1. A fully discrete whole life policy to (60) has a death benefit of 20,000 and an annual gross premium of 865.

Mortality follows the Illustrative Life table with \( i = 0.05 \). Note that the interest rate is NOT 6%.

The policy incurs the following expenses:
   i. 30 per policy at the beginning of each policy year.
   ii. 50% of premium during the first policy year.
   iii. 10% of premium during each year after the first policy year.

Calculate the Asset Share at the end of the second year.
2. A fully discrete 20 year endowment insurance policy to (40) has a death benefit of 25,000 and annual premiums for 20 years.

You are given that mortality follows the Illustrative Life Table and \( i = 0.06 \).

Calculate \( 10 V^n \), the net benefit reserve at the end of 10 years.
3. A fully discrete whole life insurance policy on (70) has a death benefit of 70,000 and annual premiums for the life of the insured.

You are given that mortality follows the Illustrative Life Table and \( i = 0.06 \).

Calculate \( P_{1}^{FPT} \), the first year net premium under Full Preliminary Term reserves and \( V_{12}^{FPT} \), the reserve at the end of the 12th year under Full Preliminary Term reserves.
4. For a fully discrete whole life policy to (65) with a death benefit of 75,000, the annual gross premium is 4000.

You are given the following expenses are used to determine the reserves:
   i. Commissions are 40% of premiums in the first year and 5% thereafter.
   ii. Per policy expenses are 40 at the beginning of every year including the first year.

You are also given:
   i. $10 V^g = 13,000$
   ii. $i = 0.04$
   iii. $q_{75} = 0.050$
   iv. $q_{76} = 0.057$

Calculate $10.3 V^g$. 
5. For a fully continuous whole life to \((x)\) with a death benefit of 35,000, you are given that:

i. \( \frac{d}{dt} V^x = 1475 \) at \( t = 10 \)

ii. \( \int_{10}^{20} 0.02 + 0.01t \)

iii. Expenses incurred continuously are:

1. 25% of premium in the first year and 5% of premium in renewal years
2. Per policy expense at a rate of 100 per year

iv. The force of interest is 5%.

v. \( \mu_{x+t} = 0.02 + 0.01t \)

vi. The gross premium is paid at a rate of \( P \) per year.

Determine \( P \).
6. A fully discrete whole life insurance policy to (45) has a death benefit of 200,000 and annual premiums for as long as the insured is alive.

You are given the following expenses were used for the reserves and the gross premium:
   i. Commissions of 50% of premiums the first year and 8% of premiums in renewal years.
   ii. Issue expenses at the beginning of the first year of 150 per policy.
   iii. Maintenance expenses of 25 per policy at the start of each year including the first year.

You are also given that mortality follows the Illustrative Life Table and $i = 0.06$.

The net benefit premium is 2851.45 and the gross premium is 3243.05.

Calculate the expense reserve at the end of the 5th year.
The part highlighted in yellow is repeated from Question 6.

7. A fully discrete whole life insurance policy to (45) has a death benefit of 200,000 and annual premiums for as long as the insured is alive.

You are given the following expenses were used for the reserves and the gross premium:

i. Commissions of 50% of premiums the first year and 8% of premiums in renewal years.
ii. Issue expenses at the beginning of the first year of 150 per policy.
iii. Maintenance expenses of 25 per policy at the start of each year including the first year.

You are also given that mortality follows the Illustrative Life Table and \( i = 0.06 \).

The net benefit premium is 2851.45 and the gross premium is 3243.05.

The actual experience during the 11\(^{th}\) year for this policy was:

i. Interest was earned at a rate of 5.75%
ii. Expenses were 7% of premium and 30 per policy at the start of the year.
iii. Mortality was actually 90% of the Illustrative Life Table

You calculate the profit by source allocating the profit first to interest, then to expenses, and finally to mortality.

Calculate the gain from expenses in the 11\(^{th}\) year.
8. For an insurance policy, the insured can be in one of three states:
   i. State 0 is healthy
   ii. State 1 is disabled
   iii. State 2 is dead

   A person can transition from State 0 to State 1 or State 2. Additionally, a person in State 1 can transition into State 2. Finally, a person in State 2 cannot transition.

   You are given:
   i. \( \mu_x^{01} = 0.04 \)
   ii. \( \mu_x^{02} = 0.02 \)
   iii. \( \mu_x^{12} = 0.05 \)

   Calculate \( s \rho_x^{02} \).
9. For an insurance policy, the insured can be in one of three states:
   i. State 0 is healthy
   ii. State 1 is disabled
   iii. State 2 is dead

A person can transition from State 0 to State 1 or State 2. Additionally, a person in State 1 can transition into State 0 or State 2. However, a person in State 2 cannot transition.

You are given the following forces of transition:

i. \( \mu_x^{01} = 0.06 \)
ii. \( \mu_x^{02} = 0.03 + 0.012t \)
iii. \( \mu_x^{12} = (0.12)(1.1^t) \)
iv. \( \mu_x^{10} = 0.05 \)
v. Only one transition may occur during any one month period.

