SOCIETY OF ACTUARIES

Advanced Topics in General Insurance

Exam GIADV

Date: Friday, November 1, 2024

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 13 questions numbered 1 through 13 with a total of 60 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) Calculations should be done in Excel and entered as formulas. 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 unique candidate number in the filename. To maintain anonymity, please refrain from using your name and instead use your candidate number.

4. The Word and Excel files that contain your answers must be uploaded before the five-minute upload period expires.

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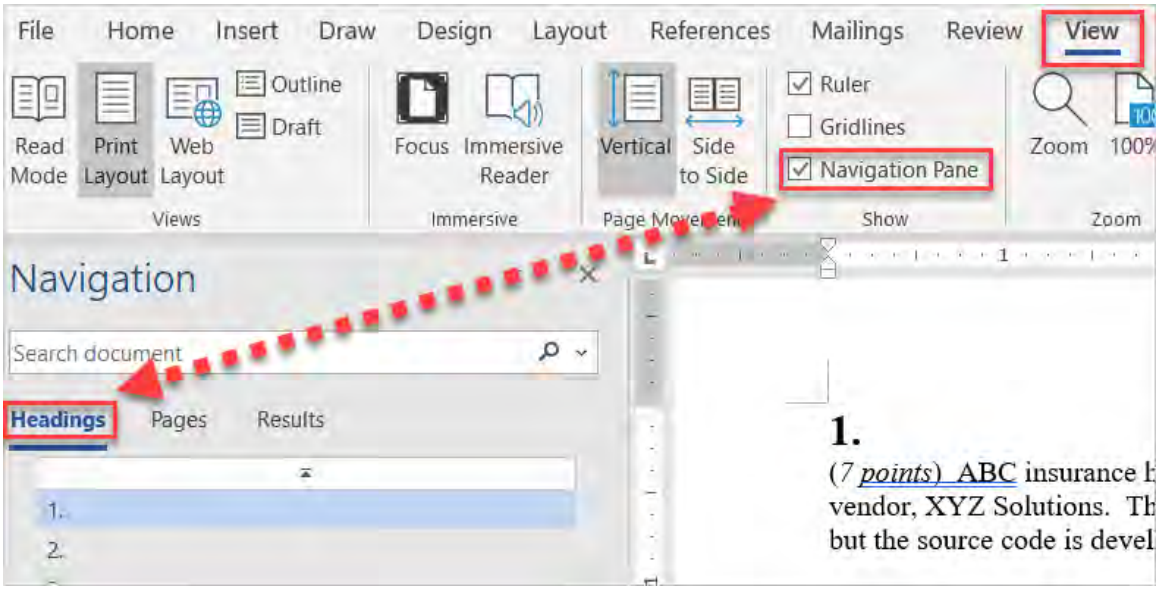
Navigation Instructions

Open the Navigation Pane to jump to questions.

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



1.

Provide the response for this question in the Excel spreadsheet.

(*4 points*) You are exposure rating a workers compensation treaty.

You are given the following:

- The treaty covers the layer 300,000 excess of 100,000 for losses from two states, X and Y.

State	Expected Loss Ratio
X	50%
Y	70%

State	Hazard Group	Standard Premium
X	J	70,000
X	K	120,000
Y	J	110,000
Y	K	100,000

Both states have the following NCCI excess loss factors (ELF):

Loss Size	Hazard Group J	Hazard Group K
200,000	0.030	0.069
1,000,000	0.006	0.019

You approximate the NCCI ELF curves with an inverse power curve of the form $ELF_L = a\,L^{-b}$.

(a) (*1 point*) Calculate the values of a and b for each hazard group.

(b) (*2.5 points*) Calculate the loss cost rate for the treaty.

(c) (*0.5 points*) Explain how excluding state X will affect the loss cost rate for the treaty.

2.

(*4 points*) Premium rating schemes used by insurers include schedule rating, judgement rating, and experience rating.

