E355 Engineering Economics Spring 2022
Homework #6

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

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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%.

EOY	Old Machine		New Machine	
	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]

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

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

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

Defender:

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

$$EUAC_1 = (90000 - 75000) * (\tfrac{A}{P}, 10\%, 1) + (75000 * 0.10) = (15000) * (1.1) + 7500$$
$$EUAC_1 = \$24,000$$
$$EUAC_{MC_1} = (15000) * (\tfrac{A}{F}, 10\%, 1) = \$15,000$$

$$EUAC_2 = (90000 - 50000) * (\tfrac{A}{P}, 10\%, 2) + (50000 * 0.10) = (40000) * (0.5762) + 5000$$
$$EUAC_2 = \$28,048$$
$$EUAC_{MC_2} = (18000 + 15000 * (\tfrac{F}{P}, 10\%, 1)) * (\tfrac{A}{F}, 10\%, 2) = \$16,428.90$$

$$EUAC_3 = (90000 - 25000) * (\tfrac{A}{P}, 10\%, 3) + (25000 * 0.10) = (65000) * (0.4021) + 2500$$
$$EUAC_3 = \$28,636.50$$
$$EUAC_{MC_3} = (22000 + 18000 * (\tfrac{F}{P}, 10\%, 1) + 15000 * (\tfrac{F}{P}, 10\%, 2)) * (\tfrac{A}{F}, 10\%, 3) = \$18,110.90$$

EOY	Defender CR EUAC	Defender MC EUAC	Defender Total	Challenger CR EUAC	Challenger MC EUAC	Challenger 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**

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

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

$$EUAC_2 = (3800(\tfrac{P}{F}, 12\%, 1) + 4560(\tfrac{P}{F}, 12\%, 2)) \times (\tfrac{A}{P}, 12\%, 2)$$
$$EUAC_2 = (7028.25) \times (0.5917) = \$4,158.62$$

$$EUAC_3 = (7028.25 + 3200(\tfrac{P}{F}, 12\%, 3)) \times (\tfrac{A}{P}, 12\%, 3)$$
$$EUAC_3 = (9306.01) \times (0.4163) = \$3,874.09$$

$$EUAC_4 = (9306.01 + 2160(\tfrac{P}{F}, 12\%, 4)) \times (\tfrac{A}{P}, 12\%, 4)$$
$$EUAC_4 = (10678.69) \times (0.3292) = \$3,515.43$$

$$EUAC_5 = (10678.69 + 2516(\tfrac{P}{F}, 12\%, 5)) \times (\tfrac{A}{P}, 12\%, 5)$$
$$EUAC_5 = (12106.27) \times (0.2774) = \$3,358.28 \leftarrow \textbf{The economic life ends after 5 years}$$