SOCIETY OF ACTUARIES

Ratemaking & Reserving

Exam GIRR

MORNING SESSION

Date: Wednesday, May 1, 2019
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 GIRR.

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 GIRR-Front Cover

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

1. (*5 points*) XYZ Insurance acquired a book of business with 100 annual policies on November 30, 2016.

- Each policy had an annual premium of 1,500, and a renewal date of June 1.
- For both the 2017 and 2018 renewals there was a premium increase of 10% and a renewal rate of 80%.

In addition, XYZ Insurance started writing new business in 2017 with the following transactions during calendar years 2017 and 2018:

Transaction ID	Transaction Type	Policy Number	Effective Date	Policy Term	Transaction Amount
1	New business	101	May 1, 2017	12 months	1,600
2	New business	102	July 1, 2017	18 months	2,100
3	New business	201	March 1, 2018	6 months	800
4	Renewal	101	May 1, 2018	12 months	1,800
5	New business	202	June 1, 2018	24 months	2,500
6	Cancellation	102	June 30, 2018	n/a	–700

XYZ Insurance earns premium evenly throughout the year.

(a) (*1.5 points*) Calculate the total earned premium for calendar year 2017.

(b) (*1.5 points*) Calculate the total unearned premium as of June 30, 2018.

XYZ implemented a rate change where the premium for all policies was increased by 5% for each policy written or renewed on or after October 1, 2018.

XYZ is conducting a ratemaking analysis with new rates to be effective April 1, 2019.

(c) (*1.5 points*) Calculate the calendar year 2017 earned premium at current rate levels using the extension of exposures method.

(d) (*0.5 points*) State why the parallelogram approach is not appropriate to use in part (c).

2. (*5 points*) You are analyzing claim trend for a line of business. Actuaries often adjust historical data for unusually large claims when analyzing claim trend.

(a) (*1 point*) State two other reasons why actuaries may need to adjust historical data when analyzing claim trend.

You are fitting historical data using exponential regression and are given the following information:

- Exponential regression analysis was applied to semi-annual data to produce semi-annual trend indications.
- The exponential regression best fit line selected for severity is: $s = 40{,}000e^{0.0101t}$, where t is time in half-years.
- The exponential regression best fit line selected for frequency is: $f = 0.001e^{0.0292t}$, where t is time in half-years.
- Rates will be effective October 1, 2019 for one year.
- Prior to October 1, 2019 all policies are twelve-month policies.
- Starting October 1, 2019, one-third of all written policies are expected to be six-month policies and two-thirds are expected to be twelve-month policies.

(b) (*2.5 points*) Calculate the pure premium trend factor for accident year 2016.

You have introduced an existing line of business into a new jurisdiction but do not yet have sufficient volume for a trend analysis.

(c) (*0.5 points*) Provide two potential supplementary sources of data for the trend analysis.

(d) (*1 point*) Describe two considerations when evaluating supplementary sources of data.

3. (*5 points*) Insurer BCD started writing medical malpractice business on January 1, 2016. You are given the following information:

Report Year	Earned Exposures	Estimated Ultimate Claims
2016	1,220	1,025,000
2017	1,540	1,290,000
2018	1,800	1,516,000

Maturity Age in months	Reported Age-to-Ultimate Development Factors
12	3.480
24	1.860
36	1.310

Calendar Year	Paid ULAE	Expected Paid Claims
2016	19,100	132,200
2017	44,500	317,100
2018	86,500	678,300

(a) (*1 point*) Explain why the classical paid-to-paid method may not be appropriate for estimating unpaid ULAE in this case.

(b) (*3 points*) Calculate the ULAE ratio for each year using the Mango and Allen smoothing adjustment.

(c) (*0.5 points*) Recommend the ULAE ratio to use for this line of business. Justify your recommendation.

