CURATED PAST EXAM ITEMS
- Questions -

CFE 101 – Enterprise Risk Management

Important Information:

- These curated past exam items are intended to allow candidates to focus on past SOA fellowship assessments. These items are organized by topic and learning objective with relevant learning outcomes, source materials, and candidate commentary identified. We have included items that are relevant in the new course structure, and where feasible we have made updates to questions to make them relevant.
- Where an item applies to multiple learning objectives, it has been placed under each applicable learning objective.
- Candidate solutions other than those presented in this material, if appropriate for the context, could receive full marks. For interpretation items, solutions presented in these documents are not necessarily the only valid solutions.
- Learning Outcome Statements and supporting syllabus materials may have changed since each exam was administered. New assessment items are developed from the current Learning Outcome Statements and syllabus materials. The inclusion in these curated past exam questions of material that is no longer current does not bring such material into scope for current assessments.
- Thus, while we have made our best effort and conducted multiple reviews, alignment with the current system or choice of classification may not be perfect. Candidates with questions or ideas for improvement may reach out to education@soa.org. We expect to make updates annually.

Course CFE 101

Curated Past Exam Questions

All Learning Objectives

Learning Objective 1: Enterprise Risk Management Foundations

Learning Objective 2: Risk Analysis and Evaluation

Learning Objective 3: Embedding ERM into Decision-Making

The following questions are taken from Enterprise Risk Management Exams from 2020 – 2024. They have been mapped to the learning objectives and syllabus materials for the CFE101 2025-2026 course and in some cases modified to fit the 2025-2026 curriculum.

The related solutions and Excel spreadsheets are provided in separate files.

The case study that was originally used for each question is linked at the start of each question.

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2. Fall 2024 ERM Exam (LOs 2.1a, 3.2c)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2 Risk Taxonomy
    - Ch. 15: Risk Mitigation Using Options and Derivatives
- CFE101-109-25: Managing 21st-Century Political Risk

(*17 points*) GRD, a U.S. manufacturer of educational-themed toys, has seen surging sales and is considering becoming a publicly traded company. The company utilizes a factory in Country X, whose currency is ELI, for manufacture of cost-effective parts and import of completed parts for assembly and sale in the U.S. Historically, GRD's relationship with the factory has been strong, with GRD receiving on-time deliveries despite occasional factory shutdowns due to social unrest or political events.

Over the past several years, Country X's economy has been volatile, but the trade relationship between Country X and the U.S. has been stable. As GRD approaches its initial public offering, it is required to disclose its risk management program. You are a risk consultant who has been hired to assess the effectiveness of GRD's risk management program.

(a) **(LO 2.1a)** (*4 points*)

(i) Describe the three types of exchange rate risk as they apply to GRD.

ANSWER:

(ii) Assess whether each type of risk described in (i) is low, medium, or high for GRD. Justify your answer.

ANSWER:

2. Continued

Jon Doe, the CFO of GRD, states the following:

> "*While we lack a formal exchange rate risk management program, we've been actively monitoring the fluctuations of the ELI against the US Dollar (USD). Historically, we've mitigated potential risk by using currency forwards when anticipating a stronger ELI. This approach has been successful in the past and we expect it to continue working in the future. Considering the ELI has been consistently weakening since the pandemic, the exchange rate risk is a positive risk for us. We've got this under our control and don't need to spend any more time on this risk.*"

(b) **(LO 3.2c)** (*3 points*) Critique Jon Doe's statements on exchange rate risk management.

ANSWER:

(c) **(LO 3.2c)** (*8 points*) GRD does not have expertise in investing and hedging. You have been helping the company design its hedging strategies and explore hedging instruments in both OTC and exchange-traded markets. GRD is considering the following alternatives for its hedging strategy.

- Currency (call) options
- Currency futures

(i) Assess the suitability of each alternative for mitigating exchange rate transaction risk including any risk implications. Justify your response.

ANSWER:

2. Continued

GRD has decided to further consider currency (call) options as an alternative to forwards (as noted by Jon Doe) and would now like to examine cash flows and potential benefits. There is an upcoming payment of 1 million ELI in three months.

As of today, the prevailing spot exchange rate stands at $1.26 per ELI.

You have two choices for hedging:

- An over-the-counter three-month currency forward contract with a predetermined forward rate of $1.30 per ELI. There are no transaction costs.
- An exchange-traded three-month currency call option on ELI with a strike price of $1.28 per ELI. The premium for the call option is $0.012 per ELI.

You are given:

- The interest rate in the U.S. is 2.5% per annum.
- The interest rate in Country X is 1.75% per annum.
- It is forecasted that the exchange rate will increase to at least $1.30 per ELI in three months.

This information is shown in tab "F24 Q2.c.ii Question" of the Excel spreadsheet.

(ii) Calculate the dollar costs in three months for each of the two hedge choices assuming the forecast is correct. Show your work.

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

(iii) Recommend which hedging choice best meets the needs of the company. Justify your answer.

ANSWER:

2. Continued

You are asked to perform a sensitivity analysis on the exchange rate which would impact the choice of hedging instrument.

(iv) Calculate the breakeven exchange rate in three months such that the dollar costs in three months of the currency forward and currency option are equal. Refer to tab "F24 Q2.c.iv Question" of the Excel spreadsheet. Show your work.

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

(d) **(LO 2.1a)** (*2 points*) As you continue your review, you note that there have been more instances where political issues have caused disruptions than you were originally led to believe. You recommended to GRD management that it add political risk to its risk taxonomy. Katie, a director of Risk Management at GRD, disagrees with your recommendation. In her email, she states:

"*We believe the company's exposure to political risk in Country X is minimal and doesn't necessitate active management. Here's our reasoning:*

- *Limited Ownership: We don't directly own the factory, minimizing direct risk from disruptions.*
- *Non-Sensitive Goods: The imported components are not subject to heightened regulatory scrutiny due to their nature.*
- *Past Performance: The factory has maintained deliveries despite previous political events in Country X.*"

Critique Katie's statement on political risk.

ANSWER:

Question 3 pertains to the Case Study.
https://www.soa.org/4a30be/globalassets/assets/files/edu/2024/fall/case-study/2024-fall-erm-case-study.pdf

3. Fall 2024 ERM Exam (LOs 2.2g, 3.3c, 3.3d, 3.3e)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 18: Quantitative Enterprise Risk Management by Mary Hardy and David Saunders, Chapter 18: Risk-Adjusted Measures of Profit and Capital Allocation* (Except Section 18.6)

(*13 points*) You are the Deputy CRO for Pryde. Pryde currently uses a Co-CTE approach to allocate capital to its two business units and a RAROC approach for compensation. You have been asked to assist with risk budgeting and performance measurement.

Refer to Section 4.5 of the Case Study.

(a) **(LOs 2.2g, 3.3c, 3.3d, 3.3e)** (*7 points*)

(i) Compute the capital allocated to each business unit using Pryde's current approach and the projected 2024 data provided in the tab "F24 Q3-30k CapitalSim Scenarios" of the Excel spreadsheet. Refer to tab "F24 Q3.a.i Question" of the Excel spreadsheet. Show your work.

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

You decide to evaluate alternative capital allocation methods.

(ii) Calculate the allocated capital following the Proportional and the Co-VaR allocation methods based on the VaR(99.6) and using the projected 2024 data provided in the tab "F24 Q3 - 30k CapitalSim Scenarios" of the Excel spreadsheet. Refer to tab "F24 Q3.a.ii Question" in the Excel spreadsheet. Show your work.

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

(iii) Recommend a change to Pryde's current methodology. Justify your answer.

ANSWER:

3. Continued

(b) **(LO 3.3e)** (*6 points*) Pryde uses RAROC to reward appropriate risk-taking behaviors in its compensation structure for business unit leaders.

Pryde's net income by line of business was as follows (000's):

	2022	**2023**
Commercial Multiple Peril	77,184	20,696
Workers Compensation	6,179	6,716
Total Net Income	83,363	27,412

(i) Compute the retrospective RAROC for Pryde's two lines of business for 2022 and 2023. Use Pryde's current approach for calculating economic capital (EC) and assume the EC is constant throughout each year. Refer to tab "F24 Q3.b.i Question" of the Excel spreadsheet. Show your work.

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

The Commercial Multiple Peril business unit leader asserts that the RAROC-based compensation structure is unfair, but the Workers Compensation business unit leader disagrees.

(ii) Explain each business unit leader's reasoning.

ANSWER:

(iii) Recommend a change to address fairness for both business unit leaders. Justify your recommendation.

ANSWER:

Questions 4 pertains to the Case Study.
https://www.soa.org/4a30be/globalassets/assets/files/edu/2024/fall/case-study/2024-fall-erm-case-study.pdf

4. Fall 2024 ERM Exam (LOs 1.2a, 2.1a, 2.2h, 3.2f)

Relevant Sources:

- CFE101-108-25: Managing Environmental, Social and Governance Risks in Life & Health Insurance Business
- CFE101-107-25: Developing Key Risk Indicators to Strengthen Enterprise Risk

(*15 points*) You are an actuary working for SLIC.

SLIC has recently hired a new CRO who is interested in managing mortality and longevity risks more proactively. She has requested you to review the metrics included in the Risk Management Committee's quarterly KRI dashboard. The quarterly dashboard currently includes:

- Loss Ratio
- New sales dollars, count, and growth rate
- Count of claims ceded to SLIC's reinsurer

Refer to Sections 3.2 and 4.5 of the Case Study.

(a) **(LOs 1.2a, 2.2h)** (*5 points*)

(i) Identify one element of good KRIs that is present in the quarterly dashboard's metrics. Justify your response.

ANSWER:

(ii) Identify one element of good KRIs that is missing from the quarterly dashboard's metrics. Justify your response.

ANSWER:

(iii) Recommend three specific ways that SLIC could benefit from including more effective KRIs. Justify your recommendation.

ANSWER:

4. Continued

(b) **(LOs 2.1a, 2.2h)** (*7 points*) The new CRO is particularly concerned about the impact of Environmental, Social, and Governance ("ESG") risks on the organization's key risks. Refer to tab "F24 Q4.b Question" in the Excel spreadsheet.

(i) Identify three ESG risks that could be significant to the financial results of SLIC's life and annuity blocks.

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

(ii) Evaluate the anticipated risk impact and likelihood of each identified risk with regard to SLIC's life and annuity blocks by placing it on the likelihood/severity table in the Excel spreadsheet.

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

(iii) Justify each identified risk's placement on the likelihood/severity table.

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

(c) **(LO 3.2f)** (*3 points*) Recommend a KRI to monitor for each ESG risk from part (b). Justify your recommendation using the characteristics of good KRIs.

ANSWER:

Question 1pertains to the Case Study. https://www.soa.org/49a9d1/globalassets/assets/files/edu/2024/spring/case-study/spring-2024-erm-case-study.pdf

1. Spring 2024 ERM Exam (LOs 2.1a, 2.1b)

Relevant Sources:

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 8: Risk Identification
- CFE101-113-25: Identifying and Evaluating Emerging Risks

(*10 points*) You are a consultant at Caerus who has been hired by the CRO of SeaLux to assist with a risk analysis for SeaLux's Board of Directors. The Board is concerned about emerging risks and wishes to avoid any unpleasant surprises.

Refer to Section 1.8 of the Case Study

(a) **(LOs 2.1a, 2.1b)** (*2 points*) Describe two key opportunities and two key threats to include in a SWOT analysis of SeaLux.

ANSWER:

(b) **(LOs 2.1a, 2.1b)** (*3 points*) As part of your analysis you meet with senior officers of SeaLux to get their thoughts on emerging risks facing the company. The CFO expresses concern about exchange rate risk because SeaLux wants to expand in markets such as China and Southeast Asia where it currently has low penetration. Meanwhile, the Chief Technology Officer (CTO) is concerned with cyber attacks if SeaLux expands in these markets.

(i) Critique whether interviewing senior officers is an effective technique to identify the emerging risks facing SeaLux.

ANSWER:

(ii) Assess whether the risks identified by the CFO and CTO are emerging risks for SeaLux.

ANSWER:

1. Continued

(c) **(LO 2.1b)** (*5 points*) You are preparing a presentation to the Board on the most important emerging risks for SeaLux. They have asked you to present one risk from the five Industry Key Risks listed in Section 1.8 of the Case Study, and one risk not on that list. The CRO has asked you to choose risks that are both highly material to SeaLux and good examples of emerging risks.

(i) Recommend which of the five Industry Key Risks you will present to the Board. Justify why your recommendation fits both criteria.

ANSWER:

(ii) Recommend one risk not listed in the five Industry Key Risks to present to the Board. Justify why your recommendation fits both criteria.

ANSWER:

Questions 2 pertains to the Case Study. https://www.soa.org/49a9d1/globalassets/assets/files/edu/2024/spring/case-study/spring-2024-erm-case-study.pdf

2. Spring 2024 ERM Exam (LOs 1.2a, 2.1a, 3.2a, 3.2d, 3.2f)

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 16: Responses to Risk
- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- CFE101-120-25: IAA Risk Book Reinsurance
- CFE101-108-25: Managing Environmental, Social and Governance Risks in Life & Health Insurance Business
- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis

(*8 points*) Caerus Consulting is supporting the introduction of a Term with Accelerated Underwriting (TAU) product at SLIC. The product will rely on an External Consumer Data and Information Source (ECDIS) to provide a risk score based on personal credit for each applicant. This risk score will supplement responses to medical questions answered in a digital application.

Refer to Section 3.2 and Section 4.5 of the Case Study.

(a) **(LOs 2.1a, 3.2a, 3.2d)** (*4 points*)

(i) Describe one operational risk associated with designing the TAU product that SLIC should now consider when evaluating the overall risk of its Term product portfolio.

ANSWER:

(ii) Explain one approach to mitigate the risk described in part (i). Justify your response using details from the Case Study.

ANSWER:

2. Continued

William Xu's November 15th, 2022, memorandum discusses whether death benefit limits and reinsurance arrangements are needed for TAU. Refer to Section 4.5 of the Case Study.

(iii) Critique the recommendations in Xu's memorandum, considering SLIC's existing Term products and reinsurance.

ANSWER:

(b) **(LOs 1.2a ,3.2f)** (*4 points*) A state where SLIC is licensed has proposed a new ECDIS regulation as part of Environmental, Social and Governance issues, designed to protect consumers from potential bias and misinformation in underwriting algorithms used by insurance companies.

The following is an excerpt from the regulation:

"External Consumer Data and Information Source" or "ECDIS" means any data or information source used by a life insurer to supplement or supplant traditional underwriting factors or to establish lifestyle indicators that are used in insurance practices. This term includes credit scores, social media habits, purchasing habits, home ownership, educational attainment, licensures, civil judgments, court records or occupation that does not have a direct relationship to mortality, morbidity or longevity risk, and any insurance risk scores derived by the insurer or third-party from the above list or similar data and/or information source.

Life insurers that use ECDIS as well as any algorithms and/or predictive models incorporating ECDIS must establish a governance framework that facilitates and supports policies, procedures, and systems designed to determine whether the ECDIS are credible in all material respects and that their use in any insurance practice does not result in unfair discrimination."

(i) Evaluate how SLIC can address this underwriting regulation in its existing risk policies. Justify your response using details from the Case Study.

ANSWER:

(ii) Propose how SLIC can stay aware of similar regulations going forward.

ANSWER:

3. Spring 2024 ERM Exam (LO 2.2c)

Relevant Sources:

- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)

(*10 points*) You are an analyst at MOK, a large life insurance and annuity company, working on its Economic Capital model. MOK models the following risks on a standalone basis and calculates diversified required Economic Capital at 99.5% using a variance-covariance approach.

MOK Standalone Risk Types
Interest Rate Risk
Credit Risk
Lapse Risk
Mortality Risk
Operational Risk

MOK management is considering the use of copulas to calculate diversified Economic Capital, and initially wants to limit testing scope to aggregating two risks.

Standalone cumulative distribution functions for potential losses (in '000s) for each risk are shown in the tab "Q3 – Standalone CDFs" of the Excel spreadsheet.

(a) **(LO 2.2c)** (*3 points*)

(i) Explain two key challenges MOK would face implementing a copula model for aggregating risks.

ANSWER:

(ii) Recommend which two risk types should be selected to test the new copula aggregation method based on the provided standalone CDFs. Justify your selection.

ANSWER:

3. Continued

(b) **NO LONGER RELEVANT**

(*7 points*) Management has decided that you should focus on Interest Rate Risk and Lapse Risk, regardless of what was chosen in a(ii). You have decided to use the following Gaussian copula function to aggregate the selected risks.

$$Z(p,q) = a \times \Phi_{-1}(p) + \sqrt{1 - a^2} \times \Phi_{-1}(q)$$

Assume that a = 0.75. Refer to the tab "Q3.b" of the Excel spreadsheet.

(i) Calculate diversified Interest Rate and Lapse Risk at the 99.5th percentile by applying the Gaussian copula for provided independent uniform draws p and q.

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

(ii) Calculate the correlation parameter ρ that would lead to an equivalent diversified Interest Rate and Lapse Risk at the 99.5th percentile using the variance-covariance aggregation method.

