Name:
Total Points: 100

CE 167 - Mid Term 1

Fall 2019
Oct 3, 2019

Problem 1 [15]

Your construction company needs to purchase a new steamroller. You consider three major steamroller manufacturers. Considering a MARR of 12%, which manufacturer should you purchase from if you plan to use this roller for 8 years? Explain your reasoning.

	A	**B**	**C**
Initial Cost	$\$125,034$	$\$101,858$	$\$119,565$
Annual Revenue	$\$90,000$	$\$30,000$	$\$40,000$
Annual Maintenance	$\$10,000$	$\$15,000$	$\$20,000$
Salvage Value at 8yr	$\$60,000$	$\$40,000$	$\$50,000$

Problem 2 [20]

An investment alternative is represented by the following cash flow:

Time=	***Cash Flow***
0	$-\$500$
1	$\$0$
2	$+\$1,649$
3	$-\$700$
4	$-\$500$

Analyze the IRR of this cash-flow and provide a recommendation if the MARR is:

(a) 12%

(b) 15%

(c) 20%

Problem 3 [10]

(a) With the help of a graph, explain how the level of influence and the cumulative cost of a project vary over the project life-cycle.

(b) Explain the difference between Design-Build and Design-Bid-Build project delivery methods using the level of influence concept.

Problem 4 [15]

You deposit money once into a savings account at $time = 0$ that has a nominal interest rate of 12%.

(a) What is the effective interest rate of this savings account if compounded annually for 6 years?

(b) If this account is worth $858 at the end of 5 years and the 12% nominal interest rate is compounded quarterly, how much money was initially deposited?

Problem 5 [10]

(a) What does BIM stand for?

(b) What are three major advantages of BIM to a contractor?

(c) What are three major advantages of BIM to an owner?

Problem 6 [10]

Explain the key differences between the Construction Management at risk and the professional Construction Management method of project delivery. Also draw their typical project organisation trees.

Problem 7 [20]

Consider the following property investments under a discount rate of 12%:

	A	**B**
Initial Cost (in $)	$60,000$	$70,000$
Life	$4yrs$	$8yrs$
Salvage Value (in $)	$47,000$	$20,000$
Annual Revenue (in $)	$20,000$	$18,000$
Annual Cost (in $)	$10,000$	$8,000$
Discount Rate	12%	12%

Which property would you recommend on the basis of the discounted payback method? Which one would you recommend on the basis of NPV?

Reference Equations

- **[F/P, i, n]** $= (1+i)^n$
- **[P/F, i, n]** $= \dfrac{1}{(1+i)^n}$
- **[F/A, i, n]** $= \dfrac{(1+i)^n - 1}{i}$
- **[A/F, i, n]** $= \dfrac{i}{(1+i)^n - 1}$
- **[P/A, i, n]** $= \dfrac{(1+i)^n - 1}{i(1+i)^n}$
- **[A/P, i, n]** $= \dfrac{i(1+i)^n}{(1+i)^n - 1}$
- $i_{eff} = \left(1 + \dfrac{i_{nominal}}{p}\right)^p - 1$, where p = number of compounding periods per year

12% Compound Interest Factors 12%

	Single Payment		Uniform Payment Series				Arithmetic Gradient		
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	Gradient Uniform Series Find A Given G A/G	Gradient Present Worth Find P Given G P/G	n
1	1.120	.8929	1.0000	1.1200	1.000	0.893	0	0	1
2	1.254	.7972	.4717	.5917	2.120	1.690	0.472	0.797	2
3	1.405	.7118	.2963	.4163	3.374	2.402	0.925	2.221	3
4	1.574	.6355	.2092	.3292	4.779	3.037	1.359	4.127	4
5	1.762	.5674	.1574	.2774	6.353	3.605	1.775	6.397	5
6	1.974	.5066	.1232	.2432	8.115	4.111	2.172	8.930	6
7	2.211	.4523	.0991	.2191	10.089	4.564	2.551	11.644	7
8	2.476	.4039	.0813	.2013	12.300	4.968	2.913	14.471	8
9	2.773	.3606	.0677	.1877	14.776	5.328	3.257	17.356	9
10	3.106	.3220	.0570	.1770	17.549	5.650	3.585	20.254	10

