SOCIETY OF ACTUARIES
Introduction to Ratemaking & Reserving

Exam GIIRR

MORNING SESSION

Date: Wednesday, October 30, 2013
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.

Tournez le cahier d'examen pour la version française.

475 N. Martingale Road
Schaumburg, IL 60173-2226

Printed in the U.S.A.
Exam GIIRR-Front Cover

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

1. (*4 points*) All automobile insurance policies for A-Z Insurance Company sold in 2012 have premiums paid annually of 1,680. Effective January 1, 2013, there was a 20% rate increase for all new and renewal policies.

You are given the following information for three policies:

Policy Number	Effective Date	Policy Status as of 12/31/2013
14902	09/01/2012	Cancelled 02/28/2013
14903	12/16/2012	Expired 12/15/2013
14904	06/16/2013	In-force as of 12/31/2013

Assume all months count as 1/12th of a year, and approximate mid-month dates as one half of a month.

(a) (*3 points*) Calculate the total earned exposure units and total earned premium in each of the four calendar quarters in 2013.

(b) (*1 point*) Calculate the total unearned premium at December 31, 2012 and December 31, 2013.

2. (*5 points*) You are investigating data triangles from your company's liability line of business. The annual trend is expected to be 9%.

(a) (*1 point*) Describe the patterns that would be expected in the triangle of average reported claims (i.e., reported severities) and in the triangle of the ratios of closed to reported counts in a stable environment.

You have calculated the average case estimate triangle as follows:

Accident Year	Average Case Estimate by Month of Development				
	12	**24**	**36**	**48**	**60**
2008	4,505	5,126	5,467	6,730	8,256
2009	4,723	4,950	5,734	8,235	
2010	5,246	5,679	6,934		
2011	5,436	7,924			
2012	6,234				

(b) (*1 point*) Determine whether the above triangle of average case estimates is representative of a stable environment.

(c) (*1 point*) Identify two reasons why historical reported claims may not be appropriate for use in a traditional development-based projection method.

(d) (*2 points*) Describe an approach, for each of the two reasons identified in (c), that the actuary can implement for use in a development-based projection.

3. (*5 points*) You are given the following information to formulate rates for the forecast period for a company that writes kite manufacturer product liability policies:

Experience Period	Total Kite Sales Revenue	Distribution of Sales by Policy Limits	
		1 Million	2 Million
2010	96,000	53%	47%
2011	100,000	50%	50%
2012	150,000	65%	35%
2013	110,000	48%	52%
Forecast Period			
2015	120,000	45%	55%
Current Limit Differential		1.00	1.50

The exposure base for the product liability insurance policy is sales revenue and the assumed annual trend in sales revenue for the experience and forecast periods is 5%. All policies are annual and are assumed to be written uniformly throughout the year.

(a) (*1 point*) Describe the purpose of premium trend and on-level factors.

(b) (*2 points*) Calculate premium trend factors to apply to each of the four years in the experience period.

(c) (*1 point*) Assign weights to each year in the experience period and describe the rationale for such weights.

(d) (*1 point*) Explain how the premium trend factors would be affected by the following:

(i) A 10% rate increase that is implemented at the beginning of 2014.

(ii) The introduction of a loyalty discount program at the beginning of 2015.

4. (*7 points*) Assume that the information in the table below represents the experience for a portfolio of automobile third-party liability coverage and that the annual pure premium trend is 2.1%.

Accident Year	On Level Earned Premium	Paid Claims	Paid Cumulative Development Factors
2009	14,900	6,200	1.50
2010	14,800	4,600	2.30
2011	14,400	2,200	4.80
2012	14,900	800	18.70

(a) (*4 points*) Calculate the projected ultimate claims using the Cape Cod method with paid claims.

You have also calculated the projected ultimate claims using the Cape Cod method with reported claims. The projected ultimate claims using reported claims are significantly greater than the projected ultimate claims using paid claims.

(b) (*1 point*) Explain two situations that could result in such a difference in Cape Cod projections based on paid and reported claims.

(c) (*1 point*) Describe how the actuary can incorporate professional judgment in the Cape Cod method.

(d) (*1 point*) Explain the major difference between the Bornhuetter Ferguson and Cape Cod projection methods.

5. (*4 points*) You have submitted an automobile insurance rate filing to the regulator. This line of business has a mandatory coverage as well as an optional coverage, and fixed expenses have been allocated to both mandatory and optional coverages in determining the overall rate change indications.

