1. (35 p) The two cash flow transactions shown in the accompanying cash flow diagram are said to be equivalent at 6% interest compounded quarterly. Find the unknown value of $X$ that satisfies the equivalence.

![Cash Flow Diagram]

2. (35 p) A company that manufactures amplified pressure transducers is trying to decide between the machines shown below:

<table>
<thead>
<tr>
<th>Variable Speed</th>
<th>Dual Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment, $</td>
<td>-250 000</td>
</tr>
<tr>
<td>Annual operating cost, $/year</td>
<td>-231 000</td>
</tr>
<tr>
<td>Overhaul in year 3, $</td>
<td>-</td>
</tr>
<tr>
<td>Overhaul in year 4, $</td>
<td>-39 000</td>
</tr>
<tr>
<td>Salvage value, $</td>
<td>50 000</td>
</tr>
<tr>
<td>Life, years</td>
<td>6</td>
</tr>
</tbody>
</table>

a) Compare them on the basis of their annual equivalent (AE), if the company’s MARR is 15% per year. Which machine should be selected?

b) To compare these mutually exclusive alternatives on the basis of incremental cash flow rate of return, write the root-finding equation to be solved for $i$ by trial and error or Excel?

3. (30 p) A fiber optics testing device is to be depreciated. It has an initial cost of $25 000 and an estimated salvage value of $2500 after 12 years.

a) Calculate the depreciation and book value for years 1 and 4 by using SL method.

b) Calculate the depreciation and book value for years 1 and 4 by using DB method.

c) Calculate the depreciation and book value for years 1 and 4 by using DDB method.

Fixed percentage Matheson formula:

$$a = 1 - \left(\frac{S}{I}\right)^{\frac{1}{N}}$$
1. Given: both yearly deposits \((K = 1)\) of cash flows

\[
r = 6\% \text{ compounded quarterly}
\]

\[
M = 4, \quad K = 1, \quad C = \frac{M}{K} = 4
\]

Find: Equivalent annual deposit amount \((X)\) of the second cash flow for the same \(P\) or \(F\) value with the 1st cash flow.

First cash flow:

\[
i_p = i_a = (1 + i_c)^C - 1 = (1 + \frac{r}{M})^C - 1 = (1 + \frac{0.06}{4})^4 - 1 = 0.0614 (6.14\%)
\]

Second cash flow:

It is based on equal end-of-year deposit over 5 years with the same interest compounding.

\[
K = 1, M = 4
\]

\[
C = \frac{M}{K} = \frac{4}{1} = 4
\]

\[
i_p = i_a = (1 + i_c)^C - 1 = (1 + \frac{0.06}{4})^4 - 1 = 0.0614 (6.14\%)
\]

Effective annual interest = \(i_a = (1 + i_p)^C - 1 = i_p = 0.0614(6.14\%)

\(A\) can be calculated by equating the present worth of the first cash flow to the present worth of the second cash flow as follows:

\[
\begin{align*}
\text{Interest factors were taken from Park Table/p.890} \\
200 + 100(P/A, 6.14\%, 5) + 50(P/F, 6.14\%, 1) + 50(P/F, 6.14\%, 4) \\
+ 100(P/F, 6.14\%, 5) &= X(P/A, 6.14\%, 5) \\
A &= 185.96
\end{align*}
\]

2. Given: \(MARR = 15\%\) per year

a) \(AE(15\%)_{\text{Variable Speed}} = -250\,000(A/P, 15\%, 6) - 231\,000 -39\,000(P/F, 15\%, 4)(A/P, 15\%, 6) + 50\,000(A/F, 15\%, 6)

\[
= -250\,000(0.2642) - 231\,000 -39\,000(0.5718)(0.2642) + 50\,000(0.1142)
\]

\[= \text{-297231.71} \] (Interest factors were taken from Park Table/p.890)

