

ISE 307: Engineering Economic Analysis (Term 253)

Practice Problem Set: Major 2 Exam

In-Class Activity 20

Name: _____ Student ID: _____

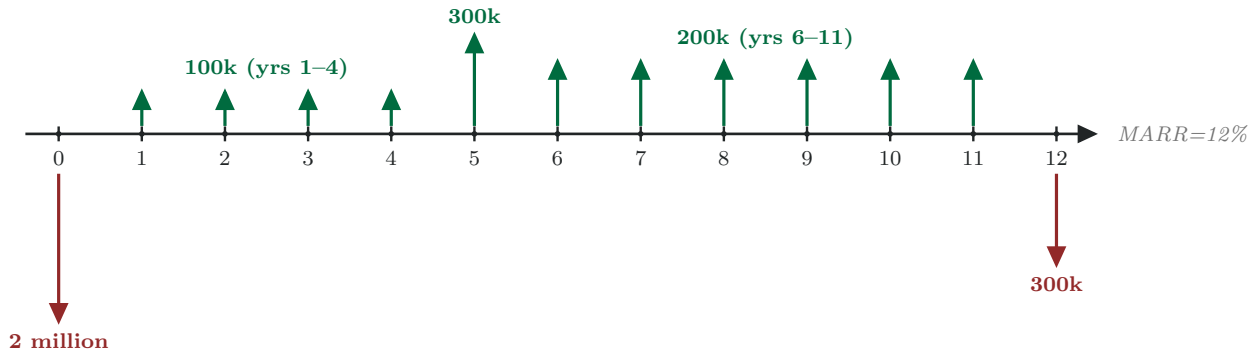
Section: _____ Date: _____

Instructions

1. Read each question carefully and answer using only the information given.
2. Write clearly, legibly, and neatly. If your handwriting is not legible, you may lose partial or full credit.
3. For the calculation parts, write ALL the steps. Writing final answer only will NOT receive full credit.

Problem 1 (30 pts)

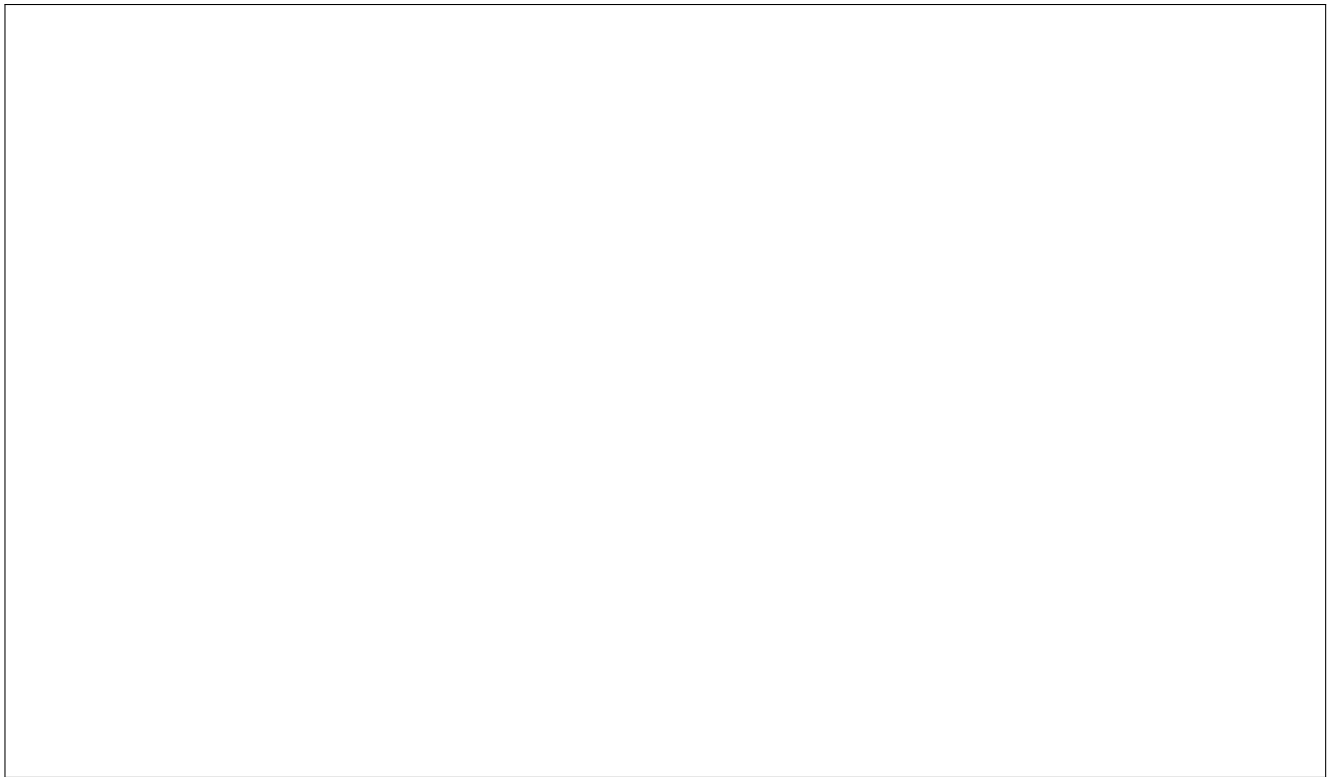
You are starting your own investment company. You are managing a portfolio of projects. One of the projects have the following *net* cash flows (in SAR):



