

Exam GIADV

Date: Friday, May 13, 2022

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 8 questions numbered 1 through 8 with a total of 40 points.

The points for each question are indicated at the beginning of the question.

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

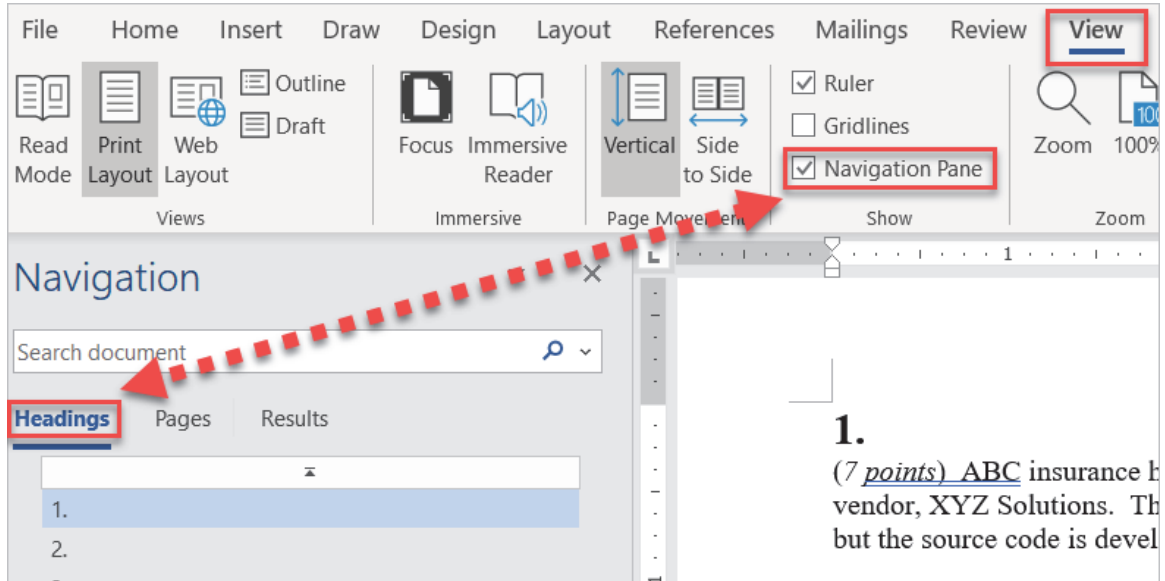
Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel 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 σ^2 can be typed as sigma^2.
 - 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. Rows can be inserted to the answer input area as required to provide space for your answer.
 - c) Individual exams may provide additional directions that apply throughout the exam or to individual items.
2. The answer should be confined to the question as set.
3. Prior to uploading your Word and Excel files, each file should be saved and renamed with your five-digit candidate number in the filename.
4. The Word and Excel 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:



1.

(5 points) A reinsurance company is writing a casualty per occurrence excess treaty for accident year 2023 covering the layer 500,000 excess of 250,000.

You are given the following information:

Loss Experience Evaluated as of December 31, 2021		
Accident Date	Untrended Loss	Untrended ALAE
7/1/2019	400,000	250,000
7/1/2020	900,000	600,000
7/1/2021	250,000	300,000

- All losses of at least 200,000 are shown.
- All policy limits throughout the experience period are 750,000 and are expected to remain at this level through 2023.
- On level subject premium is 4,000,000 for each year from 2019-2021.
- ALAE is allocated to layer in proportion to losses.
- Loss and ALAE trend are each 5% per year.
- The treaty premium is set at 15% of the subject premium base.

The following accident year development factors are applicable to both loss and ALAE in the layer 500,000 excess of 250,000:

12-Ultimate	2.30
24-Ultimate	1.35
36-Ultimate	1.10

- (a) (3 points) Calculate the annual treaty loss ratios including ALAE for each accident year, 2019-2021 (at the 2023 level).

Provide the response for this part in the Excel spreadsheet.

The reinsurance company is considering introducing a swing plan as follows:

- $\text{Retro Premium} = (\text{Actual Layer Losses}) \times 100/80$
- $\text{Provisional Rate} = 15\%$
- $\text{Maximum Premium} = 20\% \times \text{Subject Premium}$
- $\text{Minimum Premium} = 10\% \times \text{Subject Premium}$

- (b) (1.5 points) Calculate the annual treaty loss ratios including ALAE with the proposed swing plan for each accident year, 2019-2021 (at the 2023 level).

