Name: Solution

You may use the FE Handout for Engineering Economics provided to complete this test.  
To get any partial credit, you must show your work.  
All work should be shown on these pages.

1. (15 Points) On a piece of machinery, it is estimated that the maintenance expense will be as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$100</td>
</tr>
<tr>
<td>2</td>
<td>$200</td>
</tr>
<tr>
<td>3</td>
<td>$300</td>
</tr>
<tr>
<td>4</td>
<td>$400</td>
</tr>
</tbody>
</table>

What is the equivalent uniform annual maintenance cost for the machinery if the interest rate is 12%?

a) $135.89  
b) $185.36  
c) $223.21  
d) $233.89

\[
\text{Gradient not in proper format}
\]

\[
A = 100 + 100 \left( A \left( 1.05, 12\%, 4 \right) \right) = 100 + 100 \left( 1.3589 \right) = 235.89
\]
2. (20 points) The electric company needs to upgrade a portion of its power system. Based on expected needs, there are two options.

<table>
<thead>
<tr>
<th></th>
<th>Option A</th>
<th>Option B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Upgrade</td>
<td>$10,000</td>
<td>$22,000</td>
</tr>
<tr>
<td>Second Upgrade at Year X</td>
<td>$46,609</td>
<td>$25,000</td>
</tr>
</tbody>
</table>

If interest rates are 4%, how many years between the initial expenditure and the future expenditure will make the two methods economically equal?

a) 4 years  

b) 8 years  

c) 10 years  

d) 15 years

\[
\int_{10,000}^{46,609} = \int_{21,000}^{25,000}
\]

\[
10,000 + 46,609 \left( \frac{P}{F, 4\%, n} \right) = 22,000 + 25,000 \left( \frac{P}{F, 4\%, n} \right)
\]

\[
\left( \frac{P}{F, 4\%, n} \right) = \frac{22,000 - 10,000}{46,609 - 25,000} = 0.5552
\]

See Table: \( n = 15 \)
3. (15 points) The monthly maintenance costs associated with a machine are $6,000 for the first 12 months and $8,000 thereafter. The machine has a life of 30 months. What is the future worth of the monthly disbursements if the annual interest rate is 6%? Clearly indicate your answer.

\[ F = 6k \left( \frac{F}{A}, 0.5\% \text{, } 0 \right) + 2k \left( \frac{F}{A}, 0.5\% \text{, } 18 \right) \]

\[ F = 6k \left( 32.28 \right) + 2k \left( 18.7858 \right) \]

\[ F = 231,252 \]

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4. (15 Points) What is the annual equivalent cost of the following cash flow diagram? The interest rate is 12%.

\[
\dot{C} = 12\% \\

A_{eq} = 7k + \left[ 18k \left( P/F, 12\%, 3 \right) + 3k \left( P/F, 12\%, 7 \right) \right] \left( A/P, 12\%, 9 \right)
\]

Present value of outlays at years 3 and 7

\[
A_{eq} = 7k + [18k(0.7118) + 3k(0.4523)](0.1877)
\]

\[
A_{eq} = 8,660
\]
5. (15 points) The following alternatives are being considered for a governmental service. Compare the present worths of the cost of 24 years of service for an interest rate of 10%.

<table>
<thead>
<tr>
<th></th>
<th>Option A</th>
<th>Option B</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Cost</td>
<td>$9,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>Salvage Value</td>
<td>$0</td>
<td>$4,000</td>
</tr>
<tr>
<td>Annual Maintenance</td>
<td>$2,200</td>
<td>$1,400</td>
</tr>
<tr>
<td>Useful Life (years)</td>
<td>12</td>
<td>24</td>
</tr>
</tbody>
</table>

Option A $\rightarrow$ 2 cycles

\[ P_A = 9k + 2.2k \left( P_{A_1}, 10\%_0, 24 \right) \]
\[ + 9k \left( P_{A_1}, 10\%_0, 12 \right) \]
\[ = 9k + 2.2k (8.947) + 9k (0.3186) \]
\[ P_A = 31.624 \]

Option B $\rightarrow$ 3 cycle

\[ P_B = 20k + 1.4k \left( P_{B_1}, 10\%_0, 24 \right) \]
\[ - 1.4k \left( P_{B_1}, 10\%_0, 12 \right) \]
\[ = 20k + 1.4k (8.947) - 1.4k (0.1015) \]
\[ P_B = 22.173 \]

5/6
6. (15 points) A piece of equipment will cost $5,000 new and have no salvage value at the end of its 6 year life. The taxes, insurance, maintenance, fuel, and other service are estimated to be $1,500 in the first year, $1,700 in the second year, $1,900 in the third year, and to continue to increase by $200 each year thereafter. What is the equivalent uniform annual cost of this piece of equipment if the interest rate is 12%?

\[ A_{eq} = 6K \left( \frac{A/P}{12\%, 6} \right) + 1.5K + 0.2K \left( \frac{A/F}{6, 12\%, 6} \right) \]

\[ = 6K \left( 0.2432 \right) + 1.5K + 0.2K \left( 2.1770 \right) \]

\[ A_{eq} = \$3,394 K \]

\[ A_{eq} = \text{\$3,394} \]