1. (20 p) Suppose you deposit $500 at the end of each quarter for five years at an interest rate of 8% compounded monthly.
   a) (5 p) What is quarterly effective interest rate ($i_q$)?
   b) (5 p) What is annual effective interest rate ($i_a$)?
   c) (5 p) What is the future worth ($F$) of this quarterly deposit series?
   d) (5 p) What equal end-of-year deposit (Annuity) over the five years would accumulate the same amount of $F$ at the end of five years under the same interest compounding?

2. (30 p) Consider two mutually exclusive investment projects, each with MARR = 12%, as shown in the table below:

<table>
<thead>
<tr>
<th>n</th>
<th>Project’s Cash Flow ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0</td>
<td>-14 500</td>
</tr>
<tr>
<td>1</td>
<td>12 610</td>
</tr>
<tr>
<td>2</td>
<td>12 930</td>
</tr>
<tr>
<td>3</td>
<td>12 300</td>
</tr>
</tbody>
</table>

   a) (8 p) Compute NPW(12%) for Project A.
   b) (8 p) Compute NPW(12%) for Project B.
   c) (4 p) On the basis of the NPW criterion, which alternative would be selected?
   d) (10 p) On the basis of the NFW criterion, which alternative would be selected?

3. (30 p) Consider the following investment projects:

<table>
<thead>
<tr>
<th>n</th>
<th>Project 1</th>
<th>Project 2</th>
<th>Project 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1 000</td>
<td>-5 000</td>
<td>-2 000</td>
</tr>
<tr>
<td>1</td>
<td>500</td>
<td>7 500</td>
<td>1 500</td>
</tr>
<tr>
<td>2</td>
<td>2 500</td>
<td>600</td>
<td>2 000</td>
</tr>
</tbody>
</table>

Assume that MARR = 15%.

   a) (15 p) Compute the IRR for each project.
   b) (15 p) On the basis of IRR criterion, if the three projects are mutually exclusive investments, which project should be selected?

4. (20 p) Consider the following tabulated data on an asset:
   a) Compute the annual depreciation allowances ($D_n$) and the resulting book values ($B_n$), using straight-line depreciation method (SL).
   b) Compute the annual depreciation allowances ($D_n$) and the resulting book values ($B_n$), using the declining balance method according to the Matheson formula.

<table>
<thead>
<tr>
<th>n</th>
<th>SL</th>
<th>DDB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$D_n$ ($)</td>
<td>$B_n$ ($)</td>
</tr>
<tr>
<td>0</td>
<td>132 000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>20 000</td>
<td></td>
</tr>
</tbody>
</table>
1. \( a) \) Given: \( r = 8 \% \); \( K = 4 \); \( A_q = 500 \); \( M = 12 \); \( C = M/K = 12/4 = 3 \)

Find: \( i_p \)

\[
i_p = \left[ 1 + \frac{r}{(CK)} \right]^C - 1 = \left[ 1 + 0.08/12 \right]^3 - 1 = (1 + 0.00667)^3 - 1 = 0.02013(2.013\%) \]

\( b) \) Find \( i_a \)

\[
i_a = \left( 1 + i_p \right)^K - 1 = \left( 1 + i_e \right)^M - 1 = \left( 1 + 0.02013 \right)^4 - 1 = \left( 1 + 0.00667 \right)^2 - 1 = 0.0830(8.30\%) \]

c) Find \( F \)

\[
F = A_q \left( F/A, i, N \right) = $500 \left( F/A, 2.013\%, 20 \right) = $500 \left[ \frac{\left( 1 + 0.02013 \right)^{20} - 1}{0.02013} \right] = $12164.42
\]

\( 2^{nd} \) way:

\[
F = $500 \left( F/A, 2.013\%, 4 \right) \left( F/A, 8.30\%, 5 \right) = $12164.81
\]

d) Equal end-year deposit \( A \):

\[
A = A_q \left( F/A, i, N \right) = $500 \left( F/A, 2.013\%, 4 \right) = $500 \left[ \frac{\left( 1 + 0.02013 \right)^{4} - 1}{0.02013} \right] = $2061.21
\]

2. \( a) \) Find \( NPW(12\%)_A \)

\[
NPW(12\%)_A = -$14500 + $12610(P/F, 12\%, 1) + $12930(P/F, 12\%, 2) + $12300(P/F, 12\%, 3)
\]

\[
NPW(12\%)_A = -$14500 + $12610(0.8929) + $12930(0.7972) + $12300(0.7118) = $15822.41
\]