The following information was submitted to the regulator:

	Mandatory Coverage	**Optional Coverage**
Trended ultimate claims (000)	2,250	1,695
Trended earned premium at current rate level (000)	3,260	2,190
ULAE as a ratio to claims	8.0%	8.0%
Variable expenses as a percentage of premium	10.0%	10.0%
Profit and contingencies as a percentage of premium	5.0%	5.0%
Fixed expenses as a ratio to premium at current rate level	11.5%	11.5%
Indicated Rate Change	1.2%	11.9%
Proposed Rate Change Submitted to Regulator	0.0%	10.0%

The regulator has responded to your rate filing submission and is asking you to allocate all fixed expenses to the mandatory coverage.

(a) (*2.5 points*) Determine the revised indicated rate change for both the mandatory coverage and optional coverage by allocating all fixed expenses to the mandatory coverage.

(b) (*1.5 points*) Draft a response to the regulator outlining why you believe your expense allocation method is more appropriate.

6. (*4 points*) You are projecting ultimate claims for Dunkum Auto Insurer for its third-party automobile property damage coverage. Investigative testing and interviews with management have led you to believe that a Berquist Sherman adjustment may be necessary.

You are given the information in the following table about closed and ultimate counts:

Closed Counts at Maturity Ages in Months					
Accident Year	**12**	**24**	**36**	**48**	**Selected Ultimate Counts**
2009	1,777	2,310	2,541	2,617	2,617
2010	1,884	2,449	2,514		2,800
2011	1,997	2,345			2,938
2012	1,860				3,081

(a) (*1 point*) Describe two situations where Berquist Sherman methods are most commonly implemented.

(b) (*1 point*) Recommend disposal ratios for each maturity age.

(c) (*1 point*) Calculate the development triangle of adjusted closed counts using your recommended ratios from (b).

You determine that the best relationship between closed counts and cumulative paid claims (in thousands) can be described by an exponential curve of the form $y = ae^{bx}$, where y represents cumulative paid claims and x represents closed counts. Your analysis shows that the parameters for accident year 2009 from 24 to 36 months are a = 2,345.11 and b = 0.00047.

(d) (*1 point*) Calculate adjusted paid claims at December 31, 2011 for accident year 2009 using the information above and the adjusted closed count triangle.

7. (*4 points*) Grossi and Kunreuther define two types of uncertainty, aleatory and epistemic.

The definitions are:

> "Aleatory uncertainty is the inherent randomness associated with natural hazard events …"
>
> "… epistemic uncertainty is the uncertainty due to lack of information or knowledge of the hazard."

(a) (*2 points*) Provide an example of each type of uncertainty with regard to earthquake models and explain why each example reflects that type of uncertainty.

(b) (*1 point*) Describe which of these types of uncertainty can be reduced by collecting more data, and illustrate your response using your example from part (a).

(c) (*1 point*) Explain how logic trees can be used to reflect epistemic uncertainty in the construction of exceedance probability curves.

8. (*5 points*) You are given the following claims information about an insurer that has been operating for three years:

Accident Year	Paid Claims at Maturity Ages			Ultimate Claims	Case Estimates as of Dec. 31, 2012
	12	24	36		
2010	7,000	9,000	10,000	10,000	0
2011	5,000	8,000		10,000	1,000
2012	4,000			10,000	4,000

Paid ULAE is equal to 500, 800, and 1,000 in calendar years 2010-2012, respectively. For each accident year, 50% of claims are expected to be paid during the first 12 months, 30% from 12 to 24 months, and 20% from 24 to 36 months.

(a) (*0.5 points*) Describe two of the key assumptions of the classical paid-to-paid method.

(b) (*1.5 points*) Estimate unpaid ULAE as of December 31, 2012 using the classical paid-to-paid method and a multiplier of 50%. Justify any selections.

(c) (*0.5 points*) Describe the Kittel refinement to the classical paid-to-paid method and the weakness it is designed to address.

(d) (*1 point*) Explain the weakness of the classical paid-to-paid method that the Mango-Allen smoothing adjustment is designed to address and identify a situation in which it would be useful.

(e) (*1 point*) Estimate unpaid ULAE as of December 31, 2012 using the classical paid-to-paid method, a multiplier of 50%, and the Mango-Allen smoothing adjustment.

(f) (*0.5 points*) Compare the significance of ULAE for reinsurers to that of primary insurers and explain the reason for any difference.

