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**SOCIETY OF ACTUARIES**  
**Life Finance & Valuation - Canada**

# Exam ILALFVC

## MORNING SESSION

**Date:** Thursday, November 2, 2017

**Time:** 8:30 a.m. – 11:45 a.m.

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### INSTRUCTIONS TO CANDIDATES

#### General Instructions

1. This examination has a total of 100 points. It consists of a morning session (worth 60 points) and an afternoon session (worth 40 points).
  - a) The morning session consists of 6 questions numbered 1 through 6.
  - b) The afternoon session consists of 4 questions numbered 7 through 10.

The points for each question are indicated at the beginning of the question.
2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.
3. 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.

#### 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 that 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 morning or afternoon session for Exam ILALFVC.
6. Be sure your essay answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d'examen pour la version française.





**\*\*BEGINNING OF EXAMINATION\*\***  
**Morning Session**

1. (9 points) You are given the following for a 2-year non-renewable term life policy accounted for under IFRS 4 Phase II rules:

| Scenario   | Probability | PV(CF) |
|--|-------------|--------|
| Policyholder dies during policy year 1   | 0.2%        | 25,000 |
| Policyholder dies during policy year 2   | 0.3%        | 20,000 |
| Policyholder lapses during policy year 1   | 6.5%        | -20    |
| Policyholder lapses during policy year 2 or survives to end of year and does not convert | 53%         | -50    |
| Policyholder converts at end of policy year 2  | 40%         | -243   |

Assume:

- PV(CF) = present value at issue of cash outflows minus cash inflows
- The policy can only be converted at the end of policy year 2
- Risk adjustment at issue: 11

(a) (5 points)

(i) (3 points) Calculate the Contractual Service Margin (CSM) at issue. Show all work.

(ii) (2 points) You are given the following at the end of policy year 1:

- Best estimate liability: -7.92
- Risk adjustment: 5.48

Calculate the CSM at the end of policy year 1, assuming no changes in assumptions. Show all work.

## 1. Continued

(b) (4 points) You are given four possible events:

- A. At the end of policy year 1, the probability of converting at the end of year 2 is increased.
- B. At the end of policy year 1, the discount rate is increased.
- C. The policyholder does not die during the first policy year.
- D. The policyholder does not lapse during the first policy year.

Determine the direction of each event's impact, if any, on the following policy year 1 financial results:

- (i) the underwriting result on the income statement
- (ii) the investment result on the income statement
- (iii) other comprehensive income

Justify your responses.

2. (10 points) On a closed block of business, ABC Life has an existing 60% quota share reinsurance treaty with reinsurer DEF. DEF retrocedes to reinsurer GHI on an excess of loss basis of 500,000 per risk.

The following applies to the reinsured closed block of business:

| Company | Invested Assets at Beginning of Year t | Annual Operating Expenses |
|---------|--|---------------------------|
| ABC     | 1,750,000                              | 100,000                   |
| DEF     | 3,000,000                              | 50,000                    |
| GHI     | 500,000                                | 25,000                    |

| Cohort | Total Face Amount per Policy | Reserve per Policy at Beginning of Year t | Reserve per Policy at End of Year t | Annual Premium per Policy | Number of Lives at Beginning of Year t | Expected Claims in Year t |
|--------|------------------------------|---|-------------------------------------|---------------------------|--|---------------------------|
| 1      | 1,500,000                    | 3,500                                     | 3,750                               | 9,000                     | 200                                    | 1,500,000                 |
| 2      | 800,000                      | 4,300                                     | 4,450                               | 5,400                     | 400                                    | 2,400,000                 |

Assume:

- All lives in each cohort are identical
  - Premium rates are the same for each company
  - Premiums are paid at beginning of year
  - Death benefits are incurred at end of year
  - Operating expenses are incurred at end of year
  - No premium taxes
  - No reinsurance allowances
  - Investment income = 3.5%
- (a) (3 points) Explain the advantages and disadvantages of coinsurance to reinsure an inforce block of business.
- (b) (6 points) Calculate the gain from operations for each company in year t. Show all work.
- (c) (1 point) Recommend whether company ABC Life should recapture the business. Justify your answer.

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**3.** (9 points)

(a) (5 points)

You are given the following information for WXY:

- Risk free rate of return is 6%
- Risk premium is 7%
- Cost of debt is 14% based on WXY's credit rating
- Tax rate is 35%
- WXY is financed with 50% debt and 50% common stock
- WXY allocates its equity over three profit centers

| <b>Five Year Financial Plan (in millions)</b> |                      |                         |                      |
|---|----------------------|-------------------------|----------------------|
| <b>Profit center</b>                          | <b>Five-Year ROE</b> | <b>Beginning Equity</b> | <b>Ending Equity</b> |
| Traditional Insurance                         | 17%                  | 50                      | 70                   |
| Non-Traditional Insurance                     | 8%                   | 230                     | 450                  |
| Non-Insurance                                 | 12%                  | 120                     | 340                  |

Assess the equity allocation in the five-year financial plan based on cost of capital. Show all work.



### 3. Continued

- (b) (4 points) WXY is introducing a 1-year term insurance product with the following results (in thousands):

|                          |     |
|--------------------------|-----|
| PV of Premiums and Fees  | 650 |
| PV of Investment Income  | 25  |
| PV of Expenses           | 120 |
| PV of Benefits           | 525 |
| Initial Required Capital | 250 |
| Tax Rate                 | 35% |

- (i) Calculate the return on capital assuming the cost of capital is 10%. Show all work.
- (ii) WXY's capital policy requires them to hold the economic capital at a level that will withstand a 1-in-200 year credit loss event over a 12-month horizon.