(a) (10 pts) Analyze the project and make decision. Would you invest in this project? Why or why not?

- (b) (10 pts) Calculate the internal rate of return for this project. Your chief of finance (CFO) analyzes that the project is rather risky and requires that for risky projects like this, the IRR must be at least 18% (not the standard 12% MARR). Is this project acceptable? Show your analysis.

- (c) (10 pts) Your co-CEO also is also evaluating another project and considers financing that one too, but it will not start until end of year 8 (since they are still struggling with obtaining permits and licenses, which takes time). **The company requires your project to return the investment within 8 years.** Is your project still acceptable? Show your analysis.



Problem 2 (20 pts)

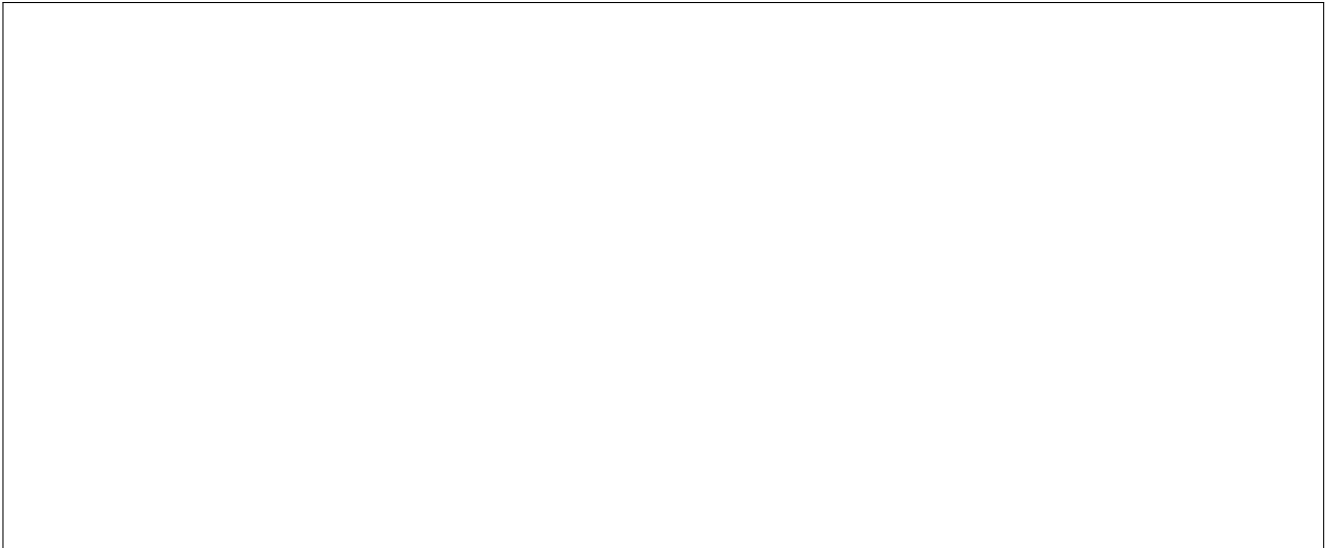
One of the projects you funded, an electric vehicle (EV) workshop, must keep one machine of a given type running to do a required job. Two models are available with different useful lives. The MARR is 12.0%.