(a) (*1.5 points*) Compare schedule rating with judgement rating.

ANSWER:

Insurance companies typically only use schedule rating for certain types of general insurance policies.

(b) (*1 point*) Describe these types of policies.

ANSWER:

In developing a prospective experience rating program, the first step for insurers is to determine the primary objectives of the program.

(c) (*1.5 points*) Identify three primary objectives typically used by insurers in this determination.

ANSWER:

3.

Provide the response for this question in the Excel spreadsheet.

(*5 points*) You have been provided data extracted from a triangle of cumulative paid losses. You are also provided with a set of onlevel premiums. The data are provided on tab "Q03" in the Excel file.

You plan to apply Clark's stochastic reserving model using the Cape Cod method and are considering the following three distributions:

- Weibull;
- Gamma; and
- Loglogistic.

Clark discusses two distributions, Weibull and loglogistic, as being appropriate for development modeling.

(a) (*0.5 points*) Explain why the gamma distribution is also appropriate for use in Clark's model.

(b) (*0.5 points*) Explain why the gamma distribution may not be the most reasonable choice.

In addition to providing the data, the spreadsheet tab also has the calculations for fitting all three distributions as well as the calculation of the scale factor estimate, σ^2.

(c) (*4 points*) Recommend which of the three distributions should be used based upon fit to the data. Justify your recommendation including one numerical and one graphical argument.

4.

Provide the response for this question in the Excel spreadsheet.

(*8 points*) You are determining the variability of unpaid claim estimates. The triangle of cumulative paid claims data is presented below. It is assumed that all claims are fully developed after ten years.

Accident Year (AY)	Development Year (DY)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	30,635	75,918	103,075	125,164	141,147	148,303	156,205	162,274	162,822	167,371
2	30,486	83,621	114,168	133,409	147,859	156,463	164,248	164,993	171,679	
3	35,418	94,329	129,403	149,407	161,144	174,302	178,234	189,111		
4	31,988	86,950	125,282	147,174	166,267	174,933	186,389			
5	41,863	108,494	151,006	170,927	188,961	201,914				
6	69,271	185,534	231,294	274,553	293,180					
7	70,874	176,227	230,361	258,473						
8	60,124	147,680	193,988							
9	61,571	146,296								
10	48,754									

(a) (*1.5 points*) Calculate the development factors (f_k) and complete the triangle using Mack's chain ladder approach.

(b) (*1 point*) Calculate the values of α_8^2 and α_9^2.

(c) (*1 point*) Calculate the standard error of the reserve estimator for AYs 2 and 3.

(d) (*1.5 points*) Calculate a 95% confidence interval for the AY 8 reserve estimate using Mack's approach based on the lognormal distribution. (The 97.5 percentile of the normal distribution is 1.96.)

Your assistant has suggested that the variance of the overall reserve estimator can be calculated by summing the individual AY variances.

(e) (*0.5 points*) Explain why your assistant's approach is incorrect.

(f) (*0.5 points*) Explain why the correct value is larger than that obtained via your assistant's approach.

Venter's paper introduces the following notation:

- $c(w, d)$ – The cumulative loss from AY w as of age d.
- $q(w, d)$ – The incremental loss from AY w from age $d - 1$ to age d.
- $f(d)$ – The factor applied to $c(w, d)$ to estimate $q(w, d + 1)$.

4. Continued

Venter restates one of Mack's assumptions as $E[q(w, d + 1) \mid \text{data to } w + d] = f(d)c(w, d)$.

(g) (*0.5 points*) State the assumption in words.

Venter provides three alternative expressions for $E[q(w, d + 1) \mid \text{data to } w + d]$ that are worth investigating.

(h) (*1.5 points*) State a formula for each of the three alternative expressions including a verbal description of what they represent.

Formula 1: $E[q(w, d + 1) \mid \text{data to } w + d] =$

Formula 2: $E[q(w, d + 1) \mid \text{data to } w + d] =$

Formula 3: $E[q(w, d + 1) \mid \text{data to } w + d] =$

5.

