
Hauling expense	RM 5.40/yd^3-mile	RM 5.40/yd^3-mile	RM 5.40/yd^3-mile
Flag person	Not required	RM 90/day	RM100/day
Authority Permit	RM 500	RM 500	RM 1000

Table Q3 (c): The Past Price of Standard Malaysia Rubber (SMR)

SMR	**Price (sen/ kg) in Year**		
	2012	**2013**	**2014**
SMR CV	1088	919	753
SMR L	1046	832	696
SMR 5	974	794	579

Table Q4(c): Costs breakdown of high speed rail construction 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 fees	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 6%

TABLE C-9 Discrete Compounding; $i = 6\%$

	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	1.0600	0.9434	1.0000	0.9434	1.0000	1.0600	0.000	0.0000	1
2	1.1236	0.8900	2.0600	1.8334	0.4854	0.5454	0.890	0.4854	2
3	1.1910	0.8396	3.1836	2.6730	0.3141	0.3741	2.569	0.9612	3
4	1.2625	0.7921	4.3746	3.4651	0.2286	0.2886	4.946	1.4272	4
5	1.3382	0.7473	5.6371	4.2124	0.1774	0.2374	7.935	1.8836	5
6	1.4185	0.7050	6.9753	4.9173	0.1434	0.2034	11.459	2.3304	6
7	1.5036	0.6651	8.3938	5.5824	0.1191	0.1791	15.450	2.7676	7
8	1.5938	0.6274	9.8975	6.2098	0.1010	0.1610	19.842	3.1952	8
9	1.6895	0.5919	11.4913	6.8017	0.0870	0.1470	24.577	3.6133	9
10	1.7908	0.5584	13.1808	7.3601	0.0759	0.1359	29.602	4.0220	10
11	1.8983	0.5268	14.9716	7.8869	0.0668	0.1268	34.870	4.4213	11
12	2.0122	0.4970	16.8699	8.3838	0.0593	0.1193	40.337	4.8113	12
13	2.1329	0.4688	18.8821	8.8527	0.0530	0.1130	45.963	5.1920	13
14	2.2609	0.4423	21.0151	9.2950	0.0476	0.1076	51.713	5.5635	14
15	2.3966	0.4173	23.2760	9.7122	0.0430	0.1030	57.555	5.9260	15
16	2.5404	0.3936	25.6725	10.1059	0.0390	0.0990	63.459	6.2794	16
17	2.6928	0.3714	28.2129	10.4773	0.0354	0.0954	69.401	6.6240	17
18	2.8543	0.3503	30.9057	10.8276	0.0324	0.0924	75.357	6.9597	18
19	3.0256	0.3305	33.7600	11.1581	0.0296	0.0896	81.306	7.2867	19
20	3.2071	0.3118	36.7856	11.4699	0.0272	0.0872	87.230	7.6051	20
21	3.3996	0.2942	39.9927	11.7641	0.0250	0.0850	93.114	7.9151	21
22	3.6035	0.2775	43.3923	12.0416	0.0230	0.0830	98.941	8.2166	22
23	3.8197	0.2618	46.9958	12.3034	0.0213	0.0813	104.701	8.5099	23
24	4.0489	0.2470	50.8156	12.5504	0.0197	0.0797	110.381	8.7951	24
25	4.2919	0.2330	54.8645	12.7834	0.0182	0.0782	115.973	9.0722	25
30	5.7435	0.1741	79.0582	13.7648	0.0126	0.0726	142.359	10.3422	30
35	7.6861	0.1301	111.4348	14.4982	0.0090	0.0690	165.743	11.4319	35
40	10.2857	0.0972	154.7620	15.0463	0.0065	0.0665	185.957	12.3590	40
45	13.7646	0.0727	212.7435	15.4558	0.0047	0.0647	203.110	13.1413	45
50	18.4202	0.0543	290.3359	15.7619	0.0034	0.0634	217.457	13.7964	50
60	32.9877	0.0303	533.1282	16.1614	0.0019	0.0619	239.043	14.7909	60
80	105.7960	0.0095	1746.5999	16.5091	0.0006	0.0606	262.549	15.9033	80
100	339.3021	0.0029	5638.3681	16.6175	0.0002	0.0602	272.047	16.3711	100
∞				16.6667		0.0600			∞

