

ISE 307: Engineering Economic Analysis (Term 253)

Major Exam 2 — Practice Set 3

Practice — untimed; try under exam conditions (90 min)

Name: _____ Student ID: _____

Section: _____ Date: _____

Problem 1 (30 pts)

A company is evaluating a single project. It requires **300,000 SAR** now (end of year 0) and returns a net cash inflow of **70,000 SAR** at the end of each year for **6 years**. At the end of year 6 the equipment is sold for **35,000 SAR** (salvage). The MARR is **10.0%**.

- (a) (8 pts) Compute the **net present worth** at the MARR and state accept or reject.

- (b) (6 pts) Compute the **annual equivalent** and the **future worth**. Is any of them negative?

- (c) (10 pts) The company wants their money back within 5 years, considering the time value of money. Is the project acceptable?

- (d) (6 pts) If the company requires a minimum return of 18%, is the project acceptable?

Problem 2 (25 pts)

A company buys a production machine for **145,000 SAR**. It can be sold for **35,000 SAR** after **6 years**. Operating cost is **20,000 SAR/yr** in years **1–2**, then **25,000 SAR/yr** in years **3–6**. The machine makes **7,000 units/yr**. MARR **10.0%**.

- (a) (7 pts) Compute the **capital recovery cost** $CR(10.0\%)$.

- (b) (10 pts) A supplier offers the same part for **8.50 SAR/unit**; should the company make in-house or buy from the supplier?

- (c) (8 pts) In the long run the machine is replaced identically *forever*, and a major overhaul of **35,000 SAR** is needed **every 10 years**. What is the total cost of the whole operation at present value?

Problem 3 (25 pts)

A workshop must keep one machine running for a required job (a **service** project, costs only). Two models with **different useful lives** are available. MARR **10.0%**.

	First cost	Operating cost/yr	Life (yr)	Salvage
X (short life)	−26,000	−6,000	4	+5,000
Y (long life)	−40,000	−4,500	6	+6,000

- (a) (15 pts) Which model is cheaper and what is its annual equivalent cost?

- (b) (10 pts) The CEO wants to know if the choice is still valid if we use the same duration for both models (shorter one can be replicated). What is the potential savings (in present worth) if the company choose the cheaper model vs the alternative?

Multiple-Choice Questions (20 pts)

1. (2.5 pts) The internal rate of return of a *simple* project is the interest rate at which the unrecovered project balance becomes exactly zero:
 - (A) at the end of year 1.
 - (B) at the end of the project's life.
 - (C) at the conventional payback year.
 - (D) at every year of the project.
2. (2.5 pts) A simple project's IRR is 14%. As the MARR rises from 10% to 14%, the accept/reject decision moves from:
 - (A) reject toward accept.
 - (B) reject, and stays reject throughout.
 - (C) accept toward reject, because PW turns negative at the IRR.
 - (D) accept toward indifferent, because PW falls to zero at the IRR.
3. (2.5 pts) For a simple project, $PW(10\%) = +3,200$ and $PW(15\%) = -1,800$. The interpolated IRR is closest to:

- (A) 13.2%
 - (B) 14.1%
 - (C) 12.5%
 - (D) 11.8%
4. (2.5 pts) Two mutually exclusive simple projects, both above $MARR = 12\%$: $IRR_A = 28\%$, $IRR_B = 19\%$, and B is the *larger* investment. The increment $B - A$ has $i^* = 16\%$. Choose:
- (A) A — the increment earns less than IRR_A .
 - (B) neither — the two IRRs disagree.
 - (C) A — it has the higher individual IRR.
 - (D) B — the extra capital earns $16\% > 12\%$ MARR.
5. (2.5 pts) Alternatives (5-yr lives, $MARR = 10\%$): A = $-25,000$, $+7,000/\text{yr}$; B = $-40,000$, $+10,800/\text{yr}$ (both acceptable alone). For $B - A$, $(P/A, 8\%, 5) = 3.9927$ and $(P/A, 9\%, 5) = 3.8897$. The incremental IRR and decision are:
- (A) about 3% (i.e. $13\% - 10\%$); keep A.
 - (B) about 13%; switch to B.
 - (C) about 8.4%; keep A (the extra 15,000 fails the 10% MARR).
 - (D) about 8.4%; switch to B.
6. (2.5 pts) In the champion–challenger tournament with a do-nothing option allowed, the very first duel (smallest alternative versus do-nothing) reduces to:
- (A) comparing the two most expensive alternatives.
 - (B) computing the LCM of all the lives.
 - (C) selecting the alternative with the highest revenue.
 - (D) checking that alternative's own IRR against the MARR.
7. (2.5 pts) Two service alternatives have 3-year and 5-year lives. Before forming the incremental cash flow you must first:
- (A) put both on a common horizon ($LCM = 15$ yr, or compare by AE) and then subtract.
 - (B) drop the salvage values from both.
 - (C) choose the 5-year alternative outright.
 - (D) subtract the raw yearly cash flows directly.
8. (2.5 pts) Applied correctly, the alternative selected by the incremental rate-of-return method:
- (A) is always the same as the one that maximizes present worth.
 - (B) may differ from the present-worth choice.
 - (C) is always the one with the lowest first cost.
 - (D) is always the one with the highest individual IRR.