Provide the response for this question in the Excel spreadsheet.

(*5 points*) WXY Insurance is quoting catastrophe insurance renewal premiums for three accounts (AA, BB, CC). WXY calculates catastrophe insurance premiums as the expected loss plus a risk load.

(a) (*1 point*) Explain why using a premium risk load based upon the Marginal Surplus method is problematic.

WXY decides to use the Shapley Method to calculate premium risk loads.

Each account is exposed to a catastrophic risk that has six possible outcomes as follows:

Outcome	Probability	Loss to Account		
		AA	BB	CC
P	0.925	0	0	0
Q	0.031	5,200	1,100	700
R	0.022	7,500	4,700	5,500
S	0.014	7,700	10,300	8,000
T	0.006	15,300	11,000	11,600
U	0.002	25,600	11,900	16,400

WXY will insure the losses to the accounts at a total premium in which the risk load is the variance of the portfolio times the risk load multiplier, λ, with λ set equal to 0.0001.

(b) (*1 point*) Calculate the total premium to be received by WXY.

(c) (*2.5 points*) Calculate the premium for each account using the Shapley method.

(d) (*0.5 points*) Demonstrate that the Shapley method does not have the problem identified in part (a).

6.

(*4 points*) You are given the following information for an excess of loss contract:

- ***R*** is the retention
- ***S*** is the retention plus the limit
- ***F*** is the cumulative distribution function
- ***G*** = 1 – ***F***
- $\boldsymbol{A} = \int_R^S G(x)dx$, $\boldsymbol{B} = \int_R^S xdG(x)$, $\boldsymbol{C} = \int_R^S F(x)dx$ and $\boldsymbol{D} = \int_R^S xdF(x)$

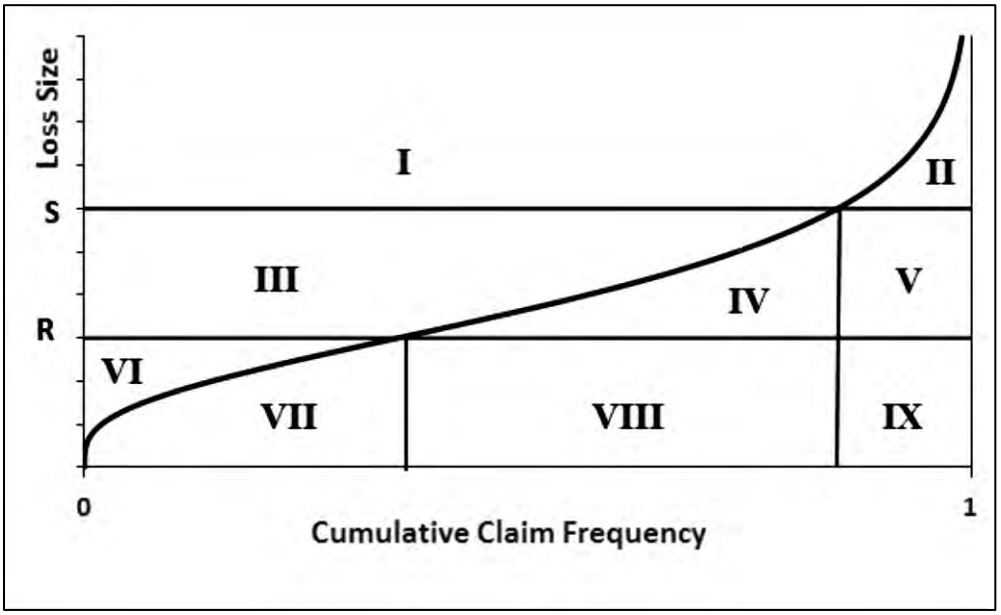
(a) (*2 points*) Provide the equation for the expected payment per ground-up claim on this contract using ***A***, ***B***, ***C***, ***D***, ***R***, ***S***, ***F*** and/or ***G***, for the following methods.

