Society of Actuaries

Canadian Institute of Actuaries

Exam MLC
Models for Life Contingencies

Tuesday,
April 29, 2014
8:30 a.m. – 12:45 p.m.

MLC

INSTRUCTIONS TO CANDIDATES

General Instructions

1. Write your candidate number here _____. Your name must not appear.

2. Do not break the seal of this book until the supervisor tells you to do so.

3. Tables and numerical values necessary for solving some of the questions on this examination will be distributed by the Supervisor.

4. This examination has a total of 96 points. It consists of:

   Section A: 20 multiple-choice questions, each worth 2 points for a total of 40 points, and

   Section B: 7 written-answer questions, worth a total of 56 points. The point value for each written-answer question is indicated at the beginning of the question.

   You may divide your time between the two sections of the examination (written-answer, and multiple-choice) as you choose. You should keep in mind the relative weight of the two sections.

5. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.

6. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Multiple-Choice Instructions

1. A separate answer sheet for the multiple-choice questions is inside the front cover of this book. During the time allotted for this examination, record all your answers on the back of the answer sheet.   NO ADDITIONAL TIME WILL BE ALLOWED FOR THIS PURPOSE. No credit will be given for anything indicated in the examination book but not transferred to the answer sheet. Failure to stop writing or coding your answer sheet after time is called will result in the disqualification of your answer sheet or further disciplinary action.

2. On the front of the answer sheet, space is provided to write and code candidate information. Complete the information requested by printing in the squares and blackening the circles (one in each column) corresponding to the letters or numbers printed.   For each empty box blacken the small circle immediately above the "A" circle. Fill out the boxes titled:

   (a) Name
        (include last name, first name and middle initial)

   (b) Candidate Number
        (Candidate/Eligibility Number, use leading zeros if needed to make it a five digit number)

   (c) Test Site Code
        (The supervisor will supply the number.)

   (d) Examination Part
        (Code the examination that you are taking by blackening the circle to the left of "Exam MLC")

   (e) Booklet Number
        (The booklet number can be found in the upper right-hand corner of this examination book. Use leading zeros if needed to make it a four digit number.)

In box titled "Complete this section only if instructed to do so", fill in the circle to indicate if you are using a calculator and write in the make and model number.

In the box titled "Signature and Date" sign your name and write today's date. **If the answer sheet is not signed, it will not be graded**.

Leave the boxes titled "Test Code" and "Form Code" blank.

On the back of the answer sheet fill in the Booklet Number in the space provided.

CONTINUED ON INSIDE FRONT COVER

3. Your score will be based on the number of questions which you answer correctly. No credit will be given for omitted answers and no credit will be lost for wrong answers: hence, you should answer all questions even those for which you have to guess.

4. Five answer choices are given with each multiple-choice question, each answer choice being identified by a key letter (A to E). Answer choices for some questions have been rounded. For each question, blacken the circle on the answer sheet which corresponds to the key letter of the answer choice that you select.

5. Use a soft-lead pencil to mark the answer sheet. To facilitate correct mechanical scoring, be sure that, for each question, your pencil mark is dark and completely fills only the intended circle. Make no stray marks on the answer sheet. If you have to erase, do so completely.

6. Do not spend too much time on any one question. If a question seems too difficult, leave it and go on.

7. Clearly indicated answer choices in the test book can be an aid in grading examinations in the unlikely event of a lost answer sheet.

8. Use the blank portions of each page for your scratch work. Extra blank pages are provided at the back of the examination book.

9. After the examination, the supervisor will collect this book and the answer sheet separately. DO NOT ENCLOSE THE ANSWER SHEET IN THE BOOK OR IN THE ESSAY ANSWER ENVELOPE. All books and answer sheets must be returned. THE QUESTIONS ARE CONFIDENTIAL AND MAY NOT BE TAKEN FROM THE EXAMINATION ROOM.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.

2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question you are answering. Do not answer more than one question on a single sheet.

3. The answer should be confined to the question as set.

4. When you are asked to calculate, show all your work including any applicable formulas.

5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets because they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate Exam MLC.