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: v1.2, last updated: 2026-07-05.*

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:

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

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

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

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

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

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

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

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

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

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)

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

Interest Factor Tables

 $i = 1\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0100	0.9901	1.0000	1.0000	0.9901	1.0100	0.0000
2	1.0201	0.9803	2.0100	0.4975	1.9704	0.5075	0.9803
3	1.0303	0.9706	3.0301	0.3300	2.9410	0.3400	2.9215
4	1.0406	0.9610	4.0604	0.2463	3.9020	0.2563	5.8044
5	1.0510	0.9515	5.1010	0.1960	4.8534	0.2060	9.6103
6	1.0615	0.9420	6.1520	0.1625	5.7955	0.1725	14.3205
7	1.0721	0.9327	7.2135	0.1386	6.7282	0.1486	19.9168
8	1.0829	0.9235	8.2857	0.1207	7.6517	0.1307	26.3812
9	1.0937	0.9143	9.3685	0.1067	8.5660	0.1167	33.6959
10	1.1046	0.9053	10.4622	0.0956	9.4713	0.1056	41.8435
11	1.1157	0.8963	11.5668	0.0865	10.3676	0.0965	50.8067
12	1.1268	0.8874	12.6825	0.0788	11.2551	0.0888	60.5687
13	1.1381	0.8787	13.8093	0.0724	12.1337	0.0824	71.1126
14	1.1495	0.8700	14.9474	0.0669	13.0037	0.0769	82.4221
15	1.1610	0.8613	16.0969	0.0621	13.8651	0.0721	94.4810
16	1.1726	0.8528	17.2579	0.0579	14.7179	0.0679	107.2734
17	1.1843	0.8444	18.4304	0.0543	15.5623	0.0643	120.7834
18	1.1961	0.8360	19.6147	0.0510	16.3983	0.0610	134.9957
19	1.2081	0.8277	20.8109	0.0481	17.2260	0.0581	149.8950
20	1.2202	0.8195	22.0190	0.0454	18.0456	0.0554	165.4664
21	1.2324	0.8114	23.2392	0.0430	18.8570	0.0530	181.6950
22	1.2447	0.8034	24.4716	0.0409	19.6604	0.0509	198.5603
23	1.2572	0.7954	25.7163	0.0389	20.4558	0.0489	216.0660
24	1.2697	0.7876	26.9735	0.0371	21.2434	0.0471	234.1800
25	1.2824	0.7798	28.2432	0.0354	22.0232	0.0454	252.8945
26	1.2953	0.7720	29.5256	0.0339	22.7952	0.0439	272.1957
27	1.3082	0.7644	30.8209	0.0324	23.5596	0.0424	292.0702
28	1.3213	0.7568	32.1291	0.0311	24.3164	0.0411	312.5047
29	1.3345	0.7493	33.4504	0.0299	25.0658	0.0399	333.4863
30	1.3478	0.7419	34.7849	0.0287	25.8077	0.0387	355.0021
36	1.4308	0.6989	43.0769	0.0232	30.1075	0.0332	494.6207
48	1.6122	0.6203	61.2226	0.0163	37.9740	0.0263	820.1460
60	1.8167	0.5504	81.6697	0.0122	44.9550	0.0222	1192.8061
72	2.0471	0.4885	104.7099	0.0096	51.1504	0.0196	1597.8673
100	2.7048	0.3697	170.4814	0.0059	63.0289	0.0159	2605.7758

 $i = 2\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0200	0.9804	1.0000	1.0000	0.9804	1.0200	0.0000
2	1.0404	0.9612	2.0200	0.4950	1.9416	0.5150	0.9612
3	1.0612	0.9423	3.0604	0.3268	2.8839	0.3468	2.8458
4	1.0824	0.9238	4.1216	0.2426	3.8077	0.2626	5.6173
5	1.1041	0.9057	5.2040	0.1922	4.7135	0.2122	9.2403
6	1.1262	0.8880	6.3081	0.1585	5.6014	0.1785	13.6801
7	1.1487	0.8706	7.4343	0.1345	6.4720	0.1545	18.9035
8	1.1717	0.8535	8.5830	0.1165	7.3255	0.1365	24.8779
9	1.1951	0.8368	9.7546	0.1025	8.1622	0.1225	31.5720
10	1.2190	0.8203	10.9497	0.0913	8.9826	0.1113	38.9551
11	1.2434	0.8043	12.1687	0.0822	9.7868	0.1022	46.9977
12	1.2682	0.7885	13.4121	0.0746	10.5753	0.0946	55.6712
13	1.2936	0.7730	14.6803	0.0681	11.3484	0.0881	64.9475
14	1.3195	0.7579	15.9739	0.0626	12.1062	0.0826	74.7999
15	1.3459	0.7430	17.2934	0.0578	12.8493	0.0778	85.2021
16	1.3728	0.7284	18.6393	0.0537	13.5777	0.0737	96.1288
17	1.4002	0.7142	20.0121	0.0500	14.2919	0.0700	107.5554
18	1.4282	0.7002	21.4123	0.0467	14.9920	0.0667	119.4581
19	1.4568	0.6864	22.8406	0.0438	15.6785	0.0638	131.8139
20	1.4859	0.6730	24.2974	0.0412	16.3514	0.0612	144.6003
21	1.5157	0.6598	25.7833	0.0388	17.0112	0.0588	157.7959
22	1.5460	0.6468	27.2990	0.0366	17.6580	0.0566	171.3795
23	1.5769	0.6342	28.8450	0.0347	18.2922	0.0547	185.3309
24	1.6084	0.6217	30.4219	0.0329	18.9139	0.0529	199.6305
25	1.6406	0.6095	32.0303	0.0312	19.5235	0.0512	214.2592
26	1.6734	0.5976	33.6709	0.0297	20.1210	0.0497	229.1987
27	1.7069	0.5859	35.3443	0.0283	20.7069	0.0483	244.4311
28	1.7410	0.5744	37.0512	0.0270	21.2813	0.0470	259.9392
29	1.7758	0.5631	38.7922	0.0258	21.8444	0.0458	275.7064
30	1.8114	0.5521	40.5681	0.0246	22.3965	0.0446	291.7164
36	2.0399	0.4902	51.9944	0.0192	25.4888	0.0392	392.0405
48	2.5871	0.3865	79.3535	0.0126	30.6731	0.0326	605.9657
60	3.2810	0.3048	114.0515	0.0088	34.7609	0.0288	823.6975
72	4.1611	0.2403	158.0570	0.0063	37.9841	0.0263	1034.0557
100	7.2446	0.1380	312.2323	0.0032	43.0984	0.0232	1464.7527

