

Exam ILALPM

Date: Thursday, November 5, 2020

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 10 questions numbered 1 through 10 with a total of 100 points.

The points for each question are indicated at the beginning of the question.

2. 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 provided in this document.

Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel document as directed within each question. Graders will only look at work in the indicated file.
 - a) In the Word document, answers should be entered in the box marked ANSWER within each question. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example, β_1 can be typed as beta_1, and x^2 can be typed as x^2.
 - b) In the Excel document formulas should be entered. For example, $X = \text{component1} + \text{component2}$. Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit.
 - c) Individual exams may provide additional directions that apply throughout the exam or to individual items.
2. The answer should be confined to the question as set.
3. The Word and Excel documents that contain your answers must be uploaded before time expires.

Recognized by the Canadian Institute of Actuaries.

1. (9 points) You are given the following information about Term Co's 5 and 10-year level term life insurance products:

- They are renewable at a higher premium amount beyond the initial level term period pattern
- The issue age range is 18-65
- There is no maximum face amount
- Premium rates per 1,000 do not vary by face amount
- The mortality pricing assumption is based on Term Co experience and varies by gender and attained age

(a) (1 point) Critique the mortality pricing assumption.

ANSWER:

1. Continued

- (b) (4 points) You are given Term Co's 10-year term GAAP results for the prior quarter:

Aggregate Reserve Rollforward	
Beginning of Period Reserves	675,000
Net Premium	370,000
Reserve Released for Maintenance Expenses	(125,000)
Interest Added to Reserves	X
Reserve Released for Death Benefits	(220,000)
Reserve Released for Surrenders	(18,000)
End of Period Reserves	695,500

Actual Experience	
Net Premium	390,000
Investment Income	9,500
Death Benefits Paid	245,000
Surrender Benefits Paid	0
Maintenance Expenses Paid	128,000

- (i) (0.5 point) Calculate X in the Aggregate Reserve Rollforward. Show all work, including writing out relevant formulas used in any calculations.

The response for this part is to be provided in the Excel document.

- (ii) (2.5 points) Create a Source of Earnings analysis for the actual results.

The response for this part is to be provided in the Excel document.

- (iii) (1 point) Determine the expected total variance between actual results and projected valuation results. Show all work, including writing out relevant formulas used in any calculations.

The response for this part is to be provided in the Excel document.

1. Continued

Term Co plans to sell Universal Life (UL) to the same issue ages with face amounts up to one million. Term Co will price this product to achieve the same internal rate of return (IRR) as the 10-year term product. The UL product will use an automated underwriting process for those that qualify (“AUW”). Those that do not qualify for AUW will have identical underwriting as the term product.

(c) (3 points) Describe considerations that should be incorporated into the following term assumptions before they are used to price the UL product:

(i) Mortality

ANSWER:

(ii) Lapse

ANSWER:

(iii) Interest

ANSWER:

(d) (1 point) List considerations when selecting a profitability metric.

ANSWER:

2. (11 points) ABC Life Insurance Company has been selling term products in the U.S. since 1970. Its products have kept pace with the evolution of term products in the market over the years, other than the lack of a conversion option.

- (a) (2 points) Evaluate ABC's plan to set term lapse assumptions for 2020 new business based on ABC's historical lapse experience for the level term and post-level term periods.

ANSWER:

- (b) (4 points) ABC will introduce a conversion option on its term products, allowing policyholders to convert to one of ABC's permanent products before the end of the initial level term period.

- (i) (1 point) Explain how a conversion option benefits the policyholder.

ANSWER:

- (ii) (1 point) State two reasons why companies would offer conversion options on their term products.

ANSWER:

- (iii) (2 points) Explain the advantages and disadvantages of building conversion costs into ABC's term products as opposed to their permanent products.

ANSWER:

2. Continued

- (c) (5 points) ABC's Pricing Actuary has proposed the following assumptions to price the conversion option of its 10-year term product. ABC uses the same mortality rates for term and permanent life business.

