1. (25 p) Suppose you deposit $1,000 at the end of each quarter for 5 years at an interest of 8% compounded weekly. What equal end-of-year deposit over 5 years would accumulate the same amount at the end of 5 years under the same interest compounding (8%, compounded weekly)?

2. (25 p) Compare the mutually exclusive alternatives shown below on the basis of their annual equivalent (AE), using an interest rate 12% per year, compounded quarterly. Which alternative should be selected using AE evaluation?

<table>
<thead>
<tr>
<th>Alternative E</th>
<th>Alternative F</th>
<th>Alternative G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment, $</td>
<td>$200,000</td>
<td>$300,000</td>
</tr>
<tr>
<td>Quarterly income, $/quarter</td>
<td>$30,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>Salvage value, $</td>
<td>$50,000</td>
<td>$70,000</td>
</tr>
<tr>
<td>Life, years</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

3. (25 p) A manufacturing firm is considering the mutually exclusive alternatives shown below. Determine which project is a better choice at a MARR=18% based on the incremental rate of return analysis (IRR).

<table>
<thead>
<tr>
<th>n</th>
<th>Project A</th>
<th>Project B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-2600</td>
<td>-3700</td>
</tr>
<tr>
<td>1</td>
<td>1700</td>
<td>2800</td>
</tr>
<tr>
<td>2</td>
<td>1940</td>
<td>2400</td>
</tr>
</tbody>
</table>

4. (25 p) Two electrical and electronics engineers who own a process analysis and control business for which they have purchased computer equipment for $25,000. They do not expect the computers to have a positive salvage or trade-in value after the anticipated 5-year life. For book depreciation purposes, they want to determine depreciation costs ($D_n$, $S$) and book values ($B_n$, $S$) in a table for the following methods: a) Straight-line depreciation method (SL), b) 125% Declining-Balance (DB) method, c) Double Declining-Balance (DDB) method.
ECON 305 ENGINEERING ECONOMICS SPRING 11-12 FINAL EXAM SOLUTIONS

1. Given: deposit frequency=$1000 per quarter

\[ r = 8\% \text{ compounded weekly} \]
\[ N = 20 \text{ quarters} \]

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

**First cash flow:**

\( K = 4, M = 52 \)
\[ C = \frac{M}{K} = \frac{52}{4} = 13 \]

\[ i_p = (1 + i_c)^C - 1 = (1 + \frac{r}{M})^C - 1 = (1 + \frac{0.08}{52})^{13} - 1 = 0.0202 \ (2.02\%) \]

**Second cash flow:**

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

\( K = 1, M = 52 \)
\[ C = \frac{M}{K} = \frac{52}{1} = 52 \]

\[ i_p = i_a = (1 + i_c)^C - 1 = \left(1 + \frac{1}{52}\right)^{52} - 1 = 0.0832 \ (8.32\%) \]

Effective annual interest \( i = (1 + i_p)^K - 1 = i_p = 0.0832(8.32\%) \)

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

\[ \$1000(F/A, 2.02\%, 20) = A \frac{F}{A, 8.32\%, 5} \]

From the equal payment series compound amount formula (Table 3.4/Textbook/Park 4\(^{th} \) ed.):

\[ A = \frac{F}{A, 8.32\%, 5} = \frac{1000(1 + 0.0202)^{20} - 1}{0.0202} = \frac{(1 + 0.0832)^5 - 1}{0.0832} \]

\[ A = \$4123.51 \]

2. Given: \( r = 12\% \text{ compounded quarterly}, \text{ quarterly income}, C = \frac{M}{K} = \frac{4}{4} = 1 \)

\[ i_p = i_c = \frac{r}{M} = \frac{0.12}{4} = 0.03 \ (3\%) \]

\[ A = \frac{F}{A, 3\%, 8} + 30 000 + 50 000(A/F, 3\%, 8) \]
\[ = 200 000(1.1425) + 30 000 + 50 000(0.1125) \]
\[ = \$7125 \] (Interest factors were taken from Park Table/p.878)

\[ A = \frac{F}{A, 3\%, 16} + 10 000 + 70 000(A/F, 3\%, 16) \]
\[ = 300 000(0.0796) + 10 000 + 70 000(0.0496) \]
\[ = \$10408 \] (Interest factors were taken from Park Table/p.878)

\[ A = \frac{F}{A, 3\%, N \to \infty} + 40 000 + 100 000(A/F, 3\%, N \to \infty) \]

\[ \lim_{N \to \infty} (A/P, 3\%, N \to \infty) = \lim_{N \to \infty} \left[ \frac{i(1 + i)^N}{(1 + i)^N - 1} \right] = \lim_{N \to \infty} \left[ \frac{1}{i - 1} \right] = i \]

\[ \lim_{N \to \infty} (A/F, 3\%, N \to \infty) = \lim_{N \to \infty} \left[ \frac{i}{(1 + i)^N - 1} \right] = 0 \]
AE(12%)₇₀ = - 900 000(1) + 40 000 + 100 000(0)