	First cost	Operating cost/yr	Life (yr)	Salvage
X (short life)	−20,000	−6,000	3	+5,000
Y (long life)	−32,000	−4,000	6	+6,000

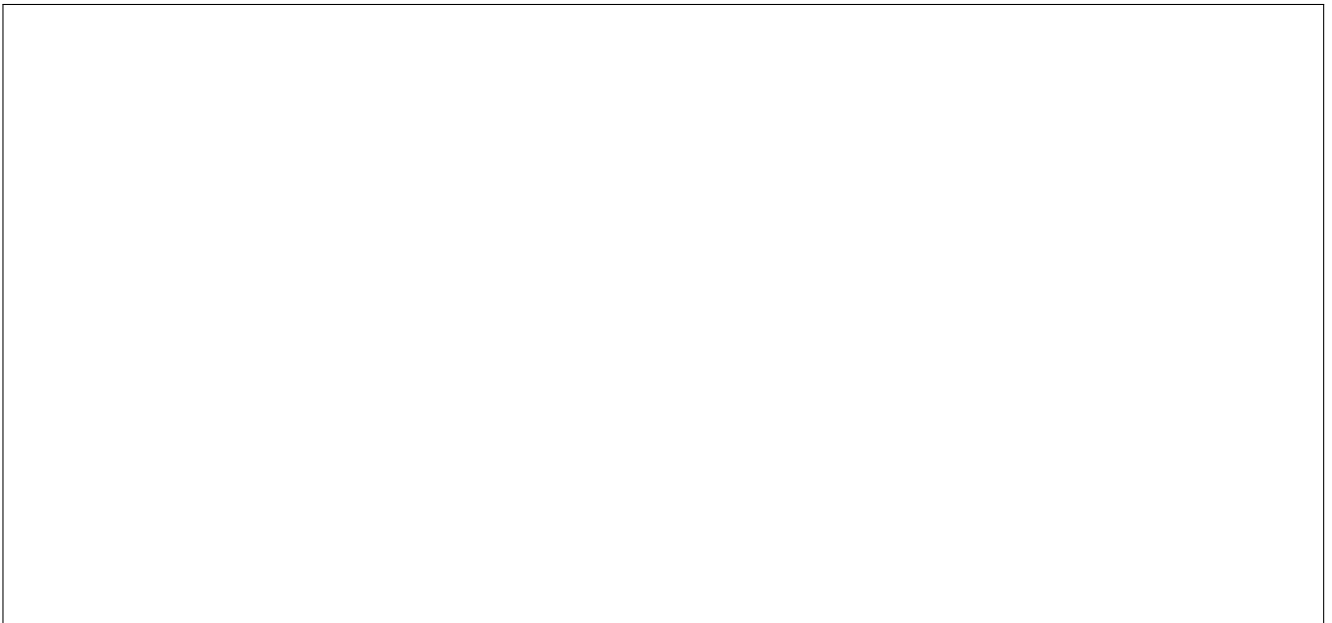
(a) (10 pts) A so-called agentic AI advisor service is used by the company to analyze the project. After running the analysis with the data you gave it, the AI shows its analysis as follows:

- For Model X, the cost per year is $\frac{-20,000 - 6,000 \times 3 + 5,000}{3} = \frac{-33,000}{3} = -11,000.00$ SAR
- For Model Y, the cost per year is $\frac{-32,000 - 4,000 \times 6 + 6,000}{6} = \frac{-50,000}{6} = -8,333.33$ SAR

The AI chooses Model Y. Do you agree with this? Why or why not?



(b) (10 pts) Make your own analysis and recommendation! Why is your analysis better than the AI's?



