UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BME 4023
COURSE	: ENGINEERING ECONOMICS
SEMESTER/SESSION	: 1-2023/2024
DURATION	: 2.5 HOURS

Instructions:

1. This booklet contains **5** questions. Answer all questions
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, rise up your hand and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 9 PRINTED PAGES INCLUDING COVER PAGE

Answer all five (5) questions.

Question 1

Consumer products company has business that their products can be sold approximately $D = 780 - 10p$ units per month. (D is demand or quantity sold per month, and p is the price in dollars). The fixed cost is $750 per month, and the variable cost is $30 per unit produced. **Determine** optimum demand, maximum profit, breakeven volume and range of profit demand. Sketch where appropriate.

(16 marks)

Question 2

You are proposing your company to purchase an asset (lathe machine) with an expected life of five (5) years. Investment cost is $60,000. Uniform annual revenue is estimated at $20,000, annual service and maintenance expenses of $4,000. At the end of the fifth (5^{th}) year, the asset is expected to be sold for $9,000, while $800 will be paid as transportation costs. If the MARR is 8%, by using the PW, FW and AW methods, **evaluate** whether the asset should be purchased or not. Sketch where appropriate.

(25 marks)

Question 3

A small company purchased now for $2,500 will lose $150 for the first ($1^{st}$) year and $100 for the second ($2^{nd}$) year. An additional $200 invested in the company during the second (2^{nd}) year will result in a profit of $1,500 each year from the third (3^{rd}) year through the fifth (5^{th}) year. At the end of five (5) years, the company can be sold for $1000. **Estimate** the Internal Rate of Return (IRR) (try with rate 6% and 12%) and External Rate of Return (ERR) (when $\epsilon = 15\%$) of this investment. Sketch where appropriate.

(25 marks)

Question 4

Four (4) mutually exclusive alternative projects has been proposed for consideration. The respective cost and revenue are included in the Table 1 that follows. Each of the proposal has a useful life of twenty (20) years, and MARR is 10% per year. **Recommend** which proposal should be selected. (17 marks)

Table 1

	Proposal W	Proposal X	Proposal Y	Proposal Z
First cost, $	1.2mil	1.5mil	1.6mil	1.9mil
Annual M & O cost, $/year	80k	60k	50k	35k
Revenue, $/year	230k	245k	256k	260k

Question 5

As a manufacturing engineer you are responsible for calculating the depreciation of the Grinding machine that to be purchased by your company. Price of the machine to be purchased is $20,000. The estimated residual value after ten (10) years was $1,000. Using Straight-Line (SL) and Declining Balance (DB) method (R =2/N), **determine** the annual rate of depreciation and the amount of depreciation and Book Value (BV) at the end of three (3) years after the purchased of the machine. (17 marks)

----------End of questions ----------

Related equations:

When price, p = \$..

Breakeven point, $D = \frac{C_F}{(p - C_v)}$

Profit = $(p - C_v)D - C_F$
Total revenue = $Px\ D$
Total cost = $(C_v\ x\ D) + C_F$

When price, $p = a - bD$

Optimal demand / Maximum profit, $D^* = \frac{a - C_v}{2b}$

Profit (loss) = $- bD^2 + (a - C_v)D - C_F$

Breakeven, $D = \frac{-(a - c_v) \pm \sqrt{(a - c_v)^2 - 4(-b)(-C_F)}}{2(-b)}$

Simple Interest,

$I = (P)(N)(i)$

Single Cash Flow

Finding P when given F

$P = F(1 + i)^{-N}$ or $P = F(P/F, i\%, N)$

Finding F when given P

$F = P(1 + i)^{N}$ or $F = P(F/P, i\%, N)$

Finding the Interest rate when given P, F & N

$i = \sqrt[N]{F/P} - 1$

Finding N when given P, F, & i

$N = \frac{log(F/P)}{log(1 + i)}$

Uniform Series (Annuity)

Finding P when given A

$$P = A\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right] \quad \text{or} \quad P = A(P/A, i\%, N)$$

Finding F when given A

$$F = A\left[\frac{(1+i)^N - 1}{i}\right] \quad \text{or} \quad F = A(F/A, i\%, N)$$

Finding A when given F

$$A = F\left[\frac{i}{(1+i)^N - 1}\right] \quad \text{or} \quad A = F(A/F, i\%, N)$$

Finding A when given P

$$A = P\left[\frac{i(1+i)^N}{(1+i)^N - 1}\right] \quad \text{or} \quad A = P(A/P, i\%, N)$$

Present Worth, PW = PW of cash inflows – PW of cash outflows

Bond Value,

$$V_N = C\,(P/F, i\%, N) + rZ\,(P/A, i\%, N)$$

Future Worth, *FW = FW of cash inflows – FW of cash outflows*

Annual Worth, *AW*

$$AW(i\%) = R - E - CR(i\%)$$

$$CR(i\%) = I(A/P, i\%, N) - S(A/F, i\%, N)$$

Internal Rate of Return (IRR),

$$IRR = PW = 0$$

IRR = % Lower rate + $\left[\frac{NPV\ at\ Lower\ Rate}{NPV\ at\ Lower\ Rate - NPV\ at\ Higher\ rate}\right]$ x $(\%\ higher - \%\ lower)$