6. Be sure your essay answer envelope is signed because if it is not, your examination will not be graded.

7. For all parts of all problems, to maximize the credit earned, candidates should show as much work as possible, considering the time allotted for the question. Answers lacking justification will receive no credit. Answers should be organized so that the methods, logic, and formulas used are readily apparent. Candidates should not round their answers excessively; enough precision should be provided so that their answers can be accurately graded.

In some cases, candidates are asked to show that a calculation results in a particular number. Typically the answer given will be rounded; candidates should provide a greater level of accuracy than the number given in the question. This structure of question is intended to assist the candidate by giving an indication when the calculation has been done incorrectly, providing an opportunity to explore an alternative approach. It also allows a candidate who cannot obtain the correct answer to use the answer given to proceed with subsequent parts of the problem. (Candidates who are able to solve the problem should use their exact answer for subsequent parts.)

For questions requiring candidates to derive or write down a formula or equation, the resulting expression should be simplified as far as possible, and where numerical values are provided in the problem, they should be used.

Exam MLC

SECTION A – Multiple-Choice

1. You are given the following information from a life table:

(i)

x	l_x	d_x	p_x	q_x
95	–	–	–	0.40
96	–	–	0.20	–
97	–	72	–	1.00

(ii) $l_{90} = 1000$ and $l_{93} = 825$

(iii) Deaths are uniformly distributed over each year of age.

Calculate the probability that (90) dies between ages 93 and 95.5.

(A) 0.195

(B) 0.220

(C) 0.345

(D) 0.465

(E) 0.668

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2. You are given the following extract from a table with a 3-year select period:

(i)

x	$q_{[x]}$	$q_{[x]+1}$	$q_{[x]+2}$	q_{x+3}	$x+3$
60	0.09	0.11	0.13	0.15	63
61	0.10	0.12	0.14	0.16	64
62	0.11	0.13	0.15	0.17	65
63	0.12	0.14	0.16	0.18	66
64	0.13	0.15	0.17	0.19	67

(ii) $e_{64} = 5.10$
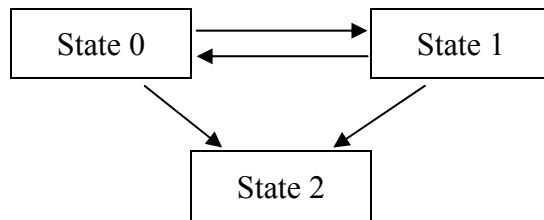
Calculate $e_{[61]}$.

(A)   5.30

(B)   5.39

(C)   5.68

(D)   5.85

(E)   6.00

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3. A continuous Markov process is modeled by the following multiple state diagram:

You are given the following constant transition intensities:

(i) $\mu^{01} = 0.08$

(ii) $\mu^{02} = 0.04$

(iii) $\mu^{10} = 0.10$

(iv) $\mu^{12} = 0.05$

For a person in State 1, calculate the probability that the person will continuously remain in State 1 for the next 15 years.

(A) 0.032

(B) 0.105

(C) 0.151

(D) 0.250

(E) 0.350

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4. You are given:

    (i) $Z(n)$ is the present value random variable for an n-year term insurance on a life age x, based on the current yield curve.

    (ii) $E[Z(1)] = 0.014354$ and $E[Z(2)] = 0.032308$

    (iii)   The current one-year spot rate is 4.50%.

    (iv) $q_{x+1} = 0.02$

Calculate the current two-year spot rate.

(A)   4.55%

(B)   4.75%

(C)   4.95%

(D)   5.15%

(E)   5.35%

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5. For a whole life insurance of 1000 on (50), you are given:

(i) The death benefit is payable at the end of the year of death.

(ii) Mortality follows the Illustrative Life Table.

(iii) $i = 0.05$ in the first year, and $i = 0.06$ in subsequent years.

Calculate the actuarial present value of this insurance.

(A) 237

(B) 249

(C) 251

(D) 263

(E) 265

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6. For a group of 100 lives age x with independent future lifetimes, you are given:

    (i)   Each life is to be paid 1 at the beginning of each year, if alive.

