1. (25 p) A series of equal quarterly deposits of 1000 $ extends over a period of three years at 12 % nominal interest rate \((r)\) 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 three years would accumulate the same amount of \(F\) at the end of three years under the same interest compounding?

2. (35 p) Consider the following two investment alternatives:

   \[
   \begin{array}{ccc}
   \text{Project’s Cash Flow ($)} & A & B \\
   \hline
   0 & -15 000 & -25 000 \\
   1 & 9 500 & 0 \\
   2 & 12 500 & X \\
   3 & 7 500 & X \\
   \hline
   \text{NPW(15%)} & ? & 9 300
   \end{array}
   \]

   The firm’s MARR is known to be 15%.
   a) (7 p) Compute \(\text{NPW(15%)}\) for Project A.
   b) (8 p) Compute the unknown cash flow \(X\) in years 2 and 3 for Project B.
   c) (10 p) Compute the project balance\((PB)\) at 15% of Project A at the end of period 3.
   d) (5 p) If these two projects are mutually exclusive alternatives, which one would you select?

3. (40 p) A manufacturing company is considering the following mutually exclusive alternatives:

   \[
   \begin{array}{ccc}
   \text{Net Cash Flow ($)} & \text{Project A} & \text{Project B} \\
   \hline
   0 & -2 000 & -3 000 \\
   1 & 1 400 & 2 400 \\
   2 & 1 640 & 2 000 \\
   \end{array}
   \]

   a) (20p) Compute the IRR for each project.
   b) (20p) On the basis of IRR criterion, which project should be selected at a MARR = 15%?
1. a) Given: \( r = 12\% \); \( K = 4 \), \( A_q = 1000 \) $; \( M = 12 \); \( C = M/K = 12/4 = 3 \)

Find: \( i_p \)

\[
i_p = \left[1 + \frac{r}{(CK)}\right]^C - 1 = \left[1 + \frac{0.12}{12}\right]^3 - 1 = (1 + 0.01)^3 - 1 = 0.0303(3.03\%)
\]

(as given in the diagram below)

**Effective interest rate per payment period**

\[
i = (1 + 0.01)^3 - 1 = 3.03\%
\]

\[
\[
\[
\]
\]

b) Find \( i_a \)

\[
i_a = \left(1 + i_p\right)^K - 1 = (1 + 0.0303)^4 - 1 = (1 + 0.01)^2 - 1 = 0.1268(12.68\%)
\]

c) Find \( F \)

\[
F = A_q \left(\frac{F}{A}, i_p, N\right) = \$1000 \left(\frac{F}{A}, 3.03\%, 12\right) = \$1000 \left[\frac{(1 + 0.0303)^{12} - 1}{0.0303}\right] = \$14216
\]

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

\[
\]

2\(^{nd}\) way:

\[
F = \$1000 \left(\frac{F}{A}, 3.03\%, 4\right) \left(\frac{F}{A}, 12.68\%, 3\right) = \$14216
\]

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

\[
A = A_q \left(\frac{F}{A}, i_p, N\right) = \$1000 \left(\frac{F}{A}, 3.03\%, 4\right) = \$1000 \left[\frac{(1 + 0.0303)^4 - 1}{0.0303}\right] = \$4185,50
\]

2. a) Find \( NPW(15\%)_A \)

\[
NPW(15\%)_A = -\$15000 + \$9500\left(P_{F}, 15\%, 1\right) + \$12500\left(P_{F}, 15\%, 2\right) + \$7500\left(P_{F}, 15\%, 3\right)
\]

\[
NPW(15\%)_A = -\$15000 + \$9500(0,8696) + \$12500(0,7561) + \$7500(0,6575) = \$7643,70
\]

Factors from Textbook-Table/p.890

b) Find \( X \)
NPW\left(15\%\right)_B = -25000 + 0\left(\text{P/F}, 15\%, 1\right) + \text{X}\left(\text{P/F}, 15\%, 2\right) + \text{X}\left(\text{P/F}, 15\%, 3\right)

NPW\left(15\%\right)_B = -25000 + 0(0.8696) + \text{X}(0.7561) + \text{X}(0.6575) = 9300

\text{X} = 24264.29

c) Find PB\left(15\%\right)_3 of Project A:
Project Balance of A at the end of 3 years will be equal to Future worth of Project A as follows:

\text{PB}\left(15\%\right)_3 = NPW\left(15\%\right)\left(\text{F/P}, 15\%, 3\right) = 7643.70 (1,5209) = 11625.30

Table/p.890

d) NPW\left(15\%\right)_B > NPW\left(15\%\right)_A ; Select Project B

<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>-2 000</td>
<td>-3 000</td>
<td>-1 000</td>
</tr>
<tr>
<td>1</td>
<td>1 400</td>
<td>2 400</td>
<td>1 000</td>
</tr>
<tr>
<td>2</td>
<td>1 640</td>
<td>2 000</td>
<td>360</td>
</tr>
<tr>
<td>IRR(%)=32,08</td>
<td></td>
<td>30,92</td>
<td></td>
</tr>
</tbody>
</table>

Determine IRR of project A and B to see IRRs of both projects greater than MARR (15%) as 32.08% and 30.92% respectively. To decide for the alternative to be chosen, determine incremental cash flow rate of return \( \text{IRR}_{B-A} \) as follows:

\[ i^*_{B-A} = \text{IRR}_{B-A} = -1000 + \frac{1000}{1+i} + \frac{360}{(1+i)^2} = 0; \frac{1}{1+i} = X \]

\[-1000 + 1000X + 360X^2 = 0; X_{1,2} = \frac{-1000 \pm \sqrt{1000^2 - 4(360)(-1000)}}{2(360)} \]

\[ X_1 = 0.7806 = \frac{1}{1+i}; i = 0.2811(28.11\%) \]

\[ X_2 = -3.5584 = \frac{1}{1+i}; i = -1.28(-128%(-100\%) no economic significance \]

\[ i^*_{B-A} = \text{IRR}_{B-A} = 28.11\% > 15\%(MARR) \]

Select Project B.