1. **Learning Objectives:**
   1. The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

**Learning Outcomes:**
(1o) Describe how taxes may be treated in a pricing model and the impact of tax reform on life products profitability.

**Sources:**
Taxes, Ch. 9, Life Insurance Products and Finance, Atkinson and Dallas

Profit Measures and Analysis, Atkinson and Dallas, Ch. 11 - pp. 499-502

Tax Reform Impacts on Life Pricing and Profitability, Milliman,

**Commentary on Question:**
Commentary listed underneath question component.

**Solution:**
(a) Calculate the 2018 tax on earnings.

**Commentary on Question:**

Part (a) tested candidates’ understanding of how taxes are calculated, which is needed for part (b). Candidates generally did well on part (a) with many candidates receiving full credit or only minor deductions.

The most common point of confusion was differentiating between pretax solvency earnings and taxable earnings, with some candidates using pretax solvency earnings as the basis for taxes. Candidates generally used Method 1 for calculating taxable earnings.

(Method 1): Calculate Taxable Earnings Directly

Taxable Earnings = Premiums - Benefits - Expenses + Investment Income - Investment Income x Non-taxable Investment % - Tax Reserve Increases

= 27000 - 12000 - 9000 + 2800 x (1 - 0.32) - (79250 - 75000)

= 3654
1. Continued

(Method 2) Calculate Taxable Earnings from Pretax Solvency Earnings

Pretax Solvency Earnings (shown in part (b)) = 7300

Timing Difference = Solvency Reserve Increase – Tax Reserve Increase
= (92500 - 91000) - (79250 - 75000)
= -2750

Permanent Difference = - Investment Income x Non Taxable Investment Proportion
= -2800 x 32%
= -896

Taxable Earnings = Pretax Solvency Earnings + Timing Difference + Permanent Difference
= 7300 - 2750 - 896
= 3654

Calculate Tax Amount
Tax = Earned Tax Rate x Taxable Earnings
= 0.21 x 3654
= 767.34

(b) Calculate the 2018 distributable earnings.

Commentary on Question:
Part (b) required the result from part (a) to calculate distributable earnings. Thus, candidates were not penalized again if they incorrectly calculated the tax amount in part (a) but applied it correctly in part (b). Candidates generally did well on part (b) with many receiving full credit or only minor deductions.

Some candidates correctly calculated the tax amount in part (a) and then incorrectly recalculated the tax amount in part (b) by using pretax solvency earnings as the basis. This resulted in minor deductions for that component within this part.

Pretax Solvency Earnings = Premiums - Benefits - Expenses + Investment Income - Solvency Reserve Increases
= 27000 - 12000 - 9000 + 2800 - (92500 - 91000)
= 7300

After Tax Solvency Earnings = Pretax Solvency Earnings – Tax
= 7300 - 767.34
= 6532.66
1. Continued

\[\text{Distributable Earnings} = \text{After Tax Solvency Earnings} - \text{Required Capital Increase} + \text{After Tax Investment Income on Required Capital}\]

\[= 6532.66 - (2215 - 2000) + 180 \times (1 - 0.21)\]

\[= 6459.86\]

(c) Critique the following statements made by the Chief Actuary of the Company with regard to the 2017 Tax Cut and Jobs Act (Tax Reform)

(A) “The company is anticipating a significant tax benefit due to the tax reform rate change. However, this is largely offset by the RBC, DAC tax and tax reserve changes.”

(B) “In addition, the tax reform impact on the company will not vary by product groups or blocks of business.”

Commentary on Question:
Quality of the responses varied on this part, and candidates generally didn’t do as well. Candidates needed to properly critique each statement to get full credit. Simply stating (A) is accurate and (B) is inaccurate, while rehashing information given in the question was only enough for partial credit.

Leeway was given to how candidates interpreted “largely offset” in statement (A), as it depended on the type of product. If candidates could correctly confirm and comment on the general direction of each of the four main changes, full credit was given.

(A)

This statement is generally accurate. The impact of the 2017 Tax Cuts and Jobs Act on profitability varied by type of product. For the products studied in the reading, the impact was generally slightly positive, however the overall impact depended on the sum of the combined impacts of the following key changes:

(i) The increase in the proxy DAC amortization period and increase in proxy DAC tax rate had a negative impact on profitability

(ii) The new 92.81% of stat reserves methodology for calculating tax reserves had a negative impact on profitability

(iii) The reduction in the federal income tax rate from 35% to 21% had a positive impact on profitability

(iv) The increase in RBC factors by \((1 - .21) / (1 - .35)\) had a negative impact on profitability
1. Continued

This statement is inaccurate. The impact of tax reform varies by product, and the overall impact to the company will depend on the company’s product mix. Different product features may make one product more sensitive to one of the tax law changes compared to other products. For example, the magnitude of the impact would differ for products with different (premium) funding levels. Also, within a given product type, different valuation methods a product is subjected to may cause it to be more or less sensitive to the tax law change. For example, the same Term type product valued under AG48 will observe a significantly larger (magnitude wise) impact due to the tax reform changes compared to the same product valued under VM20.
2. Learning Objectives:
5. The candidate will understand the role of the Investment Actuary and the Portfolio Management Process in the Life Insurance company context, as well as the common forms of Fixed income securities and their uses, and the methods and processes used for evaluating portfolio performance and asset allocation.

Learning Outcomes:
(5b) Describe and evaluate how a company's objectives, needs and constraints affect investment strategy and portfolio construction (including capital, funding objectives, risk appetite and risk return tradeoff, tax and accounting, accounting considerations, and constraints such as regulation, rating agency ratings and liquidity.

(5c) Describe and assess the role of and significant considerations related to the design and function of asset allocation strategies.

(5h) Describe and apply conventional yield metrics used in bond performance evaluation.

(5i) Describe the attributes of US Treasuries, Agency Debt Securities, Municipal bonds, Corporate bonds, Private Money Market securities, Floating Rate Agreements, Agency Mortgage Backed securities, Agency Collateralized Mortgage securities, Interest Rate Swaps and Swaptions, Credit Derivatives and High Yield Bonds, and the markets they are traded in.

Sources:
The Handbook of Fixed Income Securities, Fabozzi, 8th Ed, Chapters 9, 11, 12, 16, 25, 62
Managing Investment Portfolios, Magnin and Tuttle, Chapters 5 and 6

Commentary on Question:
Commentary listed underneath question component.

Solution:
(a)
(i) Rank NIN’s current holdings from least to most credit default risk. Justify your ranking.

(ii) Assess how the ranking would change if based on expected yield in a normal yield curve environment. Justify your answer.
2. Continued

**Commentary on Question:**

For (a)(i), candidates generally did well with this question ranking the securities in the proper order, although very few got the exact order in order to receive the full credit. Candidates did very well with the justification since the question itself provided features of each security. Further explanation was required for full credit, though.

For (a)(ii), candidates generally did well in explaining how yield is impacted by the term to maturity or by a higher credit risk. Very few candidates related liquidity to the impact on yield, however.

Part (a)(i) asked the candidates to rank NIN Life’s current asset holdings from least to most credit default risk, and to justify their ranking.

- This question tested the candidates’ knowledge of different types of fixed income securities and required them to relate the features of these securities to their credit default risk.
- To receive full credit, the candidate needed to rank the securities in the correct order and provide justification for their ranking.

The correct order for “least to most credit default risk”, along with justification that would have received full credit, is:

1. Treasury Bond – Issued by the US Government, is generally considered risk-free
2. Mortgage Backed Security – guaranteed by Fannie Mae, which has an implied guarantee from the US Government. This is not entirely risk-free but it is generally considered less risky than an asset rated AAA.
3. Commercial Paper – Since this is rated AAA, this is the highest credit rating available for a corporate asset
4. Swap – This is rated AA, so it is lower than AAA, but it is still considered an investment grade asset.
5. Municipal Bond – Since this is rated MIG3, this is the lowest investment grade of municipal bonds.
6. Bond – The BB rating is considered a non-investment grade, so this has the most credit default risk.

Part (a)(ii) asked the candidates to assess how the ranking of the securities would change if it was based on the expected yield in a normal yield curve environment.

