SOCIETY OF ACTUARIES

Introduction to Ratemaking & Reserving

Exam GIIRR

MORNING SESSION

Date: Wednesday, October 31, 2018
Time: 8:30 a.m. – 11:45 a.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 100 points. It consists of a morning session (worth 60 points) and an afternoon session (worth 40 points).

   a) The morning session consists of 13 questions numbered 1 through 13.

   b) The afternoon session consists of 8 questions numbered 14 through 21.

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

2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.

3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.

2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.

3. The answer should be confined to the question as set.

4. When you are asked to calculate, show all your work including any applicable formulas.

5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets since they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate morning or afternoon session for Exam GIIRR.

6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Recognized by the Canadian Institute of Actuaries.

Tournez le cahier d'examen pour la version française.

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Exam GIIRR-Front Cover

****BEGINNING OF EXAMINATION****
Morning Session

1. (*4 points*) You are given the following information on the only three policies that ABC Insurance has written:

Policy	Policy Term	Written Premium	Initial Effective Date
1	12 months	1,800	April 1, 2016
2	24 months	3,000	June 1, 2016
3	6 months	1,200	Sept 1, 2016

- ABC Insurance records written premium in the year of the effective date.
- All premiums were increased by 10% for policies written or renewed on or after March 15, 2017.
- No other rate changes have occurred since March 15, 2017.
- All policies have renewed at the end of every policy term.

(a) (*1 point*) Calculate the unearned premium as of December 31, 2016.

(b) (*1.5 points*) Calculate the calendar year 2017 earned premium.

(c) (*1 point*) Calculate the unearned premium as of December 31, 2017.

(d) (*0.5 points*) Calculate the premium on-level factor to adjust the 2017 calendar year earned premium to the current rate level.

2. (*5 points*)

(a) (*1.5 points*) State two advantages for each of the following insurance policy coverage features from an insurer perspective:

(i) Deductible

(ii) Policy Limit

(iii) Coinsurance

You are given the following information:

Policy	Property Value	Limit	Deductible	Coinsurance Requirement
A	100,000	90,000	800	80% of property value
B	100,000	50,000	800	100% of property value
C	100,000	50,000	800	No coinsurance requirement

The agent has told the policyholder that, in the event of a loss, the coinsurance is applied first, followed by the policy limit, and then the deductible.

(b) (*1.5 points*) Calculate the amount paid by the insurer for a covered loss of 1,000 under each policy based on the agent's stated position.

The policyholder takes a different position that, in the event of a loss, the deductible applies first, followed by coinsurance, then the policy limit.

(c) (*1.5 points*) Calculate the amount paid by the insurer for a covered loss of 91,000 under each policy based on the policyholder's position.

(d) (*0.5 points*) State what determines the order of applying coinsurance, deductible, and policy limit.

3. (*5 points*) You are estimating claims using the frequency-severity closure method.

(a) (*1 point*) Describe two primary assumptions underlying this method.

You are given the following count information:

Accident Year	Cumulative Closed Counts				Selected Ultimate Counts
	12	24	36	48	
2014	7,700	9,650	10,300	10,900	10,900
2015	5,600	6,800	7,500		7,850
2016	4,600	5,800			6,800
2017	3,900				5,600

(b) (*1 point*) Calculate the accident year 2014 proportion of closed counts at each maturity age.

(c) (*1 point*) Calculate the accident year 2016 incremental closed counts for maturities 36 and 48 months using the proportion of closed counts from part (b).

You are given the following additional information:

Accident Year	Incremental Paid Severity			
	12	24	36	48
2014	1,160	4,300	10,600	9,900
2015	860	3,150	9,800	
2016	940	3,360		
2017	1,050			

Selected Incremental Paid Severity at 2017 Cost Level by Development Month			
12	24	36	48
1,100	3,500	10,340	11,200

The annual severity trend is 3%.

(d) (*1 point*) Calculate the accident year 2016 incremental paid severity for maturities 36 and 48 months.

(e) (*1 point*) Calculate the accident year 2016 projected ultimate claims.

4. (*4 points*) You are analyzing reported claims.

(a) (*0.5 points*) State two benefits of using a development triangle to review reported claims.

You are given the following cumulative reported claims as of December 31, 2017:

Accident Year	Cumulative Reported Claims				
	12	**24**	**36**	**48**	**60**
2013	2,000	6,000	10,000	12,000	12,000
2014	2,500	5,500	9,000	11,000	
2015	1,500	6,000	7,200		
2016	3,000	3,500			
2017	4,000				

(b) (*1.5 points*) Describe two possible data issues with the incremental reported claims.

(c) (*0.5 points*) Describe a diagnostic test you could use to investigate one of the issues identified in part (b).

A claims review determined that the following three claims should be removed from the reported claims:

Claim	Report Date	Occurrence Date	Amount
A	July 2016	July 2014	2,000
B	October 2016	July 2015	3,000
C	May 2017	July 2014	1,500

(d) (*1.5 points*) Revise the incremental reported claims triangle to reflect the removal of the three claims.

