E355 Engineering Economics Spring 2022
Homework #5

"I pledge my honor that I have abided by the Stevens Honor System"

By: Alexander Gaskins, Daniel Goldberg, and Samuel Gavrilov

5.1 Acai, a company specializing in developing AI technology in food transportation systems, wants to invest in a hardware system for their new office. Listed below is the economic data for the investment:

1	Depreciable Capital - year 0	$ 500,000
2	Salvage Value (FMV) (at the end of project life)	$ 90,000
3	Non-depreciable Capital - year 0	$ 90,000
4	Non-depreciable Capital (at the end of project life)	$ 170,000
5	Expected Revenue ($ / yr.)	$ 1,800,000
6	O&M Cost ($ / yr.)	$ 300,000
7	Useful life (years)	2
8	Working Capital - year 0	$ 250,000
9	Working Capital - (at the end of the project life)	$ 250,000
10	Loan Proceeds - year 0	$ 650,000
11	Interest on Loan - per year	10%
12	Loan Period - years	2
13	Tax rate - per year	25%
14	ITC - year 1	$ 90,000
15	ITC - year 2	$ 120,000
16	MARR per year	20%

This system qualifies as a special 2-year MACRS Depreciation (with factors 0.6 and 0.4). Assume that the working capital is returned in year 2. Assume that the company has income from other projects and this system is sold at the end of year 2.

Note: Use the following tables to calculate the above values.

a) Calculate the interest and principal repayments for the loan. [6 points]

Year	Beginning Balance	Annual Payment	Interest (10%)	Principal Repayment	Ending Balance
1	$650,000	$374,530	650000*0.10 **=$65,000**	374530-65000 **=$309,530**	650000-309530 **=$340,470**
2	$340,470	$374,530	340470*0.10 **=$34,047**	374530-34047 **=$340,483**	340470-340483 **= -$13**
Total			$99,047	$650,013	

$A = 650000\,(\frac{A}{P}, 10\%,\ 2) = 650000\,(0.5762) = 374530$

b) Find the depreciation expenses and accumulated depreciation expenses (using the special MACRS rate) for this system. [5 points]

Year	Initial Cost	Depreciation Rates	Depreciation Expenses	Accumulated Depreciation	Ending BV
0	$500,000	-	-	-	-
1	↓	60%	500000*0.60 **=$300,000**	$300,000	500000-300000 **=$200,000**
2		40%	500000*0.40 **=$200,000**	$500,000	200000-200000 **=$0**
Total			$500,000		

c) Calculate the after-tax cash flows from salvage of depreciable and non-depreciable capital. [6 points]
Depreciable

$Tax\ Rate\ (TR) = 25\% = 0.25$

Depreciable:
$End\ of\ life\ (FMV) = 90000$
$Year\ 0\ (IC) = 0$

$Tax = (FMV - IC)(TR) = (90000 - 0)(0.25)$
$Tax = \$22,500$

$After\ Tax\ Cash\ Flow = (FMV - Tax) = (90000 - 22500)$
$After\ Tax\ Cash\ Flow = \$67,500$

Non-Depreciable:
$End\ of\ life\ (FMV) = 170000$
$Year\ 0\ (IC) = 90000$

$Tax = (FMV - IC)(TR) = (170000 - 90000)(0.25)$
$Tax = \$20,000$

$After\ Tax\ Cash\ Flow = (FMV - Tax) = (170000 - 20000)$
$After\ Tax\ Cash\ Flow = \$150,000$

d) Calculate the Net Cash Flow from operating income. [8 points]

