Each problem is worth 10 points. Show all work for full credit, and use correct notation.

1. For a fully continuous whole life insurance of 1,000 issued to (30), you are given:
   (i) The level annual premium rate is determined using the equivalence principle.
   (ii) $\bar{A}_{30} = 0.10$
   (iii) $A_{50} = 0.20$
   (iii) $^2A_{50} = 0.06$

   Determine $Var(20L)$.

   $Var(20L) = 1000^2 \cdot \frac{2A_{50} - (A_{50})^2}{(1-\bar{A}_{30})^2}$

   $\therefore Var(20L) = 24,690$

2. For a fully discrete 20-year endowment insurance of 5000 issued to (20), use the SULT actuarial assumptions to determine the net premium reserve at time $t = 10$.

   $10V = 5000 \left( 1 - \frac{\bar{a}_{30:10}}{\bar{a}_{20:20}} \right) = 1899$

   There are several other correct ways to answer this question. The method above is the most time-efficient.

3. For a fully continuous whole life insurance of 1000 on (40), you are given:
   (i) $\mu = 0.04$ and $\delta = 0.06$
   (ii) the annual gross premium (rate), payable continuously for a maximum of 10 years, is 72
   (iii) expenses are
     (a) an initial expense of 20
     (b) 3 per year, payable continuously for the lifetime of (40)

   Determine $20V^g$, the gross premium reserve at time $t = 20$.

   Since there are no more future premiums at time $t = 20$, then

   $20V^g = APV(\text{FB} + \text{FE}) = 1000\bar{A}_{60} + 3\bar{a}_{60} = 1000 \frac{\mu}{\mu+\delta} + 3 \frac{1}{\mu+\delta} = 430$
4. For a fully discrete whole life insurance issued to (20), you are given:

(i) The death benefit is 100,000 in year 1; 200,000 in year 2; and $X$ thereafter
(ii) The premiums are 250 in year 1; 600 in year 2; and $Y$ thereafter
(iii) Using the SULT actuarial assumptions, $0V = E[0L] = 0$

Using the SULT actuarial assumptions, determine the time 2 reserve, $2V = E[2L]$.

By (iii), we can use a retrospective calculation.

$$2V = AAV(PP) - AAV(PB) = \frac{250 + 600vp_{20}}{v^2 \cdot 2p_{20}} - \frac{100000vq_{20} + 200000v^2 \cdot 1q_{20}}{v^2 \cdot 2p_{20}}$$

$$= 2V = 829$$

5. For a fully discrete 3-year endowment insurance of 1000 on $(x)$, you are given:

(i) Expenses, payable at the beginning of the year, are:

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Percent of Premium</th>
<th>Per Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20%</td>
<td>15</td>
</tr>
<tr>
<td>2 and 3</td>
<td>8%</td>
<td>5</td>
</tr>
</tbody>
</table>

(ii) The expense reserve at the end of year 2 is $-23.64$.
(iii) The gross annual premium calculated using the equivalence principle is $G = 368.05$.
(iv) $G = 1000P_{x:3} + P^e$, where $P^e$ is the expense loading.

Calculate $P_{x:3}$.

At time $t = 2$, the future expenses are $0.08(368.05) + 5 = 34.444$, payable at time 2, and the future expense premium is $P^e$, payable at time 2.

So, by (ii), we have $-23.64 = 2V^e = 34.444 - P^e$, and so $P^e = 58.084$.

$$= G = 368.05 = 1000P_{x:3} + 58.086 \implies P_{x:3} = 0.309966$$