    (ii) $A_x = 0.45$

    (iii) $^2A_x = 0.22$

    (iv) $i = 0.05$

Y is the present value random variable of the aggregate payments.

Using the normal approximation to Y, calculate the initial size of the fund needed in order to be 95% certain of being able to make the payments for these life annuities.
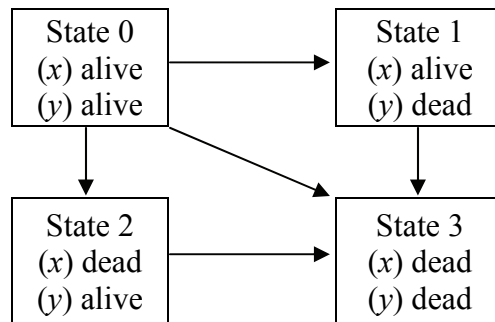
(A)   1170

(B)   1180

(C)   1190

(D)   1200

(E)   1210

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7. The joint mortality of two lives (x) and (y) is being modeled as a multiple state model:

You are given:

(i) $\mu^{01} = 0.010$

(ii) $\mu^{02} = 0.030$

(iii) $\mu^{03} = 0.005$

(iv) $\delta = 0.05$

A special joint whole life insurance pays 1000 at the moment of simultaneous death, if that occurs, and zero otherwise.

Calculate the actuarial present value of this insurance.

(A)   52.6

(B)   55.6

(C)   87.9

(D)   90.9

(E)   93.9

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8. For a special fully discrete whole life insurance of 100,000 on (40), you are given:

      (i)   The annual net premium is P for years 1 through 10, $0.5P$ for years 11 through 20, and 0 thereafter.

      (ii)   Mortality follows the Illustrative Life Table.

      (iii) $i = 0.06$

Calculate P.

    (A)   1560

    (B)   1660

    (C)   1760

    (D)   1860

    (E)   1960

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9. For a fully discrete whole life insurance of 1000 on (x) with net premiums payable quarterly, you are given:

    (i) $i = 0.06$

    (ii) $\ddot{a}_x = 3.4611$

    (iii) $P^{(W)}$ and $P^{(UDD)}$ are the annualized net premiums calculated using the 2-term Woolhouse (W) and the uniform distribution of deaths (UDD) assumptions, respectively.

Calculate $\dfrac{P^{(UDD)}}{P^{(W)}}$.

(A)   1.001

(B)   1.003

(C)   1.005

(D)   1.007

(E)   1.009

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10. For a fully discrete 20-year endowment insurance of 100,000 on (30), you are given:

(i) $d = 0.05$

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

	First Year		Renewal Years	
	Percent of Premium	Per Policy	Percent of Premium	Per Policy
Taxes	4%	0	4%	0
Sales Commission	35%	0	2%	0
Policy Maintenance	0%	250	0%	50

(iii) The net premium is 2143.

Calculate the gross premium using the equivalence principle.

(A) 2410

(B) 2530

(C) 2800

(D) 3130

(E) 3280

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11. For a 2-year last survivor term life insurance on two lives each age 30, with independent future lifetimes, you are given:

(i) The insurance pays 10,000 at the end of the year of the second death.

(ii) For each life, $q_{30} = 0.04$ and $q_{31} = 0.06$

(iii) Premiums are payable at the beginning of the year while either life is alive.

(iv) $i = 0.05$

Calculate the annual net premium for this insurance.

(A) 39

(B) 41

(C) 43

(D) 45

(E) 47

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12. For two fully continuous whole life insurance policies on (x), you are given:

(i)

	Death Benefit	Annual Premium Rate	Variance of the Present Value of Future Loss at t
Policy A	1	0.10	0.455
Policy B	2	0.16	-

(ii) $\delta = 0.06$

Calculate the variance of the present value of future loss at t for Policy B.

(A) 0.9

(B) 1.4

(C) 2.0

(D) 2.9

(E) 3.4

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13. For a special fully discrete 25-year endowment insurance on (44), you are given:

(i)   The death benefit is $(26-k)$ for death in year k, for $k=1,2,3…25$.

