SOCIETY OF ACTUARIES®

Exam ILALAM

Date: Friday, November 1, 2024

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 6 questions numbered 1 through 6 with a total of 60 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 unique candidate number in the filename. To maintain anonymity, please refrain from using your name and instead use your candidate number.

4. The Word and Excel documents that contain your answers must be uploaded before time expires.

Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:
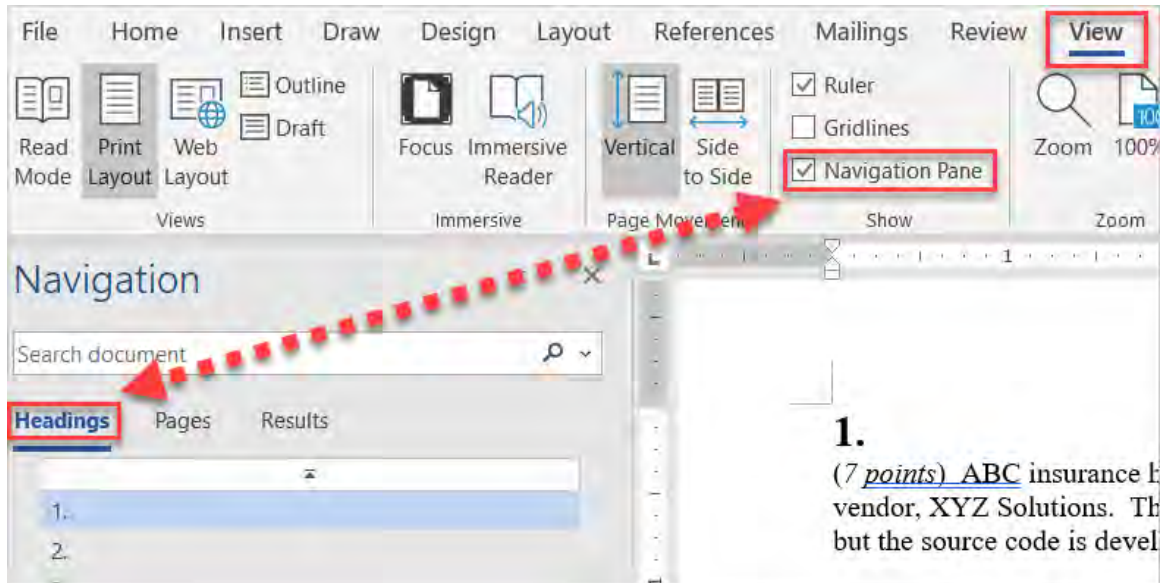
1.

(*9 points*) Your company would like to model mortality, lapse, and reinsurance on a stochastic basis for a universal life (UL) product.

(a)　　(*3 points*) Critique the following statements about risks to consider when building a stochastic mortality model:

　　A.　　*Underwriting error reflects the risk in assigning the wrong risk class to each model point.*

ANSWER:

　　B.　　*If the underlying product is interest sensitive, interest rate risk needs to be incorporated when building a stochastic mortality model.*

ANSWER:

　　C.　　*If the insured sample size is large, volatility risk can be ignored.*

ANSWER:

　　D.　　*To model catastrophe risk, the worst possible scenario must be modeled regardless of the complexity of achieving this.*

ANSWER:

　　E.　　*Trend risk is critical and should always be included.*

ANSWER:

　　F.　　*When combining the effect of different mortality risk factors, companies may consider having separate stochastic mortality multiples for different demographic cohorts.*

ANSWER:

1.   Continued

After running 10,000 scenarios your model has summarized the ending asset balance by risk element at select percentiles. All values are in millions.

Percentile	Underwriting	Volatility	Catastrophe	Trend	Cumulative
99%	24	36	13.5	34	10
95%	28.5	37	27	36	18
90%	31	37.6	30.5	37	26

- The best estimate ending asset balance is 40 million.

(b)   (*2 points*)

   (i)   Calculate the expected impact on the ending asset balance of a 1-in-10 chance of the best estimate mortality being wrong (underwriting error). Show all work.

   (ii)   Calculate the expected impact on the ending asset balance of a 1-in-100 chance of the underwriting, volatility, catastrophe, and trend risks all occur. Show all work.

   (iii)   Identify the risk element that is the least impactful to the mortality result. Justify your response.

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

1. Continued

The model also provided the following ending asset balances. All values are in millions.