15% Compound Interest Factors 15%

	Single Payment		Uniform Payment Series				Arithmetic Gradient		
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	Gradient Uniform Series Find A Given G A/G	Gradient Present Worth Find P Given G P/G	n
1	1.150	.8696	1.0000	1.1500	1.000	0.870	0	0	1
2	1.322	.7561	.4651	.6151	2.150	1.626	0.465	0.756	2
3	1.521	.6575	.2880	.4380	3.472	2.283	0.907	2.071	3
4	1.749	.5718	.2003	.3503	4.993	2.855	1.326	3.786	4
5	2.011	.4972	.1483	.2983	6.742	3.352	1.723	5.775	5
6	2.313	.4323	.1142	.2642	8.754	3.784	2.097	7.937	6
7	2.660	.3759	.0904	.2404	11.067	4.160	2.450	10.192	7
8	3.059	.3269	.0729	.2229	13.727	4.487	2.781	12.481	8
9	3.518	.2843	.0596	.2096	16.786	4.772	3.092	14.755	9
10	4.046	.2472	.0493	.1993	20.304	5.019	3.383	16.979	10

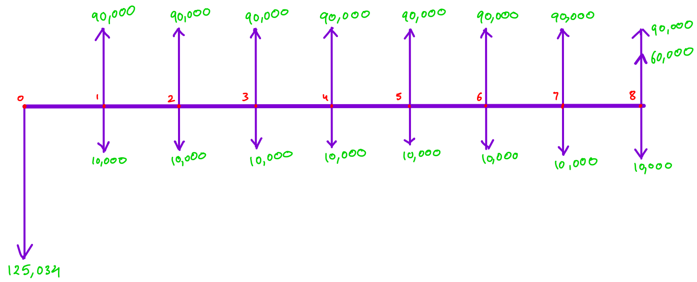
20% Compound Interest Factors 20%

	Single Payment		Uniform Payment Series				Arithmetic Gradient		
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	Gradient Uniform Series Find A Given G A/G	Gradient Present Worth Find P Given G P/G	n
1	1.200	.8333	1.0000	1.2000	1.000	0.833	0	0	1
2	1.440	.6944	.4545	.6545	2.200	1.528	0.455	0.694	2
3	1.728	.5787	.2747	.4747	3.640	2.106	0.879	1.852	3
4	2.074	.4823	.1863	.3863	5.368	2.589	1.274	3.299	4
5	2.488	.4019	.1344	.3344	7.442	2.991	1.641	4.906	5
6	2.986	.3349	.1007	.3007	9.930	3.326	1.979	6.581	6
7	3.583	.2791	.0774	.2774	12.916	3.605	2.290	8.255	7
8	4.300	.2326	.0606	.2606	16.499	3.837	2.576	9.883	8
9	5.160	.1938	.0481	.2481	20.799	4.031	2.836	11.434	9
10	6.192	.1615	.0385	.2385	25.959	4.192	3.074	12.887	10

Mid Term 1 Solutions

1

Steamroller A



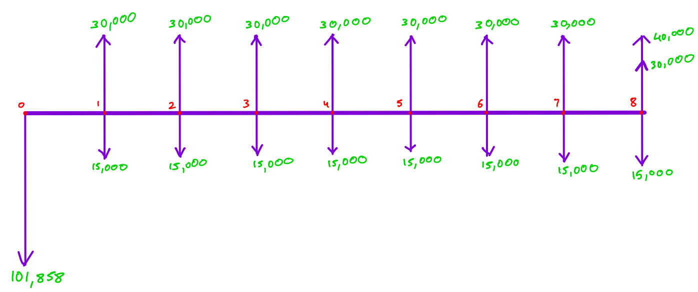
$NPV_A = -125{,}034 + (90{,}000 - 10{,}000)[P/A, 12\%, 8] + (60{,}000)[P/F, 12\%, 8]$

