1. You are given:
   a. \(1000A_{20} = 200\)
   b. \(1000A_{35} = 360\)
   c. \(1000A_{20:35} = 440\)
   d. \(\nu = 0.9\)

   Calculate the annual net benefit premium for a fully discrete last survivor whole life issued to (20) and (35) which has a death benefit of 1,000,000.

   Solution:

   \[ P = \frac{1,000,000A_{20:35}}{\ddot{a}_{20:35}} \]

   \[ A_{20:35} + A_{20:35} = A_{20} + A_{35} \implies A_{20:35} = A_{20} + A_{35} - A_{20:35} = 0.200 + 0.360 - 0.440 = 0.120 \]

   \[ \ddot{a}_{20:35} = \frac{1 - A_{20:35}}{d} = \frac{1 - 0.120}{1 - 0.9} = 8.8 \]

   \[ P = \frac{1,000,000A_{20:35}}{\ddot{a}_{20:35}} = \frac{(1,000,000)(0.120)}{8.8} = 13,636.36 \]
2. For two independent lives $x$ and $y$, you are given:

   a. $^{10}q_{xy} = 0.16875$
   
   b. $^{10}q_{yx} = 0.00625$

   Calculate the possible values for $^{10}q_x$.

   **Solution:**

   
   
   $^{10}q_{xy} + ^{10}q_{yx} = ^{10}q_x + ^{10}q_y \implies 0.16875 + 0.00625 = 0.175 = ^{10}q_x + ^{10}q_y \implies ^{10}q_y = 0.175 - ^{10}q_x$

   
   
   $^{10}q_{xy} = ^{10}q_x \cdot ^{10}q_y = 0.00625 \implies ^{10}q_x (0.175 - ^{10}q_x) = 0.0625$

   
   
   $^{10}q_x (0.175) - (^{10}q_x)^2 = 0.00625 \implies (^{10}q_x)^2 - ^{10}q_x (0.175) + 0.00625 = 0$

   
   
   $^{10}q_x = \frac{0.175 \pm \sqrt{(-0.175)^2 - (4)(1)(0.00625)}}{(2)(1)} = 0.125 \ or \ 0.05$
3. A three year term life insurance policy on (85) pays a death benefit of 15,000 at the end of the year of death. The premiums are payable annually.

You are given:

a. Mortality follows the Illustrative Life Table.
b. The following forward interest rate curve:

<table>
<thead>
<tr>
<th>Time</th>
<th>Forward Interest Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>f(0,1)</td>
<td>3%</td>
</tr>
<tr>
<td>f(1,2)</td>
<td>4%</td>
</tr>
<tr>
<td>f(2,3)</td>
<td>5%</td>
</tr>
<tr>
<td>f(3,4)</td>
<td>6%</td>
</tr>
<tr>
<td>f(4,5)</td>
<td>7%</td>
</tr>
<tr>
<td>f(5,6)</td>
<td>8%</td>
</tr>
</tbody>
</table>

Calculate the net benefit premium based on the equivalence principle.

Solution:

<table>
<thead>
<tr>
<th>t</th>
<th>v(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/1.03</td>
</tr>
<tr>
<td>2</td>
<td>1/(1.03)(1.04) = 1/1.0712</td>
</tr>
<tr>
<td>3</td>
<td>1/(1.03)(1.04)(1.05) = 1/1.12476</td>
</tr>
</tbody>
</table>

Using \( l' \)'s and \( d' \)'s

\[
P = \frac{15,000[v(1) \cdot d_{85} + v(2) \cdot d_{86} + v(3) \cdot d_{87}]}{l_{85} + v(1) \cdot l_{86} + v(2) \cdot l_{87}}
\]

\[
15,000 \left[ \frac{2,358,246 - 2,066,090}{1.03} + \frac{2,066,090 - 1,787,299}{1.0712} + \frac{1,787,299 - 1,524,758}{1.12476} \right] =
\]

\[
2,358,246 + \frac{2,066,090}{1.03} + \frac{1,787,299}{1.0712}
\]

1932.80
4. You are given the following mortality table:

