GI 301 Model Solutions
March 2026

1.

Learning Objectives:

1. The candidate will understand how to use stochastic loss development models to estimate reserve variability.

Learning Outcomes:

(1a) Identify the assumptions underlying the chain ladder estimation method.

(1b) Test for the validity of these assumptions

Sources:

Outstanding Claims Reserves, Hardy, SOA Study Note

Commentary on Question:

This item tested a candidate's ability to identify calendar year effects in a loss development triangle and apply Mack's L-S triangle approach to test for them. The model solution is in the solutions spreadsheet. This document is for informational purposes only.

Solution:

(a) Explain how calendar year effects might impact a chain ladder model.

Commentary on Question:

The solution below is an example of a full credit response.

- For the chain ladder approach's conclusions to hold, individual accident years must be independent from one another with the same underlying development factors f_j.
- A systematically larger or smaller development factor affecting most accident years in the same calendar year would violate this independence assumption and make the chain ladder approach flawed.

(b) Analyze the development triangle for calendar year effects using Mack's L-S triangle approach, in which development factors are classified as above the median (L), below the median (S), or at the median (*).

Commentary on Question:

The model solution is in the solutions spreadsheet.

For information only:

- Under the null hypothesis of no calendar year effect, L_k and S_k have a bin(n_k , 0.5) distribution, where n_k = S_k + L_k.
- This leads to a test statistic based on Z_k = MIN(S_k , L_k).
- The test statistic is p =2 (1−Φ(|Z−E[Z]| / Var[Z])).
- Z, E[Z], Var[Z] are the sums of Z_k, E(Z-k) and Var(Z_k) for calendar years with more than 1 development factor in the development table.
- m_k = (n_k - 1) / 2, E(Z_k) and Var(Z_k) were automatically calculated in the spreadsheet from the entered values of n_k.

The solution process for full credit was:

- Calculate the median f_j from the f_{ij} triangle for each development column.
- Fill the L-S table: classify each individual development factor as L (above median), S (below median), or * (equal to median).
- Use the table to calculate S_k and L_k values for each calendar year k.
- Calculate Z_k = MIN(S_k, L_k) and n_k = S_k + L_k.
- Use column sums of Z-k, E(Z_k) and Var(Z_k) and NORMDIST (or NORM.S.DIST) to calculate the two-sided p-value.

(c) Interpret the results of the analysis performed in (b). *[Does there appear to be a calendar year effect underlying this data set?]*

Commentary on Question:
The solution below is an example of a full credit response.

A p-value of 0.0376 suggests that, with a threshold of 0.05, there is evidence that a calendar year effect is present in this data set.

2. Learning Objectives:

1. The candidate will understand how to use stochastic loss development models to estimate reserve variability.

Learning Outcomes:

(1e) Apply a parametric model of loss development

(1f) Estimate the standard deviation of a parametric estimator of unpaid claims.

Sources:

LDF Curve Fitting and Stochastic Reserving: A Maximum Likelihood Approach, Clark

Commentary on Question:

This item tested a candidate's understanding of Clark's parametric model using the loglogistic distribution and the Cape Cod method. The model solution is in the solutions spreadsheet. This document is for informational purposes only.

Solution:

(a) Calculate the maximum likelihood estimates of the incremental losses for the periods 0-12 and 12-21 months for accident year X.

Commentary on Question:

The model solution is in the solutions spreadsheet.

Steps in solution:

- Select proper x values for each development stage: x = 0 and 6 for the 0-12 month period; x = 6 and 15 for the 12-21 month period. (x is the age in months at the midpoint of the development interval.)
- Calculate $G(x)$ from the loglogistic CDF: $G(x) = x^w / (x^w + q^w)$, with $w = 2$, $q = 10$. $G(0) = 0$; $G(6) = 36 / (36 + 100) = 0.2647$; $G(15) = 225 / (225 + 100) = 0.6923$.
- Calculate MLE of incremental losses = $[G(x_2) - G(x_1)] \times \text{ELR} \times \text{Premium}$. Period 0-12: $[0.2647 - 0] \times 0.7 \times 15{,}000 = 2{,}779$. Period 12-21: $[0.6923 - 0.2647] \times 0.7 \times 15{,}000 = 4{,}490$.

(b) Calculate the estimated reserve for accident year X as of 21 months, assuming no further development information is available.