 $i = 3\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0300	0.9709	1.0000	1.0000	0.9709	1.0300	0.0000
2	1.0609	0.9426	2.0300	0.4926	1.9135	0.5226	0.9426
3	1.0927	0.9151	3.0909	0.3235	2.8286	0.3535	2.7729
4	1.1255	0.8885	4.1836	0.2390	3.7171	0.2690	5.4383
5	1.1593	0.8626	5.3091	0.1884	4.5797	0.2184	8.8888
6	1.1941	0.8375	6.4684	0.1546	5.4172	0.1846	13.0762
7	1.2299	0.8131	7.6625	0.1305	6.2303	0.1605	17.9547
8	1.2668	0.7894	8.8923	0.1125	7.0197	0.1425	23.4806
9	1.3048	0.7664	10.1591	0.0984	7.7861	0.1284	29.6119
10	1.3439	0.7441	11.4639	0.0872	8.5302	0.1172	36.3088
11	1.3842	0.7224	12.8078	0.0781	9.2526	0.1081	43.5330
12	1.4258	0.7014	14.1920	0.0705	9.9540	0.1005	51.2482
13	1.4685	0.6810	15.6178	0.0640	10.6350	0.0940	59.4196
14	1.5126	0.6611	17.0863	0.0585	11.2961	0.0885	68.0141
15	1.5580	0.6419	18.5989	0.0538	11.9379	0.0838	77.0002
16	1.6047	0.6232	20.1569	0.0496	12.5611	0.0796	86.3477
17	1.6528	0.6050	21.7616	0.0460	13.1661	0.0760	96.0280
18	1.7024	0.5874	23.4144	0.0427	13.7535	0.0727	106.0137
19	1.7535	0.5703	25.1169	0.0398	14.3238	0.0698	116.2788
20	1.8061	0.5537	26.8704	0.0372	14.8775	0.0672	126.7987
21	1.8603	0.5375	28.6765	0.0349	15.4150	0.0649	137.5496
22	1.9161	0.5219	30.5368	0.0327	15.9369	0.0627	148.5094
23	1.9736	0.5067	32.4529	0.0308	16.4436	0.0608	159.6566
24	2.0328	0.4919	34.4265	0.0290	16.9355	0.0590	170.9711
25	2.0938	0.4776	36.4593	0.0274	17.4131	0.0574	182.4336
26	2.1566	0.4637	38.5530	0.0259	17.8768	0.0559	194.0260
27	2.2213	0.4502	40.7096	0.0246	18.3270	0.0546	205.7309
28	2.2879	0.4371	42.9309	0.0233	18.7641	0.0533	217.5320
29	2.3566	0.4243	45.2189	0.0221	19.1885	0.0521	229.4137
30	2.4273	0.4120	47.5754	0.0210	19.6004	0.0510	241.3613
36	2.8983	0.3450	63.2759	0.0158	21.8323	0.0458	313.7028
48	4.1323	0.2420	104.4084	0.0096	25.2667	0.0396	455.0255
60	5.8916	0.1697	163.0534	0.0061	27.6756	0.0361	583.0526
72	8.4000	0.1190	246.6672	0.0041	29.3651	0.0341	693.1226
100	19.2186	0.0520	607.2877	0.0016	31.5989	0.0316	879.8540