AE(12%)₇₀ = - 900 000(0.03) + 40 000 = $13000

AE₇₀ > AE₇₁ > AE₇₂; Select Alternative G (highest AE worth)

3. Net Cash Flow ($)

<table>
<thead>
<tr>
<th>n</th>
<th>Project A</th>
<th>Project B</th>
<th>B-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-2600</td>
<td>-3700</td>
<td>-1100</td>
</tr>
<tr>
<td>1</td>
<td>1700</td>
<td>2800</td>
<td>1100</td>
</tr>
<tr>
<td>2</td>
<td>1940</td>
<td>2400</td>
<td>460</td>
</tr>
</tbody>
</table>

To decide for the alternative to be chosen, determine the incremental cash flow rate of return \( IRR_{b-a} \) as follows:

\[
i^*_{b-a} = IRR_{b-a} = -1100 + \frac{1100}{1+i} + \frac{460}{(1+i)^2} = 0; \frac{1}{1+i} = X
\]

\[
-1100 + 1100X + 460X^2 = 0; X_{1,2} = \frac{-1100 \pm \sqrt{1100^2 - 4(460)(-1100)}}{2(460)}
\]

\[
X_1 = 0.7591 = \frac{1}{1+i}; i = 0.3174(31.74%)
\]

\[
X_2 = -3.1504 = \frac{1}{1+i}; i = -1.32(-132%(-100%) no economic significance
\]

\[
i^*_{b-a} = IRR_{b-a} = 31.74% \text{ (MARR)}
\]

Select Project B.

4. a) \( D_{SL} = \frac{I - S}{N} = \frac{25000 - 0}{5} = $5000 \)

\( B_n = I - nD = $25000 - n($5000) \)

\( B_N = I - ND = $25000 - 5($5000) = 0 = S \)

b) \( \alpha = (Multiplier) \left( \frac{1}{N} \right) = (125%) \left( \frac{1}{5} \right) = (1.25) \left( \frac{1}{5} \right) = 0.25 \text{ (25% fixed depreciation rate)} \)

\( D_n = \alpha B_{n-1}; B_{n-1} = I(1 - \alpha)^{n-1} = 25000(1 - 0.25)^{n-1} \)

c) \( \alpha = (Multiplier) \left( \frac{1}{N} \right) = (200%) \left( \frac{1}{5} \right) = (2.0) \left( \frac{1}{5} \right) = 0.40 \)

\( D_n = \alpha B_{n-1}; B_{n-1} = I(1 - \alpha)^{n-1} = 25000(1 - 0.40)^{n-1} \)

From the corresponding depreciation formulas of the methods given above for part (a), (b) and (c); the results are tabulated as follows (without switching to SL for part b and c):
<table>
<thead>
<tr>
<th>$n$</th>
<th>SL $D_n$ ($)</th>
<th>$B_n$ ($)</th>
<th>SL $D_n$ ($)</th>
<th>$B_n$ ($)</th>
<th>SL $D_n$ ($)</th>
<th>$B_n$ ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25 000</td>
<td></td>
<td>25 000</td>
<td></td>
<td>25 000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5 000</td>
<td>20 000</td>
<td>6250</td>
<td>18 750</td>
<td>10 000</td>
<td>15 000</td>
</tr>
<tr>
<td>2</td>
<td>5 000</td>
<td>15 000</td>
<td>4688</td>
<td>14 062</td>
<td>6 000</td>
<td>9 000</td>
</tr>
<tr>
<td>3</td>
<td>5 000</td>
<td>10 000</td>
<td>3516</td>
<td>10 547</td>
<td>3 600</td>
<td>5 400</td>
</tr>
<tr>
<td>4</td>
<td>5 000</td>
<td>5 000</td>
<td>2637</td>
<td>7910</td>
<td>2 160</td>
<td>3 240</td>
</tr>
<tr>
<td>5</td>
<td>5 000</td>
<td>0</td>
<td>1978</td>
<td>$5932 \neq 0$</td>
<td>1 296</td>
<td>$1944 \neq 0$</td>
</tr>
</tbody>
</table>