SOCIETY OF ACTUARIES
Introduction to Ratemaking & Reserving

Exam GIIRR

MORNING SESSION

Date: Wednesday, April 25, 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 11 questions <u>numbered 1 through 11</u>.

   b) The afternoon session consists of 8 questions <u>numbered 12 through 19</u>.

   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.

1. (*4 points*)

  (a)   (*0.5 points*) State one advantage and one disadvantage of using the extension of
         exposures method to adjust historical premiums for prior rate changes.

  (b)   (*0.5 points*) State two key assumptions for the parallelogram method to be
         appropriate with policies of any term.

You are given the following information for third party auto liability premium rate
changes by year. All policies are twelve-month policies.

Calendar Year	Rate Change % in Year	Effective Date of Rate Change
2015	7%	July 1, 2015
2016	11%	July 1, 2016
2017	13%	July 1, 2017

  (c)   (*2 points*) Calculate the on-level factor to use for ratemaking for calendar year
         2016 earned premium using the parallelogram method.

The parallelogram method has shortcomings that affect its use for risk classification
analysis.

  (d)   (*0.5 points*) Describe one shortcoming.

  (e)   (*0.5 points*) Describe how you can adapt the analysis to address this shortcoming.

2. (*8 points*) XYZ Insurance has acquired a new line of business with the following information:

Accident Year	Cumulative Paid Claims (000)		Incremental Paid Claims Jan. 1, 2017 through Nov. 30, 2017 (000)
	12	24	
2015	18	48	30
2016	24		25
2017			26

Accident Year	Case Estimates (000)		Case Estimates as of Nov. 30, 2017 (000)
	12	24	
2015	45	35	22
2016	55		62
2017			30

Accident Year	Open Counts		Open Counts as of Nov. 30, 2017
	12	24	
2015	85	65	45
2016	115		75
2017			120

During the month of December 2017, only the following transactions were recorded:

- A new claim which occurred on December 2, 2017 has been reported with an initial case estimate of 20,000. No payment has yet been made on this claim.
- An open claim from accident year 2016 was closed on December 15, 2017 with a lump sum payment of 15,000. The case estimate as of November 30, 2017 for this claim was 25,000.
- A closed claim from accident year 2015 was reopened on December 20, 2017, with a new case estimate of 10,000 and no new payments.

(a)   (*2 points*) Calculate the calendar year 2017 reported claims.

2. **Continued**

As part of the year-end valuation, you are estimating the ultimate claims for each of the accident years using the development method. Due to the lack of data, you have selected development factors based on industry experience for the following development ages:

Age-to-Age Factors	24-36	36-Ult
Paid Claims	1.50	1.20

(b)   (*1 point*) Calculate ultimate claims using the paid development method.

(c)   (*1 point*) Construct a triangle of average case estimates as of December 31, 2017.

(d)   (*1 point*) Construct a triangle of paid to reported ratios as of December 31, 2017.

(e)   (*1 point*) Explain whether or not the two triangles in parts (c) and (d) indicate any change in case adequacy.
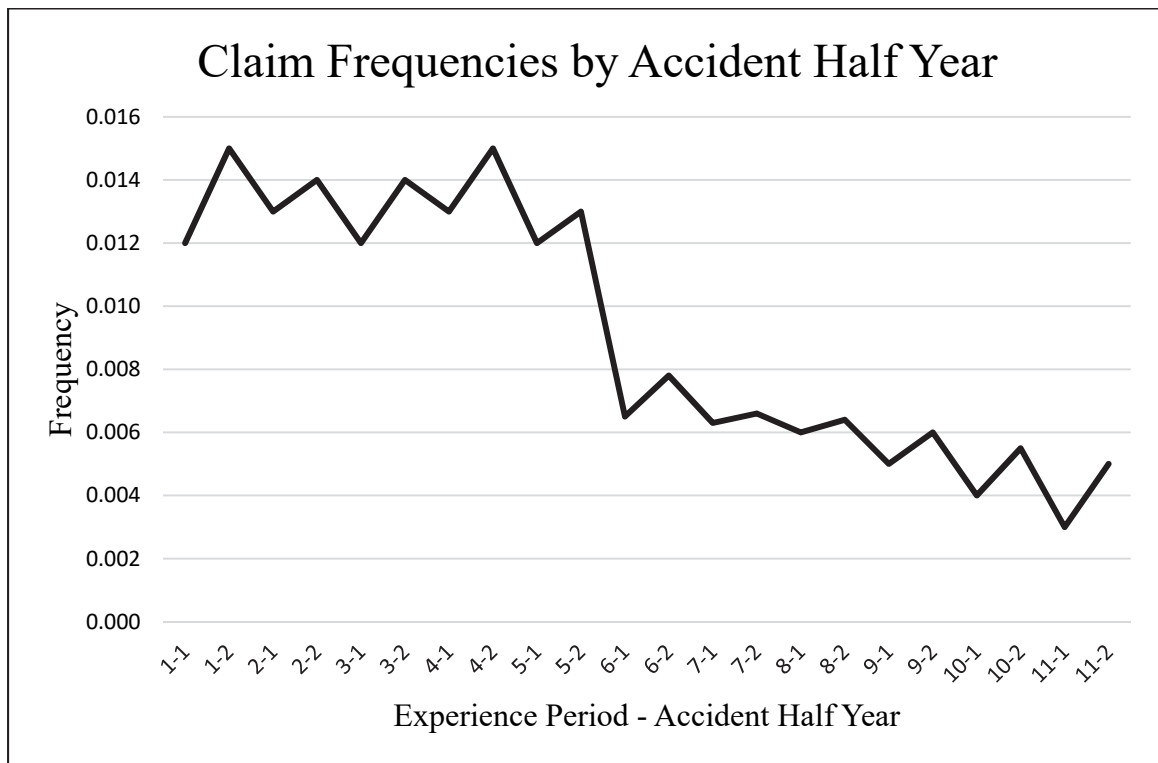
You are given the following additional information:

