CURATED PAST EXAM ITEMS
- Questions -

GI 301 – Further Topics in General Insurance

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 The inclusion in these curated past exam questions of material that is no longer current does not bring such material into scope for current assessments.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.

GI 301 Learning Objective 1 Curated Past Exam Questions

Message to Candidates

While the learning objectives and outcomes for Topic 1 have not materially changed since 2020, starting with the Fall 2025 administration of GI 301 key readings for this topic have changed. The unchanged reading is Clark's LDF curve fitting paper. Questions based on that paper are number 3 in the prior questions presented here.

Question 4 in each prior exam is based on readings from papers by Mack and Venter. Many of the methods and formulas from those papers are also in the required readings for GI 301. For those items we have indicated parts that are no longer applicable (noting that there may be similar concepts in the current readings), but have retained the full item for continuity. The current papers use different notation, but the translation should be obvious.

It is also important to note that the current readings include topics not covered in Mack and Venter and hence the prior exams are not sufficient preparation.

GIADV, Fall 2020, Q3

(*5 points*) You are given the following data extracted from a triangle of cumulative paid losses:

Accident Year	From (months)	To (months)	Increment	Diagonal Age	Accident Year Total
2016	0	12	2,500	48	5,000
2016	12	24	1,800	48	5,000
2016	24	36	500	48	5,000
2016	36	48	200	48	5,000
2017	0	12	4,100	36	7,000
2017	12	24	2,000	36	7,000
2017	24	36	900	36	7,000
2018	0	12	4,600	24	6,800
2018	12	24	2,200	24	6,800
2019	0	12	5,300	12	5,300

You are also given the following onlevel premiums:

Accident Year	Onlevel Premium
2016	10,000
2017	12,000
2018	15,000
2019	18,000

You apply Clark's stochastic reserving model using the Cape Cod method and a loglogistic distribution with cumulative distribution function $G(x) = \frac{x^{\omega}}{x^{\omega} + \theta^{\omega}}$ where x is in months.

In Clark's model, the distribution of ultimate reserves is approximated by a discrete distribution.

(a) (*0.5 points*) Explain why this should not be a cause for concern.

ANSWER:

Maximum likelihood estimates can be obtained by maximizing the function $\ell = \sum_i \left[c_i \ln(\mu_i) - \mu_i \right]$. The maximum likelihood estimate of θ is 6.7805, of ω is 0.9993, and of *ELR* is 0.6386.

(b) (*2 points*) Calculate the value of ℓ at its maximum.

The response for part (b) is to be provided in the Excel spreadsheet.

(c) (*1 point*) Estimate the scale factor, σ^2.

The response for part (c) is to be provided in the Excel spreadsheet.

(d) (*1 point*) Create a scatter plot in which the *x* values are the expected incremental losses and the *y* values are the normalized residuals.

The response for part (d) is to be provided in the Excel spreadsheet.

(e) (*0.5 points*) Interpret the scatter plot in part (d) with regard to determining if the model assumptions are correct.

ANSWER:

GIADV, Fall 2020, Q4

(*9 points*) You are interested in determining the variability of unpaid claim estimates. The triangle of paid claims data you are working with, by accident year (AY) and development year, is presented below. It is assumed that all claims are fully developed after seven years.

Mack's method of estimating reserve variability is to be applied to this triangle.

	Development Year							
AY	1	2	3	4	5	6	7	Standard Error
1	5,012	8,269	10,907	11,805	13,539	16,181	18,009	0
2	106	4,285	5,396	10,666	13,782	15,599		559
3	3,410	8,992	13,873	16,141	18,735			
4	5,655	11,555	15,766	21,266				
5	1,092	9,565	15,836					7,865
6	1,513	6,445						6,234
7	557	1,629						14,344
	Age-to-Age Factors							
1	1.650							
2	40.425							
3	2.637							
4	2.043							
5	8.759							
6	4.260							
f_k	2.925							
α_k^2	40,350							

(a) (*1.5 points*) State the three statistical assumptions underlying the chain ladder model.

ANSWER:

(b) (*1 point*) Complete the triangle of age-to-age factors.

The response for part (b) is to be provided in the Excel spreadsheet.

(c) (*1.5 points*) Calculate the remaining values of f_k and α_k^2.

The response for part (c) is to be provided in the Excel spreadsheet.

(d) (*1 point*) Square the development triangle by completing the remaining shaded cells, where one calculated value is provided.

The response for part (d) is to be provided in the Excel spreadsheet.

(e) (*3 points*) Calculate the remaining standard errors of the reserve estimators for the individual accident years.

The response for part (e) is to be provided in the Excel spreadsheet.

An alternative to the chain ladder model is the parameterized BF model.

(f) (*1 point*) Describe how expected future emergence differs between the two models.

ANSWER:

GIADV, Spring 2021, Q3

(*4 points*) You are given the following data extracted from a triangle of cumulative paid losses:

Accident Year	From (months)	To (months)	Increment	Diagonal Age	Accident Year Total
2017	0	12	2,500	48	5,000
2017	12	24	1,800	48	5,000
2017	24	36	500	48	5,000
2017	36	48	200	48	5,000
2018	0	12	4,100	36	7,000
2018	12	24	2,000	36	7,000
2018	24	36	900	36	7,000
2019	0	12	4,600	24	6,800
2019	12	24	2,200	24	6,800
2020	0	12	5,300	12	5,300

You are also given the following onlevel premiums:

Accident Year	Onlevel Premium
2017	10,000
2018	12,000
2019	15,000
2020	18,000

You apply Clark's stochastic reserving model using the Cape Cod method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-x/\theta}$ where x is in months.

The maximum likelihood estimate of *ELR* is 0.5424 and of θ is 8.104.

(a) (*1 point*) Estimate the scale factor, σ^2.

Provide the response for this part in the Excel spreadsheet.

(b) (*1.5 points*) Estimate the process standard deviation of the loss reserve for all accident years combined.

Provide the response for this part in the Excel spreadsheet.

In 2022, the premium is expected to be 20,000.

(c) (*0.5 points*) Estimate the expected loss for 2022.

Provide the response for this part in the Excel spreadsheet.

(d) (*0.5 points*) Estimate the coefficient of variation due to process variance for the 2022 loss.

Provide the response for this part in the Excel spreadsheet.

The covariance matrix of the estimates of *ELR* and θ, respectively, is:

$$\begin{pmatrix} 0.00147 & 0.01112 \\ 0.01112 & 0.64988 \end{pmatrix}$$

(e) (*0.5 points*) Estimate the coefficient of variation due to parameter variance for the 2022 loss.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2021, Q3

(*5 points*) You are given the following data extracted from a triangle of cumulative paid losses:

Accident Year	From (months)	To (months)	Increment	Diagonal Age	Accident Year Total
2017	0	12	2,500	48	5,000
2017	12	24	1,800	48	5,000
2017	24	36	500	48	5,000
2017	36	48	200	48	5,000
2018	0	12	4,100	36	7,000
2018	12	24	2,000	36	7,000
2018	24	36	900	36	7,000
2019	0	12	4,600	24	6,800
2019	12	24	2,200	24	6,800
2020	0	12	5,300	12	5,300

You apply Clark's stochastic reserving model using the LDF method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-x/\theta}$ where x is in months.

The maximum likelihood estimate of θ is 8.15473.

(a) (*2 points*) Calculate the maximum likelihood estimate of ultimate losses (*ULT*) for each of the four accident years.

Provide the response for this part in the Excel spreadsheet.

(b) (*1 point*) Estimate the scale factor, σ^2.

Provide the response for this part in the Excel spreadsheet.

(c) (*1 point*) Estimate the process standard deviation of the loss reserve for all accident years combined.

Provide the response for this part in the Excel spreadsheet.

In the Excel spreadsheet, there is a graph that shows the normalized residuals plotted against the increment age. It will be automatically populated with values once the work in parts (a) and (b) is completed.

(d) (*0.5 points*) Describe how the graph should appear if the model assumptions are satisfied.

Provide the response for this part in the Excel spreadsheet.

(e) (*0.5 points*) Determine if the model assumptions are satisfied, based on this graph.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2021, Q4

Parts (d) to (f) are not on GI 301

(*9 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:

	Development Year						
AY	1	2	3	4	5	6	7
1	6,012	8,269	11,907	12,805	15,539	17,181	20,009
2	106	5,285	5,396	11,666	13,782	16,599	
3	4,410	8,992	14,873	16,141	19,735		
4	4,655	11,555	14,766	21,266			
5	2,092	9,565	16,836				
6	513	6,445					
7	1,557						

(a) (*1.5 points*) State the three statistical assumptions underlying the chain ladder model.

Provide the response for this part in the Excel spreadsheet.

Note: This test is in the study note written by M. Hardy.

(b) (*2 points*) Demonstrate that the test statistic suggested by Mack to test for a calendar year effect is equal to 2.

Provide the response for this part in the Excel spreadsheet.

A test statistic equal to 2 indicates that there is a calendar year effect and implies that one of the chain ladder assumptions does not hold.

(c) (*0.5 points*) Identify that assumption.

Provide the response for this part in the Excel spreadsheet.

As an alternative to the chain ladder model, you begin with the Cape Cod method where the expected emerged loss at each age is a development term $f(d)$. This is equivalent to the additive chain ladder model.

~~(d) (*1 point*) Calculate the development terms $f(1)$ $f(7)$ that minimize the sum of squared residuals.~~

~~*Provide the response for this part in the Excel spreadsheet.*~~

(e) (*1 point*) Estimate the loss that will emerge in the next calendar year for accident years 2-7 combined.

Provide the response for this part in the Excel spreadsheet.

You then add diagonal effects, so the expected emerged loss is a development term $f(d)$ times a diagonal effect $g(w + d)$. Without loss of generality, you assume that $g(8) = 1$.

(f) (*3 points*) Calculate the values of $f(1)$-$f(7)$ and $g(2)$-$g(7)$ that minimize the sum of squared residuals by fixing the f values to estimate the g values by linear regression, then fixing the g values to estimate the next iteration of f values by linear regression, and so on until consecutive g values agree to two decimal places. Begin the iterative process with the f values calculated in part (d).

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2022, Q3

(*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:

Maximum likelihood estimates can be obtained by maximizing the function $\ell = \sum_i \left[c_i \ln(\mu_i) - \mu_i \right]$. 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.

GIADV, Fall 2022, Q3

(*5 points*) You are given the following data extracted from a triangle of cumulative paid losses:

Accident Year	From (months)	To (months)	Increment	Diagonal Age	Accident Year Total
2018	0	12	2,500	48	5,000
2018	12	24	1,800	48	5,000
2018	24	36	500	48	5,000
2018	36	48	200	48	5,000
2019	0	12	4,100	36	7,000
2019	12	24	2,000	36	7,000
2019	24	36	900	36	7,000
2020	0	12	4,600	24	6,800
2020	12	24	2,200	24	6,800
2021	0	12	5,300	12	5,300

You apply Clark's stochastic reserving model using the LDF method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-x/\theta}$ where x is in months.

The maximum likelihood estimate (MLE) of θ is 8.1547.

(a) (*1 point*) Calculate the MLEs of *ULT* for each accident year.

Provide the response for this part in the Excel spreadsheet.

(b) (*0.5 points*) Calculate the value of the loglikelihood function at its maximum.

Provide the response for this part in the Excel spreadsheet.

(c) (*0.5 points*) Estimate σ^2, the scale factor.

Provide the response for this part in the Excel spreadsheet.

The contribution for accident year 2021 to the estimate of σ^2 is zero.

(d) (*1 point*) Explain why an accident year with a single incremental value will always contribute zero to the estimate.

Provide the response for this part in the Excel spreadsheet.

(e) (*0.5 points*) Estimate the process variance of the reserve for accident year 2020.

Provide the response for this part in the Excel spreadsheet.

(f) (*1.5 points*) Estimate the parameter variance of the reserve for accident year 2020.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2022, Q4

Parts (c) to (f) are not on GI 301

(*9 points*) You are interested in determining the variability of unpaid claim estimates. The triangle of paid claims data you are working with, by accident year (AY) and development year, is presented below. It is assumed that all claims are fully developed after seven years.

Mack's method of estimating reserve variability is applied to this triangle.

	Development Year								
AY	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Reserve**	**Standard Error**
1	2,089	7,443	12,056	14,891	17,770	19,852	20,727	0	0
2	3,096	9,116	11,930	16,779	18,552	20,232		892	198
3	2,382	8,774	11,820	16,451	18,064			2,750	477
4	1,899	7,537	12,697	16,974				5,130	1,251
5	1,538	6,670	9,658					7,221	1,592
6	1,928	7,197						11,305	2,931
7	2,579							21,382	4,670
Overall								48,679	6,651
f_k	3.61406	1.47094	1.34208	1.13019	1.10357	1.04408			
σ_i^2	494.976	221.738	72.280	43.233	6.426	0.955			

(a) (*2.5 points*) Demonstrate that the reserve and standard error for accident year 5 have been correctly calculated.

Provide the response for this part in the Excel spreadsheet.

(b) (*0.5 points*) Estimate the coefficient of variation of the unpaid claims for each of accident years 2-7 and overall.

Provide the response for this part in the Excel spreadsheet.

~~(c) (*1.5 points*) Estimate the upper 90% confidence limit of the overall unpaid claims using a lognormal distribution. (Note: The 90th percentile of a standard normal distribution is 1.28.)~~

~~*Provide the response for this part in the Excel spreadsheet.*~~

~~(d) (*1.5 points*) Allocate the overall amount from part (c) to accident years 2-7 in such a way to reach the same level of confidence for each accident year. (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*) Explain the empirical approach to establishing confidence limits as described by Mack.~~

~~*Provide the response for this part in the Excel spreadsheet.*~~

~~(f) (*0.5 points*) Explain why this empirical approach to establishing confidence limits does not seem to be reasonable.~~

~~*Provide the response for this part in the Excel spreadsheet.*~~

(g) (*1 point*) Create a scatter plot to check the assumption that the expected losses at age 2 are proportional to the losses at age 1.

Provide the response for this part in the Excel spreadsheet.

(h) (*1 point*) Interpret the scatter plot in part (g) with regard to determining whether the assumption is correct. If it is not, recommend an alternative model.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q3

(*5 points*) You are given the following data extracted from a triangle of cumulative paid losses.

Accident Year	From (months)	To (months)	Increment	Diagonal Age	Accident Year Total
2019	0	12	3,100	48	7,100
2019	12	24	2,400	48	7,100
2019	24	36	1,100	48	7,100
2019	36	48	500	48	7,100
2020	0	12	2,300	36	3,800
2020	12	24	600	36	3,800
2020	24	36	900	36	3,800
2021	0	12	3,200	24	6,000
2021	12	24	2,800	24	6,000
2022	0	12	3,600	12	3,600

You are also given the following onlevel premiums:

Accident Year	Onlevel Premium
2019	10,000
2020	12,000
2021	15,000
2022	18,000

You apply Clark's stochastic reserving model using the Cape Cod method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-x/\theta}$ where x is in months.

Clark assumes that the incremental loss emergence follows an overdispersed Poisson distribution.

(a) (*1 point*) State two advantages of using the overdispersed Poisson distribution as opposed to the Poisson distribution.

ANSWER:

Clark also assumes that the incremental losses are independent and identically distributed.

(b) (*0.5 points*) Describe a situation where incremental losses may not be independent.

ANSWER:

(c) (*0.5 points*) Describe a situation where incremental losses may not be identically distributed.

ANSWER:

The maximum likelihood estimate (MLE) of θ is 12.3549.

(d) (*1 point*) Demonstrate that the MLE of *ELR* is 0.5251.

Provide the response for this part in the Excel spreadsheet.

(e) (*1 point*) Estimate the scale factor, σ^2.

Provide the response for this part in the Excel spreadsheet.

(f) (*1 point*) Estimate the process standard deviation of the loss reserve for all accident years combined.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q4

Part (f) is not on GI 301

(*9 points*) You are interested in determining the variability of unpaid claim estimates. The triangle of paid claims data you are working with is presented below. It is assumed that all claims are fully developed after four years.

Mack's method of estimating reserve variability is applied to this triangle.

Accident Period	Development Period							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1st Half 2019	2,011	4,747	5,863	8,713	13,512	18,518	20,589	21,443
2nd Half 2019	1,900	6,042	12,150	21,622	34,104	42,257	44,612	
1st Half 2020	2,185	4,436	8,699	13,914	19,905	21,101		
2nd Half 2020	1,957	3,519	6,247	9,799	10,823			
1st Half 2021	2,065	3,863	8,290	10,675				
2nd Half 2021	1,896	4,627	8,442					
1st Half 2022	1,698	5,493						
2nd Half 2022	1,923							
f_k	2.38674	1.82459	1.56908	1.44953	1.21260	1.07283	1.04148	
σ_i^2	654.963	469.913	310.802	537.915	411.856	40.532	3.989	

Accident Period	Reserve	Standard Error
1st Half 2019	0	0
2nd Half 2019	1,850	751
1st Half 2020	2,476	1,200
2nd Half 2020	3,841	2,693
1st Half 2021	10,290	4,862
2nd Half 2021	17,572	6,542
1st Half 2022	25,392	9,065
2nd Half 2022	23,883	10,569

One of the statistical assumptions underlying the chain ladder model is that the accumulated total claim amounts from different accident periods are independent.