Commentary on Question:

The model solution is in the solutions spreadsheet.

Steps in solution:

- Calculate ultimate as ELR × Premium = 0.7 × 15,000 = 10,500.
- Reserve = Ultimate − MLE(0-12) − MLE(12-21) = 10,500 − 2,779 − 4,490 = 3,231.

(c) Identify one reason why the answer should be "no" and one reason why it should be "yes."

Commentary on Question:
The solution below is an example of a full credit response. Credit was given for other reasonable answers.

- No: The CV is derived entirely from this model and its MLE. If the selected reserve differs from the MLE, the CV characterizes the uncertainty of the MLE reserve, not the selected reserve, so applying it to the selected reserve is not valid.
- Yes: Actuarial judgment always plays a role, and mechanical models are rarely used without modification. The CV is itself a selection, so applying it to a reserve close to the MLE is a reasonable professional judgment.

3. Learning Objectives:

2. The candidate will understand the considerations in the development of losses for excess limits and layers.

Learning Outcomes:

(2a) Estimate ultimate claims for excess limits and layers.

(2b) Understand the differences in development patterns and trends for excess limits and layers.

Sources:

Fundamentals of General Insurance Actuarial Analysis, Friedland, 2nd Ed. (2022)

- Appendix G

Commentary on Question:

This item tested a candidate's ability to apply Siewert's formula to calculate severity relativities at different development stages and use these to develop excess-layer ultimate claims for TUV Insurance. The model solution is in the solutions spreadsheet. This document is for informational purposes only.

Solution:

(a) Calculate LOB1 severity relativities for each limit, at each stage of development (from one to four years), using Siewert's formula.

Commentary on Question:

The model solution is in the solutions spreadsheet.

Steps in solution:

- Calculate CDFs for the total, 500k, and 1M limits by accumulating the provided age-to-age LDFs.
- Calculate severity relativities R_t at each development stage t using Siewert's formula: $R_t(\text{Lim}) = R(\text{Lim}) \times [\text{CDF}(\text{Total}, t) / \text{CDF}(\text{Lim}, t)]$, where R(Lim) is the selected ultimate severity relativity for that limit.

(b) Calculate TUV's LOB1 ultimate claims for the layer 500,000 to 1,000,000 using TUV selected development factors and the severity relativities from part (a).

Commentary on Question:

The model solution is in the solutions spreadsheet.

Steps in solution:

- Calculate TUV 500k CDFs from the provided TUV 500k LDFs.
- Calculate TUV Total CDFs: TUV 500k $\text{CDF}_t \times R_t(500\text{k}) / R(500\text{k})$, using Siewert relativities from part (a).

- Calculate TUV 1M CDFs: TUV Total $CDF_t \times R(1M) / R_t(1M)$.
- Apply Lim CDFs to each AY's reported amounts at 500k and 1M limits to obtain ultimate amounts.
- Ultimate in the 500k-to-1M layer = Ultimate(1M) − Ultimate(500k).

(c) Evaluate the applicability of using the relativities from part (a) for TUV's analysis. Assume TUV's risk profile is similar to that for the industry.

Commentary on Question:
The solution below is an example of a full credit response. Credit was given for other reasonable answers.

- Development not only depends upon risk profile but also claims department policies and procedures. These may differ significantly from the industry average even when risk profile is similar.
- TUV's selected 500k limit CDF is significantly lower than the industry 500k limit CDF at 12 months of development, suggesting TUV's emergence pattern differs from the industry.

For these reasons, there is a reasonable likelihood that the relativities may not be applicable to TUV, and this approach should be used only as a supplemental method.

4. Learning Objectives:

4. The candidate will understand the considerations in selecting a risk margin for unpaid claims.

Learning Outcomes:

(4a) Describe a risk margin analysis framework.

(4b) Identify the sources of uncertainty underlying an estimate of unpaid claims.

(4c) Describe methods to assess this uncertainty

Sources:

A Framework for Assessing Risk Margins, Marshall et al.

Commentary on Question:

This item tested a candidate's understanding of hindsight analysis, external benchmarking, CoV scale construction, and the treatment of emerging risks within the three sources of uncertainty. This document is for informational purposes only.

Solution:

(a) Describe how a mechanical hindsight analysis could be used to assess each of the following: (i) Independent risk; (ii) Internal systemic risk.