Conversion Rate:	6% at the end of each year in years 1 to 10
Post - Conversion Mortality:	120% of ABC's current point-in-scale mortality rates for all conversions in durations 1-10
Lapse rate:	0% in all years
Interest rate:	0% in all years

Additionally, you are given the following for a policy issued at age 50:

Converted face amount = initial face amount = 500,000

$q_{[50]}$	0.0011
$q_{[50]+1}$	0.0014

$$\sum_{t=0}^{\infty} {}_t p'_{[50]+1} * q_{[50]+1+t} = 0.81$$

$$\sum_{t=0}^{\infty} {}_t p'_{[50]+2} * q_{[50]+2+t} = 0.79$$

${}_t p_{[x]+s}$, $q_{[x]+s}$ denote survivorship and mortality for ABC's base mortality assumptions (prior to the conversion offering)

${}_t p'_{[x]+s}$ denotes survivorship of a converted policy

- (i) (3 points) Calculate the expected conversion cost of this policy for conversions in the first 2 durations using ABC's proposed conversion assumptions. Show all work, including writing out relevant formulas used in any calculations.

The response for this part is to be provided in the Excel document.

- (ii) (2 points) Critique the proposed conversion rate and post-conversion mortality assumptions, based on the findings of the *SOA Report on the Conversion Experience Study for Level Premium Term Plans*.

ANSWER:

3. (9 points) DEF Life is switching investment funds backing a Universal Life (UL) product and has narrowed it down to two funds. Both funds use strategic asset allocation (SAA) combined with tactical asset allocation (TAA).

(a) (1 point) Compare SAA and TAA.

ANSWER:

(b) (4 points) You are given that DEF's numerical risk aversion is 4, and the following for the funds under consideration:

	Fund A	Fund B
Expected Return	10%	8%
Historical Return	11%	7%
Standard Deviation of Return	5%	3%

(i) Calculate the utility for each fund. Show all work, including writing out relevant formulas used in any calculations.

The response for this part is to be provided in the Excel document.

(ii) Calculate Roy's safety-first criterion for each fund, assuming the spending rate is 5% and the inflation rate is 2%. Show all work, including writing out relevant formulas used in any calculations.

The response for this part is to be provided in the Excel document.

(iii) Recommend which fund DEF should invest in. Justify your answer.

The response for this part is to be provided in the Excel document.

3. Continued

- (c) (4 points) Both funds include investments in floating rate securities (“floaters”) which back the guaranteed crediting rate offered by the UL product. The floaters are based on a three-month London Interbank Offer Rate (LIBOR) with a floor. Critique the following statements:

A. *The floater’s price is very sensitive to interest rates. The price fluctuation is more sensitive than a fixed coupon bond. A factor that may change the price of a floater is whether the floor is reached.*

ANSWER:

B. *Investing in floaters with a floor is a good strategy if you think that the LIBOR will increase above the guaranteed crediting rate.*

ANSWER:

C. *This portfolio will not face any reinvestment risk because the average duration of the floaters is longer than the duration of the UL guaranteed crediting rate.*

ANSWER:

D. *The duration of floaters will not be impacted by changes in interest rates because floaters adjust their coupon rates based on LIBOR, unless they are reaching the floor.*

ANSWER:

4. (11 points)

- (a) (2 points) Describe two challenges insurers face in modeling policyholder behavior.

ANSWER:

- (b) (3 points) With regard to understanding and modeling policyholder behavior, you are given the following current practices for XYZ insurance company:

Category	XYZ Current Practices
Data collection, analysis, and assumption setting	<ul style="list-style-type: none">• Reviewing company experience analysis• Maintaining an assumption repository for policyholder behavior including information from the administrative system
Modeling	<ul style="list-style-type: none">• Assumptions are owned by each functional group (Pricing, ALM, Valuation)
Validation	<ul style="list-style-type: none">• Model steward validates changes and results at high level
Governance process	<ul style="list-style-type: none">• Based upon resource availability, periodic updates are performed for experience data• Assumption changes are recommended and approved informally within each functional group

Evaluate whether XYZ's current practices are consistent with industry current practices for each category.

ANSWER:

4. Continued

- (c) (3 points) XYZ has completed product development for a new Indexed Annuity product and has experience with a Variable Annuity with a Guaranteed Minimum Withdrawal Benefit (GMWB) product.