(a) (*1 point*) State whether or not this implies that the errors in reserve estimates for different accident periods are independent. Justify your answer.

ANSWER:

(b) (*1 point*) State the other two statistical assumptions underlying the chain ladder model.

ANSWER:

(c) (*2 points*) Demonstrate that the standard error for the first half of 2021 has been correctly calculated.

Provide the response for this part in the Excel spreadsheet.

(d) (*2 points*) Calculate the standard error for the full year of 2021.

Provide the response for this part in the Excel spreadsheet.

Note to candidates: This test is described in the study note by M. Hardy.

(e) (*1 point*) Describe Mack's nonparametric test for correlations between development factors.

Provide the response for this part in the Excel spreadsheet.

~~(f) (*0.5 points*) Describe the adjustment that Venter suggests to correct for correlation between adjacent development factors.~~

~~*Provide the response for this part in the Excel spreadsheet.*~~

Note to candidates: This test is described in the study note by M. Hardy.

(g) (*1 point*) Describe Mack's nonparametric test for calendar year effects.

Provide the response for this part in the Excel spreadsheet.

Note to candidates: This model is described in the study note by the SOA.

(h) (*0.5 points*) Describe a model that Venter suggests could account for calendar year effects.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2023, Q3

Provide the response for this question in the Excel spreadsheet.

(*6 points*) You are given the following data extracted from a triangle of cumulative paid losses:

Accident Year	From (months)	To (months)	Increment	Diagonal Age	Accident Year Total
2019	0	12	2,500	48	5,000
2019	12	24	1,800	48	5,000
2019	24	36	500	48	5,000
2019	36	48	200	48	5,000
2020	0	12	4,100	36	7,000
2020	12	24	2,000	36	7,000
2020	24	36	900	36	7,000
2021	0	12	4,600	24	6,800
2021	12	24	2,200	24	6,800
2022	0	12	5,300	12	5,300

You apply Clark's stochastic reserving model using the LDF method and a loglogistic distribution with cumulative distribution function $G(x) = \dfrac{x^{\omega}}{x^{\omega} + \theta^{\omega}}$ where x is in months.

Clark states "The Cape Cod method … will usually produce a significantly smaller estimation error [than the LDF method]."

(a) (*1 point*) State two reasons why this is the case.

The maximum likelihood estimate (MLE) of θ is 6.8410 and of ω is 0.9804.

(b) (*2 points*) Calculate the maximum likelihood estimates of *ULT* for each of the four accident years.

(c) (*1 point*) Calculate $\hat{\sigma}^2$, the estimate of the scale factor.

(d) (*1 point*) Estimate the process standard deviation of the loss reserve for all accident years combined.

A likelihood ratio test indicates that $\omega = 1$ is a plausible value. Using this value and re-estimating the other parameters leads to a significant reduction in the estimated scale factor.

(e) (*1 point*) Explain why this reduction is to be expected.

GIADV, Spring 2024, Q3

(*5 points*) You are reviewing your assistant's report on reserves (the full report is not provided here). Your assistant has applied Clark's stochastic reserving model using the Cape Cod method and an exponential distribution with cumulative distribution function $G(x) = 1 - e^{-x/\theta}$ where x is in months.

Your assistant provided an Excel worksheet with all their calculations. You will find them on the "Q03" tab in the supplied Excel file.

You are to critique the extracts below from the report.

- In some cases, the report extracts and supporting calculations may be accurate and all you need to do is note that.
- However, if there are errors, you are to identify them and provide an explanation of why the report extract or calculation is incorrect.
- If the error is wording or an explanation, provide the correct wording along with an explanation of why the report is incorrect.
- If the error is in a calculation, you need only identify the error. You do not need to modify the spreadsheet or calculate the correct number(s).
- Assume that your assistant successfully maximized their version of the likelihood function.
- Assume any formulas that apply to multiple cells are either correct for all such cells or have the same error in all such cells.

Provide your response in this document, and not the Excel spreadsheet.

(a) (*1 point*) Critique Part 1.

Part 1: *I have been provided with a loss triangle representing accident years 2016-2023. All possible twelve-month development periods are represented. I noticed that one of the increments is negative. While the algorithm provides results for this case, Clark's procedure should not be used when there are negative increments.*

ANSWER:

(b) (*1 point*) Critique Part 2.

Part 2: *I have performed maximum likelihood estimation of the two parameters. The calculations are in cells G7:K43 and the maximizing values are in cells H44 and H45. The values that maximize the likelihood function are* $\theta = 37.44$ *and ELR = 0.5506.*

ANSWER:

(c) (*1 point*) Critique Part 3.

Part 3: *I have calculated the estimate of the scale factor in cells M7:M44 as* $\hat{\sigma}^2 = 309.1$.

ANSWER:

(d) (*1 point*) Critique Part 4.

Part 4: *I have calculated the loss reserve estimate for all years in cell F60 as 31,103. I have further calculated the process standard deviation of the loss reserve in cell F62 as 3,101. Assuming a normal distribution, two standard deviations provide 95% confidence. Therefore, we can be 95% confident that the actual development will be between 24,901 and 37,304.*

ANSWER:

(e) (*1 point*) Critique Part 5.

Part 5: *Clark recommends several graphs that can be used to verify if the assumptions of the model hold. Two such graphs are on the worksheet. One graph plots normalized residuals against increment age and the other plots them against the expected increments. The second graph shows a curved, rather than horizontal pattern. Hence the underlying assumptions may not hold.*

ANSWER:

GIADV, Spring 2024, Q4

Provide the response for this question in the Excel spreadsheet.

Parts (d) to (g) are not on GI 301

(*8 points*) You are interested in 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	30,374	76,584	104,035	124,753	139,829	148,994	156,583	164,187	165,169	169,267
2	30,346	83,030	114,913	133,802	146,265	157,740	163,287	167,517	170,685	
3	35,782	93,320	131,071	145,988	160,291	171,415	179,806	185,071		
4	32,230	87,349	124,761	148,440	163,804	175,738	184,092			
5	41,583	109,196	147,524	176,075	187,492	204,788				
6	70,281	183,436	234,094	273,204	291,046					
7	71,668	177,489	229,819	258,084						
8	59,878	150,125	191,380							
9	61,721	146,504								
10	47,807									

(a) (*2 points*) Calculate the following amounts using the chain ladder (CL) method:

(i) Age-to-age factors

(ii) Expected values for each DY (starting with DY 2), based on the previous DY, for which there are observed values

Note to candidates: The plot in (i) can be constructed, and its interpretation completed, based on the supplied study notes.

Mack suggests two plots that can be used to check the validity of the assumptions underlying the CL estimates.

(b) (*2 points*) Construct the following scatterplots for each of DYs 1 to 3:

(i) Development along with a fitted regression line

(ii) Weighted residuals versus values from the previous DY

(c) (*1 point*) Determine the validity of the assumptions underlying the CL estimates based upon part (b). Justify your determination.

~~Assume that the scatterplots indicate that the assumptions are not valid. Mack provides two other formulas for calculating age-to-age factors that could be tested.~~

(d) (*0.5 points*) State one of these alternatives. Do not do any calculations.

Venter proposes an alternative test that involves age-to-age factors. His test is to perform a regression on the increments versus the prior cumulative value.

(e) (*0.5 points*) Input the appropriate values to perform this regression analysis.

(f) (*1 point*) Determine the validity of the assumptions underlying the CL estimates based upon the results of the regression analysis in part (e). Justify your determination.

(g) (*1 point*) Propose an alternative model that is more consistent with the results of the regression analysis in part (e).

GIADV, Fall 2024, Q3

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.

GIADV, Fall 2024, Q4

Provide the response for this question in the Excel spreadsheet.

Parts (d), (g) and (h) are not on GI 301

(*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 $q(w, d + 1)$.~~

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

GI 301 Learning Objective 2 Curated Past Exam Questions

GIADV, Spring 2023, Q10

(*4 points*) You are given the following information for estimating claims in excess of 400,000 for a liability line of business:

Accident Year	Reported Claims (000) at Total Limits					
	12	24	36	48	60	72
2017	784	880	938	983	1,006	1,016
2018	1,011	1,164	1,288	1,367	1,380	
2019	1,062	1,233	1,331	1,404		
2020	1,120	1,231	1,328			
2021	1,230	1,400				
2022	1,200					

Accident Year	Reported Claims (000) at 400,000 Limit					
	12	24	36	48	60	72
2017	770	862	917	959	980	989
2018	932	1,002	1,091	1,159	1,168	
2019	862	942	1,008	1,054		
2020	1,100	1,203	1,297			
2021	1,093	1,190				
2022	1,133					

Summary of Severity Relativity (R_t) of 400,000 Limit to Total Limits by maturity age					
12	24	36	48	60	72
0.88	0.84	0.81	0.79	0.79	0.79

There is no development beyond 72 months.

(a) (*2 points*) Calculate the total IBNR for claims excess of 400,000 as of December 31, 2022 using each of the following approaches:

(i) Development factors calculated using a simple average

(ii) Theoretically-derived development factors based on Siewert's formula

Provide the response for this part in the Excel spreadsheet.

(b) (*0.5 points*) Describe two considerations in the calculation of R_t values.

Provide the response for this part in the Excel spreadsheet.

(c) (*1 point*) Explain why alternative methods should be considered based on the results from part (a).

Provide the response for this part in the Excel spreadsheet.

You are assessing the increased limits factors approach as an alternative.

(d) (*0.5 points*) Identify two considerations when applying the increased limits factors approach.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2023, Q10

Provide the response for this question in the Excel spreadsheet.

(*4 points*) You are estimating ultimate claims for the layer of 500,000 excess of 250,000. You are given the following information including estimated cumulative development factors (CDFs):

Accident Year (AY)	Reported Claims (000) at 12/31/2022			Estimated CDF	Severity Relativity (R_t)	
	250,000 Limits	750,000 Limits	Total Limits	Total Limits	250,000 to Unlimited	750,000 to Unlimited
2016	4,978	5,693	6,170	1.000	0.730	0.901
2017	4,332	5,040	5,616	1.005	0.733	0.903
2018	5,088	5,785	6,167	1.013	0.739	0.909
2019	4,334	5,192	5,699	1.033	0.747	0.913
2020	3,704	4,298	5,029	1.085	0.751	0.917
2021	4,222	4,640	4,721	1.248	0.762	0.951
2022	3,721	3,978	3,999	1.747	0.780	0.975

There is no development beyond 84 months.

(a) (*1.5 points*) Calculate total IBNR for the layer as of December 31, 2022 using Siewert's formula.

(b) (*1 point*) Describe a peculiarity with the CDFs derived from Siewert's formula in part (a).

You are considering using the increased limit factor (ILF) method to estimate ultimate claims for the layer. You have the following additional information:

- Ultimate claims at 250,000 limits for AY 2022 using actual development factors are 5,019,000.
- The estimated ILF at 750,000 relative to 250,000 at the January 1, 2020 cost level is 1.19.
- The selected annual trend factor for a 750,000 limit is 2.2%.
- The selected annual trend factor for a 250,000 limit is 1.0%.

(c) (*1.5 points*) Calculate the layer IBNR for AY 2022 as of December 31, 2022 using the ILF method.

GIADV, Spring 2024, Q10

Provide the response for this question in the Excel spreadsheet.

(*4 points*) You are performing a reserve analysis for the layer of 150,000 excess of 50,000 as of December 31, 2023.

Accident Year	Reported Claims (000) at 50,000 Limits					
	12	**24**	**36**	**48**	**60**	**72**
2018	3,742	4,715	5,116	5,372	5,533	5,588
2019	2,986	3,703	4,036	4,258	4,343	
2020	3,846	4,884	5,289	5,606		
2021	3,571	4,492	4,851			
2022	3,214	4,050				
2023	3,055					

Accident Year	Reported Claims (000) at 200,000 Limits					
	12	**24**	**36**	**48**	**60**	**72**
2018	N/A	N/A	N/A	N/A	N/A	7,706
2019	N/A	N/A	N/A	N/A	7,435	
2020	N/A	N/A	N/A	7,692		
2021	N/A	N/A	7,047			
2022	N/A	5,630				
2023	4,239					

	50,000 Limits	**200,000 Limits**
Calendar Year 2023 Earned Premium (000)	6,000	11,500
Expected Loss Ratio	70%	65%

- The 200,000 limits loss data for prior reporting periods is not available due to a database issue.
- There is no loss development beyond 72 months.
- All the claims have been trended to December 31, 2023.
- Total ultimate claims for 200,000 limits for all accident years are 46,986,000.
- There were no rate changes from 2021 through 2023.
- The annual premium trend is 3%.

(a) (*1 point*) Calculate the total IBNR for the layer of 150,000 excess of 50,000 using volume-weighted average loss development factors.

(b) (*0.5 points*) Explain why the expected method would be a viable alternative to the development method.

(c) (*0.5 points*) Describe a limitation of using the expected method.

(d) (*1 point*) Calculate the AY 2023 IBNR for the layer using the expected method.

You are considering the increased limit factor (ILF) method to estimate the layer reserves. The ILF applicable to premium for 200,000 limits relative to 50,000 limits at the December 31, 2023 cost level is 1.9. You use the ultimate claims for the 50,000 limits from part (a).

(e) (*1 point*) Calculate the AY 2023 IBNR for the layer using the ILF method.

GIADV, Fall 2024, Q10

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.

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.

GI 301 Learning Objective 3 Curated Past Exam Questions

GIRR, Fall 2020, Q8

(*5 points*)

(a) (*1 point*) Describe the difference between claim liabilities and premium liabilities.

ANSWER:

The two main approaches for determining the central estimate of premium liabilities are the premium approach and the claims approach.

(b) (*1 point*) Describe each of these approaches.

ANSWER:

(c) (*0.5 points*) Provide one challenge with the premium approach.

ANSWER:

You are estimating the policy liabilities for an insurer that started writing business on March 1, 2020. You have decided to use the claims approach and are given the following additional information:

Line of Business	Gross Written Premium (000)	Gross Expected Claim Ratios including ALAE
Property	1,305	82%
General Liability	1,539	56%
Automobile	1,244	79%

- All policies were written on March 1, 2020 and are for 12-month terms.
- There is a 25% quota share reinsurance treaty.
- ULAE is 12.9% of gross claims (including ALAE).
- General expenses are 16% of gross written premiums.
- 30% of general expenses are associated with ongoing maintenance for unexpired risks.
- Incentive commissions are 3.2% of gross premiums.

(d) (*2.5 points*) Calculate the equity in unearned premiums as of June 30, 2020, net of reinsurance.

The response for part (d) is to be provided in the Excel spreadsheet.

GIRR, Spring 2021, Q7

(*5 points*) You are reviewing premium liabilities as of December 31, 2020.

You are provided with the following information:

	Property		Liability	
	Gross	**Net**	**Gross**	**Net**
Written Premiums (000) – Calendar Year				
2017	1,000	740	2,000	1,820
2018	1,100	814	3,100	2,728
2019	1,200	888	4,900	4,165
2020	1,300	962	6,000	4,920
Unearned Premiums (000) as of December 31 Each Year				
2016	525	415	950	893
2017	500	395	1,000	910
2018	550	435	1,550	1,364
2019	600	474	2,450	2,083
2020	650	514	3,000	2,460
Ultimate Claims including ALAE (000) – Accident Year				
2017	460	300	1,070	830
2018	480	310	1,530	1,190
2019	510	330	2,600	2,030
2020	590	380	3,820	2,980
Ultimate Claim Ratios including ALAE – Accident Year				
2017	45%	39%	55%	46%
2018	46%	40%	60%	52%
2019	44%	39%	65%	59%
2020	47%	41%	70%	66%

(a) (*1 point*) Verify the calculation of ultimate claim ratios.

Provide the response for this part in the Excel spreadsheet.

(b) (*1.5 points*) Recommend expected claim ratios for each line of business, gross and net of reinsurance, that will be used in the determination of premium liabilities as of December 31, 2020. Justify each recommendation.

Provide the response for this part in the Excel spreadsheet.

The following information is provided:

- ULAE is 10% of claims (including ALAE), which is not covered by reinsurance.
- The selected general expense ratio is 15% of gross written premiums.
- The proportion of general expenses applicable to unearned premiums is 25%.
- The selected incentive commission ratio is 3% of gross premiums.

(c) (*2 points*) Calculate the premium liabilities, both gross and net of reinsurance.

Provide the response for this part in the Excel spreadsheet.

(d) (*0.5 points*) Determine the equity in unearned premiums.

Provide the response for this part in the Excel spreadsheet.

GIRR, Fall 2021, Q8

(*4 points*) You are the appointed actuary for LMN Insurance Company, and you are given the following information:

Underwriting Quarter	Written Premiums During 2020	
	Auto	Homeowners
2020Q1	210,000	320,000
2020Q2	200,500	325,000
2020Q3	197,500	330,000
2020Q4	205,100	322,000

- All policies are written for 12-month policy terms and are written and earned evenly throughout the year.
- Assume each quarter has the same number of days.
- There are no policy cancellations.

(a) (*1 point*) Calculate unearned premium by line of business as of December 31, 2020.