Commentary on Question:

The solution below is an example of a full credit response. Credit was given for other reasonable answers.

(i) Focusing the analysis on periods where there was a degree of stability in the experience (with few or no systemic trends).

(ii) Applying this technique using a range of actuarial methods (preferably those used for central estimate valuation purpose) and observing the differences in volatility outcomes).

(b) Discuss the usefulness and limitations of external benchmarking.

Commentary on Question:

The solution below are examples of a full credit response. Credit was given for other reasonable answers.

- Usefulness: External benchmarks are most useful when combined with a thorough analysis of the insurer's own portfolio as a cross-check on internal results.
- Limitation: External benchmarks may differ materially from the claims portfolio being analyzed, reducing their comparability and reliability.

(c) Describe two potential problems with the CoV scale provided.

Commentary on Question:
The solution below is an example of a full credit response.

- The CoVs should be CGL > PAL > HOM based on the typical riskiness of these lines of business but it's the other way around.
- The CoV difference should decrease at a decreasing rate. CGL reduces by 1% from "1 to 1.5%" to "1.5 to 2%". This is followed by a reduction of 4% from "1.5 to 2%" to "2% to 2.5%" which violates this assumption.

(d) Explain how emerging risks should be reflected within the three sources of uncertainty for a class of business.

Commentary on Question:
The solution below is an example of a full credit response. Credit was given for other reasonable answers.

- IND: Risk from the volatility of losses from emerging risks that have occurred.
- ISR: Risk from being unable to identify emerging risks would be in this source.
- ESR: Risk from known emerging risks that have uncertainty as to how they will develop.

5. Learning Objectives:

5. The candidate will understand the methods to monitor actual versus expected experience.

Learning Outcomes:

(5a) Identify and describe approaches for monitoring results.

(5b) Prepare a comparison of actual to expected claims.

Sources:

Fundamentals of General Insurance Actuarial Analysis, Friedland, 2nd Ed. (2022)

- Chapter 37: Monitoring Results

Commentary on Question:

This item tested a candidate's ability to prepare an actual versus expected paid claims comparison and evaluate the results. The model solution is in the solutions spreadsheet. This document is for informational purposes only.

Solution:

(a) Calculate actual minus expected claims paid for the period January 1, 2026 to March 15, 2026, for each accident year from 2019 to 2025.

Commentary on Question:

The model solution is in the solutions spreadsheet.

Steps in solution for each AY:

- Identify the development period: the age at Dec 31, 2025 to the age at Mar 15, 2026 (approximately 2.5 months).
- Derive the expected paid emergence factor from the provided age-to-ultimate factors: the factor at the beginning of the period divided by the factor at the end of the period, less 1.0.
- Calculate expected paid emergence: paid at Dec 31, 2025 × emergence factor.
- Calculate actual paid emergence: paid at Mar 15, 2026 − paid at Dec 31, 2025.
- Actual − Expected = actual paid emergence − expected paid emergence.

Note: The question does not specify use of the provided development factors at year + 2.5 months. Equivalent credit was given for valid alternative methods, including linear or exponential interpolation of paid development factors and proration based on selected ultimate.

(b) Evaluate the results from part (a) including the following:

(i) Any anomalies in the results

(ii) Potential reasons for these anomalies

(iii) Additional steps that should be taken to evaluate the development from December 31, 2025, to March 15, 2026

Commentary on Question:
The solution below is an example of a full credit response. Credit was given for other reasonable answers.

- (i) Anomalies: All but one AY shows Actual − Expected > 0, indicating paid claims emerged faster than expected across most of the portfolio. The difference for AY 2025 is extremely large relative to the others.
- (ii) Potential reasons: There may have been unexpected calendar year inflation affecting all AYs. AY 2025 may have experienced an unusually large loss or elevated loss frequency.
- (iii) Additional steps: Repeat this analysis using reported (incurred) claims to separate paid activity from reserve changes. Investigate whether any unusual large losses occurred in 2025 and were paid in the first 2.5 months of 2026. Check inflation rates for any spike in early 2026.

6. **Learning Objectives:**

6. The candidate will understand and be able to apply ratemaking techniques for the following situations: classification ratemaking, deductible options, increased limit options, claims-made policies and individual risk rating.

Learning Outcomes:

(6a) Understand and apply classification ratemaking methods

(6b) Explain the issues and considerations regarding classification ratemaking.