Critique the following statements:

- A. *The cost of adding a GMWB rider is typically higher on an Indexed Annuity than a Variable Annuity.*

ANSWER:

- B. *XYZ must hedge a GMWB on an Indexed Annuity using the same approach currently used on the Variable Annuity GMWB.*

ANSWER:

- C. *XYZ can follow basic CARVM reserving, as covered in Actuarial Guideline 33, for the Indexed Annuity.*

ANSWER:

- D. *Because XYZ does not have a clearly defined hedging strategy, it must use the book value of relevant hedging instruments as the basis for its reserving.*

ANSWER:

4. Continued

- (d) (3 points) You are asked to perform a projection of liabilities for XYZ's new Indexed Annuity product and are given:

Indexed Annuity Assumption	Current Data Source	Current Structure (Static or Dynamic)
Surrenders	Company data	Dynamic
Withdrawals	Company data	Static
GLB Utilization	Company data	Static
Annuitizations	Company data	Dynamic

Evaluate the appropriateness of the data source and structure for each of the above assumptions.

ANSWER:

5. (8 points) RST Life Insurance company sells participating (par) life insurance products. The Dividend Actuary at RST recommends that a charge be applied on the dividends paid out to par policyholders.

- (a) (1 point) List the Dividend Actuary's key considerations in determining a reasonable amount of annual contributions to surplus.

ANSWER:

- (b) (1 point) Compare the considerations for the charge applied on dividends for mutual companies versus the charge for profits paid to stockholders for stock companies.

ANSWER:

5. Continued

(c) (6 points) RST's dividend rates from prior years are:

2016	2017	2018	2019
4%	4.5%	4.5%	4.5%

RST's Dividend Actuary has given the following commentary associated with the dividend recommendation of 7% for 2020, which will be paid out in cash:

- *Investment returns outperformed previous years.*
- *Lapse assumption is currently determined based on the company's experience results. It follows a static structure for all par life insurance products.*
- *Lapses have been very high in previous years but they have reduced considerably this year; this will be considered for future dividend setting.*
- *Mortality assumptions are currently determined based on the RST's own experience. A new mortality study was released this year which will be applied to reserves in the next year. The dividend rate has been reduced to smooth the results for next year's dividend.*
- *As a result of this expected change in the mortality assumption, there will be changes made to the policy rating system, which are expected to offset any resulting decrease in future dividends.*
- *RST entered into a new reinsurance contract this year which has ceded away a portion of the mortality risk. The pricing team has taken this into consideration for future pricing, but dividends have not been adjusted in response.*

Critique the recommended dividend rate based on the commentary above.
Propose changes to any assumptions if necessary.

ANSWER:

6. (11 points) Life Co is a life insurance company exploring various reinsurance options for its life insurance business. Life Co's management has the following company objectives for the current year:

1. Reduce capital,
2. Expand into the annuity business,
3. Achieve expense efficiencies, and
4. Mitigate mortality exposure.

(a) (4 points) Compare the effectiveness of the following types of reinsurance for each of the company's objectives.

(i) YRT

ANSWER:

(ii) Coinsurance

ANSWER:

(iii) Modified Coinsurance

ANSWER:

(iv) Funds Withheld Coinsurance

ANSWER:

6. Continued

- (b) (7 points) Life Co is entering a Mod-Co reinsurance arrangement with Reinsurance Inc.

Life Co	Year 1	Year 2
Premiums	2,000	0
Expenses	50	10
Commissions	250	0
Reserves	1,500	1,800
Benefits Paid	0	50
Investment Income	10%	10%
Reinsurance Co.	Year 1	Year 2
Allowance	10%	10%
Mod-Co Interest Rate	5%	5%

- (i) (4 points) Construct Life Co's Gain from Operations statement for years 1 and 2 under the reinsurance agreement.

The response for this part is to be provided in the Excel document.

- (ii) (3 points) Construct Reinsurance Inc's Balance Sheet for years 1 and 2 under the reinsurance agreement.