$= -125{,}034 + (80{,}000 \times 4.968) + (60{,}000 \times 0.4039)$

$= -125{,}034 + 397{,}440 + 24{,}234$

$\boxed{= +\$296{,}640}$

Steamroller B



$NPV_B = -101{,}858 + (30{,}000 - 15{,}000)[P/A, 12\%, 8] + (40{,}000)[P/F, 12\%, 8]$

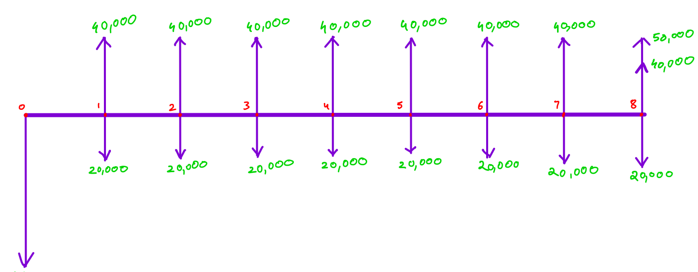
$= -101{,}858 + (15{,}000 \times 4.968) + (40{,}000 \times 0.4039)$

$= -101{,}858 + 74{,}520 + 16{,}156$

$\boxed{= -\$11{,}182}$

Only option A is feasible

Steamroller C



$NPV_C = -119{,}565 + (40{,}000 - 20{,}000)[P/A, 12\%, 8] + (50{,}000)[P/F, 12\%, 8]$

$= -119{,}565 + (20{,}000 \times 4.968) + (50{,}000 \times 0.4039)$

$= -119{,}565 + 99{,}360 + 20{,}195$

$\boxed{= -\$10}$

2

$NPV = -500 + 1649[P/F, i, 2] - 700[P/F, i, 3] - 500[P/F, i, 4]$

$$\Rightarrow NPV = \frac{-500}{(1+i)^0} + \frac{1649}{(1+i)^2} - \frac{700}{(1+i)^3} - \frac{500}{(1+i)^4}$$

@ $i = 12\%$, $NPV = -500.00 + 1314.57 - 498.25 - 317.76 = -1.44$

@ $i = 15\%$, $NPV = -500.00 + 1246.88 - 460.26 - 285.88 = +0.74$

@ $i = 20\%$, $NPV = -500.00 + 1145.14 - 405.09 - 241.13 = -1.08$

From figure 2, we get

$IRR_1 \approx 14\%$ & $IRR_2 \approx 17\%$.

