EUROPEAN UNIVERSITY OF LEFKE
FACULTY OF ENGINEERING
ECON 440(305-413) ENGINEERING ECONOMICS FALL 13-14 FINAL EXAM
Date: 15/01/2014
Instructor: Prof. Dr. Hüseyin Oğuz
Duration: 90 min
Room#: AS 208 & 210
Student Registration No: ____________________
Student Name-Surname: ______________________

Important Note: Your own interest/formula tables and scientific calculator are allowable to use during exam with forbidding of their exchanges. Please indicate your solutions starting from the rear side of your exam paper and continuing with the two (2) stamped blank sheets attached.

1. (35 p)
The cash flows (in thousands) associated with Fisher-Price’s Touch learning system are shown below at a nominal interest rate of 16% compounded semiannually:

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Cash Flow, $/Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td>2-3</td>
<td>2000</td>
</tr>
<tr>
<td>5-8</td>
<td>3000</td>
</tr>
</tbody>
</table>

What equal end-of-month deposit over two years would accumulate the same amount under the same nominal interest rate compounded continuously?

2. (35 p) The alternatives shown below are to be compared on the basis of their capitalized equivalent (CE).

<table>
<thead>
<tr>
<th></th>
<th>Alternative A</th>
<th>Alternative B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment, $</td>
<td>-500 000</td>
<td>-900 000</td>
</tr>
<tr>
<td>Annual operating cost, $/year</td>
<td>-100 000</td>
<td>-40 000</td>
</tr>
<tr>
<td>Salvage value, $</td>
<td>130 000</td>
<td>150 000</td>
</tr>
<tr>
<td>Life, years</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

At a nominal interest rate of 10% compounded quarterly (MARR), which alternative should be selected?

3. (30 p) An automated assembly robot that cost $450 000 installed has a depreciable life of 5 years and no salvage value. For book depreciation purposes, you want depreciation cost (D) and book value (B) schedules for the following methods:
   a) Straight-line depreciation method (SL),
   b) 175% Declining-Balance (DB) method,
   c) Double Declining-Balance (DDB) method

<table>
<thead>
<tr>
<th>Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SL</th>
<th>175%DB</th>
<th>DDB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$D_n$ ($)</td>
<td>$B_n$ ($)</td>
<td>$D_n$ ($)</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hint: Use switching for part (b) and (c).
1. Given: single cash flows quarterly (K=4); \( r = 16\% \), \( M=2 \) (semiannually); \( C=M/K=2/4=1/2 \)

\[
i_p = \left(1 + \frac{r}{M}\right)^{K} - 1 = \left(1 + \frac{0.16}{2}\right)^{1/2} - 1 = 0.0392 \text{ (3.92\% per quarter)}
\]

\[
P_{\text{given}} = $1000\left(\frac{P}{F}, 3.92\%, 1\right) + $2000\left(\frac{P}{A}, 3.92\%, 2\right)\left(\frac{P}{F}, 3.92\%, 1\right) + $3000\left(\frac{P}{A}, 3.92\%, 4\right)\left(\frac{P}{F}, 3.92\%, 4\right)
\]

\[
P_{\text{given}} = \frac{1}{\left(1 + 0.0392\right)^{4/2}} + \frac{\left(1 + 0.0392\right)^{2} - 1}{0.0392\left(1 + 0.0392\right)^{2}} + \frac{1}{0.0392\left(1 + 0.0392\right)^{4}}
\]

\[
P_{\text{given}} = $13951.22
\]

Find:
\( A_M \) uniform equivalent monthly cash flow under the same interest rate compounded continuously \( K=12; \ r = 16\% \), \( M=\infty \) (continuously); \( C=\infty \)

\[
i_p = e^{r/K} - 1 = e^{0.16/12} - 1 = 0.0134 \text{ (1.34\% per month)}
\]

\[
P_{\text{given}} = A_M\left(\frac{P}{A}, 1.34\%, 24\right)
\]

\[
$13951.22 = A_M\left[\frac{\left(1 + 0.0134\right)^{24} - 1}{0.0134(1 + 0.0134)^{24}}\right]
\]

\[
A_M = $683.63
\]