Percentile	Lapse Only	Mortality Only	Lapse and Mortality
99%	37.1	10	7.1
95%	37.5	18	15.5
90%	37.8	26	23.8

- The best estimate ending asset balance is 40 million.

(c) (*2 points*) Evaluate whether lapse and mortality should be modeled together or separately. Show all work.

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

You are considering the use of reinsurance for inforce UL policies. The face amounts of the policies are high and actual-to-expected mortality experience has been volatile, deviating significantly from 100%.

(d) (*2 points*) Recommend which of the following reinsurance structures the company should use for this block. Justify your response

- Excess Loss Reinsurance
- Multi-year Stop Loss Reinsurance
- Experience Refund Reinsurance

ANSWER:

2.

(*10 points*) To prepare for asset adequacy testing (AAT), you have been asked to evaluate issues your company may face when both inflation and interest rates are high.

(a)   (*3 points*) Critique the following statements:

   A.   Long term care products are not impacted by inflation.

   ┌───┐
   │ ANSWER: │
   │   │
   └───┘

   B.   In a high inflation and rising interest rate environment, lapse rates will be higher for term products and whole life products with no guarantees.

   ┌───┐
   │ ANSWER: │
   │   │
   └───┘

   C.   Inflation accompanied by higher interest rates will have a negative impact on many insurance company assets whether the company's statutory accounting is on a market value or a book value basis.

   ┌───┐
   │ ANSWER: │
   │   │
   └───┘

After a period of rapid inflation, one market source indicates the prevailing market inflation rate is 6% per annum. As a result your manager recommends changing the expense inflation assumption from 2.5% to 6%.

(b)   (*2 points*)

   (i)   Critique your manager's recommendation.

   ┌───┐
   │ ANSWER: │
   │   │
   └───┘

   (ii)   Describe three relevant considerations when setting the inflation assumption.

   ┌───┐
   │ ANSWER: │
   │   │
   └───┘

2. Continued

Your manager views the value of AAT to be limited to the compliance of regulatory requirements, especially when setting model assumptions.

(c) (*2 points*) Propose how AAT could be used to better serve the company. Justify your answer.

> ANSWER:

Your team will be implementing principle-based reserving (PBR) along with AAT. Your company contracts a consulting firm to develop the PBR model.

(d) (*2 points*) With respect to *ASOP 56, Modeling*:

   (i) Describe two considerations when assessing if the structure of the PBR model is appropriate for AAT.

   > ANSWER:

   (ii) Describe two key topics to discuss when meeting with the consulting firm to understand the model.

   > ANSWER:

The model is delivered late by the consultant. Your team has limited time to understand the underlying workings of the model and was unable to validate certain output the Chief Actuary deems to be minor.

(e) (*1 point*) Describe two key elements that should be included in the Chief Actuary's disclosure to the Board on the reliance of a model developed by an external consultant.

> ANSWER:

3.

(*10 points*) You are reviewing stock return models used in the valuation of a variable annuity (VA) with a guaranteed minimum maturity benefit (GMMB).

(a)   (*1 point*) State the pros and cons of using a lognormal (LN) model to model stock returns.

ANSWER:

(b)   (*3 points*) Critique the following statements on alternative stock return models:

A.   *Empirical models and AR(1) models capture both autocorrelation and volatility bunching.*

ANSWER:

B.   *Regime-Switching LN models use one parameter set and assume deterministic volatility. Such models are unable to capture more extreme observed behavior.*

ANSWER:

C.   *The Wilkie model is a multivariate model. It is designed for short-term applications and ideal for assessing hedging strategies.*

ANSWER:

3. **Continued**

For the VA with GMMB, you are given the following:

Initial Premium (collected at start of year)	500,000
Management Fee (collected at start of year)	2.0% of fund value
Rider Fee (collected at start of year)	2.0% of fund value
Initial Expense (incurred at start of year)	5.0% of initial premium
Annual Maintenance Expense (incurred at start of year)	300
GMMB	120% of initial premium
Term	7 years
Annual Decrement Rate (at end of year)	3.0%
Fund Return (at end of year)	6.0%
Surrender Charge	N/A
Risk-free Rate	3.0%

(c)   (*6 points*)

   (i)   Calculate the expected maturity payment for a surviving policyholder.
          Show all work.

   (ii)   Calculate the present value of the expected profit to the insurer at time 0.
          Show all work

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

4.

