1. A fully discrete whole life policy to (60) has a death benefit of 100,000 and an annual gross premium of 4,000.

You are given that mortality follows the Illustrative Life Table with interest at 6%.

The policy also has expenses of 50% of gross premiums the first year and 7% of gross premiums each year thereafter. Additionally, there is annual maintenance at the beginning of each year of 50.

Calculate \( 1_{15}V^x \).

\[
1_{15}V^x = PVFB + PVFE - PVFP \\
= 100,000 \cdot A_{75} + 7\% \cdot G \cdot \ddot{a}_{75} + 50\ddot{a}_{75} - G \cdot \ddot{a}_{75} \\
= 100,000 \cdot A_{75} + (50 - 0.93 \cdot G) \cdot \ddot{a}_{75} \\
= 100 \times 591.49 + (50 - 0.93 \times 4000) \times 7.2170 \\
\approx 32,662.61
\]
2. A fully discrete 20 year endowment policy to (70) has a death benefit of 50,000 and annual gross premiums payable for 20 years. The gross premium is calculated based on the equivalence principle.

You are given that mortality follows the Illustrative Life Table with interest at 6%.

The reserves are based on assumed expenses of 10% of premium each year.

The gross premium reserve at the end of the 10th year is 16,530.42.

During the 11th year, the actual mortality on the policy was 95% of the Illustrative Life Table. The actual interest rate earned with 6.5%. The actual expenses were 11% of premium.

Calculate the gain during the 11th year.

By the Equivalence Principle

\[ PVP = PV + PVE \]

\[ G \cdot \ddot{a}_{70\:20} = 50,000 \cdot A_{70\:20} + 10\% \cdot G \cdot \ddot{a}_{70\:20} \]

\[ G = \frac{50,000 \cdot A_{70\:20}}{0.9 \cdot \ddot{a}_{70\:20}} = \frac{50,000 \cdot \left( A_{70} - 20E_{70} \cdot A_{90} + 20E_{70} \right)}{0.9 \cdot \left( \ddot{a}_{70} - 20E_{70} \cdot \dot{a}_{90} \right)} \]

\[ = \frac{50,000 \times (0.51495 - 0.04988 \times 0.79346 + 0.04988)}{0.9 \times (8.5693 - 0.04988 \times 3.6488)} \approx 3,479.15135 \]

Expected gross premium reserve at the end of the 11th year

\[ _{11}V^E = \frac{\left( _{10}V^E + P - e' \right) \cdot (1 + i') - DB \cdot q_{80}}{1 - q_{80}} \]

\[ = \left[ 16,530.42 + 3,479.15135 \times (1-10\%) \right] \times 1.06 - 50,000 \times 0.08030 \]

\[ = 18,295.48286 \]

Actual gross premium reserve at the end of the 11th year

\[ _{11}V^A = \frac{\left( _{10}V^E + P - e' \right) \cdot (1 + i') - DB \cdot q'_{80}}{1 - q'_{80}} \]

\[ = \left[ 16,530.42 + 3,479.15135 \times (1-11\%) \right] \times 1.065 - 50,000 \times 0.95 \times 0.08030 \]

\[ = 18,499.60313 \]

Gain = \(_{11}V^A - _{11}V^E = 18,499.60313 - 18,295.48286 \approx 204.12\]
1. A fully discrete 20 year endowment policy to (70) has a death benefit of 50,000 and annual net benefit premiums payable for 20 years.

You are given that mortality follows the Illustrative Life Table with interest at 6%.

Calculate $15V^n$.

According to Equivalence Principle, $PVP = PVB$

$P \cdot \bar{a}_{70:20} = 50,000 \cdot A_{70:20}$

$P = \frac{50,000 \cdot (A_{70} - \frac{E_{70}}{2} \cdot A_{90} + \frac{E_{70}}{20} \cdot A_{70})}{\bar{a}_{70} - \frac{E_{70}}{20} \cdot \bar{a}_{90}}$

$= \frac{50,000 \times (0.51495 - 0.04988 \times 0.79346 + 0.04988)}{8.5693 - 0.04988 \times 3.6488}$

$\approx 3,131.2362$

$15V^n = PVFB - PVFP$

$= 50,000 \cdot A_{85:31} - 3131.2362 \cdot \bar{a}_{85:31}$

$= 50,000 \cdot (A_{85} - \frac{E_{85}}{3} \cdot A_{90} + \frac{E_{85}}{3} \cdot A_{85}) - 3131.2362 \cdot (\bar{a}_{85} - \frac{E_{85}}{3} \cdot \bar{a}_{90})$

$= 50,000 \times (0.73407 - 0.33540 \times 0.79346 + 0.33540) - 3131.2362 \times (4.6980 - 0.33540 \times 3.6488)$

$\approx 29,288.6585$
2. A fully discrete whole life policy to (60) has a death benefit of 100,000 and an annual gross premium of 4,000.

You are given that mortality follows the Illustrative Life Table with interest at 6%.

The policy also has expenses of 50% of gross premiums the first year and 7% of gross premiums each year thereafter. Additionally, there is annual maintenance at the beginning of each year of 50.

Calculate \( A_S\).

By Recursion formula,

\[
A_S = \frac{(A_S_{r-1} + P - e) \times (1 + i) - DB \cdot q_{x_{r-1}}}{1 - q_{x_{r-1}}}
\]

\[A_S_1 = \frac{[0 + 4000 \times (1 - 50\%) - 50] \times 1.06 - 100,000q_{60}}{1 - q_{60}} = 700.64082
\]

\[A_S_2 = \frac{[700.64082 + 4000 \times (1 - 7\%) - 50] \times 1.06 - 100,000q_{61}}{1 - q_{61}} = 3,179.61
\]