The response for this part is to be provided in the Excel document.

7. (11 points)

(a) (4 points) You are given the following about GHI Financial:

- GHI sells a UL product crediting the London Interbank Offered Rate (LIBOR) semi-annually to policyholders.
- GHI holds a 3-month British Pound to Japanese Yen cross currency swap indexed at LIBOR
- GHI holds an overnight index swap receiving a fixed interest rate and paying LIBOR
- GHI holds a 6-month interest swap paying LIBOR and receiving a fixed rate semi-annually

(i) (2 points) Evaluate the considerations GHI should take when moving from LIBOR to the Secured Overnight Financing Rate (SOFR) for each item above.

ANSWER:

(ii) (2 points) Propose changes needed to apply SOFR for each item above.

ANSWER:

7. Continued

- (b) (2 points) Critique the following statements about the 6-month interest rate swap. Justify your answer.

A. *The swap was entered into through an exchange.*

ANSWER:

B. *The notional amount of the interest rate swap is the amount paid upon agreement of the swap.*

ANSWER:

C. *The timing of cash flows for both the fixed-rate payer and floating-rate payer must be the same.*

ANSWER:

D. *The way interest accrues for each period of the transaction are the same for the fixed-rate and floating-rate payments.*

ANSWER:

7. Continued

- (c) (5 points) You are given the following information about the 6-month interest rate swap paying LIBOR and receiving a fixed rate quarterly:

Notional Amount	1,000,000
Swap Settlement Date	June 1, 2020
Swap Arrangement	Financial Settlement of the swap
Swap Spread	15 basis points
3-Month LIBOR on June 1, 2020	4.05%
Price of 3-Month Eurodollar Futures Contract settling on November 30, 2020	95.85
Annual forward rate on June 1, 2020	4.5%
Annual forward rate on September 1, 2020	4.75%

Calculate the following for the interest rate swap. Show your work, including writing out the relevant formulas used in any calculations.

- (i) (4 points) The swap rate

The response for this part is to be provided in the Excel document.

- (ii) (1 point) The payments due to GHI at August 31, 2020 and November 30, 2020.

The response for this part is to be provided in the Excel document.

8. (12 points) You are given:

- JKL Life’s 20-year term policies, issued 5 years ago, have a guaranteed level premium for 10 years followed by annually renewable premiums for 10 years.
- JKL’s earnings projection under each of the following bases from a portfolio of JKL’s inforce term policies issued 4 years ago (i.e., policy year 1 is based on actuals and years 2 through 20 are projections based on pricing assumptions at issue):

Policy Year	US Statutory (CRVM)	US GAAP	CALM	Market Consistent (Solvency II)
1	(24,641)	1,534	8,483	2,368
2	(4,424)	1,546	432	4,192
3	1,932	1,621	616	3,358
4	1,744	1,718	797	2,316
5	3,580	1,738	869	2,015
6	6,038	1,734	912	1,895
7	7,192	1,768	991	1,401
8	8,749	1,800	1,059	871
9	8,626	1,843	1,129	160
10	20,081	(1,176)	(760)	(1,963)
11	(335)	1,148	740	290
12	598	736	483	157
13	181	651	428	124
14	125	630	413	113
15	95	615	402	105
16	74	616	400	99
17	96	621	401	95
18	102	620	398	89
19	145	616	393	84
20	1,900	587	372	77

8. Continued

- (a) (4 points) JKL's actual experience from this block shows higher mortality than expected in the first 5 years. Assume the earnings are projected again with slightly higher expected mortality rates for years 6 to 10.