You are provided with the following additional information:

- 25% of ULAE is associated with opening a claim file and 75% relate to maintaining and closing a claim file
- Total claim liabilities are 2,665,000
- Case estimates for existing reported claims are 1,290,000

(d) (*0.5 points*) Calculate unpaid ULAE using the recommended ratio from part (c).

4. (*5 points*) You are performing a ratemaking analysis for BTTF Auto Insurance using the following information:

Accident Year	Earned Exposures	Ultimate Claims
2015	12,000	7,100,000
2016	13,400	8,700,000
2017	14,200	9,400,000
2018	14,800	10,400,000

- New rates are to be effective October 1, 2019 for one year, with all policies written as six-month policies.
- The annual pure premium trend is 5%.

(a) (*1.5 points*) Calculate the trended pure premiums for each accident year.

(b) (*0.5 points*) Recommend a pure premium to use for ratemaking. Justify your recommendation.

You are given the following additional information:

- The average trended earned premium at current rate level is 980
- ULAE as a ratio to claims is 8%
- The fixed expense per exposure is 60
- Variable expenses as a ratio to premiums are 14%
- Profit and contingencies as a ratio to premiums are 4%

(c) (*1 point*) Calculate the indicated rate change.

4. Continued

The premiums for BTTF Auto Insurance are calculated using the formula, *Premium* = (*base rate*)×t_i, where the current base rate is 1,000 and t_i is the rating factor for territory i.

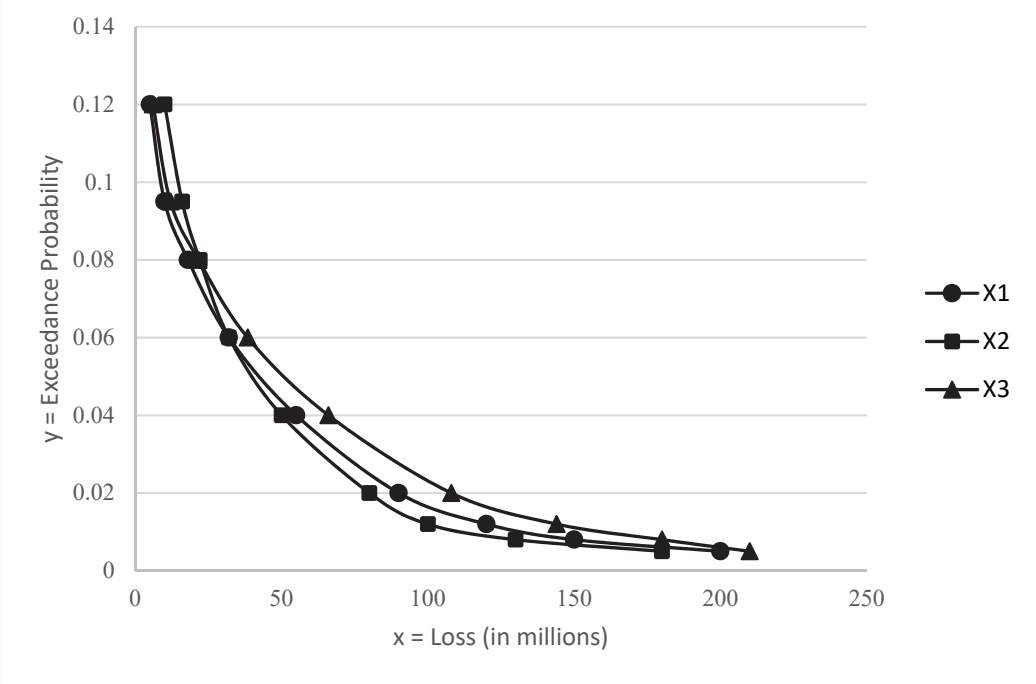
You are given the following information:

Territory	Current Rating Factors	Proposed Rating Factors	Projected Earned Exposures
1	1.00	1.00	7,500
2	1.10	1.15	5,000
3	0.95	0.92	3,000

For competitive reasons, BTTF company management decides to implement a rate change of 5%.

