Society of Actuaries

Enterprise Risk Management – General Insurance Extension

Exam ERM-GI

Date: Wednesday, May 5, 2021

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 8 questions numbered 1 through 8 with a total of 80 points.

   The points for each question are indicated at the beginning of the question. Questions 4, 5, and 6 pertain to the Case Study and questions 7 and 8 pertain to the Case Study and/or extension readings.

2. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions provided in this document.
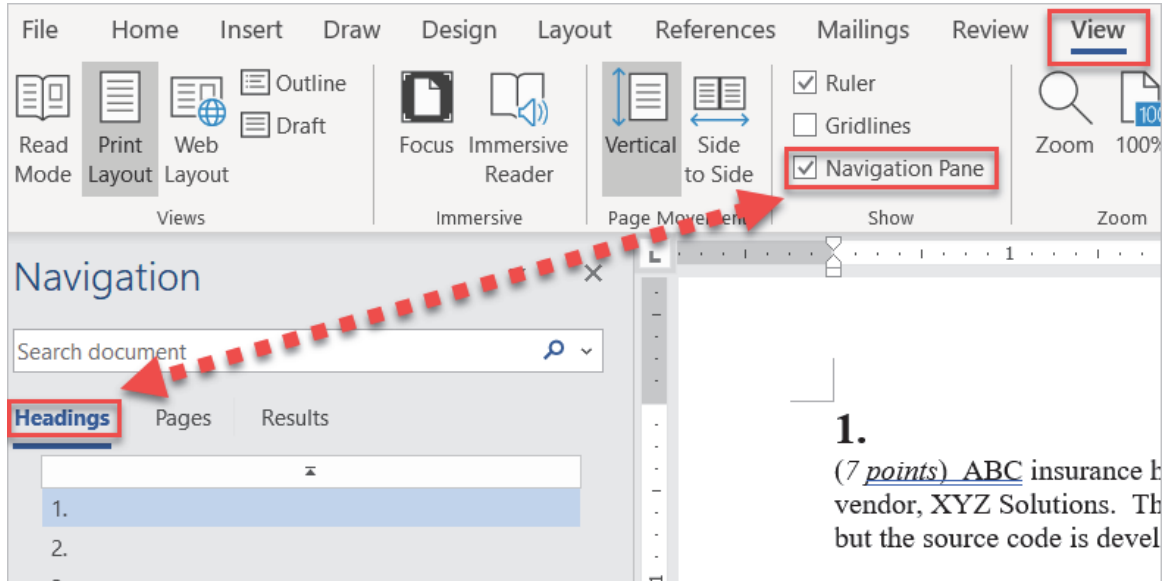
Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel file as directed. Graders will only look at work in the indicated file.

   a) In the Word document, answers should be entered in the box marked ANSWER. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example, β_1 can be typed as beta_1 (and ^ used to indicate a superscript).

   b) In the Excel document formulas should be entered. Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit.

   c) For each question part requiring an answer in Excel, (1) clearly identify the inputs to the calculations, (2) show the necessary interim calculations, adding rows and / or columns, if necessary, and (3) enter the final answer in some or all of the cells highlighted in yellow, as applicable in each circumstance. These cells should contain formulas with links to other calculations in the worksheet. Minimize the use of hard-coded figures and maximize the number of interim steps in the calculations that would demonstrate your line of thinking.

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

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

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

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Navigation Instructions

Open the Navigation Pane to jump to questions.

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

CASE STUDY INSTRUCTIONS

The case study will be used as a basis for some examination questions. Be sure to answer the question asked by referring to the case study. For example, when asked for advantages of a particular plan design to a company referenced in the case study, your response should be limited to that company. Other advantages should not be listed, as they are extraneous to the question and will result in no additional credit. Further, if they conflict with the applicable advantages, no credit will be given.

1.

(*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.

(a)   (*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: │
│   │
└───┘

1. Continued

(b)   (*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)   (*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:

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

   ANSWER:

2.

(*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)   (*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:

(b)   (*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:

2. **Continued**

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

(c) (*0.5 points*) Describe the asset liquidity impact of each option.

> ANSWER:

(d) (*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.

(*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)   (*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)   (*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)   (*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:

4.

(*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.

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

4. Continued

(a) (*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) (*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)   (*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 synthetic scenario for the analysis would be more beneficial than a historical scenario in this situation.