<table>
<thead>
<tr>
<th>( x )</th>
<th>( l_x )</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>2500</td>
</tr>
<tr>
<td>93</td>
<td>2250</td>
</tr>
<tr>
<td>94</td>
<td>2000</td>
</tr>
<tr>
<td>95</td>
<td>1600</td>
</tr>
<tr>
<td>96</td>
<td>960</td>
</tr>
<tr>
<td>97</td>
<td>384</td>
</tr>
<tr>
<td>98</td>
<td>0</td>
</tr>
</tbody>
</table>

You are also given the following forward interest rate curve:

<table>
<thead>
<tr>
<th>Time</th>
<th>Forward Interest Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(0,1) )</td>
<td>3%</td>
</tr>
<tr>
<td>( f(1,2) )</td>
<td>4%</td>
</tr>
<tr>
<td>( f(2,3) )</td>
<td>5%</td>
</tr>
<tr>
<td>( f(3,4) )</td>
<td>6%</td>
</tr>
<tr>
<td>( f(4,5) )</td>
<td>7%</td>
</tr>
<tr>
<td>( f(5,6) )</td>
<td>8%</td>
</tr>
</tbody>
</table>

A fully discrete whole life insurance on (92) has a death benefit of 25,000 and an annual net benefit premium of 5778.36.

Calculate \( 4V \)

**Solution:**

\[
4V = 25,000A_{96} - 5778.36\ddot{a}_{96}
\]

\[
A_{96} = \frac{960 - 384}{1.07} + \frac{384 - 0}{(1.07)(1.08)} = 0.9068882
\]

\[
\ddot{a}_{96} = \frac{960 + 384}{1.07} = 1.373832
\]

\[
4V = (25,000)(0.9068882) - (5778.36)(1.373832) = 14,733.71
\]
5. A whole life insurance policy on (75) has a death benefit of 100,000 paid at the end of the year of death. The annual gross premium is 9700.

Edyta performs a profit test on this policy. The interest rate used in the profit test is 8%. Mortality follows the Illustrative Life Table.

The other profit test information is listed below for the first four years:

<table>
<thead>
<tr>
<th>Year</th>
<th>Withdrawals</th>
<th>Reserve End of Year</th>
<th>Percent of Premium Expense</th>
<th>Per Policy Expense</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20%</td>
<td>3,710</td>
<td>60%</td>
<td>125</td>
</tr>
<tr>
<td>2</td>
<td>10%</td>
<td>7,390</td>
<td>10%</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>8%</td>
<td>11,033</td>
<td>5%</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>4%</td>
<td>14,625</td>
<td>2%</td>
<td>25</td>
</tr>
</tbody>
</table>

Withdrawals occur at the end of the year. Cash values are equal to 80% of the reserves.

Calculate $\pi_2$, which is the profit signature for the second year.

**Solution:**

\[ \text{Premium} = 9700.00 \]
\[ \text{Expense} = (9700)(0.1) + 25 = 995.00 \]
\[ \text{Interest} = (0.08)(9700 - 995) = 696.40 \]
\[ \text{Death Benefit} = (q_{76})(100,000) = (0.05647)(100,000) = 5647.00 \]
\[ \text{Withdrawals} = (CV_2)(1-q_{76})(w_2) = (0.8 \cdot 7390)(1-0.05647)(0.1) = 557.81494 \]
\[ \Delta\text{Reserve} = (\text{CV}_2)(1-q_{76})(1-w_2) = (7390)(1-0.05647)(1-0.1) - (3710)(1.08) = 2268.62 \]

\[ \text{Profit Vector} = \text{Premium} - \text{Expense} + \text{Interest} - \text{Death Benefit} - \text{Withdrawal} - \Delta\text{Reserve} = 9700.00 - 995.00 + 696.40 - 5647.00 - 557.81 - 2268.62 = 927.97 \]

\[ \text{InForce} = (1-q_{75})(1-w_i) = (1-0.05169)(1-0.2) = 0.758648 \]

\[ \pi_2 = (\text{Profit Vector})(\text{InForce}) = (927.97)(0.758648) = 704.00 \]
6. On a Facebook Account, a person can be in one of three statuses:

a. Status (0) – Single
b. Status (1) – Engaged
c. Status (2) – Married

The actuaries for Facebook have developed the following annual transition matrix:

\[
\begin{bmatrix}
0.50 & 0.30 & 0.20 \\
0.25 & 0.10 & 0.65 \\
0.20 & 0.05 & 0.75
\end{bmatrix}
\]

Calculate the probability that a person who is single now will be married at the end of three years.

