SOCIETY OF ACTUARIES
Introduction to Ratemaking & Reserving

Exam GIIRR

MORNING SESSION

Date: Wednesday, April 29, 2015
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 12 questions underlined numbered 1 through 12.

    b) The afternoon session consists of 8 questions underlined numbered 13 through 20.

    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.

Tournez le cahier d'examen pour la version française.

1. (*4 points*) You are given the following historical rate change information for a personal automobile line of business in State Q:

The following rate changes have occurred since 2011:

Effective Date	Rate Change
January 1, 2011	–2%
March 1, 2012	+4%
April 1, 2013	+5%
June 1, 2014	+7%

- There was a mandatory regulation change where all premiums in force on September 1, 2012 were required to be reduced by 15%.
- All policies are written for six-month policy terms.
- Policies are assumed to be written uniformly throughout a calendar year.
- Calendar year 2012 earned premium is 475,000.
- The rates currently in effect are the rates effective June 1, 2014.

(a) (*2 points*) Calculate the 2012 earned premium at current rate level using the parallelogram method.

(b) (*1 point*) Explain why you would expect the 2012 earned premium at current rate level to be greater or less than the answer from part (a) if all policies were twelve-month policies instead of six-month policies.

The regulator in State Q is considering an increase to the state-mandated minimum policy limits for all policies written on or after February 1, 2015. Insurers will increase premiums to reflect this policy limits change.

(c) (*1 point*) Explain how the increase in the state-mandated minimum policy limits would affect the on-level calculation from part (a).

2. (*7 points*) You are given the following information to estimate claim liabilities as of December 31, 2014:

Accident Year	Cumulative Reported Claims			Projected Ultimate Claims based on Development Method
	12	**24**	**36**	
2012	7,100	9,230	10,340	11,296
2013	6,900	8,970		10,975
2014	7,400			11,770

Accident Year	Cumulative Paid Claims			Projected Ultimate Claims based on Development Method
	12	**24**	**36**	
2012	3,750	6,750	8,780	10,246
2013	3,860	6,950		10,544
2014	4,100			11,196

Calendar Year	Earned Premium	Earned Exposures	Premium On Level Factors
2012	12,200	95	1.070
2013	12,900	94	1.034
2014	13,800	94	1.000

The annual trend rate for claim ratios and pure premiums is 2%.

(a) (*1 point*) Calculate the 2014 level expected claim ratio using reported claims and a three year average.

(b) (*1 point*) Calculate the 2014 level pure premium using reported claims and a three year average.

2. **Continued**

(c) (*1 point*) Calculate the accident year 2013 expected claims for the following methods:

    (i)   Use the 2014 level expected claim ratio determined in part (a).

    (ii)   Use the 2014 level pure premium determined in part (b).

(d) (*1 point*) Calculate the accident year 2013 ultimate claims using the Bornhuetter Ferguson method with the expected claims from the expected claim ratio approach in part (c) and reported claims.

(e) (*1 point*) Calculate the accident year 2013 unpaid claims using the ultimate claims calculated in part (d). Show the case estimate and indicated IBNR separately.

You are monitoring the results given the following information:

				Actual versus Expected Reported Claims from Dec. 31, 2014 through Mar. 31, 2015		
Comparison of Actual versus Expected Reported Claims						
Accident Year	**Selected Ultimate Claims**	**Expected Percent Reported at Dec. 31, 2014**	**Reported Claims at Mar. 31, 2015**	**Actual**	**Expected**	**Difference**
2013	10,975	81.7%	9,235	265	269.1	–4.1
2014	11,770	62.9%	7,960	560	555.0	5.0

Accident Year	**Selected Ultimate Claims**	**Paid Claims at Mar. 31, 2015**
2013	10,544	7,460
2014	11,196	4,790

(f) (*1 point*) Calculate the difference between the actual and expected paid claims from December 31, 2014 through March 31, 2015 for accident year 2014, using linear interpolation of the expected percent paid derived from the implied paid cumulative development factors.

(g) (*1 point*) State two possible reasons why the difference between the actual and expected reported claims is different than the difference between the actual and expected paid claims for accident year 2014.

3. (*4 points*)

    (a)   (*1 point*) Explain two situations where the pure premium ratemaking approach is preferred to the claim ratio ratemaking approach.

You are given the following information for a line of business you are pricing:

Accident Year	Projected Ultimate Severity
2012	24,900
2013	26,400
2014	27,100

- Rates are to be effective April 1, 2015 for one year.
- All policies are twelve-month policies.
- The annual severity trend is 5%.

    (b)   (*2 points*) Select the ultimate severity for the future rating period. Justify your selection.

The pure premium used for the ratemaking analysis is not fully credible. You are considering the following two possible sources as a complement of credibility:

- the pure premium underlying the current rates
- a pure premium based on industry experience

    (c)   (*1 point*) Describe an adjustment, if any, that may be required for each of these possible complements of credibility.

