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

1. A fully discrete whole life insurance of 5000 issued to (35) has annual premiums of \( \pi \). Using ILT actuarial assumptions, the reserve at time 15 is 781. Determine \( \pi \).

\[
15 V = 781 = 5000 \hat{A}_{30} - \pi \cdot \hat{a}_{30} \\
\Rightarrow \pi = 35
\]

2. Using ILT actuarial assumptions, determine the net premium reserve at time 20 for a fully discrete 30-year endowment insurance of 1000 issued to (30).

\[
20 V = 1000 \left( 1 - \frac{\hat{a}_{30:30}}{\hat{a}_{30:30}} \right) \\
\hat{a}_{30:30} = \hat{a}_{30} - 30 \hat{a}_{30} - 0.05 \hat{a}_{30} \Rightarrow 7.573 \ldots \\
\hat{a}_{30:30} = \hat{a}_{30} - 30 \hat{a}_{30} - 0.05 \hat{a}_{30} \Rightarrow 14.183 \ldots \\
\therefore 20 V = 466
\]

3. For a 3-year fully discrete term insurance of 100,000 issued to (30) that has annual premiums 150, use ILT mortality and \( i = 0.05 \) to determine \( \text{Var}(L) \).

\[
\begin{array}{c|c|c}
0 & 100000 & 100000 \\
30 & 1 & 2 \\
\hline
31 & 1 & 3 \\
\end{array}
\]

\[
\nu = \frac{1}{1.05}
\]

\[
L \\
Pr
\]

\[
\begin{align*}
100000 \rightarrow 150 & \quad q_{31} = 0.0161 \\
100000^2 \rightarrow 150 \rightarrow 150 & \quad q_{31} = 0.00169 \ldots \\
-150 \rightarrow 150 & \quad a_{31} = 0.99669 \ldots
\end{align*}
\]

Use TI-30XS Multiview: \( \text{Var}(L) = 285,15,880 \)

or use \( \text{Var}(L) = E[L]^2 - (E[L])^2 \)
4. For a fully discrete whole life insurance of 10,000 issued to (30) that has annual premiums of 70, use ILT actuarial assumptions to determine $\sqrt{\text{Var}(10L)}$.

\[ 10L = 10000 \cdot Z_{40} - 70 \cdot \dot{Y}_{40} \quad \dot{Y}_{40} = \frac{1 - Z_{40}}{\delta} \]

\[ \Rightarrow 10L = (10000 + \frac{70}{\delta}) \cdot Z_{40} - \frac{70}{\delta} \]

\[ \Rightarrow \text{Var}(10L) = \left(10000 + \frac{70}{\delta}\right)(1.06)^2 \left\lfloor \frac{2}{\delta} \cdot A_{40} - \left(A_{40}\right)^2 \right\rfloor \]

\[ \Rightarrow \sqrt{\text{Var}(10L)} = 1689.46 \]

5. For a semi-continuous whole life insurance issued to (40), you are given:

(i) A benefit of 25,000 is paid at the moment of death

(ii) Premiums, determined by the equivalence principle, are paid at the beginning of each year.

(iii) Mortality follows the Illustrative Life Table

(iv) $i = 0.06$

(v) There is a uniform distribution of deaths between integer ages.

Determine the reserve at the end of year 10.

\[ 10V = 25000 \cdot \overline{A}_{50} - \pi \cdot \dot{a}_{50} \quad \pi = \frac{25000 \cdot \overline{A}_{40}}{\overline{a}_{40}} \quad \text{or} \quad 25000 \cdot \frac{i}{\delta} \cdot A_{40} \cdot \dot{a}_{40} \]

\[ = 25000 \cdot \frac{i}{\delta} \cdot A_{50} - 25000 \cdot \frac{i}{\delta} \cdot \frac{A_{40}}{\overline{a}_{40}} \cdot \dot{a}_{50} \]

\[ = 25000 \cdot \frac{i}{\delta} \left[ A_{50} - \frac{A_{40}}{\overline{a}_{40}} \cdot \dot{a}_{50} \right] \]

\[ = (1 - \frac{\dot{a}_{50}}{\overline{a}_{40}}) = \text{reserve at } t=10 \text{ for FDWL of } 1 \text{ issued to (40)} \]

\[ \therefore 10V = 25000 \cdot (1.02771) \cdot (1 - \frac{13.2668}{14.8166}) = 2692.66 \]