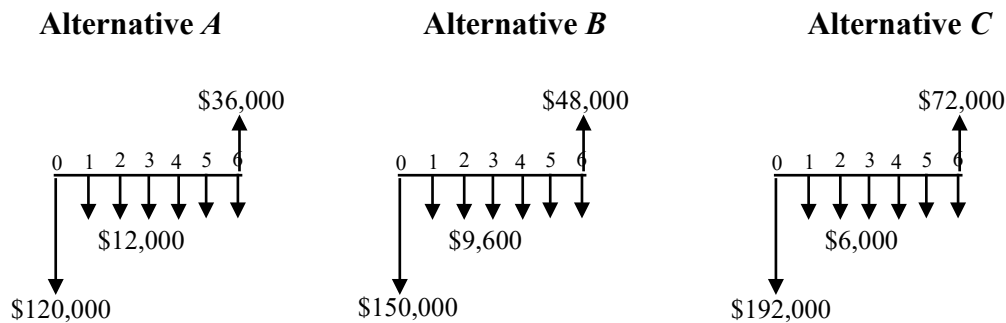


**IE2111 ISE Principles & Practice II**  
**Solutions to Assignment #3**

	Alternative A	Alternative B	Alternative C
Initial Cost	\$120,000	\$150,000	\$192,000
Useful Life	6 years	12 years	18 years
Annual O&M Cost	Year 1 to 6: \$12,000	Year 1 to 6: \$9,600 Year 7 to 12: \$14,400	Year 1 to 6: \$6,000 Year 7 to 12: \$12,000 Year 13 to 18: \$18,000
Market value at EoY 6	\$36,000	\$48,000	\$72,000
Market value at EoY 12	--	\$24,000	\$30,000
Market value at EoY 18	--	--	\$18,000

$MARR = 6\%$ .

- (a) Study period = 6 years.  
*PW* method.  
 Assume that Alternatives *B* and *C* are co-terminated at EoY 6.



$$\begin{aligned}
 &PW(6\%) \text{ of } A \text{ over 6 years} \\
 &= -120,000 - 12,000 [P/A, 6\%, 6] + 36,000 [P/F, 6\%, 6] \\
 &= -120,000 - 12,000 (4.9173244) + 36,000 (0.7049605) \\
 &= -\$153,629.31
 \end{aligned}$$

$$\begin{aligned}
 &PW(6\%) \text{ of } B \text{ over 6 years} \\
 &= -150,000 - 9,600 [P/A, 6\%, 6] + 48,000 [P/F, 6\%, 6] \\
 &= -150,000 - 9,600 (4.9173244) + 48,000 (0.7049605) \\
 &= -\$163,368.21
 \end{aligned}$$

$$\begin{aligned}
 &PW(6\%) \text{ of } C \text{ over 6 years} \\
 &= -192,000 - 6,000 [P/A, 6\%, 6] + 72,000 [P/F, 6\%, 6] \\
 &= -192,000 - 6,000 (4.9173244) + 72,000 (0.7049605) \\
 &= -\$170,746.79
 \end{aligned}$$

**Answer:** Choose Alternative *A* which has the highest *PW* over the study period of 6 years.

- (b) Study period = 6 years.  
Incremental *IRR* method  
Assume that Alternatives *B* and *C* are co-terminated at EoY 6.  
Project Type: Cost/Service projects

Initialization:

Projects sorted in increasing initial cost = [ *A*, *B*, *C* ]  
Base project = “*A*”.  
Next project = “*B*”  
List = [ *C* ]

Iteration 1:

	Cash flows for “ <i>B</i> – <i>A</i> ”	
Initial Cost	$-150,000 - (-120,000) =$	$-\$30,000$
Annual O&M Y1 to Y6	$-9,600 - (-12,000) =$	$\$2,400$
Market value at EoY 6	$48,000 - 36,000 =$	$\$12,000$

To find  $IRR(“B - A”)$ , we solve:

$$-30,000 + 2,400 [P/A, i\%, 6] + 12,000 [P/F, i\%, 6] = 0$$

Using Excel:  $=RATE(6, 2400, -30000, 12000, 0, 0.1) = -0.02695$

$$IRR(“B - A”) = -2.695\% < MARR = 6\%.$$

$\Rightarrow$  Incremental investment from A to B is infeasible

Base project = “*A*”.  
Next project = “*C*”  
List = [ ]

Iteration 2:

	Cash flows for “ <i>C</i> – <i>A</i> ”	
Initial Cost	$-192,000 - (-120,000) =$	$-\$72,000$
Annual Benefits	$-6,000 - (-12,000) =$	$\$6,000$
Market value at EoY 6	$72,000 - 36,000 =$	$\$36,000$

To find  $IRR(“C - A”)$ , we solve:

$$-72,000 + 6,000 [P/A, i\%, 6] + 36,000 [P/F, i\%, 6] = 0$$

Using Excel:  $=RATE(6, 6000, -72000, 36000, 0, 0.1) = 0.00$

$$IRR(“C - A”) = 0\% < MARR = 6\%.$$

$\Rightarrow$  The incremental investment for A to C is infeasible

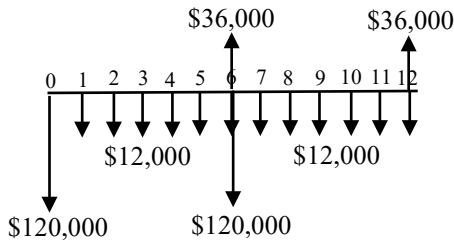
**Answer: Choose Alternative *A* based on the incremental *IRR* analysis.**

(c) Study period = 12 years.