4. (*5 points*)

(a)   (*1 point*) Explain two weaknesses of the classical paid-to-paid unallocated loss adjustment expenses (ULAE) estimation method.

You are estimating ULAE reserves for ABC Insurance Company's property business as of December 31, 2014 and decide to use the Wendy Johnson count-based method. A special study on claim department time and activity was previously conducted for ABC's property claims and based on this information you selected the following weights for the three different types of claim counts:

- 20% for newly reported counts;
- 70% for open counts; and
- 10% for closed counts.

You are also given the following information:

Historical ULAE				
Calendar Year	Paid ULAE	Counts		
		Newly Reported During the Year	Open at End of Year	Closed During the Year
2012	1,862	1,550	577	1,580
2013	2,100	1,700	614	1,663
2014	1,995	1,685	621	1,678

Projection of Unpaid ULAE			
Calendar Year	Counts		
	Newly Reported During the Year	Open at End of Year	Closed During the Year
2015	665	316	970
2016	150	82	384
2017	-	-	82

- Property claims are all closed within three years after the end of an accident year.
- Historical expense trend over the past 3 years has been flat (zero).
- The prospective annual expense trend from 2014 is expected to be 3%.

(b)   (*4 points*) Estimate unpaid ULAE as of December 31, 2014 using a simple three-year average of historical experience.

5. (*4 points*) A fundamental relation connecting the Table L savings, $\psi^*(r)$, and the Table L charge, $\phi^*(r)$, in a retrospective rating plan with a per accident limitation is $\psi^*(r) = \left[\phi^*(r) - k\right] + r - [1-k]$, where r is the entry ratio and k is the loss elimination ratio associated with the per accident limitation.

     (a)   (*1 point*) Explain what the Table L savings and Table L charge indicate.

     (b)   (*1 point*) Draw a graph with cumulative claim frequency along the x-axis and entry ratio along the y-axis, and identify the areas on the graph corresponding to $\psi^*(r)$ and $\phi^*(r)$.

     (c)   (*1 point*) Demonstrate the validity of the fundamental relation above using the areas of the graph.

     (d)   (*1 point*) Define $\psi^*(r)$ for the limiting case where losses are all equal.

6. (*5 points*) You are given the following company development triangle:

Accident	Paid Claims			
Year	12	24	36	48
2011	25,000	30,000	40,000	46,000
2012	18,000	26,000	38,000	
2013	20,000	25,000		
2014	23,000			

(a) (*1 point*) Calculate the age-to-age factors for paid claims using the geometric three-year method.

(b) (*1 point*) State one advantage and one disadvantage of Boor's algebraic method.

You are given the following additional information:

Accident Year	Reported Claims at Dec. 31, 2014
2011	48,000
2012	45,000
2013	40,000
2014	35,000

Selected Reported Claims Age-to-Age Factors			
12-24	24-36	36-48	48-Ult
1.30	1.15	1.07	1.03

(c) (*1 point*) Calculate the paid claims tail factors for accident years 2011 and 2012 using Boor's algebraic method.

You are considering the use of benchmark data for selecting tail factors.

(d) (*0.5 points*) State two common sources of benchmark data.

(e) (*0.5 points*) State two potential limitations of benchmark data.

(f) (*1 point*) Explain how you would evaluate and incorporate the benchmark data in your tail factor selection.

7. (*6 points*) Seaport Insurance Company (SIC) offers the following straight deductible options:

Deductible	Premium
0	10,000
1,000	9,500
2,500	8,745
5,000	7,960

(a) (*0.5 points*) Explain the importance of consistency in setting deductible factors.

(b) (*1 point*) Demonstrate that the implied deductible factors are inconsistent.

(c) (*0.5 points*) Adjust one premium so that the table has a consistent pattern.

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

   (i) Franchise deductible

   (ii) Time deductible

(e) (*1 point*) Explain how the responsibility for claims handling differs between large deductible policies and self-insured retention policies.

Consider a property insurance policy with the following characteristics:

- Property value of 200,000
- Policy amount of 150,000 and deductible equal to 10% of the policy amount

(f) (*2 points*) Illustrate graphically what the insurer would pay for losses from zero up to the property value in the following situations:

   (i) 100% coinsurance requirement applicable to the loss before the deductible

   (ii) No coinsurance requirement

8. (*6 points*) The triangle of average case estimates is a valuable investigative tool for assessing whether or not there have been changes in the overall adequacy of case estimates during the experience period.

(a) (*1 point*) Explain two reasons why an actuary must be careful in using this investigative tool to reach a conclusion on the level of overall adequacy of case estimates.

You are given the following:

Accident	Reported Claims		
Year	12	24	36
2012	73,800	98,400	104,600
2013	75,600	88,200	
2014	66,000		

Accident	Paid Claims		
Year	12	24	36
2012	49,200	61,500	92,300
2013	50,400	63,000	
2014	52,800		

Accident	Open Counts		
Year	12	24	36
2012	154	275	209
2013	168	300	
2014	161		

The annual severity trend is 3%.