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

You are estimating policy liabilities as of December 31, 2020 and are given the following information:

Accident Year 2020 Actual Claim Ratios by Quarter		
	Auto	Homeowners
2020Q1	73.6%	71.2%
2020Q2	71.9%	72.5%
2020Q3	71.5%	77.7%
2020Q4	73.1%	69.8%

Accident Year 2021 Expected Claim Ratios by Quarter		
	Auto	Homeowners
2021Q1	72.0%	70.0%
2021Q2	72.0%	70.0%
2021Q3	72.0%	80.0%
2021Q4	72.0%	70.0%

- The higher expected claim ratio for homeowners in 2021Q3 reflects hurricane season.
- The company does not purchase reinsurance.
- ULAE is 7.5% of claims for automobile and 10% of claims for homeowners.

- Policy acquisition costs are 5% of written premiums.
- The selected general expense ratio is 15% of written premiums.
- One-third of general expenses are associated with ongoing policy administration and maintenance.

(b) (*2.5 points*) Calculate the equity in unearned premiums as of December 31, 2020 by line of business.

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

Additionally, a colleague has calculated the equity in the unearned premiums for the general liability line of business and the result is a large negative number. LMN Insurance Company writes no other lines of business besides auto, homeowners, and general liability.

(c) (*0.5 points*) Describe two potential implications of this result.

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

GIRR, Spring 2022, Q14

(*5 points*) You are estimating premium liabilities for a company as of December 31, 2021, and are given the following information:

Calendar/ Accident Half Year	Written Premiums	Earned Premiums	Ultimate Claims including ALAE
2019-1	523,613	518,804	364,784
2019-2	517,408	520,827	232,393
2020-1	500,255	514,671	365,518
2020-2	518,366	509,071	229,396
2021-1	506,720	510,927	366,542
2021-2	518,714	512,630	233,315

- The amounts in the table are before any reinsurance.
- Each year, the company renews quota share reinsurance on its gross business (premiums and claims including ALAE) ceding 25% to a reinsurer.
- The company only writes 12-month fire insurance policies.
- There have been no rate changes since January 1, 2017.
- Policies are written evenly throughout the year.
- ULAE is 5.7% of gross claims (including ALAE).
- The selected general expense ratio is 18% of gross written premiums.
- The proportion of general expenses applicable to unearned premiums is 30%.
- The annual claim trend is 1%.
- Claim frequency is significantly higher in the first half of any year.
- The gross unearned premiums are 515,716 as of December 31, 2021.

(a) (*1 point*) Verify that the following amounts are consistent with the written premiums provided:

(i) Calendar half-year 2021-1 gross earned premium of 510,927

(ii) Year-end 2021 gross unearned premiums of 515,716

Provide the response for this part in the Excel spreadsheet.

(b) (*2.5 points*) Recommend the expected claim ratio to be used in the determination of premium liabilities as of December 31, 2021. Justify your recommendation.

Provide the response for this part in the Excel spreadsheet.

(c) (*1.5 points*) Calculate the premium liabilities as of December 31, 2021, both gross and net of reinsurance.

Provide the response for this part in the Excel spreadsheet.

GIRR, Fall 2022, Q9

(*4 points*) You are calculating premium liabilities as of December 31, 2021 for ABC Insurance. You are given the following information:

Gross Unearned Premium	5,000,000
Selected Ultimate Claims Ratio, including ALAE	60%

- Policies are annual and are written uniformly throughout the year.
- The only reinsurance in force during 2021 was a 20% quota share treaty covering policies written in 2021.
- Reinsurance does not cover ULAE or general expenses.
- ULAE is estimated at 10% of gross claims including ALAE.
- The general expense ratio is 20% of gross premium.
- The proportion of general expense applicable to unearned premium is 25%.

A new catastrophe excess of loss reinsurance policy will be added effective January 1, 2022. This will cover claims incurred in 2022 and apply after the quota share treaty. The cost of the catastrophe reinsurance will be 5% of net earned premium. The impact on the claim ratio is expected to be negligible.

(a) (*3 points*) Calculate the premium deficiency reserve or equity in the unearned premium as of December 31, 2021.

Provide the response for this part in the Excel spreadsheet.

Recent legislative changes will increase the cost of all claims incurred after December 31, 2021 by 50%.

(b) (*1 point*) Recalculate the premium deficiency reserve or equity in the unearned premium as of December 31, 2021, incorporating this legislative change.

Provide the response for this part in the Excel spreadsheet.

GI 301 Learning Objective 4 Curated Past Exam Questions

GIADV, Fall 2020, Q6

(*4 points*) You are calculating a risk margin for outstanding claim liabilities as discussed in "A Framework for Assessing Risk Margins." There are two lines of business, motor and home.

There are two sources of systemic risk: internal risk and external risk.

(a) (*1 point*) Define each source.

ANSWER:

There are two sources of independent risk: parameter risk and process risk.

(b) (*1 point*) Define each source.

ANSWER:

You are provided the following information about the risks associated with these lines of business:

	Motor	**Home**
Percentage of Liabilities	60%	40%
Independent Risk CoV	8%	5%
Internal Systemic Risk CoV	4%	7%
External Systemic Risk CoV	4%	3%

The correlations between motor and home liabilities for each risk source are:

- Independent Risk: 0%
- Internal Systemic Risk: 50%
- External Systemic Risk: 30%

(c) (*1.5 points*) Calculate the coefficient of variation for each risk source for both lines combined.

The response for part (c) is to be provided in the Excel spreadsheet.

(d) (*0.5 points*) Calculate the consolidated coefficient of variation from the three sources of uncertainty. Assume independence between each of the sources of uncertainty.

The response for part (d) is to be provided in the Excel spreadsheet.

GIADV, Spring 2021, Q6

(*4 points*) You are calculating a risk margin for claim liabilities using the methodology set out in "A Framework for Assessing Risk Margins."

The risk margin is to be calculated at the 80% adequacy level and is to be based on the following sources of uncertainty, which are assumed to be mutually independent:

		Coefficients of Variation		
Line of Business	**Claim Liabilities**	**Independent Risk**	**Internal Systemic Risk**	**External Systemic Risk**
Motor	8,000	6.0%	5.0%	4.5%
Property	4,000	10.0%	9.0%	4.0%
Total	**12,000**	**5.2%**	**5.0%**	**3.3%**

- The correlation between lines for internal systemic risk was assessed at 25%.
- The correlation between lines for external systemic risk was assessed at 0%.
- Claims are assumed to be normally distributed.
- The z-value of the 80th percentile of the normal distribution is 0.8416.

(a) (*1 point*) Verify that the internal systemic risk coefficient of variation is 5.0% (rounded to one decimal place).

Provide the response for this part in the Excel spreadsheet.

(b) (*1 point*) Calculate the aggregate coefficient of variation for both lines combined.

Provide the response for this part in the Excel spreadsheet.

(c) (*1 point*) Calculate the amount of the risk margin at the 80% adequacy level.

Provide the response for this part in the Excel spreadsheet.

An alternative to the normal distribution assumption is the lognormal distribution.

(d) (*1 point*) Provide one argument in favor of and one argument against assuming the lognormal distribution for claims in this situation.

ANSWER:

GIADV, Fall 2021, Q6

(*5 points*) You are calculating a risk margin for the insurance liabilities of an insurer writing only one line of business using the methodology set out in "A Framework for Assessing Risk Margins" by Marshall et al.

They categorize risk into the following sources of uncertainty:

I. Independent Risk
II. Internal Systemic Risk
III. External Systemic Risk

(a) (*1.5 points*) Identify the source of uncertainty to which each of the following belongs:

(i) uncertainty from changes to the process of setting up case reserves

(ii) insurance process too complex for any model to fully capture

(iii) unavailability of data required to conduct a credible valuation

(iv) randomness associated with the insurance process compromising the ability to select appropriate parameters

(v) uncertainty of claim costs arising from catastrophes

(vi) pure effect of the randomness associated with the insurance process

ANSWER:

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

(b) (*1 point*) Provide two reasons why stochastic modeling techniques do not enable a complete analysis of all sources of uncertainty.

ANSWER:

The risk margin is to be calculated at the 75% adequacy level and is to be based on the following information:

Type of Liabilities	Amount of Liabilities	Coefficients of Variation		
		Independent Risk	Internal Systemic Risk	External Systemic Risk
Outstanding Claims Liabilities (CL)	9,000	6%	5%	3%
Premium Liabilities (PL)	6,000	4%	3%	8%

	Independent Risk	Internal Systemic Risk	External Systemic Risk
Correlation between CL and PL	0%	50%	25%

- The sources of uncertainty are assumed to be mutually independent.
- Claims are assumed to be normally distributed.
- The z-value of the 75th percentile of the normal distribution is 0.674.

(c) (*1.5 points*) Calculate the coefficient of variation for each risk source for the total insurance liabilities.

Provide the response for this part in the Excel spreadsheet.

(d) (*1 point*) Calculate the amount of the risk margin for the total insurance liabilities at the 75% adequacy level.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2022, Q6

(*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)

GIADV, Fall 2022, Q6

(*5 points*) You are calculating a risk margin for insurance liabilities using the methodology set out in "A Framework for Assessing Risk Margins."

A balanced scorecard approach is used to determine the internal systemic risk coefficients of variation (CoVs) by line of business. You are given the following information:

Amount	Motor	Home
Outstanding Claim Liabilities (CL)	5,351,000	2,486,000
Premium Liabilities (PL)	4,215,000	3,993,000

	Potential Risk Indicators for Internal Systemic Risk	Score for	
		Motor CL	Home CL
1	Best predictors have been identified	5	4
2	Knowledge of past processes affecting predictors	3	3
3	Range of results produced by models	6	2
4	Number and importance of subjective adjustments to factors	4	3
5	Extent, timeliness, consistency and reliability of information from business	3	5
6	Value of predictors used	5	3

Internal Systemic Risk Correlation Matrix				
	Motor CL	Motor PL	Home CL	Home PL
Motor CL	100%	60%	35%	30%
Motor PL	60%	100%	15%	40%
Home CL	35%	15%	100%	50%
Home PL	30%	40%	50%	100%

Score from Balanced Scorecard Assessment	Motor CoV	Home CoV
1.0 to 1.5	19.0%	18.0%
1.5 to 2.0	15.0%	13.0%
2.0 to 2.5	12.5%	10.5%
2.5 to 3.0	10.5%	8.5%
3.0 to 3.5	9.0%	7.5%
3.5 to 4.0	8.0%	6.5%
4.0 to 4.5	7.5%	6.0%
4.5 to 5.0	7.0%	5.5%
5.0 to 6.0	6.5%	5.0%

- Risk indicator weights are equal within each source of internal systemic risk.
- Risk indicator weights for each source of internal systemic risk are:

    - 25% for specification error,
    - 55% for parameter selection error, and
    - 20% for data error.

(a) (*2 points*) Calculate the internal systemic risk CoV for each of the following:

(i) Motor CL

(ii) Home CL

(iii) Total CL

Provide the response for this part in the Excel spreadsheet.

The internal systemic risk CoVs for PL are as follows:

Motor PL	**Home PL**	**Total PL**
6.50%	6.00%	5.24%

(b) (*2 points*) Calculate the internal systemic risk CoV for total insurance liabilities, both lines combined.

Provide the response for this part in the Excel spreadsheet.

You are given the following additional information:

CoVs for total insurance liabilities	
Independent Risk	5.25%
External Systemic Risk	7.60%

- The correlation between internal systemic risk and external systemic risk is assumed to be 20%.
- The total insurance liabilities are assumed to be normally distributed.
- The z-value of the 75th percentile of the Standard Normal distribution is 0.674.

(c) (*1 point*) Calculate the risk margin for the total insurance liabilities at the 75% adequacy level.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q8

(*4 points*) In "A Framework for Assessing Risk Margins," Marshall et al. (Marshall) list nine components of their risk margin framework. This includes independent risk analysis, internal systemic risk analysis and external systemic risk analysis.

(a) (*1 point*) Describe two of these components, other than the three listed above.

ANSWER:

Marshall outlines a balanced scorecard approach to analyze internal systemic risk. This approach requires subjective decisions to be made.

(b) (*1 point*) Identify four subjective decisions that are required in this approach.

ANSWER:

You are employing the approach set out in Marshall and are given the following:

Valuation Class	**Proportion of Total Insurance Liabilities**	
	Outstanding Claims	**Premium Liabilities**
Auto	22.5%	30.0%
Liability	40.0%	7.5%

Valuation Class	**Coefficient of Variation (CoV)**				
	Independent Risk		**Internal Systemic Risk**		**External Systemic Risk**
	Outstanding Claims	**Premium Liabilities**	**Outstanding Claims**	**Premium Liabilities**	
Auto	8.00%	5.00%	4.00%	6.00%	3.50%
Liability	6.00%	10.00%	10.00%	12.50%	6.00%
Total	***X***		7.05%	***Y***	***Z***

- Assume the same correlation between the two valuation classes for both outstanding claims and premium liabilities with respect to internal systemic risk.
- The correlation between the two valuation classes for external systemic risk is 0.3.

(c) (*2 points*) Calculate the following:

(i) Total independent risk CoV for both valuation classes combined (***X***)

(ii) Correlation between the valuation classes for outstanding claims for internal systemic risk

(iii) Internal systemic risk CoV for premium liabilities for both valuation classes combined (***Y***)

(iv) Total external systemic risk CoV for both valuation classes combined (***Z***)

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2023, Q8

Provide the response for this question in the Excel spreadsheet.

(*4 points*) "A Framework for Assessing Risk Margins," by Marshall et al. (Marshall), described various methods for assessing correlation effects with respect to risk margins.

(a) (*1 point*) Identify two reasons that quantitative methods should not be used to assess these correlation effects.

You are calculating a risk margin for claim liabilities in a long-tailed line of business. You are using Marshall's balanced scorecard approach to measure the internal systemic risk coefficient of variation (CoV).

Your balanced scorecard approach has the following features:

- Each of the three main sources of internal systemic risk has only two risk indicators.
- Risk indicators are given equal weight within each source of internal systemic risk.
- You assign a score of 1 or 5 to each risk indicator. A score of 1 represents poor practice, while a score of 5 represents good practice.

You are given the following information for this line of business:

- Actuaries meet regularly with the relevant managers to discuss business and claim process changes.
- Two different models were used to estimate the claim liabilities. The first model has 8 predictors and produces a result of 12 million. The second model has 6 predictors and produces a result of 23 million.
- Claim level data is available to analyze key predictors.
- The claims data used for modeling was reconciled to the general ledger. There were no material differences.

(b) (*2.5 points*) Complete the following internal systemic risk balanced scorecard:

Complete in the Excel spreadsheet.

Risk Source	Risk Indicator	Score (1 or 5)	Reason for receiving the score	Weight
Parameter selection error	Ability to identify and use best predictors	5		30%
	Best predictors are stable over time	1		
Specification error				40%
Data error				30%

You are provided with the following CoV scale:

Score from balanced scorecard assessment	Internal Systemic Risk CoV
1.0-2.0	12.5%
2.0-3.0	8.5%
3.0-4.0	6.5%
4.0-5.0	5.5%

(c) (*0.5 points*) Select the internal systemic risk CoV using the completed internal systemic risk balanced scorecard from part (b).

GIADV, Spring 2024, Q8

Provide the response for this question in the Excel spreadsheet.

(*4 points*) You are calculating a risk margin for an insurance company with two lines of business using the method set out in "A Framework for Assessing Risk Margins."

Line of Business	Central Estimate (in millions)	
	Outstanding claims (OSC)	**Premium liabilities (PL)**
Auto	24	50
Home	16	30

Line of Business	Coefficient of Variation (CoV)			
	Internal Systemic Risk		**External Systemic Risk**	
	OSC	**PL**	**OSC**	**PL**
Auto	4.0%	6.0%	8.0%	5.0%
Home	10.0%	12.5%	6.0%	10.0%

	Internal systemic risk correlation matrix			
	Auto OSC	**Auto PL**	**Home OSC**	**Home PL**
Auto OSC	100%	50%	25%	0%
Auto PL	50%	100%	25%	0%
Home OSC	25%	25%	100%	0%
Home PL	0%	0%	0%	100%

- The total independent risk CoV for the company's insurance liabilities is 4.5%.
- For external systemic risk, assume there is no correlation between lines of business and between the components of insurance liabilities (OSC and PL).
- The three sources of uncertainty (independent risk, internal systemic risk, and external systemic risk) are assumed to be mutually independent.
- Assume that the underlying distribution of insurance liabilities for this company is the Normal distribution.
- The z-value of the 80th percentile of the Normal distribution is 0.8416.

(a) (*1 point*) Describe two considerations why correlation effects exist within internal systemic risk.

(b) (*3 points*) Calculate the following for the company:

(i) Total internal systemic risk CoV

(ii) Total external systemic risk CoV

(iii) Total consolidated CoV for all sources of risk

(iv) Risk margin at the 80% adequacy level

GIADV, Fall 2024, Q8

(*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			

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:

GI 301 Learning Objective 5 Curated Past Exam Questions

GIRR, Fall 2020, Q14

(*6 points*) You are given the following information as of December 31, 2019:

Accident Year	Reported Claims (000)						Ultimate Claims (000)
	12	24	36	48	60	72	
2014	3,013	4,401	5,552	6,159	6,509	6,557	6,557
2015	3,401	4,902	6,078	6,747	7,242		7,293
2016	3,559	5,374	6,744	7,544			8,087
2017	3,189	4,604	5,988				7,150
2018	3.292	5,018					7,572
2019	3,537						7,875

- Estimated ultimate claims were based on the development method applied to reported claims.

You are also given the following actual reported claims evaluated as of September 30, 2020.

