1. (20 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. (30 p) Consider the following two investment alternatives:

<table>
<thead>
<tr>
<th>n</th>
<th>Project’s Cash Flow ($)</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-15 000</td>
<td>-25 000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>9 500</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>12 500</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7 500</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>NPW(15%)</strong></td>
<td>?</td>
<td>9 300</td>
</tr>
</tbody>
</table>

   The firm’s MARR is known to be 15%.
   a) (7 p) Compute **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. (25 p) A manufacturing company is considering the following mutually exclusive alternatives:

<table>
<thead>
<tr>
<th>n</th>
<th>Project A</th>
<th>Project B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-2 000</td>
<td>-3 000</td>
</tr>
<tr>
<td>1</td>
<td>1 400</td>
<td>2 400</td>
</tr>
<tr>
<td>2</td>
<td>1 640</td>
<td>2 000</td>
</tr>
</tbody>
</table>

   Determine which project is a better choice at a MARR = 15%, based on the IRR criterion.

4. (25 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 double-declining-balance method (DDB) allowed by respective law.

<table>
<thead>
<tr>
<th>n</th>
<th>SL DDB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D_n ($)</td>
</tr>
<tr>
<td>0</td>
<td>110 000</td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>10 000</td>
</tr>
</tbody>
</table>
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 \( i_a \)

\[
i_a = (1 + i_p)^K - 1 = (1 + 0.0303)^4 - 1 = (1 + 0.01)^{12} - 1 = 0.1268(12.68\%)
\]

c) Find \( F \)

\[
F = A_q \left(\frac{F}{A}, i, N\right) = $1000 \left(\frac{F}{A}, 3.03\%, 12\right) = $1000 \left[\frac{(1 + 0.0303)^2 - 1}{0.0303}\right] = $14216
\]

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

2\textsuperscript{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 \( A \):

\[
A = A_q \left(\frac{F}{A}, i, N\right) = $1000 \left(\frac{F}{A}, 3.03\%, 4\right) = $1000 \left[\frac{(1 + 0.0303)^4 - 1}{0.0303}\right] = $4185.50
\]

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

\[
NPW(15\%)_A = -$15000 + $9500(P/F,15\%,1) + $12500(P/F,15\%,2) + $7500(P/F,15\%,3)
\]

\[
NPW(15\%)_A = -$15000 + $9500(0.8696) + $12500(0.7561) + $7500(0.6575) = $7643.70
\]

Factors from Textbook-Table/p.890

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

\[ NPW(15\%)_B = -25000 + \$0 \times 0.8696 + \$X \times 0.7561 + \$X \times 0.6575 = \$9300 \]

\[ X = \frac{-25000 + \$X \times 0.7561 + 0.6575}{\$9300} = \$24264.29 \]

c) Find \( PB(15\%)_3 \) of Project A:
Project Balance of A at the end of 3 years will be equal to Future worth of Project A as follows:
\[ PB(15\%)_3 = NPW(15\%) \left( \frac{F}{P, 15\%, 3} \right) = \$7643.70(1,5209) = \$11625.30 \]

Table/p.890

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

3.

<table>
<thead>
<tr>
<th>( n )</th>
<th>Net Cash Flow ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Project A</td>
</tr>
<tr>
<td>0</td>
<td>-2 000</td>
</tr>
<tr>
<td>1</td>
<td>1 400</td>
</tr>
<tr>
<td>2</td>
<td>1 640</td>
</tr>
<tr>
<td></td>
<td>32.08</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:

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

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

\[ X_1 = 0.7806; i = 0.2811(28.11\%) \]

\[ X_2 = -3.5584; i = -1.28(-128\%); \text{no economic significance} \]

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

Select Project B.

5. Given: Cost of asset, \( I=\$110\ 000 \); Useful life, \( N=5 \) years; Salvage value, \( S=\$10\ 000 \)
Find a) \( D_n \) and \( B_n \) values by SL method:

\[ D_n = \frac{(I-S)}{N} = \frac{($110 000 - $10 000)}{5} = $20 000; \ B_n = I - (D_1 + D_2 + ... + D_n) = I - nD \]

\[ D_1 = D_2 = D_3 = D_4 = D_5 = D = $20 000; \ B_1 = I-D = 110 000 - 20 000 = $90 000 \]

\[ B_2 = I-D = 110 000 - 20 000 = $90 000 \]

\[ B_3 = I-D = 110 000 - 30 000 = $80 000 \]

\[ B_4 = I-D = 110 000 - 40 000 = $70 000 \]

\[ B_5 = I-D = 110 000 - 50 000 = $60 000 \]

b) \( D_n \) and \( B_n \) values by DDB method allowed by law:
\[
\alpha = 2 \frac{1}{N} = 2 \frac{1}{5} = 0.40 (\text{cons tan} \, \theta) ; \quad D_1 = \alpha I = 0.40 ($110000) = $44000; \quad B_1 = I - D_1 = 110000 - 44000 = $66000
\]

\[
\begin{align*}
D_2 &= \alpha B_1 = 0.40 ($66000) = $26400; \quad B_2 = B_1 - D_2 = 66000 - 26400 = $39600 \\
D_3 &= \alpha B_2 = 0.40 ($39600) = $15840; \quad B_3 = B_2 - D_3 = 39600 - 15840 = $23760 \\
D_4 &= \alpha B_3 = 0.40 ($23760) = $9504; \quad B_4 = B_3 - D_4 = 23760 - 9504 = $14256 \\
D_5 &= \alpha B_4 = 0.40 ($14256) = $5702.4; \quad B_5 = B_4 - D_5 = 14256 - 5702.4 = $8553.6 \\
\end{align*}
\]

Last year depreciation will be corrected as 4 256 $ to reach $10 000 salvage value (S) as required.

<table>
<thead>
<tr>
<th>(n)</th>
<th>SL</th>
<th>DDB</th>
</tr>
</thead>
<tbody>
<tr>
<td>(D_n) (S)</td>
<td>(B_n) (S)</td>
<td>(D_n) (S)</td>
</tr>
<tr>
<td>0</td>
<td>110 000</td>
<td>110 000</td>
</tr>
<tr>
<td>1</td>
<td>20 000</td>
<td>90 000</td>
</tr>
<tr>
<td>2</td>
<td>20 000</td>
<td>70 000</td>
</tr>
<tr>
<td>3</td>
<td>20 000</td>
<td>50 000</td>
</tr>
<tr>
<td>4</td>
<td>20 000</td>
<td>30 000</td>
</tr>
<tr>
<td>5</td>
<td>20 000</td>
<td>10 000</td>
</tr>
</tbody>
</table>