Provide the response for this part in the Excel spreadsheet.

1. Continued

- (c) (0.5 points) Provide one argument for and one argument against introducing the swing plan.

Provide the response for this part in the Excel spreadsheet.

2.

(4 points) You are calculating premiums and the underwriting profit margin (UPM) using the Risk Adjusted Discount Technique.

- (a) (0.5 points) Define “Risk Adjusted” in the context of the Risk Adjusted Discount Technique.

ANSWER:

You are given the following assumptions about a one-year policy:

- The premium (P) will be collected one month after policy inception.
- Expenses (E) of 24 will be paid at policy inception.
- Expected losses (L) are 120 and will be paid at policy expiration.
- The tax rate (t) on all income is 25% and taxes will be paid at policy expiration.
- Equity (S) of 90 supports the policy from inception to expiration.
- The risk-free rate is 4.2%.
- The risk-adjusted rate is 1.6%.

- (b) (1 point) State the discount rate (risk-free or risk-adjusted) that should be used with each cash flow.

ANSWER:

P:
E:
L:
S:

The equation for the premium is $PV(P) = PV(L) + PV(E) + PV(TUW) + PV(TII)$.

- (c) (1.5 points) Calculate each of these five values using a trial premium of 150.

Provide the response for this part in the Excel spreadsheet.

- (d) (0.5 points) Calculate the premium for this policy. (Note: Using Excel’s Goal Seek function is an acceptable approach.)

Provide the response for this part in the Excel spreadsheet.

- (e) (0.5 points) Calculate the UPM for this policy.

Provide the response for this part in the Excel spreadsheet.

3.

(5 points) You are given the following data extracted from a triangle of cumulative paid losses. Note that the final development period covers only nine months.

Accident Year	From (months)	To (months)	Increment	Diagonal Age	Accident Year Total
2018	0	12	2500	45	5000
2018	12	24	1800	45	5000
2018	24	36	500	45	5000
2018	36	45	200	45	5000
2019	0	12	4100	33	7000
2019	12	24	2000	33	7000
2019	24	33	900	33	7000
2020	0	12	4600	21	6800
2020	12	21	2200	21	6800
2021	0	9	5300	9	5300

You are also given the following onlevel premiums:

Accident Year	Onlevel Premium
2018	10,000
2019	12,000
2020	15,000
2021	18,000

You apply Clark's stochastic reserving model using the Cape Cod method and a Weibull distribution with cumulative distribution function $G(x) = 1 - \exp\left[-(x/\theta)^\omega\right]$ where x is in months.

- (a) (1 point) State three advantages of using a parametric curve to model development.

ANSWER:

- (b) (0.5 points) State one reason the Cape Cod method is generally preferred over the LDF method.

ANSWER:

3. Continued

Maximum likelihood estimates can be obtained by maximizing the function $\ell = \sum_i [c_i \ln(\mu_i) - \mu_i]$. The maximum likelihood estimate (MLE) of ω is 0.7103 and of θ is 9.823.

- (c) (1.5 points) Calculate the MLE of ELR .

Provide the response for this part in the Excel spreadsheet.

- (d) (1 point) Calculate the value of the loglikelihood function at its maximum.

Provide the response for this part in the Excel spreadsheet.

- (e) (1 point) Calculate the total reserve for the four accident years combined.

Provide the response for this part in the Excel spreadsheet.

4.

(8 points) You are interested in determining a model for loss development. The triangle of loss data you are working with, by accident year (AY) and development year, is:

AY	Development Year						
	1	2	3	4	5	6	7
1	2,089	7,443	12,056	14,891	17,770	19,852	20,727
2	3,096	9,116	11,930	16,779	18,552	20,232	
3	2,382	8,774	11,820	16,451	18,064		
4	1,899	7,537	12,697	16,974			
5	1,538	6,670	9,658				
6	1,928	7,197					
7	2,579						

Three possible sets of age-to-age factors are obtained by using:

- (i) A simple average of individual accident year age-to-age factors
- (ii) Mack's weighted average of individual accident year age-to-age factors
- (iii) A standard unweighted least squares regression of each column against the previous column

- (a) (1.5 points) State the variance assumption that underlies each set of age-to-age factors.

ANSWER:

Two of Venter's six testable implications of assumptions are the linearity of a model and the stability of its age-to-age factors. He suggests looking at plots of residuals to test each of these.

- (b) (1 point) Identify the independent variable for each of these two tests.