Solution:

\[
Q_0 = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}
\]

\[
Q_1 = Q_0 \cdot Q_t = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0.50 & 0.30 & 0.20 \\
0.25 & 0.10 & 0.65 \\
0.20 & 0.05 & 0.75
\end{bmatrix} = \begin{bmatrix} 0.5 & 0.3 & 0.2 \end{bmatrix}
\]

\[
Q_2 = Q_1 \cdot Q_t = \begin{bmatrix} 0.5 & 0.3 & 0.2 \end{bmatrix} \begin{bmatrix} 0.50 & 0.30 & 0.20 \\
0.25 & 0.10 & 0.65 \\
0.20 & 0.05 & 0.75
\end{bmatrix} = \begin{bmatrix} 0.365 & 0.19 & 0.445 \end{bmatrix}
\]

\[
Q_3 = Q_2 \cdot Q_t = \begin{bmatrix} 0.365 & 0.19 & 0.445 \end{bmatrix} \begin{bmatrix} 0.50 & 0.30 & 0.20 \\
0.25 & 0.10 & 0.65 \\
0.20 & 0.05 & 0.75
\end{bmatrix} = \begin{bmatrix} 0.319 & 0.15075 & 0.53025 \end{bmatrix}
\]

\text{Answer} = 0.53025
This information applies to both Questions 7. and 8.

A whole life policy to (60) has a death benefit of 50,000 paid at the end of the year of death. The gross premium for this policy is paid annually and is determined based on the equivalence principle.

You are given that gross premiums were determined using:

a. Mortality follows the Illustrative Life Table.

b. \( i = 6\% \)

c. Expenses are incurred at the beginning of the year and are:
   i. 60% of premiums in the first year
   ii. 10% of premiums in years two and later
   iii. Issue expense of 100 per policy
   iv. Maintenance expense of 30 per policy in all years including the first year.

7. Determine \( 20V \), the gross premium reserve at the end of the 20\(^{th} \) year.

Solution:

\[
P^x \cdot \dd{60} = 50,000A_{60} + 0.5P^x + 0.1P^x \cdot \dd{60} + 100 + 30 \cdot \dd{60}
\]

\[
P^x = \frac{50,000A_{60} + 100 + 30 \cdot \dd{60} - 0.1P^x \cdot \dd{60} - 0.5P^x}{\dd{60} - 0.1P^x \cdot \dd{60} - 0.5} = \frac{(50,000)(0.36913) + 100 + 30(11.1454)}{0.9(11.1454) - 0.5} = 1982.07318
\]

\[
20V = 50,000A_{60} + 0.1P^x \cdot \dd{60} + 30 \cdot \dd{80} - P^x \cdot \dd{80} = 50,000A_{60} + (30 - 0.9P^x)\dd{80} = (50,000)(0.66575) + [30 - (0.9)(1982.07318)](5.9050) = 22,930.92
\]
8. During the 21\textsuperscript{st} policy year, the actual experience for this policy was:

a. Mortality of 110\% of the Illustrative Life Table.

b. \( i = 7.5\% \)

c. Expenses, incurred at the beginning of the year, were:
   i. Percent of Premium expense of 8\%.
   ii. Maintenance expense of 35\%.

Determine the annual profit during the 21\textsuperscript{st} policy year.

\textbf{Solution:}

\[ 21V \]

\[ 21V = \frac{(20V + P^e - e - X)(1 + i) - 50,000q_{80}}{1 - q_{80}} = \]

\[ \frac{(22,930.92 + 1982.07)(0.90 - 30)(1.06) - (50,000)(0.08030)}{1 - 0.08030} = 24,084.89 \]

\textit{Now using experience assumptions}

\[ \text{Profit} = (20V + P^e - e - X)(1 + i) - 50,000q_{80} - (1 - q_{80})_{21V} \]

\[ (22,930.92 + 1982.07)(0.92 - 35)(1.075) - (50,000)(1.1)(0.08030) - [1 - (1.1)(0.08030)](24,084.89) \]

\[ = 199.41 \]
9. A whole life policy on (35) pays a death benefit of 250,000 at the moment of death. The policy has net benefit premiums payable annually. The premiums are determined using the equivalence principle.

You are given that mortality follows the Illustrative Life Table and $i = 6\%$.

You are also given that deaths are uniformly distributed between integral ages.