a) If $MARR = 12\%$,

$IRR_1, IRR_2 > MARR$

$\therefore$ Investment is favorable

b) If $MARR = 15\%$,

$IRR_1 < MARR < IRR_2$

$\therefore$ Cannot make a recommendation

c) If $MARR = 20\%$,

$IRR_1, IRR_2 < MARR$

$\therefore$ Investment is not favorable

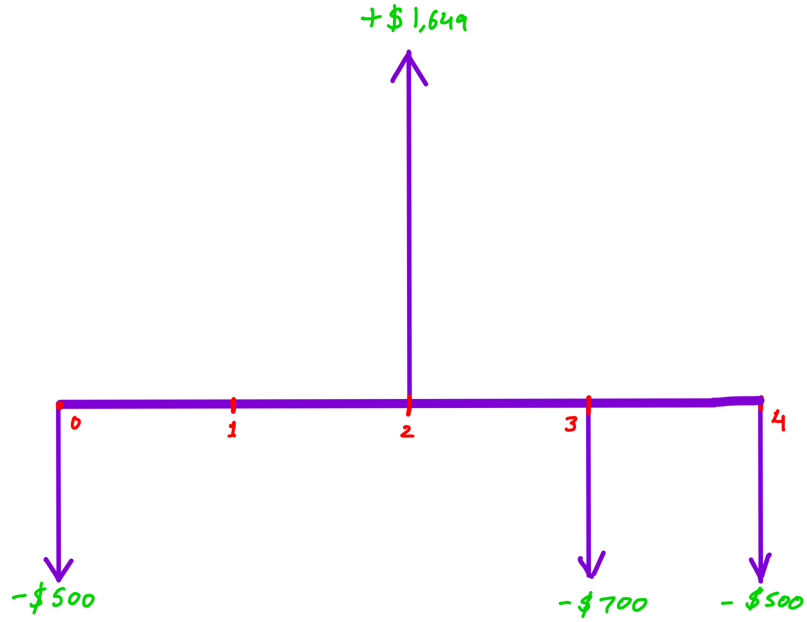


Figure 1

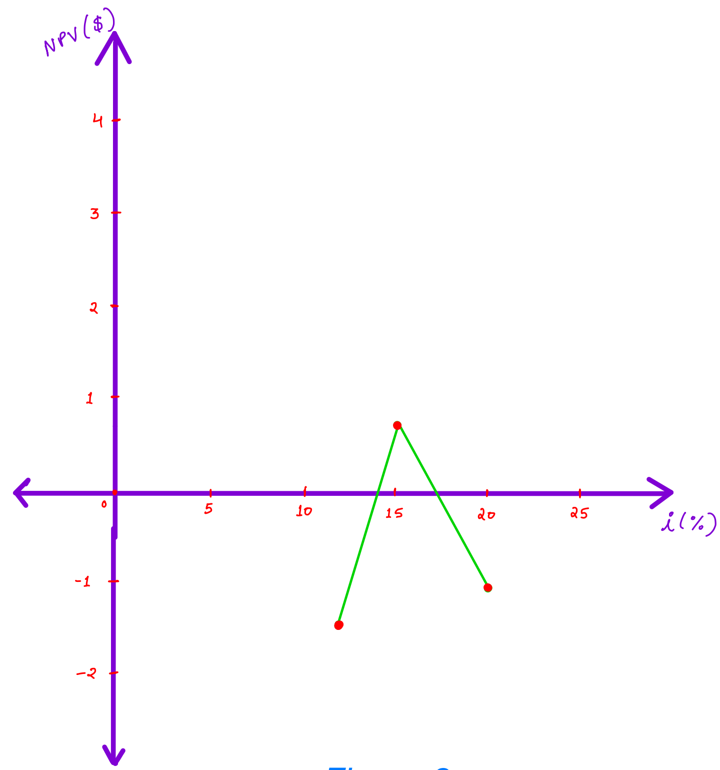
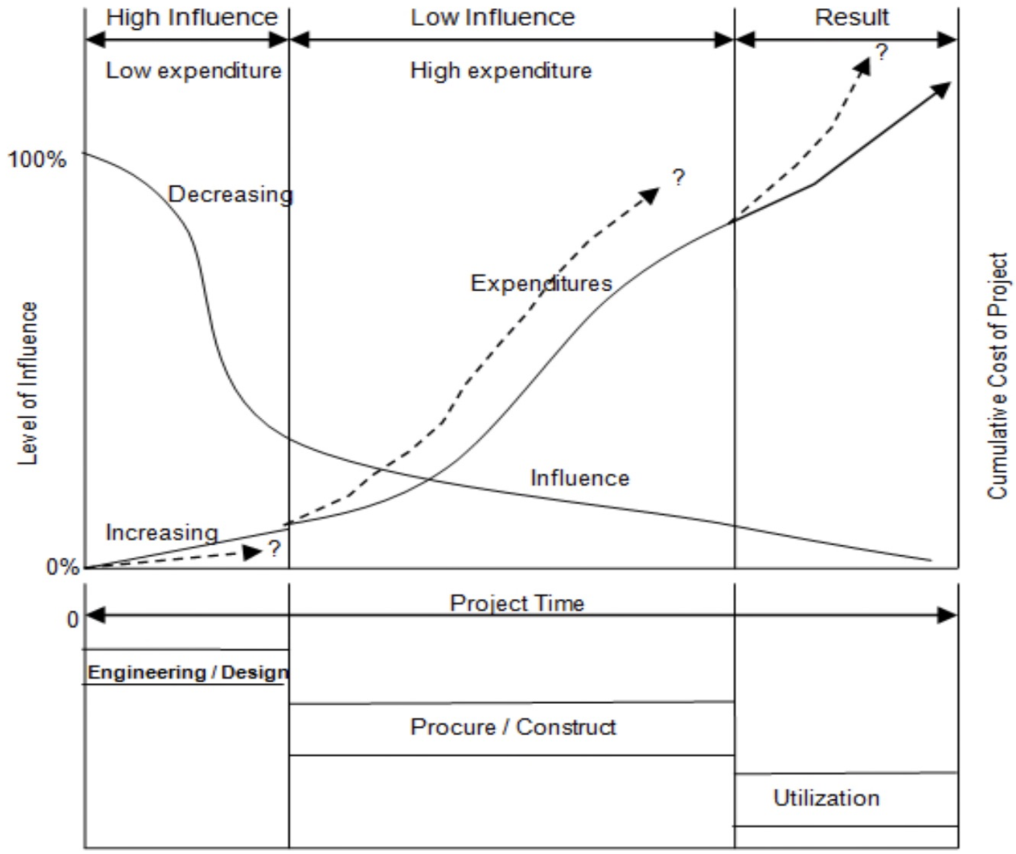