(ii)   The endowment benefit in year 25 is 1.

(iii) $q_{55} = 0.15$

(iv) $i = 0.04$

(v) $_{11}V$, the net premium reserve at the end of year 11, is 5.00.

(vi) $_{24}V$, the net premium reserve at the end of year 24, is 0.60.

Calculate $_{12}V$, the net premium reserve at end of year 12.

(A)   3.63

(B)   3.74

(C)   3.88

(D)   3.98

(E)   4.09

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14. For a fully discrete 30-year endowment insurance of 1000 on (40), you are given:

(i)   Mortality follows the Illustrative Life Table.

(ii) $i = 0.06$

Calculate the full preliminary term (FPT) reserve for this policy at the end of year 10.

(A)   167

(B)   192

(C)   217

(D)   242

(E)   267

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15. Your company issues whole life annuities to a group of lives age 70. For each policy, you are given:

(i) The annuity pays 2000 at the end of each year.

(ii) The single gross premium is 26,600.

(iii) Profits are based on gross premium reserves.

(iv) The gross premium reserve at the end of year 10 is 8929.18 per policy.

(v) Expenses are paid at the end of each year for any policyholder who does not die during the year.

During year 11, anticipated and actual experience are as follows:

(a)

	Anticipated	Actual
Mortality	$q_{80} = 0.11$	200 deaths
Interest	$i = 0.03$	$i = 0.04$
Expenses	30 per policy	35 per policy

(b) 1000 such policies are in force at the beginning of year 11.

For year 11, you calculate the gain due to interest prior to calculating the gain from other sources.

Calculate the gain due to interest during year 11.

(A) 87,560

(B) 87,902

(C) 88,435

(D) 88,880

(E) 89,292

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16. 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:

Year(s)	Percent of Premium	Per Policy
1	20%	15
2 and 3	8%	5

(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) $G = 1000 P_{x:\overline{3}|} + P^e$, where P^e is the expense loading.

Calculate $P_{x:\overline{3}|}$.

(A)   0.290

(B)   0.295

(C)   0.300

(D)   0.305

(E)   0.310

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17. Anne and Julie, each age x, purchase identical Type B universal life policies:

(i) The death benefit, payable at the end of the year of death, is F plus the account value at the end of the year. F is the same for both policies.

(ii)

Policy Year k	Percent of Premium Charge	Annual Expense Charge	Annual Cost of Insurance Rate Per 1000	Annual Credited Interest Rate
1	40%	50	1.1	6%
2-20	10%	10	$1.0+0.1k$	6%

(iii) Anne pays 1000 at the beginning of the first year and 500 at the beginning of each subsequent year.

(iv) Julie pays 500 at the beginning of the first year and 1000 at the beginning of each subsequent year.

(v) Both Anne and Julie are alive at the end of 20 years.

(vi) The account value of Anne's policy at the end of 20 years is 10,660.

Calculate the account value of Julie's policy at the end of 20 years.

(A) 24,940

(B) 25,370

(C) 25,800

(D) 26,380

(E) 26,950

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18. Bob, currently exact age 40, joined a defined benefit pension plan at exact age 35. His current salary is 50,000 per year. He will retire at exact age 65.

You are given:

(i) Bob's salary will increase at the rate of 2% each year on his future birthdays.

(ii) The annual retirement benefit is 0.5% of the final three-year average salary for each year of service.

(iii) Bob wants to supplement this annual retirement benefit with benefits provided from a defined contribution plan, so that the total annual benefit is 42,000.

(iv) Retirement benefits will commence at exact age 65 and are payable at the beginning of each year for life.

(v) $\ddot{a}_{65} = 9.9$

Calculate the defined contribution plan accumulation needed at age 65 so that Bob receives his desired annual benefit.

(A) 200,000

(B) 225,000

(C) 250,000

(D) 275,000

(E) 300,000

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19.

A pension plan offers a career average retirement benefit where a member will receive, upon retirement at age 65, an annual pension of 2% per year of service of the average annual salary received throughout the member's years of service.