You are given the following information:

|                                  |    |     |     |      |       |
|----------------------------------|----|-----|-----|------|-------|
| Percentile of annual credit loss | 50 | 95  | 99  | 99.5 | 99.9  |
| Amount of loss (in thousands)    | 80 | 500 | 600 | 625  | 8,000 |

Assume WXY internally allocates economic capital.

Recommend whether WXY should launch the term product given the economic capital requirement on a risk adjusted basis. Show all work.

**4.** (10 points)

(a) (6 points) You are given the following projections for a block of liabilities:

| <b>Time</b> | <b>Premium</b> | <b>Benefits</b> | <b>Total Asset Value</b> |
|-------------|----------------|-----------------|--------------------------|
| 0           | 10,000         | -               | 15,000                   |
| 5           | 2,000          | -               | 17,000                   |
| 10          | 2,000          | 22,000          | 10,000                   |
| 20          | -              | -               | 20,000                   |
| 25          | 2,000          | 1,000           | 28,000                   |
| 30          | -              | 36,000          | 0                        |

Some of the assets backing the liabilities are invested in a non-fixed income asset class with the following best estimate assumptions:

- Growth of 10%
- Income of 0%
- Investment expenses of 0.50%
- The volatility correlates 100% with Canadian equities.

The investment strategy is to cap the non-fixed income asset at 35%.

Calculate the maximum amount of the non-fixed income asset permitted at time 0 and time 20. Show all work.

(b) (4 points) Your company will be investing in the common stock market of the country of Naboo, an emerging market, to support a block of Canadian liabilities with a mean duration of 14. You are given:

| <b>Market</b>            | <b>Canada</b> | <b>Naboo</b> |
|--------------------------|---------------|--------------|
| Historical Growth Rate   | 8.0%          | 15.0%        |
| Historical Dividend Rate | 2.0%          | 3.0%         |
| Historical Volatility    | 20%           | 35%          |
| Historical Period        | 60 years      | 20 years     |
| Risk Free Rate           | 2.0%          | 4.5%         |

#### **4. Continued**

You currently use a 10% margin for adverse deviation for Canadian dividends.

Recommend the best estimate assumption and margin for adverse deviation for Naboo's:

- (i) growth rate
- (ii) dividend rate

Show all work.

5. (12 points) You are meeting with the Chief Actuary to discuss the use of nested stochastic valuation techniques for a block of segregated fund business. Prior to the meeting he sends you the following email:

*“We use a classic compression algorithm to achieve a manageable run time in our models but we have observed this method creates an unacceptable amount of volatility in our reserve. We should consider modifying our approach to use a clustering technique instead of compression.”*

- (a) (2 points) Describe the drawbacks of the classic compression approach, which could have led to the reserve volatility.
- (b) (2 points) List the advantages of using a clustering technique as opposed to a classic approach.
- (c) (8 points) You are given the following current inforce policyholder extract:

| Policy | Attained Age | Guarantee Type    | Current Account Value | Reserve at End of Last Quarter |
|--------|--------------|-------------------|-----------------------|--------------------------------|
| 1      | 66           | Maturity (GMMB)   | 100                   | 10                             |
| 2      | 77           | Withdrawal (GMWB) | 100                   | 25                             |
| 3      | 68           | Maturity (GMMB)   | 125                   | 15                             |
| 4      | 82           | Withdrawal (GMWB) | 130                   | 30                             |
| 5      | 84           | Withdrawal (GMWB) | 140                   | 40                             |
| 6      | 70           | Maturity (GMMB)   | 130                   | 16                             |
| 7      | 81           | Withdrawal (GMWB) | 110                   | 20                             |
| 8      | 74           | Maturity (GMMB)   | 110                   | 14                             |

Apply the clustering technique described in *Cluster Analysis: A Spatial Approach to Actuarial Modelling* to produce a policyholder extract composed of 2 cells.

Show all work.

- 6.** (10 points) XYZ, a Canadian life insurance company, currently sells a segregated fund product which only includes a Guaranteed Minimum Death Benefit (GMDB). This year, XYZ launches a new segregated fund product with the GMDB as well as a Guaranteed Lifetime Withdrawal Benefit (GLWB). The GLWB will provide a guaranteed minimum income of 5% per year of the initial deposit for the lifetime of the policyholder. XYZ wants to use the same assumptions as the existing product for the new product.
- (a) (1 point) List four common characteristics of segregated fund products that can contribute to volatility on the balance sheet.
  - (b) (2 points) Describe the methodology used in setting the appropriate best estimate expense assumption for the new segregated fund product.
  - (c) (3 points) Evaluate the appropriateness of using the existing product surrender assumptions for the valuation of the new product. Justify your answer.
  - (d) (4 points) A recent mortality experience study of the existing product showed a significant increase in mortality rates compared to past trends. The valuation actuary recommends revising the best estimate mortality assumption of the existing product to reflect the recent experience and removing the mortality improvement assumption. These revised assumptions will also be used in the new product's reserve calculation.
    - (i) Critique the above recommendation with respect to the best estimate mortality assumption.
    - (ii) Recommend an appropriate mortality assumption MfAD. Justify your recommendation.

**\*\*END OF EXAMINATION\*\***  
**Morning Session**

**USE THIS PAGE FOR YOUR SCRATCH WORK**