- This question tested the candidates’ knowledge of the impact on asset features to the expected yield.
2. Continued

- To receive full credit, the candidate needed to rank the securities in the correct order and provide justification for their ranking. Justification required that the candidate relate yield to credit risk, duration and liquidity. In particular, it required mention of the following:
  - Credit (High Credit Risk = Higher Yield, or vice versa)
  - Liquidity (High Liquidity = Lower Yield, or vice versa)
  - Duration (Higher Term to Maturity = Higher Yield, or vice versa)

The correct order for “least to most credit default risk” based on expected yield in a normal yield curve environment, along with justification that would have received full credit, is:
1. Commercial Paper – Low Duration, Low Credit Risk, Moderate Liquidity
2. Municipal Bond – Medium Duration, Moderate Credit Risk, Better Liquidity than Corporate Bond
3. Bond – Medium Duration, High Credit Risk, Low Liquidity will increase yield
4. Treasury Bond – High Duration, Risk-free
5. Swap – High Duration, Low-risk
6. Mortgage Backed Security – High Duration, Low-risk, yield tends to be higher than comparable duration securities because of pre-payment risk

The main factor in the ranking was the term to duration, but for those securities that had similar duration, the credit rating and liquidity would also need to be considered to achieve the final ranking.

(b) Explain four possible reasons the 10-Year swap may have a lower yield-to-maturity than the 10-Year Treasury Bond.

**Commentary on Question:**
*Candidates generally performed poorly in identifying suitable reasons why the swap might have a lower yield than the treasury bond.*

Part b) asked the candidates to explain four possible reasons why the 10-Year swap may have a lower yield-to-maturity than the 10-Year Treasury Bond. To receive full credit, candidates needed to identify four suitable reasons why the swap might have a lower yield than the treasury bond, and provide justification for each of the four reasons.

Possible suggestions and justifications for why the swap could have a lower yield were:
- Liquidity: In particular, there is more demand for receive-fixed vs pay-fixed, which drives down the receive-fixed yield.
- Collateral: since swaps are mark-to-market, there is virtually no loss on default.
- With no default risk, the yield would be lower
2. Continued

Regulatory considerations: The floating arm of the swap is based on LIBOR, which is being discontinued. Companies may be willing to accept a lower fixed rate if they expect the floating rate payment under the LIBOR replacement to be lower.

Shape of the yield curve: related to the market’s expectations of the future interest rates

Hedging costs: the spread between the LIBOR and the appropriate repo rate

(c) Propose two adjustments to NIN’s holdings or strategic asset allocation for each of the following:

(i) Achieve a yield of 0.5% above the risk-free rate to support product pricing assumptions

(ii) Minimize credit risk, especially default risk

(iii) Minimize interest rate risk by matching asset and liability durations

(iv) Maintain sufficient liquidity to make liability payments as they come due

Commentary on Question:

*Overall, most candidates did well on this question. At a minimum, most candidates were able to propose at least one adjustment for each part of this question.*

Part (c)(i) tested the candidates’ ability to identify ways to achieve a yield higher than the risk-free rate.

- Possible solutions were:
  - Shifting treasuries to riskier credit assets to achieve a higher yield
  - Investing in more private placement corporates that decreases liquidity but generally would achieve a higher yield.
  - Investing in longer duration assets, since longer assets generally achieve a higher yield.
  - Adding equities or alternative non-fixed income assets to achieve a higher yield.

Candidates generally did well with this question of identifying that NIN should invest in assets with a higher credit risk to achieve a higher yield. A decent number of candidates also suggested investing in more corporates or investing in longer duration assets.
2. Continued

Part (c)(ii) tested the candidates’ ability to identify ways to minimize credit risk, and especially default risk.
- Possible solutions were:
  Investing in assets with higher credit ratings
  Using credit default swaps to control the risk
  Using exchange-traded swaps instead of swaps with a direct counterparty
  Diversifying to more individual issuers
Candidates generally did well with identifying that NIN should invest in assets with higher credit ratings in order to minimize risk. A decent number of candidates also suggested using credit default swaps to control the risk.

Part (c)(iii) tested the candidates’ ability to identify ways to minimize the interest rate risk by matching asset and liability durations.
- Possible solutions were:
  Hedging key rate durations instead of overall duration for tighter matching
  Reducing the use of Mortgage Backed Securities, which are less predictable and have negative convexity, causing more challenges with hedging the risk
  Rebalancing the hedging more frequently

Most candidates made mention of purchasing a swap to minimize the interest rate risk. A decent number of candidates mentioned rebalancing hedging more frequently. A decent number also mentioned matching the duration of the assets with the liability. Credit was not given for this as it basically was a repeat of the question.

Part (c)(iv) tested the candidates’ ability to identify ways to maintain sufficient liability in order to be able to make liability payments as they come due.
- Possible solutions were:
  Utilizing Treasuries and Mortgage Backed Securities more, and corporates less.
  Invest primarily in on-the-run securities instead of off-the-run securities
  Only utilize marketable bonds and not private placements

Most candidates suggested holding more cash and short term treasuries, which did provide credit to the candidates.
3. **Learning Objectives:**

3. The candidate will understand common issues and practices related to In Force and New Business Product Management, and how experience studies are designed and used for evaluating past experience and for setting assumptions.

5. The candidate will understand the role of the Investment Actuary and the Portfolio Management Process in the Life Insurance company context, as well as the common forms of Fixed income securities and their uses, and the methods and processes used for evaluating portfolio performance and asset allocation.

**Learning Outcomes:**

(3d) Describe and evaluate the challenges insurers face in a low and potentially rising interest rate environment.

(5g) Describe the principles of Liquidity Risk Management in an insurance company portfolio management context.

**Sources:**
Liquidity Risk Management Best Risk Management Practices, CRO Forum, 2008, Sections 1 to 5.8

Interesting Challenges for Insurers, Fenton, Scanlon, Iyers - Product Matters, June 2012, pp. 10 - 16

**Commentary on Question:**
The goal of this question is to assess the candidate's understanding of liquidity risk management in an insurance company portfolio management context, as well as other types of challenges (such as interest rates) facing life insurers nowadays. The candidate should be able to demonstrate strong understanding of liquidity risk and best risk management practices, as well as potential business strategies in dealing with other types of stress scenarios.

**Solution:**

(a) List four objectives of a company’s liquidity risk policy.

**Commentary on Question:**
Candidates generally did well on this question and were able to list appropriate liquidity risk policy objectives. Appropriate answers not in the solution below were also given credit.

1) Define liquidity adequacy in the context of the company's risk philosophy and tolerances.
2) Define the degree to which the company will expect to rely on external cash sources versus self-funding liquidity needs should be clearly described.
3) Specify minimum standards that the company must meet to consider itself to be adequately protected from liquidity risk.
4) Specify how frequently liquidity adequacy is to be measured.
3. Continued

(b) Describe product design features that will mitigate liquidity risk for the new SPUL product.

**Commentary on Question:**

Candidates were generally able to identify product design features, but struggled to describe how the product features would mitigate liquidity risk.

To mitigate liquidity risk, the new SPUL product can incorporate various features. Since single premium UL generally has a high account value, policyholders are more likely to utilize withdrawal options (such as partial or full surrenders, policy loans). These withdrawals are a significant source of liquidity risk, so product design features should encourage the preservation of customer balances by managing claims concentration.

Examples of some of the product features that could mitigate liquidity risk are surrender charges or a market-value adjustment to discourage withdrawals, a persistency bonus to encourage preservation of account value, or additional underwriting requirements to manage claims concentration in early years.

(c)

(i) Evaluate the appropriateness of assessing liquidity risk using only the 3 month liquidity stress scenario. Show your work.

(ii) Recommend next steps to manage potential liquidity risk for this product based on the output of the stress scenario.

(iii) Describe four additional stress scenarios that TEN Life could use to identify liquidity risk.

**Commentary on Question:**

Candidates generally did well on this question. For part ii, candidates struggled to relate the stress scenario output to liquidity risk. For part iii, some candidates did not explain how the stress scenarios would identify liquidity risk. Appropriate answers not in the solution below were also given credit.

(i) Using only the 3-month stress scenario is generally not a long enough time horizon to evaluate liquidity risk. To evaluate the liquidity risk, one can look at the Liquidity Coverage Ratios in month 3, 6, and 12.

\[
\text{Liquidity Coverage Ratio} = \frac{\text{Projected Cash Sources}}{\text{Projected Cash Needs}}
\]

3-month Stress Scenario: \((15+0.25+1)/(10+0+4.5) = 112\%\)

6-month Stress Liquidity Coverage Ratio: \((20+0.25+1.5)/(15+0+6) = 104\%\)
3. Continued

1-year Stress Liquidity Coverage Ratio: \( \frac{35 + 0.25 + 2}{45 + 0 + 8} = 70\% \)

Therefore, the statement is not appropriate because testing the 3 month liquidity stress scenario would have missed the 1-year time horizon coverage ratio falling below 100%. Furthermore, the ratio suggests that the company does not expect to be able to fund its cumulative Cash Needs over that time horizon, under that scenario.