- The annual severity trend in a stable environment is 4%, and
- Tort reform resulted in a claim cost decrease of 10% for all accidents occurring on or after January 1, 2016.

(f)   (*2 points*) Calculate an adjusted triangle of reported claims using the Berquist-Sherman methodology.

3. (*4 points*) Changes in an insurance company's portfolio can effect frequency trend or severity trend, or both.

    (a)   (*0.5 points*) Describe the effect, if any, that increasing policy limits can have on frequency trend and on severity trend.

You are conducting a trend analysis on industry frequency data shown in the following graph.

An industry reform was introduced in year 6, which resulted in an immediate change in claim frequency.

    (b)   (*1 point*) Recommend two approaches for the trend analysis to consider the industry reform.

One approach to adjust the trending analysis to account for seasonality is to perform a multi-variable regression analysis that takes seasonality into account as a variable in the analysis.

    (c)   (*1 point*) Describe two other approaches that can be used to adjust the trending analysis to account for seasonality.

3. **Continued**

You are also given the following results from various multi-variable regression models that take seasonality into account as a variable in the analysis:

Model	Time Period	Annual Trend	Goodness of Fit (R^2)
I	All Years	-13.9%	89.2%
II	Years 1-5 Only	-1.1%	71.0%
III	Years 6-11 Only	-11.8%	86.4%

(d)   (*1.5 points*) Critique the appropriateness of each model with respect to selecting a frequency trend to use for ratemaking.

4. (*5 points*) You are estimating ultimate auto collision salvage recoveries as of December 31, 2017 and are given the following information:

Accident Year	Actual Salvage Received	Actual Salvage Reported	Development Age in Months	Reported Age-to-Age Development Factors
2015	68,000	68,000	36-48	0.999
2016	66,000	66,000	24-36	0.995
2017	49,000	65,000	12-24	0.980

- No development is expected after 48 months.
- You have decided to use the Bornhuetter Ferguson method to estimate ultimate salvage recoveries for accident year 2017.
- The a priori expected salvage recoveries for accident year 2017 are 67,000.

(a) (*0.5 points*) Estimate projected ultimate salvage for accident year 2017 using the Bornhuetter Ferguson method.

(b) (*0.5 points*) Calculate unreported salvage for accident year 2017 as of December 31, 2017.

(c) (*0.5 points*) Calculate the difference between accident year 2017 actual and expected reported salvage recoveries as of December 31, 2017, using the a priori expected salvage recoveries.

(d) (*0.5 points*) Assess the reasonableness of the inputs for the Bornhuetter Ferguson method using your results from part (c).

(e) (*1 point*) Identify two issues to investigate from your salvage analysis.

Actual reported salvage on accident year 2017 as of June 30, 2018 is 64,600.

(f) (*1.5 points*) Calculate the difference between accident year 2017 actual and expected reported salvage from December 31, 2017 through June 30, 2018, using linear interpolation and your results from part (a).

(g) (*0.5 points*) Describe one situation where you would not want to use linear interpolation for estimating expected development between annual evaluations.

5. (*5 points*) You are performing a reserve analysis for two lines of business, A and B. In the steady state, the following claim projection methods produce the same estimates:

I.   Expected method
II.   Development method applied to reported claims
III.   Bornhuetter Ferguson method applied to reported claims
IV.   Cape Cod method applied to reported claims

Line of business A has experienced a *reduction in claim costs* over the last two years and no modifications have been made to the projection methods to adjust for this change.