ISE 307: Engineering Economic Analysis (Formula Sheet)

This formula sheet is compiled with the help of GenAI. It has been reviewed and corrected by the instructor, but may still miss some course content or contain mistakes. If you find any issues, please report it so we can correct it for everyone's use. *Current version: v1.3, last updated: 2026-07-19.*

Linear Interest

$$F = P(1 + iN)$$

Single Payment

$$F = P(1 + i)^N = P(F/P, i, N)$$

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

$$N = \frac{\ln(F/P)}{\ln(1+i)}, \quad i = \left(\frac{F}{P}\right)^{1/N} - 1$$

$$N_{\text{double}} \approx 72/i (\%) \quad (\text{Rule of 72})$$

Equal-Payment (Uniform) Series

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

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

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

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

Linear Gradient Series

$$P = G \left[\frac{(1+i)^N - iN - 1}{i^2(1+i)^N} \right] = G(P/G, i, N)$$

$$A = G \left[\frac{(1+i)^N - iN - 1}{i[(1+i)^N - 1]} \right] = G(A/G, i, N)$$

Geometric Gradient Series

$$P = \begin{cases} A_1 \left[\frac{1 - (1+g)^N(1+i)^{-N}}{i - g} \right], & i \neq g \\ A_1 \left(\frac{N}{1+i} \right), & i = g \end{cases}$$

Useful Relationships

$$(P/F) = 1/(F/P) \quad \text{Reciprocals}$$

$$(A/F) = 1/(F/A)$$

$$(A/P) = 1/(P/A)$$

$$(A/P) = (A/F) + i \quad \text{Sinking/recovery}$$

$$(P/A) = (P/F) \cdot (F/A) \quad \text{Series link}$$

Nominal & Effective Rates

$$i = r/M$$

$$i_a = \left(1 + \frac{r}{M}\right)^M - 1$$

$$i = \left(1 + \frac{r}{M}\right)^C - 1$$

$$i_a = e^r - 1, \quad F = P e^{rN}$$

Inflation

$$i = i' + f + i'f$$

$$i' = \frac{1+i}{1+f} - 1 = \frac{i-f}{1+f}$$

$$A'_n = A_n(1+f)^{-n}$$

$$\bar{f} = \left[\prod_{k=1}^N (1+f_k) \right]^{1/N} - 1$$

Loans

$$B_t = A(P/A, i, N - t + 1)$$

$$I_t = B_t \times i \quad PP_t = A - I_t$$

Perpetuity (Capitalized Cost)

$$P = A/i$$

Worth & Equivalent-Cost Methods

$$PW(i) = \sum_{n=0}^N A_n(1+i)^{-n}$$

$$FW(i) = PW(i)(F/P, i, N)$$

$$AE(i) = PW(i)(A/P, i, N)$$

$$CE(i) = A/i$$

Capital Recovery with Return

$$CR(i) = (I - S)(A/P, i, N) + iS$$

$$AEC = CR + AE \text{ of operating costs}$$

Rate of Return (IRR)

Find i^* (the IRR) that satisfies:

$$PW(i^*) = \sum_{n=0}^N A_n(1+i^*)^{-n} = 0$$

Accept if $i^* \geq \text{MARR}$

Benefit-Cost & Profitability

$$BC(i) = \frac{B}{I+C'}, \quad PI(i) = \frac{B-C'}{I}$$

Depreciation

$$D_n = \frac{I-S}{N} \quad \text{Straight-line}$$

$$D_n = (I - S) \frac{U_n}{U_{\text{total}}} \quad \text{Units of prod.}$$

$$D_n = \alpha B_{n-1} = \alpha I(1 - \alpha)^{n-1} \quad \text{Declining bal.}$$

$$D_n = I \times r_n \quad \text{MACRS } (r_n \text{ table})$$

$$B_n = I - \sum_{k=1}^n D_k \quad \text{Book value}$$

Gains, Losses & Taxes

$$\text{gain} = S - B_n$$

$$\text{gains tax} = (S - B_n)t$$

$$\text{net salvage} = S - (S - B_n)t$$

$$TI = \text{Rev} - \text{Exp} - D_n$$

$$\text{income tax} = TI \times t$$

$$\text{ATCF} = (\text{Rev} - \text{Exp})(1 - t) + t D_n$$

Replacement Analysis

$$AEC(N) = CR(N) + AEC \text{ of O\&M}(N)$$

Break-Even & Sensitivity

$$Q^* = \frac{\text{Fixed cost}}{\text{Price} - \text{Variable cost}}$$

Standardized Normal (Risk)