External Rate of Return (ERR),

All expenses = All revenues

$$\sum_{k=0}^{N} E_k\ (1+i)^{-k}\ (1+\ i')^{N}\ =\ \sum_{k=0}^{N} R_k\ (1+\epsilon)^{N-k}$$

Benefits Cost Ratio Analysis,

$$B/C = \frac{PW_B}{PW_C}$$

Depreciation,

$$d_k = \frac{(B - SV_N)}{N}$$

$d_k^* = k\ .\ d_k$ For $1 \leq k \leq$

$BV_k = B - d_k^*$

$d_1 = B(R),$

$d_k = B(1-R)^{k-1}(R)$

$d_k^* = B[1 - (1-R)^k]$

$BV_k = B(1-R)^k$

TABLE C-8 Discrete Compounding; $i = 5\%$

	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	
	To Find F Given P	To Find P Given F	To Find F Given A	To Find P Given A	To Find A Given F	To Find A Given P	To Find P Given G	To Find A Given G	
N	F/P	P/F	F/A	P/A	A/F	A/P	P/G	A/G	N
1	1.0500	0.9524	1.0000	0.9524	1.0000	1.0500	0.000	0.0000	1
2	1.1025	0.9070	2.0500	1.8594	0.4878	0.5378	0.907	0.4878	2
3	1.1576	0.8638	3.1525	2.7232	0.3172	0.3672	2.635	0.9675	3
4	1.2155	0.8227	4.3101	3.5460	0.2320	0.2820	5.103	1.4391	4
5	1.2763	0.7835	5.5256	4.3295	0.1810	0.2310	8.237	1.9025	5
6	1.3401	0.7462	6.8019	5.0757	0.1470	0.1970	11.968	2.3579	6
7	1.4071	0.7107	8.1420	5.7864	0.1228	0.1728	16.232	2.8052	7
8	1.4775	0.6768	9.5491	6.4632	0.1047	0.1547	20.970	3.2445	8
9	1.5513	0.6446	11.0266	7.1078	0.0907	0.1407	26.127	3.6758	9
10	1.6289	0.6139	12.5779	7.7217	0.0795	0.1295	31.652	4.0991	10
11	1.7103	0.5847	14.2068	8.3064	0.0704	0.1204	37.499	4.5144	11
12	1.7959	0.5568	15.9171	8.8633	0.0628	0.1128	43.624	4.9219	12
13	1.8856	0.5303	17.7130	9.3936	0.0565	0.1065	49.988	5.3215	13
14	1.9799	0.5051	19.5986	9.8986	0.0510	0.1010	56.554	5.7133	14
15	2.0789	0.4810	21.5786	10.3797	0.0463	0.0963	63.288	6.0973	15
16	2.1829	0.4581	23.6575	10.8378	0.0423	0.0923	70.160	6.4736	16
17	2.2920	0.4363	25.8404	11.2741	0.0387	0.0887	77.141	6.8423	17
18	2.4066	0.4155	28.1324	11.6896	0.0355	0.0855	84.204	7.2034	18
19	2.5270	0.3957	30.5390	12.0853	0.0327	0.0827	91.328	7.5569	19
20	2.6533	0.3769	33.0660	12.4622	0.0302	0.0802	98.488	7.9030	20

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	
	To Find F Given P	To Find P Given F	To Find F Given A	To Find P Given A	To Find A Given F	To Find A Given P	To Find P Given G	To Find A Given G	
N	F/P	P/F	F/A	P/A	A/F	A/P	P/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

TABLE C-14 Discrete Compounding; $i = 12\%$

	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	1.1200	0.8929	1.0000	0.8929	1.0000	1.1200	0.000	0.0000	1
2	1.2544	0.7972	2.1200	1.6901	0.4717	0.5917	0.797	0.4717	2
3	1.4049	0.7118	3.3744	2.4018	0.2963	0.4163	2.221	0.9246	3
4	1.5735	0.6355	4.7793	3.0373	0.2092	0.3292	4.127	1.3589	4
5	1.7623	0.5674	6.3528	3.6048	0.1574	0.2774	6.397	1.7746	5
6	1.9738	0.5066	8.1152	4.1114	0.1232	0.2432	8.930	2.1720	6
7	2.2107	0.4523	10.0890	4.5638	0.0991	0.2191	11.644	2.5515	7
8	2.4760	0.4039	12.2997	4.9676	0.0813	0.2013	14.471	2.9131	8
9	2.7731	0.3606	14.7757	5.3282	0.0677	0.1877	17.356	3.2574	9
10	3.1058	0.3220	17.5487	5.6502	0.0570	0.1770	20.254	3.5847	10

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

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