Calculate $25.3 V$.

Solution:

\[
P = \frac{250,000 \overline{A}_{35}}{\overline{a}_{35}} = \frac{(250,000)(1.02971)(0.12872)}{15.3926} = 2152.72714
\]

\[
25 V = 250,000 \overline{A}_{60} - (2152.72714)(\overline{a}_{60}) = (250,000)(1.02971)(0.36913) - (2152.72714)(11.1454) = 71,031.20799
\]

\[
25 V = 250,000 \overline{A}_{61} - (2152.72714)(\overline{a}_{61}) = (250,000)(1.02971)(0.38279) - (2152.72714)(10.9041) = 75,067.1207
\]

\[
25.3 V = (0.7)(25 V + P) + (0.3)(26 V) = (0.7)(71,031.20799 + 2152.72714) + (0.3)(75,067.1207) = 73,748.89
\]
10. For a multiple state model, there are three states:

i. State 0 is a person who is healthy

ii. State 1 is a person who is permanently disabled

iii. State 2 is a person who is dead

Further you are given that a person can transition from State 0 to State 1 or State 2. Also, a person in State 1 can transition to State 2, but not to State 0. Finally, a person in State 2 cannot transition.

You are given the following transitional intensities:

i. \( \mu_{01}^{01} = 0.05 - 0.001t \) for \( 0 \leq t \leq 40 \)

ii. \( \mu_{02}^{02} = 0.03 + 0.001t \) for \( 0 \leq t \leq 40 \)

iii. \( \mu_{12}^{12} = 0.10 \)

A 40 year temporary annuity pays 100 at the beginning of each year as long as a person healthy. No payments are made after the 40th payment.

If \( \delta = 0.02 \), calculate the Actuarial Present Value of this annuity.

**Solution:**

\[
\bar{a}_{x:40}^{00} = \int_0^4 (\mu_{01}^{01} + \mu_{02}^{02}) \, dt = e^0 - e^0 = e^{-0.08t}
\]

\[
\bar{a}_{x:40} = \sum_{t=0}^{39} t \cdot \bar{a}_{x:40}^{00} = \sum_{t=0}^{39} e^{-0.02t} \cdot e^{-0.08t} = \sum_{t=0}^{39} e^{-0.10t} = \frac{1 - e^{-4}}{1 - e^{-0.1}} = 10.3159
\]

**Answer** \( \Rightarrow 100\bar{a}_{x:40} = 100(10.3159) = 1031.59 \)
11. A whole life insurance policy on \((x)\) has a death benefit of 50,000 paid at the end of the year of death. The gross premium for this policy is 3750.

You are given:

\[ a. \quad i = 8\% \]

\[ b. \quad \text{Expenses are incurred at the beginning of the year and are:} \]

i. 60% of premiums in the first year

ii. 10% of premiums in years two and later

iii. Issue expense of 100 per policy

iv. Maintenance expense of 30 per policy in all years including the first year.

\[ c. \quad AS_1 = -21.03 \quad \text{and} \quad AS_2 = 1931.52 \]

Calculate \( q_{x+1} \)

Solution:

\[
(AS_1 + P(1-e) - c)(1+i) = (q_{x+1})(50,000) + (1-q_{x+1})(AS_2)
\]

\[
[-21.03 + (3750)(0.9) - 30] = (q_{x+1})(50,000) + (1-q_{x+1})(1931.52) = 48,068.48(q_{x+1}) + 1931.52
\]

\[
q_{x+1} = \frac{-21.03 + (3750)(0.9) - 30 - 1931.52}{48,068.48} = 0.0345
\]
12. A whole life policy on (92) has a death benefit of 75,000 payable at the end of the year of death. Premiums are payable annually.

You are given that \( v = 0.9 \) and the following mortality table:

<table>
<thead>
<tr>
<th>( x )</th>
<th>( l_x )</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>2500</td>
</tr>
<tr>
<td>93</td>
<td>2250</td>
</tr>
<tr>
<td>94</td>
<td>2000</td>
</tr>
<tr>
<td>95</td>
<td>1600</td>
</tr>
<tr>
<td>96</td>
<td>960</td>
</tr>
<tr>
<td>97</td>
<td>384</td>
</tr>
<tr>
<td>98</td>
<td>0</td>
</tr>
</tbody>
</table>

You are also given:

a. \( P^{FPT}_1 \) is the first year premium under the Full Preliminary Term reserve method.

b. \( P^{FPT}_{x+1} \) is the renewal premium for years 2 and later under Full Preliminary Term.

c. The expense allowance is defined as \( P^{FPT}_{x+1} - P^{FPT}_1 \).