ANSWER:

(ii)   Design a company-specific synthetic 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:

5.

(*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)   (*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) (*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)   (*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:

6.

(*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)   (*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)   (*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)   (*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:

7.

(*10 points*) You are working as an actuary for Pryde and have been approached by Karl Michaels and Archie Daniels to help set Pryde's risk appetite.

(a)   (*2 points*) You start your analysis by considering the following four risks which were highlighted by the European Insurance and Occupational Pensions Authority (EIOPA) as being the four largest risks for non-life insurers.

        I.   Technical provisions – evaluation risk

        II.   Management & staff competence risk

        III.   Internal Governance & control risk

        IV.   Underwriting risk

For each of the four risks:

(i)   Describe the risk.

ANSWER:

(ii)   Provide an example of either a current practice or a past action by Pryde that has impacted its exposure to the risk.

ANSWER:

7. **Continued**

(b) (*3 points*) Pryde is considering the following initiatives:

       I.   Provide an e-bike endorsement to homeowner's policies, with a separate deductible from the main policy. This endorsement would cover damage or theft of an e-bike and liability arising from the use of an e-bike.

      II.   Adopt a new software product which promises to automate commercial policy underwriting using machine learning algorithms.

      III.   Begin offering 24-month policies to auto customers (currently, most have 6-month policies).

For each of the three initiatives:

(i) Explain which risk or risks in (a) are increased.

ANSWER:

(ii) Recommend an action to mitigate the increased risk exposure. Justify your answer.

ANSWER:

7. Continued

(c) (*2.5 points*)

    (i)   Describe the four most common early identification indicators for non-life insurers identified by the EIOPA.

> ANSWER:

    (ii)   Propose a risk limit that Pryde could establish for each indicator in (i), such that a breach of the limit would serve as an early warning signal for that indicator.

> ANSWER:

(d) (*2.5 points*) In response to Karl Michaels' October 30, 2020 memo to Archie Daniels regarding Key Risk Indicators (Section 6.5 of the Case Study), Pryde establishes a new risk appetite limit based on the "Earnings at Risk" Key Risk Indicator.

Identify three distinct strategies to help satisfy this risk appetite limit. Justify your answer.

> ANSWER:

8.

(*10 points*) The United States has been experiencing a pandemic. Population mortality has increased 10%, widespread stay-at-home orders were issued, and many people have been working from home. In the midst of the pandemic, Roberta James has heard that prevailing premium rates in the market for providing excess mortality coverage have increased by 50%.

The excess mortality coverage is sold as reinsurance. In exchange for a quarterly premium, the reinsurer pays a benefit if actual to expected mortality over a three-month period exceeds a threshold. This coverage is usually purchased by life insurance companies worried about death benefit losses. Roberta would like to explore offering excess mortality coverage as a new line of business for Pryde.

(a)   (*4 points*) Karl Michaels is concerned that Pryde does not have the expertise to evaluate excess mortality risk. Roberta James thinks that the risk can be modeled using the same approach as other catastrophes.

    (i)   Explain how you would use the components (modules) of a catastrophe model to quantify extreme mortality risk.

ANSWER:

    (ii)   Describe the elements of uncertainty that would exist in the model.

ANSWER:

8. **Continued**

Archie Daniels likes the potential diversification benefit of providing excess mortality protection. He states, "The risk of a pandemic is independent from the risk of a hurricane or earthquake. The Lyon shareholders should be happy with a decision to increase profits with only a slight increase in our aggregate risk exposure."

(b) (*2 points*) Critique Archie Daniels' statement from the standpoint of both Pryde and Lyon.

ANSWER:

Roberta James would like to see a financial analysis of whether it makes sense to provide excess mortality protection as a new line of business. You have been asked to develop a risk-adjusted performance measure for the analysis.

(c) (*4 points*)

(i) Recommend a risk-adjusted performance measure to evaluate the excess mortality protection line of business. Justify your recommendation.

ANSWER:

(ii) Describe the assumptions needed to determine Pryde's and Lyon's aggregate risk exposures when assuming an entrance into the excess mortality protection line of business.

ANSWER:

(iii) Recommend a method for allocating risk capital to the excess mortality protection line of business. Justify your recommendation.

ANSWER:

8. Continued

    (iv)   Describe the steps in implementing your recommended method for allocating risk capital in (iii).

ANSWER:

END OF EXAMINATION