	CASH FLOWS	0	1	2
1	Operating Revenue	-	$1,800,000	$1,800,000
2	Cash Expenses	-	$300,000	$300,000
3	Oper. Income Before Depr.	-	1800000-300000 **=$1,500,000**	1800000-300000 **=$1,500,000**
4	Depreciation (From Part B)	-	$300,000	$200,000
5	Oper. Income	-	1500000-300000 **=$1,200,000**	1500000-200000 **=$1,300,000**
6	Interest Expense (From Part A)	-	$65,000	$34,047
7	Pretax Net Income	-	1200000-65000 **=$1,135,000**	1300000-34047 **=$1,265,953**
8	Income Taxes (25%)	-	1135000*0.25 **=$283,750**	1265953*0.25 **=$316,488.25**
9	Investment Tax Credit	-	ITC Year 1 $90,000	ITC Year 2 $120,000
10	Net Income AT	-	(1135000-283750) +90000 **=$941,250**	(1265953-316488.25) +120000 **=$1,069,464.75**
11	Depreciation (From Box 4)	-	$300,000	$200,000
12	Net C.F. from Oper. (Box 10 + Box 11)	-	941250+300000 **=$1,241,250**	1069464.75+200000 **=$1,269,464.75**

e) Calculate the Net Capital Cash Flow. [6 points]

13	Principal Repayment (From Part A)	-	$309,530	$340,483
14a	Depreciable Capital	$500,000	-	$67,500
14b	Non-Depreciable Capital	$90,000	-	$150,000
14c	Loan Proceeds	$650,000	-	-
15	Capital Gains/Losses (Using Part C)	-	-	67500+150000 **=$217,500**
16	Working Capital	$250,000	-	$250,000
17	Net Capital Cash Flow	(590000-650000) +250000 **=$190,000**	-$309,530	[(340483-217500) -250000] **=$127,030**

f) Calculate the Net Present Value. [2 points]

18	Total Cash Flow (Box 12 - Box 17)	[(0-190000)] **= -$190,000**	(1241250-309530) **=$931,720**	(1269464.75+127030) **=$1,396,494.75**
19	Discount Factor [P(T)]	1	0.8333	0.6944
20	Net Present Value (NPV)	190000*1 **= -$190,000**	931720*0.8333 **=$776,402.28**	1396494.75*0.6944 **=$969,725.95**
21	Cumulative NPV	-$190,000	[(776402.28-190000)] **=$586,402.28**	[(586402.28+969725.95)] **=$1,556,128.23**

Discount Factor:

$P(T) = 1 / (1 + r)^T$

r = MARR = 20%

$$P(0) = \frac{1}{(1+0.20)^0} = 1 \quad P(1) = \frac{1}{(1+0.20)^1} = 0.8333 \quad P(0) = \frac{1}{(1+0.20)^2} = 0.6944$$

g) Should the investment be undertaken? Why or why not, explain. [1 point]

The investment should be undertaken because the net present value of the investment is positive.

E355 Engineering Economics Spring 2022
Homework #6

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By: Alexander Gaskins, Daniel Goldberg, and Samuel Gavrilov

6.1 The Hoboken Hospital is considering the replacement of an old diagnostic machine. The purchase cost of a new equipment will be $160,000 and will have lower maintenance costs per year compared with the older one. The current machine can be sold for $90,000 now. The salvage value and maintenance costs per year are listed below for both alternatives. Assume a 3-year useful life and the MARR is 10%.

	Old Machine		New Machine	
EOY	Salvage Value	Maintenance Costs	Salvage Value	Maintenance Costs
0	$ 90,000	$ -	$ 160,000	$ -
1	$ 75,000	$ 15,000	$ 145,000	$ 12,000
2	$ 50,000	$ 18,000	$ 125,000	$ 15,000
3	$ 25,000	$ 22,000	$ 105,000	$ 19,000

a) Calculate the Marginal Cost of the Old machine (Defender). Which replacement analysis technique will you use and why? [4.5 points]

EOY	S Value at EOY	Loss in Market Value	Interest Rate	Interest in Year N	Maint. Cost	Total Marginal Cost
0	$90,000	-	-	-	-	-
1	$75,000	$15,000	10%	$9,000	$15,000	$39,000
2	$50,000	$25,000	10%	$7,500	$18,000	$50,500
3	$25,000	$25,000	10%	$5,000	$22,000	$52,000

Technique 1 will be used, as the total marginal cost is **strictly** increasing.

b) Find the EUACs of the Capital Recovery for new machine (Challenger). [4.5 points]