(ii) As shown from part i), the 1-year stress scenario falls below 100%. The main driver of the decrease in the 1-year ratio appears to be the spike in claims during the second half of the year. More analysis should be completed to understand the results and ensure appropriate management.

Firstly, follow up with the company expert who contributed to developing the company-specific stress scenario to understand what products are driving this increase in mortality and the concentration of business in those products. Second, follow up with Experience Studies regarding drivers of this increase in projected mortality. Finally, contact the liquidity management team to understand their contingency plan for selling assets and/or preserving product balances.

(iii) 1) Non-parallel shifts in rates due to tilts and bends in the yield curve(s), such that asset-liability gaps at various maturities may be exposed to different shocks and "risk concentrations" may be exposed

2) Disintermediation scenario, in which a sudden material rise in interest rates triggers heightened withdrawal activity and lower expected prepayments on interest sensitive assets

3) Catastrophic claims scenario, in which one or several catastrophic events leads to unprecedented demands for cash over a short period of time

4) Impaired markets scenario, in which it assumes "frozen capital markets" for all asset classes except for the highest quality and most liquid, such as government bonds

(d) Propose two SPUL product design strategies that can help mitigate interest rate risk. Justify your answer.

Commentary on Question:
Candidates generally did well on this question. Some candidates confused liquidity risk with interest rate risk and did not receive credit for liquidity risk mitigation strategies. Responses that were appropriate but not listed below were also given credit.
3. **Continued**

1) Reduce the minimum guaranteed crediting rate. When minimum guaranteed crediting rate is too high, TEN Life may have difficulty in finding assets to support a high crediting rate. It would significantly impact TEN Life’s profits.

2) Create a more flexible/dynamic product design. This would involve moving products that contain locked-in features to a design that allows them to change product features based on movement in interest rates (such as a market value adjustment)
4. **Learning Objectives:**

1. The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

3. The candidate will understand common issues and practices related to In Force and New Business Product Management, and how experience studies are designed and used for evaluating past experience and for setting assumptions.

**Learning Outcomes:**

1j) Describe the operation of Life Acceleration Riders and their role in meeting market needs.

1o) Describe how taxes may be treated in a pricing model and the impact of tax reform on life products profitability.

1q) Describe and evaluate the types of assumptions commonly used in actuarial pricing and product development.

3e) Describe and evaluate how diversification of insurance risks can reduce volatility.

**Sources:**

Understanding the Volatility of Experience and Pricing Assumptions of LTC, SOA Research 2014, pp. 4 - 46

Quantification of the Natural Hedge Characteristics of Combo Life or Annuity Products Linked to LTC Insurance, SoA Milliman - 2012, pp. 9 - 35

Life Insurance Acceleration Riders, Fillmore, SoA Reinsurance News, 2013, pp. 35-38

**Commentary on Question:**

*This question tested the candidates’ understanding of various risks associated to LTC products and how these risks are mitigated by a combo life-LTC design. Parts a and c of this question was answered reasonably well by candidates, although many candidates struggled in part b in the application portion of understanding the impact on profitability based on changes in pricing assumptions.*

**Solution:**

(a) For each of the following:

- Process Risk
- Parameter Risk
- Economic Scenario Risk
4. Continued

(i) Define each risk.

(ii) Describe the causes and contributing factors of each risk specific to long-term care insurance.

(iii) Describe the level of each risk for long-term care insurance. Justify your answer.

(iv) Evaluate how each risk is impacted by adding the long-term care rider to a life insurance product.

Commentary on Question:
To receive full credit, candidates were required to explain each risk and how it is impacted from a long-term care (LTC) product perspective. Common mistakes were not properly identifying (1) that economic scenario risk is a high level risk for LTC products and (2) that introducing LTC to a life insurance product would increase the overall economic scenario risk. Most candidates failed to recognize that the long duration of LTC products is the key driver for economic scenario risk. Some candidates also failed to identify that process risk becomes small over the long run, and that parameter risk remains high because it cannot be diversified away. Partial marks we given for other reasonable answers.

(i) Process Risk is the risk of how events/probabilities unfold over time even if assumption distributions are known perfectly.

Parameter Risk is the uncertainty in the parameters of distribution of assumptions/events.

Economic Scenario Risk is the uncertainty in future interest rates / investment income, especially results that differ from what is expected in pricing/valuation.

(ii) Process Risk
The process risk is driven by the following items;
- Probability of distributions that drive mortality, morbidity, and lapse, where the actuals could occur differently than assumed
- Type of benefits, where maximum lifetime caps or stricter requirements to make claims mean less risk
- Number of policies, where more policies mean less risk
- Demographics, where underwritten policies have less risk
- Length of policy, where longer duration means lower risk
4. Continued

Parameter Risk
Parameter risk is driven by either sampling risk, data bias or model misspecification:

- Sampling Risk: for LTC, much of the risk is concentrated at the extreme ages for which there is little historical (sample) data, sampling risk can be especially high at those ages.
- Data Bias: for LTC, we do not know what future mortality and morbidity will look like. If mortality continues to improve, it is unclear if the additional years of life will be healthy. This could potentially lead to longer periods of care.
- Model Misspecification: Since LTC is a new product, we do not have sufficient data or understanding of true causes of underlying risks.

Economic Scenario Risk
Duration is a key contributing factor for economic scenario risk because LTC is a long duration product. For relatively short liability horizons, interest rate risk can be mitigated by asset portfolio management. However, asset portfolio management can become less effective when the duration of the liabilities is very long.

(iii) Process Risk
This risk can cause high volatility over a short-period of time but averages to low risk in the long-run (this is due to the law of large numbers).

Parameter Risk
This is high risk because an incorrect assumption can not be diversified away.

Economic Scenario Risk
This is high risk because nearly half of LTC benefits are funded by earned interest (rather than net premiums). Given the fact that uncertainty regarding future interest rates cannot be diversified away, the risk and uncertainty about this aspect of the product is crucial.

(iv) Process Risk
This risk should be greatly reduced by the combo product because benefit payments will be more predictable. We expect either LTC or life insurance to payout at some point, so the risk is related to timing rather than amount. The policy duration gets longer, so less process risk over longer timeframe.
Sales might be higher, so less risk when diversified across more policies. Underwriting may be better for life insurance, so risk may be lower.
4. Continued

**Parameter Risk**
This risk should be reduced by the combo product because there is more data to estimate parameters accurately. Life insurance products have been around longer and more data is available to quantify mortality rates. Lapse rates should be lower and more predictable because there is less incentive to lapse. There is less impact from getting a morbidity assumption wrong because disability benefits are only a portion of total benefits.

**Economic Scenario Risk**
This risk will increase by the combo product because the duration of the product will be longer. There is more economic uncertainty in the long-run so a longer product has more economic risk since pricing and valuation will be highly impacted by change in long-term interest rates / investment income.

(b) Evaluate the impact to the overall profitability of Product X if increases were made to the following pricing assumptions:

(i) Mortality for disabled lives

(ii) Mortality for active lives

(iii) Lapse rates for active lives

(iv) Incidence rates for active lives

**Commentary on Question:**
*In general, many candidates struggled with this question by not considering profitability impacts on both the base life insurance policy and the LTC rider. Most candidates understood the different direction of impacts to Life and LTC products but did not mention that the profitability of the combined product relies on their weighting.*

(i) Higher disabled lives mortality usually leads to higher profits. Disabled lives mortality rates act much like a policy lapse, as they end not only the current claim, but the entire policy.
4. Continued

(ii) LTC benefits from higher mortality due to lower claims for deaths before disability. Life insurance benefits from lower mortality due to lower claims. The effects of increasing active life mortality will vary based on the weights of the life insurance benefit and the LTC benefit. If LTC outweighs the life insurance benefit, then increasing active life mortality will increase the profit, and vice versa. Policy design features such as linking benefits to inflation or richer extension of benefit beyond the insurance face amount will increase the weight of LTC benefits.

(iii) LTC is typically lapse-supported (especially at later durations) and profits will increase from higher lapses. Life insurance is typically persistency-supported, and profits will decrease from higher lapses. The effects of increasing lapse rate will vary based on the weights of the life insurance benefit, the LTC benefit, and the duration of the policy. Higher LTC weight / later duration will result in higher profits from lapse.

(iv) Increase in morbidity incidence rates for active lives will increase payouts on LTC rider, decreasing profit. Disabled life mortality tends to be higher, so higher morbidity will increase mortality and thus increase life insurance payouts, decreasing profits.