Accident Year	Reported Claims as of September 30, 2020 (000)
2014	6,557
2015	7,283
2016	7,923
2017	6,572
2018	6,335
2019	5,129

(a) (*1.5 points*) Calculate the difference between the actual and expected reported claims from December 31, 2019 through September 30, 2020 for all accident years, using a linear interpolation of the development pattern.

The response for part (a) is to be provided in the Excel spreadsheet.

(b) (*0.5 points*) Provide an interpretation of the results for the actual versus expected analysis derived in part (a).

ANSWER:

You are told that the claim department outsourced a portion of its claim handling effective March 2019. There are concerns that operational changes may have affected development patterns in immature accident periods.

You are given the following additional information for the same line of business to perform diagnostic testing.

Accident Year	Paid Claims (000)					
	12	**24**	**36**	**48**	**60**	**72**
2014	1,377	2,616	3,958	4,809	5,675	6,010
2015	1,553	2,928	4,381	5,275	6,221	
2016	1,692	3,238	4,860	5,887		
2017	1,446	2,749	4,152			
2018	1,496	2,849				
2019	1,448					

Accident Year	Closed Counts					
	12	**24**	**36**	**48**	**60**	**72**
2014	477	666	727	753	781	796
2015	487	697	762	786	806	
2016	521	736	802	827		
2017	457	640	697			
2018	452	641				
2019	447					

Accident Year	Open Counts					
	12	**24**	**36**	**48**	**60**	**72**
2014	297	176	126	100	72	57
2015	320	186	128	104	84	
2016	309	191	136	111		
2017	277	157	111			
2018	272	158				
2019	267					

(c) (*2.5 points*) Evaluate if the data indicates a possible change in case reserve adequacy using two different diagnostic tests.

The response for part (c) is to be provided in the Excel spreadsheet.

(d) (*1.5 point*) Evaluate if the data indicates a possible change in case settlement rates using a diagnostic test different than either of the two tests from part (c).

The response for part (d) is to be provided in the Excel spreadsheet.

GIRR, Fall 2021, Q9

Parts (a) to (c) are not in GI 301

~~(*7 points*) You are projecting ultimate claims using the Cape Cod method and a pure premium approach.~~

~~(a)~~ ~~(*0.5 points*) Describe why an exposure base that is not inflation-sensitive is preferred over an exposure base that is inflation-sensitive.~~

Part (a) not in GI 301

~~ANSWER:~~

~~You are asked to project ultimate claims evaluated as of December 31, 2020 using the Cape Cod method. You are given the following information:~~

Accident Year	**~~Earned Exposures~~**	**~~Paid Claims as of Dec. 31, 2020 (000)~~**	***Reported Claims as of Dec. 31, 2020 (000)***	**~~Reported Age-to-Age Factors~~**
2012	~~8,391~~	~~828~~	*1,002*	~~1.008~~
2013	~~8,402~~	~~831~~	*1,045*	~~1.012~~
2014	~~8,788~~	~~922~~	*1,216*	~~1.018~~
2015	~~9,088~~	~~473~~	*664*	~~1.024~~
2016	~~9,325~~	~~467~~	*710*	~~1.032~~
2017	~~9,704~~	~~353~~	*593*	~~1.044~~
2018	~~10,073~~	~~390~~	*739*	~~1.071~~
2019	~~10,339~~	~~299~~	*632*	~~1.167~~
2020	~~10,591~~	~~183~~	*448*	~~1.500~~
Total	**~~84,701~~**	**~~4,746~~**	***7,049***	-

- ~~All policies are annual, and they are written and earned evenly throughout the years.~~
- ~~The annual pure premium trend is 1%.~~
- ~~Tort reform resulted in an estimated claim decrease of 5% for all accidents occurring on or after January 1, 2018.~~

~~(b)~~ ~~(*2.5 points*) Derive a selected adjusted expected pure premium.~~

Part (b) not in GI 301

~~*Provide the response for this part in the Excel spreadsheet.*~~

~~(c)~~ ~~(*1.5 points*) Derive projected ultimate claims.~~

Part (c) not in GI 301

~~*Provide the response for this part in the Excel spreadsheet.*~~

From part (c), for part (d):

AY	*Reported Claims as of Dec. 31, 2020*	*Expected Reported Claims*
2012	*1,002*	*868*
2013	*1,045*	*851*
2014	*1,216*	*865*
2015	*664*	*865*
2016	*710*	*852*
2017	*593*	*840*
2018	*739*	*766*
2019	*632*	*667*
2020	*448*	*451*
Total	*7,049*	*7,025*

(d) (*1 point*) Calculate the difference between the expected reported claims underlying the Cape Cod calculations in part (c) and actual reported claims as of December 31, 2020.

Provide the response for this part in the Excel spreadsheet.

Your manager has given you the following actual versus expected results for a *different line of business*. The Cape Cod method was also used to estimate expected reported claims for this business.

Accident Year	**Claims (000)**		
	Reported Claims as of Dec 31, 2020	**Expected Reported Claims**	**Difference Actual vs. Expected**
2012	8,363	7,570	793
2013	8,186	7,331	855
2014	7,047	6,145	902
2015	5,540	4,612	928
2016	6,035	7,629	(1,594)
2017	5,041	7,521	(2,480)
2018	6,282	7,406	(1,124)
2019	5,372	6,233	(861)
2020	3,808	4,465	(657)
Total	**55,674**	**58,912**	**(3,238)**

You have identified an anomaly in these results beginning in accident year 2016. There are several circumstances (business, operational, environmental, etc.) that could cause such an anomaly. One possible circumstance would be that the Cape Cod method uses the same trend rate for all years and if the underlying trend decreased in 2016 the Cape Cod method might overestimate the expected reported claims in recent accident years.

(e) (*1.5 points*) Describe two other possible circumstances that could cause an anomaly as shown above.

Provide the response for this part in the Excel spreadsheet.

GIRR, Spring 2022, Q5

Parts (a) to (f) are not in GI 301

~~*(12 points)*~~ You are estimating unpaid claims for a line of business using several different methods, and are given the following information evaluated as of December 31, 2021:

Required for parts (g)-(h)

Accident Year	***Reported Claims (000)***							***Ultimate Claims***
	12	***24***	***36***	***48***	***60***	***72***	***84***	
2015	*26,457*	*24,686*	*25,884*	*32,193*	*32,398*	*32,722*	*32,886*	*33,051*
2016	*24,327*	*23,397*	*26,233*	*33,132*	*34,281*	*34,555*		*34,902*
2017	*29,941*	*26,497*	*27,059*	*35,029*	*35,972*			*36,660*
2018	*27,447*	*28,164*	*32,125*	*35,453*				*36,950*
2019	*27,994*	*28,557*	*33,927*					*43,359*
2020	*28,178*	*31,041*						*43,793*
2021	*34,227*							*47,706*

~~**Accident Year**~~	~~**Paid Claims (000)**~~						
	~~**12**~~	~~**24**~~	~~**36**~~	~~**48**~~	~~**60**~~	~~**72**~~	~~**84**~~
~~2015~~	~~8,658~~	~~16,875~~	~~22,688~~	~~27,108~~	~~29,707~~	~~31,198~~	~~31,530~~
~~2016~~	~~10,793~~	~~18,254~~	~~24,319~~	~~29,431~~	~~31,170~~	~~32,966~~	-
~~2017~~	~~9,664~~	~~17,663~~	~~25,519~~	~~30,636~~	~~32,690~~	-	-
~~2018~~	~~10,721~~	~~18,976~~	~~25,797~~	~~32,579~~	-	-	-
~~2019~~	~~11,866~~	~~20,748~~	~~26,519~~	-	-	-	-
~~2020~~	~~13,014~~	~~19,889~~	-	-	-	-	-
~~2021~~	~~12,410~~	-	-	-	-	-	-

~~**Calendar/ Accident Year**~~	~~**Earned Premiums**~~	~~**Premium On-Level Factors**~~	~~**Trended On-Level Claim Ratios based on Reported Claims**~~
~~2015~~	~~49,736,108~~	~~1.0722~~	~~76.8%~~
~~2016~~	~~52,114,124~~	~~1.0681~~	~~74.9%~~
~~2017~~	~~55,021,088~~	~~1.0420~~	~~73.8%~~
~~2018~~	~~56,278,147~~	~~1.0265~~	~~71.2%~~
~~2019~~	~~58,829,789~~	~~1.0182~~	~~77.7%~~
~~2020~~	~~61,195,354~~	~~1.0092~~	~~73.5%~~
~~2021~~	~~60,091,505~~	~~1.0000~~	~~79.4%~~

- ~~The annual claim severity trend is 5%.~~
- ~~The annual claim frequency trend is -1.3%.~~

(a) (*4.5 points*) Calculate the ultimate claims for all accident years using the development method with paid claims. Justify any selections you make.

Not in GI 301 LO 5

Provide the response for this part in the Excel spreadsheet.

(b) (*1.5 points*) Calculate the trended on-level claim ratios for all accident years using the ultimate claims calculated in part (a).

Not in GI 301 LO 5

Provide the response for this part in the Excel spreadsheet.

Trended on-level claim ratios derived from reported claims as well as paid claims are considered for the expected claim ratio.

(c) (*1.5 points*) Recommend a 2021 cost level expected claim ratio to use for estimating expected claims. Justify your recommendation.

Not in GI 301 LO 5

Provide the response for this part in the Excel spreadsheet.

(d) (*1 point*) Calculate expected claims for all accident years based on the recommendation in part (c).

Not in GI 301 LO 5

Provide the response for this part in the Excel spreadsheet.

(e) (*1 point*) Calculate ultimate claims for all accident years using the Bornhuetter Ferguson method based on paid claims. Use the expected claims from part (d).

Not in GI 301 LO 5

Provide the response for this part in the Excel spreadsheet.

Required for part (g)

Your appointed actuary has selected the following ultimate claims for this line of business as of December 31, 2021:

Accident Year	Selected Ultimate Claims
2015	33,050,822
2016	34,902,242
2017	36,660,362
2018	37,986,078
2019	41,178,916
2020	42,698,643
2021	45,316,988
Total	**271,794,051**

(f) ~~(*0.5 points*) Calculate the total unpaid claims for this line of business as of December 31, 3021, showing the case estimate and indicated IBNR separately.~~
Not in GI 301 LO 5

~~*Provide the response for this part in the Excel spreadsheet.*~~

You are provided with the following additional information:

Accident Year	Reported Claims as of March 31, 2022
2015	32,925,000
2016	34,599,600
2017	36,055,609
2018	36,105,780
2019	35,158,600
2020	32,342,000
2021	33,780,455
Total	**240,967,044**

(g) (*1.5 points*) Calculate the difference between the actual and expected reported claims for this line of business from December 31, 2021 through March 31, 2022 for all accident years, using linear interpolation.

Provide the response for this part in the Excel spreadsheet.

(h) (*0.5 points*) Provide an interpretation of the results for the actual versus expected analysis derived in part (g).

Provide the response for this part in the Excel spreadsheet.

GI 301 Learning Objective 6 Curated Past Exam Questions

GIRR, Fall 2020, Q3

(*4 points*)

(a) (*0.5 points*) Describe why the risk of reserve inadequacy is greatly reduced for claims-made policies compared to occurrence policies.

ANSWER:

You are given the following accident year lag by report year matrix:

Reported Claims								
Accident Year Lag	**Report Year**							
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
0	160	168	176	185	194	204	214	225
1	240	252	265	278	292	306	322	338
2	240	252	265	278	292	306	322	338
3	160	168	176	185	194	204	214	225

(b) (*1.5 points*) Calculate the total reported claims for each of the following:

(i) A first-year claims-made policy effective January 1, 2013

(ii) A third-year claims-made policy effective January 1, 2015

(iii) A tail policy purchased after the third-year claims-made policy from part (b)(ii)

The response for part (b) is to be provided in the Excel spreadsheet.

You are conducting a ratemaking analysis for a professional liability coverage with the following information:

- The total reported claims for accident year 1 are 800.
- There is a four-year reporting pattern of equal percentages each year.
- There is 10% annual pure premium trend in accident year claims.

(c) (*2 points*) Calculate each of the following factors for this coverage:

(i) A second-year claims-made step factor

(ii) A mature claims-made tail factor

The response for part (c) is to be provided in the Excel spreadsheet.

GIRR, Fall 2020, Q10

(*4 points*) Experience rating plans are generally designed to recognize both the frequency and severity inherent in an insured's actual claims.

(a) (*0.5 points*) Describe how the NCCI split rating experience rating plan differentiates between the frequency and severity of an insured's experience.

ANSWER:

(b) (*0.5 points*) Provide another way that an experience rating formula can differentiate between frequency and severity, other than the approach identified in part (a).

ANSWER:

You are given the following information:

Claims ID	Actual Reported Claims
# 2	15,000
# 4	40,000
# 7	5,000
Claims less than 1,000	20,000

Classification Code	Payroll	Expected Loss Rate (per 100 of payroll)	D-ratio
A	1,400,000	0.10	0.5
B	1,600,000	2.00	0.4
C	1,000,000	1.50	0.3

- The primary threshold for reported claims, for rating purposes, is 10,000.

(c) (*1.5 points*) Calculate the following:

(i) Total actual excess claims

(ii) Total expected primary claims

(iii) Expected excess claims for Classification Code C

The response for part (c) is to be provided in the Excel spreadsheet.

The formula for the NCCI experience rating modification factor is given as follows:

$$M = \frac{A_P + (1-W) \times E_{XS} + B + W \times A_{XS}}{E_P + (1-W) \times E_{XS} + B + W \times E_{XS}}$$

(d) (*0.5 points*) Calculate the NCCI experience rating modification factor using W = 0.5 and B = 50,000.

The response for part (d) is to be provided in the Excel spreadsheet.

(e) (*1 point*) Recommend two ways to increase responsiveness of this experience rating plan.

ANSWER:

GIRR, Fall 2020, Q11

(*6 points*) You are conducting an analysis of deductible factors for ratemaking using empirical individual claims data.

(a) (*0.5 points*) Describe a potential issue related to the absence of complete data when using reported claim data from recent years.

ANSWER:

(b) (*1 point*) Describe a potential issue related to claim development when using individual reported claim data from recent years.

ANSWER:

You are given the following information:

Claim #	Date of Claim	Ground Up Ultimate Claims
1	January 1, 2017	7,500
2	July 1, 2017	800
3	July 1, 2017	1,600
4	January 1, 2018	2,400
5	January 1, 2018	6,700
6	July 1, 2018	2,300
7	January 1, 2019	700
8	July 1, 2019	300
9	July 1, 2019	1,100
10	July 1, 2019	4,500

- New rates are to be effective March 1, 2021 for one year.
- All policies are written as 12-month policies.
- The annual claim severity trend is 5%.

(c) (*2.5 points*) Calculate the indicated deductible factors for deductibles of 500 and 1,000 relative to a base deductible of zero.

The response for part (c) is to be provided in the Excel spreadsheet.

(d) (*1 point*) Explain why the deductible factors would be higher if an annual severity trend greater than 5% is used in part (c).

ANSWER:

(e) (*1 point*) Evaluate the reasonability of the deductible factors calculated in part (c) by performing a consistency test.

The response for part (e) is to be provided in the Excel spreadsheet.

GIRR, Spring 2021, Q6

(*4 points*)

(a) (*0.5 points*) Describe why grouping risks into more homogeneous classes can improve the effectiveness of a risk classification system.

ANSWER:

(b) (*0.5 points*) Describe how an effective risk classification system can contribute to availability of coverage.

ANSWER:

(c) (*2 points*) Evaluate each of the following risk characteristics for use in a risk classification system for automobile insurance:

(i) Gender

(ii) Credit score

(iii) Age

(iv) Telematics data

ANSWER:

(d) (*1 point*) Describe two problems encountered with a one-way analysis of a risk classification system.

ANSWER:

GIRR, Spring 2021, Q10

(*6 points*)

(a) (*1.5 points*) Explain the effect of a straight per-event deductible on each of the following:

(i) An insurer's claim frequency

(ii) An insurer's claim severity

ANSWER:

(b) (*0.5 points*) Describe the reason for a coinsurance clause in a property insurance policy.

ANSWER:

A property is valued at 1,000,000.

- The amount of insurance purchased for the property is 500,000.
- The coinsurance requirement is 80% of the property value, applied before the deductible.

(c) (*1 point*) Calculate the claims paid by the insurer under the following scenarios:

(i) Loss amount is 800,000 and the deductible is 10,000

(ii) Loss amount is 900,000 and the deductible is 0

Provide the response for this part in the Excel spreadsheet.

You are given the following aggregated claims data for auto collision coverage:

Indemnity Range	Counts	Claims
0 – 1,000	1,510	1,049,000
Over 1,000	10,620	59,410,000

(d) (*0.5 points*) Calculate the elimination ratio to be used for pricing a deductible option of 1,000.

Provide the response for this part in the Excel spreadsheet.

The current rate for this auto collision coverage is 110 with no deductible.

- The underlying claim ratio is 70%.
- The underlying variable expense ratio is 20%.
- The underlying fixed expense ratio is 10%.
- There is no profit load.

(e) (*1 point*) Calculate a rate for the 1,000 deductible option using results from part (d).

Provide the response for this part in the Excel spreadsheet.