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

(iii) Compare your results from part (ii) with the implied overall distribution correlation using the copula.

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

4. Spring 2024 ERM Exam (LOs 2.1a, 2.2h, 3.2f)

Relevant Sources:

- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-107-25: Developing Key Risk Indicators to Strengthen Enterprise Risk

(*12 points*) You are an actuary reporting to the CRO at DEF Life Insurance Company. During the last year two significant changes have taken place:

- DEF has started a new policyholder wellness program. Policyholders can connect their fitness trackers to DEF's mobile wellness app and are rewarded when they meet exercise targets.
- DEF has adopted a new HR policy allowing all employees to work remotely from wherever they choose, including internationally.

Prior to the past year the company experienced on average fewer than one cyber security incident per year. However, in the last year DEF has experienced at least one cyber security incident per month. Recent cyber security incidents have had various causes, including employees clicking on links in phishing emails and hacker attacks through the wellness app used by policyholders.

(a) **(LO 2.1a)** (*3 points*) The CRO is concerned about the growing risks from cyber security threats and asked you to review three proposed Key Risk Indicators (KRI):

I. Number of attempted phishing attacks at DEF

II. Average amount of time for DEF's cyber security team to identify a cyber security incident

III. Number of insurance industry data breaches

Critique each of the three proposed KRIs.

ANSWER:

4. Continued

(b) **(LO 2.2h)** (*5 points*) You would like to better understand how the KRIs relate to actual losses from cyber incidents at DEF.

The loss amount due to cyber incidents is based on total expenses incurred per month for investigation and resolution of cyber incidents.

Month	Loss amount due to cyber incidents (dollars)	KRI 1: Number of attempted phishing attacks	KRI 2: Average time to log a cybersecurity incident (mins)	KRI 3: Number of insurance industry data breaches
January	33,000	7	80	11
February	18,000	5	35	1
March	51,000	18	8	5
April	100,000	22	29	7
May	27,000	8	18	0

(i) Calculate Kendall's Tau for each of the three KRIs compared to loss amounts. Show your work.

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

(ii) Analyze the reasonableness of the results from part (i).

ANSWER:

(c) **(LO 3.2f)** (*4 points*) The CRO has asked you to recommend a KRI to be included in the monthly "Key Risk Dashboard" shared with executives throughout the company.

(i) Recommend one of the three proposed KRIs to be included in the "Key Risk Dashboard". Justify why you would include your chosen metric over the other two.

ANSWER:

(ii) Propose a new KRI to supplement your recommendation in part (i) by covering its weaknesses. Justify your proposal.

ANSWER:

5. Spring 2024 ERM Exam (LOs 2.1a, 3.1b, 3.2a, 3.3c)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
    - Ch. 3: Risk Measures
- Risk Appetite: Linkage with Strategic Planning Report
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
    - Ch. 16: Responses to Risk

(*11 points*) XYZ is an insurance company that sells life and annuity products. You have been hired as a consultant by XYZ to help enhance the asset allocation framework to achieve risk-return optimization. The first step in the process is to conduct a thorough investment risk assessment to identify and prioritize the organization's key asset-related risks.

XYZ has historically invested in bonds, mortgages, and equities. Its current asset holdings are summarized below:

Asset Categories	**Percentage**
Long-term Bonds	35%
Short-term Bonds	5%
Domestic Stocks	20%
Foreign Stocks	10%
Mortgages	30%
Total	**100%**

(a) **(LOs 2.1a, 3.2a)** (*4 points*)

You have identified three key risks related to XYZ's asset portfolio: Credit risk, Market risk, and Disintermediation risk.

(i) Explain the relevance of each of these key risks for XYZ.

ANSWER:

5. Continued

(ii) Recommend an appropriate risk management approach for each of the three key risks. Justify your response.

ANSWER:

With interest rates rising rapidly in the previous year and equity markets being extremely volatile, XYZ's senior management team is concerned about certain asset-related risks.

(iii) Identify which of the three key risks XYZ should monitor more closely in the environment described above. Justify your response.

ANSWER:

(b) **(LOs 3.1b, 3.3c)** (*7 points*) XYZ is evaluating its bond portfolio to determine if its current holdings align with its investment goals.

XYZ's goals:

- Less than 0.5% of the portfolio expected to default over the next year
- Expected annualized return of portfolio at time 0 greater than 5.0%
- VaR(95) of expected capital charge for bond portfolio less than 2.5% at the end of year 1

Below are the three initial portfolio options that XYZ is considering.

Bond Ratings	**Portfolio 1**	**Portfolio 2**	**Portfolio 3**
AAA	10.0%	10.0%	2.5%
AA	15.0%	25.0%	2.5%
A	25.0%	30.0%	5.0%
BBB	30.0%	25.0%	65.0%
BB	15.0%	5.0%	15.0%
B	5.0%	5.0%	10.0%
CCC	0.0%	0.0%	0.0%
Total	**100.0%**	**100.0%**	**100.0%**

5. Continued

You were able to obtain a credit rating migration matrix from a well-known rating agency – the transition probabilities are given in the "Q5.b.i" tab of the Excel spreadsheet.

In addition, Capital Charge Risk Factors by rating and 100 1-year simulations of each portfolio are given in the "S24 Q5.b.ii Question" tab of the Excel spreadsheet.

(i) Calculate the expected 1-Year default rate and expected annualized return at time 0 for each of the portfolios shown above.

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

(ii) Calculate the VaR(95) expected capital charge for each bond portfolio at the end of year 1 using the 100 simulations provided in the "S24 Q5.b.ii Question" tab of the Excel spreadsheet.

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

(iii) Recommend which portfolio allocation should be adopted. Justify your response.

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

Question 6 pertains to the Case Study.
https://www.soa.org/49a9d1/globalassets/assets/files/edu/2024/spring/case-study/spring-2024-erm-case-study.pdf

6. Spring 2024 ERM Exam (LOs 1.2a, 2.1a, 2.2h)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 13: Liquidity Risk
- CFE101-119-25: IAA Risk Book - Chapter 13: Asset Liability Management Techniques and Practices for Insurance Companies
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks

(*9 points*) SLIC is considering revising its investment strategy for the Single Premium Immediate Annuity (SPIA) block to increase its allocation to higher yielding assets. Refer to Section 3.2 of the Case Study.

In the most recent SLIC Risk Management Committee meeting, the VP of ALM recommended that the revised investment strategy also be used to support the Universal Life (UL) block.

You are on the Risk Management Committee and have concerns about liquidity risk.

(a) **(LOs 2.1a, 2.2h)** (*2 points*) Describe how the revised investment strategy might impact SLIC's liquidity risk.

ANSWER:

6. Continued

(b) **(LO 2.2h)** (*3 points*) William King, a director in the ERM department, made the following comments on liquidity risk:

"Unlike banks, liquidity risk is minimal for life insurance companies like SLIC. There haven't been any failures of life insurance companies caused by liquidity issues. SLIC has long-duration liabilities and predictable policyholder behavior. We hold sufficient liquid assets and would not need to liquidate these new assets to pay benefits. In fact, liquidity risk is usually a consequence of inappropriate management of other risks. If we manage other risks properly, we shouldn't be worried about liquidity risk."

Critique William King's comments.

ANSWER:

(c) **(LO 1.2a)** (*4 points*) The SLIC Risk Management Committee approved applying the revised investment strategy to both SPIA and UL blocks. However, the Committee wants to enhance SLIC's current liquidity risk management framework. Refer to SLIC's current Liquidity Risk Policy described in Section 3.2 of the Case Study.

Recommend ways to enhance the liquidity risk management framework.

ANSWER:

1. Fall 2023 ERM Exam (LOs 3.1b, 3.3b)

Relevant Sources:

- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-107-25: Developing Key Risk Indicators to Strengthen Enterprise Risk

(*10 points*) You are an actuary working for CDE Life Insurance Company. CDE currently uses the following metrics in its New Business Budgeting process:

- Market Consistent Embedded Value (MCEV)
- Economic Value Added (EVA)

You recommend to your manager that CDE consider incorporating Risk-Adjusted Return on Capital (RAROC) in its New Business Budgeting process and establish RAROC as a Key Risk Indicator (KRI) for decision-making purposes.

(a) **(LOs 3.1b, 3.3b)** (*5 points*)

(i) Explain the value each of the existing metrics MCEV and EVA adds to the New Business Budgeting process.

ANSWER:

(ii) Describe how RAROC fulfills each of the six core elements of a well-designed KRI.

ANSWER:

(iii) Assess whether RAROC provides additional value to CDE's existing New Business Budgeting Process.

ANSWER:

1. Continued

(b) **(LO 3.3b)** (*5 points*) The New Business Budgeting process for the following year has begun. CDE has put forward the following New Business Budgeting plan.

All values in millions

Product Line	Historical New Business Premium	Projected New Business Premium	Projected Underwriting Profit	MCEV of New Business	RAROC
Term Life	52	61	4	12.0	7.4%
VA	234	280	14	35.1	4.7%
UL	196	205	14	23.9	9.4%
SPIA	22	25	1	3.6	14.7%
All Lines	**504**	**571**	**33**	**74.6**	**7.1%**

The Company agrees to adopt RAROC as a KRI and adjusts its Risk Appetite to include:

- The aggregate RAROC must exceed 8%.
- The RAROC for each product line must exceed 5%.

(i) Verify the Term Life RAROC of 7.4% using the data provided in the "F23 Q1.b.i Question" tab of the accompanying Excel spreadsheet.

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

(ii) Critique the Company's New Business Budgeting plan.

ANSWER:

2. Fall 2023 ERM Exam (LOs 1.2a, 2.1a, 2.2d, 3.1a, 3.2a)

Relevant Sources:

- CFE101-108-25: Managing Environmental, Social and Governance Risks in Life & Health Insurance Business
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing

(*6 points*) You are the newly hired CRO for ABC Life Company, a traditional life and annuity carrier. ABC Life is planning to introduce an algorithmic underwriting program that uses the following information in place of full medical underwriting:

- Credit scores
- Driving records
- Prescription drug information
- Height/Weight
- Occupation
- Zip code

Your CEO would like to incorporate Environmental, Social, and Governance (ESG) risks into the ERM framework and the new underwriting guidelines.

(a) **(LOs 2.1a, 3.2a)** (*3 points*)

(i) Describe three examples of potential Social Risks generated by ABC Life's proposed new underwriting program.

ANSWER:

(ii) Recommend ways ABC Life can alleviate these Social Risks in the new underwriting program.

ANSWER:

2. Continued

(b) **(LOs 1.2a, 3.1a)** (*2 points*) The CEO would like to develop a Risk Appetite Statement for ESG risks, incorporating both quantitative and qualitative components, which will make it clear to the Board where ABC Life stands on Social Risk

Construct a Risk Appetite Statement for ABC Life for Social Risk in underwriting that is responsive to the CEO's request.

ANSWER:

(c) **(LO 2.2d)** (*1 point*) One of ABC Life's board members mentions that ESG risks might be prominent in newspaper headlines but are not as important as ABC Life's traditional risks.

Design scenarios, one for each category shown below, where ignoring Social Risks could have a large detrimental impact for ABC Life:

- Reputation
- Financial results

ANSWER:

Question 3 pertains to the Case Study.
https://www.soa.org/4ac521/globalassets/assets/files/edu/2023/fall/exams/fall-2023-erm-exam-case-study.pdf

3. Fall 2023 ERM Exam (LOs 2.2c, 2.2f, 3.3b)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
    - Ch. 14: Model Risk and Governance
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-120-25: IAA Risk Book Reinsurance

(*11 points*) You are a new employee on the Caerus team specializing in model risk. Your first task will be to assist Big Ben Bank.

You start by reviewing Martin Willow's memo at the end of Section 1.5 of the Case Study.

(a) **(LO 2.2f)** (*3 points*) Critique the proposed model governance process presented in the memo.

ANSWER:

3. Continued

(b) **(LO 2.2f)** (*3 points*) As part of your engagement, you are asked to devise a detailed validation plan for Big Ben's Economic Capital model as described in Section 1.5 of the Case Study. Your proposed validation plan includes the following steps:

-Step 1: Planning phase
-Step 2: Review of model inputs
-Step 3: Review of the calculation engine
-Step 4: Review of model outputs

Recommend specific tasks for Big Ben for each of the steps shown above.

ANSWER:

(c) **(LOs 2.2c, 3.3b)** (*5 points*) Big Ben has asked you for feedback on the Economic Capital model approach described in Section 1.5 of the Case Study. Management knows there are many improvements they could make, but they want to focus their efforts.

(i) Identify three areas where model risk could have the biggest impact on Big Ben's Economic Capital results. Justify your selections.

ANSWER:

(ii) Assess the diversification benefit methodology and results in Big Ben's Economic Capital model.

ANSWER:

Question 4 pertains to the Case Study.
https://www.soa.org/4ac521/globalassets/assets/files/edu/2023/fall/exams/fall-2023-erm-exam-case-study.pdf

4. Fall 2023 ERM Exam (LOs 2.2c, 3.1a, 3.2d, 3.3c)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 3: Risk Measures
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-120-25: IAA Risk Book Reinsurance

(*14 points*) Pryde's chairman, Ebony James, is concerned about the riskiness of Pryde's business segments and the effectiveness of its reinsurance agreements.

Refer to Sections 4.1 and 4.5 of the Case Study.

The actuarial team has used CapitalSim to model Pryde's projected accident year ultimate claim losses for 2024. Each segment of business and the correlations between the segments were modeled as follows:

- Property was split into property catastrophe and property non-catastrophe segments.
- Losses were modeled gross and net of reinsurance.
- Property catastrophe loss parameters were determined using industry standard catastrophe models and Pryde's policy data.
- 10,000 simulations were run, each representing a possible year of losses for Pryde.

Note that the Commercial Multiple Peril (CMP) line of business includes both property and casualty segments.

Note the actuarial team is using Relative VaR (VaR minus the mean) for this analysis.

Refer to the tabs starting with "F23 Q4" in the accompanying Excel spreadsheet for the data from the actuarial team's model.

4. Continued

(a) **(LO 3.3c)** (*5.5 points*)

(i) For relevance, this question has been modified from the original exam format in this fashion: A note was added defining Relative VaR.

Calculate the following risk metrics for each segment and in total, gross and net of reinsurance

- Relative VaR (99.6) assuming the data follows a normal distribution
- Relative VaR (99.6) using the distribution implied by the simulation data

Note: Relative VaR is equal to VaR minus the mean loss.

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

(ii) Recommend the VaR risk metric in part (i) that would be most appropriate for these lines. Justify your response.

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

(iii) NO LONGER RELEVANT
~~Determine the following:~~

- ~~The business segment with the highest inherent risk~~
- ~~The business segment with the lowest residual risk~~

~~Justify your responses.~~

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

4. Continued

(b) **(LO 2.2c)** (*4.5 points*) CapitalSim models correlation between business segments using a Student's t copula. The CRO ask you to use Spearman's correlation and the simulation outputs to validate the results.

(i) Calculate the Spearman's correlation for all 10,000 simulations of gross losses between each segment of business.

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

(ii) Determine which segments appear to be correlated with regard to gross loss using Spearman's correlation from part (i). Justify your response.

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

(c) **(LO 3.2a, 3.2b)** (*4 points*) Pryde's reinsurance treaties are coming up for renewal in three months and Ebony is concerned about the risks in the Property Catastrophe segment of business given the recent hurricane events and news about climate change.

You are given the following information:

- Pryde has Property Catastrophe reinsurance for aggregate losses for a year with retention of $20M and limit of $150M
- Pryde's risk tolerance for property catastrophe risk is to have annual Property Catastrophe modeled net losses at VaR (99.6) to be less than 2% as a percentage of surplus
- Pryde's 2024 projected statutory surplus is $1,052,864,000.

(i) Assess whether the property catastrophe risk exposure is within the risk tolerance.

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

(ii) Recommend whether Pryde should increase its property catastrophe reinsurance retention. Justify your response.

ANSWER:

5. Fall 2023 ERM Exam (LOs 2.2g, 3.1a, 3.1b, 3.2a, 3.2d)

Relevant Sources:

- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-120-25: IAA Risk Book Reinsurance

(*10 points*) GAK's ERM Committee has notified management that the latest risk review shows GAK exceeding its established enterprise risk tolerance. In the Committee's report, cyber risk is identified as contributing disproportionately to GAK's overall level of risk.

You are a risk manager for GAK and have been asked to identify which mitigation strategies will be the most effective for GAK.

(a) **(LOs 3.1b, 3.2a)** (*3 points*) Your team's initial review of cyber risk finds that GAK's system security is not up to today's standards, leaving GAK vulnerable to data breaches and network outages. Your team has modeled GAK's potential cyber losses and has assessed annual VaR(99.6) at $100 million dollars. To reduce the potential losses, your team has presented two strategies:

> Strategy A - Educate GAK's workforce on hacking and phishing attempts, while improving its cyber security and controls on sensitive data. The estimated cost of this strategy is $8M-$10M in aggregate over the first two years and $1M annually thereafter for maintenance.
>
> Strategy B - Purchase a cyber insurance policy that covers both data breaches and network outages. Annual premium for these policies ranges from $3M-$4M and depends on GAK's current security standards, the deductible for each incident, and the coverage limit for the policy. The policy could be put in place almost immediately.

