IE2111 ISE Principles & Practice II
Solutions to Assignment #6

(*a*) Economic Service Life of the Challenger

MARR = 12%

Useful life = 4 years.

The challenger's total marginal costs and *EUAC* for each year of service are computed as follows:

	(A)	(B)	(C)	(D)	(E)=(B)+(C)+(D)	(F)
EoY	MV(k)	Loss of MV during year k	Cost of capital = i*MV(k-1)	Annual expenses E(k)	Total Marginal Cost TC(k)	EUAC
0	95,000.00					
1	75,000.00	20,000.00	11,400.00	10,000.00	41,400.00	41,400.00
2	65,000.00	10,000.00	9,000.00	12,000.00	31,000.00	36,494.34
3	51,000.00	14,000.00	7,800.00	13,000.00	34,800.00	35,992.22
4	33,000.00	18,000.00	6,120.00	16,500.00	40,620.00	36,960.51

The economic service life of the challenger is **3 years**

Optimal *EUAC*= **$35,992.22.**

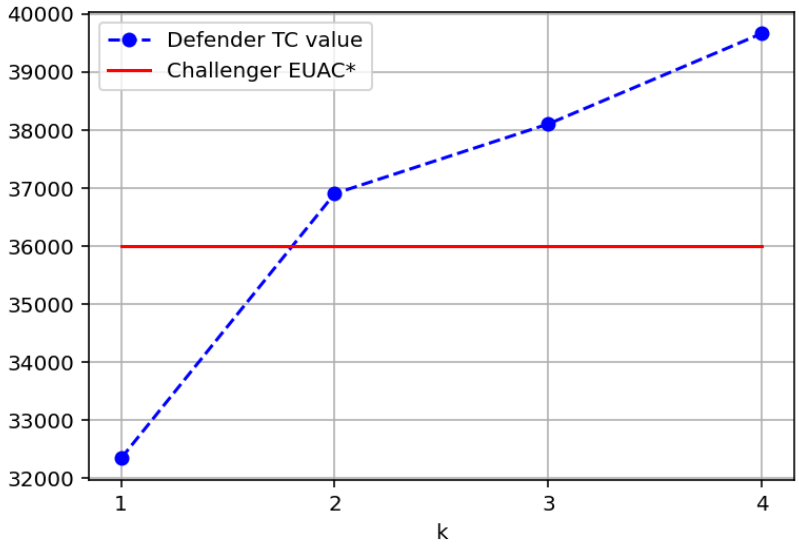
This means that if the challenger is purchased for use and its service is required for a very long time, it should be replaced with an identical one every 3 years under the repeatability assumption.

(*b*) Study period = infinity

Based on the opportunity cost approach, the year-by-year total marginal costs of the defender are computed as follows:

	(A)	(B)	(C)	(D)	(E)=(B)+(C)+(D)
EoY	MV(k)	Loss of MV during year k	Cost of capital = i*MV(k-1)	Annual expenses E(k)	Total Marginal Cost TC(k)
0	57,000.00				
1	45,000.00	12,000.00	6,840.00	13,500.00	32,340.00
2	30,000.00	15,000.00	5,400.00	16,500.00	36,900.00
3	18,000.00	12,000.00	3,600.00	22,500.00	38,100.00
4	6,000.00	12,000.00	2,160.00	25,500.00	39,660.00

First, we observed that the defender's TC_k values are monotonically increasing:



Next, we note that:

TC_1 of defender = \$32,340.00 < *EUAC** of Challenger < TC_2 of defender = \$36,900.00

Optimal replacement plan:

Keep the Defender for 1 more year.

Replace it with the Challenger at EoY 1.

The Challenger is then repeated every 3 years.

EPC (opportunity cost) of the optimal plan = $\dfrac{32{,}340 + 35{,}992.22/0.12}{(1+0.12)} = \$296{,}674.28$

EUAC (cash flow) of the optimal replacement plan

= (\$296,674.28 – 57,000.00) (0.12) = \$ **28,760.91**

(*c*) Study period = 2 years

Let (k_1, k_2, k_3) denotes the plan for using the defender for k_1 more year before replacing it by a challenger, using it for k_2 years, and then replacing it by another challenger using it for k_3 years.

There are four feasible alternative replacement plans:

No	Plan	Year 1	Year 2	*EPC*
1	(0, 1, 1)	41,400.00	41,400.00	$69,968.11
2	(0, 2, 0)	41,400.00	31,000.00	$61,677.30
3	(1, 1, 0)	32,340.00	41,400.00	$61,878.83
4	(2, 0, 0)	32,340.00	36,900.00	$58,291.45

The optimal plan is (2, 0, 0), i.e., keep the defender and use it for 2 more years. The challenger is not used.

EPC (opportunity cost) of the optimal plan= $58,291.45

EUAC (cash flow) of the optimal replacement plan = ($58,291.45 – $57,000.00) [*A*/*P*, 12%, 2]
= 1,291.45 (0.5916981)
= **$ 764.15**

(*d*) Study period = 4 years with max 2 replacements

Using the same notations as above, there are 11 feasible alternative replacement plans if only up to two replacements are allowed:

No	Plan	Year 1	Year 2	Year 3	Year 4	PWC
1	(0, 1, 3)	41,400.00	41,400.00	31,000.00	34,800.00	$114,149.33
2	(0, 2, 2)	41,400.00	31,000.00	41,400.00	31,000.00	$110,846.06
3	(0, 3, 1)	41,400.00	31,000.00	34,800.00	41,400.00	$112,757.70
4	(0, 4, 0)	41,400.00	31,000.00	34,800.00	40,620.00	$112,261.99
5	(1, 1, 2)	32,340.00	41,400.00	41,400.00	31,000.00	$111,047.59
6	(1, 2, 1)	32,340.00	41,400.00	31,000.00	41,400.00	$110,254.46
7	(1, 3, 0)	32,340.00	41,400.00	31,000.00	34,800.00	$106,060.04
8	(2, 1,1)	32,340.00	36,900.00	41,400.00	41,400.00	$114,069.60
9	(2, 2, 0)	32,340.00	36,900.00	41,400.00	31,000.00	$107,460.22
10	(3, 1, 0)	32,340.00	36,900.00	38,100.00	41,400.00	$111,720.73
11	(4, 0, 0)	32,340.00	36,900.00	38,100.00	39,660.00	$110,614.93

The optimal replacement plan is (1, 3, 0), i.e., keep the defender for one more year and then replace it by the challenger and use it for 3 years.

EPC (opportunity cost) of the optimal replacement plan = $106,060.04

EUAC (cash flow) of the optimal replacement plan = (106,060.04 – $57,000.00) [*A*/*P*, 12%, 4]
= 49,060.04 (0.32923444)
= **$ 16,152.26**