1. (35 p) Suppose you deposit $1,000 at the end of each quarter for 5 years at an interest of 8% compounded monthly. What equal end-of-year deposit over 5 years would accumulate the same amount at the end of 5 years under the nominal interest rate of 9% compounded quarterly?

2. (35 p) Compare the mutually exclusive alternatives shown below on the basis of their capitalized equivalent (CE), using an interest rate 10% per year as MARR.
   a) Which alternative should be selected using CE evaluation?
   b) If the rate of return (ROR) analysis based on the incremental cash flow is used to decide, write down the corresponding equation to be solved for the decision.

<table>
<thead>
<tr>
<th>Alternative A</th>
<th>Alternative B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment, $</td>
<td>-300 000</td>
</tr>
<tr>
<td>Annual operating cost, $/year</td>
<td>-100 000</td>
</tr>
<tr>
<td>Annual revenues, $/year</td>
<td>500 000</td>
</tr>
<tr>
<td>Salvage value, $</td>
<td>70 000</td>
</tr>
<tr>
<td>Life, years</td>
<td>6</td>
</tr>
</tbody>
</table>

3. (30 p) Consider the following data on an asset:

   | Cost of the asset, I | $75000 |
   | Useful life, N | 8 years |
   | Salvage value, S | $2500 |

Compute the annual depreciation allowances and the resulting book values in a table, initially using the DDB and then switching to SL.
1. Given: deposit frequency=$1000 per quarter
   \( r = 8\% \) compounded monthly
   \( N = 20 \) quarters

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

**First cash flow:**
\( i_p \) should be determined according to the payment period of the first cash flow by considering compounding monthly:
\[
K = 4, M = 12 \\
C = \frac{M}{K} = \frac{12}{4} = 3 \\
\]
\[
i_p = (1 + i_c)^C - 1 = (1 + \frac{r}{M})^C - 1 = \left(1 + \frac{0.08}{12}\right)^3 - 1 = 0.0201 (2.01\%)
\]

**Second cash flow:**
It is based on equal end-of-year deposit over 5 years with the 9\% nominal interest rate compounded quarterly.
\[
K = 1, M = 4 \\
C = \frac{M}{K} = \frac{4}{1} = 4 \\
\]
\[
i_p = i_a = (1 + i_c)^C - 1 = \left(1 + \frac{0.09}{4}\right)^4 - 1 = 0.0931 (9.31\%)
\]

Effective annual interest rate = \( i_a = (1 + i_p)^K - 1 = i_p = 0.0931 \) (9.31\%)

\( A \) can be calculated by equating the future worth of the first cash flow to the future worth of the second cash flow as follows:
\[
$1000(F/A, 2.01\%, 20) = A (F/A, 9.31\%, 5)
\]

From the equal payment series compound amount formula (Table 3.4/Textbook/Park 4th ed.):
\[
$1000 \left[\frac{(1 + 0.0201)^{20} - 1}{0.0201}\right] = A \left[\frac{(1 + 0.0931)^5 - 1}{0.0931}\right]
\]
\[
A = $4038.93
\]

2. a)

Given: Nominal Interest Rate 10\% compounded annually (MARR)
Annual operating costs and revenues (K=1); \( r = 10\% \), M=1 (annual compounding); C=M/K=1/1=1
\[
r = i_p = i_a = 0.10 \text{ (effective annual interest rate 10\%)}
\]

\[
(CE)_{Alternative A} = \frac{(AE)_{Alternative A}}{i_p}
\]
\[
(CE)_{Alternative A} = \frac{-300000(A/P, 10\%, 6) - 100000 + 500000 + 70000(A/F, 10\%, 6)}{0.10} = $340192
\]
\[
(CE)_{Alternative A} = \frac{-300000(0.2296) - 100000 + 500000 + 70000(0.1296)}{0.10} = $340192
\]
\[
(CE)_{Alternative A} = \frac{340192}{0.10} = $3401920
\]
(CE)_{Alternative B} = \frac{(AE)_{Alternative B}}{i_p} 

\begin{align*}
(AE)_{Alternative B} = -150000 \left( \frac{A}{P}, 10\%, 6 \right) - 55000 + 300000 + 30000 \left( \frac{A}{F}, 10\%, 6 \right) \\
(AE)_{Alternative B} = -150000(0.2296) - 55000 + 300000 + 30000(0.1296) = 214448 \\
(CE)_{Alternative B} = \frac{214448}{0.10} = 2144480 \\
(CE)_{Alternative A} > (CE)_{Alternative B} \\
3401920 > 2144480
\end{align*}

Select: Alternative A based on AE or CE method.

b)
<table>
<thead>
<tr>
<th></th>
<th>Alternative A</th>
<th>Alternative B</th>
<th>A-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment, $</td>
<td>-300 000</td>
<td>-150 000</td>
<td>-150 000</td>
</tr>
<tr>
<td>Annual operating cost, $/year</td>
<td>-100 000</td>
<td>-55 000</td>
<td>-45 000</td>
</tr>
<tr>
<td>Annual revenues, $/year</td>
<td>500 000</td>
<td>300 000</td>
<td>200 000</td>
</tr>
<tr>
<td>Salvage value, $</td>
<td>70 000</td>
<td>30 000</td>
<td>40 000</td>
</tr>
<tr>
<td>Life, years</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

\[ PW(i^*) = -150000 + 155000 \left( \frac{(1 + i^*)^6 - 1}{i^*(1 + i^*)^6} \right) + 400000 \left( \frac{(1 + i^*)^6 - 1}{i^*(1 + i^*)^6} \right) = 0 \]

This equation given above should be solved for the root \( i^* \) by trial and error or Excel. For the decision based on incremental analysis, \( i^* \) to be found should be higher than 10\% (MARR).

3.
\[ \alpha = (Multiplier) \left( \frac{1}{N} \right) = (200\%) \left( \frac{1}{8} \right) = (2.0) \left( \frac{1}{8} \right) = 0.25 \]
\[ D_n = \alpha B_{n-1}; B_{n-1} = I(1 - \alpha)^{n-1} = 75000(1 - 0.25)^{n-1} \]

The depreciation allowances and book values were tabulated as follows by switching to SL on the year 6:

<table>
<thead>
<tr>
<th>( n )</th>
<th>( D_n )</th>
<th>( B_n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>75000(0.25) = 18750</td>
<td>75000 - 18750 = 56250</td>
</tr>
<tr>
<td>2</td>
<td>56250(0.25) = 14063</td>
<td>56250 - 14063 = 42187</td>
</tr>
<tr>
<td>3</td>
<td>42187(0.25) = 10547</td>
<td>42187 - 10547 = 31640</td>
</tr>
<tr>
<td>4</td>
<td>31640(0.25) = 7910</td>
<td>31640 - 7910 = 23730</td>
</tr>
<tr>
<td>5</td>
<td>23730(0.25) = 5933</td>
<td>23730 - 5933 = 17797</td>
</tr>
</tbody>
</table>

\[ D_{SL} = \frac{23730 - 2500}{4} = 5308 \text{ < 5933 do not switch to SL} \]

6.
\[ D_{SL} = \frac{17797(0.25) = 4449}{3} = 5099 \text{ > 4449, switch to SL} \]

<table>
<thead>
<tr>
<th>( n )</th>
<th>( D_{SL} )</th>
<th>( B_{SL} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>5099</td>
<td>12698 - 5099 = 7599</td>
</tr>
<tr>
<td>8</td>
<td>5099</td>
<td>7599 - 5099 = 2500 = S</td>
</tr>
</tbody>
</table>