Assignment 9: Engineering Economy
Due: 8:25AM Tuesday Nov. 29
100 Points

Show your work and explain what you are doing. No round down or up, use 2 decimals for dollar values and 4 decimals for factors

PROBLEM 1
You invest $10,000 now in a project that pays back your money plus the interest.

1. How long would you have to wait to double your money if interest rate were 20% simple?

Future worth formula for simple interest is:
$F = P (1 + iN)$
$i = 20\% = 0.20$ $P = \$10,000$ $F = \$20,000$ $N =$ unknown

Solving for N
$20000 = 10000 (1+0.2N)$
$1+0.2N = 2$
$0.2N = 2 - 1 = 1$

N = 5 years

2. How long would you have to wait to double your money if interest rate were 20% compounded annually?

Future worth formula for compounded interest is:
$F = P (1 + i)^N$
$i = 20\% = 0.20$ $P = \$10,000$ $F = \$20,000$ $N =$ unknown

Solving for N
$20000 = 10000 (1+0.2)^N$
$(1.2)^N = 2$
$N \text{ Log } (1.2) = \text{Log } 2$
$0.07918\ N = 0.30103$
$N = 0.30103 / 0.07918 = 3.8018$

N = 3 years, 9 months and 19 days

3. What should the simple interest rate be for you to double your money in 20 years?

Future worth formula for simple interest is:
$F = P (1 + iN)$
i = unknown P = \$10,000 F = \$20,000 N = 20 years

Solving for i
$20000 = 10000 (1+20i)$
$1+20i = 2$
$20i = 2 - 1 = 1$

$i = 1/20 = 5\%$ annual

4. What should the compounded annually interest rate be for you to double your money in 20 years?

Future worth formula for compounded interest is:
$F = P (1 + i)^N$
i = unknown P = \$10,000 F = \$20,000 N = 20

Solving for N
$20000 = 10000 (1+i)^{20}$
$(1+i)^{20} = 2$
$1+i = (2)^{(1/20)} = (2)^{(0.05)} = 1.03526$
$i = 1.03526 – 1 = 0.03526$

$i = 0.035 = 3.5\%$

PROBLEM 2

You have decided to invest $2,xxx (xxx is the last three digits of you Student ID) at the end of each year for the next several years in an investment that pays 15% interest rate compounded annually.

For the solution key let's assume xxx is 123, so the annual investment is $2,123. We can use either formula or table. Let's do both for one of them.

1. How much would you receive after 20 years?

Future worth formula for compounded interest of annual payments is:

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

F = unknown A = $2,123 i = 15% = 0.15 N = 20

$$F = 2123\left[\frac{(1.15)^{20} - 1}{0.15}\right]$$

Performing calculations, we have:

F = 2123 (102.444) = $217,488.60

Using tables, we reach the same conclusion

F = A (F/A, i, n) = 2123 (F/A, 15%, 20) = 2123 (102.444) = $217,488.60

The table is shown in the next page.

2. What is the present worth of the investment now?

P = unknown A = $2,123 i = 15% = 0.15 N = 20

Using tables:

P = A (P/A, i, n) = 2123 (P/A, 15%, 20) = 2123 (6.259) = $13,287.86

15%

Compound Interest Factors

	Single Payment		Uniform Payment Series			
n	Compound Amount Factor Find *F* Given *P* *F/P*	Present Worth Factor Find *P* Given *F* *P/F*	Sinking Fund Factor Find *A* Given *F* *A/F*	Capital Recovery Factor Find *A* Given *P* *A/P*	Compound Amount Factor Find *F* Given *A* *F/A*	Present Worth Factor Find *P* Given *A* *P/A*
1	1.150	.8696	1.0000	1.1500	1.000	0.870
2	1.322	.7561	.4651	.6151	2.150	1.626
3	1.521	.6575	.2880	.4380	3.472	2.283
4	1.749	.5718	.2003	.3503	4.993	2.855
5	2.011	.4972	.1483	.2983	6.742	3.352
6	2.313	.4323	.1142	.2642	8.754	3.784
7	2.660	.3759	.0904	.2404	11.067	4.160
8	3.059	.3269	.0729	.2229	13.727	4.487
9	3.518	.2843	.0596	.2096	16.786	4.772
10	4.046	.2472	.0493	.1993	20.304	5.019
11	4.652	.2149	.0411	.1911	24.349	5.234
12	5.350	.1869	.0345	.1845	29.002	5.421
13	6.153	.1625	.0291	.1791	34.352	5.583
14	7.076	.1413	.0247	.1747	40.505	5.724
15	8.137	.1229	.0210	.1710	47.580	5.847
16	9.358	.1069	.0179	.1679	55.717	5.954
17	10.761	.0929	.0154	.1654	65.075	6.047
18	12.375	.0808	.0132	.1632	75.836	6.128
19	14.232	.0703	.0113	.1613	88.212	6.198
20	16.367	.0611	.00976	.1598	102.444	6.259