Sources:

ASOP No. 12, Risk Classification (for All Practice Areas)

Fundamentals of General Insurance Actuarial Analysis, Friedland, 2nd Ed. (2022)

- Chapter 33: Basic GI Risk Classification

Commentary on Question:

This item tested a candidate's knowledge of ASOP 12 risk classification considerations, the GLM assumptions that make it equivalent to the minimum bias method, and the relative advantages and disadvantages of GLM for classification ratemaking. This document is for informational purposes only.

Solution:

(a) Describe three other issues the actuary should consider as noted in ASOP 12.

Commentary on Question:

The solution below is an example of a full credit response (any 3 of the following from ASOP 12 Section 3.2, other than the "relationship" issue stated in the question):

- Causality: It is not necessary to establish a cause-and-effect relationship between the risk characteristic and expected outcomes, although it is desirable.
- Objectivity: A selected risk characteristic should be capable of being objectively determined.
- Practicality: A selected risk characteristic should reflect the tradeoffs between practical and other relevant considerations (e.g., cost, time, and effort needed to evaluate the risk characteristic).
- Applicable Law: A selected risk characteristic should comply with applicable laws and regulations.
- Industry Practices: Consideration should be given to the usual and customary risk classification practices for the type of financial system under consideration.
- Business Practices: Consideration should be given to limitations created by business practices related to the financial security system and whether they are likely to have a significant impact on the risk classification system.

(b) Identify the following for the GLM that is equivalent to the minimum bias method with categrical variables and mutiplicative relativities.

(i) Probability distribution used to model the pure premium

(ii) Type of link function used [where $\mu_{ij} = \mu \, r_i^{(1)} \, r_j^{(2)}$]

(iii) Bias function, b ($\boldsymbol{p}$, $\boldsymbol{\mu}$) formula, where $\boldsymbol{p}$ is the matrix of observed pure premiums, $\boldsymbol{\mu}$ is the matrix of expected values from the link function and $\boldsymbol{w}$ is the matrix of exposures for the pure premiums.

Commentary on Question:
The solution below is an example of a full credit response.

- Probability distribution used to model the pure premium: Poisson
- Link function: Log link, OR $\exp(\alpha + \beta_i^{(1)} + \beta_j^{(2)})$
- Bias function: $b(\mathbf{p}, \boldsymbol{\mu}) = \mathbf{w}(\mathbf{p} - \boldsymbol{\mu}) / \boldsymbol{\mu}$

(c) Identify one advantage and one disadvantage from using a GLM instead of the minimum bias method for classification ratemaking.

Commentary on Question:
The solution below is an example of a full credit response. Credit was given for other reasonable answers.

- Advantage: GLM provides statistical measures such as confidence intervals and measures of variability.
- Disadvantage: GLM is more complex and not as intuitive as the minimum bias approach;

7. **Learning Objectives:**

6. The candidate will understand and be able to apply ratemaking techniques for the following situations: classification ratemaking, deductible options, increased limit options, claims-made policies and individual risk rating.

Learning Outcomes:

(6c) Price for deductible options and increased limits

Sources:

Fundamentals of General Insurance Actuarial Analysis, Friedland, 2nd Ed. (2022)

- Chapter 34: Actuarial Pricing for Deductibles and Increased Limits

Commentary on Question:

This item tested a candidate's ability to calculate the limited average severity (LAS) for a loss layer and the increased limits factor (ILF) using empirical data, and to describe challenges in estimating ILFs for high limits. The model solution is in the solutions spreadsheet. This document is for informational purposes only.

Solution:

(a) Calculate the limited average severity for the layer 100,000 to 300,000.

Commentary on Question:
The model solution is in the solutions spreadsheet.

Steps in solution:

- Identify the count and claim amounts falling within the 100,000 to 300,000 layer from policies with limits of 300,000 and above.
- Divide total claims in the layer by the count of claims in the layer to obtain the conditional LAS (given a claim reaches the layer).
- Calculate the probability that a claim reaches the layer: count in the layer divided by the total count excluding those capped at 100,000.
- Unconditional LAS in layer = conditional LAS × probability.

(b) Calculate the increased limit factor (ILF) for a 600,000 limit, assuming the basic limit is 100,000.

Commentary on Question:
The model solution is in the solutions spreadsheet.

Steps in solution:

- Calculate LAS from 0 to 100,000 (basic layer): truncate all claims at 100,000.