(a)   (*2 points*) Explain the expected effect on projected ultimate claims under each of the projection methods (I) through (IV) for line of business A when there is a *reduction in claim costs*.

(b)   (*0.5 points*) Rank the accuracy of projection methods (I) through (IV) from most accurate to least accurate when there is a *reduction in claim costs* for line of business A.

Line of business B has experienced a *deterioration in case reserve adequacy* over the last two years and no modifications have been made to the projection methods to adjust for this change.

(c)   (*2 points*) Explain the expected effect on projected ultimate claims under each of the projection methods (I) through (IV) for line of business B when there is a *deterioration in case reserve adequacy*.

(d)   (*0.5 points*) Describe the difference in accuracy between projection methods (II) and (III) for line of business B when there is a *deterioration in case reserve adequacy*.

6. (*6 points*) You are given the following financial data:

Calendar Year	Gross Written Premium	Gross Earned Premium	Gross Incurred Claims Ratio	Gross Paid Claims	Commissions	General Expense
2015	80,000	78,000	65%	51,000	12,000	16,000
2016	90,000	86,000	68%	55,000	13,500	18,630
2017	100,000	96,000	70%	61,000	15,000	20,900

Selected ULAE ratio as a percent of claims (including ALAE)	10%
Portion of general expense applicable to unearned premium	30%
Gross unpaid claims (excluding ULAE) as of December 31, 2016	300,000
Gross unearned premium as of December 31, 2016	36,000
Quota share reinsurance applies to all premium and claims (including ALAE)	10%

- The claim ratios include ALAE and exclude ULAE.
- Commissions are paid when premium is written. There are no incentive commissions.
- There have been no rate changes in the past three years.

(a) (*2 points*) Calculate the following liabilities as of December 31, 2017:

    (i)   Net unpaid claims, excluding ULAE

    (ii)   Net unearned premium

(b) (*2.5 points*) Determine either the premium deficiency reserve or the equity in the unearned premium as of December 31, 2017 on a net of reinsurance basis, and label accordingly.

There are four types of premium development that actuaries should consider in their valuation of premium liabilities.

(c) (*0.5 points*) Identify any two of these types of premium development.

6. **Continued**

(d) (*1 point*) Select either one of the two types of premium development you identified in part (c) and:

(i) Describe how the premium development arises.

(ii) Describe how this development would be reflected in estimating premium liabilities.

7. (*6 points*) You are performing a ratemaking analysis of a homeowners book of business. As part of the analysis, you are reviewing loadings for catastrophes and large claims.

(a) (*1 point*) Describe two ways that catastrophe claims are different than large claims.

You are performing a ratemaking analysis in State C which is part of Region W. As part of the analysis, you review 10 years of wildfire claims in State C. Only two years in the period covering accident years 2008 through 2017 have any wildfire claims. You are given the following information for State C:

Accident Year	Earned House Years (EHY)	Ultimate Wildfire Claims (000)
2008	14,000	400
2014	13,600	275
Total 2008-2017	**170,000**	**675**

- The new rates are to be effective October 1, 2018 through September 31, 2019.
- All policies are written for 12-month policy terms.
- The annual frequency trend is 0% and the annual severity trend is 8% for wildfire claims.
- 2017 EHY = 14,050.
- State C credibility for wildfire claims = 20%.
- Region W wildfire pure premium per 100 EHY = 1,000.

(b) (*2.5 points*) Calculate the expected wildfire claims in State C to use for ratemaking.

7. **Continued**

You are given the following additional information:

				State C Combined Property excluding Wildfire Claims		
Accident Year	**Earned House Years**	**Earned Premiums**	**Earned Premiums at Current Rate Level**	**Trended Earned Premiums at Current Rate Level**	**Trended Ultimate Claims**	**Accident Year Weights**
2015	13,400	8,781,000	9,220,100	10,454,300	6,482,000	20%
2016	13,800	9,442,000	9,672,300	10,647,600	6,772,000	30%
2017	14,050	9,835,000	9,835,000	10,511,300	6,204,000	50%
Total	**41,250**	**28,058,000**	**28,727,400**	**31,613,200**	**19,458,000**	**100%**

- The full credibility standard is 80,000 EHY.
- The square root rule is used for partial credibility.
- The Region W trended, adjusted ultimate claim, including ULAE, ratio is 75%.
- The ULAE to claim ratio is 14%.
- The selected fixed expenses to premiums ratio is 4%.
- The selected variable expenses to premiums ratio is 12%.
- The selected profit and contingencies to premiums ratio is 6%.

(c)   (*2.5 points*) Calculate the indicated rate level change.

8. (*6 points*)

    (a)   (*0.5 points*) Describe the meaning of the term "used-up premiums" when using the Cape Cod method.

    (b)   (*0.5 points*) State one way in which actuaries can incorporate professional judgment into the Cape Cod method.

