Society of Actuaries
Exam MLC: Actuarial Models - Life Contingencies Segment
Draft 2012 Learning Objectives
Document Version: August 2, 2010

Learning Objective	Proposed Weighting* (%)
Understand how decrements are used in insurances, annuities, and investments. Understand the models used to model decrements used in insurances, annuities, and investments and calculate probabilities based on those models.	20
Understand the non-stochastic interest rate models used to calculate present values and accumulated values of cash flows and calculate present values and accumulated values of cash flows.	5
Understand the models used to model cash flows of traditional life insurances and annuities and calculate the present values of the cash flows.	20
Understand reserves as liabilities. Understand net (benefit) reserves and calculate net (benefit) reserves for traditional life insurances and annuities.	20
Understand how concepts presented for traditional life insurances and annuities extend to non-interest sensitive insurances other than traditional insurances (examples include: disability income insurance, product warranty insurance, defined benefit pension plans, and health insurance).	10
Understand the models used to model cash flows for basic universal life insurances and basic variable annuities and calculate contract level values. Understand the models used to model cash flows of basic universal life insurance and basic variable annuities and calculate the present values of the cash flows. Understand the net (benefit) reserve for and calculate net (benefit) reserves for basic universal life insurances and basic variable annuities.	10
Understand the relationship between expenses and gross (contract) premium and calculate contract level values based on the gross (contract) premium for life insurances and annuities, including gross (contract) premium reserve and asset share.	15
Total	100

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* Proposed weightings are provided as guidance for study material authors and may not be representative of the percentage of exam questions for a particular set of learning objectives.

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Learning Objectives and Learning Outcomes

1) Understand how decrements are used in insurances, annuities, and investments.
   a. Describe the common decrements.
   b. Describe select, ultimate, and aggregate decrements and their applications.
   c. State the applications of and the differences between decrements for: general population versus insured population; life insurance versus annuity; individual life insurance versus group life insurance; pricing versus valuation; and historic versus projected.
2) Understand the models used to model decrements used in insurances, annuities, and investments and calculate probabilities based on those models.
   a. For single decrement on single life models, multiple decrements on single life models, and single decrement on multiple lives models (assuming independent lives, or dependent lives and the common shock model):
      i. Describe the model.
      ii. Define the time-to-decrement, age-to-decrement, and cause-of-decrement random variables.
      iii. State the density, distribution, and survival functions for the random variables.
      iv. Calculate single, joint, marginal, and conditional probabilities, as applicable, and moments for the random variables where the random variable is represented by:
         1. A continuous model (including: uniform, exponential, Makeham, and Gompertz).
         2. The values in a decrement table and a fractional age assumption (including: linear, exponential, and hyperbolic).
      v. State the force of decrement function.
      vi. Demonstrate that the age-at-decrement random variable is a special case of the time-to-decrement random variable.
      vii. State the relationship between a multiple decrement rate and the associated single decrement rates under different fractional age assumptions (including: linear, exponential, and hyperbolic).
   b. For the multi-state decrement model:
      i. Describe the model.
      ii. Describe how the model is a general model for decrements.
      iii. Define the model as a stochastic process.
      iv. Describe how the single decrement on single life models, multiple decrements on single life models, and single decrement on multiple lives models can be represented as multi-state models.
      v. Describe how the model can be applied to multiple decrements on multiple lives.
   c. For the continuous-time Markov chain model:

    i. Describe the model.

    ii. State the Kolmogorov forward equations for computing transition probabilities.

    iii. Calculate the probability of being in a particular state when the force of transition can differ by time period but the force of transition is constant within a time period.

  d. Using discrete approximations of continuous-time Markov chain models:

    i. Calculate the transition probabilities using Kolmogorov forward equations with discrete time steps.

    ii. Calculate the probability of being in a particular state with transitions only at the ends of the time periods.