(d) (*2 points*) Demonstrate that the new base rate needed to achieve this increase is 1,039.50.

5. (*4 points*) You are evaluating a property book of business for NAN Insurance Company, which is subject to catastrophe losses from hurricane, earthquake, flood, and tornadoes. Your evaluation considers the results from three different model vendors for the same book of business, with the following results:



(a) (*2 points*) Explain how each module of the catastrophe models could contribute to the difference in the modeling results from each vendor for the same book of business, for each the following modules.

(i) Hazard

(ii) Inventory

(iii) Vulnerability

(iv) Loss

(b) (*0.5 points*) Determine the 1-in-25 year probable maximum loss (PML) for Model X2.

5. Continued

The following modeling results are provided:

Model	Annual Average Loss (AAL) in millions
X1	12.55
X2	13.14
X3	14.91

(c) (*1 point*) Recommend an approach for selecting or deriving an appropriate AAL from the three estimates. Justify your recommendation.

The initial runs (shown above) used the actual policy information. The Management asked each cat modeler to re-run the same portfolios with construction type set to "unknown." The re-runs with "unknown" construction type all produced a smaller AAL. The actuary decided to present the re-runs to a prospective reinsurer.

(d) (*0.5 points*) Explain one implication of replacing the original model runs with the re-runs.

6. (*4 points*) MSB Actuarial Consulting Inc. (MSB) is a sole proprietorship actuarial consulting firm with the following characteristics:

- Operated for nearly 50 years without any professional liability insurance
- No reported claims
- No incidents that could give rise to a claim
- Steady revenue for last ten years with the expectation of declining revenue and ceasing business in the next few years
- MSB is in discussion to purchase insurance coverage with XYZ, a professional liability insurer

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

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

(c) (*1 point*) Provide one advantage and one disadvantage for MSB to purchase a *claims-made* policy.

(d) (*1 point*) Provide one advantage and one disadvantage for MSB to purchase an *occurrence* policy.

7. (*4 points*) You are conducting a ratemaking analysis for a line of business and are given the following information:.

Pure premium	325
Current rate per unit of exposure	500
Fixed expense per exposure	50
Variable expenses as a percent of premium	22%
Profit target as a percent of premium	4%

(a) (*0.5 points*) Calculate the indicated rate change using the claim ratio approach.

The regulator requires that the total expense provision, excluding loss adjustment expenses, not exceed 28% of premium.

(b) (*0.5 points*) Provide one reason why the regulator would impose such a maximum expense provision.

(c) (*1.5 points*) Verify that the calculations with the expense capping produces a negative rate indication.

(d) (*1.5 points*) Calculate the underwriting profit resulting from charging the indicated rate from part (c).

8. (*6 points*)

(a) (*0.5 points*) Explain the benefit of using the Bornhuetter Ferguson method over the development method.

(b) (*0.5 points*) Explain the benefit of using the Bornhuetter Ferguson method over the expected method.

The Bornhuetter Ferguson method can be applied to both paid and reported claims.

(c) (*1 point*) Compare the effects of using the Bornhuetter Ferguson method applied to paid and reported claims when claim experience is improving.

ABC Insurance Company writes auto liability business in State A. Experience for State A has been realtively stable. You are given the following information as of December 31, 2018.

State A Experience			
Accident Year	**Earned Vehicles**	**Projected Ultimate Claims (000)**	**Reported Age-to-Ultimate Development Factors**
2015	72,900	17,100	1.540
2016	75,000	17,900	1.980
2017	80,100	20,100	2.900
2018	78,000	19,700	5.700

The annual claim trend is 2.5%.

ABC expanded into State B effective January 1, 2017. State B has similar costs of living and demographic characteristics as State A.