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Interest Table 15%

TABLE C-15 Discrete Compounding; $i = 15\%$

	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	1.1500	0.8696	1.0000	0.8696	1.0000	1.1500	0.000	0.0000	1
2	1.3225	0.7561	2.1500	1.6257	0.4651	0.6151	0.756	0.4651	2
3	1.5209	0.6575	3.4725	2.2832	0.2880	0.4380	2.071	0.9071	3
4	1.7490	0.5718	4.9934	2.8550	0.2003	0.3503	3.786	1.3263	4
5	2.0114	0.4972	6.7424	3.3522	0.1483	0.2983	5.775	1.7228	5
6	2.3131	0.4323	8.7537	3.7845	0.1142	0.2642	7.937	2.0972	6
7	2.6600	0.3759	11.0668	4.1604	0.0904	0.2404	10.192	2.4498	7
8	3.0590	0.3269	13.7268	4.4873	0.0729	0.2229	12.481	2.7813	8
9	3.5179	0.2843	16.7858	4.7716	0.0596	0.2096	14.755	3.0922	9
10	4.0456	0.2472	20.3037	5.0188	0.0493	0.1993	16.980	3.3832	10
11	4.6524	0.2149	24.3493	5.2337	0.0411	0.1911	19.129	3.6549	11
12	5.3503	0.1869	29.0017	5.4206	0.0345	0.1845	21.185	3.9082	12
13	6.1528	0.1625	34.3519	5.5831	0.0291	0.1791	23.135	4.1438	13
14	7.0757	0.1413	40.5047	5.7245	0.0247	0.1747	24.973	4.3624	14
15	8.1371	0.1229	47.5804	5.8474	0.0210	0.1710	26.693	4.5650	15
16	9.3576	0.1069	55.7175	5.9542	0.0179	0.1679	28.296	4.7522	16
17	10.7613	0.0929	65.0751	6.0472	0.0154	0.1654	29.783	4.9251	17
18	12.3755	0.0808	75.8364	6.1280	0.0132	0.1632	31.157	5.0843	18
19	14.2318	0.0703	88.2118	6.1982	0.0113	0.1613	32.421	5.2307	19
20	16.3665	0.0611	102.4436	6.2593	0.0098	0.1598	33.582	5.3651	20
21	18.8215	0.0531	118.8101	6.3125	0.0084	0.1584	34.645	5.4883	21
22	21.6447	0.0462	137.6316	6.3587	0.0073	0.1573	35.615	5.6010	22
23	24.8915	0.0402	159.2764	6.3988	0.0063	0.1563	36.499	5.7040	23
24	28.6252	0.0349	184.1678	6.4338	0.0054	0.1554	37.302	5.7979	24
25	32.9190	0.0304	212.7930	6.4641	0.0047	0.1547	38.031	5.8834	25
30	66.2118	0.0151	434.7451	6.5660	0.0023	0.1523	40.753	6.2066	30
35	133.1755	0.0075	881.1702	6.6166	0.0011	0.1511	42.359	6.4019	35
40	267.8635	0.0037	1779.0903	6.6418	0.0006	0.1506	43.283	6.5168	40
45	538.7693	0.0019	3585.1285	6.6543	0.0003	0.1503	43.805	6.5830	45
50	1083.6574	0.0009	7217.7163	6.6605	0.0001	0.1501	44.096	6.6205	50
60	4383.9987	0.0002	29219.9916	6.6651	a	0.1500	44.343	6.6530	60
80	71750.8794	a	478332.5293	6.6666	a	0.1500	44.436	6.6656	80
100	1174313.4507	a	7828749.6713	6.6667	a	0.1500	44.444	6.6666	100
∞				6.6667		0.1500			∞

[a] Less than 0.0001.

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Interest Table 20%

TABLE C-17 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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LIST OF EQUATION

1	$C_n = C_k \left(\frac{I_n}{I_k}\right)$	6	Conventional B-C ratio B-C = PW(B) ÷ [(I – 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)] ÷ [I – PW(MV)] B-C = [AW(B) – AW(O&M)] ÷ CR
3	$Z_u = K(u^{\left(\frac{\log s}{\log t}\right)})$	8	$I_{effective} = \left(1 + \frac{r}{m}\right)^m - 1$
4	$p(1+i)^n$		
5	$I_n = \frac{W1\,(C_{n1}/C_{k2}) + W2\,(C_{n2}/C_{k2}) + W\ldots\,(C_n\ /C_k\ )}{W1 + W2 + W\ldots\ldots} X\ I_k$		