3) Understand the non-stochastic interest rate models used to calculate present values and accumulated values of cash flows and calculate present values and accumulated values of cash flows.

  a. For fixed interest rates (level or varying over time); yield curves (spot and forward interest rates); and interest rate scenarios models:

    i. Describe the models.

    ii. Calculate present values and accumulated values.

4) Understand the models used to model cash flows of traditional life insurances and annuities and calculate the present values of the cash flows.

  a. Describe cash flow models.

    i. Describe the cash flows.

    ii. Describe the models for annual cash flows, cash flows more frequent than annually, and continuous cash flows.

    iii. State the application of and the differences between the cash flow models.

  b. For single decrement on single life models, multiple decrements on single life models, and single decrement on multiple lives models:

    i. Define the present-value-of-benefits and present-value-of-premium random variables.

    ii. State the density, distribution, and survival functions of the random variables.

    iii. Calculate single, joint, marginal, and conditional probabilities, as applicable, and moments of the random variables.

    iv. Calculate single, joint, marginal, and conditional probabilities, as applicable, and moments of the random variables when only annual values are available using:

      1. Woolhouse's formula.

      2. uniform distribution of decrement.

      3. using monthly calculations with cash flows assumed at beginning, end, or middle of month depending on type of cash flow and a fractional age assumption.

     v.   State the force of decrement function.

     vi.   Calculate present values of the cash flows.

  c. Redefine the present-value-of-benefit and present-value-of-premium random variables to Markov chain models to calculate present values of cash flows:

     i.   at transitions between states; and

     ii.   while in a state.

5) Understand reserves as liabilities.

  a. Define reserves as liabilities for contracts with cash flows occurring over time.

  b. Describe how reserves are used as an accounting entry to allocate income over the life of a contract.

     i.   Describe the differences between level premium reserves and modified premium reserves.

     ii.   Describe how to explicitly allow for expenses by using an expense-augmented model.

     iii.   Describe the use of reserves for regulatory, financial, and tax purposes and how reserves calculated for these purposes may differ.

6) Understand net (benefit) reserves and calculate net (benefit) reserves for traditional life insurances and annuities.

  a. For single decrement on single life models and multiple decrements on single life models:

     i.   Define loss-at-issue random variable, future-loss random variable, and net (benefit) premiums.

     ii.   State the distribution function and the density function of the random variables.

     iii.   Define the moments of the random variables.

     iv.   Describe the relationship between the loss-at-issue random variable and the time-until-decrement random variable.

     v.   State the equivalence principle.

     vi.   Describe the following methods of calculating net (benefit) premium reserves:

        1.   Prospective method.

        2.   Retrospective method.

        3.   Recursive method.

     vii.   Demonstrate the equivalence of the prospective, retrospective, and recursive methods.

     viii.   Define the net (benefit) reserve calculated using the prospective method as the expected value of the future-loss random variable.

     ix.   Calculate level net (benefit) premiums for life insurances based on single decrement on single life models and multiple decrements on single life models for the following cases:

        1.   fully discrete with annual or mthly premiums.

        2.   semi-continuous with annual or mthly premiums.

3. fully continuous.

x. Calculate net (benefit) premium reserves at fractional durations for life insurances based on a single decrement on single life model using the following methods:

1. exact; and
2. approximate (linear interpolation between terminal reserves plus unearned net (benefit) premium).

b. For Markov chain models:

i. Calculate the net (benefit) premium reserves using a Markov chain model with specified cash flows payable at the beginning of each time period while in each state and at the end of the time period of transition between states using:

1. the prospective method including the following special cases: the multiple life model and the multiple decrement model.
2. the recursive method, including the following special cases: the multiple life model and the multiple decrement model.

ii. Calculate the net (benefit) premium reserves for a continuous-time Markov chain model with specified discrete and/or continuous cash flows payable while in each state and upon transition between states using:

1. the prospective method including the following special cases: the multiple life model and the multiple decrement model.
2. by solving Thiele's differential equation using discrete steps including the following special cases: the multiple life model and the multiple decrement model.