(c) Critique the following statements:

(i) HLC could reduce acquisition expenses and streamline the underwriting process for Product X by only underwriting the life insurance application.

(ii) HLC could increase future sales by allowing life insurance policy holders to add the long-term care rider, without underwriting, while their life insurance policy is inforce.

(iii) HLC could limit risk for a long-term care rider by adding a restriction that the loss of activities of daily living must be expected to be permanent.

(iv) HLC could increase sales by adding a critical illness rider that accelerates a portion of the face amount if the policyholder has a life expectancy of less than 12 months.

Commentary on Question:
Most candidates were able to accurately identify the reasonability of the first three statements. In general, many candidates struggled identifying the difference between a critical illness rider and terminal illness rider.
4. Continued

(i) This is not a reasonable suggestion. Although limiting the underwriting to the application may reduce expenses and streamline the process, additional/supplemental underwriting is a critical risk control measure for LTC combo products. The supplemental underwriting typically consists of questions related to the applicant’s medical history with respect to the triggers that are used for the acceleration benefit.

(ii) This is not a reasonable suggestion. Although sales might be higher, one common risk control is limiting the issue ages at which the chronic illness rider can be added, especially at older ages.

(iii) This is a reasonable suggestion. In the absence of such as definition an otherwise healthy individual could claim under the rider when there is a situation that involves a temporary loss of ADLs.

(iv) This is not a reasonable suggestion. The critical illness rider is being confused with a terminal illness rider in this statement. A critical illness rider pays when meeting the criteria for one or more critical illnesses. A terminal illness rider is one that allows policyholders to accelerate a portion of their face amount when they have a life expectancy of less than X months.
5. Learning Objectives:
1. The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

3. The candidate will understand common issues and practices related to In Force and New Business Product Management, and how experience studies are designed and used for evaluating past experience and for setting assumptions.

Learning Outcomes:
(1a) Describe the designs of the common life and annuity products and evaluate their associated features and inherent risks.

(1b) Describe and evaluate methods and metrics used to design and price these products, and assess their profitability.

(3l) Explain and apply the Limited Fluctuation and Buhlmann credibility methods to mortality and lapse experience study data.

Sources:
Life Insurance Acceleration Riders, Fillmore, SoA Reinsurance News, 2013

Experience Assumptions for Individual Life Insurance and Annuities

Credibility Theory Practices, SoA 2009

Commentary on Question:
See question specific commentary below

Solution:
(a) Recommend changes to the product design to mitigate risk.

Commentary on Question:
Candidate generally performed well on this part of the question. Other appropriate answers beyond this list were accepted.

• Use a supplemental underwriting application rather than using the life insurance application.
• Require certification from an approved licensed health care practitioner of whether the policyholder is unable to perform the ADLs instead of a certification from company underwriter.
• Limit the issue ages at which the chronic illness rider can be added (and/or add a cognitive skills test at advanced ages).
• Add additional exclusions on the rider such as mental/nervous disorders, alcoholism, drug addiction, or act of war.
5. Continued

- Limit availability of this rider to certain age groups and/or underwriting classes.
- Require completion of the rider application if the policyholder wants to convert from a term policy without the rider to a permanent policy with the rider.
- Add elimination period/waiting period for the rider.
- Limit the max benefit < 100% of death benefit and/or both the annual & max acceleration amount to some specific dollar amount.
- Define the loss of ADLs as expected to be permanent to reduce the claims.

(b) FIV Life is considering reinsuring the rider with the following reinsurance terms:

- The method of reinsurance is YRT using select and ultimate rates that continue point in scale following conversion
- FIV Life will retain the risk on the base life insurance policy
- To promote the rider, FIV Life may offer the rider to existing term life policyholders without requiring evidence of insurability and reinsure the rider as a new coverage

Explain possible concerns a reinsurer may have with this proposal.

Commentary on Question:
Candidates struggled with this part of the question. Many candidates mentioned anti-selection but didn’t fully describe how reinsurance premium rates are affected. Credit was also given for other reasonable concerns if properly explained.

(i) In theory, the rider attached to a permanent product should cost less because the cost of acceleration is strictly a timing difference, whereas for a term product, there isn’t a guarantee that the death benefit will be paid. The pricing would either have to be lower for permanent products, or a constant rate pre and post conversion and therefore would be underpriced for the term product and excessive for the permanent product.

(ii) Limiting the cost of the rider to a timing difference should make the product more attractive to reinsurers, as there is some element of diversification; if the life portion is fully retained by the ceding company, the chronic illness rider is effectively a standalone product to the reinsurer, who may then ascribe greater risk (and therefore cost) to the reinsurance terms and pricing.
5. Continued

(iii) If there is no evidence of insurability required, the point in scale rates priced for new business will probably be insufficient for existing policies. It is also unclear if there is a limitation on eligible attained ages in relation to the proposed issue ages for new policies. If either evidence is required for inforce policies, or the eligibility is limited for younger attained ages (e.g. up to 40-50).

(c) You are given:

<table>
<thead>
<tr>
<th>2018 inforce policy count (beginning of year)</th>
<th>2018 actual claims due to chronic illness count</th>
<th>Industry study morbidity rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>34,321</td>
<td>350</td>
<td>0.005</td>
</tr>
</tbody>
</table>

(i) Calculate the 95% confidence interval \((z = 1.96)\) of the morbidity rate for company FIV’s experience using the Binomial Model.

(ii) Calculate the credibility of company FIV’s experience according to Limited Fluctuation Theory using an error margin of 0.05.

(iii) Recommend an incidence rate to use for company FIV’s chronic illness rider.

Show all work.

Commentary on Question:
Candidates performed well on part i) and iii) but struggled in part ii). Most candidates were able to correctly calculate the confidence interval of FIV’s experience. Some candidates incorrectly calculated the confidence interval of industry experience and some mistakenly calculated the confidence of claim count instead of morbidity rate. Very few candidates correctly used the formula for credibility using the Binomial Model in part ii). A common mistake made was to use the Poisson Model (which is the approximation to Binomial Model) to calculate credibility. However, most candidates were able to come up with reasonable recommendation in part iii)

(i) Estimated morbidity rate
\[ q = \frac{\text{Claims}}{n} = \frac{350}{34,321} = 0.0102 \]

Expected claims for \(n = 34,321\) policies
\[ E = \text{Claims} = nq = 350 \]

Variance of expected claims for \(n = 34,321\) policies
\[ \text{Var} = npq = 34,321 \times 0.0102 \times (1 - 0.0102) = 346.43 \]
5. Continued

95% Confidence Interval of expected claims
E \pm 1.96 \times \sqrt{\text{Var}} = 350 \pm 1.96 \times \sqrt{346.43} = 350 \pm 36.48

95% Confidence Interval of morbidity rate
(E \pm 1.96 \times \sqrt{\text{Var}}) \div n = 0.0102 \pm 0.00106

(ii) Credibility assessment using Binomial Model
Z = \min\{m \div (z \times \sigma), 1\}
r=0.05; m= E \text{ from above}; \sigma= \sqrt{\text{Var}}; z=1.96
Z=0.4797

(iii) Credibility blended rate
= Z \times \text{company experience} + (1-Z) \times \text{Industry experience}
=0.4797 \times 0.0102 + (1-0.4797) \times 0.05
=0.00749

Recommend using industry weighted morbidity rate of 0.7% for the chronic illness rider.
6. Learning Objectives:
1. The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

3. The candidate will understand common issues and practices related to In Force and New Business Product Management, and how experience studies are designed and used for evaluating past experience and for setting assumptions.

Learning Outcomes:
(1a) Describe the designs of the common life and annuity products and evaluate their associated features and inherent risks.

(3f) Describe and evaluate approaches for quantifying the price of VA guarantees and evaluating hedge effectiveness.

Sources:
ILA: Variable Annuity Guaranteed Living Benefits Utilization, SOA LIMRA Research 2014 – Executive Summary only (pp. 19 – 32)


Commentary on Question:
This question tested candidates’ understanding of a variable annuity with a GLWB rider, impacts of economic factors on the value of the guarantee, risks to the company by offering the GLWB option, and the design/construction of a hedge to mitigate the risks associated with this option.

Solution:
(a)
(i) List the considerations for policyholders taking withdrawals.

(ii) Evaluate the appropriateness of using the given experience from the existing block as the proposed assumptions on the new GLWB rider.