$$z = \frac{x - \mu}{\sigma}, \quad \Phi(-z) = 1 - \Phi(z)$$

$i = 16\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.1600	0.8621	1.0000	1.0000	0.8621	1.1600	0.0000
2	1.3456	0.7432	2.1600	0.4630	1.6052	0.6230	0.7432
3	1.5609	0.6407	3.5056	0.2853	2.2459	0.4453	2.0245
4	1.8106	0.5523	5.0665	0.1974	2.7982	0.3574	3.6814
5	2.1003	0.4761	6.8771	0.1454	3.2743	0.3054	5.5858
6	2.4364	0.4104	8.9775	0.1114	3.6847	0.2714	7.6380
7	2.8262	0.3538	11.4139	0.0876	4.0386	0.2476	9.7610
8	3.2784	0.3050	14.2401	0.0702	4.3436	0.2302	11.8962
9	3.8030	0.2630	17.5185	0.0571	4.6065	0.2171	13.9998
10	4.4114	0.2267	21.3215	0.0469	4.8332	0.2069	16.0399
11	5.1173	0.1954	25.7329	0.0389	5.0286	0.1989	17.9941
12	5.9360	0.1685	30.8502	0.0324	5.1971	0.1924	19.8472
13	6.8858	0.1452	36.7862	0.0272	5.3423	0.1872	21.5899
14	7.9875	0.1252	43.6720	0.0229	5.4675	0.1829	23.2175
15	9.2655	0.1079	51.6595	0.0194	5.5755	0.1794	24.7284
16	10.7480	0.0930	60.9250	0.0164	5.6685	0.1764	26.1241
17	12.4677	0.0802	71.6730	0.0140	5.7487	0.1740	27.4074
18	14.4625	0.0691	84.1407	0.0119	5.8178	0.1719	28.5828
19	16.7765	0.0596	98.6032	0.0101	5.8775	0.1701	29.6557
20	19.4608	0.0514	115.3797	0.0087	5.9288	0.1687	30.6321
21	22.5745	0.0443	134.8405	0.0074	5.9731	0.1674	31.5180
22	26.1864	0.0382	157.4150	0.0064	6.0113	0.1664	32.3200
23	30.3762	0.0329	183.6014	0.0054	6.0442	0.1654	33.0442
24	35.2364	0.0284	213.9776	0.0047	6.0726	0.1647	33.6970
25	40.8742	0.0245	249.2140	0.0040	6.0971	0.1640	34.2841
26	47.4141	0.0211	290.0883	0.0034	6.1182	0.1634	34.8114
27	55.0004	0.0182	337.5024	0.0030	6.1364	0.1630	35.2841
28	63.8004	0.0157	392.5028	0.0025	6.1520	0.1625	35.7073
29	74.0085	0.0135	456.3032	0.0022	6.1656	0.1622	36.0856
30	85.8499	0.0116	530.3117	0.0019	6.1772	0.1619	36.4234
36	209.1643	0.0048	1301.0270	0.0008	6.2201	0.1608	37.8000
48	1241.6051	0.0008	7753.7818	0.0001	6.2450	0.1601	38.7894
60	7370.2014	0.0001	46058	0.0000	6.2492	0.1600	39.0063
72	43750	0.0000	273429	0.0000	6.2499	0.1600	39.0513
100	2791251	0.0000	17445314	0.0000	6.2500	0.1600	39.0623