You are given the following aggregated claims data for a different coverage:

Indemnity Range	**Counts**	**Claims**
0 – 10,000	5,000	35,000,000
10,000 – 20,000	1,500	25,000,000
20,000 – 100,000	500	15,000,000

(f) (*1.5 points*) Calculate the increased limits factors relative to a basic limit of 10,000 for:

(i) 20,000 limit, and

(ii) 100,000 limit.

Provide the response for this part in the Excel spreadsheet.

GIRR, Spring 2021, Q13

(*5 points*)

(a) (*0.5 points*) Describe why the risk of a reserve inadequacy is greatly reduced for claims-made policies compared to occurrence policies.

ANSWER:

(b) (*1 point*) Explain how a coverage gap can be created when the insured switches:

(i) From claims-made to occurrence coverage

(ii) From occurrence to claims-made coverage

ANSWER:

One principle of claims-made ratemaking states that a claims-made policy will cost less than an occurrence policy when claim costs are increasing.

(c) (*1.5 points*) Construct a numerical example demonstrating this principle.

Provide the response for this part in the Excel spreadsheet.

Another principle of claims-made ratemaking states that claims-made policies priced on the basis of prior trend will be closer to the correct price than occurrence policies priced in the same way, when there is a sudden unpredictable change in the underlying trend.

(d) (*2 points*) Construct a numerical example demonstrating this principle.

Provide the response for this part in the Excel spreadsheet.

GIRR, Spring 2021, Q17

(*4 points*) You are a consulting actuary who has been asked to evaluate individual risk rating for LMN Delivery Services (LMN). You are given the following information:

- LMN is a small business with strong financials.
- LMN's current premiums are based on manual rates.
- LMN has ten years of claims experience, which fluctuated significantly from year to year.
- A new safety program was implemented two years ago, which is expected to reduce claims by 10%.
- LMN prefers stable rates.

(a) (*3 points*) Evaluate the suitability of each of the following individual risk rating programs for LMN:

(i) Schedule rating

(ii) Prospective experience rating

(iii) Retrospective experience rating

ANSWER:

You have recommended a prospective experience rating program for LMN. A principle of prospective experience rating is that frequency is a better predictor of future claims than severity.

(b) (*1 point*) Explain how this principle can be considered in the design of LMN's prospective experience rating program.

ANSWER:

GIRR, Fall 2021, Q3

(*5 points*) Insurance policies may include deductibles and limits. Both features are used to reduce the claims paid by insurers with a corresponding adjustment to the premium.

(a) (*0.5 points*) Provide two reasons insurers use deductibles, other than to directly reduce the amount of claims paid.

ANSWER:

(b) (*0.5 points*) Provide two reasons insurers use limits, other than to directly reduce the amount of claims paid.

ANSWER:

Both increased limits factors and deductible factors may be estimated using either empirical data or a statistical distribution.

(c) (*1 point*) Explain why an analysis of increased limits factors is more likely to use a statistical distribution.

ANSWER:

You are given the following information for a deductible analysis using empirical data:

Accident Year	Trended Ultimate Claims, Adjusted to Deductible Level			
	Base Deductible	Optional Deductibles		
	100	250	500	1,000
2015	1,128,906	1,085,419	1,038,175	1,003,976
2016	1,205,190	1,114,475	1,049,455	1,001,738
2017	1,259,261	1,146,143	1,077,875	1,028,878
2018	1,327,281	1,222,920	1,150,421	1,097,933
2019	1,154,561	1,039,514	972,689	925,746
2020	1,479,204	1,371,604	1,296,218	1,241,697

(d) (*2 points*) Determine the elimination ratios and deductible factors for each of the deductible options.

Provide the response for this part in the Excel spreadsheet.

(e) (*1 point*) Evaluate the reasonability of the deductible factors calculated in part (d) using a consistency test.

Provide the response for this part in the Excel spreadsheet.

GIRR, Fall 2021, Q10

(*4 points*)

(a) (*1 point*) State one advantage and one disadvantage of claims-made coverage from an insurer's perspective.

ANSWER:

(b) (*1 point*) Demonstrate, with a numerical example, a situation in which the claims-made loss cost is greater than the occurrence loss cost.

Provide the response for this part in the Excel spreadsheet.

CM Insurance Company writes claims-made coverage with a 4-year reporting pattern where 40% of the claims incurred in an accident year are reported in the year of occurrence, and 20% are reported in each of the next three years. The annual report year pure premium trend is 0%.

(c) (*1 point*) Calculate tail factors for a claims-made policy for the following maturities:

(i) Second-year

(ii) Mature

Provide the response for this part in the Excel spreadsheet.

(d) (*1 point*) Calculate CM's earned premium for 2021, 2022 and 2023 for a mature tail policy effective January 1, 2021 with a premium of 25,000.

Provide the response for this part in the Excel spreadsheet.

GIRR, Spring 2022, Q3

(*4 points*) AV is an architectural consulting firm with the following characteristics:

- Has been in operation for five years without any professional liability insurance
- No reported claims
- One past incident that could give rise to a claim
- Steadily increasing revenue for the last five years with an expectation of increasing revenue in the next few years

AV is considering the purchase of insurance coverage from a professional liability insurer, XYZ.

(a) (*1 point*) Provide two reasons why AV might decide to purchase coverage.

ANSWER:

(b) (*1 point*) Recommend two exposure base options for XYZ to consider in providing insurance coverage. Justify your recommendations.

ANSWER:

(c) (*1 point*) Provide one advantage and one disadvantage to AV in purchasing a *claims-made* policy.

ANSWER:

(d) (*1 point*) Provide one advantage and one disadvantage to AV in purchasing an *occurrence* policy.

ANSWER:

GIRR, Spring 2022, Q6

(*5 points*)

(a) (*1.5 points*) Define the following terms in the context of individual risk rating:

(i) Prospective experience rating plan

(ii) Retrospective experience rating plan

(iii) Expense modification plan

ANSWER:

(b) (*0.5 points*) Provide one benefit of insurance company reliance on an insured's historical claims to project future claims for a prospective experience rating plan.

ANSWER:

(c) (*1 point*) Critique the use of a prospective experience rating plan for personal property coverage from an insurance company's perspective.

ANSWER:

An insurer is considering a new prospective experience rating plan with the following characteristics:

- Only the most recent three years of the insured's claims experience is included, and
- Actual claims are segregated into primary claims and excess claims in the experience rating formula.

(d) (*1 point*) Critique each characteristic in the new plan.

ANSWER:

(e) for each of the following:

(i) Insureds with low premium volume

(ii) Insureds with poor claims experience

ANSWER:

GIRR, Spring 2022, Q7

(*5 points*) Your company uses only two rating variables for its homeowners insurance policy. One is class (A, B, and C) and the other is territory (1, 2, and 3). Rates are determined as:

base rate × class factor × territory factor.

The exposures for the nine rating combinations are given in the following table:

Exposures			
	Territory		
Class	**1**	**2**	**3**
A	2,700	2,700	2,025
B	1,350	2,025	2,700
C	1,350	675	4,050

(a) (*1.5 points*) Determine if there is distributional bias in the exposure data. Support your conclusion.

Provide the response for this part in the Excel spreadsheet.

The trended ultimate pure premiums are given in the following table:

Pure Premiums				
	Territory			
Class	**1**	**2**	**3**	**Total**
A	240.00	200.00	450.00	282.73
B	270.00	250.00	450.00	343.33
C	300.00	260.00	500.00	428.89
Total	262.50	226.25	473.08	**346.90**

(b) (*1.5 points*) Calculate the rebalanced pure premiums using the one-way analysis relativities for each rating variable combination.

Provide the response for this part in the Excel spreadsheet.

The minimum bias approach is to be used to obtain the final relativities. The process starts with the one-way relativities for territory.

(c) (*1.5 points*) Calculate the revised relativities by class that result from a single iteration of the minimum bias method.

Provide the response for this part in the Excel spreadsheet.

(d) (*0.5 points*) Describe the condition under which the converged results of the minimum bias method will be factors that reproduce all nine observed trended ultimate pure premiums.

Provide the response for this part in the Excel spreadsheet.

GIRR, Spring 2022, Q19

(*5 points*) You are given the following uncensored aggregated information for a line of business:

Indemnity Range	Counts in Interval	Indemnity
0 – 500	2,570	886,650
501 – 1,000	2,860	1,976,260
1,001 – 2,000	2,235	3,256,395
2,001 – unlimited	1,975	6,485,900
Total	**9,640**	**12,605,205**

The base deductible is 500.

(a) (*1.5 points*) Calculate the indicated deductible factor for a deductible of 1,000.

Provide the response for this part in the Excel spreadsheet.

(b) (*2.5 points*) Recommend a factor for a deductible of 1,500. Justify your recommendation.

Provide the response for this part in the Excel spreadsheet.

(c) (*0.5 points*) Describe why you would not be able to use data from policies with a 2,000 deductible to determine the deductible factor for a 1,000 deductible if the data was censored.

Provide the response for this part in the Excel spreadsheet.

(d) (*0.5 points*) Provide a reason why you would choose to determine deductible factors using a classification ratemaking approach instead of using the elimination ratio approach.

Provide the response for this part in the Excel spreadsheet.

GIRR, Fall 2022, Q1

(*4 points*) A suburban city flooded, damaging 80 vehicles parked in an underground garage. The garage's owner is liable to each vehicle owner for 1,000 in property liability damage. The garage owner maintains a large deductible policy which includes property damage liability coverage.

(a) (*1.5 points*) Calculate the losses retained by the garage owner under each of the following deductible scenarios:

(i) Straight deductible of 500 per vehicle

(ii) Deductible of 20% of the garage owner's liability

(iii) Diminishing deductible per event where:

- The garage owner would fully retain any losses less than 50,000,
- The insurer would pay the total value of any covered loss greater than 100,000, and
- Losses with a total value between 50,000 and 100,000 would be proportionately shared between the garage owner and the insurer.

Provide the response for this part in the Excel spreadsheet.

(b) (*0.5 points*) State one advantage of a deductible from an insurer's perspective.

Provide the response for this part in the Excel spreadsheet.

The garage facility was also damaged with losses of 450,000. The garage is valued at 800,000. There is no deductible on the coverage for the facility.

(c) (*1.5 points*) Calculate the claims paid by the insurer under each of the following scenarios:

(i) The insured purchased coverage of 200,000 with a 50% coinsurance requirement.

(ii) The insured purchased coverage of 500,000 with an 80% coinsurance requirement.

(iii) The insured purchased coverage of 750,000 with a 90% coinsurance requirement.

Provide the response for this part in the Excel spreadsheet.

(d) (*0.5 points*) State one reason why insurers favor including a coinsurance requirement in property policies.

Provide the response for this part in the Excel spreadsheet.

GIRR, Fall 2022, Q8

(*6 points*) DSI provides insurance that covers the replacement of an electric vehicle's battery when it is damaged in an accident. You are given the following DSI claims experience for this product:

Age Group	Sex	Number of Vehicles	Estimated Ultimate Claims
25 and over	Male	480	52,000
	Female	160	8,000
Under 25	Male	240	38,000
	Female	120	12,000
Total		**1,000**	**110,000**

The company is using an underlying pure premium of 100 per year for every vehicle in the rating plan. Your colleague recommends increasing the pure premium to 110 for all vehicles.

(a) (*1 point*) Critique your colleague's recommendation.

Provide the response for this part in the Excel spreadsheet.

Another colleague proposes a single variable risk classification analysis for each of the variables, age group and sex. The new premium for each combination of age group and sex is determined as $P_{ij} = \mu A_i S_j$, where

- μ is the overall average pure premium underlying the experience of all insureds with given risk characteristics,
- A_i is the relativity for an insured in risk class i, age group, ($i = 1$ for 25 and over, $i = 2$ for under 25)
- S_j is the relativity for an insured in risk class j, sex. ($j = 1$ for male, $j = 2$ for female)

(b) (*1.5 points*) Calculate A_2, S_2, and μ with the single variable risk classification analysis, by setting the base class as "25 and over", "male."

Provide the response for this part in the Excel spreadsheet.

(c) (*1.5 points*) Describe two possible issues, in general, with the use of a single variable risk classification analysis.

Provide the response for this part in the Excel spreadsheet.

(d) (*1.5 points*) Describe two approaches that address the issues identified in part (c).

Provide the response for this part in the Excel spreadsheet.

Credibility and homogeneity frequently present conflicting objectives in the actuarial work supporting risk classification systems.

(e) (*0.5 points*) Describe this conflict.

Provide the response for this part in the Excel spreadsheet.

GIRR, Fall 2022, Q19

(*3 points*) You are calculating the experience rating modification for a commercial general liability policy. You are given the following information:

Policy Year	Claim ID	Reported Claims as of July 1, 2022	
		Total Limits Indemnity	ALAE
July 1, 2019 – June 30, 2020	1	14,000	35,000
	2	32,000	20,000
July 1, 2020 – June 30, 2021	3	22,000	16,000
	4	10,000	3,000

Policy Year	Basic Limits Premiums Subject to Experience Rating	Percentage of Claims Expected to be Unreported as of July 1, 2022
July 1, 2019 – June 30, 2020	88,600	16%
July 1, 2020 – June 30, 2021	92,200	38%

- The basic limit for indemnity is 20,000.
- The Maximum Single Limit (MSL) is 45,000.
- The Adjusted Expected Loss Ratio (AELR) is 0.67.
- Partial credibility is assigned to claims using *basic limits premiums subject to experience rating*, the square root rule and a full credibility standard of 2,000,000.

Calculate the experience rating modification.

Provide the response for this part in the Excel spreadsheet.

GIFREU, Fall 2020, Q15

Part (b) is not in GI 301

1. (*5 points*) U.S. general insurer, WFH General, writes retrospectively rated workers compensation policies. You have the following information for WFH's retrospectively rated policies. Amounts in the second table are in millions of dollars ($M) as indicated.

	Retro Adjustment Period				
	1	**2**	**3**	**4**	**5**
Loss Evaluation Age in Months	18	30	42	54	66
Selected Premium Development to Loss Development (PDLD) Ratio	1.755	0.625	0.475	0.325	0.000
Percentage of Loss Emerged Since Prior Evaluation	76%	12%	6%	4%	2%

	Policy Year				
	2014	**2015**	**2016**	**2017**	**2018**
Completed Retro Adjustments as of 12/31/2019	4	3	2	1	0
Reported Losses as of 12/31/2019 ($M)	180	169	108	102	78
Losses Reported at Prior Retrospective Adjustment ($M)	179	166	104	90	0
Premium Booked at Prior Retrospective Adjustment ($M)	230	228	170	162	0
Premium Booked as of 12/31/2019 ($M)	230	226	170	165	155

	Development age in months				
	12	**24**	**36**	**48**	**60**
Cumulative Development Factors for Reported Policy Year Losses (i.e., reported loss age-to-ultimate factors)	3.075	1.325	1.133	1.030	1.008

- Premiums for policy years 2018 and prior are fully earned as of year-end 2019.
- Assume that no losses are reported for a policy year after 66 months of development.
- None of the unbilled premiums from the retrospectively rated policies are secured.

The responses for all parts of this question are to be provided in the Excel spreadsheet.

(a) (*4.5 points*) Calculate the premium asset on WFH's retrospectively rated policies as of Dec. 31, 2019.

~~(b) (*0.5 points*) Calculate the admitted portion of the premium asset from part (a) under U.S. statutory accounting.~~

Part (b) is not in GI 301

GIFREU, Fall 2021, Q5

Part (a) is not in GI 301

~~(*5 points*) Statement of Statutory Accounting Principles (SSAP) No. 66 establishes statutory accounting principles for retrospectively rated contracts.~~

~~(a) (*1.5 points*) Describe the recording of the amounts for *accrued additional retrospective premiums* in the statutory financial statement as per SSAP No. 66 with respect to the following:~~

~~(i) the accounting transaction including where amounts are recorded~~

~~(ii) the timing of when amounts are recorded~~

Part (a) is not in GI 301

~~ANSWER:~~

In calculating the premium asset on retrospectively rated polices, Teng and Perkins describe an approach using Premium Development to Loss Development (PDLD) ratios. These PDLD ratios may be determined using a formula approach with the retrospective rating parameters or an approach using historical data.

(b) (*0.5 points*) Describe a benefit of using the formula approach over an approach using historical data for calculating PDLD ratios.

ANSWER:

You are given the following retrospective rating parameters:

Basic premium factor	0.225
Expected loss ratio	0.700
Loss conversion factor	1.200
Tax multiplier	1.035
Loss capping ratio at the first retrospective adjustment	0.875
Incremental loss capping ratio for the second retrospective adjustment period	0.590
Expected percentage of loss emerged for the first retro adjustment	85%

(c) (*1.5 points*) Calculate the Premium Development to Loss Development (PDLD) ratios under the formula approach for the first and second retrospective premium adjustments.

Provide the response for this part in the Excel spreadsheet.

You are given the following information regarding the retrospective rated policies:

Retro Adjustment Period	% Loss Emerged
First	85%
Second	13%
Third	2%

The PDLD ratio for the third retrospective adjustment period is 0.

(d) (*1 point*) Calculate the cumulative PDLD (i.e., CPDLD) ratios for the first and second retrospective premium adjustments.

Provide the response for this part in the Excel spreadsheet.

You are given the following premium and loss information for policy years 2019 and 2020 combined as of December 31, 2020.