Commentary on Question:
On part (i), some candidates were able to identify age and source of money being the two most important influences on when owners start taking withdrawals, however most candidates struggled with identifying additional considerations. On part (ii), when evaluating the appropriateness of using the given experience, some candidates failed to provide specific reasons why it was inappropriate.
6. **Continued**

(i) Source of money (i.e. qualified or non-qualified)
- Age
- Size of the contracts
- Deferral incentives

(ii) Using the given experience from the existing blue collar workers block as the proposed assumptions on the new GLWB rider targeted to high net worth retirees is not appropriate, as the experience comes from different demographic groups.

Age – In general, younger owners and particularly those under age 60 are more likely to take withdrawals greater than the maximum amount allowed. This is not the case for older policyholders. Therefore, using withdrawal experience for younger policyholders is not appropriate.

Affluence – Higher contract value variable annuity owners are less likely than those with lower contract values to take withdrawals that significantly exceed the benefit maximum. Thus, a product targeted at high net worth clients will have different withdrawal experience.

Surrender Rates – The surrender rates among GLWB owners, particularly amongst older ages and retirees who take withdrawals, are lower than surrender rates for younger workers.

(b) Evaluate the impact of each of the following scenarios on the value of the GLWB rider:

(i) Favorable stock market return

(ii) Decreasing interest rate

(iii) Increasing equity volatility

(iv) Increasing surrender rates

**Commentary on Question:**

Candidates were generally successful in identifying the directional impact on the value of the guarantee for each of the scenarios, however an accompanying reason for the direction of the impact was required in order to receive full credit. Explanations involving signs of the Greeks were also acceptable. Credit for part (b) was awarded for either directional impact as long as an appropriate explanation was provided.
6. Continued

(i) An increasing stock market decreases the value of the guarantee. The account value will increase, decreasing the likelihood the fund will exhaust due to future withdrawals, thus resulting in a lower likelihood that the guarantee pays out.

(ii) A decreasing interest rate will increase the account value due to increasing bond values and therefore decreases the value of the guarantee. A decreasing interest rate will decrease the risk-free rate in the valuation of the guarantee if the underlying is assumed to be in equity, which increases the value of the guarantee.

(iii) Increasing equity volatility increases the value of the guarantee. Since the underlying fund returns are more volatile, there is a high likelihood of the account value dropping and triggering the guarantee.

(iv) Increasing the probability of surrender decreases the value of the guarantee. Payouts decrease because more policies are surrendered before the account value hits zero and the guarantee is triggered. The policyholder is less likely to keep their policy in force long enough to achieve full benefits of guarantee living withdrawals.

(c) The company is considering the following dynamic hedging strategies:

- No hedging
- Delta hedging
- Delta and Vega hedging

(i) Define each hedging strategy.

(ii) Compare the use of the Black-Scholes and Heston models for determining the fair value of the guarantee.

(iii) Evaluate how each hedging strategy is affected by the choice of Black-Scholes or Heston models for valuing the guarantee.

Commentary on Question:
Most candidates had difficulty with this question and didn’t provide appropriate justification for their responses. On part (ii), many candidates were able to describe the difference in assumed volatility as well as the complexity between the two models.
6. Continued

(i) No hedging – Invests all guarantee-fees in the money market account.

Delta hedging – Immunizes the portfolio against small changes in the price of the underlying fund.

Delta and Vega hedging – Neutralizes the portfolio to changes in price of the underlying fund and changes in volatility, through the use of a straddle option.

(ii) The Black-Scholes model assumes that the underlying account value follows geometric Brownian motion.

The Heston model is an extension to the Black-Scholes model which allows for a more realistic modeling of volatility.

The Black-Scholes model assumes a deterministic and constant volatility, while the Heston model assumes the instantaneous variance of the underlying account value are stochastic (same one-factor process as the Cox-Ingersol-Roll interest model).

Fair prices of the guarantee are very similar under the two models. The long-term volatility assumption is more important than the model chosen.

The Black-Scholes model is easier to work with because it has a closed form solution. In contrast, the Heston model does not have a closed form solution and must be calculated with numerical methods.

(iii) No hedging – Unaffected by the choice of model.

Delta hedging – Theoretically a perfect hedge under Black-Scholes but not under the Heston Model. It’s much easier to work with Black-Scholes because it has a closed form solution for the required delta hedging, whereas the Heston model must use numerical techniques to estimate the level of delta hedging needed.

Delta and Vega hedging – The Black-Scholes model hedges the modified vega instead of the actual vega. The Heston model slightly improves hedging results.
7. Learning Objectives:
2. The candidate will understand the theory of "Value Creation" for life and annuity products and how to evaluate the patterns of earnings emergence under various regulatory regimes.

Learning Outcomes:
(2c) Describe and evaluate the emergence of earnings under various financial reporting regimes US Statutory, US GAAP, Canadian CALM and Solvency II regimes.

Sources:
Earnings Emergence Insurance Accounting under Multiple Financial Reporting Bases, SoA, 2015, pp. 4-6, 10-24, 45-53

Commentary on Question:
In general, candidates scored well on calculating pre-tax earnings for each methodology. A common mistake was incorrectly identifying the reserve type to use for each methodology. Candidates struggled more with Part B in connecting the impact of revised best-estimate assumptions for post-level term to the level term period and/or providing an explanation for the earnings impact.

Solution:
(a) Calculate the pre-tax earnings during the first two years under the above methodologies. Show all work.

Commentary on Question:
Most candidates were able to correctly complete the calculations for pre-tax earnings for each of the methodologies. However, many candidates incorrectly identified the appropriate reserve type for each methodology. In addition, when calculating the GAAP reserve, many candidates used types G and H for DAC instead of solely type H. When calculating the CALM reserve many candidates incorrectly included DAC and/or the risk margin and/or the contract service margin. Candidates also often forgot to include the risk margin for Solvency II or incorrectly used the contract service margin instead.

General formula for all reserve methodologies:
Pre-Tax Earnings = Cash Flows + Investment Income - ΔIncLiability

The increase in liability varies by reserve methodology.

US GAAP uses net premium reserve and best-estimate assumptions with PAD which is represented by reserve type D. US GAAP also includes DAC based on first year commissions which is represented by DAC type H.
US GAAP Pre-Tax Earnings Year 1 = Cash Flows(1) + Investment Income (1) – [ΔIncReserve – ΔIncDAC]

\[-2,775 + -111 – [(1,239 – 0) – (3,536 – 0)]\]

= -589

US GAAP Pre-Tax Earnings Year 2 = Cash Flows(2) + Investment Income(2) – [ΔIncReserve – ΔIncDAC]

\[= 1,757 + 161 – [(2,195 – 1,239) – (3,189 – 3,536)]\]

= 615

CALM uses gross premium reserve with best estimate assumption and “worst-case” interest scenario which is represented by reserve type C.

CALM Pre-Tax Earnings Year 1 = Cash Flows(1) + Investment Income(1) – ΔIncReserve

\[= -2,775 + -111 – (-4,607 – 0)\]

= 1,721

CALM Pre-Tax Earnings Year 2 = Cash Flows(2) + Investment Income(2) – ΔIncReserve

\[= 1,757 + 161 – (-3,048 – -4,607)\]

= 359

Solvency II uses gross premium reserve with risk free rate plus margin which is represented by reserve type B. Solvency II also includes a risk margin.

Solvency II Pre-Tax Earnings Year 1 = Cash Flows(1) + Investment Income (1) – [ΔIncReserve + ΔIncRiskMargin]

\[-2,775 + -111 – [(-6,719 – 0) + (1,830 – 0)]\]

= 2,003

Solvency II Pre-Tax Earnings Year 2 = Cash Flows(2) + Investment Income(2) – [ΔIncReserve + ΔIncRiskMargin]

\[= 1,757 + 161 – [(-5,026 – -6,719) + (1,668 – 1,830)]\]

= 387
7. Continued

(b) Predict how earnings will change for years 4 and 5 under each of the three accounting methodologies in part (a) using the revised best-estimate assumption.

**Commentary on Question:**
Many candidates incorrectly assumed that the increase in actual post-level term mortality compared to expected meant that the company would likely pay out additional death benefits in years 4 and 5 causing a decrease to earnings. Many candidates did not include explanations for their predications to the earnings impact.

Under US GAAP, assumptions are locked-in so a revision to best-estimate ultimate mortality assumption will have no impact to earnings for years 4 and 5.

Under CALM, assumptions are not locked-in so increasing the best-estimate ultimate mortality assumption will cause an increase to reserves and therefore a decrease to earnings. The increase will be largest in year 4; therefore, we expect a larger decrease to earnings in year 4 than year 5.