Figure 2

3

a



4

a

$$i_{eff} = \left(1 + \frac{0.12}{1}\right)^{1} - 1$$

$$= 0.12 \text{ OR } 12\%$$

b

$$i = \frac{12\%}{4} = 3\%$$

$n = 5 \text{ years} \times 4 \text{ quarters/year}$

$= 20$

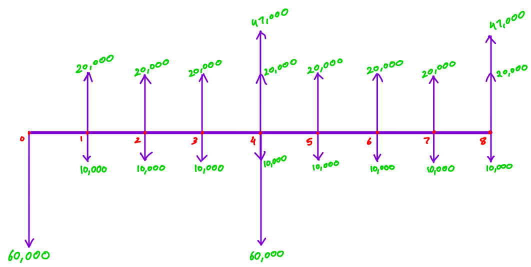
$$P = F\,[P/F, \overset{3\%}{i}, \overset{20}{n}]$$

$$= \frac{858}{(1+0.03)^{20}}$$

$$P = \$475.03$$

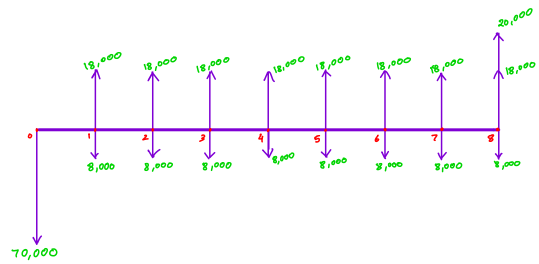
7

Investment A



n	cash flow	Present Value	Cummulative discounted cash flow
0	-60,000	-60,000	-60,000
1	10,000	8,929	-51,071
2	10,000	7,971	-43,099
3	10,000	7,118	-35,981
4	-3,000	-1,907	-37,888
5	10,000	5,674	-32,213
6	10,000	5,066	-27,147
7	10,000	4,523	-22,623
8	57,000	23,021	+ 398

Investment B



n	cash flow	Present Value	Cummulative discounted cash flow
0	-70,000	-70,000	-70,000
1	10,000	8,929	-61,071
2	10,000	7,971	-53,100
3	10,000	7,118	-45,982
4	10,000	6,355	-39,627
5	10,000	5,674	-33,953
6	10,000	5,066	-28,887
7	10,000	4,523	-24,364
8	30,000	12,116	-12,248

$$\frac{n-7}{22623} = \frac{8-n}{398}$$

$\therefore\ n = 7.98$ years

$\rightarrow$ Choose option A ; Option B does not break even

$$
\begin{aligned}
NPV_A &= -60,000 \\
&\quad + (20,000 - 10,000)[P/A, 12\%, 8] \\
&\quad - 60,000[P/F, 12\%, 4] \\
&\quad + 47,000[P/F, 12\%, 4] \\
&\quad + 47,000[P/F, 12\%, 8] \\
&= -60,000 \\
&\quad + 10,000(4.968) \\
&\quad - 60,000(0.6355) \\
&\quad + 47,000(0.6355) \\
&\quad + 47,000(0.4039) \\
&= +401.8
\end{aligned}
$$

$$
\begin{aligned}
NPV_B &= -70,000 \\
&\quad + (18,000 - 8,000)[P/A, 12\%, 8] \\
&\quad + 20,000[P/F, 12\%, 8] \\
&= -70,000 \\
&\quad + 10,000(4.968) \\
&\quad + 20,000(0.4039) \\
&= -12,242
\end{aligned}
$$

$NPV_A > NPV_B$

$\rightarrow$ choose option A