Describe two advantages and two disadvantages for each of the strategies.

ANSWER:

5. Continued

(b) **(LO 2.2g)** (*4 points*) You've decided to recommend a blend of Strategies A and B to the ERM committee. You have identified a cost-effective pool of insurers to provide this coverage. The pool of insurers would provide a total of $60M of coverage. Their ratings are listed below.

Reinsurer	Coverage provided in cyber event	Credit Rating
Insurer Blue	$10M	Ba
Insurer Green	$20M	B
Insurer Red	$30M	Caa

The ERM Committee is concerned that the selected insurers do not meet GAK's internal counterparty credit risk standards.

You have the following table from Kelly Rating Agency:

Rating	Annual Default Rate	Recovery on Default
Aaa	0.01%	25%
Aa	0.03%	25%
A	0.06%	25%
Baa	0.14%	25%
Ba	0.82%	20%
B	3.16%	15%
Caa	11.40%	10%

(i) Calculate the cumulative default rate over 5 years for each insurer using the annual default rates shown above. Assume no rating transitions for simplicity.

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

The ERM Committee is also concerned about collectability if a cyber event occurs. They ask you to assess the expected losses in the following scenario:

Assume that a cyber event occurs at the full coverage limit and the three insurers each owe GAK their full coverage amounts.

(ii) Calculate GAK's expected credit loss for this cyber event scenario. Assume a one-year default rate for simplicity

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

5. Continued

(c) **(LOs 3.1a, 3.2d)** (*3 points*) GAK has decided to accept your recommendation and move forward with a combination of Strategies A and B.

Your modeling shows that Strategy A would reduce the cyber VaR(99.6) by $25M. GAK would like to use insurance to reduce the VaR by an additional $50M to come down to GAK's enterprise risk tolerance level.

To estimate the reduction in VaR provided by the insurance, assume the VaR decreases by the amount paid by the pool net of defaults and deductibles in a $60M loss event.

GAK is considering three alternative deductible structures that the group of insurers have proposed:

Deductible	Annual Cost
$0 per event	$4.0M
$5M per event	$3.5M
$10M per event	$3.0M

You have been given a total budget of $30M over five years to achieve the implementation of both Strategies A and B.

Recommend a deductible structure to the ERM Committee using all information provided and your responses from parts a and b. Justify your response.

ANSWER:

6. Fall 2023 ERM Exam (LOs 1.3a, 2.2c, 2.2g, 3.3b)

Relevant Sources:

- CFE101-103-25: ORSA and the Regulator by American Academy of Actuaries
- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 &7)

(*9 points*) You have been hired as the first CRO at DEF Life, a U.S. insurance company. Premium projections show that DEF will be required to file its first ORSA report in the next year. The CEO is asking you questions about an ORSA and its purpose.

(a) NO LONGER RELEVANT

~~(*2 points*) You explain that an ORSA starts with a description of the company's risk management framework.~~

~~Describe four characteristics of a risk culture that DEF could adopt, which AM Best would consider strong.~~

~~ANSWER:~~

(b) **(LOs 1.3a, 3.3b)** (*1.5 points*) You explain that Section 3 of an ORSA includes an assessment of risk capital. The CEO points out that DEF already calculates risk capital under NAIC Risk Based Capital (RBC).

Compare and contrast how capital adequacy is analyzed as part of an ORSA versus RBC.

ANSWER:

6. Continued

(c) **(LOs 2.2c, 2.2g)** (*5.5 points*) You are discussing with the CEO possible assumptions for aggregating risks. The CEO would like you to consider both the diversification method used by the RBC formula and the Correlation Matrix method.

DEF has computed risk capital using the RBC method for the following risk components:

Risk Components	**Values in $millions**
C1o Asset Risk – other	150
C2 Insurance Risk	30
C3a Interest Rate Risk	85
C3c Market Risk	20
C4a Business Risk	15

A consultant has suggested the risk correlation matrix shown below as appropriate for a company of DEF's size and type.

	Asset Risk Other	Insurance Risk	Interest Rate Risk	Market Risk	Business Risk
Asset Risk Other	1.00	0.50	0.80	0.70	0.50
Insurance Risk	0.50	1.00	0.50	0.50	0.20
Interest Rate Risk	0.80	0.50	1.00	0.50	0.90
Market Risk	0.70	0.50	0.50	1.00	0.80
Business Risk	0.50	0.20	0.90	0.80	1.00

(i) Compute the diversification benefit for these risks under the RBC method (Authorized Control Level).

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

(ii) Compute the diversification benefit for these risks under the Correlation Matrix method.

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

6. Continued

(iii) Recommend which of these methods should be used to compute the diversification benefit for DEF's ORSA report. Justify your response.

ANSWER:

Question 1 pertains to the Case Study.
https://www.soa.org/49ac19/globalassets/assets/files/edu/2023/spring/exams/spring-2023-exam-erm-case-study.pdf

1. Spring 2023 ERM Exam (LOs 1.2c, 1.2d, 2.1a, 2.2d, 2.2f, 3.1b, 3.2a)

Relevant Sources:

- CFE101-102-25: Leveraging COSO Across The Three Lines Of Defense
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
    - Ch. 14: Model Risk and Governance
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 16: Responses to Risk
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing
- CFE101-101-25: IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry, Section 1.5 Section 1.5 and Pages 9–38
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35

(*11 points*) William Xu, SLIC SVP for Term Life operations, is advocating the use of predictive analytics to improve the competitiveness of the term life insurance products. Jamal Robinson, VP and Actuary - Operational Risk Management, raises the following concerns on the readiness of SLIC to support this strategy:

- SLIC does not have an established model risk governance framework.
- SLIC has no experience in predictive modeling.
- This model would have heavier reliance on data quality compared to traditional models. However, SLIC does not have a data governance strategy.
- Bias and privacy issues associated with this type of model are getting regulator attention; risks associated with bias and privacy have not been areas of focus in the past for SLIC.

1. Continued

(a) **(LOs 1.2c, 1.2d)** (*2 points*) A working group has been established to assess the proposed accelerated underwriting strategy using predictive analytics. Refer to section 3.5 of the Case Study. Working group members are listed in the table below.

Voting	Name	Department	Title
Yes	William Xu	Operations	SVP - Term Life
Yes	Mary Smith	Risk Management	VP & Actuary - Financial Risk Management
No	Robert Johnson	Risk Management	Director - Capital Management
No	Patricia Chen	Risk Management	Director - Risk Reporting
No	Paul Miller	Risk Management	Director - Risk Modeling
Yes	Jamal Robinson	Risk Management	VP & Actuary - Operational Risk Management
Yes	Andrew Lopez	Compliance	Director
Yes	Mark Wilson	Internal Audit	VP
No	Michelle Taylor	Product Management	Director

Critique the composition of this working group based on the governance structures recommended by the Committee of Sponsoring Organizations (COSO).

ANSWER:

1. Continued

Below are some features of a proposed accelerated underwriting model:

- Internal data contains both data collected from the applicants during online application and data from affiliate companies.
- External data includes health records, drug-use records, driving records, and credit related information.
- Applicants with probability of 95% or more of passing medical underwriting will be offered a policy using accelerated underwriting; the applicants with a probability of 1% or less of passing medical underwriting will be automatically rejected; and the rest of applicants will be sent through full underwriting.

The working group is performing a risk assessment of the accelerated underwriting proposal. The following risks are identified as relevant.

Operational Risk	Strategic Risk	Insurance Risk
People Risk	Competitive Risk	Mortality Risk
IT Risk	Reputation Risk	
Model Risk		
Laws/Regulation Risk		

(b) **(LOs 2.1a, 2,2d, 2.2f)** (*7 points*)

(i) Evaluate how Model Risk, Mortality Risk, and IT Risk are impacted by accelerated underwriting.

ANSWER:

The working group identified the following key model risk management roles and responsibilities for SLIC to implement in developing its model risk management framework.

Roles	Responsibility
First Line Model Owner	Model development, implementation, and testing
	Model documentation
	Model risk assessment
Second Line Model Validator	Model validation

1. Continued

(ii) Identify one additional responsibility for each role.

ANSWER:

(iii) Justify why the additional responsibilities you identified in (ii) are important in managing accelerated underwriting model risk for SLIC.

ANSWER:

The working group also proposed quantifying the risk exposure through stress / scenario testing. Risk exposures under each risk category are assessed independently using historical scenarios. Strategic risk is excluded for the following reasons:

- The working group views that applying accelerated underwriting will improve SLIC's competitiveness (i.e., positive risk).
- Reputation risk is assumed to be minimal, considering the customers who are eligible for accelerated underwriting are limited, and history has shown that "the internet has short memory" on reputational events.

(iv) Critique the working group's stress / scenario testing proposal.

ANSWER:

1. Continued

The most recent performance data reflects a diminishing market share of SLIC's term life insurance products. Analyses of root cause indicate that SLIC has higher expenses than its peer companies and is losing clients that do not want to go through the hassle of full underwriting. In addition, the use of predictive analytics in the insurance industry is less regulated and most of SLIC's competitors have received the benefits of being early adopters of accelerated underwriting.

(c) **(LOs 3.1b, 3.2a)** (*2 points*)

(i) Evaluate the risk-return trade-off of this accelerated underwriting strategy including your analyses in (b).

ANSWER:

(ii) Recommend three risk mitigation actions that SLIC could take to limit and control its risk exposure if SLIC decided to go forward with this strategy.

ANSWER:

Question 4 pertains to the Case Study.
https://www.soa.org/49ac19/globalassets/assets/files/edu/2023/spring/exams/spring-2023-exam-erm-case-study.pdf

4. Spring 2023 ERM Exam (LOs 2.1a, 2.2d, 3.3b)

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 8: Risk Identification
- CFE101-103-25: ORSA and the Regulator by American Academy of Actuaries
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing

(*8 points*) Refer to sections 2 and 3 of the Case Study.

You are an actuary at Lyon assisting in developing this year's ORSA report.

(a) **(LO 2.1a)** (*5 points*) In preparing this year's ORSA, the sub-unit responsible for AHA has asked you to assist in the risk identification process. The sub-unit team leader has suggested the use of a brainstorming session to identify risks facing AHA.

(i) Describe two shortcomings of brainstorming as a risk identification technique.

ANSWER:

(ii) Propose a strategy to address each shortcoming you have identified in (i).

ANSWER:

4. Continued

The proposed brainstorming group is made up of the following AHA employees.

Name	Department	Job Title
Frances Ngarta	New Business Group Sales	Vice President
James Buchanan	Claims Operations	Director
Helen Stevenson	Claims Operations	Claim Intake Specialist
Salim Khalil	Valuation	AVP, Health Insurance Reserving
Joan Vickers	Claims Operations	Claim Intake Associate

(iii) Critique the makeup of the proposed group including recommending alternatives.

ANSWER:

(b) **(LOs 2.2d, 3.3b)** (*3 points*) Lyon management has requested that this year's ORSA reflect risk associated with the persistence of COVID-19.

(i) Assess how the persistence of COVID-19 could affect the diversification benefits for Lyon at the enterprise level.

ANSWER:

(ii) Propose a method for reflecting the risk of future pandemic events in assessing prospective solvency. Focus on SLIC in developing your response.

ANSWER:

5. Spring 2023 ERM Exam (LOs 2.2b, 2.2f, 3.3c)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 3: Risk Measures
    - Ch. 14: Model Risk and Governance

(*7 points*) You are an actuarial student on the modeling team at MEK, a life insurance company. You have been given responsibility to maintain MEK's Monte Carlo market loss model which is used to estimate changes in surplus given movement in market parameters. The previous model owner has left the company without providing documentation or reporting the results of the analysis. The following table shows results for 2020-2022 based on a 95% confidence internal and a 1-year time horizon.

$ thousand	2020	2021	2022
VaR	1,428	1,345	870
TVaR	1,458	1,450	725

Refer to the tab corresponding to this question, S23 Q5, in the accompanying Excel workbook for data, assumptions, and the simulation output of market losses.

You have confirmed that the simulation output matches what was used by your predecessor.

(a) **(LO 3.3c)** (*2 points*) Your manager is puzzled by the 2022 results.

(i) Explain what caused the 2022 results to differ greatly from the previous two years.

ANSWER:

(ii) Calculate the correct VaR and TVaR for 2022.

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

(b) **(LO 2.2b)** (*2 points*) Critique the use of VaR and TVaR from this Monte Carlo simulation for understanding the market exposure of MEK.

ANSWER:

5. Continued

MEK's CRO proposes to expand the use of the model to estimate operational risk. The CRO believes the model's versatility allows it to minimize the number of software packages used by the company.

The model uses aggregated data from a third party.

The model results were copied and pasted into the Excel workbook and were compared against the prior year's model results as a check of reasonableness.

(c) **(LO 2.2f)** (*3 points*)

(i) Identify three questions you should consider in evaluating the CRO's proposal.

ANSWER:

(ii) Describe three other review and testing procedures that MEK can use to improve model validation.

ANSWER:

6. Spring 2023 ERM Exam (LOs 3.2c, 3.2e)

Relevant Sources:

- CFE101-119-25: ERM-144-20: IAA Risk Book - Chapter 13: Asset Liability Management Techniques and Practices for Insurance Companies
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 16: Responses to Risk

(*7 points*) ABC, a public Canadian life insurance company, is interested in developing a comprehensive ALM framework. ABC has the following characteristics:

- Its main products are long duration universal life products with death benefits based on a fixed account value with minimum guaranteed crediting interest rate.
- ABC also offers products with adjustable features, namely participating insurance with dividends.
- It follows the Canadian Asset Liability Method (CALM) and is required to include Margins for Adverse Deviations (MfADs) when conducting ALM.
- ABC's main strategy is to focus on its long-term economic results.

You are hired as a consultant to assist with this process.

(a) **(LO 3.2e)** (*1.5 points*) Critique ABC's strategy of focusing on long-term economic results.

ANSWER:

ABC has proposed the following ALM conceptual framework.

- Financial Objectives: Optimize long-term economic results
- Risk Tolerances: Establish specific risk limits for each financial variable that is material to the company's long-term economic results.

(b) **(LO 3.2e)** (*1 point*) Evaluate ABC's proposal.

ANSWER:

6. Continued

The CRO of ABC made the following statement regarding ALM strategy:

> "By requiring the book value of assets equal the book value of liabilities and matching the modified duration of the assets and liabilities, our economic surplus will be fully immunized from changes in interest rates."

(c) **(LO 3.2e)** (*1.5 points*) Critique the CRO's statement.

ANSWER:

To help achieve its financial objectives and a comprehensive ALM framework, ABC implemented a carve-out strategy by investing in a portfolio of equities that is actively managed with a benchmark to the S&P 500 index with a carve-out point 20 years in the future.

Now, five years after its implementation, the CFO is concerned that there will be a significant increase in market volatility and wants to temporarily hedge ABC's exposure by selling 2-year futures contracts on the S&P 500 index.

You are given the following information:

- Market value of the carve-out portfolio is $150 million.
- The size of each 2-year S&P 500 futures contract is $12 per S&P 500 point.
- The current S&P 500 index value is 5000.
- The beta of the portfolio relative to the S&P 500 index is 1.5.

(d) **(LOs 3.2c, 3.2e)** (*3 points*)

(i) Describe two ways that ABC can measure the risk exposure associated with the carve-out strategy.

ANSWER:

(ii) Calculate the number of contracts required to hedge this position. Show all work.

ANSWER:

6. Continued

One year after selling the hedge, the CFO wishes to close out the hedge by buying equivalent futures contracts. You are given the following information:

- The size of each 1-year S&P 500 futures contract is $11 per S&P 500 point.
- The S&P 500 index value has decreased to 4500.
- Market value of the carve-out portfolio is $127.5 million.

(iii) Calculate the net value of the hedge position and the total gain/loss for the carve-out portfolio. Show all work.

ANSWER:

(iv) Evaluate the effectiveness of the hedge. Justify your answer.

ANSWER:

Question 7 pertains to the Case Study.
https://www.soa.org/49ac19/globalassets/assets/files/edu/2023/spring/exams/spring-2023-exam-erm-case-study.pdf

7. Spring 2023 ERM Exam (LOs 1.3a, 2.1a, 2.1b, 2.2h)

Relevant Sources:

- CFE101-113-25: Identifying and Evaluating Emerging Risks
- CFE101-107-25: Developing Key Risk Indicators to Strengthen Enterprise Risk
- CFE101-109-25: Managing 21st-Century Political Risk

(*7 points*) Disruptive Energy (DE) is looking to improve its risk management practices with respect to battery design and manufacturing, as batteries are a critical component of growth in all its current businesses.

You have been hired by DE to enhance risk management identification and reporting specifically related to emerging and political risks.

Refer to section 1.8 of the Case Study.