Solvency II will also see a decrease in earnings due to the increase in reserves from increasing the best-estimate ultimate mortality assumption. Solvency II will have a larger earnings decrease than CALM due to its lower interest rate.
8. **Learning Objectives:**

4. The candidate will understand the various forms of traditional reinsurance, will be able to assess how and when they are effectively used, and will be able to perform the associated accounting (from both ceding and assuming perspectives) for basic reinsurance transactions.

**Learning Outcomes:**

(4a) Evaluate and analyze traditional and advanced reinsurance transactions, and prepare related financial statement entries.

(4c) Describe risk transfer considerations, and evaluate their impact on reinsurance agreement provisions.

(4e) Describe and evaluate how strategic/customized reinsurance solutions may enhance insurer prospects.

**Sources:**


Tiller, 4th edition, Chapter 9: Risk Transfer Considerations (pp. 269 - 280)

**Commentary on Question:**

*Commentary listed underneath question component.*

**Solution:**

(a) List the three categories of motivations behind customized reinsurance.

**Commentary on Question:**

_Candidates needed to provide 3 reasons customized reinsurance is used for full credit. Candidates failed to get full credit on this part, as they were able to list capital/solvency reasons, however company growth and transferring risk were less common responses. Partial credit was given for each adequate response._

1) Reduce/Transfer Risk
2) Financially Driven – capital adequacy, lower capital requirements
3) Drive Growth – Long term goals/relationship with reinsurer, grow capital

(b) Recommend a reinsurance solution for each company’s insurance objective. Justify your recommendations.
Commentary on Question:
Candidates were required to provide a specific reinsurance solution for each company along with justification in order to receive full credit. Partial credit was given for only recommending the reinsurance solution, where full credit was given for also providing justification and support for the goal of each company. Several candidates neglected to provide a reinsurance solution, only explaining how reinsurance would provide the goals for each company. The majority of candidates received only partial credit for this part.

Company A – Candidates generally did poorly on this solution, neglecting to suggest appropriate reinsurance for a P&C company wishing to retain their policyholders. Very few candidates received full credit.
Company B – Candidates did well on this section.
Company C – Candidates generally did well on this section. Candidates who did poorly neglected to provide a reinsurance solution which would fully transfer risks, like YRT.
Company D – Candidates generally provided a correct reinsurance solution, though few provided justification. Candidates who did poorly suggested to transfer business via assumption reinsurance, but one of the main goals for company D was to retain the existing traditional life business while expanding into other products.

Company A
Catastrophic reinsurance would be a good solution. Cat reinsurance provides protection against low frequency and high severity risks, this prevents negative surprises. The capital requirements are then lowered, with a one-time price associated to transfer the risk.

Company B
Mod-Co or Coinsurance are both good options here. Coinsurance will lower the capital requirements, which then increases the insurers solvency ratio. With new regulations that may require a higher solvency ratio, the lower required capital results in a higher ratio.

Company C
100% quota share coinsurance will provide full risk transfer. This will increase surplus, providing capital relief and improving ROE. This will stabilize earnings for inforce business.

Company D
Modified Coinsurance, this allows capital to free up and the ceding company can still retain assets in their control to improve ROE. This covers all existing business, allowing the company to maintain both traditional life business and venture into products with lower capital requirements and higher returns.
8. Continued

(c) Determine whether a ceding company can recognize a reinsurance reserve credit for its statutory reserves for each of the situations below, assuming all other conditions for a reinsurance reserve credit are met. Justify your response.

(i) The ceding company is required to recapture all its business at policy year 10.

(ii) The ceding company receives an experience refund, if the reinsured block is profitable.

(iii) The ceding company receives the settlement amount every 30 days.

(iv) The ceding company pays back some of the losses, if the business is unprofitable.

Commentary on Question:
Candidates who provided justification generally did well on this part. A justification was required to receive credit for this part. If candidates simply responded with ‘Credit’ or ‘No Credit’ without any justification, no credit was given. The justification had to be thorough enough to receive full credit, but partial credit was given for less thorough justifications.

(i) Candidates did poorly on this section, not recognizing that the date specified for recapture disallows the credit.

(ii) About half the candidates received full credit, recognizing that sharing profits is allowable.

(iii) Candidates did very well here, noting the more frequent payments than required by law.

(iv) About half the candidates received full credit, recognizing poor performance or losses don’t qualify as risk transfer.

(i) No credit. The ceding company cannot be required to recapture business at a specified date, they may have the option at any point in time.

(ii) Credit. Sharing profitability provides incentive for the insurer to have good business, this is common practice.

(iii) Credit. Settlements within the quarterly requirement are eligible.

(iv) No credit. This is not appropriate risk transfer if the ceding company is required to pay for losses or poor performance.
9. **Learning Objectives:**
2. The candidate will understand the theory of "Value Creation" for life and annuity products and how to evaluate the patterns of earnings emergence under various regulatory regimes.

3. The candidate will understand common issues and practices related to In Force and New Business Product Management, and how experience studies are designed and used for evaluating past experience and for setting assumptions.

**Learning Outcomes:**
(2a) Describe, evaluate and apply the economic value creation framework.

(2e) Describe and evaluate fundamental strategies for enhancing value through active in-force and operational management.

(3g) Describe how experience studies are designed and used for evaluating past experience, and for setting assumptions.

**Sources:**
Life in-force management: improving consumer value and long-term profitability, Swiss Re Sigma, 2017

Experience Study Calculations, Society of Actuaries, Ch. 3, 4,11

Evolving Strategies to Improve Inforce Post-Level Term Profitability, Product Matters, Feb 2015

**Commentary on Question:**
This question tested candidates’ understanding about common issues and practices related to in-force and new business insurance product management, ability to design experience study and set various assumptions, as well as knowledge of evaluating fundamental strategies for enhancing value through active inforce and operational management. Generally, candidates did well on part a) and part c). Many candidates correctly calculated the mortality rates by using the grouped exposure methodology while very few candidates were able to apply shock lapse or exposure formula for lapse rate calculation.

**Solution:**
(a)
(i) Identify reasons policyholders might lapse.

(ii) Explain ways ABC Life can improve policyholder persistency.
9. Continued

**Commentary on Question:**

*Candidates generally did well on part (i). Most candidates were able to list a couple of consumer specific drivers. A common mistake on part (ii) was to list approaches to improve post-level term profitability instead of policyholder persistency. Some candidates were able to explain multiple ways that ABC Life can improve policyholder persistency.*

(i) **There are consumer and market drivers that cause lapses.**

Consumer specific drivers might include:
- Consumer can find the same coverage available for less elsewhere
- Policyholder can be looking for a product better suited to his/her current circumstances
- Coverage can be not required anymore (e.g. because of transition to a new stage of life)
- High upfront commissions to sell policies may incent advisors to advise switching policies
- Lack of direct interaction between insurer and insured

Market specific drivers include:
- Macroeconomic indicators such as interest rates (e.g. an upswing in interest rates creates incentives for consumers to exchange policies with lower guarantees)
- Unemployment and income change, weak economy

(ii) **ABC Life might consider the following approaches:**

- Offer a premium holiday or discount
- Offer an exchange of the products
- Inform the consumers about other solutions (e.g. saving-type products for retirement)
- Offer healthy life in the PLT with more gradual rate increase rather than cliff-jumps
9. Continued

(b) Calculate

(i) The mortality rates for policy years 8-10 using grouped exposure methodology.

(ii) The lapse rates for policy years 8-10 using grouped exposure methodology.

(iii) The actual to expected ratios for mortality in policy years 8-10.

(iv) The actual to expected ratios for lapses in policy years 8-10.

Show all work.

Commentary on Question:
Candidates did very well on part (i) and (iii). Very few candidates were able to receive full credit for (ii) and (iv). Common mistakes include incorrect lapse exposure calculation and missing lapse spike after level period prior to premium jump.

\[ E_x = l_{x+1} + d_x + \frac{1}{2} w_x = l_x - d_x - w_x + d_x + \frac{1}{2} w_x = l_x - \frac{1}{2} w_x \]

\[ q_x^d = \frac{d_x}{E_x} \]

\[ q_x^w = \frac{w_x}{E_x} \]

<table>
<thead>
<tr>
<th>Policy Year</th>
<th>( l_x )</th>
<th>( d_x )</th>
<th>( w_x )</th>
<th>( E^d_x )</th>
<th>i( q_x^d )</th>
<th>ii( q_x^w )</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>929</td>
<td>12</td>
<td>55</td>
<td>901.50</td>
<td>1.33%</td>
<td>6.10%</td>
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<td>862</td>
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<td>50</td>
<td>837</td>
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<td>5.97%</td>
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<tr>
<td>10</td>
<td>797</td>
<td>10</td>
<td>40+600</td>
<td>777</td>
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<td>82.37%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Policy Year</th>
<th>Actual Lapse</th>
<th>Expected Lapse</th>
<th>A/E Lapse</th>
<th>Actual Mortality</th>
<th>Expected Mortality</th>
<th>A/E Mortality</th>
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<td>8</td>
<td>6.10%</td>
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<td>0.0130</td>
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<td>100%</td>
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<td>275%</td>
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<td>0.0130</td>
<td>99%</td>
</tr>
</tbody>
</table>
9. Continued

(c)

(i) Evaluate the appropriateness of ABC’s post-level term pricing assumptions.