EOY	S Value ay EOY	P-S	(A/P,10%,N)	S*i	CR EUAC
0	$160,000	-	-	-	-
1	$145,000	$15,000	1.1	$14,500	$31,000
2	$125,000	$35,000	0.5762	$12,500	$32,667
3	$105,000	$55,000	0.4021	$10,500	$32,615.50

$$EUAC = (P - S) * (\frac{A}{P}, 10\%, N) + S * i$$

$$EUAC_1 = (160000 - 145000) * (\frac{A}{P}, 10\%, 1) + (145000 * 0.10) = (15000) * (1.1) + 14500$$
$$EUAC_1 = \$31,000$$

$$EUAC_2 = (160000 - 125000) * (\frac{A}{P}, 10\%, 2) + (125000 * 0.10) = (35000) * (0.5762) + 12500$$
$$EUAC_2 = \$32,667$$

$$EUAC_3 = (160000 - 105000) * (\frac{A}{P}, 10\%, 3) + (105000 * 0.10) = (55000) * (0.4021) + 10500$$
$$EUAC_3 = \$32,615.50$$

c) Find the EUACs of Maintenance Cost for new machine (Challenger). [9 points]

$$EUAC_{MC_1} = (12000) * (\frac{A}{F}, 10\%, 1) = \$12,000$$

$$EUAC_{MC_2} = (15000 + 12000 * (\frac{F}{P}, 10\%, 1)) * (\frac{A}{F}, 10\%, 2) = \$13,428.84$$

$$EUAC_{MC_3} = (19000 + 15000 * (\frac{F}{P}, 10\%, 1) + 12000 * (\frac{F}{P}, 10\%, 2)) * (\frac{A}{F}, 10\%, 3) = \$15,111.04$$

d) Find the Total EUACs of the two alternatives [3 points]

Defender:

$$EUAC = (P - S) * (\frac{A}{P}, 10\%, N) + S * i$$

$$EUAC_1 = (90000 - 75000) * (\frac{A}{P}, 10\%, 1) + (75000 * 0.10) = (15000) * (1.1) + 7500$$

$$EUAC_1 = \$24,000$$

$$EUAC_{MC_1} = (15000) * (\frac{A}{F}, 10\%, 1) = \$15,000$$

$$EUAC_2 = (90000 - 50000) * (\frac{A}{P}, 10\%, 2) + (50000 * 0.10) = (40000) * (0.5762) + 5000$$

$$EUAC_2 = \$28,048$$

$$EUAC_{MC_2} = (18000 + 15000 * (\frac{F}{P}, 10\%, 1)) * (\frac{A}{F}, 10\%, 2) = \$16,428.90$$

$$EUAC_3 = (90000 - 25000) * (\frac{A}{P}, 10\%, 3) + (25000 * 0.10) = (65000) * (0.4021) + 2500$$

$$EUAC_3 = \$28,636.50$$

$$EUAC_{MC_3} = (22000 + 18000 * (\frac{F}{P}, 10\%, 1) + 15000 * (\frac{F}{P}, 10\%, 2)) * (\frac{A}{F}, 10\%, 3) = \$18,110.90$$

	Defender			Challenger		
EOY	**CR EUAC**	**MC EUAC**	**Total**	**CR EUAC**	**MC EUAC**	**Total**
0	-	-	-	-	-	-
1	$24,000	$15,000	**$39,000**	$31,000	$12,000	**$43,000**
2	$28,048	$16,428.90	**$44,476.90**	$32,667	$13,428.84	**$46,095.84**
3	$28,636.50	$18,110.90	**$46,747.40**	$32,615.50	$15,111.05	**$47,726.55**

e) When (Economic Life) should the old machine be replaced? Why? [1 point]

The economic life is where the marginal cost of the defender exceeds the EUAC of the challenger. For year 1, the marginal cost is $39,000, versus the challenger's EUAC of $43,000. Thus, the defender should be kept for year 1. However, since the challenger's EUAC is smaller than the marginal costs in the following years, the old machine should be replaced at the end of year 1.