\(AE(15\%)_{\text{Dual Speed}} = -225\,000(A/P, 15\%, 6) - 235\,000 -26\,000(P/F, 15\%, 3)(A/P, 15\%, 6) + 10\,000(A/F, 15\%, 6)

\[
= -225\,000(0.2642) - 235\,000 -26\,000(0.6575)(0.2642) + 10\,000(0.1142)
\]

\[= \text{-297819.50} \] (Interest factors were taken from Park Table/p.890)

\(AE(15\%)_{\text{Variable Speed}} > AE(15\%)_{\text{Dual Speed}}\) Select Variable Speed machine requiring extra $25000 investment(higher AE than that of Dual speed alternative)
b) Root-finding equation to be solved for $i$ by trial and error or Excel was given as follows according to the incremental cash flow (Variable Speed CF-Dual Speed Cash Flow)

<table>
<thead>
<tr>
<th></th>
<th>Variable Speed</th>
<th>Dual Speed</th>
<th>Variable-Dual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment, $</td>
<td>-250 000</td>
<td>-225 000</td>
<td>-25000</td>
</tr>
<tr>
<td>Annual operating cost, $/year</td>
<td>-231 000</td>
<td>-235 000</td>
<td>4000</td>
</tr>
<tr>
<td>Overhaul in year 3, $</td>
<td>-</td>
<td>-26 000</td>
<td>26000</td>
</tr>
<tr>
<td>Overhaul in year 4, $</td>
<td>-39 000</td>
<td>-</td>
<td>-39000</td>
</tr>
<tr>
<td>Salvage value, $</td>
<td>50 000</td>
<td>10 000</td>
<td>40000</td>
</tr>
<tr>
<td>Life, years</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

$$PW(i) = -25000 + 4000(P/A, i, 6) + 26000(P/F, i, 3) - 39000(P/F, i, 4) + 40000(P/F, i, 6) = 0$$

$$-25000 + 4000 \left( \frac{(1+i)^6-1}{i(1+i)^6} \right) + 26000(1+i)^{-3} - 39000(1+i)^{-4} + 40000(1+i)^{-6} = 0$$

This equation given above should be solved for $i$ by trial and error or Excel.

(Excel gives $i=17.4\%>MARR(15\%)$. Decision will be the same with AE method: variable speed)

3. a) 

$$D_{SL} = \frac{I - S}{N} = \frac{25000 - 2500}{12} = 1875$$

$$D_1 = D_2 = \cdots = D_4 = \cdots = D_{12} = 1875$$

$$B_n = I - nD$$

$$B_3 = 25000 - (1)(1875) = 23125$$

$$B_4 = 25000 - (4)(1875) = 17500$$

b) 

$$\alpha = 1 - \left( \frac{S}{I} \right)^{\frac{1}{N}} = 1 - \left( \frac{2500}{25000} \right)^{\frac{1}{12}} = 0.1746$$

$$D_n = \alpha B_{n-1}; B_{n-1} = I(1 - \alpha)^{n-1}; B_n = I(1 - \alpha^n)$$

For $n=1$ and $n=4$:

$$D_1 = \alpha B_0 = 0.1746(25000) = 4365; B_1 = I(1 - \alpha) = 25000(1 - 0.1746) = 20635$$

$$D_4 = \alpha B_3 = 0.1746(25000)(1 - 0.1746)^3 = 2454.58$$

$$B_4 = I(1 - \alpha)^4 = 25000(1 - 0.1746)^4 = 11603.74$$

c) DDB fixed percentage:

$$\alpha = (Multiplier) \left( \frac{1}{N} \right) = (200\%) \left( \frac{1}{12} \right) = (2.0) \left( \frac{1}{12} \right) = 0.1667$$

For $n=1$ and $n=4$:

$$D_1 = \alpha B_0 = 0.1667(25000) = 4167.5; B_1 = I(1 - \alpha) = 25000(1 - 0.1667) = 20832.50$$

$$D_4 = \alpha B_3 = 0.1667(25000)(1 - 0.1667)^3 = 2411.46$$

$$B_4 = I(1 - \alpha)^4 = 25000(1 - 0.1667)^4 = 12054.40$$