 $i = 18\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.1800	0.8475	1.0000	1.0000	0.8475	1.1800	0.0000
2	1.3924	0.7182	2.1800	0.4587	1.5656	0.6387	0.7182
3	1.6430	0.6086	3.5724	0.2799	2.1743	0.4599	1.9354
4	1.9388	0.5158	5.2154	0.1917	2.6901	0.3717	3.4828
5	2.2878	0.4371	7.1542	0.1398	3.1272	0.3198	5.2312
6	2.6996	0.3704	9.4420	0.1059	3.4976	0.2859	7.0834
7	3.1855	0.3139	12.1415	0.0824	3.8115	0.2624	8.9670
8	3.7589	0.2660	15.3270	0.0652	4.0776	0.2452	10.8292
9	4.4355	0.2255	19.0859	0.0524	4.3030	0.2324	12.6329
10	5.2338	0.1911	23.5213	0.0425	4.4941	0.2225	14.3525
11	6.1759	0.1619	28.7551	0.0348	4.6560	0.2148	15.9716
12	7.2876	0.1372	34.9311	0.0286	4.7932	0.2086	17.4811
13	8.5994	0.1163	42.2187	0.0237	4.9095	0.2037	18.8765
14	10.1472	0.0985	50.8180	0.0197	5.0081	0.1997	20.1576
15	11.9737	0.0835	60.9653	0.0164	5.0916	0.1964	21.3269
16	14.1290	0.0708	72.9390	0.0137	5.1624	0.1937	22.3885
17	16.6722	0.0600	87.0680	0.0115	5.2223	0.1915	23.3482
18	19.6733	0.0508	103.7403	0.0096	5.2732	0.1896	24.2123
19	23.2144	0.0431	123.4135	0.0081	5.3162	0.1881	24.9877
20	27.3930	0.0365	146.6280	0.0068	5.3527	0.1868	25.6813
21	32.3238	0.0309	174.0210	0.0057	5.3837	0.1857	26.3000
22	38.1421	0.0262	206.3448	0.0048	5.4099	0.1848	26.8506
23	45.0076	0.0222	244.4868	0.0041	5.4321	0.1841	27.3394
24	53.1090	0.0188	289.4945	0.0035	5.4509	0.1835	27.7725
25	62.6686	0.0160	342.6035	0.0029	5.4669	0.1829	28.1555
26	73.9490	0.0135	405.2721	0.0025	5.4804	0.1825	28.4935
27	87.2598	0.0115	479.2211	0.0021	5.4919	0.1821	28.7915
28	102.9666	0.0097	566.4809	0.0018	5.5016	0.1818	29.0537
29	121.5005	0.0082	669.4475	0.0015	5.5098	0.1815	29.2842
30	143.3706	0.0070	790.9480	0.0013	5.5168	0.1813	29.4864
36	387.0368	0.0026	2144.6489	0.0005	5.5412	0.1805	30.2677
48	2820.5665	0.0004	15664	0.0001	5.5536	0.1801	30.7587
60	20555	0.0000	114190	0.0000	5.5553	0.1800	30.8465
72	149797	0.0000	832203	0.0000	5.5555	0.1800	30.8613
100	15424132	0.0000	85689616	0.0000	5.5556	0.1800	30.8642

 $i = 20\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.2000	0.8333	1.0000	1.0000	0.8333	1.2000	0.0000
2	1.4400	0.6944	2.2000	0.4545	1.5278	0.6545	0.6944
3	1.7280	0.5787	3.6400	0.2747	2.1065	0.4747	1.8519
4	2.0736	0.4823	5.3680	0.1863	2.5887	0.3863	3.2986
5	2.4883	0.4019	7.4416	0.1344	2.9906	0.3344	4.9061
6	2.9860	0.3349	9.9299	0.1007	3.3255	0.3007	6.5806
7	3.5832	0.2791	12.9159	0.0774	3.6046	0.2774	8.2551
8	4.2998	0.2326	16.4991	0.0606	3.8372	0.2606	9.8831
9	5.1598	0.1938	20.7989	0.0481	4.0310	0.2481	11.4335
10	6.1917	0.1615	25.9587	0.0385	4.1925	0.2385	12.8871
11	7.4301	0.1346	32.1504	0.0311	4.3271	0.2311	14.2330
12	8.9161	0.1122	39.5805	0.0253	4.4392	0.2253	15.4667
13	10.6993	0.0935	48.4966	0.0206	4.5327	0.2206	16.5883
14	12.8392	0.0779	59.1959	0.0169	4.6106	0.2169	17.6008
15	15.4070	0.0649	72.0351	0.0139	4.6755	0.2139	18.5095
16	18.4884	0.0541	87.4421	0.0114	4.7296	0.2114	19.3208
17	22.1861	0.0451	105.9306	0.0094	4.7746	0.2094	20.0419
18	26.6233	0.0376	128.1167	0.0078	4.8122	0.2078	20.6805
19	31.9480	0.0313	154.7400	0.0065	4.8435	0.2065	21.2439
20	38.3376	0.0261	186.6880	0.0054	4.8696	0.2054	21.7395
21	46.0051	0.0217	225.0256	0.0044	4.8913	0.2044	22.1742
22	55.2061	0.0181	271.0307	0.0037	4.9094	0.2037	22.5546
23	66.2474	0.0151	326.2369	0.0031	4.9245	0.2031	22.8867
24	79.4968	0.0126	392.4842	0.0025	4.9371	0.2025	23.1760
25	95.3962	0.0105	471.9811	0.0021	4.9476	0.2021	23.4276
26	114.4755	0.0087	567.3773	0.0018	4.9563	0.2018	23.6460
27	137.3706	0.0073	681.8528	0.0015	4.9636	0.2015	23.8353
28	164.8447	0.0061	819.2233	0.0012	4.9697	0.2012	23.9991
29	197.8136	0.0051	984.0680	0.0010	4.9747	0.2010	24.1406
30	237.3763	0.0042	1181.8816	0.0008	4.9789	0.2008	24.2628
36	708.8019	0.0014	3539.0094	0.0003	4.9929	0.2003	24.7108
48	6319.7487	0.0002	31594	0.0000	4.9992	0.2000	24.9581
60	56348	0.0000	281733	0.0000	4.9999	0.2000	24.9942
72	502400	0.0000	2511995	0.0000	5.0000	0.2000	24.9992
100	82817975	0.0000	414089868	0.0000	5.0000	0.2000	25.0000

