

# Exam ILALAM

**Date:** Thursday, October 29, 2020

## INSTRUCTIONS TO CANDIDATES

### General Instructions

1. This examination has 4 questions numbered 1 through 4 with a total of 40 points.

The points for each question are indicated at the beginning of the question.

2. 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 provided in this document.

### Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel document as directed within each question. Graders will only look at work in the indicated file.
  - a) In the Word document, answers should be entered in the box marked ANSWER within each question. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example,  $\beta_1$  can be typed as beta\_1, and  $x^2$  can be typed as x^2.
  - b) In the Excel document formulas should be entered. For example,  $X = \text{component1} + \text{component2}$ . Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit.
  - c) Individual exams may provide additional directions that apply throughout the exam or to individual items.
2. The answer should be confined to the question as set.
3. The Word and Excel documents that contain your answers must be uploaded before time expires.

*Recognized by the Canadian Institute of Actuaries.*

1. (7 points) ABC insurance has licensed actuarial modeling software from a third-party vendor, XYZ Solutions. The software will be stored and used on ABC's infrastructure but the source code is developed and updated periodically by XYZ.

To protect proprietary technology ABC's access will be limited to end-user functionality but the underlying calculation engine and methodology will not be available for review or modification by ABC.

- (a) (5 points) Critique each statement below in the context of Model Risk Management.

A. *There are five elements of model risk defined in "Model Validation for Insurance Enterprise Risk and Capital Models". With respect to the management of this actuarial software, ABC should be concerned with all five risks.*

ANSWER:

B. *To assess and manage model reporting risk, ABC plans to survey business users as to whether they consider the reports to be useful and meaningful for decision support. To avoid asymmetric user feedback, only users that are significantly affected by the model's output are included in the survey.*

ANSWER:

C. *Allowing only in-house data and assumptions is the most effective way to manage vendor risks.*

ANSWER:

## 1. Continued

*D. An internal review group within XYZ performed a validation of the calculation engine prior to releasing the software to ABC. No further validation of the software is required by ABC.*

ANSWER:

*E. ABC's actuarial model validation framework is deemed satisfactory because ABC periodically reviews the quality and conceptual soundness of the model design and construction, and the methodologies used.*

ANSWER:

ABC has received a user guide for the actuarial software from XYZ. The user guide has detailed instructions on how to operate the software and descriptions of the features available to the end-users. ABC plans to supplement this guide with additional documentation to help mitigate model risk and reduce model-related costs.

(b) (2 points) Identify the types of model documentation ABC should develop. Justify your answer.

ANSWER:

2. (12 points) CW Life is attempting to acquire a block of insurance. You have been asked to recommend a discount curve and assess the interest rate exposure of the block. You are given:

- 100 years of monthly liability cashflows
- The investment strategy is to match asset and liability cash flows
- Detailed information about assets in the portfolio

(a) (3 points)

(i) Compare the following principles used to construct discount curves:

- Matching Principle
- Budgeting Principle

ANSWER:

(ii) Recommend which principle should be used to construct the discount curve. Justify your answer.

ANSWER:

After constructing the discount curve, your manager asks you to recommend controls to promote its accuracy. For this particular situation:

(b) (2 points)

(i) Describe how data visualization could be used as an effective control.

ANSWER:

(ii) Recommend one effective data visualization control.

ANSWER:

## 2. Continued

After completing your task, you ask your manager to review and approve your work. Your manager sends the following response:

*“I have reviewed for reasonableness, consider this my approval.”*

- (c) (1 point) Critique the response from your manager

ANSWER:

Your model has produced the following results:

Effective Duration by Term	1 Year	5 Years	10 Years	20 Years	30 Years	Total
Asset	0.1	0.5	0.9	2	9.9	X
Liability	0.05	Y	0.4	1	12	Z
Portfolio Size	100,000	200,000	100,000	300,000	300,000	1,000,000

- Income impact of a minus 10 basis point parallel shift = -200

- (d) (4 points)

- (i) Calculate the values for X, Y, and Z in the chart.

*The response for this part is to be provided in the Excel document*

- (ii) Calculate the income impact from the following movement in interest rates:

In basis points	1 Year	5 Year	10 Year	20 Year	30 Year
Interest Rate Change	20	15	-30	-20	-5

Show all work, including writing out relevant formulas used in any calculations

*The response for this part is to be provided in the Excel document*

- (iii) Recommend changes to the asset portfolio to reduce interest rate exposure.