(ii) Propose two ways to improve ABC’s post-level term profitability. Justify your answers.

Commentary on Question:
Some candidates struggled with part (i) and provided incorrect assumption assessment for both lapse and mortality. Only a few candidates clearly mentioned that premium cliff-jump post level term should result in much higher lapse.

Candidates would also be awarded full credit for part (ii) if appropriate answers had been previously stated elsewhere.

(i) ABC’s post-level term pricing assumptions seem inappropriate.
   • Premium jump is 16 times, therefore spike lapse in year 10 should be more than 30-50%; should be closer to 95%
   • Mortality after the shock period should increase significantly as the healthy policyholders have lapsed, leaving the unhealthy policyholders in the inforce block.

(ii) Simplified re-underwriting: company offers the insured the option to answer a simplified issue underwriting questionnaire as the PLT approaches and assign them to a risk class. Those who decline to reply default to a traditional guaranteed YRT rate.
   Reason: it's a win-win for the company and the consumer; Consumer can get a discount on premium and if they decline, they can still retain their coverage. From ABC's perspective, they assign appropriate pricing based on risk class.

   Graded approach - allows insurers to ease in higher rates that are much more attractive to the p/h while retaining the right to increase the ceiling (non-guaranteed rates).
   Reason: has the most actual supportable experience. This should imply a better mortality profile.

   Class-Continuation Approach: company would modify the rate increase based on the insured's select risk class, with rates converging to an ultimate rate in later durations.
   Reason: seems to be the fairest approach in that it relies upon the select underwriting to determine the magnitude of the PLT jump. However, the structure also lends itself to the highest selective lapse risk among the approaches.
10. **Learning Objectives:**

5. The candidate will understand the role of the Investment Actuary and the Portfolio Management Process in the Life Insurance company context, as well as the common forms of Fixed income securities and their uses, and the methods and processes used for evaluating portfolio performance and asset allocation.

**Learning Outcomes:**

(5b) Describe and evaluate how a company's objectives, needs and constraints affect investment strategy and portfolio construction (including capital, funding objectives, risk appetite and risk return tradeoff, tax and accounting, accounting considerations, and constraints such as regulation, rating agency ratings and liquidity.

(5c) Describe and assess the role of and significant considerations related to the design and function of asset allocation strategies.

(5d) Describe and assess Fixed Asset Portfolio management methods, and immunization (including derivatives) and cash matching strategies, including:
   - Considerations such as managing funds against a bond market index, the classification of possible strategies, the impact of risk factors and tracking risk, and the use of indexing and active strategies
   - Considerations such as managing funds against liabilities, the use of dedication strategies and immunization strategies, the assessment of risk minimization for immunized portfolios, and the use of cash flow matching and combo strategies
   - The use of derivative enabled strategies, and the use of futures, swaps, and options

(5e) Describe and assess Alternative Investment Portfolios (including real estate) in the context of an insurance company portfolio.

(5f) Describe and apply methods and processes for evaluating portfolio performance, including performance attribution, sources of earnings analysis on investment income, benchmarks, metrics, and risk adjusted performance appraisals (including total return vs reported earnings).

**Sources:**
Managing Investment Portfolios, Tuttle – Chapter 5, 6, 8

**Commentary on Question:**
This question was testing the candidates understanding of the risk-adjusted Roy’s safety-first calculations; their understanding of direct real estate investments within the asset allocation strategy; and the calculation of tracking risk. If the calculations were done correctly, and the candidate made a recommendation and justified the recommendation (ie explained why they made the recommendation they did) then they would receive full marks.
10. Continued

Solution:
(a)

(i) Recommend a portfolio for XYZ based on risk-adjusted expected returns.

(ii) Recommend a portfolio for XYZ based on Roy’s safety-first criterion.

Justify your recommendations.

Commentary on Question:
Overall candidates did well on this question. However, candidates lost partial credit if they did not justify their recommendation. Partial credit was given for showing correct formulas, even if the calculations were wrong.

In part i), the two common mistakes were (1) using a risk threshold of 0.5% instead of 5% (insisted by XYZ) and (2) not squaring the standard deviation $\sigma_m$ in the risk penalty formula. Candidates received full credit for recommending Portfolio B, Portfolio C or both.

In part ii), the common mistake was squaring the standard deviation $\sigma_P$ and not justifying your recommendation.

(i) Risk-adjusted expected return = expected return for mix m – risk penalty

$U_m = E(R_m) - 0.5R_A\sigma_m^2$

$U_m = E(R_m) - 0.5(4)\sigma_m^2$

$U_m = E(R_m) - 2\sigma^2_m$

$A = 9.25\% - 2*(19\%)^2 = 2.03\%$
$B = 8.50\% - 2*(15\%)^2 = 4.00\%$

$C = 6.00\% - 2*(10\%)^2 = 4.00\%$

Portfolio B or C are the preferred portfolios because they have the highest risk adjusted returns.

(ii) Roy’s safety-first criterion states that the optimal portfolio minimizes the probability over a stated time horizon that the portfolio return (R_P) will fall below some threshold level, R_L that the investor insists on meeting or exceeding. The safety-first optimal portfolio maximizes the safety-first ratio (SFRatio):


10. Continued

\[
SFRatio = \frac{E(R_p) - R_L}{\sigma_P}
\]

A = \frac{(9.25\% - 5\%)}{19\%} = 0.224  
B = \frac{(8.50\% - 5\%)}{15\%} = 0.233  
C = \frac{(6.00\% - 5\%)}{10\%} = 0.100

Portfolio B is the preferred portfolio according to Roy’s safety-first criterion since it is the highest.

(b) XYZ proposes adding a direct real estate investment to the strategic asset allocation. You are given the following information about the real estate asset:

<table>
<thead>
<tr>
<th>Expected Return</th>
<th>Standard Deviation of Return</th>
<th>Correlation Coefficient between Real Estate Investment and Current Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.20%</td>
<td>7.50%</td>
<td>70%</td>
</tr>
</tbody>
</table>

(i) List two advantages and two disadvantages of direct equity real estate investing.

(ii) Recommend whether real estate investments should be added to the portfolio selected using Roy’s safety-first criterion. Show all work.

Commentary on Question:
In part i), most candidates provided two advantages and two disadvantages. However, some candidates only provided one of each and lost partial credit. Candidates did not receive additional credit for providing more than two of each.

Part ii) was done well. A fair number of candidates multiplied the real-estate ratio by the correlation coefficient instead the current portfolio ratio. Partial credit was given for showing correct formulas, even if the calculations were wrong. Candidates lost partial credit if they did not justify their recommendation.

Full credit was given for any of the following two advantages and disadvantages:

Advantages:
1. Real estate investors have direct control over property and may take action.
2. Geographical diversification can reduce exposure to catastrophic risks.
3. Real estate returns, on average, have relatively low volatility compared to public equities.
4. Owners of real estate may benefit from tax subsidies if mortgage interest, property taxes and other are tax deductible as permissible by law.
10. Continued

Disadvantages:
1. The cost of acquiring information is high because each piece of real estate is unique.
2. Real estate involves substantial operating and maintenance costs.
3. Real estate brokers charge high commissions compared to securities transactions fees.
4. Real estate investors are exposed to the risk of neighborhood deterioration.

(ii) Adding the real estate investment to the selected portfolio is optimal if the Sharpe ratio for real estate investment exceeds the product of (1) the current portfolio’s Sharpe ratio and (2) correlation between real estate investment and current portfolio.

Sharpe ratio for real estate = \[\frac{E(R_{\text{new}}) - R_F}{\sigma_{\text{new}}} = \frac{(8.20\% - 5.00\%)}{7.5\%} = 0.427\]
Sharpe ratio for current portfolio selected using Roy’s safety-first criterion = 0.233 (from part a-ii)
Correlation = 70%

\[0.427 > 0.233 \times 0.7 = 0.163\]

Therefore, real-estate investment should be added to the portfolio since the real estate investment ratio exceeds the current portfolio.