(a) **(LO 2.1b)** (*2 points*)

For relevance, this question has been modified from the original exam format in this fashion: The question now asks about types of emerging risks instead of characteristics of emerging risks due to a syllabus change.

Explain the three major types of emerging risks and how they specifically apply to DE's battery design and manufacturing.

ANSWER:

7. Continued

(b) **(LO 2.2h)** (*2 points*) In reviewing management reports, you determine that most of the metrics outlined are Key Performance Indicators (KPIs), which are not particularly effective at being "early warning indicators" for risk events. You work with DE's management to determine potential Key Risk Indicators (KRIs) it can use to augment DE's existing reports. To begin, you plan not only to survey individuals in the battery-manufacturing business but also to consider external sources.

(i) Describe two benefits of using external data sources to develop KRIs.

ANSWER:

You survey several managers throughout the business to gather potential metrics to track. One manager recommends monitoring delays in shipping manufactured lithium batteries to DE's car factories as a KRI. Another recommends monitoring recently added futures contracts for lithium on the commodities exchange as a KRI.

(ii) Critique both recommendations.

ANSWER:

(c) **(LOs 1.3a, 2.1a)** (*3 points*) DE looks to continue growing its geographic footprint by expanding into new countries. However, the new China plant is not yet capable of providing sufficient supply of cobalt-free batteries. As a result, executives at DE are concerned about the increased dependence on the cobalt mining operations.

(i) Identify two types of political risk that DE might face specifically related to cobalt mining. Support your response with examples from the Case Study.

ANSWER:

NO LONGER RELEVANT

~~You have also been asked to update the Residual Risk Effort Matrix (RREM) of political risk for the battery design and manufacturing.~~

~~(ii) Describe how the four factors of the RREM change with the expanded development of cobalt-free batteries as a mitigation to the political risks of cobalt mining for DE.~~

Questions 1 pertains to the Case Study.
https://www.soa.org/4ac732/globalassets/assets/files/edu/2022/spring/exams/fall-2022-exam-erm-case-study.pdf

1. Fall 2022 Exam ERM (LOs 2.2b, 2.2c, 2.2g, 3.3a, 3.3b, 3.3c, 3.3d)

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 14: Quantifying Particular Risks
  - Ch. 16: Responses to Risk
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-101-25: IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry, section 1.5 and pp. 9-38
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
  - Ch. 3: Risk Measures
  - Ch. 18: Risk-Adjusted Measures of Profit and Capital Allocation (excluding section 18.6)
- CFE101-117-25: Economic Capital-Practical Considerations-Milliman (Section 7 Only)

(*11 points*) You are an actuary at Lyon working on capital requirements. Improving the economic capital (EC) calculations has been identified as a priority this year.

Refer to section 2 of the Case Study.

(a) **(LO 3.3c)** (*1.5 points*) SLIC has recently engaged more heavily in the use of interest rate swaps to mitigate interest rate risk. SLIC currently uses Lyon's approach of applying a factor to Corporate assets to account for credit risk in the EC framework.

Annabelle, your actuarial student, asserts the exposure to interest rate swap counterparties constitutes additional credit risk and as a result, SLIC's credit risk profile is now materially different than that of Lyon's Corporate assets. She plans to show that continuing with a factor approach may no longer be appropriate for SLIC.

1. Continued

You are given the following information:

- Annabelle suggests that assessing the counterparty credit risk for interest rate swaps will add complexity.
- Annabelle will draft a communication to alert senior management of the emerging counterparty risk, but she admits the risk's relevance is not obvious until she completes a materiality study.
- Annabelle acknowledges that it will be difficult to explain the change in credit risk to internal stakeholders, since swaps are new to both SLIC and Lyon. However, the associated credit risk is well-documented industry-wide and best practices exist for assessing the risk.

Assess the appropriateness of continuing with the factor approach to determine credit risk for SLIC based on Annabelle's suggested approach. Justify your answer.

ANSWER:

(b) **(LOs 2.2b, 2.2g)** (*3 points*) You and Annabelle decide to recommend that SLIC move to a more sophisticated approach to calculating EC for interest rate swap credit risk. Annabelle proposes the following:

1. Use a Monte Carlo simulation combined with an appropriate interest rate model to generate interest rates in one year.

2. From the resulting distribution of projected interest rates, determine the VaR(85) of the replacement value of each swap transaction. The replacement value for each swap is the credit exposure.

3. For counterparties with multiple swaps, assume netting applies and is enforceable. Then the potential exposure for that counterparty is the gross loss; that is, the sum of all positive exposures only.

4. The maximum potential exposure is then simply the sum of all individual counterparty exposures.

Critique each of Annabelle's proposed steps.

ANSWER:

1. Continued

(c) **(LOs 2.2c, 3.3b, 3.3d)** (*4 points*) Senior management shifts focus to the enterprise assessment of EC, as described in Lyon's recent ORSA report.

Refer to sections 2.11 and 2.12 of the Case Study.

(iii) Discuss an advantage and a disadvantage of Lyon's approach to calculating required EC.

ANSWER:

(iv) Annabelle suggests that it is reasonable to assume complete independence between all of Lyon's subsidiaries, including Lyon Corporate, under normal business and economic conditions. She proceeds with the independence assumption and calculates a combined required EC of $2,048,357,000 reflecting the diversification benefit of $1,288,269,000.

Critique Annabelle's assumption.

ANSWER:

(v) Marcus, your supervisor, states it is a mistake to use Annabelle's correlation assumption in a stressed business and economic environment.

Explain your supervisor's statement.

ANSWER:

(vi) Propose two unique modeling solutions that could address the correlation issue. Justify your answer.

ANSWER:

1. Continued

(d) **(LOs 2.2g, 3.3a)** (*2.5 points*) You have completed additional analyses and determine the following:

a. The changes for the enterprise EC would result in approximately 50% of the diversification effect shown in (c)(ii).
b. The changes to the calculation of credit risk could further reduce Lyon's EC by approximately 5% of the diversification effect shown in (c)(ii).

Recommend if Lyon should move forward with each of the changes, based on your answers to (a) through (c) and the additional analyses above. Justify your response.

ANSWER:

2. Fall 2022 Exam ERM (LOs 2.1a, 2.2g, 3.2c, 3.3b, 3.3c)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 3: Risk Measures
    - Ch. 10: Economic Scenario Generators
- CFE101-117-25: Economic Capital-Practical Considerations-Milliman (Section 7 Only)
- CFE101-118-25: What is Basis Risk? Definition and Types of Basis Risk, Examples (corporatefinanceinstitute.com)
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- CFE101-103-25: ORSA and the Regulator

(*13 points*) EFG Life is a medium-size life insurance company selling traditional whole life policies. You are given the following information:

- EFG is planning to enter the Variable Annuity (VA) market and launch a new VA product this year.
- The guarantees included with the VA product are:
    - Guaranteed minimum accumulation benefit (GMAB): 100% of the initial deposit is returned at maturity
    - Guaranteed minimum death benefit (GMDB): 100% of the initial deposit is paid on death of a policyholder
- Each contract matures after 10 years.
- Policyholders can invest in various equity mutual funds available at contract inception.
- Withdrawals are permitted with a surrender charge of 10% of the account value in the first three years. Afterwards, the surrender charge reduces annually by 2% until it is eliminated.
- Initial deposits at launch total $30 million.
- A management charge of 200 basis points per year is applied to the account value at the beginning of each year, a portion of which is used to cover the cost of the guarantees.

2. Continued

(a) **(LOs 2.2g, 3.3b, 3.3c)** (*7 points*) EFG's CRO would like to integrate the VA product into the company Economic Capital (EC) model. You are given the following assumptions:

- The annual mortality rate is assumed to be constant at 0.001
- Renewals, withdrawals, and rollovers are ignored
- The discount rate is 3.00%.

Equity returns are modeled using the distribution described below.

- $S(T) = S(0)e^{\left(\mu-\frac{\sigma^2}{2}\right)T+\sigma\epsilon\sqrt{T}}$, where
- S(0) = 1.0
- μ = 3.00%
- σ = 0.3, and
- ε is a random variable from a N(0,1) distribution.

The EC framework will be based on 100 scenarios of equity returns for the next 10 years. The EC requirement is set as CTE(95) - CTE(0) based on the distribution of losses.

95 total simulations have already been run, and the resulting liability calculations are shown on the tab 'F22 Q2(a)(rank) Question' in the accompanying Excel workbook. Pseudo-random simulated values from the U(0,1) distribution for the final five scenarios are also available on the tab 'F22 Q2(a)(cash flow) Question'.

(i) Describe the process of simulating stock price paths using Monte Carlo methods.

ANSWER:

(ii) Calculate the required EC for the VA risk. Show your work.

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

(iii) Critique EFG's approach for modeling EC for VA risk.

ANSWER:

2. Continued

(b) **(LOs 3.2c, 3.3c)** (*3 points*) To manage risks associated with VA guarantees, EFG is planning to implement a dynamic hedging program.

(i) Describe the risks associated with implementing and maintaining dynamic hedging as it relates to the new VA product.

ANSWER:

(ii) Explain how dynamic hedging could be reflected in EFG's EC framework.

ANSWER:

(c) **(LOs 2.1a, 2.2g, 3.2c, 3.3c)** (*3 points*) Within two years of the successful product launch, EFG Life grew its assets under management by 500%. Due to this growth, EFG doubled its workforce and implemented a new hedging platform and administrative system to manage the VA business but did not have enough time to properly train the new employees.

EFG had previously identified the following key risks arising from the traditional life insurance business:

- Mortality
- Interest rate
- Credit
- Liquidity

(i) Evaluate how the success of the new VA product launch should be reflected in the assessment of each of these risks.

ANSWER:

(ii) Recommend two ***key*** additional risks that EFG should consider when assessing the newly launched VA block. Justify your recommendation.

ANSWER:

Question 3 pertains to the Case Study.
https://www.soa.org/4ac732/globalassets/assets/files/edu/2022/spring/exams/fall-2022-exam-erm-case-study.pdf

3. Fall 2022 ERM Exam (LOs 2.1a, 2.1b, 2.1c, 3.2f)

Relevant Sources:

- CFE101-113-25: Identifying and Evaluating Emerging Risks
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 8: Risk Identification
  - Ch. 16: Responses to Risk
- CFE101-110-25: IAA Paper: Importance of Climate-Related Risks for Actuaries (Pages 2-14)
- CFE101-103-25: ORSA and the Regulator

(*11 points*) You are an actuary with Caerus Consulting and have been given an assignment to help Lyon Corporation update its ORSA report. Lyon's last ORSA report generated questions from the regulators on the failure to address emerging risks.

Your task is to work with Lyon management to identify and assess relevant emerging risks, and to address them in the next ORSA report. While Lyon does have a new Corporate Risk Committee, you have noted the Committee's relative inexperience with emerging risks.

(a) **(LO 2.1a)** (*2 points*) Rank the appropriateness of the following risk identification techniques for emerging risks. Justify your ranking.

- Individual risk interviews of Lyon's senior management
- Brainstorming among Lyon's senior management as a group
- Case studies of other companies and how they dealt with emerging risks

ANSWER:

3. Continued

(b) **(LOs 2.1a, 2.1b, 2.1c)** (*2 points*) Lyon's management has decided to focus on climate change as the key emerging risk.

Describe two ***key*** impacts of climate change on each of Lyon's four subsidiaries.

ANSWER:

(c) **(LOs 2.1b, 2.1c, 3.2f)** (*3 points*) Recommend a risk mitigation strategy, other than reinsurance, for each risk identified in (b). Justify your response.

ANSWER:

(d) **(LOs 2.1a, 3.2f)** (*3 points*) Explain how you would incorporate climate change risk into each of the three sections of the ORSA report.

ANSWER:

(e) **(LOs 2.1a, 2.1b, 2.1c, 3.2f)** (*1 point*) Identify the subsidiary most likely to be impacted by climate change. Justify your answer.

ANSWER:

4. Fall 2022 ERM Exam (LOs 1.2a, 1.3a, 2.2c, 2.2d, 3.3b)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10: Economic Scenario Generators
- CFE101-117-25: Economic Capital-Practical Considerations-Milliman (Section 7 Only)
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-102-25: Leveraging COSO Across The Three Lines Of Defense
- CFE101-103-25: ORSA and the Regulator

(*9 points*) Company XYZ is a small life insurance company that has been selling Life and Annuity products for the past 20 years.

Detailed information on each product is given below:

- Traditional Life Insurance
    - Level term period of either 20 or 30 years
    - 25% YRT reinsurance
    - Gross reserves of $50 million, with most policies issued between 2016 and 2018
- Universal Life
    - Designed to accumulate high cash surrender values relative to the death benefit
    - 3% guaranteed minimum crediting rate
    - Gross reserves of $250 million, with most policies issued between 2005 and 2007
- Fixed Deferred Annuity
    - Flexible premium with a guaranteed crediting rate of 2%
    - Gross reserves of $150 million
- Variable Annuity
    - Return of Premium Guaranteed Minimum Death Benefit (ROP GMDB), reduced dollar for dollar by withdrawals.
    - Optional Guaranteed Minimum Withdrawal Benefit (GMWB) guarantees the contract holder the ability to withdraw 5% of the benefit base per year for life. An annual fee of 1% is charged on the benefit base.
    - Gross reserves of $10 million, split equally between policies with GMWB and policies without GMWB.

4. Continued

All mortality and lapse assumptions are based on industry studies, modified by internal experience factors.

In past years, XYZ has relied on external consultants to conduct its scenario and stress testing. XYZ has recently invested in new modeling software with stochastic capabilities, and senior management has expressed interest in bringing its modeling in-house to assist with capital allocation decisions. As the Chief Actuary at XYZ, you are in charge of evaluating XYZ's new modeling capabilities.

You have identified the following three major risk types as relevant to XYZ's current product portfolio:

- Underwriting/Insurance Risk
- Credit/Asset Risk
- Market Risk

(c) **(LO 2.2d)** (*3 points*) XYZ currently has limited capacity to implement stochastic scenario testing and plans to apply stochastic modeling for a single product at this time.

(i) Assess, for each product, which risk type would be best suited for stochastic modeling.

ANSWER:

(ii) Recommend which product should be selected for stochastic modeling. Justify your response.

ANSWER:

4. Continued

(d) **(LO 2.2c)** (*1.5 points*) XYZ is considering the following four aggregation approaches for calculating Economic Capital:

- Fixed diversification percentage
- Correlation matrix based on its own experience
- Correlation matrix based on industry experience
- Copulas. The software that XYZ has licensed can model copulas, although XYZ has done limited testing of that capability.

Recommend an aggregation technique appropriate for XYZ. Justify your response.

ANSWER:

(e) **(LOs 1.2a, 3.3b)** (*2.5 points*) At the quarterly meeting of XYZ senior managers, the topic of scenario and stress testing in the internal models was discussed. The following items were specifically mentioned by the CEO:

- Because our ERM department serves as our company's first line of defense, our CRO and her team should be responsible for developing the scenarios and stresses.
- We will rely on the ERM team to explain the results.
- Our risks are siloed enough that we should not have to worry about dependencies.
- These results should be provided shortly after quarter-end reporting if we are to use them in our planning processes.

Critique each of the CEO's statements.

ANSWER:

(f) **(LOs 1.3a, 2.2d)** (*2 points*) In past cycles, XYZ has leveraged stress tests promulgated by regulators to demonstrate the strength of the business.

Explain why adopting an internal model could be viewed favorably by regulators.

ANSWER:

5. Fall 2022 ERM Exam (LOs 2.1a, 2.2h)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 13: Liquidity Risk
- CFE101-110-25: IAA Paper: Importance of Climate-Related Risks for Actuaries (Pages 2-14)

(*5 points*) You are an actuary, recently hired by QRY as part of the new corporate level ERM function. QRY is a stock-based holding company that owns the following subsidiaries:

Company	Description, including existing risk management	Challenges
Hollywood Life	A life insurance company, providing individual whole life coverage to wealthy clients, with 20% quota share reinsurance with a highly rated reinsurer for all policies. The company has a very conservative investment policy, holding only Treasuries and investment grade corporate bonds. The Asset-Liability Management team produces quarterly duration analysis and requires rebalancing whenever liability durations exceed asset durations by more than 1.0.	Profit margins have been quite low, so the company has started to add private placements and oil and gas investments to increase yield.
California HomeGuard	A California-based property and casualty company which provides home and property coverage to California residents only. No reinsurance exists for this subsidiary; it is informally assumed that the holding company provides adequate protection if required.	The company has been profitable until recently when wildfires generated unexpected levels of claims.
HealthGuard	A health insurer, with a relatively young customer demographic. Prior to 2020, profits from this subsidiary provided a regular dividend to QRY. Because customers are young, no reinsurance is in place.	COVID-19 experience has led to increased liabilities and claims expenses, and no dividend was paid to QRY in 2020 or 2021.

Using its accumulated retained earnings, QRY is planning to invest in a fourth subsidiary and is considering multiple options.

You have been asked to consider the importance of liquidity risk to QRY and its subsidiaries.