(b) (*1 point*) Calculate the triangle of average case estimates.

(c) (*0.5 points*) Explain why the triangle of average case estimates may indicate a change in case adequacy.

(d) (*1.5 points*) Adjust the reported claims triangle using the Berquist-Sherman methodology.

You use the reported development method to estimate ultimate claims.

(e) (*1 point*) Describe what adjustments may be appropriate to the tail factor.

(f) (*1 point*) Explain why the IBNR based on the adjusted reported claims is likely to be higher or lower than the IBNR based on the unadjusted reported claims.

9. (*4 points*) XYZ Insurance company management requires that the probability of catastrophe losses exceeding 500 million be less than or equal to 1%. After running a catastrophe model some of the points on the exceedance probability curve are:

Loss (millions)	Exceedance probability
400	0.025
500	0.019
600	0.014
700	0.010
800	0.007
900	0.005
1000	0.004

XYZ is considering the following three strategies to meet this requirement:

1. Reduce the portfolio by 30%. This can be done so that the table above is changed where each loss is simply multiplied by 0.7.
2. Purchase reinsurance coverage where the reinsurer will pay 80% of all losses above 400 million, with a maximum payment of 480 million.
3. Securitization through an index-based transaction that mimics the reinsurance coverage from strategy 2.

(a) (*1 point*) Indicate for each of strategies 1 and 2 if it meets or does not meet XYZ management's requirement. Justify your conclusions.

(b) (*1 point*) State the advantages and disadvantages of selecting strategy 1 instead of strategy 2.

(c) (*1 point*) Explain why, based on the information above, it is not possible to determine whether strategy 3 meets or does not meet XYZ management's requirement.

(d) (*1 point*) Compare, with explanations, strategies 2 and 3 with regard to moral hazard and basis risk.

10. (*5 points*) The basic prospective experience rating formula is as follows:

$$\text{experience modification factor} = \frac{\text{actual claims}}{\text{expected claims}} \times \text{credibility} + (1 - \text{credibility})$$

(a) (*0.5 points*) Explain why insurers use experience rating.

(b) (*0.5 points*) Explain why you may choose to base credibility on premium in individual risk rating.

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

(d) (*1 point*) State three examples of risk characteristics used in schedule rating plans.

(e) (*0.5 points*) Define premium discounts and expense constants.

Actuaries involved with the creation of a prospective experience rating plan can assist with the following items:

- Trend factors
- Development factors
- Expected claim ratios
- Large claim thresholds
- Credibility

(f) (*1 point*) Select two items from the list above and explain how actuaries can assist in their development and maintenance.

Your chief marketing officer (CMO) has recommended introducing a retrospective rating plan for small manufacturers to cover their property exposure.

(g) (*1 point*) Explain two problems with a retrospective rating plan in this case.

11. (*6 points*) You are estimating ultimate claims using the frequency-severity closure method, which requires the selection of claims trend.

Actuaries often adjust historical data for measurable changes, such as unusually large losses, before conducting trending procedures.

(a)   (*1 point*) State two other changes in historical data that would require adjustment.

Actuaries may take into account several information sources when selecting trend rates.

(b)   (*1.5 points*) State three information sources you may take into account.

You are given the following information for a frequency-severity closure method analysis:

Accident Year	Earned Exposures	Projected Ultimate Counts from Development Method
2012	35,000	910
2013	36,000	900
2014	37,000	960

The annual frequency trend is –2%.

(c)   (*1 point*) Calculate the indicated ultimate frequency at the 2014 level using a three-year average.

(d)   (*0.5 points*) Project the ultimate counts for accident year 2013 using the indicated ultimate frequency from part (c).

You are given the following information for accident year 2013:

	12	24	36	48
Incremental closed counts	450	330		
Selected proportion of closed counts			0.8	1.0
Selected incremental paid severity	1,000	5,200	14,300	19,100

(e)   (*1.5 points*) Calculate the ultimate claims for accident year 2013 using the frequency-severity closure method.

(f)   (*0.5 points*) Explain what adjustments, if any, are made to frequency-severity closure method estimates of ultimate claims when case reserve adequacy is changing.

12. (*4 points*) You are given the following information on general expenses for a line of business you are pricing:

Calendar Year	Earned Premium	Earned Exposures	Total General Expenses
2012	4,019,000	2,770	452,100
2013	4,307,000	2,910	495,300
2014	4,571,000	2,930	502,800
Total:	12,897,000	8,610	1,450,200

- Rates are to be effective July 1, 2015 for one year.
- All policies are twelve-month policies.
- General expenses are assumed to be 40% variable expenses and 60% fixed expenses for all years.
- The annual trend in fixed expense per exposure is 2%.

(a)   (*1 point*) Select the variable expense percentage to use for ratemaking based on the historical ratio of variable expense to premium. Justify your selection.

(b)   (*2 points*) Select the fixed expense per exposure to use for ratemaking. Justify your selection.

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

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

END OF EXAMINATION
Morning Session

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