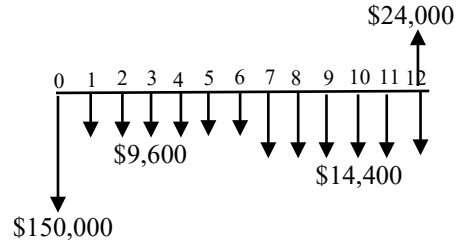
*PW* method.

Assume that Alternative *A* is repeated once at EoY 6 and  
Alternative *C* is co-terminated at EoY 12.

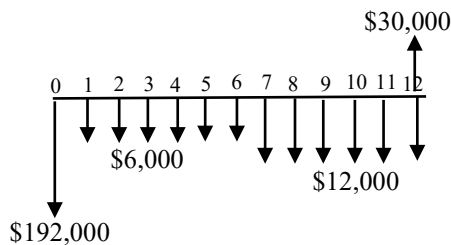
**Alternative A**



**Alternative B**



**Alternative C**



*PW*(6%) of *A* over 12 years

$$\begin{aligned}
 &= PW(6\%) \text{ of } A \text{ over first 6 years } (1 + [P/F, 6\%, 6]) \\
 &= -153,629.31 (1 + 0.7049605) \quad // \text{ from part (a)} \\
 &= -\$261,931.92
 \end{aligned}$$

*PW*(6%) of *B* over 12 years

$$\begin{aligned}
 &= -150,000 - 9,600 [P/A, 6\%, 6] - 14,400 [P/A, 6\%, 6] [P/F, 6\%, 6] + 24,000 [P/F, 6\%, 12] \\
 &= -150,000 - 9,600 (4.9173243) - 14,400 (4.9173243) (0.7049605) + 24,000 (0.4969694) \\
 &= -\$235,196.93
 \end{aligned}$$

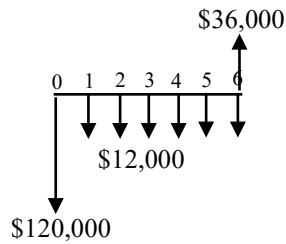
*PW*(6%) of *C* over 12 years

$$\begin{aligned}
 &= -192,000 - 6,000 [P/A, 6\%, 6] - 12,000 [P/A, 6\%, 6] [P/F, 6\%, 6] + 30,000 [P/F, 6\%, 12] \\
 &= -192,000 - 6,000 (4.9173243) - 12,000 (4.9173243) (0.7049605) + 30,000 (0.4969694) \\
 &= -\$248,193.10
 \end{aligned}$$

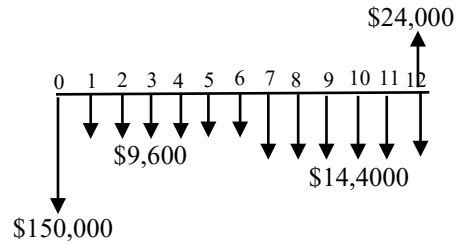
**Answer: Choose Alternative *B* which has the highest *PW* over the study period of 12 years.**

- (d) Study Period = Infinity.  
*AW* method.  
 Assume all 3 alternatives can be repeated indefinitely.

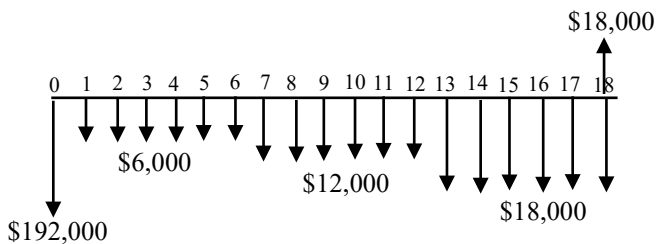
**Alternative A (1 life cycle)**



**Alternative B (1 life cycle)**



**Alternative C (1 life cycle)**



$$\begin{aligned}
 &AW(6\%) \text{ of } A \text{ over 1 life cycle} \\
 &= PW(6\%) \text{ over 6 years } [A/P, 6\%, 6] \\
 &= -153,629.31 (0.2033626) \\
 &= -\$ 31,242.46
 \end{aligned}$$

$$\begin{aligned}
 &AW(6\%) \text{ of } B \text{ over 1 life cycle} \\
 &= PW(6\%) \text{ over 12 years } [A/P, 6\%, 12] \\
 &= -\$235,196.93 (0.1192770) \\
 &= -\$ 28,053.59
 \end{aligned}$$

$$\begin{aligned}
 &AW(6\%) \text{ of } C \text{ over 1 life cycle} \\
 &= \{ -192,000 - 6,000 [P/A, 6\%, 6] - 12,000 [P/A, 6\%, 6] [P/F, 6\%, 6] \\
 &\quad - 18,000 [P/A, 6\%, 5] [P/F, 6\%, 12] \} [A/P, 6\%, 18] \quad \# \text{ net CF at EoY 18 is zero} \\
 &= \{ -192,000 - 6,000 (4.9173243) - 12,000 (4.9173243) (0.7049605) \\
 &\quad - 18,000 (4.2123638) (0.4969694) \} 0.0923565 \\
 &= -\$ 27,779.34
 \end{aligned}$$

**Answer: Choose System C which has the highest *AW* over the study period of infinity.**