5. Continued

(a) **(LOs 2.1a, 2.2h)** (*3 points*)

(iii) Describe the two types of liquidity risk.

ANSWER:

(iv) Evaluate how the current operations and planned activities expose QRY to each type of liquidity risk.

ANSWER:

(b) **(LO 2.2h)** (*2 points*)

(i) Evaluate existing risk management techniques for liquidity risk for QRY and its subsidiaries based on the information provided above.

ANSWER:

(ii) Recommend improvements to liquidity risk management for QRY and its subsidiaries, including both changes to existing risk management techniques and new approaches. Justify your response.

ANSWER:

6. Fall 2022 ERM Exam (LOs 1.2c, 2.2c, 3.1a, 3.2a, 3.3b, 3.3e)

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 14: Quantifying Particular Risks
  - Ch. 16: Responses to Risk
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
  - Ch. 10: Economic Scenario Generators
  - Ch. 18: Risk-Adjusted Measures of Profit and Capital Allocation (excluding section 18.6)
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-121-25: Economic Value Added: A Primer For European managers
- CFE101-105-25: Agency Theory And Asymmetric Information

(*11 points*) ABC is an insurance company specializing in auto and property insurance. ABC's risk management team is evaluating the risk of the company's two lines of business.

6. Continued

(a) **(LOs 3.1a, 3.2a)** (*3 points*) A normal distribution is used to estimate the annual claim loss for each line of business below. The risk tolerance is set to the maximum annual claim loss for each line that management is willing to accept. ABC management defines the aggregate risk tolerance for the company as the sum of risk tolerances for each line of business.

Annual Claim Losses

Line of Business	Mean ($ million)	Standard Deviation ($ million)	Risk Tolerance ($ million)
Auto	200	20	210
Property	40	5	45

(i) Calculate the probability that annual claim losses are above the risk tolerance for each line of business. Show your work.

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

(ii) NO LONGER RELEVANT

~~Calculate the probability that at least one of the lines of business losses is above the risk tolerance using the Clayton Copula function for the dependence below using the tab 'Q6(a)(i)(ii)' in the accompanying Excel workbook. Show your work.~~

~~$C(u_1, u_2) = (u_1^{-2} + u_2^{-2} - 1)^{-1/2}$~~

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

(iii) Recommend two risk management actions to lower the aggregate risk of the portfolio. Justify your response.

ANSWER:

6. Continued

(b) **(LOs 2.2c, 3.2a, 3.3b. 3.3e)** (*6 points*) A stochastic model was used to create 10,000 simulations of ABC's annual losses by line of business. The table in the accompanying Excel workbook, tab 'F22 Q6(b)(i)(ii)(iii) Question', shows the 100 highest total simulated losses (in $ millions). The company uses Risk-Adjusted Return on Risk-Adjusted Capital (RARORAC) and Economic Value Added (EVA) in analyzing its results.

Assume the following:

- The total required risk capital for ABC is $200 million and the opportunity cost is 8%.
- The projected risk-adjusted return is $5 million for Auto and $4 million for Property.
- The projected net income is equal to projected risk-adjusted return for each line of business.

(i) Calculate the amount of risk capital to assign to each line of business using a Co-TVaR capital allocation approach at the 99.6 percentile. Show your work.

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

(ii) Calculate RARORAC for each line of business. Show your work.

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

(iii) Calculate EVA for each line of business. Show your work.

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

(iv) Recommend two risk mitigation actions for the company given the RARORAC and EVA for each line of business. Justify your response.

ANSWER:

6. Continued

(c) **(LOs 1.2a, 3.2a)** (*2 points*) ABC executives target a 20% growth in auto insurance sales.

A new bonus structure is being introduced to incentivize sales growth over a one-year horizon. You discover that the executive bonus structure is heavily tied to sales growth but does not consider risk.

(i) Explain what risk governance issues are created by this bonus structure.

ANSWER:

(ii) Recommend two additions to the executive bonus structure to mitigate the risk governance issues you identified in (i). Justify your response.

ANSWER:

1. Spring 2022 ERM Exam (LOs 3.3a, 3.3b, 3.3d)

Relevant Sources:

- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 18: Risk-Adjusted Measures of Profit and Capital Allocation* (Except Section 18.6)

(*9 points*) Acme, a stock company, sells life insurance, annuities, and pet insurance. You have been tasked with building an Economic Capital (EC) model for Acme. Acme's performance on the life business has shown poor results due to excess COVID-19 deaths.

Acme has three Business Units (BU) A, L and P. Acme's management will use the EC by BU to determine risk-adjusted returns for the managers of the BUs. Risk Capital (RC) amounts for each BU as standalone entities are as follows:

BU	Line of Business	RC
A	Annuities	100
L	Life	50
P	Pet	25

(a) **(LO 3.3b)** (*2 points*)

(i) Identify and describe four of Acme's ***key*** stakeholders.

ANSWER:

(ii) Outline the RC considerations of each key stakeholder, reflecting Acme's recent experience.

ANSWER:

1. Continued

(b) **(LO 3.3d)** (*1.5 points*) Acme's management is considering a restructure, whereby some BUs would be divided and a new BU added. The proposed structure is described as follows:

- A is divided into two, unequal parts
- L is divided into two, identical parts
- P is unchanged
- N is the new business unit, which is considered risk-free.

The proposed new capital allocation is as follows:

BU	RC
A_1	95
A_2	4
L_1	30
L_2	20
P	15
N	5

Assess whether the new allocation satisfies the requirements of a Coherent Capital Allocation methodology by comparing the proposed RC allocation to the existing allocation.

ANSWER:

1. Continued

(c) **(LOs 3.3a, 3.3b, 3.3d)** (*5.5 points*) Acme's management decided not to proceed with the restructure but wants to free up as much capital as possible. Management believes it can reduce the overall EC amount by taking into account the correlations between BUs.

You are given the following correlation matrix:

	A	**L**	**P**
A	1.0	0.7	0.3
L	0.7	1.0	0.4
P	0.3	0.4	1.0

(i) Demonstrate that the amount by which total capital can be reduced with diversification is 24.58. Assume that the risks are normally distributed.

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

(ii) Calculate the amount of RC for each BU using the Pro Rata (linear) approach. Show all work.

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

(iii) Calculate the amount of RC for each BU using the Discrete Marginal Contribution approach. Show all work.

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

(iv) Recommend either the Pro Rata or the Discrete Marginal Contribution method of allocation for Acme. Justify your answer.

ANSWER:

2. Spring 2022 ERM Exam (LOs 2.2c, 2.2d)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10 Economic Scenario Generators
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)

(*11 points*) Addison Carter, the CFO of a small dental and vision insurer, has recently been given the additional title of CRO. She has approached you for consulting services. Her company uses an internal model to determine VaR for its investment portfolio of $30 million in assets. The model was built by one of her two risk analysts and has been in use for one year.

Recently, the Board of Directors has expressed concerns that monthly reported VaR levels fluctuate significantly even though the portfolio change has been immaterial. There have also been two months in the past year where reporting was unavailable due to output errors from the model. The Board is losing confidence in the model's ability to appropriately assess investment risk and has requested an external review of the model.

(a) **(LOs 2.2c, 2.2d, 2.2g)** (*3.5 points*) The first objective of the external review is to assess the VaR model's design. Addison describes the methodology, data and assumptions as follows:

- The model uses parameters based on one year of historical market data as inputs to calculate VaR
- The calculation employs a Monte Carlo simulation and assumes that changes in risk factors follow a well-defined distribution, e.g., normal distribution or t-distribution
- To determine aggregated VaR, the model assumes correlations between the risk factors and a t-copula to incorporate increased correlation in the tail of the combined distribution
- The correlation assumptions are based on recent data and they have been backtested.

Critique the model design.

ANSWER:

2. Continued

(b) **NO LONGER RELEVANT**

~~(*3.5 points*) After your review of the model design, Addison indicates she would like to address the Board's concerns, beginning with the monthly VaR fluctuations. Monthly data updates involve appending new data from a public online source ("data pull") to the existing data set.~~

~~The following changes have been made to the monthly update process since model inception:~~

- ~~The implementation of a simple process to identify and remove duplicated data~~
- ~~The automation of the monthly data pull~~
- ~~The recent requirement of an approval from IT once the data has been appended.~~

~~You review the data from the online source and find that it contains duplicates at times and that the format is not standardized. For example, it may be reported in thousands or millions depending on the size of recent market movements. You also learn that the internal approval process does not include a review of the data.~~

~~You next review the internal data to address incidents of VaR errors. In your review, you note the following:~~

- ~~Some of the fields in the data are empty~~
- ~~Expected returns for some of the investments in their system are negative~~
- ~~The model is meant to aggregate the risk for four different risk factors in the investment portfolio, but the risk type field for each entry is restricted to only three choices.~~

~~The company has an internal requirement to follow Moody's Data Quality practices.~~

~~(i) Describe the most critical step in the Moody's recommended seven-step quality process that is not being followed. Justify your response.~~

~~ANSWER:~~

~~(ii) Describe the two most critical data quality rules applicable to this data. Justify your response.~~

~~ANSWER:~~

2. Continued

(c) **(LO 2.2d)** (*4 points*) After addressing issues found in your review, the internal VaR model appears to be capturing aggregate tail risk appropriately. The Board wants to understand the specific conditions that could result in tail losses and whether there would be any associated long-term impacts to their business. Addison is considering complementing their current VaR analysis with scenario and sensitivity analysis.

The company's investment portfolio is 65% investment grade bonds, 30% equities and 5% cash equivalents.

Addison has decided to begin with a sensitivity analysis where there is a 5% decline in the equity markets. She would use the resulting impact to the investment portfolio to enhance the reporting to the Board.

(i) Critique Addison's decision.

ANSWER:

You tell Addison that other scenario types should also be considered. Addison returns with the following scenarios:

- Single Factor Scenario – an unexpected spike in claims that requires the liquidation of 10% of the investment portfolio at current market prices
- Multi-Factor Stress Scenario – a 1-year recession that depresses the market value of equities in the portfolio, results in defaults in their bond portfolio and drives inflation resulting in increased claim costs and a slight dip in business volume late in the year
- Multi-Factor Multi-Period Stress Scenario – a severe, 2-year market downturn that increases the severity of the Multi-Factor Stress Scenario. Additionally, the scenario reflects a significant reduction to investment income and business volumes in year 2.

(ii) Evaluate each scenario type given the Board's needs and Addison's available resources.

ANSWER:

2. Continued

(iii) Recommend the most appropriate scenario type based on your analysis in part (ii). Justify your response.

ANSWER:

Questions 3 pertains to the Case Study. https://www.soa.org/49af5b/globalassets/assets/files/edu/2022/fall/exams/spring-2022-exam-erm-case-study.pdf

3. Spring 2022 ERM Exam (LOs 1.3a, 2.1a, 2.2d, 2.2g, 2.2h, 3.3b)

Relevant Sources:

- CFE101-103-25: ORSA and the Regulator by American Academy of Actuaries
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing
- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)
- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8

(*12 points*) The Massachusetts regulator has recently reviewed Lyon's ORSA and provided feedback. The regulatory response included several critical comments of items that need to be addressed. As an actuary on the newly formed Corporate Risk Committee, you have been asked to provide responses and recommend improvements to Lyon's ERM framework and future ORSA reporting.

Refer to sections 2.11 and 2.12 of the Case Study.

(a) **(LOs 1.3a, 2.1a)** (*2 points*) The following feedback was provided by the regulator:

"A key weakness of Lyon's approach to the group capital assessment of the enterprise in the ORSA is the lack of group-level analysis."

Explain the issue raised by the regulator using two relevant examples from the Case Study.

ANSWER:

3. Continued

(b) **(LOs 2.2g, 3.3b)** (*2 points*) Another key issue raised was that Lyon's Corporate capital quantification for credit risk is not modeled, even though credit risk is a key risk for the enterprise.

A consultant was hired to develop loss scenarios on the Corporate asset portfolio. He produced the following results.

Percentile	Loss (in 000s) at end of year
75%	$5,450
90%	$9,681
95%	$14,368
98%	$17,725

Evaluate the reasonableness of Lyon's Corporate Economic Capital value for Credit Risk given these scenario results.

ANSWER:

(c) **(LOs 1.3a, 2.2d, 3.3b)** (*2 points*) Senior management has requested that the Corporate Risk Committee develop improvements to the ORSA for next year's submission.

(i) Explain how stress and scenario testing can improve Lyon's ERM framework and ORSA reporting.

ANSWER:

(ii) Describe two items that regulators will consider when evaluating stress testing in the ORSA report.

ANSWER:

3. Continued

(d) (*6 points*) **(LOs 2.1a, 2.2h)** Senior management has requested several enhancements to the group capital assessment and scenario/stress testing. The first recommendation is to develop an Operational Risk provision for the enterprise.

(i) Describe two quantitative approaches to modeling Operational Risk that would be appropriate for Lyon.

ANSWER:

(ii) Explain the considerations of the following as they relate to data used in modeling Operational Risk:

- Internal vs External data
- Hard vs Soft data.

ANSWER:

3. Continued

NO LONGER RELEVANT

~~For calculating Operational Risk capital, a colleague suggests using a Generalized Pareto Distribution with a threshold at $1 million, the calibrated shape parameter at 0.80 and the calibrated scale parameter at 0.5.~~

$$Q_a = d + \frac{b}{k}\left(\left(\frac{S_X(d)}{1-a}\right)^k - 1\right)$$

~~There are a total of 500 loss values collected across the businesses. You are provided the following table showing the top 30 largest losses, in millions of dollars.~~

12.33	8.71	6.74	4.41	4.20
3.31	2.97	2.65	2.58	2.40
2.29	2.21	2.12	1.89	1.76
1.35	1.34	1.28	1.27	1.25
1.15	1.13	1.10	1.07	1.05
0.99	0.97	0.96	0.92	0.91

(iii) ~~Calculate the 99th percentile of operational losses using the GPD. Show all work.~~

~~ANSWER:~~

(iv) ~~Evaluate the result from (iii) and discuss how it relates to the economic capital held by Lyon. Justify your answer using information from the Case Study.~~

~~ANSWER:~~

4. Spring 2022 ERM Exam (LOs 1.2a, 2.1a, 2.2b, 2.2h, 3.1a, 3.3b)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch.13: Liquidity Risk
- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)

For relevance, this question has been modified from the original exam format in this fashion: ABC was changed from a health insurer to a life insurer, because health RBC is no longer on the syllabus. In addition, the term "asset liquidity" was changed to "market liquidity".

(*12 points*) ABC is a life insurer. ABC has established a market liquidity risk limit system as one of its risk management mechanisms. Two of the limits are shown below, both assessed over a one-year time horizon.

Application	Asset Liquidity Risk Limit(s)	Risk Owner	Mitigation Requirement Upon Breach
Individual assets	LVAR/VAR – 1 < 35% for each individual asset at a confidence level of 95%	CIO	CIO analysis and risk report to Risk Committee; no explicit action required
Asset portfolio	LVAR/VAR – 1 < 25% for the portfolio of assets at a confidence level of 95%	CIO	Breach required to be corrected within 30 days of triggering event

4. Continued

Recent risk monitoring activity has indicated a breach in the portfolio-level market liquidity risk limit. To correct the breach, the Chief Investment Officer (CIO) intends to sell one of the four following assets. Assume the following:

- All proceeds will be held as cash.
- Bid/ask spreads will not change upon liquidation.
- All the assets are unaffiliated.

Asset	Market Value	Statutory Book Value	Bid/Ask Spread	Volatility (σ)	Post-tax RBC Factor
BBB Corp Bond	245.0	250.0	0.30	0.30	0.010
BB Corp Bond	242.0	252.0	0.47	0.38	0.020
B Corp Bond	244.0	248.0	0.70	0.65	0.045
Equity	240.0	244.0	1.80	2.00	0.150

(a) **(LOs 2.1a, 2.2b, 2.2h, 3.1a)** (*4 points*) In considering which asset to sell, the CIO asks you if any of the four assets have breached the individual market liquidity limit. Assume a normal distribution and critical value of 1.645.

(i) Determine which, if any, of the individual assets have breached the market liquidity limit. Show all work.

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

(ii) Recommend which asset to sell based on the results in (i). Justify your response.

ANSWER:

4. Continued

(b) **(LO 3.1a, 3.3b)** (*5 points*) The CIO communicates internally the intent to sell the asset based on your recommendation. ABC's CFO points out that the impact on the company's RBC ratio may vary depending on which asset is sold, and this should be considered when determining which asset to sell.

ABC uses the NAIC Life RBC formula when calculating the RBC ratio. The following table shows book values and average post-tax RBC factors by risk category used by ABC to calculate its RBC ratio.

RBC Category	Book Value	Average post-tax RBC Factor
C0	1,299	0.030
C1o	23,612	0.022
C2	32,000	0.044
C3a	12,478	0.032
C4	2,220	0.050

Total Adjusted Capital (TAC) = 5,527

(i) Describe what RBC is intended to measure.

ANSWER:

(ii) Assume that cash held on the balance sheet has a 0% RBC factor.