    (c)   (*0.5 points*) Describe the purpose of a decay factor in the Generalized Cape Cod method.

You are given the following information:

Accident Year	Earned Exposures	Reported Claims	Reported Cumulative Development Factors
2015	1,000	320,000	1.500
2016	1,100	150,000	3.400
2017	1,200	85,000	7.000

- A rate increase of 6% was effective January 1, 2015.
- The annual claim trend is 4%.

    (d)   (*1.5 points*) Calculate the expected pure premium for accident year 2017 using the Generalized Cape Cod method applied to reported claims and a decay factor of 90%.

Most reserving methods work well when projections are based on stable, mature data. However, each method also has assumptions that make it well suited for other situations.

    (e)   (*1.5 points*) Describe one other situation for each of the following projection methods, such that the method is well-suited for the situation. Do not repeat any situations.

        (i)   Cape Cod method applied to reported data

        (ii)   Bornhuetter Ferguson method applied to paid data

        (iii)   Frequency-severity closure method

    (f)   (*1.5 points*) Provide three reasons why the claim experience of a reinsurer may have greater variability than the claim experience of a primary insurer.

9. (*5 points*) IFTEM Insurance Company is working with King Consultants (King) to build a catastrophe model for its exposure to earthquake losses. You are an actuary working for King and are reviewing a draft report by IFTEM containing the statements below.

Explain why each of the following statements is either correct or incorrect.

(i) In developing the model domain (the geographic extent of the region to be modeled) it is sufficient to know the location and likely magnitude of future earthquakes.

(ii) The return period (time until the next earthquake) and magnitude of the earthquake can be separately modeled.

(iii) To model IFTEM's specific portfolio for the *inventory* module, detailed information will be required for each building in the portfolio.

(iv) To model IFTEM's specific portfolio for the *vulnerability* module, detailed information will be required for each building in the portfolio.

(v) The total loss from an event (prior to applying the terms of the insurance coverage) could come from either the vulnerability module or the loss module.

10. (*6 points*) You are estimating ultimate claims using the expected method and are given the following information:

Accident Year	Earned Premiums (000)	Paid Claims as of Dec. 31, 2017 (000)	Claim Trend Factor
2015	1,520	650	1.042
2016	1,790	530	1.021
2017	2,050	240	1.000

Development experience of similar products has the following payment pattern:

Incremental Payment Pattern	
0-12 months	24%
12-24 months	32%
24-36 months	23%
36 months to ultimate	21%

- All premiums were increased by 5% for policies written on or after July 1, 2016. This rate change was the only rate change for this book of business.
- All policies are written for 12-month policy terms.

(a)   (*3 points*) Recommend the 2017 cost and rate level expected claim ratio to be used to estimate expected claims. Justify your recommendation.

(b)   (*1 point*) Calculate the expected claims for each accident year.

You are given the following additional information:
- The selected ratio of Unallocated Loss Adjustment Expenses (ULAE) to claims is 11.5%.
- Ultimate claims for each accident year are based on the expected claims from part (b).
- The total case estimate for the three accident years combined is 536,000.
- 65% of claim department expenses relate to opening a claim file, and 35% relate to maintaining and closing a claim file.

(c)   (*1.5 points*) Calculate the unpaid ULAE as of December 31, 2017 using the classical paid-to-paid method.

(d)   (*0.5 points*) Calculate the total claim liability for this book of business.

11. (*5 points*)

    (a)   (*0.5 points*) Describe the difference between an occurrence policy and a claims-made policy with respect to the trigger for coverage.

The following three one-year term policies contributed earned exposures to report year 5:
- Policy A: occurrence policy effective January 1, year 3
- Policy B: mature claims-made policy effective March 1, year 4
- Policy C: mature claims-made policy effective January 1, year 5

    (b)   (*1.5 points*) Calculate the report year 5 earned exposures (i.e., $E_{i,5}$, where $i =$ accident year lag).

You are given the following additional information:

Accident Year Lag	Pure Premiums by Report Year				
	5	6	7	8	9
0	60	63	66	69	72
1	110	116	122	128	134
2	130	137	144	151	159
3	110	116	122	128	134
4 +	90	95	100	105	110

- The fixed expense per policy is 10.
- Variable expenses are 15% of premium.
- The profit provision is 4% of premium.

    (c)   (*1 point*) Calculate the indicated rate for a mature claims-made policy, effective January 1, year 5.

    (d)   (*1 point*) Calculate the tail factor for a second year claims-made coverage, effective January 1, year 5.

    (e)   (*1 point*) Explain why a tail factor determined from a reporting pattern that is equal across each of the five accident year lags (i.e., 20% per year) is less than the tail factor calculated in part (d).

END OF EXAMINATION
Morning Session

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