Expected Future Loss emergence	Premiums Booked from Prior Adjustment	Premiums Booked as of 12/31/20	Completed Retro Adjustments as of 12/31/2020
479,250	0	573,750	0

(e) (*0.5 points*) Calculate the premium asset on retrospectively rated polices for policy years 2019 and 2020 combined as of December 31, 2020.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q2

(*4 points*)

(a) (*1.5 points*) Describe how an insured's risk control activities affect each of the following individual risk rating plans:

(i) Schedule rating

(ii) Prospective experience rating

(iii) Retrospective experience rating

ANSWER:

(b) (*0.5 points*) Explain why insurers use schedule rating.

ANSWER:

The basic formula for the experience modification factor in prospective experience rating is as follows:

$$\frac{AZ + E(1-Z)}{E}$$

Where:

A is for actual claims
E is for expected claims
Z is for credibility

The NCCI "Experience Rating Plan Manual for Workers' Compensation and Employers' Liability Insurance" includes a formula for the experience modification factor that differs from the basic formula.

(c) (*1.5 points*) Describe how the NCCI formula differs from the basic formula.

ANSWER:

Retrospective experience rating is not appropriate for insureds with a small premium size.

(d) (*0.5 points*) Identify two other characteristics of insureds that would make retrospective experience rating inappropriate.

ANSWER:

GIADV, Spring 2023, Q7

(*4 points*) The premium asset on retrospectively rated polices may be calculated using either of the following methods:

- Fitzgibbon's method
- PDLD method (developed by Teng and Perkins)

In Fitzgibbon's method, a linear function relates retrospective premium to losses incurred. This can be restated as $Y = A + Bx$ where Y is the retrospective adjustment as a percentage of standard premium.

(a) (*1 point*) Describe what each of A, B, and x represent.

ANSWER:

(b) (*1 point*) Describe how the PDLD method differs from Fitzgibbon's method with respect to the function relating retrospective premium to losses incurred.

ANSWER:

(c) (*0.5 points*) Describe the two methods for calculating PDLD ratios.

ANSWER:

You are given the following information for a company's retrospectively rated policies:

Retro Adjustment Period	Loss Evaluation Point in Months	Percentage of Loss Emerged Since Prior Evaluation	Selected PDLD Ratio
First	18	68.0%	1.710
Second	30	19.5%	0.715
Third	42	9.5%	0.445
Fourth	54	3.0%	0.300

No losses are reported after the fourth retro adjustment.

You have the following amounts from the company's retrospectively rated policies for policy years 2020 and 2021:

Policy Year	Premium Booked as of Year-End 2022	Completed Retro Adjustments as of Year-End 2022	Expected Loss Emergence after Last Completed Retrospective Adjustment	Premium Booked from Prior Retrospective Adjustment
2020	385,800	1	85,500	375,200
2021	371,500	0	320,100	0

(d) (*1.5 points*) Calculate the premium asset on retrospectively rated policies as of December 31, 2022 arising from policy years 2020 and 2021 using the PDLD method.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q11

(*4 points*)

(a) (*1.5 points*) Describe the following terms with respect to claims-made insurance:

(i) Step factor

(ii) Tail policy

(iii) Tail factor

ANSWER:

An insurer writes claims-made coverage with a 6-year reporting pattern. The reporting pattern is as follows:

Claims Incurred in an Accident Year are Reported in the Year of	**Percent**
Occurrence	25%
Occurrence + 1	30%
Occurrence + 2	20%
Occurrence + 3	10%
Occurrence + 4	10%
Occurrence + 5	5%

The annual accident year trend is 5%.

(b) (*2.5 points*) Calculate tail factors for a claims-made policy for the following maturities:

(i) First year

(ii) Third year

(iii) Mature

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q12

(*4 points*)

(*5 points*) You are conducting an increased limits analysis for an insurer looking to enter a liability line of business. You are given the following insurance industry aggregated claims data by size of claim:

Indemnity Range (000)		Counts in Interval	Indemnity Severity in Interval	ALAE % of Indemnity
From	To			
0	500	2,881	235,817	20.2%
501	1,000	384	715,448	15.3%
1,001	1,500	124	1,232,765	16.5%
1,501	2,500	77	1,960,198	14.0%
2,501	3,500	22	2,825,640	9.5%
3,501	5,000	41	4,243,226	7.4%

- Data is evaluated as of December 31, 2022 and includes accident years 2018 and 2019 combined.
- The line of business for the industry data is similar to that being looked at by the insurer.
- ALAE is unlimited.

(a) (*1 point*) Describe two issues that should be investigated with respect to the industry data used in this analysis.

ANSWER:

(b) (*2 points*) Calculate the observed increased limits factors (ILFs) for the following indemnity limits, relative to a basic indemnity limit of 1,000,000:

(i) 1,500,000

(ii) 2,500,000

(iii) 3,500,000

(iv) 5,000,000

Provide the response for this part in the Excel spreadsheet.

(c) (*1 point*) Test the consistency of the ILFs calculated in part (b).

Provide the response for this part in the Excel spreadsheet.

(d) (*1 point*) Recommend an ILF for a 2,000,000 indemnity limit. Justify your recommendation.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2023, Q2

(*4 points*)

(a) (*1.5 points*) Explain how certain features included in prospective experience rating plans promote equity among insureds regarding the determination of premiums.

ANSWER:

(b) (*1 point*) Describe split rating as it pertains to the NCCI experience rating plan.

ANSWER:

(c) (*1 point*) Explain why the use of prospective experience rating for an insured does not eliminate the need for schedule rating of that insured.

ANSWER:

(d) (*0.5 points*) Identify two examples of risk characteristics used in schedule rating plans.

ANSWER:

GIADV, Fall 2023, Q7

Provide the response for this question in the Excel spreadsheet.

(*4 points*) You are given the following information for a general insurance company that writes retrospectively rated policies:

Retrospective Rating Parameters	
Basic premium factor (BPF)	0.225
Expected ultimate loss divided by standard premium (ELR)	65%
Loss conversion factor (LCF)	1.255
Tax multiplier (TM)	1.035

Retrospective Adjustment	Cumulative Expected Percentage of Loss Emerged	Incremental Loss Capping Ratio
First	79%	87.5%
Second	92%	61.4%
Third	98%	20.2%
Fourth	100%	18.8%

Policy Year	Ultimate Losses	Losses Reported at Prior Retro Adjustment	Premium Booked from Prior Adjustment	Premium Booked as of 12/31/22	Completed Retro Adjustments as of 12/31/22
2019	234,150	199,950	345,790	351,120	2
2020	228,660	172,530	339,570	345,680	1
2021	289,800	0	0	385,644	0

(a) (*2 points*) Calculate the implied Cumulative Premium Development to Loss Development (CPDLD) ratios for the first to fourth retrospective rating adjustments using the formula approach.

(b) (*1 point*) Provide two situations in which one would favor the formula approach to estimating PDLD ratios over the empirical approach assuming there is sufficient data to use the empirical approach.

(c) (*1 point*) Calculate the premium asset on retrospectively rated policies as of December 31, 2022.

GIADV, Fall 2023, Q11

Provide the response for this question in the Excel spreadsheet.

(*3 points*)

(a) (*0.5 points*) Identify two advantages of claims-made coverage.

(b) (*0.5 points*) Identify two advantages of occurrence coverage.

A regional association of professionals is considering a malpractice coverage program for its members. The members were experiencing availability and affordability issues in the insurance market. It is thought that better terms can be had in the market by negotiating as a group.

All of the association members have been practicing for at least four years. Some members have purchased claims-made coverage in the past, but premiums were considered too high.

You are provided with the following historical information for the association:

- Report year 2021 ultimate claims are comprised of the following:
  - 40% from accident year lag 0,
  - 25% from accident year lag 1,
  - 20% from accident year lag 2, and
  - 15% from accident year lag 3.
- The annual claim trend is 8.5%.

(c) (*1 point*) Compare the size of expected ultimate claims for report year 2024 to expected ultimate claims for accident year 2024.

The association has decided upon obtaining occurrence coverage policies for its members. All members that obtained claims-made coverage policies had effective dates of January 1 with a policy term of one year.

(d) (*1 point*) Explain why members with claims-made policies for prior years will have a coverage gap if they decide to get coverage with the association on January 1, 2024.

GIADV, Fall 2023, Q12

Provide the response for this question in the Excel spreadsheet.

(*4 points*)

(a) (*1.5 points*) Explain how insurance policy deductibles assist in reducing both moral and morale hazard.

(b) (*1 point*) Define the following terms:

(i) Franchise deductible

(ii) Disappearing deductible

You are given the following information for four property insurance policies:

Policy	Property Value	Insured Limit	Straight Deductible	Coinsurance Requirement
A	600,000	500,000	1,000	85% of property value
B	600,000	500,000	1,000	100% of property value
C	600,000	500,000	2,000	None
D	600,000	500,000	2,000	90% of property value

The policy terms are applied in the following order:

- coinsurance requirement
- limit
- deductible

(c) (*1.5 points*) Determine the total amount paid by the insurance company if the following loss amounts occurred on <u>each</u> of policies A to D:

(i) 3,500

(ii) 350,000

GIADV, Spring 2024, Q2

(*4 points*)

(a) (*1 point*) Select one of the options from within the brackets to fill in the blank to make each of the following statements true regarding individual risk rating.

(i) The schedule rating adjustment is typically applied _____ premium discounts. [*after, before*]

(ii) An experience modification factor of _____ is referred to as a credit modification. [*greater than 0, greater than 1, less than 0, less than 1*]

(iii) Increasing the cap applied to claims _____ the responsiveness of an experience rating formula. [*decreases, does not affect, increases*]

(iv) D-ratio curves relate to _____ in experience rating. [*application of premium discounts, determination of credibility, limiting of claims*]

(b) (*2 points*) Select one of the options from within the brackets to fill in the blank to make each of the following statements true regarding insurer dividend plans.

(i) Insurers offer dividend plans to U.S. insureds for_____coverage. [*commercial automobile, professional liability, workers compensation*]

(ii) Dividend plans closely resemble _____rating plans. [*prospective, retrospective, schedule*]

(iii) Dividend plans are also referred to as _____. [*participating policies, predictive rating plans, risk-control plans*]

(iv) Dividend payments may require approval by the _____. [*insurer's board of directors, insurer's shareholders, regulatory authority*]

(v) In a sliding-scale dividend plan, the insured's claims experience _____ dividend payments. [*affects, does not affect*]

(vi) An insurer's board of directors may _____dividend payments for all dividend plan policies. [*not reject, reject*]

(vii) Dividend payments occur after _____. [*the end of the policy period, the filing of the financial statements, settlement of the claims on the policy*]

(viii) A combined dividend plan is a combination of the sliding-scale and _____dividend plans. [*flat, schedule-rated, split-rated*]

(c) (*1 point*) Describe the use of safety groups for U.S. workers compensation dividend plans.

ANSWER:

GIADV, Spring 2024, Q7

Provide the response for this question in the Excel spreadsheet.

(*4 points*) You are estimating the premium asset for retrospectively rated polices using the PDLD method developed by Teng and Perkins. You are given the following information for a retrospectively rated book of business.

Basic premium (BP)	31.5 million
Standard premium (SP)	140 million
Expected loss ratio (ELR)	87.5%
Loss conversion factor (LCF)	1.19
Tax multiplier (TM)	1.02

Retrospective Adjustment	**Expected percentage of loss emerged (EPLE)**	**Loss elimination ratio from per accident limit (LEPA)**	**Loss elimination ratio from retro formula max and min (LEMM)**
First	82.30%	2.1%	3.0%
Second	91.10%	2.6%	4.6%
Third	97.80%	3.0%	7.5%
Fourth	100.00%	3.2%	9.0%

(a) (*2.5 points*) Calculate the cumulative premium development to loss development (CPDLD) ratio for each retrospective adjustment period using the formula approach.

(b) (*0.5 points*) State the formula to estimate the premium asset that includes the CPLD ratio as one of the elements in the formula.

(c) (*0.5 points*) Identify two situations where an empirical approach to estimating PDLD ratios would be preferred to the formula approach.

(d) (*0.5 points*) Provide a reason the PDLD method might be preferred to Fitzgibbon's method.

GIADV, Spring 2024, Q11

(*4 points*) During the 1970s, circumstances in the United States created a shift to claims-made coverage for certain types of insurance.

(a) (*1 point*) Describe these circumstances.

ANSWER:

(b) (*0.5 points*) Identify two reasons that this shift to claims-made coverage was not as prevalent outside of the United States.

ANSWER:

A key concept of claims-made coverage is the retroactive date.

(c) (*0.5 points*) Define the claims-made coverage retroactive date.

ANSWER:

Marker and Mohl identified five principles of claims-made ratemaking.

(d) (*2 points*) State four of these principles.

ANSWER:

GIADV, Spring 2024, Q12

Provide the response for this question in the Excel spreadsheet.

(*5 points*)

(a) (*1.5 points*) Describe three ways that a self-insured retention (SIR) differs from the use of a deductible.

The elimination ratio approach is one of the ways to determine deductible factors.

(b) (*1.5 points*) Provide the following with respect to an insurer's application of this approach.

(i) Definition of elimination ratio

(ii) Formula for elimination ratio

The reduction in premium is not proportional to the size of the deductible for many lines of general insurance, particularly automobile physical damage coverages and personal property insurance.

(c) (*0.5 points*) Explain why this should be expected.

You are given the following:

- An insured property is valued at 200,000.
- The amount insured is 100,000.
- The insurance policy includes a coinsurance percentage of 60%.
- A loss occurred and the loss amount is 40,000.

(d) (*1.5 points*) Determine the amount the insurer would pay to the insured for this loss under the following scenarios. State any assumptions required.

(i) The policy has no deductible.

(ii) The policy has a deductible of 2,500.

GIADV, Fall 2024, Q2

(*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:

GIADV, Fall 2024, Q7

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

(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).

GIADV, Fall 2024, Q11

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

GIADV, Fall 2024, Q12

(*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:

GI 301 Learning Objective 7 Curated Past Exam Questions

GIADV, Fall 2020, Q1

(*5 points*) Casualty Reinsurance Company is writing a casualty per occurrence excess treaty for accident year 2021 covering the layer 750,000 excess of 250,000.

You are given the following information:

Loss Experience Evaluated as of December 31, 2019		
Accident Date	**Untrended Loss**	**Untrended ALAE**
July 1, 2017	200,000	150,000
July 1, 2017	350,000	400,000
July 1, 2018	225,000	0
July 1, 2018	900,000	450,000
July 1, 2019	250,000	50,000
July 1, 2019	800,000	275,000

- All losses of at least 200,000 are shown.
- All policy limits throughout the experience period are 1,000,000 and are expected to remain at this level through 2021.
- On level subject premium is 10,000,000 for each year from 2017-2019.
- ALAE is allocated to layer in proportion to losses.
- Loss and ALAE trend are each 5% per year.
- The following accident year development factors are applicable to both loss and ALAE in the layer 750,000 excess of 250,000:

12-Ultimate	2.40
24-Ultimate	1.40
36-Ultimate	1.10

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

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

GIADV, Fall 2020, Q8

(*5 points*) Specialist Reinsurance Company is offering finite reinsurance to Ceding Insurance Company to cover its aggregate annual losses.

The annual number of losses has a Poisson distribution with mean 1.5.

The loss size distribution is:

Loss Size (millions)	Probability
1	0.5
2	0.4
3	0.1

Loss sizes are independent of one another and independent of the number of losses.

(a) (*2 points*) Complete the following aggregate loss probability table:

Aggregate Losses (millions)	Probability
0	
1	0.1673
2	0.1966
3	0.1496
4	
5	
6	0.0411
7	
8	
9	
10	
11	
12	
13	
14	0.0001
15	0.0000

The response for part (a) is to be provided in the Excel spreadsheet.

The finite risk cover has the following terms:

- Annual Premium: 2.5 million
- Limit: 10 million

- Profit Commission: 80% after 10% margin on Annual Premium
- Additional Premium: 50% of (Loss + Margin – Annual Premium)

The underwriting results for different aggregate losses are:

Aggregate Losses (millions)	**Underwriting Result (millions)**
0	0.700
1	0.500
2	0.300
3	(0.125)
4	(0.625)
5	(1.125)
6	(1.625)
7	(2.125)
8	(2.625)
9	(3.125)
10 +	(3.625)

(b) (*2 points*) Verify the following underwriting results for Specialist:

(i) A profit of 0.3 million if aggregate losses are 2 million.

(ii) A loss of 1.125 million if aggregate losses are 5 million.

The response for part (b) is to be provided in the Excel spreadsheet.

(c) (*0.5 points*) State the two conditions that a finite reinsurance arrangement must fulfill for a ceding company to consider it insurance.

ANSWER:

(d) (*0.5 points*) Explain whether the finite reinsurance can be considered insurance by Ceding Insurance Company.

ANSWER

GIADV, Spring 2021, Q1

(*5 points*) Casualty R Us Reinsurance Company is evaluating a proposed casualty per occurrence excess treaty.

You are developing increased limits factors (ILFs) using a lognormal model.

The underlying losses have the following characteristics:

- Mean 300
- Standard Deviation 1,200

The estimated parameters of the lognormal distribution based on the method of moments are:

- mu (μ) 4.287
- sigma (σ) 1.683

(a) (*1 point*) Demonstrate that this is true.

Provide the response for this part in the Excel spreadsheet.