Identify which of the following will have the higher expected change in earnings in year 6:

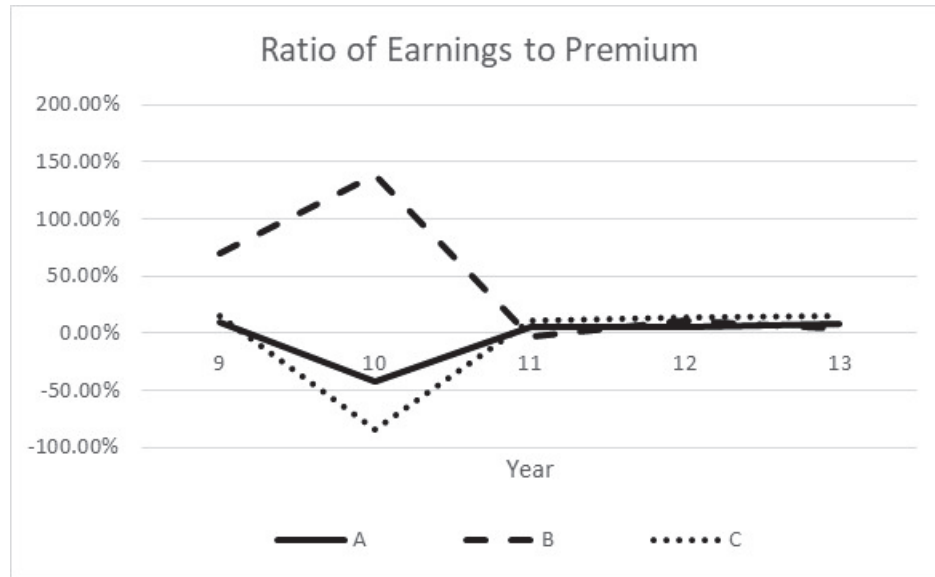
- A. US Statutory
- B. CALM

Justify your answer.

The response for this part is to be provided in the Excel document.

8. Continued

- (b) (3 points) You are given the follow graphs of the annual ratio of earnings to premium projections for years 9-13 assuming that only the pricing shock lapse rate was lowered in year 10 by one third:



Assume the product has no surrender value.

Identify which graph corresponds with each of the following methods:

- (i) US GAAP
- (ii) US Statutory
- (iii) CALM

Justify your answers.

ANSWER:

8. Continued

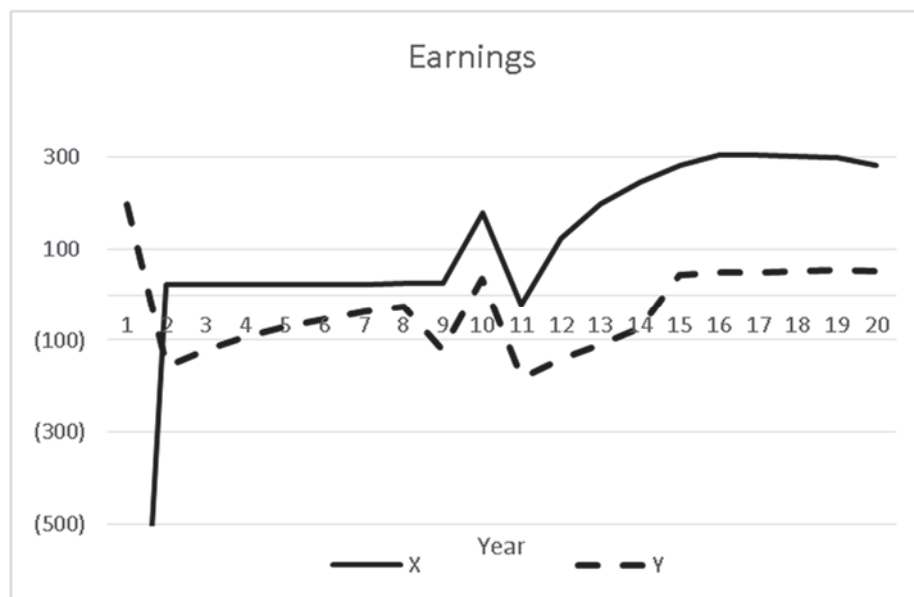
- (c) (5 points) JKL's inforce was priced based on the Traditional Approach of a jump to YRT premiums at the end of the level term period. JKL just completed re-pricing based on CALM and Solvency II using the Graded Approach. Under this approach, the post-level-term (PLT) YRT rates will increase gradually over 5 years jumping to the original YRT schedule in year 16.