Using the Euler method, calculate 1000 times the probability that a person who is healthy today is disabled at the end of 2 months.
10. Actuarial students can be in one of three states:
   i. State 0 is actively taking exams
   ii. State 1 is taking a break from exams
   iii. State 2 is no longer taking exams (either because they quit or because they are finished with exams)

A student can transition from State 0 to State 1 or State 2. Additionally, a student in State 1 can transition into State 0 or State 2. However, a student in State 2 cannot transition.

The following matrix represents the probability of transition between any two states in a year:

\[
\begin{pmatrix}
0.7 & 0.2 & 0.1 \\
0.4 & 0.1 & 0.5 \\
0 & 0 & 1
\end{pmatrix}
\]

Today, Akey Assurance Company has 70 actuarial students who are actively taking exams and 30 actuarial students who are taking a break.

\( N \) is the number of these 100 students who will still be actively taking exams at the end of 2 years.

Calculate \( E[N] \).
11. For an insurance policy, the insured can be in one of three states:
   i. State 0 is healthy
   ii. State 1 is in a nursing home
   iii. State 2 is dead

   A person can transition from State 0 to State 1 or State 2. Additionally, a person in State 1 can transition into State 0 or State 2. However, a person in State 2 cannot transition.

   Ahmad Assurance Company issues a three year term insurance policy that pays 50,000 at the end of the year of death. It also pays 100,000 at the end of each year that a person is in a nursing home. The insured pays annual premiums each year during the policy provided the insured is healthy.

   You are given that $v = 0.9$ and the following transitional probability matrix:

   $\begin{bmatrix}
   0.70 & 0.20 & 0.10 \\
   0.35 & 0.15 & 0.50 \\
   0 & 0 & 1
   \end{bmatrix}$

   Calculate the net benefit premium for this insurance policy assuming that the policy is only sold to a healthy person.
12. Dai Dog Insurance Company sells a policy that covers the life of a dog. The policy pays a death benefit of 500 at the end of the year of death if the dog dies from natural causes and pays a death benefit of 1000 at the end of the year of death if the dog dies from accidental causes. The policy requires annual premiums as long as the policy is active.

You are given that $v = 0.95$ and the following double decrement table where decrement (1) is natural death and decrement (2) is death from accidental causes:

<table>
<thead>
<tr>
<th>Age</th>
<th>$x$</th>
<th>$q_x^{(1)}$</th>
<th>$q_x^{(2)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td></td>
<td>0.17</td>
<td>0.27</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>0.35</td>
<td>0.08</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>0.78</td>
<td>0.03</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>1</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Calculate the net annual benefit premium for a policy issued to a dog age 8.
13. In a two decrement model, you are given:
   
   i. \( I^{(r)}_x = 100,000 \)
   
   ii. \( q_x^{(1)} = 0.3 \)
   
   iii. \( q_x^{(2)} = 0.2 \)

If decrements are uniformly distributed in the Multiple Decrement Table, \( M d_x^{(1)} \) is the number of decrements from cause (1) at age \( x \).

If decrements are uniformly distributed in the associated Single Decrement Tables, \( A d_x^{(1)} \) is the number of decrements from cause (1) at age \( x \).

Calculate \( M d_x^{(1)} - A d_x^{(1)} \).
14. You are given that:
   a. Mortality follows the Illustrative Life Table
   b. $i = 0.06$
   c. (50) and (60) are independent lives

Calculate the net annual benefit premium for a survivor whole life policy that pays a death benefit of 250,000 at the end of the year of the second death of (50) and (60). The premium is paid each year that at least one of the insureds is alive.
15. You are given that $\nu = 0.9$ and the following mortality tables for males and females:

<table>
<thead>
<tr>
<th>Age $x$</th>
<th>Male $l_x$</th>
<th>Female $l_x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>97</td>
<td>850</td>
<td>900</td>
</tr>
<tr>
<td>98</td>
<td>650</td>
<td>700</td>
</tr>
<tr>
<td>99</td>
<td>400</td>
<td>450</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

You are also given that male and female lives are subject to a common shock each year. The above table does not reflect deaths from the common shock. In any year, the probability of dying from common shock is 0.02.

The probability of death for males and females from causes other than the common shock are independent. Further, the probability of death from causes other than common shock are independent of the causes of death from common shock.

Calculate $\ddot{a}_{96:97}$ where (96) is a male and (97) is a female.
16. Kristen and Jacqui want to buy one of the following two annuities:

   a. A survivor annuity that will pay 50,000 at the end of each year if both Kristen and Jacqui are alive. If only Jacqui is alive, it will pay 40,000 at the end of each year. If only Kristen is alive, it will pay 25,000 at the end of each year.

   b. A reversionary annuity that will pay $X$ at the end of each year if Kristen is alive but Jacqui is not.

You are given:

   i. Kristen is (25).
   ii. Jacqui is (35).
   iii. Kristen and Jacqui are independent lives.
   iv. Mortality follows the Illustrative Life Table.
   v. $i = 0.06$.

If the two annuities have the same present value, calculate $X$. 