State B Experience			
Accident Year	**Earned Vehicles**	**Actual Paid Claims (000) as of Dec. 31, 2018**	**Actual Reported Claims (000) as of Dec. 31, 2018**
2017	11,700	1,250	1,400
2018	19,100	450	920
Total	**30,800**	**1,700**	**2,360**

(d) (*1.5 points*) Calculate the a priori expected claims for State B for accident years 2017 and 2018, based on all years' experience of State A.

(e) (*0.5 points*) Calculate the implied reported age-to-ultimate development factors for State B using the a priori expected claims from part (d).

8. Continued

You decide to use the Bornhuetter Ferguson method to estimate ultimate claims for State B. You have two sets of age-to-ultimate reported development factors:

- State A factors from the State A Experience table above, and
- State B factors from part (e).

(f) (*0.5 points*) Recommend a set of development factors to use for estimating ultimate claims for State B. Justify your recommendation.

(g) (*0.5 points*) Calculate the ultimate claims for State B using the Bornhuetter Ferguson method and the a priori expected claims from part (d).

(h) (*1 point*) Calculate the State B total unpaid claims, showing the case estimate and indicated IBNR separately.

9. (*6 points*) EWC Insurance started writing extended warranty insurance in 2016 to purchasers of consumer electronic goods. Coverage is provided for the two years after the one-year manufacturer's warranty expires.

You are reviewing premium liabilities as of December 31, 2018 and are given the following information:

	2016	**2017**	**2018**
Premiums Written	2,400	2,000	2,200

Policy Year	**% of Total Claims Arising in Policy Year**
1	0%
2	25%
3	75%

- EWC pays a 20% commission when a policy is sold.
- Premiums and commissions are paid in full when the goods are purchased.
- Premiums are earned and acquisition costs are recognized proportionately to expected claims over the policy period.
- The expected claims ratio on a policy is 60%, before claims handling costs.
- Claims handling costs are estimated at 10% of claims.
- Policy maintenance expenses are estimated at 5% of unearned premiums.
- Business is sold evenly over the calendar year.
- Claims are incurred evenly during the policy year.
- No adjustment is made for the time value of money (discounting).
- There is no reinsurance.

(a) (*3 points*) Calculate the claims expected to arise after December 31, 2018 from policies in force at that date, excluding claims handling costs.

(b) (*1 point*) Calculate the unearned premium reserve as of December 31, 2018.

(c) (*0.5 points*) Explain the purpose of a premium deficiency reserve.

(d) (*1 point*) Calculate the equity or deficiency in the unearned premium reserve as of December 31, 2018.

(e) (*0.5 points*) Calculate the maximum reported deferred policy acquisition expense (DPAE) as of December 31, 2018.

10. (*4 points*) You are estimating ultimate claims for a liability line of business using the development-based frequency-severity method and are given the following information:

Accident Year	Reported Counts				Earned Exposures
	12	24	36	48	
2015	1,140	1,120	1,130	1,135	20,950
2016	1,255	1,230	1,240		23,500
2017	1,220	1,190			23,560
2018	1,120				24,480

Accident Year	Age-to-Age Development Factors		
	12-24	24-36	36-48
2016	0.982	1.009	1.004
2017	0.980	1.008	
2018	0.975		

- There is no development after 48 months.
- The annual frequency trend is –2.5%.
- A geometric average is used for selecting age-to-age development factors.

(a) (*2.5 points*) Calculate the trended frequency at the 2018 cost level for each accident year.

(b) (*0.5 points*) Recommend the 2018 cost level frequency. Justify your recommendation.

The selected ultimate severity at the 2018 cost level is 18,500.

(c) (*0.5 points*) Calculate the accident year 2018 projected ultimate claims.

The accident year 2018 projected ultimate claims estimated using the development method is approximately 8% lower than the result from the development-based frequency-severity method.

(d) (*0.5 points*) Provide a possible explanation why the development method would produce a lower value than the development-based frequency-severity method.

11. (*4 points*) You are performing a reserve analysis for a reinsurer.

