**"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]

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| 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 |

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

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

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

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

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

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

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

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

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 ————— | | | ————— Challenger ————— | | |
| --- | --- | --- | --- | --- | --- | --- |
| | 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** |

The economic life is where the EUAC is smallest. Since the EUAC is smallest at year 1, the old machine should be replaced immediately.

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

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

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

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

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

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