STT 456 Review Problems for Final Exams
Thursday, April 29, 2015
5-8 pm, Room C-304

1. You are given:

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

   Evaluate $q^{1}_{50:55:60}$

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 $\dfrac{P}{P^*}$.

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:

x	A_x	$\ddot{a}_x$	$_{10}E_x$
55	0.5628	4.8091	0.0758
65	0.7532	2.7147	0.0015

   Calculate the benefit reserve at the end of 10 years.

4. For a double decrement table, you are given:

   - $q_x^{\prime(1)} = 0.1$
   - $q_x^{(2)} = 0.2$

- 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:

$$
\begin{array}{c@{\quad}ccc}
 & \text{S} & \text{C} & \text{D} \\
\begin{array}{c} \text{S} \\ \text{C} \\ \text{D} \end{array} &
\left(\begin{array}{ccc}
0.60 & 0.20 & 0.20 \\
0.10 & 0.50 & 0.40 \\
0.00 & 0.00 & 1.00
\end{array}\right)
\end{array}
$$

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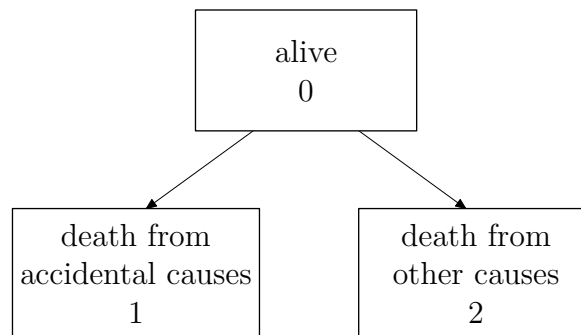
For a special whole life insurance policy issued to a life (x), you are given:

- 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

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

- $\delta = 4\%$

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.
- $i^c = i^q = 5\%$ 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^c, 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:

Month	Monthly Premium	Percent of Premium Charge	Monthly Cost of Insurance Rate per 1000	Monthly Expense Charges	Surrender Charge
12	100	15%	3.00	10	400

- 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.