Tom joins the pension plan on July 1, 2014, with a starting salary of 45,000 per year. His salary will increase by 4% each subsequent July 1st. Tom will retire on June 30, 2044.

Calculate the annual pension that Tom will receive at retirement.

(A)   49,500

(B)   50,000

(C)   50,500

(D)   51,000

(E)   51,500

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20. For a fully discrete 3-year endowment insurance of 100 on (50), you are given:

(i) The following double decrement table, where decrement d refers to death and decrement w refers to withdrawal:

x	$l_x^{(\tau)}$	$d_x^{(d)}$	$d_x^{(w)}$
50	1000	20	35
51	945	25	25
52	895	30	0

(ii) There are no benefits upon withdrawal.

(iii) $i = 0.05$

Calculate the annual net premium for this policy.

(A) 18

(B) 22

(C) 26

(D) 30

(E) 34

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SECTION B – Written-Answer

1. (*8 points*) Ben, age 40, purchases a special life insurance policy with the following features:

- Premiums are paid monthly for life.
- A death benefit of 20,000 is paid at the end of the year of death if death occurs after age 60.
- No benefit is paid if death occurs before age 60.

Premiums are calculated using the following assumptions:

- Mortality follows the Illustrative Life Table.
- The Woolhouse formula with two terms is used to calculate annuity values.
- $i = 0.06$

(a) (*1 point*) Show that the expected present value of the death benefit is 2020 to the nearest 10. You should calculate the value to the nearest 1.

(b) (*2 points*) Calculate the annualized net premium for the policy.

(c) (*2 points*) State two reasons why the annualized net premium rate will change if premiums are payable continuously, giving the direction of change for each reason.

The policy offers an optional feature under which the premium is waived if Ben's wife, Anne, dies. Anne is 50 years old at the issue date. Ben and Anne have independent future lifetimes.

(d) (*3 points*) Calculate the increase in the annualized net premium due to the premium waiver.

2. (*7 points*) An actuarial student in your department is using the following 3-state Markov model to price a one-year consumer warranty for a television.
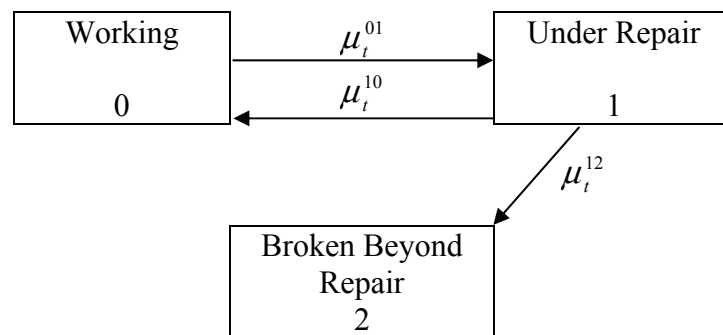
The product has the following features:

(i)   The warranty is sold at the time that a consumer purchases the television and pays a replacement cost of 1000 at the end of the half-year during which the television becomes Broken Beyond Repair.

(ii)   Premiums are payable at the beginning of each half-year, but are waived if the television is not Working at the time a premium is due.

(iii)   All televisions are in the Working state at time of purchase.

(a)   (*2 points*) Write down the Kolmogorov forward differential equations with associated boundary conditions (initial conditions) for $_t p_0^{00}$, $_t p_0^{01}$, and $_t p_0^{02}$ under this model.

The forces of transition in this model for a television purchased t years ago are:

$$\mu_t^{01} = 0.5 + 0.6t$$

$$\mu_t^{10} = 0.2$$

$$\mu_t^{12} = 2^t$$

The student has applied Euler's method to the Kolmogorov forward differential equations with a step size of $h = 0.5$ to calculate probabilities for this model. You have verified that, using this approach, $_{0.5} p_0^{00} = 0.75$.

2. **Continued**

    (b)   (*2 points*) Using the student's approach:

        (i)   Calculate $_{0.5}p_0^{01}$.