Calculate the expense allowance for this policy.

**Solution:**

\[
1P^{FPT} = Svq = (75,000)(0.9)\left(1 - \frac{2250}{2500}\right) = 6750 \\

P_{x+1}^{FPT} = \frac{75,000 A_{x+1}}{\dot{a}_{x+1}} = \frac{75,000(250v + 400v^2 + 640v^3 + 576v^4 + 384v^5)}{2250 + 2000v + 1600v^2 + 960v^3 + 384v^4} = 19,295.15 \\

Expense Allowance = P_{x+1}^{FPT} - P^{FPT}_1 = 19,295.15 - 6750 = 12,545.15
13. A fully discrete three year term life insurance policy on \( x \) pays a death benefit at the end of the year of death. The death benefit is 40,000 upon death from accidental causes (decrement (a)) and 25,000 upon death from other causes (decrement (o)).

You are given that:

a. \( q_{x+t}^{(a)} = 0.01 \)
b. \( q_{x+t}^{(o)} = 0.05(1 + t) \)
c. \( v = 0.95 \)

Calculate \( iV \), the net benefit reserve at the end of the first year.

<table>
<thead>
<tr>
<th>( t )</th>
<th>( l_{x+t} )</th>
<th>( d_s^{(a)} )</th>
<th>( d_s^{(o)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1000</td>
<td>(1000)(0.01) = 10</td>
<td>(1000)(0.05)(1 + 0) = 50</td>
</tr>
<tr>
<td>1</td>
<td>1000 – 10 – 50 = 940</td>
<td>(940)(0.01) = 9.4</td>
<td>(940)(0.05)(1 + 1) = 94</td>
</tr>
<tr>
<td>2</td>
<td>940 – 9.4 – 94 = 836.6</td>
<td>(836.6)(0.01) = 8.366</td>
<td>(836.6)(0.05)(1 + 2) = 125.49</td>
</tr>
</tbody>
</table>

**Solution:**

Using \( l' \)s and \( d' \)s

\[
P[1000 + 940(0.95) + 836.6(0.95)^2] = 40,000[10(0.95) + 9.4(0.95)^2 + 8.366(0.95)^3] + 25,000[50(0.95) + 94(0.95)^2 + 125.49(0.95)^3]
\]

\[
P = \frac{40,000[10(0.95) + 9.4(0.95)^2 + 8.366(0.95)^3] + 25,000[50(0.95) + 94(0.95)^2 + 125.49(0.95)^3]}{1000 + 940(0.95) + 836.6(0.95)^2} = \frac{1,006,251.97 + 5,998,174.72}{2,648.0315} = 2645.144776
\]

Now using the recursive formula

\[
iV = \frac{(q + P)(1 + i) - (40,000)(d_s^{(a)}) - (25,000)(d_s^{(o)})}{1 - q_{x+t}^{(a)} - q_{x+t}^{(o)}} = \frac{(0 + 2645.144776)(0.95)^{-1} - (40,000)(0.01) - (25,000)(0.05)}{1 - 0.01 - 0.05} = 1206.77
\]
14. You are given:

   a. Mortality follows the Common Shock Model.
   b. \( \mu_x = 0.005 \)
   c. \( \mu_y = 0.010 \)
   d. \( \mu_x \) and \( \mu_y \) do not reflect the common shock force of mortality.
   e. The common shock force of mortality is 0.002.

Calculate \( 20 \, p_{x,y} \).

