Exam ILALAM

Date: Friday, May 13, 2022

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, β_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 = component1 + 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.

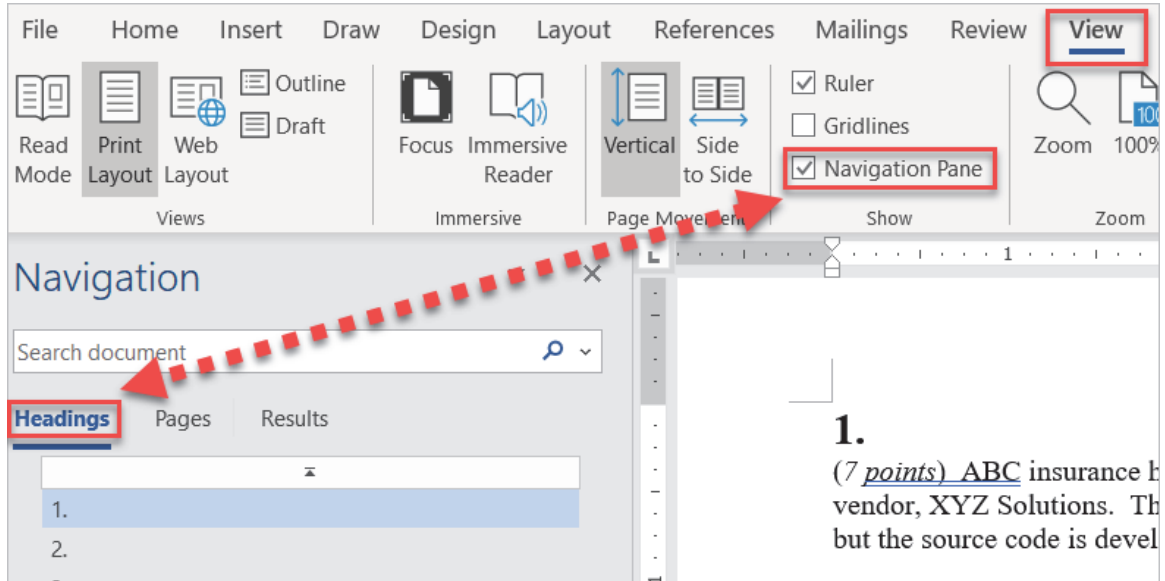2. The answer should be confined to the question as set.

3. Prior to uploading your Word and Excel files, each file should be saved and renamed with your five-digit candidate number in the filename.

4. The Word and Excel documents that contain your answers must be uploaded before the five-minute upload period expires.

Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:

1.

(*10 points*)

(a)   (*3 points*) ABC Life is planning to develop a set of first principles mortality assumptions for its block of Long-Term Care (LTC) business. Mortality is the only decrement for this business. LTC mortality experience and the legacy total life mortality assumption are provided in the excel workbook.

Recommend an appropriate approach ABC should use to develop its first principles LTC mortality assumption. Justify your answer.

The response for this part is to be provided in the Excel spreadsheet.

(b)   (*3 points*) Due to the impact of the COVID-19 pandemic on insurance and economic experience, ABC Life has decided to develop stochastic mortality and interest rates models.

(i)   (*1 point*) Explain how stochastic modeling could improve ABC's understanding of its COVID-19 driven mortality risk compared to deterministic modeling.

ANSWER:

(ii)   (*2 points*) You use the newly developed stochastic mortality model to generate loss results from 10,000 simulated scenarios (provided in the Excel workbook).

Prepare a report for senior management which summarizes the conclusions which can be drawn from the model with respect to ABC's risk and capital profile.

No calculations are required for this part.

The response for this part is to be provided in the Excel spreadsheet.

1. Continued

(c) (*4 points*) ABC Life is developing assumptions for its stochastic interest rate model and is faced with the choice between using risk-neutral and real-world scenarios

   (i) (*2 points*) Recommend the appropriate scenario choice for each of the following situations. Justify your answer.

   A. Management wants to determine the market-consistent view of liabilities under a stressed interest rate environment due to the global pandemic.

   ANSWER:

   B. Management wants to know how much capital is needed to absorb the potential earnings loss in the current low interest rate environment.

   ANSWER:

   C. To calculate the hedging cost when pricing a new Universal Life product with a minimum crediting rate guarantee.

   ANSWER:

   D. When monitoring residual market risk of a Universal Life product with a minimum crediting rate guarantee.

   ANSWER:

   (ii) (*2 points*) Critique the following statement:

   Short-term risk-free interest rates calculated using risk-neutral stochastic scenarios will be more conservative than those calculated using real-world scenarios.

   ANSWER:

2.

(*10 points*)

(a) (*3 points*) You are the lead pricing actuary of your company's fixed annuity product lines. Senior management has expressed concerns over the risk of a prolonged low-interest rate environment and the risk of a market correction resulting in a sudden upward spike in interest rates

   (i) (*2 points*) Analyze how your company's profitability may be impacted under each of the two scenarios.

   ANSWER:

   (ii) (*1 point*) Propose two strategies that the company could apply to mitigate interest rate risk on its fixed annuity products.

   ANSWER:

(b) (*7 points*) As part of your periodic review of modeling assumptions and simplifications, you are assessing if a new method of defining issue age bands in your pricing model would be appropriate.

   (i) (*2 points*) Describe the principles of professionalism outlined in *Application of Professional Judgement by Actuaries,* in the context of assumption setting.