(i) Size method

(ii) Layer method

ANSWER:
(i) Size method =
(ii) Layer method =

You are given the following graph of the loss distribution corresponding to this contract.



6. Continued

(b) (*2 points*) Restate the formulas provided in part (a) using the areas from the graph (I, II, …).

ANSWER: *Use parentheses to indicate each term in each equation.*

(i) Size method =

(ii) Layer method =

7.

Provide the response for this question in the Excel spreadsheet.

(*5 points*) A retrospective rating plan with an ultimate standard loss ratio of 65% uses the following:

Retrospective Adjustment Period	Cumulative % of Total Losses Emerged	Insurance Charge at Retro Maximum	Insurance Savings at Retro Minimum	% of Losses Eliminated by a Per Accident Limit
First	73.1%	0.102	0.005	2.4%
Second	86.2%	0.120	0.004	3.0%
Third	93.7%	0.128	0.003	3.7%
Fourth	98.0%	0.134	0.003	4.5%
Subsequent	100.0%	0.144	0.002	5.0%

(a) (*2 points*) Calculate the incremental loss capping ratio by retro adjustment period using the Teng and Perkins methodology.

After consideration of the analysis from part (a) and historical loss elimination ratios, the following incremental loss capping ratios were selected for use in the calculation of the retrospective premium asset.

Retro Adjustment Period	Selected Incremental Loss Capping Ratio
First	85%
Second	70%
Third	65%
Fourth	50%
Subsequent	0%

Additionally, you are given the following parameters for the retrospective rating formula:

Expected Loss Ratio	65%
Basic Premium Factor	0.200
Loss Conversion Factor	1.200
Tax Multiplier	1.025

7. Continued

(b) (*1.5 points*) Calculate the implied PDLD ratios at each retro adjustment period based upon the retrospective rating parameters and the selected incremental loss capping ratios.

You are given the following information for the policy period subject to its second retrospective adjustment as of December 31, 2023.

	Amount in Millions
Expected future loss emergence	72.65
Premium booked from prior adjustment	302.38
Premium booked as of December 31, 2023	298.62

(c) (*1.5 points*) Calculate the premium asset as of December 31, 2023, for the policy period subject to the second retrospective adjustment using the PDLD ratios from part (b).

8.

(*4 points*) You are calculating a risk margin for claim liabilities using the approach as set out in "A Framework for Assessing Risk Margins" by Marshall et. al. You are given the following:

I. A new AI-powered claims assessment system has been implemented to improve the claim management process.

II. Stochastic modeling techniques are used to analyze independent sources of risk.

III. A statistical method is used to determine the best predictors for the valuation model.

IV. The valuation model assumptions and results are being monitored and reviewed periodically.

V. The valuation actuaries receive consistent and reliable information in a timely manner.

VI. There was a recent state law change that affected large claims severity.

Marshall identifies three risk components of internal systemic risk.

(a) (*2 points*) Complete the following table using the information provided above.

Internal Systemic Risk			
Risk	**Risk Component**	**Risk Indicator**	**Which of I - VI are considered when scoring this risk indicator against best practice**
1			
2			
3			

8. Continued

Marshall identifies seven risk categories as sources of external systemic risk (ESR).

(b) (*0.5 points*) Identify two of these categories of ESR sources that are created from the information provided. Identify which of I through VI creates each.

ANSWER:

You are using Marshall's balanced scorecard approach to measure the internal systemic risk coefficient of variation (CoV) for two lines of business, property and liability.

In the scorecard, the scores can be from 1 through 5, where 5 represents best practice. Each line of business produces a weighted score of 3.9 from this balanced scorecard assessment.

You have the following options for the CoV scales.