The limited expected loss function for a lognormal distribution is given by:

$$E[y;L] = exp\left(\mu + \frac{\sigma^2}{2}\right)\cdot\Phi\left(\frac{ln(L)-\mu-\sigma^2}{\sigma}\right) + L\cdot\left[1-\Phi\left(\frac{ln(L)-\mu}{\sigma}\right)\right]$$

$\Phi(x)$ is the cumulative distribution function for a standard normal variable, N(0,1).
It can be produced by the Excel function NORM.S.DIST(x,TRUE).

The following increased limits factors were generated:

Policy Limit	Increased Limits Factor
500	1.00
1,000	1.28
1,500	1.44
2,000	1.53

(b) (*1.5 points*) Demonstrate that the ILF at policy limit 1,500 is 1.44.

Provide the response for this part in the Excel spreadsheet.

You are pricing the layer 1,000 excess of 500.

The following information has been provided:

Subject Premium	Underlying Limit	Policy Limit
2,000	0	1,000
2,500	0	1,500
4,000	500	1,000
4,500	500	1,500

The expected loss ratio is 55%.

(c) (*2.5 points*) Calculate the expected losses in the layer using an exposure rating approach.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2021, Q8

(*4 points*) ABC Reinsurance Company is pricing the 2021 renewal of its proportional reinsurance treaty with Ceding Insurance Company.

The treaty losses have the following loss distribution:

Loss	Probability
0	9.16%
40,000	14.65%
110,000	19.54%
180,000	19.54%
250,000	15.63%
320,000	10.42%
390,000	5.95%
400,000	5.11%

The 2021 treaty premium is 331,000.

The treaty has a sliding scale commission:

Loss Ratio	Commission
30% or below	45%
30%-50%	Sliding 0.5:1
50%-60%	Sliding 1:1
60% or above	25%

ABC expenses are 8.0% of ceded premium.

(a) (*0.5 points*) Show that with the expected loss ratio of 54.0%, the 2021 treaty profit is 7.0% of ceded premium.

Provide the response for this part in the Excel spreadsheet.

(b) (*1.5 points*) Show that using the loss distribution above, the expected 2021 treaty profit is 3.6% of ceded premium.

Provide the response for this part in the Excel spreadsheet.

(c) (*0.5 points*) State whether or not the sliding scale commission structure is "balanced." Justify your answer.

Provide the response for this part in the Excel spreadsheet.

The treaty has a carryforward provision.

The loss ratio on the 2020 treaty was 75.5%.

(d) (*1 point*) Recalculate the expected 2021 treaty profit from (b) as a percentage of ceded premium, allowing for the loss ratio in 2020.

Provide the response for this part in the Excel spreadsheet.

Another approach to assessing the effect of a carryforward provision is to look at the "long run" of the contract.

(e) (*0.5 points*) State two problems with this approach.

ANSWER:

GIADV, Fall 2021, Q1

(*4 points*) You are modeling catastrophe losses.

The number of catastrophe losses, n, follows a negative binomial distribution with parameters $\alpha = 1$ and $p = 0.5$. This results in a distribution with:

- Mean 1
- Variance 2
- $\Pr(n) = (0.5)^{n+1}$, $n = 0, 1, 2, \ldots$

The loss size distribution is:

Loss Size (billions)	Probability
1	0.6
2	0.3
3	0.1

Loss sizes are independent of one another and independent of the number of losses.

Aggregate catastrophe losses have the following probability distribution for amounts below 5 billion:

Aggregate Losses (billions)	Probability
0	0.50000
1	0.15000
2	0.12000
3	0.08350
4	0.05055

(a) (*2 points*) Calculate the probability that aggregate losses will be 5 billion.

Provide the response for this part in the Excel spreadsheet.

(b) (*1.5 points*) Calculate the mean and coefficient of variation of aggregate catastrophe losses.

Provide the response for this part in the Excel spreadsheet.

(c) (*0.5 points*) Identify one disadvantage of using a recursive formula to calculate aggregate distribution probabilities.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2021, Q8

(*5 points*) A reinsurer is pricing a property per risk excess treaty for accident year 2022 covering the layer 3,000,000 excess of 1,000,000.

You are given the following information:

Loss ID	Accident Year	Untrended Loss Evaluated as of 12/31/2020
1	2018	1,100,000
2	2018	2,100,000
3	2019	900,000
4	2019	1,400,000
5	2020	800,000
6	2020	1,800,000

- All losses of at least 500,000 are shown.
- On level subject premium is 5,000,000 for each year from 2018-2020.
- Loss trend is 5% per year.
- The insured value of each property is 6,000,000.
- Accident year development factors applicable to losses in the layer 3,000,000 excess of 1,000,000:

12-Ultimate	1.50
24-Ultimate	1.25
36-Ultimate	1.00

(a) (*2 points*) Estimate the experience rating loss cost as a percentage of the subject premium.

Provide the response for this part in the Excel spreadsheet.

(b) (*0.5 points*) Define free cover.

Provide the response for this part in the Excel spreadsheet.

The following exposure factors are considered appropriate for pricing this treaty:

Percent of Insured Value	Exposure Factor
10%	30%
20%	50%
30%	61%
40%	69%
50%	75%
60%	80%
70%	85%
80%	89%
90%	92%
100%	95%
110%	98%
120%	100%

(c) (*2 points*) Calculate a revised loss cost as a percentage of the subject premium using these exposure factors to estimate the cost of free cover.

Provide the response for this part in the Excel spreadsheet.

(d) (*0.5 points*) Assess whether the loss cost percentage you calculated in part (c) would be appropriate for pricing coverage on properties with insured values of 12 million.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2022, Q1

(*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:

- Retro Premium = (Actual Layer Losses) x 100/80
- Provisional Rate = 15%
- Maximum Premium = 20% x Subject Premium
- Minimum Premium = 10% x 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.

(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.

GIADV, Spring 2022, Q8

(*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)

(f) (*0.5 points*) Calculate the nominal rate on line.

Provide the response for this part in the Excel spreadsheet.

(g) (*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.

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

Provide the response for this part in the Excel spreadsheet.

(i) (*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.

(j) (*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.

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

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2022, Q1

(*4 points*) You are using exposure rating to price a workers compensation treaty. The treaty covers the layer 500,000 excess of 250,000. You are given the following:

State	Expected Loss Ratio
X	55%
Y	65%

State	Hazard Group	Standard Premium
X	C	200,000
X	D	180,000
Y	C	170,000
Y	D	230,000

You assume that the NCCI excess loss factor (ELF) curves can be approximated by an inverse power curve of the form $ELF_L = a\ L^{-b}$.

NCCI ELF Curve Estimation		
Parameter	**Hazard Group C**	**Hazard Group D**
a	8,000	1,200
b	1.00	0.75

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

Provide the response for this part in the Excel spreadsheet.

Casualty per occurrence excess treaties are often separated into three categories.

(b) (*1 point*) Describe the characteristics of the following categories:

(i) Working Layer

(ii) Exposed Excess

(iii) Clash Cover

Provide the response for this part in the Excel spreadsheet.

(c) (*0.5 points*) Compare the use of experience rating in pricing treaties in the three categories.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2022, Q8

(*5 points*)

(a) (*0.5 points*) Describe what is meant by "collective risk model."

Provide the response for this part in the Excel spreadsheet.

You are assessing your company's reinsurance program for the management of catastrophe risk. The annual number of catastrophe losses has a Poisson distribution with mean 1.5. The loss size distribution for catastrophes is as follows:

Loss Size (billions)	Probability
1	0.6
2	0.3
3	0.1

Loss sizes are independent of one another and independent of the number of losses.

(b) (*1.5 points*) Calculate the mean and coefficient of variation for the aggregate losses.

Provide the response for this part in the Excel spreadsheet.

(c) (*3 points*) Complete the following aggregate loss probability table:

Aggregate Losses (billions)	Probability
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q1

(*5 points*) Your reinsurance company is evaluating a proposed casualty per occurrence excess treaty covering the layer 3,000,000 excess of 1,000,000. The following information has been provided:

Subject Premium	Underlying Limit	Policy Limit
3,000,000	0	1,000,000
4,000,000	0	2,000,000
5,000,000	1,000,000	3,000,000
2,000,000	1,000,000	2,000,000
6,000,000	0	5,000,000

Policy Limit	Increased Limits Factor
1,000,000	1.00
2,000,000	1.16
3,000,000	1.28
4,000,000	1.38
5,000,000	1.46

The expected loss ratio is 60%.

(a) (*3 points*) Calculate the expected losses in the layer using an exposure rating approach.

Provide the response for this part in the Excel spreadsheet.

You are also evaluating a proportional treaty with a sliding scale commission. You are given the following information:

Loss Ratio	Probability
40%	15%
50%	35%
60%	25%
70%	15%
80%	8%
90%	2%

Sliding Scale	
Loss Ratio	**Commission**
50% or below	30%
50% - 90%	Sliding 0.5:1
90% or above	10%

(b) (*1 point*) Calculate the expected technical ratio (loss ratio plus commission ratio) for the treaty.

Provide the response for this part in the Excel spreadsheet.

(c) (*1 point*) Assess whether the sliding scale commission is balanced.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q9

(*4 points*) You are given the following information regarding a reinsurance contract:

- It applies to claims incurred in 2023 for all lines of business combined.
- It is an aggregate excess of loss contract for the layer 100 million excess of 150 million.
- Ceded premium is 48 million, paid on January 1, 2023.
- Cedant's loss participation is 65%.
- Reinsurance payments and the cedant's loss participation payment occur on July 1, 2026.

The aggregate distribution of claims incurred in 2023 is estimated as follows:

Probability of Result	Incurred in Millions
55.0%	65.5
12.0%	87.6
7.5%	108.0
5.5%	123.6
5.0%	139.3
2.5%	150.0
2.5%	165.6
2.0%	175.8
2.0%	202.6
1.5%	225.4
1.5%	253.7
1.0%	270.1
1.0%	286.5
0.5%	304.5
0.5%	345.5

- Most of the claims from this business are expected to be paid in 2023 and all will be paid before the end of 2025.
- The annual after-tax investment yield is 4.0% at inception of the reinsurance contract.

(a) (*1 point*) Explain why the risk transfer in this reinsurance contract would not be categorized as "reasonably self-evident" to permit reinsurance accounting.

ANSWER:

(b) (*2.5 points*) Determine whether or not this reinsurance contract transfers sufficient risk to permit reinsurance accounting using the Expected Reinsurer Deficit (ERD) test with a threshold of 1%.

Provide the response for this part in the Excel spreadsheet.

Reinsurance accounting may be applicable even if the risk transfer in this reinsurance contract is not categorized as "reasonably self-evident" and the contract does not meet the conditions for risk transfer from a quantitative test.

(c) (*0.5 points*) Describe when this may apply.

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2023, Q13

(*5 points*) XYZ Insurance has reinsurance arrangements applied in the following order:

Reinsurance Treaty	Description
Surplus Share	4 lines with 1,000 retained line
Per Risk Excess of Loss	2,000 in excess of 1,000
Catastrophe	6,000 in excess of 4,000

During the year, an earthquake caused the following covered losses for XYZ:

Property	Insured Value	Loss
A	2,500	1,200
B	10,000	8,000
C	1,000	400
D	4,000	1,600
E	8,000	3,000

(a) (*2 points*) Calculate the total losses recoverable under each treaty.

Provide the response for this part in the Excel spreadsheet.

You are provided with the following information on the catastrophe treaty:

- The annual premium is 600.
- There is a reinstatement provision that is 125% pro-rata as to amount.

(b) (*0.5 points*) Calculate the reinstatement premium for the catastrophe treaty.

Provide the response for this part in the Excel spreadsheet.

A different insurer, ABC Insurance, has a per risk excess of loss reinsurance treaty as follows:

Treaty Limit	6,000
Attachment Point	2,000
Annual Aggregate Deductible (AAD)	10,000

ABC's claims covered by the treaty in order of occurrence are:

Claim Number	Ultimate Claim
1	10,200
2	800
3	4,900
4	7,000
5	6,500

(c) (*2.5 points*) Calculate the amount retained by ABC for each claim.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2023, Q1

Provide the response for this question in the Excel spreadsheet.

(*5 points*) A reinsurer is pricing a property per risk excess treaty for accident year 2024 covering the layer 3,000,000 excess of 1,000,000.

You are given the following information:

Loss ID	Accident Year	Untrended Loss Evaluated as of 12/31/2022
1	2019	900,000
2	2019	2,900,000
3	2020	1,600,000
4	2020	800,000
5	2021	700,000
6	2021	2,000,000
7	2022	1,800,000
8	2022	1,400,000

Accident Year	On Level Subject Premium
2019	15,000,000
2020	6,000,000
2021	6,500,000
2022	7,500,000

- All losses of at least 500,000 are shown.
- Loss trend is 7% per year.
- Accident year development factors applicable to losses in the layer 3,000,000 excess of 1,000,000:

12-Ultimate	2.00
24-Ultimate	1.50
36-Ultimate	1.25
48-Ultimate	1.00

(a) (*3 points*) Calculate the annual experience rating loss cost for each year in 2019-2022.

Changing weather patterns are creating uncertainty in the projection of future losses. To allow for this, the 2019-2022 losses are to be adjusted as follows:

Increase in Losses	**Probability**
0%	50%
10%	30%
20%	20%

(b) (*1.5 points*) Calculate the revised expected loss cost for each year in 2019-2022.

(c) (*0.5 points*) Explain why using the average of all years may not be appropriate for pricing the 2024 treaty.

GIADV, Fall 2023, Q9

Provide the response for this question in the Excel spreadsheet.

(*4 points*)

(a) (*0.5 points*) Explain why the "10% - 10% rule" is often not considered appropriate for determining the existence of sufficient risk transfer in a reinsurance agreement.

(b) (*1 point*) Define the expected reinsurer deficit (ERD) metric as used for determining the existence of sufficient risk transfer in a reinsurance agreement.

You are given the following information regarding an annual aggregate excess of loss reinsurance agreement for UVW Insurance by X-Re:

- The aggregate excess loss layer is 800 million excess of 200 million.
- The annual after-tax investment yield is 3.5%.
- The reinsurance with X-Re is for 85% of the aggregate loss layer (i.e., participation by UVW of 15% in the aggregate excess layer).
- Reinsured losses are assumed to be settled two years after expiration of the agreement.

UVW Direct Losses (millions)	**Probability**
100	91.35%
225	1.85%
275	1.60%
350	1.35%
450	1.25%
550	0.70%
650	0.55%
750	0.40%
850	0.35%
950	0.60%

The reinsurance premium paid by UVW to X-Re results in an ERD of 5%.

(c) (*1.5 points*) Determine the reinsurance premium. [Using Excel's Goal Seek function is an acceptable method for determining this amount.]

(d) (*1 point*) Explain why UVW would likely not need to test for risk transfer with respect to this reinsurance agreement.

GIADV, Fall 2023, Q13

Provide the response for this question in the Excel spreadsheet.

(*6 points*) You are using a collective risk model to model catastrophe risks. The annual number of catastrophe losses has a Poisson distribution with mean 1. The loss size distribution for catastrophes is as follows:

Loss Size (billions)	Probability
1	0.4
2	0.3
3	0.2
4	0.1

Loss sizes are independent of one another and independent of the number of losses.

(a) (*1.5 points*) Demonstrate that the mean and coefficient of variation of aggregate losses are 2 billion and 1.118, respectively.

(b) (*3 points*) Complete the following aggregate loss probability table:

Aggregate Losses (billion)	Probability
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

You decide to approximate aggregate losses with a lognormal distribution.

(c) (*1.5 points*) Calculate the method of moments estimates for μ and σ^2.

GIADV, Spring 2024, Q1

Provide the response for this question in the Excel spreadsheet.

(*5 points*) A reinsurer is pricing a proportional treaty and is considering various adjustable features to manage profitability.

You are given the following information:

- Aggregate loss distribution:

Loss in Millions	Cumulative Probability
1	0.0526
2	0.2119
3	0.4058
4	0.5815
5	0.7191
6	0.8182
7	0.8855
8	0.9295
9	0.9573
10	0.9746
11	0.9850
12	0.9913
13	0.9949
14	0.9971
15	0.9984
16	0.9991
17	0.9995
18	0.9997
19	0.9998
20	0.9999

- Ceding commission is 30%
- Brokerage fees are 5%
- Other Expenses are 2%
- Treaty Premium is 8,000,000

(a) (*1.5 points*) Calculate the probability of a combined ratio of more than 100%.

You are considering using a loss corridor with the following feature:

Ceding company will reassume 75% of the losses in the loss ratio layer from 60% to 100%.

(b) (*1 point*) Calculate the expected loss ratio after the loss corridor.

You are further considering a sliding scale commission, to apply to loss ratios calculated **after** the loss corridor. The sliding scale commission has the following features:

- Provisional commission is 30%
- Minimum commission is 15% at a 70% loss ratio
- Commission sliding 1:1 to 25% at a 60% loss ratio
- Commission sliding 0.5:1 to a maximum of 35% at a 40% loss ratio

(c) (*1.5 points*) Calculate the expected combined ratio.

(d) (*1 point*) Assess whether the sliding scale commission is balanced.

GIADV, Spring 2024, Q9

Provide the response for this question in the Excel spreadsheet.

(*4 points*)

(a) (*0.5 points*) Describe two examples of contracts where the risk transfer is "reasonably self-evident."

The metrics expected reinsurer deficit (ERD) and risk coverage ratio (RCR) have been presented as being superior to other metrics such as value-at-risk (VaR) or tail value-at-risk (TVaR) for gauging risk transfer.

