

Exam ILALAM

Date: Friday, November 4, 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.

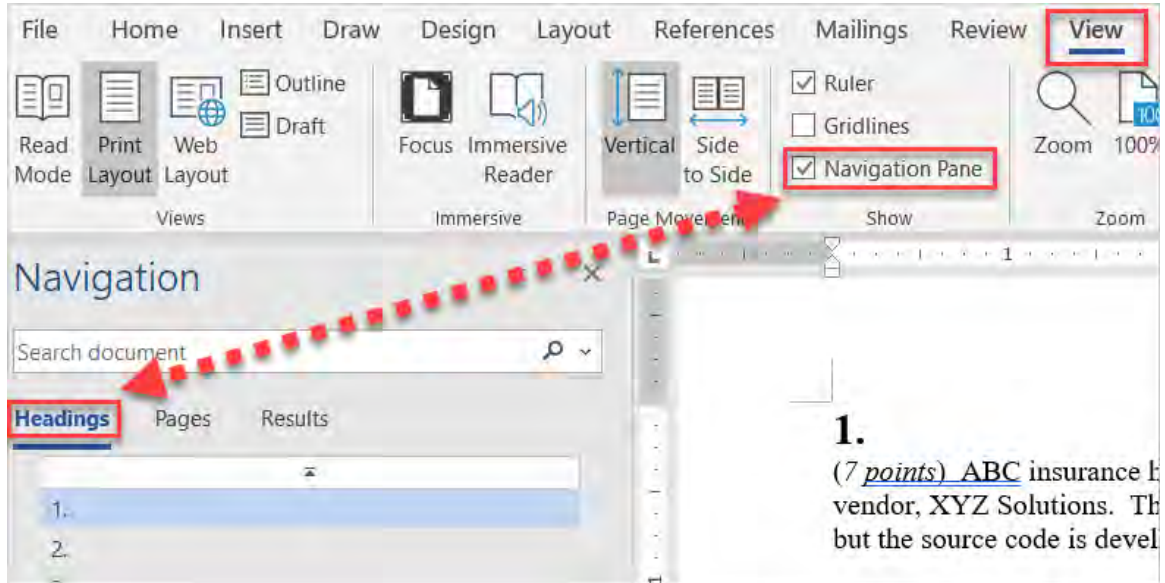
Written-Answer Instructions

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, $X = \text{component1} + \text{component2}$. 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.

(11 points) Company HLC offers a variable annuity and is considering stochastic model options to project equity returns.

You are given the following information for a European call option:

Variable	Value
$S(0)$, the current price of the underlying	100
K , the strike price of the option	100
T , the time until option maturity	1 year
σ , the volatility of the underlying	20.0%
d , the dividend rate of the underlying	0%

The following continuous-time Monte Carlo simulations were performed for the underlying stock price $S(T)$, where $S(T) = S(0) * \exp[(r - \sigma^2/2) * T + \sigma * \epsilon * T^{1/2}]$

Simulation	ϵ_i	$S_i(1)$
1	-1.7701	70.19
2	-0.7908	85.37
3	-0.3590	93.07
4	0.8190	117.80
5	-0.5828	89.00
6	0.7156	115.39
7	-0.3182	93.83
8	0.9314	120.48
9	1.2897	129.43
10	0.5930	112.59

(a) (4 points) With respect to the Monte Carlo simulation:

(i) Calculate the Monte Carlo estimate of the call option

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

(ii) Calculate the Monte Carlo sampling standard error of the estimated call option price

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

(iii) Evaluate the reasonableness of the estimated call option price

ANSWER:

1. Continued

- (iv) Explain why a company would want to use a variance reduction technique

ANSWER:

- (b) (4 points) Your company would like to explore the use of a nested stochastic model to project equity returns.

- (i) Explain how a nested stochastic model could be implemented

ANSWER:

- (ii) Discuss the advantages and disadvantages of two possible methods that could be used to manage the run-time of the model

ANSWER:

- (c) (3 points) Critique the following statements:

A. *For the underlying index, the volatility parameter is an average of 65 years of data; therefore, the credibility of such a long sample period means it is reasonable to set σ to 20% for all nodes in the model.*

ANSWER:

B. *The relation between interest rates and equity returns has been proven beyond statistical doubt. Consequently, in reserve calculations the expected return on equities should exceed the risk-free rate by an expected risk premium at every time step in every scenario.*

ANSWER:

C. *Stock prices are distributed normally and therefore the company can use the stock price volatility as a parameter in a stochastic model.*

ANSWER:

2.

(8 points)

- (a) (2 points) You oversee new product modeling at ABC Life Insurance Company. ABC is looking to develop a cost effective and controlled environment for modeling.