 $i = 4\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0400	0.9615	1.0000	1.0000	0.9615	1.0400	0.0000
2	1.0816	0.9246	2.0400	0.4902	1.8861	0.5302	0.9246
3	1.1249	0.8890	3.1216	0.3203	2.7751	0.3603	2.7025
4	1.1699	0.8548	4.2465	0.2355	3.6299	0.2755	5.2670
5	1.2167	0.8219	5.4163	0.1846	4.4518	0.2246	8.5547
6	1.2653	0.7903	6.6330	0.1508	5.2421	0.1908	12.5062
7	1.3159	0.7599	7.8983	0.1266	6.0021	0.1666	17.0657
8	1.3686	0.7307	9.2142	0.1085	6.7327	0.1485	22.1806
9	1.4233	0.7026	10.5828	0.0945	7.4353	0.1345	27.8013
10	1.4802	0.6756	12.0061	0.0833	8.1109	0.1233	33.8814
11	1.5395	0.6496	13.4864	0.0741	8.7605	0.1141	40.3772
12	1.6010	0.6246	15.0258	0.0666	9.3851	0.1066	47.2477
13	1.6651	0.6006	16.6268	0.0601	9.9856	0.1001	54.4546
14	1.7317	0.5775	18.2919	0.0547	10.5631	0.0947	61.9618
15	1.8009	0.5553	20.0236	0.0499	11.1184	0.0899	69.7355
16	1.8730	0.5339	21.8245	0.0458	11.6523	0.0858	77.7441
17	1.9479	0.5134	23.6975	0.0422	12.1657	0.0822	85.9581
18	2.0258	0.4936	25.6454	0.0390	12.6593	0.0790	94.3498
19	2.1068	0.4746	27.6712	0.0361	13.1339	0.0761	102.8933
20	2.1911	0.4564	29.7781	0.0336	13.5903	0.0736	111.5647
21	2.2788	0.4388	31.9692	0.0313	14.0292	0.0713	120.3414
22	2.3699	0.4220	34.2480	0.0292	14.4511	0.0692	129.2024
23	2.4647	0.4057	36.6179	0.0273	14.8568	0.0673	138.1284
24	2.5633	0.3901	39.0826	0.0256	15.2470	0.0656	147.1012
25	2.6658	0.3751	41.6459	0.0240	15.6221	0.0640	156.1040
26	2.7725	0.3607	44.3117	0.0226	15.9828	0.0626	165.1212
27	2.8834	0.3468	47.0842	0.0212	16.3296	0.0612	174.1385
28	2.9987	0.3335	49.9676	0.0200	16.6631	0.0600	183.1424
29	3.1187	0.3207	52.9663	0.0189	16.9837	0.0589	192.1206
30	3.2434	0.3083	56.0849	0.0178	17.2920	0.0578	201.0618
36	4.1039	0.2437	77.5983	0.0129	18.9083	0.0529	253.4052
48	6.5705	0.1522	139.2632	0.0072	21.1951	0.0472	347.2446
60	10.5196	0.0951	237.9907	0.0042	22.6235	0.0442	422.9966
72	16.8423	0.0594	396.0566	0.0025	23.5156	0.0425	481.0170
100	50.5049	0.0198	1237.6237	0.0008	24.5050	0.0408	563.1249

$i = 5\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0500	0.9524	1.0000	1.0000	0.9524	1.0500	0.0000
2	1.1025	0.9070	2.0500	0.4878	1.8594	0.5378	0.9070
3	1.1576	0.8638	3.1525	0.3172	2.7232	0.3672	2.6347
4	1.2155	0.8227	4.3101	0.2320	3.5460	0.2820	5.1028
5	1.2763	0.7835	5.5256	0.1810	4.3295	0.2310	8.2369
6	1.3401	0.7462	6.8019	0.1470	5.0757	0.1970	11.9680
7	1.4071	0.7107	8.1420	0.1228	5.7864	0.1728	16.2321
8	1.4775	0.6768	9.5491	0.1047	6.4632	0.1547	20.9700
9	1.5513	0.6446	11.0266	0.0907	7.1078	0.1407	26.1268
10	1.6289	0.6139	12.5779	0.0795	7.7217	0.1295	31.6520
11	1.7103	0.5847	14.2068	0.0704	8.3064	0.1204	37.4988
12	1.7959	0.5568	15.9171	0.0628	8.8633	0.1128	43.6241
13	1.8856	0.5303	17.7130	0.0565	9.3936	0.1065	49.9879
14	1.9799	0.5051	19.5986	0.0510	9.8986	0.1010	56.5538
15	2.0789	0.4810	21.5786	0.0463	10.3797	0.0963	63.2880
16	2.1829	0.4581	23.6575	0.0423	10.8378	0.0923	70.1597
17	2.2920	0.4363	25.8404	0.0387	11.2741	0.0887	77.1405
18	2.4066	0.4155	28.1324	0.0355	11.6896	0.0855	84.2043
19	2.5270	0.3957	30.5390	0.0327	12.0853	0.0827	91.3275
20	2.6533	0.3769	33.0660	0.0302	12.4622	0.0802	98.4884
21	2.7860	0.3589	35.7193	0.0280	12.8212	0.0780	105.6673
22	2.9253	0.3418	38.5052	0.0260	13.1630	0.0760	112.8461
23	3.0715	0.3256	41.4305	0.0241	13.4886	0.0741	120.0087
24	3.2251	0.3101	44.5020	0.0225	13.7986	0.0725	127.1402
25	3.3864	0.2953	47.7271	0.0210	14.0939	0.0710	134.2275
26	3.5557	0.2812	51.1135	0.0196	14.3752	0.0696	141.2585
27	3.7335	0.2678	54.6691	0.0183	14.6430	0.0683	148.2226
28	3.9201	0.2551	58.4026	0.0171	14.8981	0.0671	155.1101
29	4.1161	0.2429	62.3227	0.0160	15.1411	0.0660	161.9126
30	4.3219	0.2314	66.4388	0.0151	15.3725	0.0651	168.6226
36	5.7918	0.1727	95.8363	0.0104	16.5469	0.0604	206.6237
48	10.4013	0.0961	188.0254	0.0053	18.0772	0.0553	269.2467
60	18.6792	0.0535	353.5837	0.0028	18.9293	0.0528	314.3432
72	33.5451	0.0298	650.9027	0.0015	19.4038	0.0515	345.1485
100	131.5013	0.0076	2610.0252	0.0004	19.8479	0.0504	381.7492

