1. (25p) 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_p$)?
   b) (5 p) What is annual effective interest rate ($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. (35 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></td>
<td>A</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. (40 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?
1. a) Given: $r = 8\%; K = 4, A_q = 500$ $; M = 12; C = M/K = 12/4 = 3$

Find: $i_p$

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

b) Find $i_a$

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

c) Find $F$

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

(\text{\textit{F/A, i, N}} \text{ factor formula from Table 3.4 to be taken})

2nd way:

$$F = 500 \left(\frac{F}{A, 2.013\%, 4}\right) \left(\frac{F}{A, 8.30\%, 5}\right) = 12164.81$$

d) Equal end of year deposit $A$:

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

2. a) Find NPW(12\%)$_{A}$

$$NPW(12\%)_A = -14500 + 12610 \left(\frac{F}{P, 12\%, 1}\right) + 12930 \left(\frac{F}{P, 12\%, 2}\right) + 12300 \left(\frac{F}{P, 12\%, 3}\right)$$

$$NPW(12\%)_A = -14500 + 12610 \left(\frac{1}{1.12}\right) + 12930 \left(\frac{1}{1.12^2}\right) + 12300 \left(\frac{1}{1.12^3}\right) = 15822.41$$

Factors from Textbook-Table/p.887

b) Find NPW(12\%)$_{B}$

$$NPW(12\%)_B = -12900 + 11210 \left(\frac{F}{P, 12\%, 1}\right) + 11720 \left(\frac{F}{P, 12\%, 2}\right) + 11500 \left(\frac{F}{P, 12\%, 3}\right)$$

$$NPW(12\%)_B = -12900 + 11210 \left(\frac{1}{1.12}\right) + 11720 \left(\frac{1}{1.12^2}\right) + 11500 \left(\frac{1}{1.12^3}\right) = 14638.29$$

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:

$$NFW(12\%)_A = NPW(12\%)_A \left(\frac{F}{P, 12\%, 3}\right) = 15822.41 \left(\frac{1}{1.12^3}\right) = 22228.90$$

$$NFW(12\%)_B = NPW(12\%)_B \left(\frac{F}{P, 12\%, 3}\right) = 14638.29 \left(\frac{1}{1.12^3}\right) = 20565.33$$

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

Factors from Table/p.887

3. a) Net Cash Flow ($)

<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>
\[ i'_{1} = IRR_{1} = -1000 \cdot \frac{500}{1+i} + \frac{2500}{(1+i)^2} = 0; \frac{1}{1+i} = X \]

\[-1000 + 500X + 2500X^2 = 0; X_{1,2} = \frac{-500 \pm \sqrt{500^2 - 4(2500)(-100)}}{2(2500)} \]

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

\[ X_{2} = -0.740 = \frac{1}{1+i}; \ i = -2.35(-235\%)(-100\%) \text{no economic significance} \]

\[ i'_{1} = IRR_{1} = 85.08\% \] 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) \]

b) Projects should be compared mutually to decide by using incremental IRR analysis
Firstly Project 1 vs Project 2 to decide

| \( n \) | Net Cash Flow ($) |
|---|---|---|
| | Project 1 | Project 2 | 2-1 |
| 0 | -1,000 | -5,000 | -4,000 |
| 1 | 500 | 7,500 | 7,000 |
| 2 | 2,500 | 600 | -1,900 |

This is a nonsimple incremental investment. We need to compute \( \text{RIC}_{2:1} \).
Case 1: \( i(0,75; PB) \neq 0 \)

\[ PB_2 = \left[ - 4000(1 + i) + 7000 \right](1 + 0,15) - 1900 = 0 \]

\[ RIC_{2-1} = 0,3369(\%33,69)(0,75(75\%)) \]

Case 2: \( i)0,75; PB(0 \)

\[ PB_2 = \left[ - 4000(1 + i) + 7000 \right](1 + i) - 1900 = 0 \]

Solving for \( i \) gives

\[ IRR_{2-1} = -0,66(-66\%) \text{ or } 0,41(41\%)/0,75 \]

which violates the initial assumption that \( i \geq 0,75 \). 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.

<table>
<thead>
<tr>
<th>( n )</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>
</tr>
<tr>
<td>1</td>
<td>7 500</td>
<td>1 500</td>
<td>6 000</td>
</tr>
<tr>
<td>2</td>
<td>600</td>
<td>2 000</td>
<td>-1 400</td>
</tr>
</tbody>
</table>

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

Case 1: \( i(1; PB) \neq 0 \)

\[ PB_2 = \left[ - 3000(1 + i) + 6000 \right](1 + 0,15) - 1400 = 0 \]

\[ RIC_{2-3} = 0,5942(\%59,42)(1(100\%)) \]

Case 2: \( i)1; PB(0 \)

\[ PB_2 = \left[ - 3000(1 + i) + 6000 \right](1 + i) - 1400 = 0 \]

Solving for \( i \) gives

\[ IRR_{2-3} = 0,73(73\%) \text{ or } -0,73(-73\%) \]

which violates the initial assumption that \( i \geq 1 \). Therefore, Case 1 is the only correct situation. Since it indicates that \( RIC_{2-3}=IRR_{2-3} > MARR \), Select again Project 2.