Show all work for full credit, use correct notation, and clearly mark your answer.

1. Using ILT assumptions determine
   (a) (10 points) the expected present value for a whole-life insurance of 1000 issued to independent lives, ages 30 and 40, with benefit payable at the end of the year of the first death.

   \[ Z = 1000 \, Z_{30:40} \]

   \[ EPV = 1000 \, A_{30:40} = 195.84 \]

   (b) (10 points) the variance of the present value random variable for the insurance in part (a)

   \[ \text{Var}(Z) = 1000^2 \left[ (A_{30:40})^2 - (A_{30:40})^3 \right] \]

   \[ = 1000^2 (0.06672 - (1.9584)^3) = 283.67 \]

2. For a discrete whole life insurance issued to (40), you are given:

   (i) The death benefit in the first year is 1000 and increases by 1% each year.

   (ii) Mortality follows the Illustrative Life Table

   (iii) \( i = 0.0706 \)

   Determine the expected present value of the death benefit.

   \[ EPV = \frac{1000}{1.01} A_{40} + 1000 (1.01) \frac{2}{0.0706} \cdot 11 b_x + \ldots \]

   \[ = \frac{1}{1.01} \left[ 1000 (1.01) \frac{2}{0.0706} b_{40} + 1000 (1.01)^2 \frac{2}{0.0706} \cdot 11 b_x + \ldots \right] \]

   \[ = \frac{1}{1.01} \cdot \left[ 1000 A_{40} \right] = \frac{161.32}{1.01} = 159.72 \]
3. For a discrete whole life insurance on (65), you are given:

(i) The death benefit in the first year is 10,000 and increases by 1,000 each year.
(ii) \( A_{65} = 0.42898 \)
(iii) \( (IA)_{65} = 6.16761 \)

Determine the actuarial present value of the insurance benefit.

\[
\begin{array}{cccc}
9000 & 9000 & 9000 \\
1000 & 2000 & 3000 \\
10000 & 20000 & 30000 \\
\end{array}
\]

\[
APV = 9000 A_{65} + 1000 (IA)_{65} = 10,028.43
\]

4. For a special discrete 2-year term insurance issued to (x), you are given:

(i) The death benefit is 100,000 in the first year and 150,000 in the second year.
(ii) The insurer is considering adding a double indemnity clause which, if adopted, will double the death benefit if death occurs by accident.
(iii) Decrement 1 is death by accident, and decrement 2 is death by non-accident.
(iv) \( q_{x+n}^{(j)} = 0.01 \cdot j \cdot (n + 1) \) for \( n = 0, 1 \) and \( j = 1, 2 \) \( q_{x}^{(1)} = 0.01 \) \( q_{x}^{(2)} = 0.02 \) \( q_{x}^{(3)} = 0.03 \)
(v) \( \nu = 0.95 \)
\( q_{x+1}^{(1)} = 0.02 \) \( q_{x+1}^{(2)} = 0.04 \) \( q_{x+1}^{(3)} = 0.06 \)

Determine the increase in the net single premium if the double indemnity clause is adopted.

\[\text{Without the double indemnity clause:}\]

\[
\begin{array}{cccc}
100000 & 150000 \\
1 & 2 \\
\end{array}
\]

\[
SNP = 100000 \cdot q_{x}^{(1)} + 150000 \cdot q_{x}^{(2)} = 100000 (0.95 \cdot 0.01) + 150000 (0.95 \cdot 0.02) = 7828.75
\]

\[\Rightarrow SNP = 10728.75\]

\[\text{With the double indemnity clause:}\]

\[
\begin{array}{cccc}
100000 (1) & 150000 (1) \\
100000 (2) & 150000 (2) \\
1 & 2 \\
\end{array}
\]

\[
SNP = 10728.75 + 100000 \cdot q_{x}^{(1)} + 150000 \cdot q_{x}^{(2)} = q_{x}^{(1)}
\]

\[
\Delta = 100000 \cdot q_{x}^{(1)} + 150000 \cdot q_{x}^{(2)} = 100000 \cdot q_{x}^{(1)} + 150000 \cdot q_{x}^{(1)} = 3576.275
\]