Analyze the impact on the company's RBC ratio of selling each individual asset from part (a). Show all work.

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

(iii) Discuss whether your analysis performed in part (ii) has changed your prior recommendation to the CIO on which asset to sell. Justify your response.

ANSWER:

4. Continued

(c) **(LOs 1.2a, 2.1a, 2.2h)** (*3 points*) The CIO wants to review the company's liquidity contingency plan.

(i) Outline the main components of a well-designed liquidity contingency plan as part of a broader liquidity risk framework.

ANSWER:

(ii) Explain how a catastrophic event could impact the liquidity needs of ABC.

ANSWER:

(iii) Identify three factors, other than a catastrophic event, that could impact the level of ABC's available liquidity.

ANSWER:

5. Spring 2022 ERM Exam (LOs 2.2d, 3.2a, 3.2e)

Relevant Sources:

- CFE101-119-25: ERM-144-20: IAA Risk Book - Chapter 13: Asset Liability Management Techniques and Practices for Insurance Companies
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 16: Responses to Risk

(*10 points*) Magenta Rock sells life insurance and fixed annuity products.

You are a consulting actuary hired by Magenta Rock to review its asset-liability management (ALM) practices. The company recently established an Asset-Liability Committee (ALCO) to oversee asset-liability duration matching.

You are given the following information about the company's products:

- Investment returns on the life insurance business are lower than assumed in pricing.
- The fixed annuities have a guaranteed minimum interest rate, and contract-holders can withdraw their funds on demand without penalty. Interest margins are currently below those assumed in pricing.
- The effective duration of the liabilities is much longer than the effective duration of the assets for both products.

During your initial meeting with the company, Magenta Rock's CFO, Juan, states:
"I believe we spend too much time worrying about the duration gap between our assets and liabilities. Given that Magenta Rock reports its financials on a book value basis, the primary focus of the ALCO should be to minimize absolute risk from asset volatility and minimize accounting volatility."

(a) **(LO 3.2e)** (*2 points*) Evaluate the assertions made by Juan.

ANSWER:

5. Continued

(b) **(LO 3.2e)** (*3 points*) At a follow-up meeting, the ALCO expresses concerns regarding the current low interest rate environment and the volatility of the economic surplus. The ALCO suggests immunizing Magenta Rock's portfolio.

(i) Describe two ways in which Magenta Rock would still be exposed to interest rate risk even if the portfolio is immunized using effective duration.

ANSWER:

(ii) Recommend a strategic asset allocation framework that would help increase Magenta Rock's portfolio yield while still addressing its concerns of surplus volatility. Justify your response.

ANSWER:

(c) **(LOs 2.2d, 3.2e)** (*2 points*) To further test the impact of the current interest rate environment, an ALCO member suggests that the following scenario test should be conducted:

A 50 basis point parallel drop in the risk-free rates for one year followed by an additional 10 basis point drop for each of the next four years.

(i) Assess how Magenta Rock's ALM profile would be impacted under the stress test circumstances.

ANSWER:

(ii) Recommend one additional method Magenta Rock could use to measure interest rate risk to complement the scenario testing. Justify your recommendation.

ANSWER:

5. Continued

(d) **(LO 3.2e)** (*1 point*) During your review of ALCO's practices, you notice that credit risk was overlooked when analyzing future asset cash flows.

Describe how Magenta Rock could incorporate its credit risk exposure into the projected asset cash flows.

ANSWER:

(e) **(LO 3.2a)** (*2 points*) You suggest to the ALCO that the volatility of the liability cash flows could be minimized using risk transfer methods or derivatives.

Explain how each of the following methods could be used to minimize the volatility of Magenta Rock's liability cash flows:

- Reinsurance
- Interest rate swap

ANSWER:

Question 6 pertains to the Case Study.
https://www.soa.org/49af5b/globalassets/assets/files/edu/2022/fall/exams/spring-2022-exam-erm-case-study.pdf

6. Spring 2022 ERM Exam (LOs 1.2a, 3.1a, 3.2b)

Relevant Sources:

- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35
- Risk Appetite: Linkage with Strategic Planning Report
- CFE101-101-25: IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry, Section 1.5 & Sections 2 thru 5

(*6 points*) Refer to section 1.5 of the Case Study.

(a) NO LONGER RELEVANT
~~(*1 point*) Big Ben is committed to maintaining a strong capital base to support the risk associated with its business.~~

~~Describe one residual risk and one inherent risk that apply to Big Ben. Justify your response.~~

~~ANSWER:~~

(b) **(LO 3.2b)** (*2 points*) Big Ben is implementing the Model Governance framework.

(i) Define the three major types of internal controls.

ANSWER:

(ii) Provide an example of an internal control used by Big Ben in the Model Governance framework, for each type you identified in part (i).

ANSWER:

6. Continued

(c) **(LO 1.2a, 3.1a)** (*3 points*) Big Ben is formalizing its risk appetite framework.

(i) Describe the three increasingly detailed levels of a risk appetite framework.

ANSWER:

(ii) Provide two examples of risk appetite that Big Ben already utilizes or is considering. Justify your response.

ANSWER:

(iii) Provide two examples of risk tolerances that Big Ben already utilizes or is considering. Justify your response.

ANSWER:

Questions 1 pertains to the Case Study. https://www.soa.org/4ae42b/globalassets/assets/files/edu/2021/fall/exams/fall-2021-exam-erm-case-study.pdf

1. Fall 2021 ERM Exam (LOs 2.2h, 3.1b)

Relevant Sources:

- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 13: Liquidity Risk
- Embedding Cyber Risk in Risk Management: An Insurer's Perspective By Kailan Shang (pp.12 -15 of Cybersecurity: Impact on Insurance Business and Operations)

(*12 points*) Refer to section 1.5 of the Case Study.

(a) **(LO 2.2h)** (*3 points*) Big Ben considers improving its operational risk analysis by implementing one of the following:

1. Using five years of Big Ben's operational failure frequency and loss severity data, which is collected internally.
2. Using five years of Big Ben's internal data combined with industry data.
3. Using stress testing and scenario analysis.

(i) Evaluate each of the three approaches.

ANSWER:

(ii) Recommend the most appropriate approach for Big Ben. Justify your response.

ANSWER:

1. Continued

(b) **(LO 2.2h)** (*3 points*) Big Ben is considering acquiring an online life insurance company.

Taylor, an actuarial student, suggests that Big Ben implement the following in its new Liquidity Assessment Program if Big Ben undertakes the acquisition:

7. Reflect the correlation between financial markets and insurance risks
8. Measure liquidity risk using liquidity ratio and excess/deficit of liquidity
9. Assess liquidity using 10 unique stress scenarios

(i) Describe the key drivers of liquidity risk for Big Ben.

ANSWER:

(ii) Compare the liquidity risk profile between a life insurance company and Big Ben.

ANSWER:

(iii) Critique Taylor's suggestion.

ANSWER:

1. Continued

(c) **(LO 2.2h)** (*3 points*) Big Ben is evaluating its approach to managing its cyber risk given its strategy of creating a one-stop shop interface for its globally mobile clientele and its possibility of acquiring an online insurance company. Big Ben notes that cyber risk is gaining more attention given its increasing incidence rate and impact.

Big Ben's current cyber risk management framework includes:

- Hiring people with cyber risk expertise and providing training to employees
- Setting cyber risk limit using key risk indicators
- Real-time monitoring of internal, communication system, and social media data.

Taylor made the following suggestions:

- Big Ben should leverage its current infrastructure and available technologies. No new technology investment to address cyber risk should be made
- Big Ben should develop a contingency plan to cover additional financial losses that might occur
- No cyber risk insurance is necessary.

Evaluate Taylor's suggestions.

ANSWER:

1. Continued

(d) **(LOs 2.2h, 3.1b)** (*3 points*) Big Ben has hired Caerus to evaluate whether it should acquire an online life insurance company.

(i) Explain how the liquidity risk, operational risk, and cyber risk profiles might be impacted if Big Ben acquires an online insurance company.

ANSWER:

(ii) Recommend whether Big Ben should consider acquiring an online life insurance company based on your response to part (i). Justify your response.

ANSWER:

2. Fall 2021 ERM Exam (LOs 2.2f, 2.2g)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10: Economic Scenario Generators
    - Ch. 14: Model Risk and Governance

(*8 points*) PIC is a small regional insurance company that has been selling traditional life insurance and annuity products for the past two decades. The company recently added variable annuity (VA) products to its portfolio and implemented a hedging strategy to manage risk exposures from this block of business.

Considering the VA products have a different risk profile, PIC is reviewing its existing models and risk management tools to ensure risks associated with these products are well understood, monitored, and managed.

You are an actuary working in the ERM department. The existing Economic Capital model uses a one-year 99% VaR based on scenarios from historical experience.

(a) **(LOs 2.2f, 2.2g)** (*3 points*) PIC considers implementing an Economic Scenario Generator (ESG) to enhance its risk management capabilities. Your colleague Hunter commented, "since the purpose of using ESG is to manage risk, it is more appropriate to develop real-world scenarios".

(i) Describe three business uses demonstrating that an ESG could add value to PIC.

ANSWER:

(ii) Critique Hunter's comment.

ANSWER:

2. Continued

(b) **(LOs 2.2f, 2.2g)** (*5 points*) An Excel-based ESG model developed and used by the Investment Office (IO) may be leveraged for risk management purpose.

The primary use of the IO's ESG is to generate interest rate paths for PIC's fixed income assets, which constitute 93% of PIC's investment portfolio. This real-word scenario generator derives the term structure of interest rates using a Vasicek model with parameters calibrated to historical treasury rates from 1980 to 2019 using a regression approach.

You note the following modeling choices made as part of the parameterization process:

- Outliers are eliminated to generate a steady-state level
- The underlying dynamics of interest rates are described using a long-term mean and standard deviation
- The recovery path from initial condition to a steady-state level is calibrated to be consistent with historical experience. Due to long run-time, recalibration of parameters and assumptions is performed annually.

(i) Assess the limitations of this ESG model for PIC based on the features of a comprehensive ESG.

ANSWER:

(ii) Describe two sources of parameter risk in the current interest rate parameterization process.

ANSWER:

(iii) Evaluate the appropriateness of this model for each of the three business uses you identified in part (a)(i).

ANSWER:

3. Fall 2021 ERM Exam (LOs 2.2c, 2.2d, 2.2g, 3.3b)

Relevant Sources:

- Regulatory Capital Adequacy for Life Insurance Companies: A Comparison of Four Jurisdictions (Excluding Appendices)
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
- CFE101-114-25: Measurement and Modeling of Dependencies in Economic Capital (Ch 3-5 & 7)
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing

(*14 points*) LifeCo is a life insurance company with two blocks of business:

- Participating Whole Life with guaranteed cash value
    - This block is closed to new business
    - Average attained age of policyholders is 70
    - 100% of fund investment experience is passed to policyholders via dividends
    - There is no more room to pass adverse experience to policyholders. Shareholders are absorbing 100% of those impacts
- Traditional Universal Life
    - Death benefit amount is equal to the face amount elected at inception plus the fund value
    - Premiums are flexible
    - Minimum credited rate is 3.0%.

LifeCo's management is interested in incorporating an Economic Capital (EC) framework. The EC balance is calculated as of December 31, 2019.

Refer to the accompanying Excel file for the tabs mentioned.

(a) **(LOs 2.2d, 2.2g, 3.3b)** (*7 points*) The following information is provided for each of the key risks identified:

3. Continued

- Credit
  - You are given the following regarding LifeCo's Fixed Income assets portfolio. Default and recovery rates are estimated from S&P historical data from 1981 to 2004. Assume asset ratings do not change.

		Annual Default Rates			
		Year			
Exposure ($ thousand)	**Rating**	1	2	3	**Recovery Rate**
10,000	**AAA**	0.01	0.03	0.08	85%
5,000	**AA**	0.04	0.13	0.15	75%
7,500	**A**	0.08	0.15	0.20	60%
5,000	**BBB**	0.11	0.20	0.26	50%

  - EC for credit risk is set as 120% of the expected credit loss over 3 years
- Mortality
  - EC for mortality risk has been estimated using the RBC framework

- Interest Rate
  - The liability discount curve is generated using the Ho-Lee model where:
    - $\Delta R_t = A_t \Delta t + E_t$ where E_t is normally distributed with mean 0 and standard deviation 2.0%
    - E_t simulated values are derived from a U(0,1) distribution and are shown in the tab 'F21 Q3 (a)(ii) Interest Rate Question'
    - A_t is calibrated using bond prices shown in the tab 'F21 Q3 (a)(ii) Interest Rate Question'
    - The initial rate for calibration R_0 is 3.0%.

  - EC for interest rate risk is calculated as the present value of the shocked cashflows less the present values of the base cashflows, where the present value of the shocked cashflows is determined by reducing the resulting discount curve by 0.5% in all years. Liability cashflow projections for 30 years are available from the valuation models in the tab 'F21 Q3 (a)(ii) Interest Rate Question"

3. Continued

(i) Evaluate LifeCo's approach to modeling EC for the three identified key risks.

ANSWER:

(ii) Calculate credit risk EC and interest rate risk EC. Show all work.

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

(iii) Explain how you would incorporate lapse risk and reinvestment risk into LifeCo's EC framework.

ANSWER:

(b) **(LO 2.2c)** (*4 points*) LifeCo's EC requirement for mortality has been estimated as $1.5 million.

The following correlation matrix has been provided and is based on publicly available historical market data.

	Correlation Matrix		
	Credit	**Mortality**	**Interest Rate**
Credit	1.00	0.03	0.30
Mortality	0.03	1.00	0.01
Interest Rate	0.30	0.01	1.00

(i) Calculate LifeCo's aggregate EC using the given correlation matrix. Show all work.

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

(ii) Compare and contrast the following aggregation methods as they pertain to LifeCo:

- Correlation
- Copula.

ANSWER:

3. Continued

(iii) Describe the considerations for using copulas to aggregate risks in an EC framework.

ANSWER:

(c) **(LO 2.2d, 3.3b)** (*3 points*) LifeCo's management wants to assess adverse effects of the COVID-19 pandemic on its EC position as of December 31, 2020.

Management suggests using the following scenario and the correlation matrix provided in part (b):

Risk	Outcome
Credit	10% decrease in recovery rates (e.g. from 70% to 60%)
Mortality	5% increase in liability claim payments for all durations
Interest rate	10 bps decrease in base discount rates for all years

(i) Recalculate the total required EC under the pandemic scenario. Show all work.

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

(ii) Critique LifeCo's management's suggestion.

ANSWER:

4. Fall 2021 ERM Exam (LOs 1.2a, 2.1a, 3.1a, 3.2a)

Relevant Sources:

- Risk Appetite: Linkage with Strategic Planning Report
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
    - Ch. 14: Quantifying Particular Risks

(*8 points*) QPT is an insurer specializing in individual whole life insurance, term life insurance, and individual deferred annuities. You have been asked to evaluate a specific investment portfolio backing a block of deferred annuities and to make recommendations on how QPT can enhance their risk management for the block.

(a) **(LOs 1.2a, 3.1a)** (*2 points*)

(i) Describe two primary benefits of having a well-defined risk appetite framework for key organizational risks.

ANSWER:

(ii) Explain how risk appetite can be reflected in each of the following:

- Asset Allocation
- New Business Budgeting
- Performance Measurement.

ANSWER:

4. Continued

(b) **NO LONGER RELEVANT** (*4 points*) The details of the entire three-asset portfolio you have been asked to evaluate are given below. The CRO wants to evaluate risk metrics for monitoring the block and suggests that a 95% VaR may be an appropriate threshold.

Asset	Yield	Exposure ($ million)	Default Probability (1 year)	Recovery Rate
A	4%	$20	6%	40%
B	6%	$50	3%	60%
C	8%	$30	10%	10%

(i) Calculate, net of recovery, the expected loss and the variance over a one-year time horizon. Show all work.

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

(ii) Calculate the 95% VaR using the results from (i) assuming that portfolio losses are normally distributed. Show all work.

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

(iii) Determine the empirical 95% VaR based on the distribution of potential portfolio losses calculated in (i). Justify your response.

ANSWER:

(iv) Describe one key shortcoming for each metric calculated in (ii) and (iii) that should be considered when selecting an appropriate risk measure for QPT's risk appetite statement.

ANSWER:

4. Continued

(c) **(LOs 2.1a, 3.2a)** (*2 points*) QPT's CRO is planning a discussion with the internal audit department regarding risk assessment on credit risk in an inherent risk control matrix.

(i) Identify and describe three ***key*** questions that should be considered during the risk assessment phase.

ANSWER:

(ii) Recommend the most effective action to mitigate the credit risk for the portfolio in part (b). Justify your response.