Critique the following two statements:

- A. *To save time and effort a new product will be developed using a decentralized approach where a copy of an existing model will be created for the new product and maintained separately.*

ANSWER:

- B. *To avoid replicating errors in the existing model, new products will always need to be developed from first principles.*

ANSWER:

2. Continued

- (b) (5 points) ABC is growing quickly and it is becoming more challenging to manage assumption governance requirements. You have been asked to replace the current compliance focused framework with a strategic assumption governance framework.
- (i) List four beneficial byproducts of having a strategic assumption governance framework.

ANSWER:

- (ii) Recommend improvements to each of the following assumption governance requirements, if necessary. Justify your recommendations.
- A. *The top priority of assumption governance is compliance with regulatory requirements.*

ANSWER:

- B. *All models must have consistent assumptions.*

ANSWER:

- C. *Each assumption must be reviewed annually.*

ANSWER:

- D. *Assumptions should only be passed to modelers for implementation after they have been approved by all relevant stakeholders.*

ANSWER:

2. Continued

- (c) *(1 point)* Your manager has suggested to use the interest rate model developed by the American Academy of Actuaries (the Academy model) for the pricing of new products.

Assess if this is reasonable. Justify your response.

ANSWER:

3.

(11 points) You are an actuary at BAX Life and are reviewing the modeling of assets in your cash flow testing model. The model includes bonds, collateralized mortgage obligations (CMO), and mortgage-backed securities (MBS).

(a) (6 points) Critique each of the following statements:

A. *To capture varying credit losses observed historically, the models assume lower default rates in higher interest rate scenarios.*

ANSWER:

B. *To be conservative, prepayments of CMOs and MBSs are not modeled; prepayments would increase cash flows and could only improve results.*

ANSWER:

C. *Only 5% of the bonds in the portfolio are callable and many include make-whole provisions, so they are modeled as non-callable for simplicity.*

ANSWER:

D. *The reinvestment strategy is modeled as a simple reinvestment portfolio of AAA-rated 20-year bonds.*

ANSWER:

E. *Investment expenses are not modeled explicitly; instead, 10bps are deducted from the asset earned rate to represent investment expenses.*

ANSWER:

F. *The cash flow testing models will be used for BAX's ALM analysis.*

ANSWER:

3. Continued

BAX Life is redesigning a product to be more competitive with the following proposed changes:

	Current Design	Proposed Design
Guaranteed credited rate	2%	3%
Surrender charge period	10 years	5 years
Assets backing liabilities	10-year non-callable bonds	10-year callable bonds

- (b) (3 points) Evaluate the change in BAX Life's interest rate risk profile for each of the proposed product design changes.

ANSWER:

- (c) (2 points) Critique each of the following statements related to Asset Liability Management:

A. Each product should be analyzed individually so we can understand the total investment risk of the product.

ANSWER:

B. When developing new Universal Life products, we are only able to manage the investment risk through design features such as lower guaranteed credited rates and higher surrender charges.

ANSWER:

C. The best way to achieve immunization is to match the effective duration of each of our asset segments with the effective duration of their corresponding liability segments.

ANSWER:

4.

(10 points) The risk team at your company is looking to build an Economic Scenario Generator (ESG) to support the risk management of Variable Annuity (VA) products with minimum financial guarantees.

Instead of designing new software, your manager has proposed using the risk-neutral, market consistent ESG used by your pricing area. In your manager's report they provide the following rationale for their proposal.

(a) (4 points) Critique the following statements from their report:

A. *The ESG produces thousands of scenarios covering a wide distribution of projected interest rate and equity growth paths so it is ideal for risk management applications.*

ANSWER:

B. *The pricing department follows industry-leading practices to calibrate their ESG to current market conditions, producing near-perfect replication of option prices.*

ANSWER:

C. *The ESG output is regularly tested to verify the absence of arbitrage opportunities.*

ANSWER:

D. *If a new ESG is built for risk management, then for the sake of consistency between the inner loops and outer loops of nested scenarios the company should also use the new ESG for pricing.*

ANSWER:

4. Continued

Your company sells a 3-year Variable Annuity with a Guaranteed Minimum Accumulation Benefit (GMAB). The GMAB resets at the end of each year if the account value is greater than the guarantee value.

You are given the following:

Opening Account Value	100,000
Opening Guarantee Value	100,000
Rider Fee, collected at end of each year	3%

Assume no other fees, decrements, or expenses.

Your risk department proposes the following hedging strategy:

- At the beginning of each year, purchase a 1-year at the money put option with notional equal to the beginning of year account value
 - The cost per 1,000 of notional is 25
- (b) (5 points) Calculate the expected profit and loss for the product under each of the following scenarios:

- (i) The underlying equity index earns 5% per year

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

- (ii) The underlying equity index earns -5% per year

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

- (c) (1 point) Your manager has expressed a concern that the proposed product is too risky and despite the proposed risk mitigation the company could be exposed to significant claim costs if markets decrease.

Recommend changes to the hedging strategy to address your managers concerns.

ANSWER:

****END OF EXAMINATION****