 $i = 7\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0700	0.9346	1.0000	1.0000	0.9346	1.0700	0.0000
2	1.1449	0.8734	2.0700	0.4831	1.8080	0.5531	0.8734
3	1.2250	0.8163	3.2149	0.3111	2.6243	0.3811	2.5060
4	1.3108	0.7629	4.4399	0.2252	3.3872	0.2952	4.7947
5	1.4026	0.7130	5.7507	0.1739	4.1002	0.2439	7.6467
6	1.5007	0.6663	7.1533	0.1398	4.7665	0.2098	10.9784
7	1.6058	0.6227	8.6540	0.1156	5.3893	0.1856	14.7149
8	1.7182	0.5820	10.2598	0.0975	5.9713	0.1675	18.7889
9	1.8385	0.5439	11.9780	0.0835	6.5152	0.1535	23.1404
10	1.9672	0.5083	13.8164	0.0724	7.0236	0.1424	27.7156
11	2.1049	0.4751	15.7836	0.0634	7.4987	0.1334	32.4665
12	2.2522	0.4440	17.8885	0.0559	7.9427	0.1259	37.3506
13	2.4098	0.4150	20.1406	0.0497	8.3577	0.1197	42.3302
14	2.5785	0.3878	22.5505	0.0443	8.7455	0.1143	47.3718
15	2.7590	0.3624	25.1290	0.0398	9.1079	0.1098	52.4461
16	2.9522	0.3387	27.8881	0.0359	9.4466	0.1059	57.5271
17	3.1588	0.3166	30.8402	0.0324	9.7632	0.1024	62.5923
18	3.3799	0.2959	33.9990	0.0294	10.0591	0.0994	67.6219
19	3.6165	0.2765	37.3790	0.0268	10.3356	0.0968	72.5991
20	3.8697	0.2584	40.9955	0.0244	10.5940	0.0944	77.5091
21	4.1406	0.2415	44.8652	0.0223	10.8355	0.0923	82.3393
22	4.4304	0.2257	49.0057	0.0204	11.0612	0.0904	87.0793
23	4.7405	0.2109	53.4361	0.0187	11.2722	0.0887	91.7201
24	5.0724	0.1971	58.1767	0.0172	11.4693	0.0872	96.2545
25	5.4274	0.1842	63.2490	0.0158	11.6536	0.0858	100.6765
26	5.8074	0.1722	68.6765	0.0146	11.8258	0.0846	104.9814
27	6.2139	0.1609	74.4838	0.0134	11.9867	0.0834	109.1656
28	6.6488	0.1504	80.6977	0.0124	12.1371	0.0824	113.2264
29	7.1143	0.1406	87.3465	0.0114	12.2777	0.0814	117.1622
30	7.6123	0.1314	94.4608	0.0106	12.4090	0.0806	120.9718
36	11.4239	0.0875	148.9135	0.0067	13.0352	0.0767	141.1990
48	25.7289	0.0389	353.2701	0.0028	13.7305	0.0728	169.4981
60	57.9464	0.0173	813.5204	0.0012	14.0392	0.0712	185.7677
72	130.5065	0.0077	1850.0922	0.0005	14.1763	0.0705	194.6365
100	867.7163	0.0012	12382	0.0001	14.2693	0.0701	202.2001

 $i = 6\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0600	0.9434	1.0000	1.0000	0.9434	1.0600	0.0000
2	1.1236	0.8900	2.0600	0.4854	1.8334	0.5454	0.8900
3	1.1910	0.8396	3.1836	0.3141	2.6730	0.3741	2.5692
4	1.2625	0.7921	4.3746	0.2286	3.4651	0.2886	4.9455
5	1.3382	0.7473	5.6371	0.1774	4.2124	0.2374	7.9345
6	1.4185	0.7050	6.9753	0.1434	4.9173	0.2034	11.4594
7	1.5036	0.6651	8.3938	0.1191	5.5824	0.1791	15.4497
8	1.5938	0.6274	9.8975	0.1010	6.2098	0.1610	19.8416
9	1.6895	0.5919	11.4913	0.0870	6.8017	0.1470	24.5768
10	1.7908	0.5584	13.1808	0.0759	7.3601	0.1359	29.6023
11	1.8983	0.5268	14.9716	0.0668	7.8869	0.1268	34.8702
12	2.0122	0.4970	16.8699	0.0593	8.3838	0.1193	40.3369
13	2.1329	0.4688	18.8821	0.0530	8.8527	0.1130	45.9629
14	2.2609	0.4423	21.0151	0.0476	9.2950	0.1076	51.7128
15	2.3966	0.4173	23.2760	0.0430	9.7122	0.1030	57.5546
16	2.5404	0.3936	25.6725	0.0390	10.1059	0.0990	63.4592
17	2.6928	0.3714	28.2129	0.0354	10.4773	0.0954	69.4011
18	2.8543	0.3503	30.9057	0.0324	10.8276	0.0924	75.3569
19	3.0256	0.3305	33.7600	0.0296	11.1581	0.0896	81.3062
20	3.2071	0.3118	36.7856	0.0272	11.4699	0.0872	87.2304
21	3.3996	0.2942	39.9927	0.0250	11.7641	0.0850	93.1136
22	3.6035	0.2775	43.3923	0.0230	12.0416	0.0830	98.9412
23	3.8197	0.2618	46.9958	0.0213	12.3034	0.0813	104.7007
24	4.0489	0.2470	50.8156	0.0197	12.5504	0.0797	110.3812
25	4.2919	0.2330	54.8645	0.0182	12.7834	0.0782	115.9732
26	4.5494	0.2198	59.1564	0.0169	13.0032	0.0769	121.4684
27	4.8223	0.2074	63.7058	0.0157	13.2105	0.0757	126.8600
28	5.1117	0.1956	68.5281	0.0146	13.4062	0.0746	132.1420
29	5.4184	0.1846	73.6398	0.0136	13.5907	0.0736	137.3096
30	5.7435	0.1741	79.0582	0.0126	13.7648	0.0726	142.3588
36	8.1473	0.1227	119.1209	0.0084	14.6210	0.0684	170.0387
48	16.3939	0.0610	256.5645	0.0039	15.6500	0.0639	212.0351
60	32.9877	0.0303	533.1282	0.0019	16.1614	0.0619	239.0428
72	66.3777	0.0151	1089.6286	0.0009	16.4156	0.0609	255.5146
100	339.3021	0.0029	5638.3681	0.0002	16.6175	0.0602	272.0471