(b) (*1 point*) Describe two advantages of using ERD and RCR versus using VaR and TVaR.

Another metric used in the testing of risk transfer is right-tailed deviation (RTD). A risk transfer test called maximum qualified premium (Max QP) has been proposed in which the test uses a multiple, α, of RTD.

You are to use the Max QP test to determine whether risk transfer exists in a reinsurance contract given the following information:

- A catastrophe excess of loss reinsurance contract for the layer 300 million excess of 400 million.
- The reinsurance premium is a fixed amount of 48 million payable to the reinsurer at inception of the contract.

Reinsured losses (millions)	**Probability**
0	94.0%
50	3.3%
100	1.6%
200	0.8%
300	0.3%

(c) (*2.5 points*) Determine whether risk transfer exists in this contract using the Max QP test with α equal to 4.

GIADV, Spring 2024, Q13

Provide the response for this question in the Excel spreadsheet.

(*4 points*) A reinsurance broker has proposed that ABC Reinsurance Company (ABC Re) provide a finite risk cover without reinstatements to JKL Insurance Company (JKL) with the following terms:

- Annual Premium: 20,000,000
- Occurrence Limit: 150,000,000
- 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.

(b) (*0.5 points*) Calculate the underwriting loss (excluding expenses) to ABC Re if a loss fully exhausts the limit.

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

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

A catastrophe model indicates that a loss will fully exhaust the limit once every 10 years, and that the probability of a partial loss is negligible.

ABC Re has concluded that this proposal is not acceptable.

(e) (*2 points*) Construct a counterproposal that should be acceptable to both ABC Re and JKL. Justify your answer.

GIADV, Fall 2024, Q1

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.

GIADV, Fall 2024, Q9

(*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)		

(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:

GIADV, Fall 2024, Q13

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.

GI 301 Learning Objective 8 Curated Past Exam Questions

GIRR, Fall 2020, Q12

(4 *points*)

(a) (*1 point*) State four applications of catastrophe modeling for insurance.

ANSWER:

You insure a small book of property portfolios in the state of Florida. You receive two new requests (portfolio X and portfolio Y) for pricing quotes and you decide to add only one of these portfolios to the book.

You are given the following information:

	Average Annual Loss (AAL)	**100-Year Probable Maximum Loss (PML)**
Current Book	50,000	750,000
Current Book + Portfolio X	50,000 + 5,000	850,000
Current Book + Portfolio Y	50,000 + 6,000	770,000

(b) (*1 point*) Recommend which portfolio you would add to the book. Justify your recommendation.

ANSWER:

Management decided to write the portfolio you didn't recommend in part (b). The risk potential of the portfolio could be reduced by 13.7% if hurricane shutters are installed as a risk mitigation strategy. The expense load factor is 27%. The selected risk load is 440.

(c) (*1 point*) Calculate the premium for this other portfolio assuming hurricane shutters are installed on all properties in the portfolio.

The response for part (c) is to be provided in the Excel spreadsheet.

(d) (*0.5 points*) Provide a consideration in the selection of a risk load in this situation.

ANSWER:

You are concerned about the close geographical proximity of your existing book of business to the portfolio that management wants to add.

(e) (*0.5 points*) Recommend a way this risk could be managed.

ANSWER:

GIRR, Spring 2021, Q8

(a) (*2 points*) Describe four limitations of relying on historical data to analyze catastrophe events.

ANSWER:

(b) (*1 point*) Explain how catastrophe model output can be used to evaluate alternative loss mitigation strategies.

ANSWER:

You are given the following information:

County	Modeled Gross Hurricane Wind Loss Per 1,000 Coverage A	Selected Risk Load (Standard Deviation)
Monroe	13.82	27.65
Broward	5.54	11.08
Palm Beach	5.26	10.51
Miami-Dade	7.60	15.21
Hillsborough	0.75	1.51
Orange	0.36	0.72
Okeechobee	1.91	3.81
Duval	0.25	0.49
Sarasota	1.74	3.48

- The average Coverage A limit is 207,500.
- The expense load is 27%.
- The risk load includes a provision for profit.

(c) (*2 points*) Calculate the hurricane wind premium by county for a 207,500 Coverage A limit.

Provide the response for this part in the Excel spreadsheet.

GIRR, Fall 2021, Q17

(*5 points*) Primary Insurance is interested in obtaining per occurrence excess of loss reinsurance for the combined perils of hurricane wind (HW) and flood inland (FI). The reinsurance is to cover Primary's insured losses between the 100-year and 500-year PMLs from these two perils.

The proposed reinsurance cover is to be provided in two layers:

- the first layer covering Primary's insured losses between the 100-year and 250-year PMLs, and
- the second layer covering Primary's insured losses between the 250-year and 500-year PMLs.

You are given the following excerpts of catastrophe model output for Primary's portfolio of insurance policies.

Loss Basis	Return Period (Years)	PMLs (000s)		
		HW	FI	HW and FI Combined
Ground up	100	780,971	120,066	830,644
	250	1,242,287	250,762	1,362,121
	500	1,801,316	388,680	2,006,473
Gross	100	624,777	96,053	664,515
	200	993,830	200,609	1,089,697
	500	1,441,053	310,944	1,605,179

Layer (PML basis)	Statistic	AAL and Standard Deviation (SD) (000s)		
		HW	FI	HW and FI Combined
100-year to 250-year	AAL	616	45	661
	SD	6,314	1,280	6,868
250-year to 500-year	AAL	212	21	233
	SD	3,920	1,005	4,374

(a) (*0.5 points*) Calculate the probability of reaching an amount of loss that activates reinsurance coverage for each of the reinsurance layers.

Provide the response for this part in the Excel spreadsheet.

Assume that Primary purchased this reinsurance coverage and then experienced the following losses from a single catastrophic event:

- Insured losses from peril HW: 1,098,085,000
- Insured losses from peril FI: 132,325,000

(b) (*1 point*) Calculate Primary's reinsurance recoverables from this catastrophic event for each of the two layers.

Provide the response for this part in the Excel spreadsheet.

Historically, Primary has received reinsurance premium quotes that reflect an expense load of 24% and a risk load equal to the 85% of the SD.

(c) (*2 points*) Estimate Primary's reinsurance premium for each layer of coverage.

Provide the response for this part in the Excel spreadsheet.

Primary is also considering inclusion of the peril flood storm surge (FSS) for its reinsurance coverage. Primary has separate PMLs, AALs and SDs for FSS but does not have the amounts on a HW, FI and FSS combined basis. An underwriter has recommended that Primary should calculate the total reinsurance premium by estimating a premium for FSS coverage in the reinsurance layers and then adding it to the premiums estimated in part (c).

(d) (*1.5 points*) Provide two reasons why Primary should not calculate the total reinsurance premium using the underwriter's recommendation.

Provide the response for this part in the Excel spreadsheet.

GIRR, Spring 2022, Q13

(*4 points*) One of the outputs from a catatstrophe model is PML. PMLs are stated for a specified return period and may be provided for a single cause of loss or by a combination of causes of loss.

(a) (*1 point*) Explain why the 100-year PML for hurricane wind losses and the 100-year PML for tornado wind losses should not be added together to determine the 100-year PML for hurricane and tornado wind losses.

ANSWER:

Many different loss metrics may be computed for an insured property at an individual location using the output from a catastrophe model.

(b) (*1 point*) Describe how an insurer could use each of the following loss metrics to understand the risk of an individual insured.

(i) AAL to TIV ratio

(ii) PML to TIV ratio

ANSWER:

(c) (*1 point*) Explain how catastrophe models can be used by an insurer for portfolio optimization with respect to risk.

ANSWER:

Various requirements have been established to govern the use of catastrophe models. One such example is that of rating agencies mandating certain model output for their use in evaluating a risk-bearing entity's financial strength.

(d) (*1 point*) Provide two other examples of requirements that have been established to govern the use of catastrophe models.

ANSWER:

GIRR, Fall 2022, Q20

(*4 points*) Your catastrophe model produces the following annual probabilities of hurricane events and expected loss for a portfolio of policies in a zip code in Florida:

Event #	Annual Probability of Hurricane (p)	Expected Loss (L) Per $1,000 of Building Coverage
1	1.00%	$50
2	0.20%	$100
3	0.40%	$125
4	0.60%	$150
5	0.09%	$25
6	0.50%	$200
7	0.45%	$225
8	0.50%	$250
9	1.10%	$200
10	1.20%	$100

(a) (*0.5 points*) Calculate the expected Average Annual Loss (AAL) per $1,000 of building coverage.

Provide the response for this part in the Excel spreadsheet.

You are given the following additional information:

- The annual expense load is 25%.
- The average building coverage limit is $200,000

(b) (*2 points*) Calculate Hurricane Wind Premium for the average building in the zip code using the method described in the American Academy of Actuaries monograph, Uses of Catastrophe Model Output.

Provide the response for this part in the Excel spreadsheet.

Hurricane insurance costs can vary significantly by location within a state.

(c) (*0.5 points*) Describe why hurricane deductibles tend to be larger in inland areas compared to coastal regions.

Provide the response for this part in the Excel spreadsheet.

You are given the expected AAL and Probable Maximum Losses (PML) for hurricane events for two different zip codes in Florida.

Zip Code	AAL	250-year PML
A	$22.86	$2,426.10
B	$26.16	$2,025.55

(d) (*1 point*) Identify which zip code has the highest potential for loss from hurricane events. Justify your selection.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2020, Q5

(*4 points*) Big Reinsurance Company (BRC) is renewing two accounts, X and Y, each of which is exposed to three independent claim events, 1, 2 and 3. You are given the following information:

Event (*i*)		**Loss for Account**	
i	***p(i)***	**X**	**Y**
1	1%	20,000	5,000
2	2%	10,000	8,000
3	4%	5,000	2,000

- *p(i)* represents the probability of Event *i*.
- The risk load multiplier, λ, is 0.000024.

Responses for all parts of this question are to be provided in the Excel spreadsheet.

(a) (*2 points*) Calculate the renewal risk load for each account using the Marginal Variance method.

(b) (*0.5 points*) Demonstrate that the Marginal Variance method is not renewal additive.

BRC is considering using the Covariance Share method to calculate risk loads. The shared covariance of each event will be allocated to each account in proportion to its loss for that event.

(c) (*1.5 points*) Calculate the risk load for each account using the Covariance Share method.

GIADV, Spring 2021, Q5

(*5 points*) A risk load can be calculated for an account during build-up and on renewal. Consider a portfolio with two accounts, an older account X and a newer account Y.

Under the Marginal Variance method for calculating risk loads, the risk load for account X on build-up is different from the risk load for account X on renewal.

(a) (*0.5 points*) Identify which risk load is larger.

ANSWER:

(b) (*1 point*) Explain why there is this difference.

ANSWER:

An insurer is renewing these two accounts, X and Y, each of which is exposed to five independent loss events as follows:

Event (*i*)		**Loss for Account**	
i	***p*(*i*)**	**X**	**Y**
1	1.5%	15,000	500
2	1.0%	9,000	2,000
3	2.5%	6,500	2,500
4	3.0%	4,500	5,000
5	2.0%	1,000	10,000

- $p(i)$ represents the probability of Event i.
- The risk load multiplier, λ, is 0.000045.

(c) (*3.5 points*) Calculate the renewal risk load for each account using the following methods:

(i) Marginal Variance

(ii) Shapley

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2021, Q5

(*4 points*) A property catastrophe reinsurance company with a portfolio of business, portfolio Q, is considering writing an additional portfolio of property catastrophe business. The selection is to be from one of portfolios U, V, or W.

You are given the following information for independent insured events:

Event	Probability	Loss to portfolio Q	Loss to portfolio U	Loss to portfolio V	Loss to portfolio W
1	0.045	200,000	85,000	80,000	110,000
2	0.025	320,000	5,000	120,000	20,000
3	0.020	125,000	360,000	45,000	75,000
4	0.010	750,000	30,000	250,000	215,000

The company uses the Marginal Variance (MV) method to calculate risk loads.

The MV risk load multiplier, λ, is 0.00002.

(a) (*1.5 points*) Calculate the following for each of the four portfolios:

(i) Expected loss

(ii) Variance

(iii) Coefficient of variation

Provide the response for this part in the Excel spreadsheet.

(b) (*1 point*) Recommend which portfolio the reinsurance company should add if it wants to minimize the size of the total risk load. Justify your answer.

Provide the response for this part in the Excel spreadsheet.

The company calculates renewal risk loads using the Covariance Share method.

(c) (*1.5 points*) Calculate the renewal risk loads for portfolio Q and the portfolio you recommended be added in part (b).

Provide the response for this part in the Excel spreadsheet.

GIADV, Spring 2022, Q5

(*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*)	*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}.

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

(i) Expected losses

(ii) Variance of losses

(iii) Coefficient of variation

Provide the response for this part in the Excel spreadsheet.

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

(i) Marginal Variance

(ii) Shapley

(iii) Covariance Share

Provide the response for this part in the Excel spreadsheet.

(f) (*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.

GIADV, Fall 2022, Q5

(*4 points*) In "An Application of Game Theory: Property Catastrophe Risk Load," Donald Mango (Mango) used Kreps' formula to produce a risk load multiplier for the Marginal Surplus method applied to a portfolio.

You are given the following information:

- Return on marginal surplus is 20%
- Standard normal multiplier is 2.0 (corresponding to a cumulative non-exceedance probability of 97.725%)

(a) (*1 point*) Calculate the risk load multiplier using Kreps' formula.

ANSWER:

(b) (*0.5 points*) Describe how Mango converted this multiplier for use in the Marginal Variance method to ensure that the two methods have the same total risk load for the portfolio.

ANSWER:

Mango refers to portfolio variance as a *super-additive characteristic function*.

(c) (*1 point*) Explain what is meant by this reference.

ANSWER:

(d) (*1 point*) Compare the Shapley Value under a variance-based method to the Marginal Variance for calculating a risk load when adding a new account to an existing portfolio.

ANSWER:

(e) (*0.5 points*) Explain why Mango did not pursue the use of a Shapley Value under a standard deviation-based method.

ANSWER:

GIADV, Spring 2023, Q5

(*3 points*) JKL Reinsurance Company is planning to write three reinsurance treaties covering hurricane claims. The output from hurricane catastrophe modeling shows that there are six possible scenarios from writing these reinsurance treaties. You are provided with the following information:

Scenario	Probability	Loss to Treaty P	Loss to Treaty Q	Loss to Treaty R
U	0.80	0	0	0
V	0.08	50,000	100,000	80,000
W	0.06	0	150,000	120,000
X	0.03	100,000	0	175,000
Y	0.02	200,000	220,000	250,000
Z	0.01	0	300,000	0

JKL calculates the risk loads based on variance with a multiplier λ equal to 0.00000025.

(a) (*1.5 points*) Calculate the renewal risk load for each treaty using the Marginal Variance method.

Provide the response for this part in the Excel spreadsheet.

(b) (*1 point*) Calculate the renewal risk load for each treaty using the Shapley method.

Provide the response for this part in the Excel spreadsheet.

JKL is considering using the Covariance Share method to calculate the risk loads instead of the Shapley method.

(c) (*0.5 points*) Explain how the risk loads calculated using the Covariance Share method would differ from those using the Shapley method.

Provide the response for this part in the Excel spreadsheet.

GIADV, Fall 2023, Q5

Provide the response for this question in the Excel spreadsheet.

(*4 points*) ABC Reinsurance Company has three property catastrophe accounts, X, Y and Z.

You are given the following information:

Account	**X**	**Y**	**Z**
Expected Losses	5,000	4,000	2,500
Coefficient of Variation (CoV)	45%	25%	30%

Correlation of Losses Between Accounts			
	X	**Y**	**Z**
X	1.0	0.4	0.7
Y	0.4	1.0	0.2
Z	0.7	0.2	1.0

- ABC uses the Marginal Surplus method to calculate risk loads.
- The required return on marginal surplus is 10% and the z-score is 1.5.

(a) (*1.5 points*) Calculate the renewal risk loads for each of the three accounts (X, Y and Z) using the Marginal Surplus method.

ABC is considering using the Marginal Variance method to allocate risk loads. The risk load for the combined portfolio of the three accounts is the same as that calculated using the Marginal Surplus method.

(b) (*1.5 points*) Calculate the renewal risk loads for each of the three accounts using the Marginal Variance method.

(c) (*1 point*) Demonstrate that the renewal risk loads for accounts X, Y and Z, as calculated in both parts (a) and (b), are not renewal additive.

GIADV, Spring 2024, Q5

Provide the response for this question in the Excel spreadsheet.

(*4 points*) A reinsurance company is renewing three accounts, X, Y and Z, each of which is exposed to three possible claim events, 1, 2 and 3, which are independent of each other.

Event (*i*)		**Loss for Account**		
i	**p(*i*)**	**X**	**Y**	**Z**
1	0.5%	40,000	20,000	10,000
2	1.1%	20,000	10,000	5,000
3	2.1%	5,000	1,000	500

- p(i) represents the probability of event i.
- The risk load multiplier, λ, equals 0.000024.

(a) (*3.5 points*) Calculate the renewal risk load for each account using the following methods:

(i) Marginal Variance

(ii) Shapley

(b) (*0.5 points*) Demonstrate that the Shapley method is renewal additive.

GIADV, Fall 2024, Q5

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).