3. How many years do you have keep paying before the present worth of your investment is close to $20,000?

P = $20,000 A = $2,123 i = 15% = 0.15 N = unknown

P = A (P/A, 15%, n) → 20000 = 2123 (P/A, 15%, n) → (P/A, 15%, n) = 20000/2123

(P/A, 15%, n) = 9.4206

Now we can check the values under P/A of the table to see whether we can find a number close to it.

35	133.176	.00751	.00113	.1511	881.170	6.617
40	267.864	.00373	.00056	.1506	1 779.1	6.642
45	538.769	.00186	.00028	.1503	3 585.1	6.654
50	1 083.7	.00092	.00014	.1501	7 217.7	6.661
55	2 179.6	.00046	.00007	.1501	14 524.1	6.664
60	4 384.0	.00023	.00003	.1500	29 220.0	6.665
65	8 817.8	.00011	.00002	.1500	58 778.6	6.666
70	17 735.7	.00006	.00001	.1500	118 231.5	6.666
75	35 672.9	.00003		.1500	237 812.5	6.666
80	71 750.9	.00001		.1500	478 332.6	6.667
85	144 316.7	.00001		.1500	962 104.4	6.667

As can be seen the numbers much smaller for even 85 years and they are not really changing (from 50 years to 85 years only 0.006) suggesting that with $2,123 annual payment we can never get to $20,000 present worth.

4. What should the interest rate be for your investment to have a present value of $20,000 after 10 years?

P = $20,000 A = $2,123 i = unknown N = 10

P = A (P/A, i, 10) → 20000 = 2123 (P/A, i, 10) → (P/A, i, 10) = 20000/2123

(P/A, i, 10) = 9.4206

This time we know the year but not the interest rate. So we have to look at different tables of interest rate across from year 10 under the column of P/A to match a close number.

From the tables it can be seen that 9.420 is between 9.346 (for 1.25% interest rate) and 9.471 (for 1% interest rate). So the real interest rate is somewhere in that range.

1%

Compound Interest Factors

	Single Payment		Uniform Payment Series			
n	Compound Amount Factor Find *F* Given *P* *F/P*	Present Worth Factor Find *P* Given *F* *P/F*	Sinking Fund Factor Find *A* Given *F* *A/F*	Capital Recovery Factor Find *A* Given *P* *A/P*	Compound Amount Factor Find *F* Given *A* *F/A*	Present Worth Factor Find *P* Given *A* *P/A*
1	1.010	.9901	1.0000	1.0100	1.000	0.990
2	1.020	.9803	.4975	.5075	2.010	1.970
3	1.030	.9706	.3300	.3400	3.030	2.941
4	1.041	.9610	.2463	.2563	4.060	3.902
5	1.051	.9515	.1960	.2060	5.101	4.853
6	1.062	.9420	.1625	.1725	6.152	5.795
7	1.072	.9327	.1386	.1486	7.214	6.728
8	1.083	.9235	.1207	.1307	8.286	7.652
9	1.094	.9143	.1067	.1167	9.369	8.566
10	1.105	.9053	.0956	.1056	10.462	9.471

1 1/4%

Compound Interest Factors

	Single Payment		Uniform Payment Series			
n	Compound Amount Factor Find *F* Given *P* *F/P*	Present Worth Factor Find *P* Given *F* *P/F*	Sinking Fund Factor Find *A* Given *F* *A/F*	Capital Recovery Factor Find *A* Given *P* *A/P*	Compound Amount Factor Find *F* Given *A* *F/A*	Present Worth Factor Find *P* Given *A* *P/A*
1	1.013	.9877	1.0000	1.0125	1.000	0.988
2	1.025	.9755	.4969	.5094	2.013	1.963
3	1.038	.9634	.3292	.3417	3.038	2.927
4	1.051	.9515	.2454	.2579	4.076	3.878
5	1.064	.9398	.1951	.2076	5.127	4.818
6	1.077	.9282	.1615	.1740	6.191	5.746
7	1.091	.9167	.1376	.1501	7.268	6.663
8	1.104	.9054	.1196	.1321	8.359	7.568
9	1.118	.8942	.1057	.1182	9.463	8.462
10	1.132	.8832	.0945	.1070	10.582	9.346