- Calculate LAS for the 300,000 to 600,000 layer using the same approach as part (a).
- ILF(600,000) = [LAS(0 to 100k) + LAS(100k to 300k) + LAS(300k to 600k)] / LAS(0 to 100k).

(c) Describe two challenges in determining ILFs for high limits using empirical data.

Commentary on Question:
The solution below is an example of a full credit response. Credit was given for other reasonable answers.

Challenge 1 Reliance on extrapolation beyond observed limits. Empirical data frequently do not extend to the limits being priced, forcing actuaries to extrapolate beyond available experience.

Challenge 2 Censoring of loss data. Observed losses are often capped at historical policy limits, requiring adjustments or assumptions about the unobserved tail.

8. **Learning Objectives:**

6. The candidate will understand and be able to apply ratemaking techniques for the following situations: classification ratemaking, deductible options, increased limit options, claims-made policies and individual risk rating.

Learning Outcomes:

(6d) Develop rates for claims-made contracts.

Sources:

Fundamentals of General Insurance Actuarial Analysis, Friedland, 2nd Ed. (2022)

- Chapter 35: Claims-Made and Occurrence Policies

Commentary on Question:

This item tested a candidate's ability to price claims-made policies, calculate claims for a portfolio of claims-made policies, price tail coverage, and identify coverage gaps from a retroactive date restriction. The model solution is in the solutions spreadsheet. Amounts are in thousands. This document is for informational purposes only.

Solution:

(a) Calculate total claims for the following policies:

(i) Third-year claims-made policy effective January 1, 2024

(ii) All claims-made policies from 2021 to 2025 in total

(iii) Mature claims-made policy effective January 1, 2026

Commentary on Question:

The model solution is in the solutions spreadsheet.

Steps for (i) — third-year CM policy effective January 1, 2024 [all claims reported in RY 2024]:

- AY Lag0_AY24(%) × AY24 ULT = 36.8% × 1,225 = 450.80
- AY Lag1_AY23(%) × AY23 ULT = 25.0% × 985 = 246.25
- AY Lag2_AY22(%) × AY22 ULT = 22.8% × 1,034 = 235.75
- Total = 932.80

Steps for (ii) — all CM policies 2021–2025 [CM cover begins Jan 1, 2021; occurrence policies assumed prior]:

- CM_21 = AY Lag0_AY21(%) × AY21 ULT = 42.9% × 877 = 376.23
- CM_22 = AY Lag0_AY22 × AY22 ULT + AY Lag1_AY21 × AY21 ULT = 668.44
- CM_23 = AY Lag0_AY23 × AY23 ULT + AY Lag1_AY22 × AY22 ULT + AY Lag2_AY21 × AY21 ULT = 860.91
- CM_24 = AY Lag0_AY24 × AY24 ULT + AY Lag1_AY23 × AY23 ULT + AY Lag2_AY22 × AY22 ULT + AY Lag3_AY21 × AY21 ULT = 993.32

- CM_25 = AY Lag0_AY25 × AY25 ULT + AY Lag1_AY24 × AY24 ULT + AY Lag2_AY23 × AY23 ULT + AY Lag3_AY22 × AY22 ULT + AY Lag4_AY21 × AY21 ULT = 1,079.44
- Total = 3,978.34

Note: If a candidate assumed no prior occurrence policy and includes AY 2020 (Lag1–Lag4 for RY 2021–2024), that was also given full credit.

Steps for (iii) — mature CM policy effective January 1, 2026 [all reporting lags covered; AY > 2025 accident year grows at 4%]:

- AY Lag0_AY>25(%) × (AY25 ULT × 1.04)
- + AY Lag1_AY25(%) × AY25 ULT
- + AY Lag2_AY24(%) × AY24 ULT
- + AY Lag3_AY23(%) × AY23 ULT
- + AY Lag4_AY22(%) × AY22 ULT
- Total = 1,350.69

(b) Calculate the expected claims for this policy [tail coverage effective Jan 1, 2026].

Commentary on Question:
The model solution is in the solutions spreadsheet.

The tail policy covers claims reported in RY 2026 and beyond for accident years prior to 2026 — i.e., all claims not covered by any future claims-made policy. Refer to the solutions spreadsheet for the full AY/lag breakdown totaling 1,492.67.