        (ii)   Show that the probability that a television will become Broken Beyond Repair within a year of purchase is 0.18 to the nearest 0.01. You should calculate the probability to the nearest 0.001.

    (c)   (*2 points*) Using the probabilities from the student's approach and $i^{(2)} = 8\%$:

        (i)   Calculate the actuarial present value at issue of the replacement cost payments for this policy.

        (ii)   Calculate the semi-annual net premium for this policy.

    (d)   (*1 point*) Suggest a change to the student's approach that would improve the accuracy of the probability calculations.

3. (*7 points*) PonceDeLeon Pharmaceuticals is conducting a one-year study of a "Fountain of Youth" drug. They have two versions under development.

  (i)   There is a control group of 1000 subjects with independent future lifetimes who will not receive either drug. For each of these subjects, $q = 0.20$.

  (ii) Drug A will be given to 1000 subjects comprising Cohort A.

   - With probability 80%, each subject in Cohort A will have $q = 0.20$.

   - With probability 20%, each subject in Cohort A will have $q = 0.05$.

   - Conditional on q, the lives have independent future lifetimes.

  (iii) Drug B will be given to 1000 subjects with independent future lifetimes, comprising Cohort B. The drug will affect different subjects differently and independently.

   - With probability 80%, any given subject in Cohort B will have $q = 0.20$.

   - With probability 20%, any given subject in Cohort B will have $q = 0.05$.

  (a)   (*1 point*) Calculate the mean and variance of the number of deaths in the control group.

  (b)   (*2 points*) Calculate the mean and variance of the number of deaths in Cohort A.

  (c)   (*2 points*) Calculate the mean and variance of the number of deaths in Cohort B.

Mortality risk is called diversifiable if

$$\lim_{n \to \infty} \frac{\sqrt{\text{Var(number of deaths among a group of } n \text{ lives subject to the risk)}}}{n} = 0.$$

  (d)   (*2 points*) For each of the 3 groups, state whether the mortality risk is diversifiable or not diversifiable, and justify your answer. You do not need to include formulas or calculations in your justification.

4. (*8 points*) An insurer issues fully discrete whole life insurance policies to 10,000 lives, each age 45, with independent future lifetimes.

The death benefit for each policy is 100,000. Gross premiums are determined using the equivalence principle. You are given the following information:

	Pricing and Reserve Assumptions	Policy Year 1 Actual Experience	Policy Year 2 Actual Experience
Interest	6%	7%	Same as pricing
Expense at Start of the Year	75% of premium + 100 per policy in the first year; 10% of premium + 20 per policy thereafter	75% of premium + 105 per policy	Same as pricing
Settlement Expense	200 per policy	Same as pricing	220 per policy
Mortality	Illustrative Life Table	Same as pricing	70 deaths

(a) (*2 points*) Show that the gross premium for each policy is 1700 to the nearest 10. You should calculate the premium to the nearest 1.

(b) (*2 points*) Calculate the gross premium reserve for a policy inforce at the end of policy year 1.

(c) (*3 points*) For each of interest, expense and mortality, in that order, calculate the gain or loss by source in policy year 1 on this block of policies.

(d) (*1 point*) Explain the sources and direction of any gains or losses in policy year 2. Exact values are not necessary.

5. (*9 points*) There are two whole life insurances of 100,000 on (35) with death benefits payable at the end of the year of death. Policy A has annual premiums and Policy Q has quarterly premiums.

You are given:

	Policy A	Policy Q
Premiums	930 per year	240 per quarter
Commissions on initial premium	100	100
Commissions on subsequent premiums in first 10 years	45 per year	16 per quarter
Commissions on subsequent premiums after 10 years	0 per year	0 per quarter
The symbol for gross premium reserve at time t	$_tV^A$	$_tV^Q$
The symbol for the loss random variable at time 0	$_0L^A$	$_0L^Q$

You are also given:

- Mortality follows the Illustrative Life Table.

- $i = 0.06$

- $_4V^A = 1763$

- $_4V^Q = 1765$

- $_5V^A = 2552$

- $\ddot{a}^{(4)}_{40:\overline{5}|} = 4.3408$

- The Woolhouse formula with two terms is used to calculate annuity values.