ANSWER:

Question 5 pertains to the Case Study.
https://www.soa.org/4ae42b/globalassets/assets/files/edu/2021/fall/exams/fall-2021-exam-erm-case-study.pdf

5. Fall 2021 ERM Exam (LOs 1.2a, 2.1a, 2.1b, 2.1c, 2.2h, 3.2a)

Relevant Sources:

- CFE101-102-25: Leveraging COSO Across The Three Lines Of Defense
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 8: Risk Identification
- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- CFE101-113-25: Identifying and Evaluating Emerging Risks
- CFE101-110-25: IAA Paper: Importance of Climate-Related Risks for Actuaries (Pages 2-14)

(*14 points*) The CFO of Energetix wants to develop a comprehensive ERM framework at the company and has reached out to Caerus for advice on how to start.

You are an actuary at Caerus, assigned to the Energetix account. Your manager has outlined a report recommending an ERM framework. She has asked you to draft content for some of the sections, listed below.

I. The Three Lines of Defense
II. Risk Identification
III. Emerging Risks
IV. Strategic Risk

Refer to section 1.9 of the Case Study.

(a) **(LO 1.2a)** (*3 points*) For Section I - The Three Lines of Defense:

(i) Summarize the function of the 2nd line of defense.

ANSWER:

5. Continued

(ii) The CFO of Energetix has proposed that the new ERM team should report to the Manager, Engineering.

Assess this proposal.

ANSWER:

(b) **(LO 2.1a)** (*3 points*) For Section II - Risk Identification:

Propose four risk identification tools and/or techniques for Energetix and explain how Energetix could use them.

ANSWER:

(c) **(LOs 2.1a, 2.1b, 2.1c, 3.2a)** (*4 points*) For Section III - Emerging Risks:

(i) Explain how Energetix is exposed to cyber risk.

ANSWER:

(ii) Identify four risk management strategies for cyber risk for Energetix.

ANSWER:

(iii) Identify two emerging risks, other than cyber risk, faced by Energetix. Justify why they are emerging risks.

ANSWER:

(iv) Propose a methodology for monitoring early warning signals for each of the two risks identified in part (iii).

ANSWER:

5. Continued

(d) **(LOs 2.1a, 2.2h)** (*4 points*) For Section IV - Strategic Risk:

(i) The CFO has noted that climate-related damage to facilities and distribution channels may lead to service disruptions.

Provide three additional examples of how climate risk may impact the strategic planning for Energetix.

ANSWER:

(ii) Assess which of the three categories of climate risk (physical, transition or legal and reputation) is the most impactful on Energetix.

ANSWER:

6. Fall 2021 ERM Exam (LOs 2.1a, 3.2a, 3.2d)

(*4 points*) ABC Life is an insurance company selling universal life (UL) and annuity policies.

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 16: Responses to Risk
- CFE101-120-25: IAA Risk Book Reinsurance

(a) **(LO 2.1a, 3.2a)** (*2 points*) The company has taken the following risk mitigation steps:

- Moved from entering into over-the-counter swaps to using exchange-traded interest rate futures
- Signed new YRT treaties to cede death claims of UL policies to a reinsurance company
- Implemented a data analytics system to help detect claim fraud.

(i) Identify the risks being addressed in each step shown above.

ANSWER:

(ii) Identify the category of risk response for each risk mitigation.

ANSWER:

(iii) Explain what risks are created by taking each mitigation step.

ANSWER:

6. Continued

(b) **(LOs 3.2a, 3.2d)** (*2 points*) ABC Life has a wholly owned captive for its UL business. It is considering other risk transfer options because it believes the captive is too resource intensive.

(i) Compare and contrast traditional reinsurance, securitization and use of a captive.

ANSWER:

(ii) Describe the advantages of each option for ABC Life.

ANSWER:

1. Spring 2021 ERM Exam (LOs 2.1a, 2.2h, 3.2b, 3.2f)

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 8: Risk Identification
- CFE101-102-25: Leveraging COSO Across The Three Lines Of Defense
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 14: Model Risk and Governance

(*10 points*) ABC Re (ABC) is an international reinsurance company with business units in North America, Europe, and Asia.

ABC is considering outsourcing the development and maintenance of its operational systems to DEF, an external company that specializes in developing and customizing platforms for financial institutions. DEF is located in Bermuda.

You are hired as a risk management consultant by ABC's Vice President of Strategy Planning (VP).

You are given the following information:

- Currently, direct insurers send their data and financials to ABC according to a pre-arranged schedule.
- Premium, claim, inforce, and termination data from ABC's clients are in various formats and handled separately through several of ABC's existing systems which are not capable of handling large volumes of data.
- DEF will incorporate new technologies, make use of big data, and develop a system that can unify the functionalities of all of ABC's existing legacy systems in all geographies.
- DEF will be responsible for maintaining the newly developed system after it is delivered to ABC.
- If DEF is hired, the planned timeline for the development and transition is two years.
- There is disagreement amongst ABC's senior management whether to undertake this project.

1. Continued

(a) **(LOs 2.1a, 2.1h)** (*3 points*) The VP is concerned that hiring DEF will increase ABC's operational risk.

(i) Explain why each of the following operational risks could increase.

- People Risk
- Reputational Risk

ANSWER:

(ii) Explain how the new system could improve data quality.

ANSWER:

(b) **(LOs 3.2b, 3.2f)** (*3 points*) If DEF is hired, the VP will organize a steering committee consisting of key internal stakeholders.

(i) List and explain the steps that need to be taken by the steering committee to ensure an effective development process for the new system.

ANSWER:

(ii) Propose three review and testing procedures that ABC can adopt to validate the new system.

ANSWER:

(c) **(LO 3.2b)** (*3 points*) You are asked to design and implement an internal control framework for ABC to effectively manage the risk of hiring DEF and implementing the new system.

Recommend four controls to be adopted in your design. Justify your answer.

ANSWER:

1. Continued

(d) (**LO 3.2f**) (*1 point*) Recommend whether ABC should proceed with the proposal. Justify your response.

ANSWER:

2. Spring 2021 ERM Exam (LOs 2.1a, 3.2d)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
- CFE101-120-25: IAA Risk Book Reinsurance

(*11 points*) ERM Life is concerned about the impact of a potential pandemic on its mortality and liquidity risks.

In order to mitigate mortality risk, ERM Life is considering the use of either traditional or alternative risk transfer means.

(a) **(LO 3.2d)** (*2 points*) ERM Life is considering the use of reinsurance to address its concerns with catastrophic mortality claims. The following reinsurance alternatives have been offered to ERM Life:

- 50% pro-rata reinsurance
- Per risk excess of loss reinsurance
- Per occurrence excess loss reinsurance
- Aggregate excess of loss reinsurance

Assess the suitability of each of these alternatives to mitigate ERM Life's catastrophe risk exposure.

ANSWER:

2. Continued

(b) **For relevance, this question has been modified from the original exam format in this fashion: removed "Participating in a self-insurance pool"**

(LO 3.2d) (*4 points*) ERM Life is also considering the following alternative risk transfer approaches to cover catastrophic mortality claims:

- Issuing a catastrophe bond sold through a dedicated Special Purpose Vehicle (SPV)
- ~~Participating in a self-insurance pool~~
- Setting up its own captive

(i) Describe each approach.

ANSWER:

(ii) Analyze the appropriateness of each approach to mitigate ERM Life's catastrophic mortality risk.

ANSWER:

ERM Life has agreed to a reinsurance treaty. The treaty will cost ERM Life a first-year premium of $10 million to be paid one week from today. ERM Life will pay for this premium by liquidating some equity shares of its asset portfolio. ERM Life owns 100,000 shares of Stock Company with a market price of $103.00 per share as of today.

ERM Life is considering two options:

- 1st option: Liquidate 100,000 shares immediately
- 2nd option: Liquidate 20,000 shares each of the next five trading days

2. Continued

(c) **For relevance, this question has been modified from the original exam format in this fashion: the terminology was changed from "asset liquidity" to "market liquidity."**

(LO 2.1a) (*0.5 points*) Describe the market liquidity impact of each option.

ANSWER:

(d) **(LO 2.1a)** (*4.5 points*) It has been suggested that ERM Life use liquidity-adjusted VaR (LVaR) to inform its decision on how to pay the reinsurance premium. You are given the following information for the liquidation options:

- Price impact of the 1st option: $257,500
- Price impact of the 2nd option: $51,500
- Asset portfolio VaR for 2nd option: $361,623

(i) Recommend which liquidation option ERM Life should implement in order to pay the reinsurance premium. Justify your answer.

ANSWER:

(ii) Describe other aspects of asset and liability liquidity risks that ERM Life should consider when entering into this transaction.

ANSWER:

(iii) Describe two other relevant risks that ERM Life should consider when entering into this transaction.

ANSWER:

3. Spring 2021 ERM Exam (LOs 2.1a, 2.2g)

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14 Quantifying Particular Risks

(*8 points*) You work on the credit risk management team at a large insurance company. Your team's responsibilities include analyzing credit risks of the company's fixed income portfolio.

(a) **(LO 2.2g)** (*2 points*) There are several modeling approaches used for estimating default probabilities, including:

- Merton's model
- KMV Moody's
- Models incorporating bond prices

(i) Compare and contrast the structure and use of reduced-form models and structural models.

ANSWER:

(ii) Identify whether each of these models is a reduced-form model or a structural model. Justify your response.

ANSWER:

(b) **(LO 2.1a)** (*1 point*) Using bond prices, the credit spread of a bond can be calculated and used to estimate the expected credit loss. Thus, your colleague claims that if bond A has higher spread than bond B, bond A must have higher probability of default than bond B.

Explain whether your colleague's statement is correct.

ANSWER:

3. Continued

(c) NO LONGER RELEVANT

~~(*5 points*) Your team has been working on a project using simulations to estimate tail credit loss of the company's portfolio. You use copulas in the simulations to capture the dependencies between credit losses on bonds in the portfolio. You are given the following information:~~

- ~~The time horizon is one year.~~
- ~~The returns of each bond issuer's asset portfolio are simulated assuming they follow a lognormal random walk.~~
- ~~A correlation matrix of the returns of the bond issuers' assets.~~
- ~~The following have already been estimated for each bond issuer: the growth rate of the asset value, the volatility of the asset value, default threshold, exposure, and loss given default.~~

~~(i) Describe the steps to simulate the asset values of the bond issuers and to calculate credit loss of your company's portfolio using a Gaussian Copula. You do not need to give any formulas.~~

~~ANSWER:~~

~~(ii) Your other choice of copula is Student's t.~~

~~Describe how the simulation process would need to change in order to incorporate a Student's t copula into the simulation. You do not need to give any formula.~~

~~ANSWER:~~

~~(iii) You run two simulations, each generating 10,000 samples – one using a Gaussian copula and the other using a Student's t copula. You then calculate the credit loss at the 99th percentile from each simulation.~~

~~Compare the VaR(99) results you would expect between the two simulations. Justify your answer.~~

~~ANSWER:~~

~~3.~~ ~~Continued~~

~~(iv) Recommend which copula should be implemented. Justify your recommendation.~~

~~ANSWER:~~

Question 4 pertains to the Case Study.
https://www.soa.org/49c184/globalassets/assets/files/edu/2021/spring/exams/spring-2021-exam-erm-case-study.pdf

4. Spring 2021 ERM Exam (LOs 2.2d, 2.2g, 2.2h, 3.2c)

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 14: Quantifying Particular Risks
  - Ch. 16: Responses to Risk
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
  - Ch. 10: Economic Scenario Generators
  - Ch. 15: Risk Mitigation Using Options and Derivative
- CFE101-111-25: IAA Risk Book Appropriate Applications of Stress and Scenario Testing

(*10 points*) Refer to Sections 1.8 and 1.9 of the Case Study.

In anticipation of future consumer behavior, Giant Auto Motors (GAM) has decided to enter the battery electric vehicle (BEV) market. Caerus has been hired by GAM to help develop risk metrics for this venture.

GAM has identified companies A and B as potential suppliers of the parts needed for its BEVs. If the chosen supplier becomes insolvent, disruptions in the supply chain could lead to production issues. GAM wants to pick the company that is least likely to default over the next five years.

Both companies are large borrowers and heavily traded on the stock market. Your boss wants to use the Merton model to determine the default probabilities.

4. Continued

The Merton model and the financial data for both firms as of December 31, 2020 are shown below.

$$\Pr(X_T \leq B) = \Phi\left(\frac{\ln\left(\frac{B}{X_0}\right) - (r_x - \frac{\sigma_x^2}{2})T}{\sigma_x\sqrt{T}}\right)$$

Company	Total Asset Value (in millions)	Expected Growth Rate	Volatility of Growth Rate	Total Amount of Company's Borrowing (in millions)	Time of Lump Sum Payment of Company's Debt
A	$5,000	5%	35%	$1,000	5 years from today
B	$8,000	7%	25%	$2,000	5 years from today

(a) **(LO 2.2g)** (*4 points*)

(i) Assess the appropriateness of using the Merton model to measure the solvency of companies A and B.

ANSWER:

(ii) Propose one alternative method GAM could use to measure the solvency of its supplier. Justify your proposal.

ANSWER:

(iii) Demonstrate that Company B is preferable to Company A, as of December 31, 2020, using the Merton model. Show all work.

ANSWER:

4. Continued

(b) **(LOs 2.2g, 3.2c)** (*4 points*) GAM's management is concerned with the cost of lithium which heavily influences the price of the batteries and, therefore, the overall production cost of BEVs. Caerus has determined that lithium prices can be described using geometric Brownian motion.

(i) Describe a process for using Monte Carlo simulation to calculate VaR(99) for lithium prices over the next n years.

ANSWER:

(ii) Explain how the volatility of battery prices could be mitigated using:

- A forward contract on lithium
- A futures contract on lithium

ANSWER:

(iii) Recommend whether GAM should use a forward or a futures contract for lithium to hedge against battery price volatility. Justify your recommendation.

ANSWER:

4. Continued

(c) **For relevance, this question has been modified from the original exam format in this fashion: the terminology was changed from "synthetic scenario" to "hypothetical."**

(LOs 2.2d, 2.2h) (*2 points*) In response to the board meeting described in section 1.9 of the Case Study, your team has been asked to perform scenario analysis regarding GAM's strategy.

(i) Explain why using a hypothetical scenario for the analysis would be more beneficial than a historical scenario in this situation.

ANSWER:

(ii) Design a company-specific hypothetical stress scenario that could be applied to the situation where GAM remains in the PCV market. Support your answer using evidence from the Case Study.

ANSWER:

Question 5 pertains to the Case Study.
https://www.soa.org/49c184/globalassets/assets/files/edu/2021/spring/exams/spring-2021-exam-erm-case-study.pdf

5. Spring 2021 ERM Exam (2.1a, 2.1b, 2.1c, 2.2d, 2.2h, 3.1a, 3.2a)

Relevant Sources:

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- CFE101-113-25: Identifying and Evaluating Emerging Risks
- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- Risk Appetite: Linkage with Strategic Planning Report

(*12 points*) You work as a consultant with Caerus and have been assigned to the Energetix account. Refer to section 1.11 of the Case Study.

You have been asked to develop a strategy to address emerging risks in the energy industry and to establish a risk appetite statement for specific emerging risks.

(a) **(LOs 2.1b, 2.1c, 2.2h)** (*3 points*) Your initial task requires assessing key emerging risks that are relevant to Energetix.

(i) Describe the process of environmental scanning as part of an emerging risk review.

ANSWER:

(ii) Explain how a balanced environmental scanning approach could be used by Energetix to assess the potential emerging risks related to:

- Regulatory change
- Cybersecurity threats

ANSWER:

5. Continued

(b) **(LO 2.1a, 2.1b, 2.2d)** (*4 points*) You plan to coordinate scenario planning for key risks across Energetix's various subsidiaries. Caerus has identified key risk factors related to the Energy Utility Industry, and you have elaborated major themes that characterize plausible developments as follows:

1. Regulatory changes related to the environment and the potential impact of global climate change
2. Operational activities that impact the reputation or financial condition of the company.

(i) Describe a relevant scenario, specific to Energetix, for each theme.

ANSWER:

(ii) Outline the remaining steps in the scenario planning process.

ANSWER:

(iii) Provide a relevant example for each step identified in (ii) using one of your scenarios from (i).

ANSWER:

5. Continued

(c) **(LOs 3.1a, 3.2a)** (*5 points*) The Energetix Board has developed a new qualitative risk appetite statement for cybersecurity risk as follows:

"Any material damage to Energetix's reputation or interruption of business from a cybersecurity event is unacceptable."

The Energetix CRO wants more specific limits and has asked you to help establish a quantitative risk appetite statement for cybersecurity risk.

(i) Identify the challenges with translating a qualitative statement into a quantitative one for cybersecurity risk.

ANSWER:

(ii) Energetix initially proposes a quantitative risk appetite statement, as follows:

"The company cannot lose more than 20 percent of value in a cybersecurity event."

Propose a modification to the above statement incorporating each of the following:

- Energetix's current balance sheet and income statement
- Historical experience in data breaches and operational failures.

Explain your reasoning.

ANSWER:

(iii) Recommend two enhancements that Energetix could implement to support compliance with the cybersecurity risk appetite statement that you proposed in (ii). Justify your response.