Solution:

\[
20 p_{x,y} = 20 p_x + 20 p_y - 20 p_{x,y}
\]

\[
20 p_x = e^{0} - \int_{0}^{20} (\mu_x + \mu^2) \, dt = e^{0} = e^{-0.14}
\]

\[
20 p_y = e^{0} - \int_{0}^{20} (\mu_y + \mu^2) \, dt = e^{0} = e^{-0.24}
\]

\[
20 p_{x,y} = e^{0} - \int_{0}^{20} (\mu_x + \mu_y + \mu^2) \, dt = e^{0} = e^{-0.34}
\]

\[
20 p_{x,y} = 20 p_x + 20 p_y - 20 p_{x,y} = e^{-0.14} + e^{-0.24} - e^{-0.34} = 0.944216
\]
15. You are given the following profit vector for a whole life issued to (94):

<table>
<thead>
<tr>
<th>$t$</th>
<th>$Pr_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-900</td>
</tr>
<tr>
<td>1</td>
<td>700</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

Mortality is the only decrement and follows the table below:

<table>
<thead>
<tr>
<th>$x$</th>
<th>$l_x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>2500</td>
</tr>
<tr>
<td>93</td>
<td>2250</td>
</tr>
<tr>
<td>94</td>
<td>2000</td>
</tr>
<tr>
<td>95</td>
<td>1600</td>
</tr>
<tr>
<td>96</td>
<td>960</td>
</tr>
<tr>
<td>97</td>
<td>384</td>
</tr>
<tr>
<td>98</td>
<td>0</td>
</tr>
</tbody>
</table>

The gross premium used in the profit test is 1000.

Calculate the Profit Margin for this profit test using an interest rate of 8%.

**Solution:**

<table>
<thead>
<tr>
<th>$t$</th>
<th>$Pr_t$</th>
<th>In Force</th>
<th>$\pi_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-900</td>
<td>1</td>
<td>(-900)(1) = -900</td>
</tr>
<tr>
<td>1</td>
<td>700</td>
<td>1</td>
<td>(700)(1) = 700</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>$\frac{1600}{2000} = 0.8$</td>
<td>(500)(0.8) = 400</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>$\frac{960}{2000} = 0.48$</td>
<td>(300)(0.48) = 144</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>$\frac{384}{2000} = 0.192$</td>
<td>(100)(0.192) = 19.2</td>
</tr>
</tbody>
</table>

$$ Profit\ Margin = \frac{\text{Present Value of Profit}}{\text{Present Value of Premium}} = \frac{-900 + 700v + 400v^2 + 144v^3 + 19.2v^4}{1000(1 + 0.8v + 0.48v^2 + 0.192v^3)} = \frac{219.50809}{2304.679165} = 0.0952445 $$
16. Elssie (25) and Hayqual (35) purchase two annuities:

a. One is a last survivor annuity that pays 100,000 at the beginning of every year if both Elssie and Hayqual are alive. It pays 50,000 if only one is alive.

b. A reversionary annuity that pays 25,000 at the beginning of each year following Hayqual’s death as long as Elssie is alive.

You are given that mortality follows the Illustrative Life Table and $i = 6\%$.

Calculate the total Actuarial Present Value of these annuities.

**Solution:**

\[
APV \text{ of } \text{Annuity a.} = 50,000\ddot{a}_{25} + 50,000\ddot{a}_{35} - 0\ddot{a}_{2535} = \\
(50,000)(16.2242) + (50,000)(15.3926) = 1,580,840
\]

\[
APV \text{ of } \text{Annuity b.} = 25,000\ddot{a}_{3525} = 25,000[\ddot{a}_{25} - \ddot{a}_{2535}] = \\
25,000[16.2242 - 14.8617] = 34,062.5
\]

**Total Present Value** = 1,580,840 + 34,062.5 = 1,614,902.5
This information applies to both Questions 7. and 8.

A whole life policy to (60) has a death benefit of 50,000 paid at the end of the year of death. The gross premium for this policy is paid annually and is determined based on the equivalence principle.

You are given that gross premiums were determined using:

a. Mortality follows the Illustrative Life Table.

b. \( i = 6\% \)

c. Expenses are incurred at the beginning of the year and are:
   i. 60% of premiums in the first year
   ii. 10% of premiums in years two and later
   iii. Issue expense of 100 per policy
   iv. Maintenance expense of 30 per policy in all years including the first year.

7. Determine \( 20V \), the gross premium reserve at the end of the 20th year.

8. During the 21st policy year, the actual experience for this policy was:

a. Mortality of 110% of the Illustrative Life Table.

b. \( i = 7.5\% \)

c. Expenses, incurred at the beginning of the year, were:
   i. Percent of Premium expense of 8%.
   ii. Maintenance expense of 35.

Determine the annual profit during the 21st policy year.

This information is repeated at the end so you can rip this page off and use it when working Questions 7 and 8.