(c) Calculate the gap in claims covered if the policy from part (b) had a retroactive date of January 1, 2024.

Commentary on Question:
The model solution is in the solutions spreadsheet.

With a retroactive date of January 1, 2024, the tail policy covers only accident years 2024 and 2025, excluding claims from AY 2022 and AY 2023. The gap equals the tail claims attributable to AY 2022 and AY 2023 that would have been covered by an unrestricted tail policy i.e. RY 2026 lag 3 and 4, and RY 2027 lag 4. Based on the table in the solutions spreadsheet, this totals 112.04.

9. Learning Objectives:

7. The candidate will understand the fundamentals of reinsurance and demonstrate knowledge of reinsurance reserving, the fundamental techniques of reinsurance pricing and risk transfer testing of reinsurance contracts

Learning Outcomes:

(7e) Calculate the price of a reinsurance contract.

Sources:

General Insurance: Considerations in Reinsurance Reserving, Cappelletti, SOA Study Note

Commentary on Question:

This item tested a candidate's ability to apply an exposure rating approach to price a casualty per occurrence excess treaty and to describe methods for handling trend and policy limits in experience rating. The model solution is in the solutions spreadsheet. This document is for informational purposes only.

Solution:

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

Commentary on Question:

The model solution is in the solutions spreadsheet.

Steps in solution:

- Calculate Policy End for each policy = Policy Limit + Underlying Limit.
- Calculate Reinsurance Start and End each policy: RI Start = Underlying Limit + 1,000,000; RI End = MIN(Policy End, RI Start + 3,000,000),
- Calculate ILF for each policy at Policy Start (Underlying Limit), Policy End, RI Start and End using ILF = 0.2848 × LN(limit) − 2.935.
- Calculate the reinsurance factor for each policy = [ILF(RI End) – ILF (RI Start)] / [ILF(Policy End) – ILF (Policy Start)].
- Apply the reinsurance factor to Subject Premium for each policy.
- Multiply total by ELR (60%) to obtain expected losses in the layer.

(b) Describe two methods for handling trend and policy limits and the underlying assumption of each method.

Commentary on Question:

The solution below is an example of a full credit response. Credit was given for other reasonable answers.

- Method 1: Trend losses only; do not trend policy limits or adjust subject premiums. Underlying assumption: policy limits do not increase over time.

- Method 2: Trend both losses and policy limits, and adjust subject premiums upward to reflect the higher limits. Underlying assumption: policy limits increase over time proportionally with trend.

10. Learning Objectives:

8. The candidate will understand catastrophe modeling output and the allocation of catastrophe risk loads among accounts.

Learning Outcomes:

(8a) Understand the purpose and development of catastrophe models.

(8b) Understand the type of output produced by catastrophe models.

(8c) Understand how catastrophe model output can be used in actuarial tasks.

(8d) Allocate a property catastrophe risk load among different accounts.

Sources:

An Overview of Catastrophe Modeling Output, Cappelletti, SOA Study Note

Uses of Catastrophe Model Output, American Academy of Actuaries

An Application of Game Theory: Property Catastrophe Risk Load, Mango, Casualty Actuarial Society

Commentary on Question:

This item tested a candidate's understanding of catastrophe model limitations, OEP calculations, return periods, TVaR, the Marginal Surplus method for premium allocation, and the sub-additivity property of standard deviations. The model solution is in the solutions spreadsheet. This document is for informational purposes only.

Solution:

(a) Identify two limitations of using catastrophe models in predicting future losses arising from catastrophe events.

Commentary on Question:

The solution below is an example of a full credit response. Credit was given for other reasonable answers.

- There are significant uncertainties around model estimates; large ranges of output values exist across different models for the same exposure.
- Software updates can cause large year-over-year swings in estimates, creating instability in planning and pricing.

(b) Calculate the following:

(i) Occurrence exceedance probabilities (OEP) for each event

(ii) Return period for U having a loss of at least 80 million

(iii) Tail Value at Risk (TVaR) for V having a loss of at least 90 million

Commentary on Question:

The model solution is in the solutions spreadsheet.

(i) OEP: Events are already sorted from highest to lowest loss.

For each event i, OEP(i) = $1 - \prod(1 - p_j)$ for all j where loss ≥ loss(i).

(ii) Return period for U ≥ 80M: Event 3 has a loss of 82,000 to U. The OEP at this threshold accumulates Events 1, 2, and 3. Return period = 1 / OEP.

