SOCIETY OF ACTUARIES

Advanced Topics in General Insurance

Exam GIADV

Date: Thursday, April 30, 2020
Time: 2:00 p.m. – 4:15 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 40 points.

   This exam consists of 8 questions, numbered 1 through 8.

   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 because 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 Exam GIADV.

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

475 N. Martingale Road
Schaumburg, IL 60173-2226

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

****BEGINNING OF EXAMINATION****

1. (*5 points*) You are exposure rating a workers compensation treaty that covers the layer 600,000 excess of 200,000 and are given:

State	Expected Loss Ratio
X	60%
Y	80%

State	Hazard Group	Standard Premium
X	J	80,000
X	K	120,000
Y	J	110,000
Y	K	90,000

Both states have the following NCCI excess loss factors (ELF):

	NCCI Excess Loss Factors	
Loss Size	**Hazard Group J**	**Hazard Group K**
250,000	0.032	0.060
1,000,000	0.008	0.020

You approximate the NCCI ELF curves with an inverse power curve of the form $ELF_L = aL^{-b}$.

(a) (*1 point*) Calculate the values of *a* and *b* for each hazard group.

(b) (*3 points*) Calculate the loss cost rate for the treaty.

You are experience rating the same treaty.

(c) (*1 point*) Explain how you would handle:

(i) Policy limits

(ii) Discounting

2. (*4 points*) You are calculating the underwriting profit margin for a one-year policy using the Risk Adjusted Discount Technique with the following assumptions:

- The premium will be collected at policy inception.
- Expenses of 25 will be paid at policy inception.
- Losses are expected to be 125 and will be paid at policy expiration.
- The tax rate on all income is 35% and taxes will be paid at policy expiration.
- Equity of 100 supports the policy.
- The risk-free rate is 3%.
- The risk-adjusted rate for losses is –1%.

(a) (*2.5 points*) Calculate the premium for this policy.

(b) (*0.5 points*) Calculate the underwriting profit margin for this policy.

(c) (*1 point*) State two drawbacks of the Risk Adjusted Discount Technique.

3. (*5 points*) You are given the following triangle of cumulative paid losses:

	Months of Development		
Accident Year	**12**	**24**	**36**
2017	10,000	15,000	17,000
2018	11,000	16,000	
2019	12,000		

You apply Clark's stochastic reserving model using the LDF method and a Weibull distribution with cumulative distribution function $G(x) = 1 - \exp\left[-(x/\theta)^{\omega}\right]$ where x is in months.

The maximum likelihood estimate of θ is 10.68 and of ω is 0.6069.

(a) (*1.5 points*) Calculate the maximum likelihood estimates of ULT_{2017}, ULT_{2018}, and ULT_{2019}.

(b) (*0.5 points*) Estimate the reserve for the three accident years combined.

(c) (*2 points*) Estimate the scale factor, σ^2.

(d) (*1 point*) Explain the difference between the process variance and the parameter variance.

4. (*8 points*) Venter lists six testable implications of the chain ladder model of loss development. One of them is that there is no correlation among columns of development factors.

(a) (*4 points*) State four of the other testable implications and how each can be tested.

The following table shows the rankings of the development factors from smallest (rank 1) to largest within each development year of a triangle of claims data.

	Development Factors					
Accident Year	1-2	2-3	3-4	4-5	5-6	6-7
1	1	5	3	3	2	1
2	3	2	2	1	1	
3	2	4	1	2		
4	4	1	4			
5	5	3				
6	6					
7						

Mack proposes a test for correlation among columns that uses Spearman's rank correlation coefficient.

(b) (*3 points*) Demonstrate that the weighted average test statistic is –0.20.

(c) (*1 point*) State the conclusion that should be drawn from the test. Justify your answer.

5. (*4 points*) Two accounts, X and Y, are each exposed to a risk that has five possible outcomes. The five outcomes, the probability of each, and the loss to each account are provided in the following table.

Outcome	Probability	Loss to X	Loss to Y
P	0.80	0	0
Q	0.07	200	100
R	0.02	400	200
S	0.09	500	1,500
T	0.02	1,000	700

- The *z*-score corresponding to the acceptable probability that the actual result will require even more surplus than allocated is 1.5.
- The required return on marginal surplus is 10%.