 $i = 8\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0800	0.9259	1.0000	1.0000	0.9259	1.0800	0.0000
2	1.1664	0.8573	2.0800	0.4808	1.7833	0.5608	0.8573
3	1.2597	0.7938	3.2464	0.3080	2.5771	0.3880	2.4450
4	1.3605	0.7350	4.5061	0.2219	3.3121	0.3019	4.6501
5	1.4693	0.6806	5.8666	0.1705	3.9927	0.2505	7.3724
6	1.5869	0.6302	7.3359	0.1363	4.6229	0.2163	10.5233
7	1.7138	0.5835	8.9228	0.1121	5.2064	0.1921	14.0242
8	1.8509	0.5403	10.6366	0.0940	5.7466	0.1740	17.8061
9	1.9990	0.5002	12.4876	0.0801	6.2469	0.1601	21.8081
10	2.1589	0.4632	14.4866	0.0690	6.7101	0.1490	25.9768
11	2.3316	0.4289	16.6455	0.0601	7.1390	0.1401	30.2657
12	2.5182	0.3971	18.9771	0.0527	7.5361	0.1327	34.6339
13	2.7196	0.3677	21.4953	0.0465	7.9038	0.1265	39.0463
14	2.9372	0.3405	24.2149	0.0413	8.2442	0.1213	43.4723
15	3.1722	0.3152	27.1521	0.0368	8.5595	0.1168	47.8857
16	3.4259	0.2919	30.3243	0.0330	8.8514	0.1130	52.2640
17	3.7000	0.2703	33.7502	0.0296	9.1216	0.1096	56.5883
18	3.9960	0.2502	37.4502	0.0267	9.3719	0.1067	60.8426
19	4.3157	0.2317	41.4463	0.0241	9.6036	0.1041	65.0134
20	4.6610	0.2145	45.7620	0.0219	9.8181	0.1019	69.0898
21	5.0338	0.1987	50.4229	0.0198	10.0168	0.0998	73.0629
22	5.4365	0.1839	55.4568	0.0180	10.2007	0.0980	76.9257
23	5.8715	0.1703	60.8933	0.0164	10.3711	0.0964	80.6726
24	6.3412	0.1577	66.7648	0.0150	10.5288	0.0950	84.2997
25	6.8485	0.1460	73.1059	0.0137	10.6748	0.0937	87.8041
26	7.3964	0.1352	79.9544	0.0125	10.8100	0.0925	91.1842
27	7.9881	0.1252	87.3508	0.0114	10.9352	0.0914	94.4390
28	8.6271	0.1159	95.3388	0.0105	11.0511	0.0905	97.5687
29	9.3173	0.1073	103.9659	0.0096	11.1584	0.0896	100.5738
30	10.0627	0.0994	113.2832	0.0088	11.2578	0.0888	103.4558
36	15.9682	0.0626	187.1021	0.0053	11.7172	0.0853	118.2839
48	40.2106	0.0249	490.1322	0.0020	12.1891	0.0820	137.4428
60	101.2571	0.0099	1253.2133	0.0008	12.3766	0.0808	147.3000
72	254.9825	0.0039	3174.7814	0.0003	12.4510	0.0803	152.1076
100	2199.7613	0.0005	27485	0.0000	12.4943	0.0800	155.6107

$i = 9\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.0900	0.9174	1.0000	1.0000	0.9174	1.0900	0.0000
2	1.1881	0.8417	2.0900	0.4785	1.7591	0.5685	0.8417
3	1.2950	0.7722	3.2781	0.3051	2.5313	0.3951	2.3860
4	1.4116	0.7084	4.5731	0.2187	3.2397	0.3087	4.5113
5	1.5386	0.6499	5.9847	0.1671	3.8897	0.2571	7.1110
6	1.6771	0.5963	7.5233	0.1329	4.4859	0.2229	10.0924
7	1.8280	0.5470	9.2004	0.1087	5.0330	0.1987	13.3746
8	1.9926	0.5019	11.0285	0.0907	5.5348	0.1807	16.8877
9	2.1719	0.4604	13.0210	0.0768	5.9952	0.1668	20.5711
10	2.3674	0.4224	15.1929	0.0658	6.4177	0.1558	24.3728
11	2.5804	0.3875	17.5603	0.0569	6.8052	0.1469	28.2481
12	2.8127	0.3555	20.1407	0.0497	7.1607	0.1397	32.1590
13	3.0658	0.3262	22.9534	0.0436	7.4869	0.1336	36.0731
14	3.3417	0.2992	26.0192	0.0384	7.7862	0.1284	39.9633
15	3.6425	0.2745	29.3609	0.0341	8.0607	0.1241	43.8069
16	3.9703	0.2519	33.0034	0.0303	8.3126	0.1203	47.5849
17	4.3276	0.2311	36.9737	0.0270	8.5436	0.1170	51.2821
18	4.7171	0.2120	41.3013	0.0242	8.7556	0.1142	54.8860
19	5.1417	0.1945	46.0185	0.0217	8.9501	0.1117	58.3868
20	5.6044	0.1784	51.1601	0.0195	9.1285	0.1095	61.7770
21	6.1088	0.1637	56.7645	0.0176	9.2922	0.1076	65.0509
22	6.6586	0.1502	62.8733	0.0159	9.4424	0.1059	68.2048
23	7.2579	0.1378	69.5319	0.0144	9.5802	0.1044	71.2359
24	7.9111	0.1264	76.7898	0.0130	9.7066	0.1030	74.1433
25	8.6231	0.1160	84.7009	0.0118	9.8226	0.1018	76.9265
26	9.3992	0.1064	93.3240	0.0107	9.9290	0.1007	79.5863
27	10.2451	0.0976	102.7231	0.0097	10.0266	0.0997	82.1241
28	11.1671	0.0895	112.9682	0.0089	10.1161	0.0989	84.5419
29	12.1722	0.0822	124.1354	0.0081	10.1983	0.0981	86.8422
30	13.2677	0.0754	136.3075	0.0073	10.2737	0.0973	89.0280
36	22.2512	0.0449	236.1247	0.0042	10.6118	0.0942	99.9319
48	62.5852	0.0160	684.2804	0.0015	10.9336	0.0915	112.9625
60	176.0313	0.0057	1944.7921	0.0005	11.0480	0.0905	118.9683
72	495.1170	0.0020	5490.1891	0.0002	11.0887	0.0902	121.5917
100	5529.0408	0.0002	61423	0.0000	11.1091	0.0900	123.2335