(iii) TVaR for V ≥ 90M: Events with V loss ≥ 90M are Event 1 (285,500) and Event 2 (94,600). TVaR = probability-weighted average loss conditional on the loss exceeding 90M. Refer to the solutions spreadsheet for the exact calculation.

(c) Calculate the renewal premiums for U and V.

Commentary on Question:
The model solution is in the solutions spreadsheet.

Steps using the Marginal Surplus (MS) method:

- Calculate expected loss for U, V, and combined (U+V) as the probability-weighted loss across all events.
- Calculate standard deviation for U, V, and U+V. For each independent Bernoulli event i: $Var(loss_i) = p_i \times (1 - p_i) \times loss_i^2$. Total variance = sum of individual variances. SD = square root of total variance.
- Calculate marginal surplus: MS(U) = [SD(U+V) − SD(V)]; MS(V) = [SD(U+V) − SD(U)].
- Calculate marginal surplus risk load multiplier: = z-score * required return / (1 - required return).
- Risk load = Multiplier × Marginal surplus.
- Premium = (Expected Loss + Risk Load) / (1 − Expense %) = (EL + RL) / 0.95.

(d) Explain why the sum of the renewal premiums for U and V will not equal the renewal premium for U and V combined, indicating which amount would be greater than the other.

Commentary on Question:
The solution below is an example of a full credit response. Credit was given for other reasonable answers.

Due to the sub-additivity property of standard deviations, SD(U+V) < SD(U) + SD(V). Therefore, the renewal premium for the two accounts combined will be greater than the sum of the renewal premiums for the two accounts.

11. **Learning Objectives:**

7. The candidate will understand the fundamentals of reinsurance and demonstrate knowledge of reinsurance reserving, the fundamental techniques of reinsurance pricing and risk transfer testing of reinsurance contracts

Learning Outcomes:

(7i) Test for risk transfer in reinsurance contracts.

Sources:

Risk Transfer Testing of Reinsurance Contracts: Analysis and Recommendations, Ruhm and Brehm, Casualty Actuarial Society

Commentary on Question:

This item tested a candidate's ability to apply the Risk Coverage Ratio (RCR) and Right-Tailed Deviation (RTD) methods to evaluate whether a catastrophe reinsurance treaty passes the risk transfer test. The model solution is in the solutions spreadsheet. This document is for informational purposes only.

Solution:

Evaluate whether SFI's catastrophe reinsurance with RB Re passes the risk transfer test using the following methods:

(i) Risk coverage ratio (RCR), in % form, with a threshold of 90%

(ii) Right-tailed deviation (RTD) using α = 5

Commentary on Question:

The model solution is in the solutions spreadsheet.

(i) RCR Method:

Steps in solution:

- Calculate claim amounts in the layer 200 xs 50 for each catastrophe claim scenario.
- Convert conditional probabilities to overall probabilities by multiplying by 7% (the annual probability of a catastrophe occurring). Note p(0) is 1-sum of p(>0), or 1-7%+43.75%*7%.
- Calculate Gain (G) = Premium − layer loss for each scenario.
- Calculate NPV Gain and NPV Loss. No penalty for ignoring discounting or assuming 0% risk-free rate or discount at a stated suitably low 1-year rate (0.5%–4%).
- Calculate E[G] (expected NPV gain under all possibilities), p = probability of a net loss; T = expected value of net economic loss given a loss occurs; ERD = p × T / Premium
- RCR% = pT / E[G], or equivalently ERD / (E[G] / Premium)
- Conclusion: FAIL if RCR% < 90%; PASS if RCR% ≥ 90%.

(ii) RTD Method:

Steps in solution:

- Calculate F(x) = cumulative distribution of layer losses at each mass point.
- Calculate $F^*(x) = 1 - (1 - F(x))^{(1/\alpha)}$, where $\alpha = 5$.
- Calculate $p^*(x) = F^*(x) - F^*(x^-)$ at each mass point (the transformed probability mass).
- Calculate E(x) = expected layer loss under the original distribution; $E^*(x)$ = expected layer loss under the transformed distribution.
- Calculate $RTD = E^*(x) - E(x)$ and $RTD\alpha = \alpha \times RTD$.
- Conclusion: PASS if Premium $<$ RTDα; FAIL if Premium $\geq$ RTDα.