(a)   (*2 points*) Calculate $_0L^Q$ when $T_{35} = 0.30$.

(b)   (*3 points*) Calculate $E\left[_0L^Q\right]$.

(c)   (*2 points*) Show that $_5V^Q$ is 2545, to the nearest 5. You should calculate the value to the nearest 1.

(d)   (*2 points*) Sketch the graph of $_tV^A - _tV^Q$ for $4 \le t \le 5$. An exact calculation of the difference at intermediate times is not expected. Label the scales on the x (time) and y (reserve difference) axes.

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6. (*10 points*) For Type B universal life insurances with additional death benefit 100,000 on lives age 60, you are given:

Policy Year k	Annual Premium	Credited Interest Rate	Percent of Premium Expense Charge	Annual Expense Charge	Annual Cost of Insurance Rate per 1000	Surrender Charge
1	5000	5%	60%	200	6.00	600
2	1000	5%	10%	50	7.47	200
3	–	–	–	–	–	0

You are also given the following assumptions:

Policy Year k	Dependent Probabilities		Earned Interest Rate	Commissions as Percent of Premium	Other Expenses
	$q^{(d)}_{60+k-1}$	$q^{(w)}_{60+k-1}$			
1	0.004	0.100	6%	90%	100
2-10	$0.003 + 0.001k$	0.050	6%	5%	10

Expenses are incurred at the start of each policy year. Your company uses account values as reserves. The account value at the end of year 2, for a policy in force, is 1500.

(a) (*2 points*) Show that the account value at the end of year 1, for a policy in force, is 1300 to the nearest 100. You should calculate the account value to the nearest 1.

Your company discounts expected profits at 12%. The expected profits for the first three years are:

Policy Year k	Expected profits at the end of the year for a policy in force at the start of the year
1	−1206
2	374
3	400

(b) (*3 points*) Calculate the total expected present value at issue of profits for the first three years per policy issued.

6. Continued

    (c)   Your company's pricing actuary asks you to redo the profit test using the end of year cash surrender values as reserves, with no other changes.

        (i)   (*3 points*) Calculate the revised expected profits for policy year 2, per policy in force at the start of year 2.

        (ii)   (*1 point*) Explain why the expected profit in policy year 2 decreases due to this change.

        (iii)   (*1 point*) State with reasons whether the total present value of profits in all years increases, decreases, or stays the same due to this change.

7. (*7 points*)

    (a)   (*1 point*) List three reasons why employers sponsor pensions for their employees.

A benefit plan provides a retirement benefit if the employee lives to age 65, and a death benefit if the employee dies prior to age 65.

- The retirement benefit is an annual whole life annuity-due of 3% of the final 3-year average salary for each year of service.

- The death benefit is a lump sum payable at the end of the year of death equal to two times the employee's annual salary in the year of death.

You are given:

- Chris started her employment on January 2, 1990 at exact age 38 with a starting salary of 50,000.

- The company gives salary increases of 3% on January 1 each year.

- Employees can terminate employment only by retirement at 65 or death.

You are given the following:

- $q_{62+k} = 0.08 + 0.01k$ for $k = 0,1,2,3$

- The expected present value on January 1, 2017 of an annuity-due of 1 per year payable annually to Chris, if she survives, will be 4.7491.

- The *k*-year spot rates on January 1, 2014 are $0.030 + 0.005k$, for $k = 1, 2, 3$.

    (b)   (*3 points*) Calculate the actuarial present value on January 1, 2014 of Chris' death benefit.

    (c)   (*3 points*) Calculate the actuarial present value on January 1, 2014 of Chris' retirement benefit.

END OF EXAMINATION

USE THIS PAGE FOR YOUR SCRATCH WORK

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Exam MLC   Spring 2014
Multiple Choice Answer Key
February 2, 2014

Question	Answer
1	C
2	D
3	B
4	B
5	C
6	D
7	A
8	B
9	B
10	A
11	D
12	B
13	E
14	A
15	E
16	E
17	C
18	E
19	C
20	D