 $i = 12\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.1200	0.8929	1.0000	1.0000	0.8929	1.1200	0.0000
2	1.2544	0.7972	2.1200	0.4717	1.6901	0.5917	0.7972
3	1.4049	0.7118	3.3744	0.2963	2.4018	0.4163	2.2208
4	1.5735	0.6355	4.7793	0.2092	3.0373	0.3292	4.1273
5	1.7623	0.5674	6.3528	0.1574	3.6048	0.2774	6.3970
6	1.9738	0.5066	8.1152	0.1232	4.1114	0.2432	8.9302
7	2.2107	0.4523	10.0890	0.0991	4.5638	0.2191	11.6443
8	2.4760	0.4039	12.2997	0.0813	4.9676	0.2013	14.4714
9	2.7731	0.3606	14.7757	0.0677	5.3282	0.1877	17.3563
10	3.1058	0.3220	17.5487	0.0570	5.6502	0.1770	20.2541
11	3.4785	0.2875	20.6546	0.0484	5.9377	0.1684	23.1288
12	3.8960	0.2567	24.1331	0.0414	6.1944	0.1614	25.9523
13	4.3635	0.2292	28.0291	0.0357	6.4235	0.1557	28.7024
14	4.8871	0.2046	32.3926	0.0309	6.6282	0.1509	31.3624
15	5.4736	0.1827	37.2797	0.0268	6.8109	0.1468	33.9202
16	6.1304	0.1631	42.7533	0.0234	6.9740	0.1434	36.3670
17	6.8660	0.1456	48.8837	0.0205	7.1196	0.1405	38.6973
18	7.6900	0.1300	55.7497	0.0179	7.2497	0.1379	40.9080
19	8.6128	0.1161	63.4397	0.0158	7.3658	0.1358	42.9979
20	9.6463	0.1037	72.0524	0.0139	7.4694	0.1339	44.9676
21	10.8038	0.0926	81.6987	0.0122	7.5620	0.1322	46.8188
22	12.1003	0.0826	92.5026	0.0108	7.6446	0.1308	48.5543
23	13.5523	0.0738	104.6029	0.0096	7.7184	0.1296	50.1776
24	15.1786	0.0659	118.1552	0.0085	7.7843	0.1285	51.6929
25	17.0001	0.0588	133.3339	0.0075	7.8431	0.1275	53.1046
26	19.0401	0.0525	150.3339	0.0067	7.8957	0.1267	54.4177
27	21.3249	0.0469	169.3740	0.0059	7.9426	0.1259	55.6369
28	23.8839	0.0419	190.6989	0.0052	7.9844	0.1252	56.7674
29	26.7499	0.0374	214.5828	0.0047	8.0218	0.1247	57.8141
30	29.9599	0.0334	241.3327	0.0041	8.0552	0.1241	58.7821
36	59.1356	0.0169	484.4631	0.0021	8.1924	0.1221	63.1970
48	230.3908	0.0043	1911.5898	0.0005	8.2972	0.1205	67.4068
60	897.5969	0.0011	7471.6411	0.0001	8.3240	0.1201	68.8100
72	3497.0161	0.0003	29133	0.0000	8.3310	0.1200	69.2530
100	83522	0.0000	696011	0.0000	8.3332	0.1200	69.4336