Internal Systemic Risk - CoV Scales					
Score	**Scale 1**	**Scale 2**	**Scale 3**	**Scale 4**	**Scale 5**
1.0-2.0	5.0%	2.5%	11.0%	20.0%	20.0%
2.0-3.0	8.0%	5.0%	7.0%	13.0%	15.0%
3.0-4.0	10.0%	9.0%	5.5%	9.5%	10.0%
4.0-5.0	11.5%	13.0%	5.0%	7.0%	5.0%

(c) (*1.5 points*) Select the appropriate CoV to be used for each line of business. Justify your selections.

ANSWER:

9.

(*5 points*) Quantitative tests are generally required to determine if a reinsurance contract transfers sufficient insurance risk when it is not reasonably self-evident that sufficient insurance risk is transferred.

The following is a list of attributes that may be applied to certain quantitative tests of risk transfer:

I. Uses net economic outcomes

II. Relatively simple to determine given a loss distribution

III. Has a single-point focus

IV. Provides the average frequency of the worst outcomes

V. Requires a subjective threshold selection

VI. Measures risk relative to expected return

VII. Based on a fixed percentile

VIII. Fails to recognize catastrophe cover as transferring sufficient insurance risk

IX. Provides the average severity of the worst outcomes events

(a) (*2 points*) Complete the following table with the attributes listed above. *Note that an attribute may be included in more than one cell and a cell may include more than one attribute*.

Quantitative Test	Advantage(s)	Disadvantage(s)
Value-at-Risk (VaR)		
Tail Value-at-Risk (TVaR)		
Expected Reinsurer Deficit (ERD)		

9. Continued

(b) (*0.5 points*) State the following:

(i) The accounting treatment for a reinsurance contract that is categorized as not transferring sufficient insurance risk.

(ii) A type of reinsurance coverage deemed to transfer sufficient risk transfer despite being not "reasonably self-evident" and not fulfilling quantitative risk transfer tests.

ANSWER:
(i)

(ii)

(c) (*1 point*) Compare the risk measurement in the ERD test with that in the Risk Coverage Ratio (RCR) test.

ANSWER:

(d) (*1.5 points*) Show the formula for RCR (in percent form) that includes ERD as a term in the formula. Define all terms in the formula, excluding ERD.

ANSWER:

10.

Provide the response for this question in the Excel spreadsheet.

(*4 points*) You are given the following :

Accident Year (AY)	Age-to-Age Factors for 100,000 Limit					
	12 to 24	**24 to 36**	**36 to 48**	**48 to 60**	**60 to 72**	**72 to Ultimate (Ult)**
2018	1.351	1.052	1.021	1.005	1.001	
2019	1.340	1.054	1.020	1.005		
2020	1.343	1.051	1.020			
2021	1.360	1.052				
2022	1.365					
Average Factor	1.352	1.052	1.020	1.005	1.001	
	12 to Ult	**24 to Ult**	**36 to Ult**	**48 to Ult**	**60 to Ult**	**72 to Ult**
Selected CDF	1.460	1.080	1.026	1.006	1.001	1.000

Amounts for Claims at 100,000 Limit (As of Year-End 2023, in 000)	**AY 2023**	**AY 2022**	**AY 2021**	**AY 2020**	**AY 2019**	**AY 2018**
Reported	3,055	4,232	4,120	3,167	3,048	3,650
Ultimate	4,461	4,570	4,230	3,186	3,051	3,650
IBNR	1,406	339	109	19	3	0

AY	**Reported Claims (000) at 200,000 Limit**		
	12	**24**	**36**
2021	3,870	5,805	6,211
2022	4,120	7,004	
2023	4,239		

- Claims at the 200,000 limit are from 2021 as that is when the insurer began writing 200,000 limit policies.
- There is no development beyond 72 months.

Siewert's formula is to be used for the 200,000 limit because the data at that limit does not provide any information for development beyond 36 months.

10. Continued

You are given the following severity relativities based on industry data.