Factors from Textbook-Table/p.887

\( b) \) Find \( NPW(12\%)_B \)

\[
NPW(12\%)_B = -$12900 + $11210(P/F, 12\%, 1) + $11720(P/F, 12\%, 2) + $11500(P/F, 12\%, 3)
\]

\[
NPW(12\%)_B = -$12900 + $11210(0.8929) + $11720(0.7972) + $11500(0.7118) = $14638.29
\]

c) \( NPW(12\%)_A > NPW(12\%)_B \); Select Project A

d) Find \( NFW(12\%) \) of Project A and B and select based on that:

\( NFW \) of A and B will be found as follows:

\[
NFW(12\%)_A = NPW(12\%)_A \left( F/P, 12\%, 3 \right) = $15822.41(1.4049) = $22228.90
\]

\[
NFW(12\%)_B = NPW(12\%)_B \left( F/P, 12\%, 3 \right) = $14638.29(1.4049) = $20565.33
\]

\( NFW(12\%)_A > NFW(12\%)_B \); Select Project A

Factors from Table/p.887

3. \( a) \)

<table>
<thead>
<tr>
<th>( n )</th>
<th>Project 1</th>
<th>Project 2</th>
<th>Project 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1 000</td>
<td>-5 000</td>
<td>-2 000</td>
</tr>
<tr>
<td>1</td>
<td>500</td>
<td>7 500</td>
<td>1 500</td>
</tr>
<tr>
<td>2</td>
<td>2 500</td>
<td>600</td>
<td>2 000</td>
</tr>
</tbody>
</table>
Projects should be compared mutually to decide by using incremental IRR analysis. Firstly Project 1 vs Project 2 to decide:

<table>
<thead>
<tr>
<th>n</th>
<th>Project 1</th>
<th>Project 2</th>
<th>2-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1 000</td>
<td>-5 000</td>
<td>-4 000</td>
</tr>
<tr>
<td>1</td>
<td>500</td>
<td>7 500</td>
<td>7 000</td>
</tr>
<tr>
<td>2</td>
<td>2 500</td>
<td>600</td>
<td>-1 900</td>
</tr>
</tbody>
</table>

This is a nonsimple incremental investment. We need to compute RIC$_{2-1}$. 

\[
i'_1 = IRR_1 = -1000 + \frac{500}{1 + i} + \frac{2500}{(1 + i)^2} = 0; \frac{1}{1 + i} = X
\]

\[-1000 + 500X + 2500X^2 = 0; X_{1,2} = \frac{-500 \pm \sqrt{500^2 - 4(2500)(-1000)}}{2(2500)}
\]

\[X_1 = 0.5403 = \frac{1}{1 + i}; i = 0.8508(85.08\%)
\]

\[X_2 = -0.740 = \frac{1}{1 + i}; i = -2.35(-235\%(-100\%)\text{no economic significance})
\]

\[i'_1 = IRR_1 = 85.08\% 15\%(MARR)
\]

\[i'_2 = IRR_2 = -5000 + \frac{7500}{1 + i} + \frac{600}{(1 + i)^2} = 0; \frac{1}{1 + i} = X
\]

\[-5000 + 7500X + 600X^2 = 0; X_{1,2} = \frac{-7500 \pm \sqrt{7500^2 - 4(600)(-5000)}}{2(600)}
\]

\[X_1 = 0.6345 = \frac{1}{1 + i}; i = 0.5760(57.60\%)
\]

\[X_2 = -13.13 = \frac{1}{1 + i}; i = -1.08(-108\%(-100\%)\text{no economic significance})
\]

\[i'_2 = IRR_2 = 57.60\% 15\%(MARR)
\]

\[i'_3 = IRR_3 = -2000 + \frac{1500}{1 + i} + \frac{2000}{(1 + i)^2} = 0; \frac{1}{1 + i} = X
\]

\[-2000 + 1500X + 2000X^2 = 0; X_{1,2} = \frac{-1500 \pm \sqrt{1500^2 - 4(2000)(-2000)}}{2(2000)}
\]

\[X_1 = 0.6930 = \frac{1}{1 + i}; i = 0.4430(44.30\%)
\]

\[X_2 = -1.44 = \frac{1}{1 + i}; i = -1.69(-169\%(-100\%)\text{no economic significance})
\]

\[i'_3 = IRR_3 = 44.30\% 15\%(MARR)
\]
Case1: \(i(0.75; PB)\),
\[
PB_2 = \left[- 4000(1 + i) + 7000\right](1 + 0.15) - 1900 = 0
\]
\[
RIC_{2-1} = 0.3369(33.69)(0.75)(75\%)
\]
Case2: \(i); PB\),
\[
PB_2 = \left[- 4000(1 + i) + 7000\right](1 + i) - 1900 = 0
\]
Solving for \(i\) gives
\[
IRR_{2-1} = -0.66(-66\%)\text{ or 0.41(41\%)/(0.75}
\]
which violates the initial assumption that \(i > 0.75\). Therefore, Case 1 is the only correct situation. Since it indicates that \(RIC_{2-1}=IRR_{2-1} > MARR\), Select Project 2.