 $i = 10\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.1000	0.9091	1.0000	1.0000	0.9091	1.1000	0.0000
2	1.2100	0.8264	2.1000	0.4762	1.7355	0.5762	0.8264
3	1.3310	0.7513	3.3100	0.3021	2.4869	0.4021	2.3291
4	1.4641	0.6830	4.6410	0.2155	3.1699	0.3155	4.3781
5	1.6105	0.6209	6.1051	0.1638	3.7908	0.2638	6.8618
6	1.7716	0.5645	7.7156	0.1296	4.3553	0.2296	9.6842
7	1.9487	0.5132	9.4872	0.1054	4.8684	0.2054	12.7631
8	2.1436	0.4665	11.4359	0.0874	5.3349	0.1874	16.0287
9	2.3579	0.4241	13.5795	0.0736	5.7590	0.1736	19.4215
10	2.5937	0.3855	15.9374	0.0627	6.1446	0.1627	22.8913
11	2.8531	0.3505	18.5312	0.0540	6.4951	0.1540	26.3963
12	3.1384	0.3186	21.3843	0.0468	6.8137	0.1468	29.9012
13	3.4523	0.2897	24.5227	0.0408	7.1034	0.1408	33.3772
14	3.7975	0.2633	27.9750	0.0357	7.3667	0.1357	36.8005
15	4.1772	0.2394	31.7725	0.0315	7.6061	0.1315	40.1520
16	4.5950	0.2176	35.9497	0.0278	7.8237	0.1278	43.4164
17	5.0545	0.1978	40.5447	0.0247	8.0216	0.1247	46.5819
18	5.5599	0.1799	45.5992	0.0219	8.2014	0.1219	49.6395
19	6.1159	0.1635	51.1591	0.0195	8.3649	0.1195	52.5827
20	6.7275	0.1486	57.2750	0.0175	8.5136	0.1175	55.4069
21	7.4002	0.1351	64.0025	0.0156	8.6487	0.1156	58.1095
22	8.1403	0.1228	71.4027	0.0140	8.7715	0.1140	60.6893
23	8.9543	0.1117	79.5430	0.0126	8.8832	0.1126	63.1462
24	9.8497	0.1015	88.4973	0.0113	8.9847	0.1113	65.4813
25	10.8347	0.0923	98.3471	0.0102	9.0770	0.1102	67.6964
26	11.9182	0.0839	109.1818	0.0092	9.1609	0.1092	69.7940
27	13.1100	0.0763	121.0999	0.0083	9.2372	0.1083	71.7773
28	14.4210	0.0693	134.2099	0.0075	9.3066	0.1075	73.6495
29	15.8631	0.0630	148.6309	0.0067	9.3696	0.1067	75.4146
30	17.4494	0.0573	164.4940	0.0061	9.4269	0.1061	77.0766
36	30.9127	0.0323	299.1268	0.0033	9.6765	0.1033	85.1194
48	97.0172	0.0103	960.1723	0.0010	9.8969	0.1010	94.0217
60	304.4816	0.0033	3034.8164	0.0003	9.9672	0.1003	97.7010
72	955.5938	0.0010	9545.9382	0.0001	9.9895	0.1001	99.1419
100	13781	0.0001	137796	0.0000	9.9993	0.1000	99.9202

 $i = 15\%$

N	(F/P)	(P/F)	(F/A)	(A/F)	(P/A)	(A/P)	(P/G)
1	1.1500	0.8696	1.0000	1.0000	0.8696	1.1500	0.0000
2	1.3225	0.7561	2.1500	0.4651	1.6257	0.6151	0.7561
3	1.5209	0.6575	3.4725	0.2880	2.2832	0.4380	2.0712
4	1.7490	0.5718	4.9934	0.2003	2.8550	0.3503	3.7864
5	2.0114	0.4972	6.7424	0.1483	3.3522	0.2983	5.7751
6	2.3131	0.4323	8.7537	0.1142	3.7845	0.2642	7.9368
7	2.6600	0.3759	11.0668	0.0904	4.1604	0.2404	10.1924
8	3.0590	0.3269	13.7268	0.0729	4.4873	0.2229	12.4807
9	3.5179	0.2843	16.7858	0.0596	4.7716	0.2096	14.7548
10	4.0456	0.2472	20.3037	0.0493	5.0188	0.1993	16.9795
11	4.6524	0.2149	24.3493	0.0411	5.2337	0.1911	19.1289
12	5.3503	0.1869	29.0017	0.0345	5.4206	0.1845	21.1849
13	6.1528	0.1625	34.3519	0.0291	5.5831	0.1791	23.1352
14	7.0757	0.1413	40.5047	0.0247	5.7245	0.1747	24.9725
15	8.1371	0.1229	47.5804	0.0210	5.8474	0.1710	26.6930
16	9.3576	0.1069	55.7175	0.0179	5.9542	0.1679	28.2960
17	10.7613	0.0929	65.0751	0.0154	6.0472	0.1654	29.7828
18	12.3755	0.0808	75.8364	0.0132	6.1280	0.1632	31.1565
19	14.2318	0.0703	88.2118	0.0113	6.1982	0.1613	32.4213
20	16.3665	0.0611	102.4436	0.0098	6.2593	0.1598	33.5822
21	18.8215	0.0531	118.8101	0.0084	6.3125	0.1584	34.6448
22	21.6447	0.0462	137.6316	0.0073	6.3587	0.1573	35.6150
23	24.8915	0.0402	159.2764	0.0063	6.3988	0.1563	36.4988
24	28.6252	0.0349	184.1678	0.0054	6.4338	0.1554	37.3023
25	32.9190	0.0304	212.7930	0.0047	6.4641	0.1547	38.0314
26	37.8568	0.0264	245.7120	0.0041	6.4906	0.1541	38.6918
27	43.5353	0.0230	283.5688	0.0035	6.5135	0.1535	39.2890
28	50.0656	0.0200	327.1041	0.0031	6.5335	0.1531	39.8283
29	57.5755	0.0174	377.1697	0.0027	6.5509	0.1527	40.3146
30	66.2118	0.0151	434.7451	0.0023	6.5660	0.1523	40.7526
36	153.1519	0.0065	1014.3457	0.0010	6.6231	0.1510	42.5872
48	819.4007	0.0012	5456.0047	0.0002	6.6585	0.1502	43.9997
60	4383.9987	0.0002	29220	0.0000	6.6651	0.1500	44.3431
72	23455	0.0000	156363	0.0000	6.6664	0.1500	44.4221
100	1174313	0.0000	7828750	0.0000	6.6667	0.1500	44.4438