5. (*4 points*) You are given the following information for a line of business:

Calendar Year	General and Other Acquisition Expenses	Commission Expenses	Premium Taxes and Licenses	Direct Written Premiums	Direct Earned Premiums
2015	45,600	29,500	11,800	370,000	365,000
2016	46,500	30,500	12,200	381,000	375,000
2017	52,400	30,900	12,300	385,000	380,000

- Calendar year 2018 budgeted direct earned premiums are 400,000.
- Calendar year 2018 budgeted general and other acquisition expenses are 56,000.
- The percent of general and other acquisition expenses that are fixed is 25%.

(a) (*3 points*) Recommend the following expense ratios to use for ratemaking. Justify your recommendation.

(i) Fixed expense ratio

(ii) Variable expense ratio

(b) (*0.5 points*) Identify a potential distortion to a ratemaking analysis when selecting a fixed expense percentage that is applied to a projected average premium.

(c) (*0.5 points*) Recommend a solution to the potential distortion identified in part (b).

6. (*5 points*) You are reviewing estimates of ultimate claims for lines of business where conditions have been changing.

(a) (*1 point*) Explain the ability of the following methods to reflect claim deterioration with steady-state volume:

(i) The Cape Cod method

(ii) The Bornhuetter Ferguson method

You are analyzing reported claims data evaluated as of December 31, 2017 for a workers compensation line of business. A statutory benefit level change was implemented on July 1, 2014, increasing benefit levels on all open and newly reported claims.

(b) (*0.5 points*) Describe what effect this benefit level change is likely to have on reported development factors.

(c) (*1.5 points*) Explain how this benefit level change would affect the estimate of ultimate claims under each of the following methods:

(i) The development method with a Berquist-Sherman adjustment, applied to reported data

(ii) The Bornhuetter Ferguson method, applied to reported data

You are also analyzing paid claims data for an automobile line of business. Claim trend has been increasing in recent years due to distracted driving and higher repair costs.

(d) (*0.5 points*) Describe what effect, if any, the change in claim trend is likely to have on paid claims development factors.

(e) (*1.5 points*) Comment on the appropriateness of each of the following methods when a change in claim trend is occurring:

(i) The development method with a Berquist-Sherman adjustment, applied to paid data

(ii) A development-based frequency severity approach, applied to paid data

7. (*6 points*) You are performing a ratemaking analysis for a collision line of business for XYZ Insurance and are given the following information:

Accident Year	Earned Premium at Current Rate Level (000)	Ultimate Counts	Ultimate Claims (000)
2015	1,485	250	810
2016	1,620	270	890
2017	1,965	300	1,025

- The annual premium trend due to shifts in deductibles is –0.5%.
- The annual premium trend due to shifts in vehicle rate groups is 3%.
- The annual pure premium trend is 5%.
- The new rates will be effective April 1, 2019 through March 31, 2020.
- All policies are written for 12-month policy terms.
- The full credibility standard is 1,082 ultimate counts.
- The square root rule is used for partial credibility.

(a) (*2 points*) Calculate the trended claim ratios for each accident year.

(b) (*1 point*) Recommend a trended claim ratio to use for ratemaking. Justify your recommendation.

You are given the following additional information:

- The complement of credibility is derived using the data from the last ratemaking analysis.
- The last ratemaking analysis was for policies effective January 1, 2017 through December 31, 2017, where
  - the indicated rate change was 8%,
  - the approved rate change was 4%, and
  - the permissible claim ratio was 55%.

(c) (*1.5 points*) Calculate the claim ratio to use for the complement of credibility.

You are given the following additional information:

- The ratio of fixed expenses to premiums at current rates including ULAE is 18%.
- The ratio of variable expenses to premiums is 7%.
- The ratio of profit and contingencies to premiums is 4%.

(d) (*1.5 points*) Calculate the indicated rate change.

8. (*4 points*) Grossi and Kunreuther identify three special issues with respect to portfolio risk: Data Quality, Uncertainty Modeling, and the Impact of Correlation.

(a) (*1.5 points*) Describe two examples where data quality issues could arise in the inventory module of the catastrophe model.

(b) (*0.5 points*) Provide the reason why inventory is the component of the catastrophe model that requires the most attention with respect to data quality.

The mean damage ratio is the ratio of dollar loss to replacement value of the structure.

(c) (*1 point*) Provide an example that illustrates why using the mean damage ratio is insufficient when determining the insurer's expected loss.

One way that a catastrophe model can reflect correlation is if the same simulated event is applied to all insured properties.

(d) (*1 point*) Describe two additional ways that a catastrophe model can reflect correlation.

9. (*5 points*) You are a reserving actuary and decide to use the Cape Cod (CC) method applied to reported data to estimate IBNR claims.

(a) (*0.5 points*) Cite two situations for which the CC method is well-suited.

(b) (*0.5 points*) Cite a key underlying assumption of the CC method.

(c) (*1 point*) Describe the data you need for your review.