7) Understand how concepts presented for traditional life insurances and annuities extend to non-interest sensitive insurances other than traditional insurances (examples include: disability income insurance, product warranty insurance, defined benefit pension plans, and health insurance).

a. Describe the concepts.
b. Apply the concepts to:

i. loss-at-issue random variable;
ii. net (benefit) premium;
iii. future loss random variable; and
iv. net (benefit) premium reserves.

8) Understand the models used to model cash flows for basic universal life insurances and basic variable annuities and calculate contract level values.

a. Describe the common cash flows.
b. Describe the models for annual cash flows, mthly cash flows, and continuous cash flows.
c. State the application of and the differences between the cash flow models.
d. Describe the common primary and secondary contract guarantees.

    e. Describe how risk is shared when the guarantee is a constant and is a floor or a cap for the common primary and secondary contract guarantees.

    f. Calculate the contract fund value.

    g. Calculate the cash surrender value given a contract fund value and a table of surrender charges.

    h. State the conditions and demonstrate how a universal life insurance can replicate a traditional life insurance.

    i. State the conditions and demonstrate that the calculation of a universal life insurance contract fund value is equivalent to the recursive reserve method for a traditional life insurance.

9) Understand the models used to model cash flows of basic universal life insurance and basic variable annuities and calculate the present values of the cash flows.

    a. For multiple decrements on single life models:

        i. Describe the applicable decrements: mortality, lapse, surrender, and premium cessation.

        ii. Define the present-value random variable for the benefit payable upon each decrement.

        iii. Distinguish between present-value-of-benefits, present-value-of-premiums, and present-value-of-charges random variables.

        iv. Describe the relationship of the present-value random variable to the time-to-decrement random variable and the interest rate models.

        v. Calculate probabilities and moments of the random variables.

        vi. Calculate the probabilities and moments of the random variables when only annual values are available using:

            1. Woolhouse's formula;

            2. uniform distribution of decrement; and

            3. using monthly calculations with cash flows assumed at beginning, end, or middle of month depending on type of cash flow and a fractional age assumption.

        vii. Calculate present values.

    b. Redefine the present-value-of-benefit and present-value-of-premium random variables to Markov chain models to calculate present values of cash flows:

        i. at transitions between states; and

        ii. while in a state.

10) Understand the net (benefit) reserve for and calculate net (benefit reserves for basic universal life insurances and basic variable annuities.

    a. Describe reserves.

    b. Calculate the reserve using:

        i. the recursive method (fund value).

        ii. the prospective method (using assumed future net premiums).

    c. Describe the calculation of the reserve for a secondary guarantee.

11) Understand the relationship between expenses and gross (contract) premium and calculate contract level values based on the gross (contract) premium for life insurances and annuities.

    a. Describe how expenses relate to gross (contract) premium.

        i. Describe the common types of insurance company expenses (including commissions and taxes).

        ii. Describe how expenses can be categorized (acquisition, maintenance, investment, and event (for example, death, surrender).

        iii. Calculate an expense factor using the appropriate exposure (for example, gross (contract) premium).

    b. For single decrement on single life model and multiple decrements on a single life models:

        i. Define the present-value-of-expenses random variable.

        ii. Describe the relationship of the random variable to the interest rate models.

        iii. Calculate probabilities and moments of the random variable.

        iv. Calculate the probabilities and moments of the random variable when only annual values are available using:

            1. Woolhouse's formula.

            2. uniform distribution of decrement.

            3. using monthly calculations with cash flows assumed at beginning, end, or middle of month depending on type of cash flow and a fractional age assumption.

        v. Define the expense reserve and calculate the expense reserve.

        vi. Define gross premium and calculate a gross (contract) premium given expenses and benefits based on:

            1. the equivalence principle.

            2. a return on gross profits basis.

        vii. Define gross (contract) premium reserve and calculate the gross (contract) premium reserve.

        viii. State the differences between gross (contract) premium reserves and net (benefit) premium reserves and the applications of each.

        ix. Define asset share and calculate the asset share.