1. You are given:
   
   - Mortality follows the Illustrative Life Table.
   - All lives are independent.
   - Deaths are uniformly distributed over each year of age.

   Evaluate \( q_{50:55:60} \)

2. For a fully discrete whole life insurance of $1 issued to (40), you are given:
   
   - \( P \) is the annual benefit premium determined according to the equivalence principle.
   - \( P^* \) is the smallest possible annual benefit premium to ensure that the probability of a positive loss-at-issue is less than 0.50.

   You are given:
   
   - Mortality follows the Illustrative Life Table.
   - \( i = 6\% \)

   Calculate \( \frac{P}{P^*} \).

3. For a special whole life insurance on (45), you are given:
   
   - Benefit is paid at the end of the year of death. The death benefit is $100,000 for the first 20 years and reduces to $50,000 thereafter.
   - The annual benefit premium of $4,945 is payable once at the beginning of each year for the first 20 years only; no premiums are payable after 20 years.
   - The following actuarial present values:

     \[
     \begin{array}{cccc}
     x & A_x & \bar{a}_x & 10E_x \\
     \hline
     55 & 0.5628 & 4.8091 & 0.0758 \\
     65 & 0.7532 & 2.7147 & 0.0015 \\
     \end{array}
     \]

   Calculate the benefit reserve at the end of 10 years.

4. For a double decrement table, you are given:
   
   - \( q_x^{(1)} = 0.1 \)
   - \( q_x^{(2)} = 0.2 \)
• Each decrement is uniformly distributed over each year of age in its associated single decrement table.

Calculate $q_x^{(1)}$.

5. Patients are classified as Sick (S), Critical (C), or Discharged (D). Transition occur according to the following transition matrix:

$$
\begin{pmatrix}
S & C & D \\
S & 0 & 0.20 & 0.20 \\
C & 0.10 & 0.50 & 0.40 \\
D & 0.00 & 0.00 & 1.00 \\
\end{pmatrix}
$$

Calculate the probability that a patient who is classified as Sick today will be classified as Sick three days later.

6. An insurance company uses the following “accidental death” model:

For a special whole life insurance policy issued to a life ($x$), you are given:

• A benefit of $4 is payable at the moment of death of ($x$) if death is due to acidental causes; otherwise, the benefit is only $1.

• Transition intensities are

$$
\mu_{x+t}^{01} = 0.005 \text{ and } \mu_{x+t}^{02} = 0.010, \text{ for all } t > 0.
$$

• $\delta = 4\%$

Calculate the actuarial present value of the benefits provided by this policy.

7. For a Universal Life policy issued to (50) with death benefit equal to $10,000 plus the account value, you are given:

• Premiums are deposited at the start of each year.
- The expense charge in each year is 2.5% of premium. There are no other expense charges.
- The cost of insurance rate each year is equal to 150% of the applicable mortality rate at the attained age.
- $i^e = i^q = 5\%$ for all years
- The account value at the end of 5 years is $11,196.12$.
- $q_{55} = 0.002$
- The corridor factor requirement is a minimum of 1.5 each year.

Calculate the largest amount of premium this policyholder can pay at the beginning of the sixth year.

8. For a Type A universal life policy issued to (50), you are given:

- The face amount is 100,000.
- All cash flows occur at policy anniversaries.
- The policyholder pays an initial premium of 15,000.
- The cost of insurance (COI) is calculated based on 120% of the mortality in the Illustrative Life Table. The interest rate for discounting the net amount at risk, $i^q$, is 0.04.
- The expense charge is 1% of premium.
- The credited interest rate for policy year 1 is 5%.
- The corridor factor in year 1 is 2.2.
- The surrender charge in policy year 1 is 5% of the premium paid.

(a) Calculate the COI in policy year 1 assuming there is no corridor factor requirement.
(b) Calculate the COI in policy year 1 based only on the corridor factor (as if the face amount were 0).
(c) Determine the COI in policy year 1.

9. For a Type B universal life policy of 200,000 issued to (55):

- A premium of 5000 is paid at the start of the ninth year.
- Expense charges are 35% of first year premiums and 10% of renewal premiums.
- The cost of insurance in the ninth year is based on $q_{63} = 0.01$. Death benefits are assumed to be paid at the end of the year.
- The account values at the beginning and end of the ninth year are 45,000 and 49,480, respectively.
- The interest rate used to discount the COI is equal to the interest credited, $i^e$, during the ninth year.
Calculate \( i^c \).

10. For two universal life policies issued to (60): Policy 1 is a Type A universal life with death benefit of 100,000 while Policy 2 is a Type B universal life with death benefit of 100,000. For each policy:

- Death benefits are paid at the end of the month of death.
- Account values are calculated monthly.
- Level monthly premiums of \( G \) are payable at the beginning of each month. Past premiums may have been different from \( G \), and may not have been the same for both policies.
- Mortality rates for calculating COI follows the Illustrative Life Table, with the UDD assumption for fractional ages.
- Interest is credited at a monthly effective rate of 0.004.
- The interest rate used for accumulating and discounting in the COI calculation is a monthly effective rate of 0.004.
- Level expense charges of \( E \) are deducted at the beginning of each month.

At the end of the 36th month, the account value for Policy 1 equals the account value for Policy 2.
Calculate the ratio of the account value for Policy 1 at the end of the 37th month to the account value of Policy 2 at the end of the 37th month.

11. For a universal life policy with a death benefit of 10,000 plus the account value on (60), you are given:

- The following table of values:

<table>
<thead>
<tr>
<th>Month</th>
<th>Monthly Premium</th>
<th>Percent of Premium Charge</th>
<th>Monthly Cost of Insurance Rate per 1000</th>
<th>Monthly Expense Charges</th>
<th>Surrender Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>100</td>
<td>15%</td>
<td>3.00</td>
<td>10</td>
<td>400</td>
</tr>
</tbody>
</table>

- The credited interest rate is \( i^{(12)} = 0.048 \).
- The account value at the end of month 11 is 1500.

The policy is surrendered at the end of month 12. The cash surrender value is used as a single premium to purchase a whole life annuity-due whose first 10 annual payments are guaranteed. For this annuity, you are given:

- Mortality follows the Illustrative Life Table.
- \( i = 0.06 \)
- The annuity is priced using the equivalence principle.

Calculate the amount of the annual annuity payment.