Now, Project 2 should be compared with Project 3 to decide.

Project 2 vs Project 3 to decide

<table>
<thead>
<tr>
<th>(n)</th>
<th><strong>Net Cash Flow (S)</strong></th>
<th>Project 2</th>
<th>Project 3</th>
<th>2-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-5 000</td>
<td>-2 000</td>
<td>-3 000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7 500</td>
<td>1 500</td>
<td>6 000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>600</td>
<td>2 000</td>
<td>-1 400</td>
<td></td>
</tr>
</tbody>
</table>

This is another nonsimple incremental investment. We need to calculate \(RIC_{2-3}\).

Case1: \(i(1; PB)\),
\[
PB_2 = \left[- 3000(1 + i) + 6000\right](1 + 0.15) - 1400 = 0
\]
\[
RIC_{2-3} = 0.5942(59.42)(1(100\%)
\]
Case2: \(i); PB\),
\[
PB_2 = \left[- 3000(1 + i) + 6000\right](1 + i) - 1400 = 0
\]
Solving for \(i\) gives
\[
IRR_{2-3} = 0.73(73\%)\text{ or -0.73(-73\%)1}
\]
which violates the initial assumption that \(i > 1\). Therefore, Case 1 is the only correct situation. Since it indicates that \(RIC_{2-3}=IRR_{2-3} > MARR\), Select again Project 2.

4) Given: Cost of asset, I=$132 000; Useful life, N=5 years; Salvage value, S=$20 000
Find a) \(Dn\) and \(Bn\) values by SL method:
\[
D_n = \frac{(I - S)}{N} = \frac{($132000 - $20000)}{5} = $22400(cons tan \alpha); B_n = I - (D_1 + D_2 + \ldots + D_n) = I - nD
\]
\[
D_1=D_2=D_3=D_4=D_5=D=\frac{D}{\alpha} = \frac{132000-224000}{22400} = $109600
\]
\[
B_1=I-D=132000-224000 = $109600
\]
\[
B_2=I-2(D)=132000-2(22400) = 109600-22400 = $87200
\]
\[
B_3=I-3(D)=132000-3(22400) = 109600-22400 = $64800
\]
\[
B_4=I-4(D)=132000-4(22400) = 109600-22400 = $42400
\]
\[
B_5=I-5(D)=132000-5(22400) = 109600-22400 = $20000 = S
\]
b) \(Dn\) and \(Bn\) values by DB method according to the Matheson formula:
\[
\alpha = 1 - \left(\frac{S}{I}\right)^{\frac{1}{N}} = 1 - \left(\frac{20000}{132000}\right)^{\frac{1}{5}} = 0.3144 \text{ constant percentage method (31\%)}
\]
\[ \alpha = 0.31(\tan t); D_1 = \alpha I = 0.31(132000) = 40920; B_1 = I - D_1 = 132000 - 40920 = 91080 \]

\[ D_2 = \alpha B_1 = 0.31(91080) = 28234; B_2 = B_1 - D_2 = 91080 - 28234 = 62846 \]

\[ D_3 = \alpha B_2 = 0.31(62846) = 19482; B_3 = B_2 - D_3 = 62846 - 19482 = 43364 \]

\[ D_4 = \alpha B_3 = 0.31(43364) = 13443; B_4 = B_3 - D_4 = 43364 - 13443 = 29921 \]

\[ D_5 = \alpha B_4 = 0.31(29921) = 9276; B_5 = B_4 - D_5 = 29921 - 9276 = 20645 \approx S \]

The values calculated as shown were summarised in the following table:

<table>
<thead>
<tr>
<th>( n )</th>
<th>SL</th>
<th>DDB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( D_n ) ($)</td>
<td>( B_n ) ($)</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>22 400</td>
<td>109 600</td>
</tr>
<tr>
<td>2</td>
<td>22 400</td>
<td>87 200</td>
</tr>
<tr>
<td>3</td>
<td>22 400</td>
<td>64 800</td>
</tr>
<tr>
<td>4</td>
<td>22 400</td>
<td>42 400</td>
</tr>
<tr>
<td>5</td>
<td>22 400</td>
<td>20 000</td>
</tr>
</tbody>
</table>