You are considering adding Account Y to the existing Account X.

(a) (*1.5 points*) Calculate each of the following using the Marginal Surplus method:

(i) The risk load multiplier

(ii) The risk load charged to Account Y

(b) (*1.5 points*) Calculate each of the following using the Marginal Variance method:

(i) The risk load multiplier that produces the same risk load for the combined portfolio as that obtained using the Marginal Surplus method

(ii) The risk load charged to Account Y

(c) (*1 point*) Demonstrate that the Marginal Variance method is not renewal additive.

6. (*5 points*) You are calculating a risk margin for premium liabilities as discussed in "A Framework for Assessing Risk Margins." The following information is provided:

	Premium Liabilities Score	
Potential Risk Indicators	**Motor**	**Home**
1. Confidence in assessment of model goodness of fit	3	4
2. Ability to detect trends in key claim cost indicators	2	4
3. Extent, timeliness, consistency, and reliability of information	2	3
4. Extent of monitoring and review of model and assumption performance	4	5
5. Processes for obtaining and processing data are robust and replicable	5	5
6. Best predictors have been identified	4	6

Score from Balanced Scorecard	Motor CoV	Home CoV
2.0 to 3.0	15.0%	16.0%
3.0 to 4.0	10.0%	11.0%
4.0 to 5.0	8.5%	9.0%
5.0 to 6.0	5.0%	5.5%

	Proportion of Insurance Liabilities	
Line of Business	**Outstanding Claim Liabilities**	**Premium Liabilities**
Motor	20%	10%
Home	30%	40%
Total	**50%**	**50%**

- The correlation between motor and home premium liabilities is 50%.
- Risk indicator weights are equal within each source of internal systemic risk.
- Risk indicator weights for each source of internal systemic risk are:
  - 30% for specification error;
  - 50% for parameter selection error; and
  - 20% for data error.

(a) (*1.5 points*) Define each of the following sources of internal systemic risk:

- Specification error
- Parameter selection error
- Data error

6. Continued

(b) (*2.5 points*) Calculate the internal systemic risk coefficient of variation for premium liabilities for both lines combined.

A reasonable a priori assumption is that similar balanced scorecard scales can be used for both outstanding claim and premium liabilities.

(c) (*1 point*) Provide a situation where this a priori assumption may not hold.

7. (*5 points*) You are constructing Table M for a particular risk with a retrospective rating plan.

(a) (*1 point*) Express the Table M charge, $\varphi(r)$, as an integral, where r is the entry ratio, Y is a continuous random variable representing actual loss in units of expected loss, and $f(y)$ is the probability density function of Y.

Y follows a normal distribution with probability density function

$$f(y) = \frac{1}{0.2\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{y-1}{0.2} \right)^2 \right].$$

The cumulative distribution function of the standard normal distribution has value $\Phi(1) = 0.841$.

(b) (*1 point*) State the fundamental relation connecting $\psi(r)$ and $\varphi(r)$.

(c) (*3 points*) Complete the following Table M for this risk by evaluating the integral from part (a) to complete the second column and using the fundamental relation from part (b) to complete the third column:

r	$\varphi(r)$	$\psi(r)$
0.00	1.000	0.000
0.20	0.800	0.000
0.40	0.600	0.000
0.60	0.402	0.002
0.80		
1.00		
1.20		
1.40	0.002	0.402
1.60	0.000	0.600
1.80	0.000	0.800
2.00	0.000	1.000

8. (*4 points*)

(a) (*0.5 points*) Explain why adjustable features are common in proportional reinsurance treaties.

(b) (*1.5 points*) Illustrate with examples how the following adjustable features work:

(i) Sliding scale commission

(ii) Profit commission

(iii) Loss corridor

The impact of an adjustable feature is best evaluated using an aggregate loss distribution model.

(c) (*1 point*) Identify one disadvantage of each of the following approaches:

(i) Empirical distribution

(ii) Single distribution model

Carryforward provisions complicate evaluation of the impact of adjustable features.

(d) (*0.5 points*) Describe one approach to pricing the impact of a carryforward provision.

(e) (*0.5 points*) Identify one problem with the approach described in part (d).

****END OF EXAMINATION****

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