ANSWER:

Linearity:
Stability:

4. Continued

Another of Venter's testable implications of assumptions is that there is no correlation among columns of age-to-age factors. The sample correlation coefficient between the second and third columns of age-to-age factors is -0.762 .

- (c) (1 point) Determine whether this correlation is significant at the 10% level using a two-sided t-test with a critical value of 2.92.

Provide the response for this part in the Excel spreadsheet.

The covariance matrix of the reserve estimators for the individual accident years based on Mack's model is:

0	0	0	0	0	0	0
0	39,014	19,403	20,606	15,735	17,248	22,337
0	19,403	227,614	87,132	66,536	72,932	94,452
0	20,606	87,132	1,565,012	333,081	365,098	472,829
0	15,735	66,536	333,081	2,535,873	537,177	695,684
0	17,248	72,932	365,098	537,177	8,592,891	1,911,584
0	22,337	94,452	472,829	695,684	1,911,584	21,811,323

- (d) (2.5 points) Demonstrate that the variance for accident year 4 in the center of the matrix has been correctly calculated.

Provide the response for this part in the Excel spreadsheet.

- (e) (1 point) Demonstrate that the covariance between accident years 2 and 3 has been correctly calculated.

Provide the response for this part in the Excel spreadsheet.

- (f) (1 point) Calculate the standard error of the overall reserve estimator for all accident years combined.

Provide the response for this part in the Excel spreadsheet.

5.

(5 points) An insurer is renewing two portfolios of business, A and B, each of which is exposed to six independent loss events as follows:

Event(<i>i</i>)	$p(i)$	Loss to Portfolio A	Loss to Portfolio B
1	0.010	1,350,000	250,000
2	0.005	2,575,000	1,795,000
3	0.004	3,210,000	475,000
4	0.015	450,000	850,000
5	0.006	225,000	3,420,000
6	0.003	1,985,000	6,155,000

- $p(i)$ represents the probability of event i .
- The risk load multiplier, λ , is 2.4×10^{-7} .

(a) (1.5 points) Calculate the following for each portfolio and for the two portfolios combined:

- Expected losses
- Variance of losses
- Coefficient of variation

Provide the response for this part in the Excel spreadsheet.

(b) (3 points) Calculate the renewal risk load by portfolio using each of the following methods:

- Marginal Variance
- Shapley
- Covariance Share

Provide the response for this part in the Excel spreadsheet.

(c) (0.5 points) Demonstrate for each method in part (b) whether or not the risk load is renewal additive.

Provide the response for this part in the Excel spreadsheet.

6.

(5 points) In “A Framework for Assessing Risk Margins,” Marshall et al. (Marshall) categorize risk into the following sources of uncertainty:

- I. Independent risk
- II. Internal systemic risk
- III. External systemic risk

(a) (0.5 points) Define internal systemic risk.

ANSWER:

(b) (0.5 points) Describe how internal systemic risk contributes to correlation effects in an assessment of insurance liability risk margins.

ANSWER:

(c) (1.5 points) Describe the three main sources of internal systemic risk:

- (i) Specification error
- (ii) Parameter selection error
- (iii) Data error

ANSWER:

- (i)
- (ii)
- (iii)

6. Continued

- (d) (1.5 points) Identify which main source of internal systemic risk corresponds to each of the following potential risk indicators:
- (i) Best predictors have been identified
 - (ii) Extent, timeliness, consistency and reliability of information
 - (iii) Knowledge of past processes affecting predictors
 - (iv) Number and importance of subjective adjustments to factors
 - (v) Ability to detect trends in key claim cost indicators
 - (vi) Value of predictors used

ANSWER:

- (i)
- (ii)
- (iii)
- (iv)
- (v)
- (vi)

6. Continued

Marshall proposes using a balanced scorecard approach for determining the internal systemic risk coefficients of variation (CoVs) by line of business (LoB). With this approach, a score is obtained for each LoB using a scorecard assessment. These scores are then used to obtain the CoVs for each LoB using a CoV scale.