Severity Relativity (Rt)	12 to 24	24 to 36	36 to 48	48 to 60	60 to 72	72 to Ult
100,000 to Unlimited	0.795	0.697	0.676	0.653	0.639	0.620
200,000 to Unlimited	0.893	0.845	0.775	0.758	0.745	0.735

(a) (*1.5 points*) Calculate the IBNR as of December 31, 2023 by AY for the 200,000 limit using Siewert's formula.

(b) (*1.5 points*) Explain why actuarial judgement is needed when using Siewert's formula based on the results in part (a).

The increased limit factor (ILF) method is an alternative method to calculate IBNR for claims at increased limits.

You are given the following additional information:

- The ILF applicable to claims at a 200,000 limit relative to a 100,000 limit is 1.58 at the January 1, 2021 cost level.
- The annual trend for claims at a 100,000 limit is 1.8%.
- The annual trend for claims at a 200,000 limit is 2.7%.

(c) (*1 point*) Calculate the IBNR as of December 31, 2023 by AY for the 200,000 limit using the ILF method.

11.

Provide the response for this question in the Excel spreadsheet.

(*4 points*) You are provided the following accident year (AY) lag by report year (RY) pure premium matrix for claims-made insurance coverage.

AY Lag	RY								
	6	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
0	541.93	585.30	632.12	682.69	737.31	796.29	859.99	928.79	1,003.11
1	418.18	451.63	487.75	526.77	568.90	614.42	663.58	716.66	773.99
2	387.20	418.18	451.63	487.75	526.77	568.90	614.42	663.58	716.66
3	143.41	154.88	167.27	180.65	195.09	210.70	227.55	245.76	265.43
4	132.78	143.41	154.88	167.27	180.65	195.09	210.70	227.55	245.76

Determine the following:

(i) (*0.5 points*) Average annual accident year trend rate

(ii) (*1 point*) Accident year reporting pattern as a percent of total

(iii) (*1.5 points*) Step factor at each year of claims-made maturity

(iv) (*0.5 points*) Tail factor applicable to coverage following a first-year claims-made maturity policy

(v) (*0.5 points*) Tail factor applicable to coverage following a third-year claims-made maturity policy

12.

(*4 points*) Insurers use deductibles to reduce their claims paid, which as a result leads to a reduction of the premiums paid by insureds. There are many other reasons why insurers use deductibles in their policies, including reducing moral hazard and morale hazard.

(a) (*1 point*) Identify two other reasons insurers use deductibles in their policies.

ANSWER:

(b) (*1.5 points*) Provide an example of an action taken by an insured that would be considered:

(i) Moral hazard

(ii) Morale hazard

ANSWER: (i) (ii)

(c) (*1 point*) Describe a problem with the use of a percentage deductible for property insurance.

ANSWER:

(d) (*0.5 points*) Describe how a coinsurance clause in a property policy limits claims.

ANSWER:

13.

Provide the response for this question in the Excel spreadsheet.

(*4 points*) A reinsurance company is writing a casualty per occurrence excess treaty for accident year 2025 covering the layer 800,000 excess of 200,000.

You are given the following information:

Loss Experience as of December 31, 2023		
Accident Date	**Untrended Loss**	**Untrended ALAE**
July 1, 2021	120,000	90,000
July 1, 2021	0	130,000
July 1, 2022	600,000	250,000
July 1, 2022	125,000	0
July 1, 2023	140,000	50,000
July 1, 2023	300,000	225,000

- All claims with potential to exceed the treaty attachment point are shown.
- All policy limits throughout the experience period are 1,000,000 and are expected to remain at this level through 2025.
- Onlevel subject premium is 10,000,000 for each year from 2021-2023.
- ALAE is treated as "Part-of-Loss."
- Loss trend is 5% per year.
- ALAE trend is 10% per year.
- The following accident year development factors are applicable to both loss and ALAE in the layer 800,000 excess of 200,000.

12 to Ultimate	2.00
24 to Ultimate	1.40
36 to Ultimate	1.10

Estimate the experience rating loss cost, including ALAE, as a percentage of the subject premium.

****END OF EXAMINATION****