(c) Evaluate whether the following portfolio returns meet XYZ’s target tracking risk of 1%. Justify your response.

<table>
<thead>
<tr>
<th>Period</th>
<th>Portfolio Return</th>
<th>Benchmark Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.50%</td>
<td>9.25%</td>
</tr>
<tr>
<td>2</td>
<td>6.45%</td>
<td>6.10%</td>
</tr>
<tr>
<td>3</td>
<td>2.85%</td>
<td>3.30%</td>
</tr>
</tbody>
</table>

Commentary on Question:
Most papers did well on this question. Common errors were not taking the average of the Active Return; not squaring the active return minus the average active return and dividing by \(T=3\) instead of \(T=2\) in the denominator of the tracking risk. Keep in mind it is a good idea to show all your work. Part marks were given.
10. Continued

\[
TrackingRisk = \sqrt{\frac{1}{t-1} \sum (AR_i - \overline{AR})^2}
\]

Where

\[
AR_i = Portfolio\ Return_i - Benchmark\ Return_i
\]

\[
\overline{AR} = \frac{\sum AR_i}{t}
\]

<table>
<thead>
<tr>
<th>Period</th>
<th>Portfolio Return</th>
<th>Benchmark Return</th>
<th>Active Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.50%</td>
<td>9.25%</td>
<td>0.25%</td>
</tr>
<tr>
<td>2</td>
<td>6.45%</td>
<td>6.10%</td>
<td>0.35%</td>
</tr>
<tr>
<td>3</td>
<td>2.85%</td>
<td>3.30%</td>
<td>-0.45%</td>
</tr>
</tbody>
</table>

Average Active Return: 0.05%

<table>
<thead>
<tr>
<th>Period</th>
<th>(AR - Avg AR)²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0004%</td>
</tr>
<tr>
<td>2</td>
<td>0.0009%</td>
</tr>
<tr>
<td>3</td>
<td>0.0025%</td>
</tr>
</tbody>
</table>

Total: 0.0038%

Tracking risk = \[
\text{SQRT}\left(\frac{0.0038\%}{(3 - 1)}\right) = 0.4359\%
\]

Since the tracking risk of the portfolio is less than the target of 1%, the portfolio meets the company's objective.
11. Learning Objectives:
1. The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

Learning Outcomes:
(1q) Describe and evaluate the types of assumptions commonly used in actuarial pricing and product development.

Sources:
Post Level Term Experience Results - SoA RGA - Kueker Presentation, 2014, pp. 21-44
Life Products and Features
Experience Assumptions for Individual Life Insurance and Annuities

Commentary on Question:
No overall commentary has been made. Please see separate commentary for each subsection.

Solution:
(a) Assess how the following should be factored into adjusting the existing experience in order to derive the new pricing lapse assumption:

(i) KLA Life has moved from a captive agent distribution to a brokerage-based model with more sophisticated, older clients and larger coverage amounts.

(ii) To encourage new sales, the new RT10 product will have lower initial premiums and higher renewal premiums.

(iii) KLA Life now has stricter underwriting rules with fewer substandard issues than in the past and the addition of a super-preferred class.

Commentary on Question:
For the most part, Candidates did not make the connection that Part A was worth 3 points and included only 1 statement for each subsection, rather than providing a more complete response. Including 2 or 3 statements per subsection would have been consistent with the allotted time associated with a 3 point question.
11. Continued

(i) • Overall, brokerage-based business will have higher lapse rates compared to captive agents due to their greater ability to shop policies.
   • Higher lapse rates at renewals are expected from more sophisticated clients.
   • Sophisticated term buyers often need large amounts of insurance for brief periods and have the potential to lapse early compared with normal purchasers of term insurance.

(ii) • Lower initial premium rates will encourage lower early duration lapses as it is less likely that insureds will be able to find better rates elsewhere.
   • Lower initial premium rates and higher renewal premiums will increase the renewal premium jump compared to what is embedded in KLA’s lapse experience, therefore higher lapses at renewal should be expected.

(iii) • Super-preferred class will have higher shock/renewal lapses as they have a better chance of qualifying for a better deal at renewal.
   • Super-preferred class will have lower initial premiums than is embedded in KLA’s lapse experience and lower early duration lapses should be expected.
   • Slightly substandard lives are more likely to lapse and seek a better deal.
   • Fewer substandard issues going forward will reduce the expectation of deteriorating lives continuing coverage post renewal, therefore lapse experience at renewal should increase.

(b) Explain how each of the following might affect the year 11 lapse assumption:

(i) A shift in the gender mix of the business from (50% male and 50% female) to (60% male and 40% female).

(ii) A shortening of the grace period from 3 months to 2 months.

(iii) A shift to monthly premium mode from annual premium mode.
11. Continued

Commentary on Question:

This question was asking candidates to comment on the potential impact to the year 11 lapse assumption due to the changes listed in each of the subsection. In some cases, candidates focused on the impact at a specific point of year 11, while not completely responding to the overall impact to the year 11 lapse. An example of this is in subsection (iii), where some candidates provided an answer that was focused on the impact on lapses at month 1 of the 11th year, and not on the impact of the entire year. Full marks were given to candidates that answered the question of assessing the impact on the entire year 11 lapse rate, and not simply a portion of it.

It should also be noted that a number of candidates answered the question in subsection (iii) assuming the shift was from monthly to annual premium mode and not annual to monthly.

(i)

- Males tend to have a higher year 11 lapse assumption than females, therefore a shift in the proportion of males from 50% to 60% will have the effect of increasing year 11 lapses.
- Candidates who made the statement that sex on its own is not a determinant of higher/lower lapses, but that lapses are more closely related to premium jump and age, were given full marks.

(ii)

- If KLA Life considers the date of lapse to include the grace period, then a shortening of the grace period from 3 months to 2 months will not alter the number of lapses in year 11 but will shift the shock lapse from the end of month 3 to the end of month 2.
- If KLA Life considers the date of lapse to be the end of the paid premium period, then shortening the grace period from 3 months to 2 months will not have an impact of year 11 lapses as all non-payment of premium at the start of year 11 will be considered year 10 lapses.

(iii)

- A shift to monthly premium mode from annual mode will cause the Year 11 lapse rate to increase.
11. Continued

(c)

(i) Explain how lapse assumptions can impact the mortality assumption during the post level term period.

(ii) For a product cell, you are given:

<table>
<thead>
<tr>
<th></th>
<th>q_{[x]+t}</th>
<th>q_{[x]+t}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>Lapse</td>
<td>40%</td>
<td>4%</td>
</tr>
</tbody>
</table>

- Assume 90% of the extra lapses are selective.

Determine the mortality rate for persisting policyholders. Show all work.

Commentary on Question:

Candidates showed a very good understanding of the impact lapses will have on mortality during the post level term period, and how such deteriorated mortality should be calculated.

(i) When a renewable term 10 policy reaches the annually increasing premium rates, these premium rates may exceed those of a newly underwritten policy. When this occurs, healthy lives that can qualify for lower rates elsewhere are expected to lapse, while less healthy lives will keep their existing policies. The end-result is that lives remaining from the original cohort will exhibit higher mortality.

(ii) The question did not specifically state how the candidates were to treat the mortality related to the “non-selective and normal” lapses. Because of this, full marks were given for either of the following two responses/calculations.

1) Assuming “non-selective and normal” lapses will experience the same mortality as “persisters”:

\[ q^{AS}_{(x)+t} = \frac{[q_{(x)+t} - A \times q_{(x+t)}]}{(1 - A)} \]

where
- \( q^{AS}_{(x)+t} \) is the mortality rate at duration \( t \) reflecting the effect of anti-selections for persisters
- \( A \) is the portion of policies that lapse at duration 10 (renewal) to buy a newly underwritten policy = (40% - 4%) times 90% = 32.4%
11. Continued

\[ q^{AS}_{(x+t)} = \left[ 0.003 - (32.4\% \times 0.001) \right]/(67.6\%) = 0.00396 \]

2) Assuming “non-selective and normal” lapses will experience the same overall
mortality as the group:

\[ q_{(x+t)} = q_{(x+t)}^{w\text{ (selective)}} + q_{(x+t)}^{w\text{ (non-selective + normal lapses)}} + q^{AS}_{(x+t)} \times q^{w\text{ (persisters)}} \]

\[ 0.003 = 0.001 \times 32.4\% + 0.003 \times (3.6\% + 4\%) + q^{AS}_{(x+t)} \times (1-40\%) \]

\[ q^{AS}_{(x+t)} = 0.00408 \]