   ANSWER:

2. Continued

You are testing five age band definitions of varying size. The associated modeling error arising from each case is summarized below:

Case	# of Issue Age Bands	Age Error (in years)	Average Known Error	Average Unknown Error
1	15	0.1	0.5%	0.6%
2	10	0.6	3.2%	2.3%
3	8	0.7	1.2%	1.4%
4	4	0.0	0.8%	0.4%
5	3	0.4	2.4%	2.0%

Age error is defined as the weighted average difference between the weighted average issue age for each band as compared to the model issue age for that band.

(ii) (*2 points*) Assess the implications of this analysis and recommend which case(s), if any, should be further considered for implementation.

ANSWER:

(iii) (*2 points*) Your pricing model assumes the issue age of the policy is the mid-point of the age band and all age bands are of uniform width. Your manager suggests that this approach could be applied to all pricing models in the company as it is the simplest to implement.

Critique the above suggestion.

ANSWER:

(iv) (*1 point*) Compare and contrast static and dynamic model validation.

ANSWER:

3.

(*9 points*) Your company would like to build an enterprise risk framework that allows senior management to understand the aggregate risk profile across the market, insurance, and non-insurance risks it is exposed to.

(a)   (*2 points*)

  (i)   Explain why diversifying strategies are pursued by insurance companies.

  ANSWER:

  (ii)   Describe two examples of how typical insurance companies pursue diversifying strategies to improve their overall risk profile.

  ANSWER:

(b)   (*2 points*) Critique the following statements regarding methods for modelling aggregation of risk:

  A.   Simple summation produces an upper bound to the true risk figure.

  ANSWER:

  B.   It is optional to use risk diversification for the simple summation method.

  ANSWER:

  C.   Variance-covariance method allows for interaction across risk but requires data to develop the correlation matrix.

  ANSWER:

3. Continued

      D.   *The integrated model is a tool that quantifies each risk independently and aggregates results at an appropriate level.*

> ANSWER:

      E.   *Since the integrated model accounts for all risks, it is transparent and easy to understand.*

> ANSWER:

Your company develops the following data to support the implementation of the enterprise risk framework.

Correlation between Risks	Interest Rate	Equity	Mortality	Operational
Interest Rate	100%	25%	0%	50%
Equity	25%	100%	0%	50%
Mortality	0%	0%	100%	50%
Operational	50%	50%	50%	100%

Risk Type	Measure of Risk
Interest Rate	50
Equity	10
Mortality	80
Operational	20

(c)   (*3 points*) Calculate the aggregate risk exposure under each of the following risk aggregation approaches:

    (i)   Simple Summation

> *The response for this part is to be provided in the Excel spreadsheet.*

    (ii)   Variance-Covariance Matrix

> *The response for this part is to be provided in the Excel spreadsheet.*

3.   **Continued**

(d)   (*2 points*) Your company would like to approximate the variance-covariance method using a fixed diversification percentage in their modeling.

    (i)   Calculate a fixed diversification percentage based on the result calculated in part (c).

> *The response for this part is to be provided in the Excel spreadsheet.*

    (ii)   Explain why this approach may not be an accurate reflection of the aggregate risk exposure.

ANSWER:

4.

(*11 points*) Your company sells Variable Annuities with various guaranteed minimum benefits (VA) and Equity-Indexed Annuity (EIA) Products

(a)   (*2 points*) Compare how the company's net income would differ under the following two scenarios:

- Markets are up and both products are unhedged
- Markets are down and both products are hedged

ANSWER:

4.   Continued

For the EIA product, you are given the following:

Single Premium	100,000
Maturity	7 years
Ratchet	Compound Annual
Annual Equity Return Cap	10%
Annual Equity Return Floor	1%
Participation Rate	50%
Guaranteed Minimum Annual Interest Rate on Single Premium	4%

A policyholder can lapse at the end of any year and receive the maximum of the Account Value or Guarantee Value subject to a variable surrender charge.

Your company uses the following risk mitigation strategies:

- The full single-premium is invested in a 7-year zero-coupon bond earning 5% effective per year.
- A call option with the same term, strike, and notional amount of the EIA is purchased. The cost of the option is 5,000 which was priced assuming a continuously compounded risk-free interest rate of 5%.
- The bond and call option can both be sold or redeemed at any point without penalty.

(b)   (*2 points*)

(i)   Calculate the value of the guaranteed minimum annual interest rate feature using the Put-Call Parity. Show all work.

The response for this part is to be provided in the Excel spreadsheet.

(ii)   Explain why the calculated result from (i) is reasonable.

ANSWER:

4. Continued

You are given the following values of the underlying equity index and surrender charge scale for the EIA. All values are as of end of year:

Time	Index Value	Surrender Charge (% of Payout)
0	1,000	
1	900	4.5%
2	800	4.0%
3	700	3.5%
4	800	3.0%
5	1,000	2.0%
6	1,100	1.0%
7	1,250	0%

(c)   (*5 points*) Calculate the lifetime net income from this product if:

(i)   The policyholder lapses at the end of year 3. Assume the market value of the call option at time 3 is 1,904.

The response for this part is to be provided in the Excel spreadsheet.

(ii)   The policyholder holds their product to maturity

The response for this part is to be provided in the Excel spreadsheet.

Show all work.

(d)   (*1 point*) Assess how the lifetime net income calculated in part (c)(ii) would change if the product was designed using the other Ratchet methods commonly sold. Justify your answer.

ANSWER:

(e)   (*1 point*) Describe the residual hedging risk(s) your company is exposed to as a result of their risk mitigation strategy.

ANSWER:

END OF EXAMINATION