ANSWER:

## 2. Continued

After conducting your work an error in the asset information is found. What was reported as a 30-year bond is in fact a 30-year bond which can immediately be called at par.

(e) (2 points) Explain how the key rate duration profile will change if:

(i) The coupon rate of the callable bond is the same as the non-callable bond.

ANSWER:

(ii) The coupon rate of the callable bond is higher than the non-callable bond.

ANSWER:

**3.** (8 points)

(a) (4 points) Critique the following statements about stochastic modeling:

A. *A stochastic model with a Normal distribution is a good option if it is difficult to determine the actual underlying distribution of the process being modeled.*

ANSWER:

B. *Stress testing is always a good alternative to stochastic modeling.*

ANSWER:

C. *When using an Economic Scenario Generator, real-world scenarios will produce a more realistic expected present value of cash flows than risk-neutral scenarios. This is because the real-world scenarios use a discount rate that reflects the risk associated with the cash flows.*

ANSWER:

D. *Real-world scenarios cannot be used for a market-consistent valuation.*

ANSWER:

E. *Risk-neutral scenarios are calibrated using observed market prices and therefore the calibration requires very little judgment.*

ANSWER:

F. *The difference between the risk-neutral and real-world scenario paths is smaller when valuing long-term insurance contracts than when valuing short-term contracts.*

ANSWER:

### 3. Continued

BNT Life wants to implement stochastic modeling techniques. The Chief Actuary has stated it is most important that the models be accurate and efficient. BNT must first decide on a random number generator and are considering using either a True Random Number Generator or a Pseudo Random Number Generator.

- (b) (1 point) Recommend which Random Number Generator BNT should use. Justify your answer.

ANSWER:

BNT's business includes Universal Life, Whole Life, and Variable Annuities with Guarantee Minimum Withdrawal Benefit Riders. It does not currently have a hedging program but is considering implementing one.

The Chief Actuary recommends that BNT use Monte Carlo modeling instead of Nested Stochastic modeling because it is more straightforward, and simulations would take less time.

- (c) (3 points) Assess the Chief Actuary's recommendation. Justify your answer.

ANSWER:



**4.** (13 points) YYG Life, a US based insurer, offers a single premium variable annuity product with a Guaranteed Minimum Accumulation Benefit (GMAB) rider. Returns track the Nikkei 225, a weighted stock-market index in Japan.

(a) (2 points) You are developing an Economic Scenario Generator (ESG) suitable for this product.

(i) Identify the key market variables required for the ESG.

(ii) Justify why these variables are important for determining the liability of this product.

ANSWER:

Based on historical returns of the Nikkei 225, YYG decided to adopt a regime-switching log-normal model to project real-world equity returns.

(b) (2 points) Discuss the pros and cons of this ESG choice.

ANSWER:

#### 4. Continued

You are given the following information on the product:

Premium	50,000
M&E Fee (% of fund value, charged at BoY)	1% per annum
Lapse Assumption (lapses occur at EoY)	4% per annum
Expected Nikkei 225 Index Return (years 1 – 6)	6% per annum
Expected Nikkei 225 Index Return (year 7)	X%
GMAB Rider	
Guaranteed:	100% of premium
Maturity	End of year 7
Rider Fee (% of fund value, charged at BoY)	1% per annum
Expenses (incurred at BoY)	
1st Year Acquisition expense (% of premium)	5%
Maintenance Expense per year	200 per annum

Assume an interest rate of 0%

- (c) (5 points) Calculate the Expected Nikkei 225 Index Return in year 7 if the present value of future profit YYG expects to earn for this product is 0. Show all work, including writing out relevant formulas used in any calculations

*The response for this part is to be provided in either the ANSWER box below or in the Excel document*

ANSWER:

#### 4. Continued

- (d) (2 points) To improve competitiveness, the Marketing Officer has proposed a new voluntary reset feature for the GMAB rider:

*“Policyholders are allowed a one-time reset of the GMAB guarantee to the current fund level at any time prior to maturity. If the reset is exercised, the maturity date of the Variable Annuity policy is reset to 7 years from the exercise date.”*

- (i) Describe the additional risks YYG may face by adding this feature.
- (ii) Recommend possible ways to mitigate these risks.

ANSWER:

- (e) (2 points) Critique the following statement from YYG’s ALM department.

*“For this product we recommend dynamically hedging delta and rho by rebalancing our hedge portfolio daily to ensure a close match. We are confident this is a cost-effective way to eliminate all risk for the company.”*

ANSWER:

**\*\*END OF EXAMINATION\*\***