 $i = 25\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.2500	0.8000	1.0000	1.0000	0.8000	1.2500	0.0000
2	1.5625	0.6400	2.2500	0.4444	1.4400	0.6944	0.6400
3	1.9531	0.5120	3.8125	0.2623	1.9520	0.5123	1.6640
4	2.4414	0.4096	5.7656	0.1734	2.3616	0.4234	2.8928
5	3.0518	0.3277	8.2070	0.1218	2.6893	0.3718	4.2035
6	3.8147	0.2621	11.2588	0.0888	2.9514	0.3388	5.5142
7	4.7684	0.2097	15.0735	0.0663	3.1611	0.3163	6.7725
8	5.9605	0.1678	19.8419	0.0504	3.3289	0.3004	7.9469
9	7.4506	0.1342	25.8023	0.0388	3.4631	0.2888	9.0207
10	9.3132	0.1074	33.2529	0.0301	3.5705	0.2801	9.9870
11	11.6415	0.0859	42.5661	0.0235	3.6564	0.2735	10.8460
12	14.5519	0.0687	54.2077	0.0184	3.7251	0.2684	11.6020
13	18.1899	0.0550	68.7596	0.0145	3.7801	0.2645	12.2617
14	22.7374	0.0440	86.9495	0.0115	3.8241	0.2615	12.8334
15	28.4217	0.0352	109.6868	0.0091	3.8593	0.2591	13.3260
16	35.5271	0.0281	138.1085	0.0072	3.8874	0.2572	13.7482
17	44.4089	0.0225	173.6357	0.0058	3.9099	0.2558	14.1085
18	55.5112	0.0180	218.0446	0.0046	3.9279	0.2546	14.4147
19	69.3889	0.0144	273.5558	0.0037	3.9424	0.2537	14.6741
20	86.7362	0.0115	342.9447	0.0029	3.9539	0.2529	14.8932
21	108.4202	0.0092	429.6809	0.0023	3.9631	0.2523	15.0777
22	135.5253	0.0074	538.1011	0.0019	3.9705	0.2519	15.2326
23	169.4066	0.0059	673.6264	0.0015	3.9764	0.2515	15.3625
24	211.7582	0.0047	843.0329	0.0012	3.9811	0.2512	15.4711
25	264.6978	0.0038	1054.7912	0.0009	3.9849	0.2509	15.5618
26	330.8722	0.0030	1319.4890	0.0008	3.9879	0.2508	15.6373
27	413.5903	0.0024	1650.3612	0.0006	3.9903	0.2506	15.7002
28	516.9879	0.0019	2063.9515	0.0005	3.9923	0.2505	15.7524
29	646.2349	0.0015	2580.9394	0.0004	3.9938	0.2504	15.7957
30	807.7936	0.0012	3227.1743	0.0003	3.9950	0.2503	15.8316
36	3081.4879	0.0003	12322	0.0001	3.9987	0.2501	15.9481
48	44842	0.0000	179362	0.0000	3.9999	0.2500	15.9954
60	652530	0.0000	2610118	0.0000	4.0000	0.2500	15.9996
72	9495568	0.0000	37982267	0.0000	4.0000	0.2500	16.0000
100	4909093465	0.0000	19636373857	0.0000	4.0000	0.2500	16.0000