ANSWER:

Question 6 pertains to the Case Study.
https://www.soa.org/49c184/globalassets/assets/files/edu/2021/spring/exams/spring-2021-exam-erm-case-study.pdf

6. Spring 2021 ERM Exam (LOs 2.1a, 2.2h, 3.2a)

Relevant Sources:

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35

(*9 points*) Giant Auto Motors (GAM) has set the following as its strategic objectives. Refer to section 1.9 of the Case Study.

Objective	Key metric	Risk
Expand GAM's 10% ownership in current JV in China to at least 40%	Current Market Share of JV	Regulatory Changes limiting JV
Be able to produce its own BEV automotive batteries within one year	Number of batteries purchased each month should be < 90% of prior month's purchased batteries	Ability to obtain material for batteries
Become the top provider of BEV automotive batteries in China in five years	% of BEVs vs PCVs	Having the skillset in-house for continued battery improvements

GAM asked Caerus Consulting to evaluate GAM's objectives.

~~(a)~~ **NO LONGER RELEVANT** ~~(*4 points*)~~

~~(i) Evaluate whether these objectives are the appropriate ***key*** strategic objectives for GAM.~~

~~ANSWER:~~

~~(ii) Assess if the listed key metrics are suitable for measuring progress towards the stated objectives.~~

~~ANSWER:~~

6. Continued

(b) **(LOs 2.1a, 2.2h)** (*3 points*)

(i) Evaluate whether the risks identified are appropriate for the corresponding objectives.

ANSWER:

(ii) Assess if the risks identified are ***key*** risks for GAM. Justify your response.

ANSWER:

(c) **(LO 3.2a)** (*2 points*) The following controls are suggested for the risks associated with achieving the stated objectives:

- Audit the entire production process of batteries quarterly
- Test each battery to ensure it meets the guidelines needed for all global markets in which GAM participates
- Have each order for component parts be double-checked for accuracy

Assess the effectiveness of the proposed controls for each risk when implementing a risk-based controls approach. Justify your answer.

ANSWER:

1. Fall 2020 ERM Exam (LOs 2.2h, 3.3c)

Relevant Sources:

- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Chapter 3: Risk Measures

(*7 points*) Great Energy Drink (GED) is a global consumer goods company that sells flavored energy drinks via vending machines. GED wants to assess the risk that arises from drinks spoiling due to vending machine failure.

GED has compiled the following data:

- 50 years of aggregate annual loss data
- 24 months of operational failure data
- 10 years of monthly operational losses

(a) **(LO 2.2h)** (*1 point*) GED's ERM team proposes calculating the level of aggregate losses using raw empirical analysis. You are given the following information:

- GED has 50 years of annual data
- Target risk tolerance is based on the VaR(99.5) for a one-year time horizon

Assess whether GED should proceed with this approach.

ANSWER:

1. **Continued**

(b) **(LO 2.2h)** (*3 points*) To model the operational risk associated with vending machine failure, GED's ERM team proposes the following three approaches:

1. Use the most recent 24 months of GED's operation failure frequency and loss severity data, which has been collected by the GED's Data Management Team using a systematic process.
2. Use the most recent 10 years of operation failure frequency and loss severity data from Coca-Cola's media reports. Coca-Cola uses vending machines similar to GED's to distribute products, but it is much larger in size.
3. Use the most recent 24 months of GED electrician logs of machine failures and notes on losses. The data collection process by electricians on duty may not be robust, but the loss severity will be estimated based on reasonable inferences using notes.

Assess each of the three approaches.

ANSWER:

1. Continued

(c) **(LOs 2.2h, 3.3c)** (*3 points*) The ERM team has compiled monthly operational losses from GED's vending machines. The table below shows the 15 worst months over the last 10 years.

Month	Operational Losses	ERM Team's Notes
December 2017	$2,246	Unauthorized activity occurred resulting in loss of inventory
November 2018	$4,493	Unauthorized activity occurred resulting in loss of inventory
January 2017	$9,033	System breakdown causing sales for the last 10 days of the month to not be recorded
December 2018	$12,292	Access to machines was reduced due to road closures
May 2015	$12,925	GED expanded the business to Brazil, and sales data for Brazil has been added for the first time
January 2018	$14,100	Unauthorized activity occurred resulting in loss of inventory
December 2019	$16,118	Unauthorized activity occurred resulting in loss of inventory
December 2011	$16,328	Multiple routine execution errors occurred in the month due to lack of staff training and unauthorized activity resulted in loss of inventory
November 2014	$16,656	Multiple routine execution errors occurred in the month due to lack of staff training and unauthorized activity resulted in loss of inventory
March 2012	$16,886	GED expanded the business to Canada, and sales data for Canada has been added for the first time
February 2015	$17,907	Multiple routine execution errors occurred in the month due to lack of staff training
December 2013	$18,237	Multiple routine execution errors occurred in the month due to lack of staff training
October 2013	$19,133	Multiple routine execution errors occurred in the month due to lack of staff training
November 2011	$19,140	Sales data for Japan only; data for other regions were not recorded for the month.
December 2014	$19,157	GED expanded the business to Thailand, and sales data for Thailand has been added for the first time

1. Continued

(i) Calculate the monthly VaR(95) and CTE(95) of the operational losses for running the machines using the historical method.

ANSWER:

(ii) Evaluate quality of data provided in the ERM team's notes for operational risk modeling. Justify your response.

ANSWER:

2. Fall 2020 ERM Exam (LOs 2.1a, 2.2g, 2.2h, 3.2a, 3.2c)

Relevant Sources:

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks
    - Ch. 16: Responses to Risk
- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 10: Economic Scenario Generators
    - Ch. 15: Risk Mitigation Using Options and Derivatives

(*12 points*) You are a risk analyst at BlueSky Airlines working for Elon, the CEO, to analyze risks arising from the company's operations.

BlueSky is a carrier based in the United States with multiple daily flights across the U.S., Europe and the Caribbean.

BlueSky recently invested to modernize aircrafts in its aging fleet. Funds were raised by issuing bonds.

BlueSky's expenses have increased from last year due to higher repair costs, higher than expected oil prices, and expenditures in carbon reduction initiatives.

Elon is concerned with exchange rate fluctuations because a large portion of revenues are denominated in Euros, but expenses are denominated in U.S. Dollars.

2. Continued

(a) **(LOs 2.1a, 2.2h, 3.2a)** (*2 points*) Elon has identified the following risks:

- Engine failures due to mechanical or software issues
- Climate change
- Fuel price volatility

Current risk mitigation approaches include:

- Use of insurance
- Use of derivatives
- Transferring costs caused by service disruption to customers by raising ticket prices.

(i) Explain how each risk is relevant to BlueSky's operations.

ANSWER:

(ii) Explain how BlueSky's risk mitigation approaches could be used to address the identified risks. Justify your answer.

ANSWER:

2. Continued

(b) **(LO 3.2c)** (*4 points*) To hedge against an unexpected rise in interest rates, BlueSky proposes implementing a duration-based hedging strategy using futures.

You use the reference portfolio below as a proxy for BlueSky's debt exposure. The total portfolio value is 100 million USD.

	Bond 1	Bond 2
Allocation %	50%	50%
Term (in years)	1	3
Annual Coupon	2.00%	3.00%
Price	1,005	986
Yield	1.50%	3.50%
Redemption Value	1,000	1,000

To hedge your risk, you plan to enter an offsetting position on interest rate futures contracts, which will expire in three months, to deliver U.S. Treasury Bonds in exchange for cash.

The number of contracts that should be entered into is given by the following formula, with the parameters described in the table below.

$$N = \frac{PVBP_p}{PVBP_h}$$

Parameter	Description	Value
$PVBP_p$	Change in BlueSky's reference portfolio value resulting from a 1 basis point change in gross redemption yield	?
$PVBP_h$	Change in value of 1 interest rate futures contract resulting from a 1 basis point change in the interest rates	94.108

(i) Calculate the modified duration and convexity of each bond and for the reference portfolio. Show all work.

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

(ii) Determine the number of futures contracts BlueSky should enter into. Show all work.

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

2. Continued

(iii) Describe the shortcomings of this hedging strategy.

ANSWER:

(c) **(LOs 2.2g, 3.2c)** (*6 points*) BlueSky expects to receive a revenue payment of 100 million EUR in six months. BlueSky's treasury department wants to lock in the transaction at the current six-month forward exchange rate of 1.5 USD/EUR.

You are exploring two potential strategies to hedge against exchange rate risk:

Strategy A: Enter into a forward contract to deliver 100 million EUR at 1.5 USD/EUR in six months

Strategy B:

- Notional amount: 100 million EUR
- Buy a six-month European put option with exercise price of 1.49 USD/EUR
- Sell a six-month European call option with exercise price of 1.51 USD/EUR

Your assistant used a Monte Carlo method to estimate the risk-neutral payoff of each option in Strategy B but only recorded the results of the first 99 simulations. He provided the following information about the simulation:

- Sample size = 100
- Assume the exchange rate at time T follows the stochastic process given by:

$$S(T) = S(0)e^{\left(\mu - \frac{\sigma^2}{2}\right)T + \sigma\epsilon\sqrt{T}}$$

- $\mu = 0.05$
- $\sigma = 0.3$
- Risk-free rate = 0.05 compounded continuously
- Cost: 2.5 bps of notional amount per transaction
- Final N(0,1) simulated value from the sample is 0.065
- Average value of the risk-neutral payoffs for the first 99 simulations:
  - For the put option, 0.0806
  - For the call option, 0.0756

2. **Continued**

(i) Calculate the expected risk-neutral payoff of each option under Strategy B. Show all work.

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

(ii) Determine the total cost of Strategy B. Show your work.

ANSWER:

(iii) Elon says that Strategy A is more appropriate as there is no cost of entering a forward contract. Critique his assertion.

ANSWER:

Six months later the USD/EUR exchange rate is 1.52.

(iv) Calculate the profit or loss of this hedge under each strategy, relative to an unhedged position, assuming cash flows are accumulated at the risk-free rate. Show all work.

ANSWER:

4. Fall 2020 ERM Exam (LOs 2.1a, 2.2g, 3.1a, 3.1b)

Relevant Sources:

- *Quantitative Enterprise Risk Management*, Hardy, Mary and Saunders, David, 2022
    - Ch. 2: Risk Taxonomy
- Risk Appetite: Linkage with Strategic Planning Report
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
    - Ch. 14: Quantifying Particular Risks

(*12 points*) Company XYZ, a life insurer, has the following credit risk appetite statement (RAS) with regards to its investment strategy:

> "The company will not invest in any bonds that have a credit rating below A, and the company expects its assets and liabilities to be matched within 0.1 years on a Key Rate Duration basis."

XYZ has recently experienced credit losses in its bond portfolio that it thought would not occur given its RAS. XYZ's current asset allocation is shown in the table below.

Bond Rating	Market Value of Assets ($ million)
AA	27
A	15
BBB	0
Total	**42**

(a) **(LOs 2.1a, 3.1a)** (*3 points*)

(i) **For relevance, this question has been modified from the original exam format in this fashion: question now asks for two risk factors instead of three.**
Define two risk factors of credit risk related to an asset portfolio.

(ii) Identify which credit risk factor is the most likely driver of the unexpected losses given XYZ's compliance with its RAS. Justify your response.

(iii) Explain why XYZ is still exposed to credit risk, even if it complies with its RAS.

4. Continued

(iv) Recommend an additional requirement XYZ could add to its RAS that would account for the risks identified in part (iii). Justify your response.

ANSWER:

(b) **(LOs 2.1a, 3.1b)** (*5 points*) The following table shows the one-year credit migration probabilities for bonds with various ratings.

		Year-end Rating (%)				
		AA	**A**	**BBB**	**Default**	**Recovery Rate**
Initial Rating (%)	**AA**	85	13	2	0	40%
	A	12	82	4	2	25%
	BBB	5	10	76	9	20%

(i) Calculate the expected credit losses from default in the next year using the credit migration model. Show all work.

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

(ii) Calculate the expected amount of bonds that need to be sold after one year in order to satisfy the RAS. Show all work.

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

(iii) Explain a source of portfolio losses, other than defaults, that is captured in the credit migration model.

ANSWER:

4. Continued

(c) **(LO 2.2g)** (*4 points*) A portfolio manager determines XYZ's expected losses based on the Merton model, and you notice the results are different than the losses you calculated in part (b)(i).

(i) Explain how each input used in the Merton model affects the calculated probability of default.

ANSWER:

(ii) Explain why the differences between the credit migration model and the Merton model could result in different estimated defaults.

ANSWER:

(iii) Recommend which model XYZ should use going forward in order to address XYZ's unexpected losses. Justify your response.

ANSWER:

Questions 5 pertains to the Case Study.
https://www.soa.org/4ad2d3/globalassets/assets/files/edu/2020/fall/exams/edu-2020-fall-erm-exam-case-study.pdf

5. Fall 2020 ERM Exam (LOs 2.1a, 3.2a, 3.2b)

Relevant Sources:

- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 8: Risk Identification
- SOA Monograph- A New Approach to Managing Operational Risk -Chapter 8
- Embedding Cyber Risk in Risk Management: An Insurer's Perspective
- CFE101-112-25: Internal Controls Toolkit by Christine H. Doxey, Chapter 1 pp.11-17, 27-35

(*10 points*) Caerus Consulting (CC) has been hired by Big Ben Bank to assess its strategic plan. You work for CC and have been asked to assist with this project.

Refer to section 0.7 of the Case Study.

(a) **(LO 2.1a)** (*4 points*) Big Ben's strategic plans include the expansion of its Asset Management Business client base by lowering the minimum investable assets requirement. Big Ben also plans on formulating a one-stop shopping interface for its globally mobile clientele.

Assess how this strategy may affect Big Ben's:

I. Strategic risk
II. Business risk and its impact on profitability
III. Operational/technology risk in general and cybersecurity risk in particular

ANSWER:

5. Continued

(b) **(LO 3.2a, 3.2b)** (*3 points*) Big Ben is weighing a choice between retaining and transferring cybersecurity risks that would arise from the expansion strategy.

(i) Describe the advantages and disadvantages of:

- Retaining cybersecurity risk internally
- Transferring cybersecurity risk externally.

ANSWER:

(ii) Recommend a mitigation / control option for each choice. Justify your response.

ANSWER:

(c) **NO LONGER RELEVANT**

~~(*3 points*) As part of Big Ben's strategy to expand its Investment Banking business, the company decided to transfer cybersecurity risk and plans on utilizing a Special Purpose Vehicle (SPV) as a way for its clients to raise capital and transfer specific risks.~~

~~(iii) Explain how an SPV could be structured to meet Big Ben's goal.~~

~~ANSWER:~~

~~(iv) Assess the benefits and risks to Big Ben of this particular mitigation option. Justify your answer by using information from the Case Study.~~

~~ANSWER:~~

Question 6 pertains to the Case Study.
https://www.soa.org/4ad2d3/globalassets/assets/files/edu/2020/fall/exams/edu-2020-fall-erm-exam-case-study.pdf

6. Fall 2020 ERM Exam (LOs 2.1a, 3.2a, 3.2d)

Relevant Sources:

- *Financial Enterprise Risk Management*, Sweeting, Paul, 2nd Edition, 2017
  - Ch. 8: Risk Identification
  - Ch. 16. Responses to Risk
- CFE101-106-25: Strategic Risk Management Practice, Anderson and Schroder, 2010 Ch. 7 Strategic Risk Analysis
- CFE101-120-25: IAA Risk Book Reinsurance

(*10 points*) Disruptive Energy (DE) wants to expand into the autonomous vehicle market and become the leader in this technology. DE is considering hiring Caerus Consulting (CC) to identify its key risks over the next three years in achieving this goal. Refer to sections 0.1 – 0.6 and 0.10 of the Case Study.

(a) **(LO 2.1a)** (*1 point*) Recommend whether CC is an appropriate company for DE to hire to perform the risk analysis based on CC's overview in the Case Study. Justify your response.

ANSWER:

6. Continued

(b) **(LO 2.1a)** (*3 points*) An actuarial analyst at CC provides the following comments as part of the SWOT analysis for DE entering this new market.

- "(Strength) DE can quickly update all car systems via existing internet connections
- (Weakness) The market does not appear to be requesting artificial intelligence (AI) right now
- (Opportunity) Autonomous technology could easily be added to new products as they roll them out
- (Threat) DE currently doesn't have the expertise in house right now."

(i) Critique the comments provided.

ANSWER:

(ii) Provide one additional item for each SWOT component.

ANSWER:

DE wants to indemnify ($500,000 per life) on behalf of each person who dies in accidents caused by defective AI.

(c) **(LO 3.2a)** (*3 points*) The following three options for managing the risk associated with the indemnity plan were identified:

- Do nothing to mitigate the risk
- Set up a captive to insure this risk
- Buy insurance coverage from a third party

Evaluate each of these options for DE.

ANSWER:

6. Continued

(d) **(LO 3.2d)** (*3 points*) A decision was made to purchase insurance. The following insurance structures are under consideration:

- Insurance that covers all life insurance losses
- Insurance that covers losses on a 50% quota share basis
- Excess of loss insurance above a fixed annual limit of $X

Recommend which structure to implement.

ANSWER: