

Exam ILALAM

Date: Friday, November 3, 2023

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.

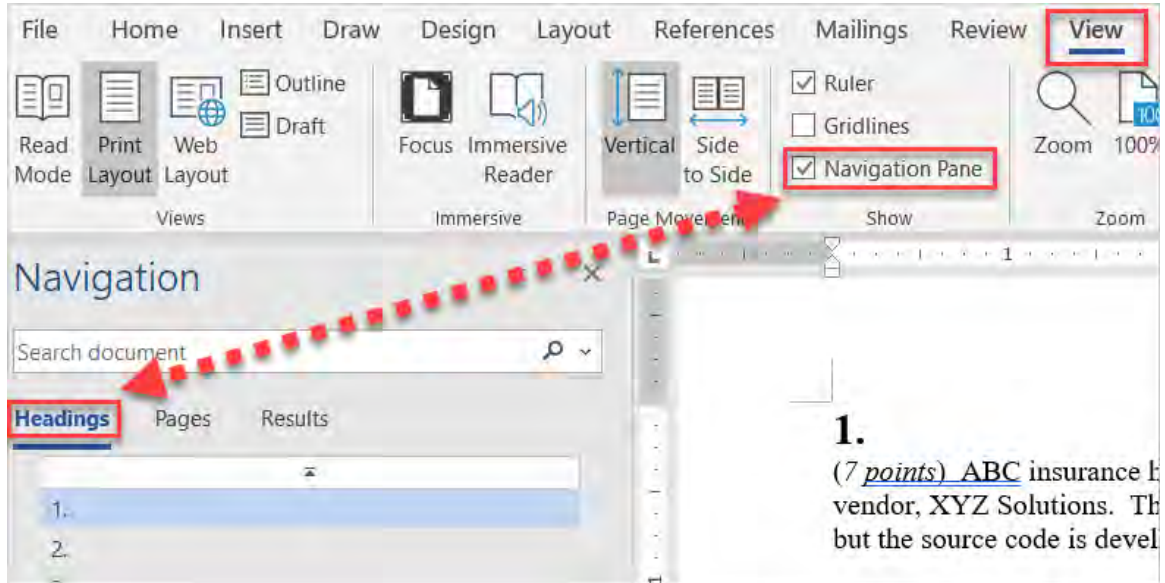
Written-Answer Instructions

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, $X = \text{component1} + \text{component2}$. 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. 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 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 is looking to enhance their long-term care (LTC) model. The model currently uses a claim cost approach and is considering changing to a first principles approach.

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

A. *A first principles approach to model LTC will always be simpler to understand than a claim cost approach.*

ANSWER:

B. *A first principles approach tends to have better internal consistency but is difficult to test sensitivity.*

ANSWER:

C. *Companies should develop their own mortality assumption on healthy lives and disabled lives based on their experience because it is the most consistent with the first principles approach to have assumptions for each cohort.*

ANSWER:

D. *When developing mortality assumptions, the most accurate way to determine the correct mortality is to separate the study into the mortality rate for the total population, the mortality rate for disabled lives, and solve for the mortality rate for healthy lives.*

ANSWER:

E. *It is reasonable to assume the same lapse assumption for the total population and the healthy cohort.*

ANSWER:

1. Continued

F. *If the credibility of data used to generate lapse and mortality assumptions are high, all the information needed to generate the non-economic assumptions for the model are present.*

ANSWER:

(b) (5 points) You are given the following information:

Year	Exposure	Lapses	Disabled Deaths	Total Terminations
1	10,000	60	9	100
2	9,900	40	10	50
3	9,850	10	11	100
4	9,750	10	12	120
5	9,630	15	6	150

- Each year 200 lives become disabled.
- Disablements occur at the beginning of the year.

(i) (3 points) Calculate the following for years 1-5:

- Disabled life mortality rate
- Active life mortality rate
- Implied lapse rate

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

(ii) (2 points) Assess the reasonableness of the results.

ANSWER:

(c) (1 point) Critique the following statement:

Our disabled life mortality is very sensitive. If we apply a 30% shock to the mortality rate, we see a 30% increase in the number of disabled lives dying. To ensure we're modeling disabled life mortality appropriately we should be using a stochastic model.

ANSWER:

2.

(10 points) With the recent increases in interest rates and inflation, your company is reviewing how the relationship between interest rates and inflation is modeled in its Economic Scenario Generator (ESG). The ESG currently relies on an industry formula which was prescribed before the recent market volatility and management is deciding if they want to develop their own approach.

(a) (3 points)

(i) Critique the use of an industry formula in their ESG.

ANSWER:

(ii) Recommend economic scenarios management should consider when developing their own approach.

ANSWER:

(iii) Recommend factors management should consider when modeling the scenarios discussed in (ii).

ANSWER:

Your company sells the following products:

- Traditional whole life insurance with fixed premiums and face amount
- Fixed universal life with a crediting rate based on your company's assets
- The same universal life product as above, with a long-term care rider

(b) (3 points) Analyze how increasing interest rates may affect the profitability of these products.

ANSWER:

2. Continued

Senior management believes the higher interest rate environment is an opportunity to launch new life insurance products which will be attractive to new policyholders.

- (c) (2 points) Recommend two new life insurance products your company can offer. Justify your answer.

ANSWER:

You are reviewing a cash flow model for a legacy block of fixed deferred annuities which are outside the surrender charge period. You are given the following:

- The credited rate is determined based on an asset portfolio less a target spread, subject to a guaranteed minimum.
- The asset portfolio is a mix of public bonds and residential mortgages with a weighted average life of 20 years.
- The model assumes a lapse rate of 7% per year, which aligns with the company's experience.

- (d) (2 points) In a rising interest rate environment:

- (i) Critique the asset portfolio supporting this line of business.

ANSWER:

- (ii) Critique the lapse assumption.

ANSWER:

3.

(11 points) ABC sells a fixed rate deferred annuity with the following features:

- Minimum guaranteed credited interest rate of 3%
- Current credited interest rate is adjusted every five years
- No surrender charge
- Assets backing the liability are invested in a mix of 60% corporate bonds and 40% residential mortgages

You are performing cash flow testing (CFT) for ABC.

(a) (3 points) The CFT results suggest that both a steep increase and a steep decrease of market interest rates could result in additional required reserves.

(i) (2 points) Explain how each scenario affects ABC from an asset and liability management perspective.

ANSWER:

(ii) (1 point) Recommend two derivatives that ABC could use as a hedge for low interest rates.

Explain how each works.

ANSWER:

(b) (2 points) You are validating the CFT model.

(i) List three model validation methods commonly applied to a CFT model.

ANSWER:

(ii) Describe how each method can be applied.

ANSWER:

3. Continued

- (c) (6 points) Insurance products are often sold with embedded options for both the policyholder and the insurance company.

For the following products:

- Deferred annuity with a minimum guaranteed crediting rate
- Participating traditional whole life insurance that provides cash value and dividends
- Long-term care product with guaranteed premium

- (i) Identify two embedded options offered to the policyholder that are shared by more than one product.

ANSWER:

- (ii) Explain which product features are triggered for the embedded option(s) in part (i).

ANSWER:

- (iii) Identify two embedded options available to the insurance company that are shared by more than one product.

ANSWER:

- (iv) Explain which product features are triggered for the embedded option(s) in part (iii).

ANSWER:

4.

(10 points) NDV Life sells a portfolio of fixed annuities. They recently experienced an excess cash inflow of 320 million and are evaluating asset mixes to reinvest the cash.

The below asset mixes are being considered. All assets pay annual coupons and have no principal repayments within the next five years.

Asset Mix	Expected Return	Standard Deviation of Return
W	9.0%	19%
X	4.5%	10%
Y	7.9%	14%
Z	6.9%	12%

NDV anticipates an excess cash outflow of 15 million in one year due to a large block of deferred annuities exiting their surrender charge period. They want to fund the cashflow with coupons from the selected asset mix rather than sell assets.

NDV recently underwent an internal risk tolerance review by surveying key stakeholders and aggregating the results based on a tolerance scale of 1 (minimal risk aversion) to 8 (significant risk aversion). The resulting company score was 4 out of 8.

(a) (5 points)

- (i) Calculate NDV's expected utility (also referred to as "risk-adjusted return") for each asset mix.

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

- (ii) Calculate the safety-first ratio from Roy's safety-first criterion for each asset mix.

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

- (iii) Recommend an optimal asset mix. Justify your answer.

ANSWER:

4. Continued

NDV is reviewing their asset portfolio in relation to requirements for annual asset adequacy analysis. The appointed actuary drafted an analysis memorandum.

(b) (5 points) Critique each of the following statements from the memorandum:

- A. *Only one asset segment exists which supports all interest sensitive liabilities. Each line of business backed by this segment is modeled with a pro-rata allocation of assets since we are not permitted to refine the allocation to optimize asset-liability duration matching.*

ANSWER:

- B. *In accordance with ASOP 22 – Statements of Opinion based on Asset Adequacy Analysis by Actuaries for Life or Health Insurers, the moderately adverse scenario chosen is based on conditions (such as rising interest rates) and assumptions (such as higher mortality) which are deemed “moderately adverse”, regardless of model results in aggregate.*

ANSWER:

- C. *Most callable bonds held at the company include a “make-whole” premium and callable bonds make up a relatively insignificant portion of the portfolio. The call option is still modeled, as required, even though we are unable to capture the “make-whole” premium in our modeling.*

ANSWER:

- D. *To ensure our model sufficiently captures prepayment of residential mortgage-backed securities, we validate that prepayment rates increase in falling interest rate scenarios and decrease in rising scenarios. We also validate that prepayment rates maintain at an elevated level as long as the projected interest rates continue to decrease in the falling scenario.*

ANSWER:

4. Continued

- E. *We calculate the modeled market value of our mortgage-backed securities (MBS) using discounted cash flows assuming interest rates remain level from each valuation point, as opposed to a stochastic method. The stochastic method caused extreme increases in run time, and we determined this would not significantly affect our analysis given the relatively small proportion of MBS in our portfolio.*

ANSWER:

5.

(9 points) BDA Life offers a variable annuity with a guaranteed minimum maturity benefit (GMMB).

(a) (3 points) Critique each of the following statements that relate to the modeling of the GMMB:

A. *When calculating the cost of the GMMB, the model will use implied volatility derived from current market statistics instead of historical volatility.*

ANSWER:

B. *When modeling equity returns to project fund values, the model assumes that continuous time returns follow a geometric Brownian motion which implies returns are lognormally distributed.*

ANSWER:

C. *It is better to use a deterministic approach instead of a stochastic approach when modeling mortality and investment guarantees. A deterministic approach will sufficiently capture the tail risk of the GMMB.*

ANSWER:

5. Continued

You are given the following:

Initial premium	100,000
Guarantee value	100,000
M&E fee (collected at end of year)	1.00%
Rider fee (collected at end of year)	0.75%
Term (years)	10
Annual mortality rate	5.00%
Risk free rate	3.50%
Sigma (standard deviation of fund return)	25.00%

- (b) (3 points) Calculate the expected value of the GMMB claims assuming a 1% fund return for all years.

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

- (c) (3 points) Determine whether the rider fee will be sufficient to cover the value of the GMMB using Black-Scholes option pricing.

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

6.

(11 points) You are given the following information about a bond:

Face value	250,000
Time to maturity	10 years
Annualized yield to maturity	3.0%
Semi-annual coupon payment	4.5%

- (a) (1 point) Calculate the Macaulay Duration of the bond.

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

You want to invest 2 million of your current funds and borrow an additional 10 million at an interest rate of 2.8% to invest in the bond from part (a).

- (b) (1 point) Calculate the rate of return that can be expected from this strategy.

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

You want to exchange one bond issue for another that you believe is undervalued.

	Existing Bond	New Bond
Market Value	350,000	n/a
Price	90	115
Duration	5	7

- (c) (1 point) Determine the par value of the new bond needed to keep the duration of the portfolio constant.

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

You are reviewing your company's liquidity risk policy.

- (d) (3 points)

- (i) Explain why insurance companies have different liquidity concerns than banks.

ANSWER:

6. Continued

- (ii) Describe two possible liquidity risk metrics your company can use.

ANSWER:

You are considering expanding the company's asset portfolio to cover the credit market, specifically, credit default swaps (CDS).

- (e) (4 points) Critique the following statements:

A. *For CDS, the buyer pays a regular floating coupon to the seller, the amount of which depends on the market value of the credit risk at that time. These payments continue to the scheduled termination date.*

ANSWER:

B. *A positive upfront payment is required to enter into a CDS.*

ANSWER:

C. *There are two possible ways to hedge credit risk: purchasing corporate bonds or purchasing a CDS. The lower transactions costs of a CDS make it a better strategy.*

ANSWER:

D. *A Standard North American CDS Contract covers all credit events.*

ANSWER:

Your boss believes there is a mismatch on some of the credit ratings of the bonds you hold today. They believe the ratings assigned by Moody's are too low.

- (f) (1 point) Recommend two strategies utilizing CDS for your company.

ANSWER:

****END OF EXAMINATION****