6.2 Crocobert Inc., a local brewery, is evaluating whether to buy a new fermenter. The initial cost of the new machine is $15,000, and the interest rate is 12%. The machine's end-of-year salvage values over the next 5 years are presented in the table below.

a) Calculate the marginal cost for the machine. [4 points]

EOY	Salvage Value at EOY	Loss in Market Value	Interest Rate	Interest	Marginal Costs
0	$15,000	-	-	-	-
1	$13,000	$2,000	12%	$1,800	$3,800
2	$10,000	$3,000	12%	$1,560	$4,560
3	$8,000	$2,000	12%	$1,200	$3,200
4	$6,800	$1,200	12%	$960	$2,160
5	$5,100	$1,700	12%	$816	$2,516

b) What is the economic life of the machine? Why? [1 point + 1 point]

Economic life can be found by finding the year where the machine has the lowest EUAC

$$EUAC_1 = 3800(\tfrac{P}{F}, 12\%, 1) \times (\tfrac{A}{P}, 12\%, 1) = \$3,800$$

$$EUAC_2 = (3800(\tfrac{P}{F}, 12\%, 1) + 4560(\tfrac{P}{F}, 12\%, 2)) \times (\tfrac{A}{P}, 12\%, 2)$$

$$EUAC_2 = (7028.25) \times (0.5917) = \$4,158.62$$

$$EUAC_3 = (7028.25 + 3200(\tfrac{P}{F}, 12\%, 3)) \times (\tfrac{A}{P}, 12\%, 3)$$

$$EUAC_3 = (9306.01) \times (0.4163) = \$3,874.09$$

$$EUAC_4 = (9306.01 + 2160(\tfrac{P}{F}, 12\%, 4)) \times (\tfrac{A}{P}, 12\%, 4)$$

$$EUAC_4 = (10678.69) \times (0.3292) = \$3,515.43$$

$$EUAC_5 = (10678.69 + 2516(\tfrac{P}{F}, 12\%, 5)) \times (\tfrac{A}{P}, 12\%, 5)$$

$$EUAC_5 = (12106.27) \times (0.2774) = \$3,358.28$$ ←**The economic life ends after 5 years**

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Homework #7

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7.1 You are an investor and want a real rate of return of 8% per year. If the expected annual inflation rate for the next years is 3.5%:

a) [2 point] What interest rate should be used in project analysis calculations? Calculate the interest rate

$$i = [(1 + r) \times (1 + a)] - 1 = [(1 + 0.08) \times (1 + 0.035)] - 1 = 0.1178 = 11.78\%$$

b) [2 point] If you invests $150,000 now, what is the amount that he should receive for the investment after 5 years?

$$FW = P(1 + i)^n = 150000(1 + 0.1178)^5 = \$261,765.13$$

7.2 [2 point] Apollo loaned his friend Demetrios $25,000 at 7% interest, compounded annually. The loan will be paid in 5 equal end-of-year payments. Apollo expects the inflation rate to be 3%. After taking inflation into account, what real rate of return is Apollo receiving on the loan? Compute your answer to the nearest 0.1%.

$i = nominal\ interest\ rate$
$r = real\ interest\ rate$
$a = inflation\ rate$

$(i + 1) = (1 + r) \times (1 + a)$
$i = [(1 + r) \times (1 + a)] - 1$
$r = \frac{(1+i)}{(1+a)} - 1 = \frac{(1+0.07)}{(1+0.03)} - 1 = 0.0388 = 3.9\%$

7.3 The Anthony's Spirits has opened a new shop in Jersey City. The initial investment cost of the shop was $200,000. It will produce $140,000 (in constant dollars) of revenue annually for 5 years. The real interest rate is 12% and there will be 3% inflation annually.

a) [4 points] Determine the current cash flows taking into account the inflation rate.