2. Given: Nominal Interest Rate 10% compounded quarterly (MARR)
Annual operating costs (K=1); \( r = 10\% \), \( M=4 \) (quarterly compounding); \( C=M/K=4/1=4 \)

\[
i_p = \left(1 + \frac{r}{M}\right)^{K} - 1 = \left(1 + \frac{0.10}{4}\right)^{4} - 1 = 0.1038 \text{ (effective annual interest rate 10.38\%)}
\]

\[
(CE)_{\text{Alternative A}} = \frac{(AE)_{\text{Alternative A}}}{i_p}
\]

\[
(AE)_{\text{Alternative A}} = -$500000\left(\frac{A}{P}, 10.38\%, 3\right) - $100000 + $130000\left(\frac{A}{F}, 10.38\%, 3\right)
\]

\[
(AE)_{\text{Alternative A}} = -$500000\left[\frac{0.1038(1 + 0.1038)^{3} - 1}{(1 + 0.1038)^{3} - 1}\right] - $100000 + $130000\left[\frac{0.1038}{(1 + 0.1038)^{3} - 1}\right]
\]

\[
= -$263272.84
\]

\[
(CE)_{\text{Alternative A}} = \frac{-$263272.84}{0.1038} = -$2536347.20
\]

\[
(CE)_{\text{Alternative B}} = \frac{(AE)_{\text{Alternative B}}}{i_p}
\]

\[
(AE)_{\text{Alternative B}} = -$900000\left(\frac{A}{P}, 10.38\%, 6\right) - $40000 + $150000\left(\frac{A}{F}, 10.38\%, 6\right)
\]
\[
\begin{align*}
(AE)_{\text{Alternative B}} & = -$900000 \left[ \frac{0.1038(1 + 0.1038)^6}{(1 + 0.1038)^6 - 1} \right] - \$40000 + \$150000 \left[ \frac{0.1038}{(1 + 0.1038)^6 - 1} \right] \\
& = -$229697.61
\end{align*}
\]

\[
(CE)_{\text{Alternative B}} = \frac{-\$229697.61}{0.1038} = -$2212886.41
\]

\[
(CE)_{\text{Alternative B}} > (CE)_{\text{Alternative A}}
\]

Select: Alternative B based on AE or CE method.

3.

a) \[
D_{SL} = \frac{I - S}{N} = \frac{$450000 - 0}{5} = $90000
\]
\[
B_n = I - nD = $450000 - n($90000)
\]
\[
B_N = I - ND = $450000 - 5($90000) = 0 = S
\]

\[
\alpha = \left( \frac{1}{N} \right) (\text{Multiplier}) = \left( \frac{1}{5} \right) (1.75) = 0.35, D_n = \alpha B_{n-1}; B_{n-1} = I(1 - \alpha)^{n-1}
\]
\[
B_N = I(1 - \alpha)^N = 450000(1 - 0.35)^5 = 52213.08 > S
\]

\text{use switching to SL at the beginning of year 4 (s.Table below)}

b) \[
\alpha = \left( \frac{1}{N} \right) (\text{Multiplier}) = \left( \frac{1}{5} \right) (2.0) = 0.4, D_n = \alpha B_{n-1}; B_{n-1} = I(1 - \alpha)^{n-1}
\]
\[
B_N = I(1 - \alpha)^N = 450000(1 - 0.4)^5 = 34992 > S
\]

\text{use switching to SL at the beginning of year 4 (s.Table below)}

From the corresponding depreciation formulas of the methods given above and the using switching to SL for part (b) and (c) at the beginning of year 4, the results are tabulated as follows:

<table>
<thead>
<tr>
<th>(n)</th>
<th>SL</th>
<th>DB ((\alpha = 0.35))</th>
<th>DDB ((\alpha = 0.40))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(D_n) ($,)</td>
<td>(B_n) ($,)</td>
<td>(D_n) ($,)</td>
</tr>
<tr>
<td>0</td>
<td>450 000</td>
<td>450 000</td>
<td>450 000</td>
</tr>
<tr>
<td>1</td>
<td>90000</td>
<td>360000</td>
<td>157500</td>
</tr>
<tr>
<td>2</td>
<td>90000</td>
<td>270000</td>
<td>102375</td>
</tr>
<tr>
<td>3</td>
<td>90000</td>
<td>180000</td>
<td>66544 &amp;&gt;63375 \text{(190125/3)}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Do not switch to SL</td>
</tr>
<tr>
<td>4</td>
<td>90000</td>
<td>90000</td>
<td>43253 &amp;&lt;61791 \text{(61791=123581/2)}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Switch to SL</td>
</tr>
<tr>
<td>5</td>
<td>90000</td>
<td>(B_N = S = 0)</td>
<td>61791</td>
</tr>
</tbody>
</table>