(*11 points*) You are evaluating two potential securities to include in a broader asset portfolio:

- Security A: 7-year zero-coupon bond (ZCB)
- Security B: An alternative asset that pays 100 at the end of years 3, 7, and 15

You are given the following prices of ZCBs maturing for 100 in (t) years.

t	3	7	15
Price	95.88	74.09	47.94

For Security B, a student has calculated the key rate durations (KRDs) for each cash flow.

t	3	7	15
KRD	1.32	2.19	3.30

(a)   (*2 points*)

(i)   Determine whether the student calculated the correct key rate durations. Show all work.

(ii)   Demonstrate that the two securities have the same effective duration. Show all work.

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

4. **Continued**

You are given the following three yield-curve shocks:

Scenario\t	3	7	15
X	0.2%	0.0%	-0.2%
Y	-0.2%	-0.2%	-0.2%
Z	-0.2%	0.0%	0.2%

(b) (*5 points*)

  (i) Calculate the change in the value of Security A and B under each scenario. Show all work.

  (ii) Explain why effective duration is often inadequate in measuring a security's interest rate risk exposure. Justify your answer using part (i).

  (iii) Identify two other advantages of key rate duration over effective duration.

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

You are considering investing in the following asset classes:

- Callable Corporate Bonds
- Callable Bonds with a Sinking Fund
- European Call Options
- European Put Options

(c) (*4 points*) Contrast the interest rate risk profile of these assets, including the sensitivity to rate changes at different points in the yield curve.

  > ANSWER:

5.

(*10 points*) Your company invests based on a tactical asset allocation (TAA) framework and is considering changing to strategic asset allocation (SAA).

(a)   (*1 points*) Describe two differences between TAA and SAA.

> ANSWER:

(b)   (*5 points*) Critique the following statements regarding asset allocation:

   A.   We should never add an asset class to our portfolio if the Sharpe ratio of the new asset class is lower than the Sharpe ratio of the existing portfolio.

> ANSWER:

   B.   Measuring growth based on a money-weighted return basis will always be materially different from using a time-weighted return basis.

> ANSWER:

   C.   Yield-to-maturity considers interest-on-interest, and it assumes that the coupon payments can be reinvested at an interest rate equal to the coupon rate.

> ANSWER:

   D.   Prepayments on a mortgage only occur when rates decrease.

> ANSWER:

   E.   If the default rate on a corporate bond is higher than its credit spread, it would always be preferable to invest in treasuries rather than that particular corporate bond.

> ANSWER:

5. **Continued**

(c) (*4 points*) Your investment team is seeking to increase yield and is investigating alternative assets. Critique the following statements:

A. *As it is outside the expertise of an insurance company and it is hard to model, real estate investment trusts should be avoided.*

ANSWER:

B. *Private equity should be managed using tactical asset allocation.*

ANSWER:

C. *Collateralized loan obligations have minimal to no risk, given there is sufficient diversification in the underlying pooled loans.*

ANSWER:

D. *Energy transition infrastructure is a safe investment vehicle for insurance companies to invest in.*

ANSWER:

6.

(*10 points*) Your company expects a fixed cash payout in two years and is developing an investment strategy to support the payout. Due to limited market liquidity, your company will need to purchase a longer duration bond and sell it before maturity to fund the payout.

	Bond X	Bond Y	Bond Z
Annual Coupon Rate	4.50%	4.75%	4.75%
Par Value	100,000	100,000	100,000
Current Price	91,000	89,000	88,000
Term to Maturity (years)	5	6	8
Projected Annual Yield on comparable bonds after 2 years	6.1%	6.4%	6.3%

- All bonds pay semi-annual coupons
- The annual reinvestment rate is 5% compounded semi-annually

(a)   (*6 points*)

(i)   Calculate the total return of each bond on a bond-equivalent basis. Show all work.

(ii)   Recommend which bond to purchase, based on your calculation from (i). Justify your answer.

(iii)   Critique the option of purchasing a different security with higher yield-to-maturity.

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

6. Continued

You are given the following information about a bond:

Time to Maturity	15 years
Annual Coupon Rate	6.5%
Par Value	1,000,000
Market Value	1,000,000

(b)   (*4 points*)

   (i)   Calculate the modified duration of the bond.

   (ii)   Calculate the convexity of the bond.

   (iii)   Estimate the change in market value of a 1% increase in interest rates
           using the information calculated in (i) and (ii).

           Show all work.

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

END OF EXAMINATION