You are estimating year-end 2017 claims reserves using the CC method and are given the following information as of December 31, 2017:

Accident Year	Cumulative Paid Claims	Cumulative Reported Claims	Expected % Reported	Expected Claims from CC Method
2015	4,000	8,000	75%	9,000
2016	2,000	6,000	50%	10,000
2017	500	3,000	25%	12,000

(d) (*1 point*) Estimate total unpaid claims.

You are given the following additional information as of December 31, 2016:

Accident Year	Cumulative Paid Claims	Estimated Unpaid Claims
2015	1,500	8,000
2016	400	10,100

(e) (*1 point*) Derive the calendar year 2017 incurred claims using your results from part (d).

You are comparing actual and expected reported claims as of June 30, 2018 as part of the monitoring process. Some differences are very significant and require further investigation.

(f) (*1 point*) Provide two questions you might ask management as part of your investigation.

10. (*4 points*) You are estimating ultimate property claims for ratemaking purposes.

(a) (*1 point*) Explain two reasons for using a large claims loading approach for estimating ultimate claims, rather than using unadjusted total limits claims.

You are given the following information:

Accident Year	Selected Ultimate Claims at 200,000 Limit (000)	Selected Ultimate Claims at Total Limits (000)
2014	3,150	3,970
2015	3,520	4,760
2016	3,720	4,630
2017	4,016	5,366

- The new rates are to be effective May 1, 2019 through April 30, 2020.
- All policies are written for 12-month policy terms.
- The annual severity trend at 200,000 limit is 4%.
- The annual severity trend at total limits is 5%.
- The large claims loading for 200,000 to total limits is 1.34 for the future rating period.

(b) (*2 points*) Calculate the large claims loadings at a 200,000 limit, adjusted to the cost level for each accident year.

(c) (*0.5 points*) Calculate the ultimate claims at total limits for each accident year using selected ultimate claims at a 200,000 limit.

(d) (*0.5 points*) Recommend the ultimate claims at total limits to use for ratemaking. Justify your recommendation.

11. (*5 points*) You are estimating ultimate claims using the expected method.

(a) (*0.5 points*) List two sources of expected claim ratios, other than that implied by prior claims experience.

You are given the following information:

Accident Year	Earned Exposures (000)	Earned Premiums (000)	Premium On-Level Factors	Reported Claims as of Dec. 31, 2017 (000)	Reported Claims Cumulative Development Factors
2014	200	20,000	1.120	19,500	1.10
2015	210	23,000	1.040	20,000	1.20
2016	230	24,000	1.010	14,000	1.40
2017	260	28,000	1.000	14,000	1.60

- Tort reform reduced claims by 25%, effective January 1, 2016.
- The annual claim trend is 3%.

(b) (*1.5 points*) Calculate the 2017 level expected claim ratio using reported claims and an all-years average.

(c) (*1 point*) Calculate the 2017 level expected pure premium using reported claims and an all-years average.

You are also estimating ultimate claims using the Bornhuetter Ferguson method, where the a priori expected claims are the average of the claim ratio and pure premium expected method results.

(d) (*1.5 points*) Calculate the accident year 2016 ultimate claims using the Bornhuetter Ferguson method.

(e) (*0.5 points*) Provide one advantage of the Bornhuetter Ferguson method over the expected method.

12. (*4 points*)

(a) (*0.5 points*) Describe one way that a coverage gap can occur for insureds purchasing claims-made coverage.

A claims-made policy will cost less than an occurrence policy when claim costs are increasing.

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

The cost of an occurrence policy will change more than the cost of a mature claims-made policy when there is a sudden unexpected shift in the reporting pattern.

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

13. (*5 points*)

(a) (*0.5 points*) Describe how insurers can promote fairness and equity with respect to premium rates through the development of a risk classification system.

(b) (*0.5 points*) Describe the financial consequences of adverse selection to an insurer resulting from an absence of a sound risk classification system.

ABC Insurance Company currently uses age of policyholder in their risk selection process and is considering adding credit score as a rating variable to their automobile insurance program.

The U.S. Standards on risk classification provides several items for actuaries to consider when developing a risk classification system.

(c) (*1 point*) Provide two considerations *in support* of using credit score as a rating variable.

(d) (*1 point*) Provide two considerations *against* using credit score as a rating variable.

You are given the following information:

Exposures	**Age Group**		
Credit Score	**18-30**	**31-50**	**51+**
Poor	100	300	150
Normal	200	600	300
Exceptional	100	300	150

Pure Premium	**Age Group**		
Credit Score	**18-30**	**31-50**	**51+**
Poor	100	50	70
Normal	70	35	49
Exceptional	50	15	18

(e) (*1 point*) Calculate one-way relativities for each credit score.

(f) (*0.5 points*) Explain whether or not this risk classification plan reflects distributional bias.

(g) (*0.5 points*) Describe how this risk classification system may exhibit dependence without having distributional bias.

****END OF EXAMINATION****
Morning Session

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