The following is a CoV scale example as used by Marshall:

Score from balanced scorecard assessment	Short-Tail LoB	Long-Tail LoB
1.0 to 1.5	17.5%	25.0%
1.5 to 2.0	13.0%	20.5%
2.0 to 2.5	10.5%	17.0%
2.5 to 3.0	8.5%	14.0%
3.0 to 3.5	7.0%	11.5%
3.5 to 4.0	6.0%	9.5%
4.0 to 4.5	5.5%	8.0%
4.5 to 5.0	5.0%	7.0%

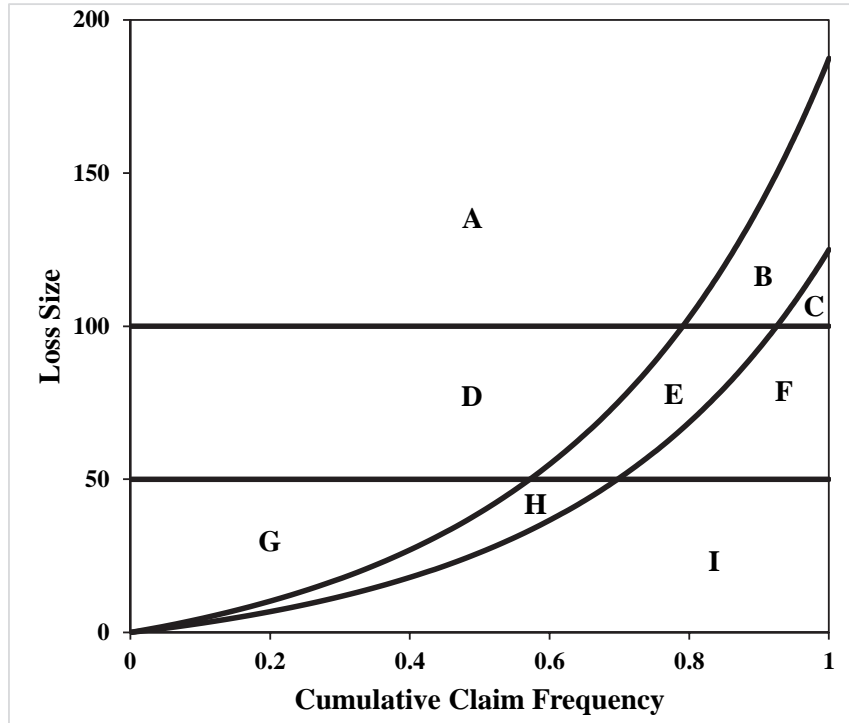
From the CoV scale example, the following characteristics are observed:

- The scale is not linear, and
 - CoVs are higher for long-tail lines.
- (e) (1 point) Provide the reasoning behind using a CoV scale with these two characteristics.

ANSWER:

7.

(4 points) You are given the following graph of a loss distribution for a coverage with a basic limit of 50, both before and after a trend factor representing positive trend is applied:



Express each of the following quantities using the labels for the nine areas on the graph:

- (i) 50
- (ii) 100
- (iii) Expected loss before trend
- (iv) Expected loss after trend
- (v) Increased limit factor for 100 before trend
- (vi) Increased limit factor for 100 after trend
- (vii) Trend factor for basic limit losses
- (viii) Trend factor for losses in excess of the basic limit

ANSWER:

- (i)
- (ii)
- (iii)
- (iv)
- (v)
- (vi)
- (vii)
- (viii)

8.

(4 points) ABC Reinsurance Company has proposed a finite risk cover without reinstatements to Ceding Insurance Company with the following terms:

- Annual Premium: 15,000,000
- Occurrence Limit: 100,000,000
- Profit Commission: 80% after 10% margin on Annual Premium
- Additional Premium: 50% of (Loss + Margin – Annual Premium)

(a) (0.5 points) Calculate the nominal rate on line.

Provide the response for this part in the Excel spreadsheet.

(b) (1 point) Calculate the underwriting loss (excluding expenses) to ABC Reinsurance if a loss fully exhausts the limit.

Provide the response for this part in the Excel spreadsheet.

(c) (0.5 points) Calculate the premium for an equivalent traditional risk cover.

Provide the response for this part in the Excel spreadsheet.

(d) (0.5 points) Calculate the rate on line for an equivalent traditional risk cover.

Provide the response for this part in the Excel spreadsheet.

A catastrophe model indicates that a loss will fully exhaust the limit once every N years and that the probability of a partial loss is negligible.

(e) (0.5 points) Calculate the minimum value of N that would allow ABC Reinsurance Company to avoid an expected underwriting loss with the finite risk cover.

Provide the response for this part in the Excel spreadsheet.

A further consideration when comparing a traditional risk cover to a finite risk cover is credit risk.

(f) (1 point) Explain how credit risk affects the comparison.

Provide the response for this part in the Excel spreadsheet.

****END OF EXAMINATION****