(a) (*0.5 points*) Describe one reason why the development method may not be suitable for reserving excess of loss reinsurance.

(b) (*0.5 points*) Describe one reason why the expected method may be more suitable for estimating reserves for reinsurers than the development method.

For a reinsurer, a claim ratio approach is almost always used for the expected method because other exposures are not usually available.

(c) (*0.5 points*) Describe one challenge when using the claim ratio approach with the expected method for reinsurance reserving.

A primary insurer has estimated ceded case estimates to be 4 million. The reinsurer has established assumed case estimates of 4.5 million for the same underlying claims.

(d) (*0.5 points*) Provide a possible reason why the case estimates for the reinsurer are different than the case estimates from the primary insurer.

11. Continued

You are the actuary for a reinsurer that reinsures claims in the layer between 200,000 limit and total limits, and are given the following information:

Accident Year	Reported Claims (000) at Total Limits				Ultimate Claims
	12	24	36	48	
2015	2,480	4,460	4,920	5,020	5,020
2016	2,780	4,560	4,860		4,959
2017	2,840	5,020			5,555
2018	2,930				5,626
Total					**21,160**

Accident Year	Reported Claims (000) at 200,000 Limit			
	12	24	36	48
2015	2,460	4,180	4,460	4,500
2016	2,600	4,200	4,420	
2017	2,720	4,750		
2018	2,680			

There is no development beyond 48 months.

(e) (*2 points*) Calculate the accident year 2018 ultimate claims for the layer 200,000 to total limits using the development method.

12. (*4 points*) You are estimating unpaid claims for lines of business where conditions have been changing.

A court decision limited Workers Compensation benefits effective July 1, 2015.

(a) (*1 point*) Describe how this change affected the reported claims development triangle evaluated as of December 31, 2018, assuming the following:

(i) The court decision affected only new claims.

(ii) The court decision affected new and open claims.

(b) (*1 point*) Describe why the Cape Cod method could be well-suited to estimate claims under scenario (a)(i) above.

(c) (*1 point*) Describe why a Berquist-Sherman data adjustment could be well-suited to estimate claims under scenario (a)(ii) above.

You are now estimating unpaid claims for a property line of business where claim trend has been increasing in recent years. The CFO suggests that you consider increasing your reported development factor selections due to the increasing trend.

(d) (*1 point*) Critique the CFO's suggestion.

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13. (*4 points*) You are estimating catastrophe loadings for a homeowners line of business with the following information:

- The new rates are to be effective August 1, 2019 through July 31, 2020.
- All policies are written for 12-month policy terms.
- The annual frequency trend is 1%.
- The annual severity trend is 6%.
- Calendar year 2018 earned premiums at current rate level are 13,000,000.
- Calendar year 2018 earned house years (EHY) are 8,500.

You are also given the following incomplete data for non-hurricane weather excluding hail:

Accident Year	Ultimate		Trended Ultimate	
	Frequency per 100 EHY	**Severity**	**Frequency per 100 EHY**	**Severity**
2014			2.10	8,600
2015	1.82	7,500		
2016			1.75	9,200
2017			2.20	8,900
2018	2.10	8,900		

(a) (*2 points*) Calculate the trended ultimate non-hurricane weather excluding hail pure premium per 100 EHY for all years.

(b) (*0.5 points*) Recommend the trended ultimate non-hurricane weather excluding hail pure premium per 100 EHY to use in determining a weather loading. Justify your recommendation.

(c) (*0.5 points*) Calculate the non-hurricane weather excluding hail loading percentage to use for ratemaking.

13. Continued

You are also given the following information related to hurricane claims:

- Annual hurricane modeled expected claims at July 1, 2018 cost level are 350,000.
- The hurricane models in-force exposures as of July 1, 2018.
- The annual exposure trend is 0%.
- The annual hurricane severity trend is 6%.

(d) (*1 point*) Calculate the hurricane catastrophe loading percentage to use for ratemaking.

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

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