

# Exam ERM

**Date:** Thursday, November 2, 2023

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## INSTRUCTIONS TO CANDIDATES

### General Instructions

1. This examination has 6 questions numbered 1 through 6 with a total of 60 points.

The points for each question are indicated at the beginning of the question. Questions 3 and 4 pertain to the Case Study.

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.

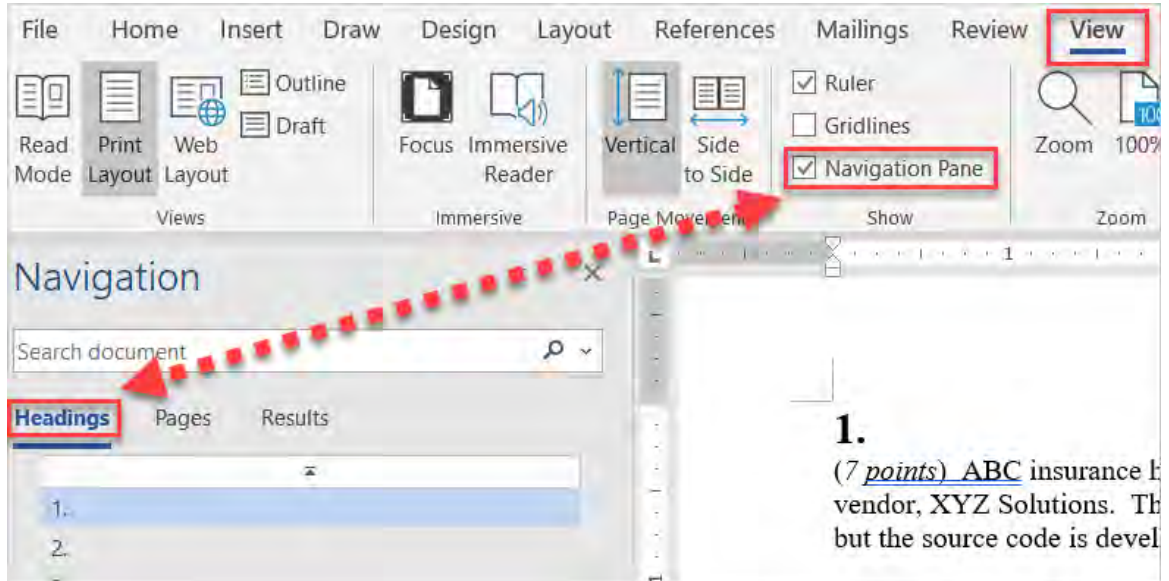
### Written-Answer Instructions

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,  $\beta_1$  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 the five-minute upload period expires.

## 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) 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) (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) (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%
<b>All Lines</b>	<b>504</b>	<b>571</b>	<b>33</b>	<b>74.6</b>	<b>7.1%</b>

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 “Q1.b.i” 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.

(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) (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:

(b) (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:

## 2. Continued

- (c) *(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:
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**Questions 3 and 4 pertain to the Case Study.  
Each question should be answered independently.**

### **3.**

*(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) *(3 points)* Critique the proposed model governance process presented in the memo.

ANSWER:

- (b) *(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) *(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:



### **3. Continued**

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

ANSWER:

***Questions 3 and 4 pertain to the Case Study.  
Each question should be answered independently.***

**4.**

(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 “Q4” in the accompanying Excel spreadsheet for the data from the actuarial team’s model.

(a) (5.5 points)

- (i) 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

*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.*

## 4. Continued

(iii) 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.*

(b) (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) (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.*

**4. Continued**

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

ANSWER:

## 5.

(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) (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:
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## 5. Continued

- (b) (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) (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.**

(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) (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) (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:

- (c) (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:

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



## 6. Continued

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.*

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

ANSWER:

**\*\*END OF EXAMINATION\*\***