EOY	Constant Dollar Cash Flow	Inflation Factor	Current Dollar Cash Flow
0	-$200,000	$1/(1.03^{0}) = 1.0000$	$-200000 \times 1 =$ -$200,000
1	$140,000	$1/(1.03^{1}) = 0.9709$	$140000 \times 0.9709 =$ $135,926
2	$140,000	$1/(1.03^{2}) = 0.9426$	$140000 \times 0.9426 =$ $131,964
3	$140,000	$1/(1.03^{3}) = 0.9151$	$140000 \times 0.9151 =$ $128,114
4	$140,000	$1/(1.03^{4}) = 0.8885$	$140000 \times 0.8885 =$ $124,390
5	$140,000	$1/(1.03^{5}) = 0.8626$	$140000 \times 0.8626 =$ $120,764

b) [6 points] Find the PW for the investment (using acutal dollar cash flow values). Hint: Find the market interest rate first.

$$i = [(1 + r) \times (1 + a)] - 1 = [(1 + 0.12) \times (1 + 0.03)] - 1 = 0.1536 = 15.36\%$$

$$PW_0 = PVIF \times -200000 = \left(\left[\frac{1}{(1.1536^{0})}\right] \times -200000 = -\$200,000\right.$$

$$PW_1 = PVIF \times 135926 = \left(\left[\frac{1}{(1.1536^{1})}\right] \times 135926 = \$117,827.67\right.$$

$$PW_2 = PVIF \times 131964 = \left(\left[\frac{1}{(1.1536^{2})}\right] \times 131964 = \$99,161.93\right.$$

$$PW_3 = PVIF \times 128114 = \left(\left[\frac{1}{(1.1536^{3})}\right] \times 128114 = \$83,450.86\right.$$

$$PW_4 = PVIF \times 124390 = \left(\left[\frac{1}{(1.1536^{4})}\right] \times 124390 = \$70,236.76\right.$$

$$PW_5 = PVIF \times 120764 = \left(\left[\frac{1}{(1.1536^{5})}\right] \times 120764 = \$59,110.03\right.$$

$$PW_{investment} = \sum_{i=0}^{5} PW_i = 117827.67 + 99161.93 + 83450.86 + 70236.76 + 59110.03 - 200000$$

$$PW_{investment} = \$229,787.25$$

c) [2 point] Was the investment worth undertaking? Why?

The investment is worth undertaking, as the PW is positive.

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Homework #8

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8.1 The Parthenon Laboratory is planning to invest $650,000 in a technology to produce a new medicine. The new drug should reduce significantly the amount of risk involved with certain types of flu. The technology will last for 20 years, however, there is some uncertainty in the size of the revenue and costs involved. Assume a MARR of 15%; The possible outcomes for revenue and costs are given

Initial Cost	$650,000		
p (probability)	0.25	0.6	0.15
Annual Revenue	$ 500,000	$ 800,000	$ 1,200,000
Annual Costs	$ 90,000	$ 120,000	$ 144,000

Determine the FW of the project [4 points]

$$FW_{0.25} = -650000(\tfrac{F}{P}, 15\%, 20) + 410000(\tfrac{F}{A}, 15\%, 20) = -650000(16.367) + 410000(102.444)$$
$$FW_{0.25} = \$31,363,490$$

$$FW_{0.60} = -650000(\tfrac{F}{P}, 15\%, 20) + 680000(\tfrac{F}{A}, 15\%, 20) = -650000(16.367) + 680000(102.444)$$
$$FW_{0.60} = \$59,023,370$$

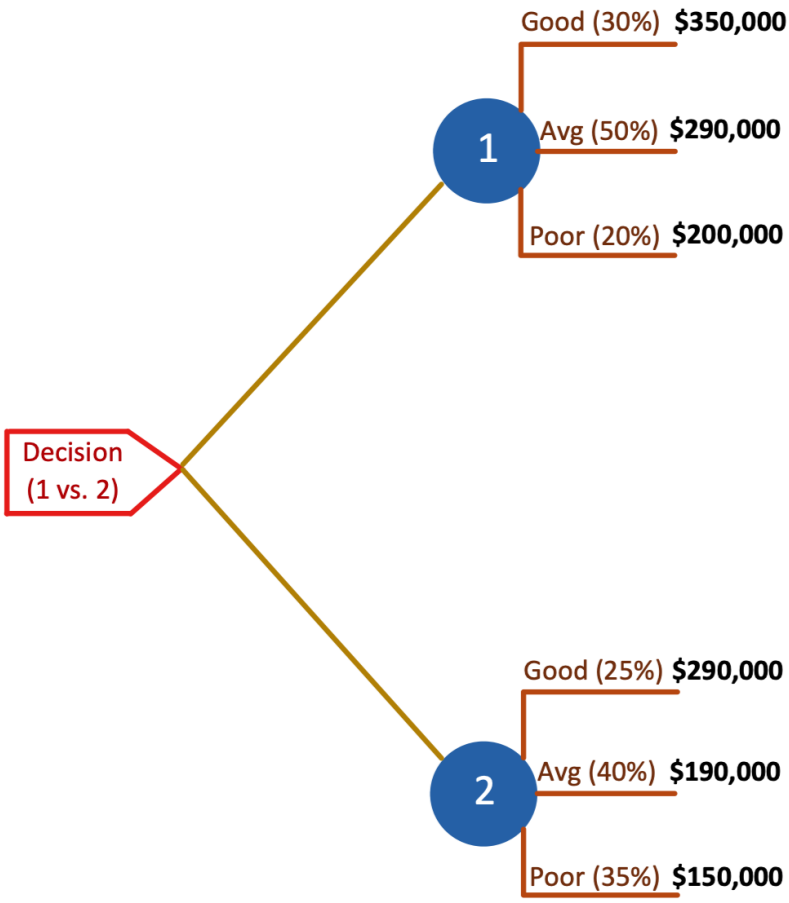
$$FW_{0.15} = -650000(\tfrac{F}{P}, 15\%, 20) + 1056000(\tfrac{F}{A}, 15\%, 20) = -650000(16.367) + 1056000(102.444)$$
$$FW_{0.15} = \$97,542,314$$

$$FW = (0.25)(\$31,363,490) + (0.60)(\$59,023,370) + (0.15)(\$97,542,314)$$
$$FW = \$57,886,241.60$$

8.2 A team at the RATP, the Parisian state-owned public transport operator, must advise which of two subway car models should be purchased (only one can be selected). Since the projects involve new technology, the performance is uncertain and the revenue will be different under each scenario. Estimated probabilities for each type of performance associated with annual savings are given below. Assume a 12% MARR and 30-year project life.

Alternative	Initial Investment	Performance	Probability	Annual Savings
1	$1,800,000	Good	0.3	$350,000
		Average	0.5	$290,000
		Poor	0.2	$200,000
2	$1,300,000	Good	0.25	$290,000
		Average	0.4	$190,000
		Poor	0.35	$150,000

a) Draw the Decision Tree [4 points]



b) What is the expected value of annual revenue for each alternative? [4 points]

Alternative 1:

$$EW = (0.3)(350000) + (0.5)(290000) + (0.2)(200000) = \$290,000$$

Alternative 2:

$$EW = (0.25)(290000) + (0.4)(190000) + (0.35)(150000) = \$201,000$$

c) What is the expected annual worth for each alternative? [4 points]

Alternative 1:

$$AW_{0.30} = -1,800,000(\tfrac{A}{P}, 12\%, 30) + 350,000 = \$126,620$$
$$AW_{0.50} = -1,800,000(\tfrac{A}{P}, 12\%, 30) + 290,000 = \$66,620$$
$$AW_{0.30} = -1,800,000(\tfrac{A}{P}, 12\%, 30) + 200,000 = -\$23,380$$

$$EW_1 = (0.3)(126620) + (0.5)(66620) + (0.2)(-23380) = \$66,620$$

Alternative 2:

$$AW_{0.25} = -1,300,000(\tfrac{A}{P}, 12\%, 30) + 290,000 = \$128,670$$
$$AW_{0.40} = -1,300,000(\tfrac{A}{P}, 12\%, 30) + 190,000 = \$28,670$$
$$AW_{0.35} = -1,300,000(\tfrac{A}{P}, 12\%, 30) + 150,000 = -\$11,330$$

$$EW_2 = (0.25)(128670) + (0.4)(28670) + (0.35)(-11330) = \$39,670$$

d) Which alternative do you recommend and why? [2 points]

I would recommend Alternative #1, as it proposes a higher annual worth than Alternative #2 (Almost double the amount) over the 30 year time period.