9. (*5 points*) You are revising your company's automobile insurance rates to include the new risk characteristic *color of car*, without introducing any change to the overall average rate level. The information in the following table was provided for the classification analysis:

Car Color	Trended Earned Premium at Current Rate Level	Trended Ultimate Claims	Ultimate Counts
White	568,000	449,000	775
Black	780,000	606,000	935
Other	1,150,000	837,000	1,635
Total	2,498,000	1,892,000	3,345

The full credibility standard is 1,537 ultimate counts.
The square root rule is used for partial credibility.
The complement of credibility is equal to 1.

(a) (*2 points*) Calculate the indicated class relativities for the risk characteristic *color of car*.

(b) (*0.5 points*) Explain what is implied by a complement of credibility of 1.

(c) (*1.5 points*) Determine the *color of car* classification relativities and the revised base rate assuming a base class of *other,* given that the current base rate is 475.

(d) (*1 point*) Describe how you could check the risk characteristic *color of car* for distributional bias relative to another risk characteristic such as *territory*.

10. (*5 points*) You are calculating premium liabilities for Acme Insurance Company, which writes only property and liability business.

Line of Business	Unearned Premiums as of Dec. 31, 2013	2011 Ultimate Accident Year Claims Ratio	2012 Ultimate Accident Year Claims Ratio	2013 Ultimate Accident Year Claims Ratio
Gross of Reinsurance				
Property	120,000	60%	500%	50%
Liability	120,000	90%	85%	95%
Net of Reinsurance				
Property	100,000	55%	100%	55%
Liability	100,000	90%	95%	100%

- The claims ratios include ALAE, but not ULAE.
- The 2012 claims ratios on property reflect the impact of a 1-in-100 year hurricane.
- ULAE is 10% of claims (including ALAE), which is not covered by reinsurance.
- There are no reinsurance costs beyond what is reflected in the net unearned premiums.
- Maintenance expenses are 5% of gross unearned premiums.
- Commission of 15% of premiums has already been paid. There is no incentive commission.

(a) (*1.5 points*) Select expected claim ratios for each line of business, gross and net of reinsurance, that will be used in the determination of premium liabilities. Justify each selection.

(b) (*2 points*) Calculate the net premium liabilities for Acme as of December 31, 2013 given the selected expected claim ratios in (a) and the information provided.

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

(d) (*0.5 points*) Determine, based on your calculations in (b), Acme's premium deficiency reserve as of December 31, 2013.

(e) (*0.5 points*) Explain how premium liabilities for Acme would change if some of the liability policies are written using sales as an exposure base that are subject to audit following the end of the policy period.

11. (*4 points*) You have been given the following information for a projection of ultimate claims:

Accident Year	Actual Reported Claims	A Priori Expected Claims	Reported CDF
2008	57,800	62,000	1.00
2009	53,100	59,500	1.05
2010	25,200	51,000	1.10
2011	20,600	49,000	1.50
2012	19,300	52,100	2.00

(a) (*2 points*) Develop an estimate of ultimate claims for 2008 and 2012 using the following methods:

(i) Development method

(ii) Expected method

(iii) Bornhuetter Ferguson method

(iv) Benktander method, one iteration

(b) (*1 point*) Evaluate the reasonableness of the inputs for the Bornhuetter Ferguson method.

(c) (*1 point*) Select estimates of ultimate claims for 2008 and 2012 and justify your selections.

12. (*4 points*) Claim sizes in a particular year are uniformly distributed on (0, 100). Over a number of years, inflation doubles all claim sizes.

(a) (*1 point*) Illustrate this inflationary trend effect on the layer from 0 to 50 and the layer from 50 to 100 using a graph with cumulative claim frequency along the x-axis and claim size along the y-axis.

(b) (*3 points*) Determine the inflationary trend factors that apply to each of the following layers using the graph from (a):

(i) 0 to 50

(ii) 50 to 100

(iii) 0 to 100

13. (*4 points*) A mature claims-made policy sold in 2013 has expected claims of 625, distributed such that expected claims with accident year lag k are 500 x $(0.2)^k$. This pattern is expected to persist with future annual report year claim trend of 10%.

(a) (*1 point*) Calculate the expected claims on an occurrence policy sold in 2013.

(b) (*1 point*) Calculate the second-year claims-made step factor.

(c) (*1 point*) Calculate the second-year claims-made tail factor.

(d) (*0.5 points*) Identify the gap in coverage that can arise when changing from claims-made coverage with one insurer to claims-made coverage with a different insurer.

(e) (*0.5 points*) Explain how the gap in (d) can be addressed.

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

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