The following were the pricing assumptions used for the Traditional and Graded Approaches:

Assumptions	Traditional Pricing	Graded Premium Re-Pricing
Premium (Yr 11+) (% 2015 VBT*)	300%	Grade from 100% to 300% in years 11-16
Mortality (Yr 11+) (% 2015 VBT)	300%	Grade from 100% to 300% in years 11-16
Shock Lapse Rate (Yr 10)	85%	50%
Post Level Lapse Rates (Yr 11+)	Grade to 10% in year 14	
CALM Mortality and Lapse PfADs (Yr 11+)	10%	10%
Risk Margin	50% years 1-9, 200% in Years 10+	Grade from 50% to 200% in years 9-15

* Valuation Basic Table

You are given the following results for the repricing compared to the traditional pricing:



8. Continued

(i) (2.5 points) Identify which graph corresponds with each of the following methods:

- CALM
- Market Consistent (Solvency II)

Justify your answers.

ANSWER:

(ii) (2.5 points) Recommend which of the two pricing approaches you would use to calculate the PLT premiums under each of the following valuation bases:

- CALM
- Market Consistent (Solvency II)

Justify your answers.

ANSWER:

9. (8 points) Friendly Annuity Company (FAC) sells a single premium deferred annuity with no surrender charges through independent financial advisors. FAC is a highly-rated company, which has significant capital for stress scenarios but does not have an explicit policy regarding cash flow needs. FAC's strategic asset allocation is:

Asset Class	Target Allocation
Treasury Bonds	15%
Agency Mortgage-Backed Securities	30%
Corporate Bonds	30%
Cash	10%
Real Estate	15%

- (a) (1 point) Rank FAC's asset classes from most to least liquid. Justify your ranking.

ANSWER:

- (b) (4 points) Propose changes to improve FAC's liquidity risk management.

ANSWER:

9. Continued

(c) (3 points) Critique the following statements:

A. *Due to current economic conditions, Treasury bonds will outperform corporate bonds over the next six months. While long term expectations are well grounded, FAC needs an immediate revision to its strategic asset allocation to take advantage of the current pricing anomaly.*

ANSWER:

B. *Mortgage-backed security valuation requires sophisticated modeling of prepayment rates. FAC has built a model with 53 parameters that fits historical data almost perfectly, which gives a significant advantage over the market.*

ANSWER:

C. *Adding Real Estate to FAC's strategic asset allocation improves risk diversification and increases the liquidity and Sharpe ratio of the portfolio.*

ANSWER:

- 10.** (10 points) LMN Life Insurance Company is updating assumptions for a block of 5-year level term life insurance which is annually renewable after year 5. You are given:

Policy Year	No. of Policies at beginning of policy year	Actual No. of lapses during the policy year
4	8,900	372
5	8,300	7,835
6	450	394

Current Assumption:

Policy Year	Expected Lapse Rate
1	1%
2	2%
3	3%
4	4%
5	90%
6	80%
7+	20%

- (a) (2 points)

- (i) Describe the pricing goals for the “shock” premium rate for year 6.

ANSWER:

- (ii) Calculate the 95th percentile confidence interval of the policy year 5 lapse rate. Show all work, including writing out relevant formulas used in any calculations.

The response for this part is to be provided in the Excel document.

- (b) (2 points) Recommend lapse assumptions for policy years 5 and 6 for the upcoming product repricing. Justify your assumptions.

The response for this part is to be provided in the Excel document.

10. Continued

- (c) (2 points) LMN is developing lapse assumptions for a new 10-year level term product, which is annually renewable after year 10. LMN has not sold 10-year level term products in the past. The Pricing Actuary has set the 10-year level term lapse assumptions based on the 5-year level term experience

Critique the Pricing Actuary's lapse assumption.

ANSWER:

- (d) (4 points) The experience studies actuary recommends use of a predictive analytics model to develop lapse experience studies for the 5 year and 10 year level term products instead of LMN's traditional approach.

- (i) (2 points) Describe the different methods and steps used in developing a predictive analytics model versus LMN's traditional approach for experience analysis studies.

ANSWER:

- (ii) (2 points) Evaluate the actuary's recommendation. Justify your answer.

ANSWER:

****END OF EXAMINATION****