

TIA Solutions to the Spring 2018 LFV-C Exam

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Introduction

You can obtain past SOA exams and SOA model solutions here:

<https://www.soa.org/multiple-choice/>

This document contains our full solutions to questions that are still relevant to the current LFV syllabus. In some cases our solution may be different from the model solution posted by the SOA. It's important to remember that the SOA's model solutions are not intended to be perfect responses. They are typically the best answer provided by an actual candidate that exam day. As such, model solutions may be incomplete, may contain errors, may contain superfluous information, and may represent only one of multiple possibilities for answering the question.

Because of these aspects of model solutions, they are not always the best instructional tool for future exam problems. Our solutions and commentary in this document tend to focus on how best to solve the problem in a way that is most consistent with the syllabus readings and also present solutions with future exam problems in mind.

In many cases, the solutions in this document are much more thorough and complete than what you can reasonably produce under exam conditions. The chief goal of our solutions is to help reinforce the topics tested and present solutions in an instructional way. However, we try to emphasize solution writing "best practices" in our solutions (e.g. write formulas first before doing calculations).

General syntax:

- *Italicized text* is instructor's commentary on the question
- **Bold text** is generally text taken directly from the question
- Regular text is instructors' solution

When in doubt, always fall back on what you've learned in the online seminar materials and source material because that information is the most consistent with the current syllabus and will therefore prepare you the most for the next exam.

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Question 1

1(a)

(6 points)

Source: LFV-137

(i) Calculate the total return on MCEV. Show all work.

(ii) Calculate the operating return on MCEV. Show all work.

Formulas:

$$\text{RoEV} = \begin{cases} \frac{\text{Total MCEV Earnings}}{\text{Opening MCEV}} & \text{(total return)} \\ \frac{\text{Operating MCEV Earnings}}{\text{Opening MCEV}} & \text{(operating return only)} \end{cases}$$

where:

$$\begin{array}{l} \text{Total MCEV Earnings} \\ \left\{ \begin{array}{l} \text{Opening MCEV} \\ + \text{Opening Adjustment} \\ + \text{New Business Value (NBV)} \\ + \text{Unwinding MCEV (U)} \\ + \text{Operating Variances (OpV)} \\ + \text{Economic Variances (EcV)} \\ + \text{Closing Adjustment} \\ = \text{Closing MCEV} \end{array} \right\} \text{Operating MCEV Earnings} \end{array}$$

1. New business value (NBV) = value of NB written in the previous period
2. Unwinding of MCEV (U) = expected contribution of existing business = sum of the following:
 - (a) Earnings during the period assuming investment returns based on the reference rate (market spot rate) at the beginning of the period
 - (b) Additional actual investment earnings in excess of (a)
 - (c) Release of profits and RC into FS
3. Operating variances (OpV) = experience variances + impact of experience assumption changes

4. Economic variances (EcV) = impact of changes in economic factors beyond management's control

It's worth noting that the study note provides two different definitions of U. The definition above appears first in the reading, but later the authors define it more formally later as:

$$U = \text{Expected investment income on VIF} = f_t \cdot \text{VIF}_{t-1}$$

$$+ \text{Cost of capital released to FS} = \text{COC} \cdot \text{NAV}_{t-1}$$

$$+ \text{Frictional costs released to FS} = [ic + t \cdot (f_t - ic)] \cdot \text{RC}_{t-1}$$

Clearly only the first definition works for this problem, so that's what we'll use.

Calculations

$$\text{NBV} = 1 \text{ (given)}$$

$$\text{OpV} = 8 \text{ (given)}$$

$$\text{EcV} = -5 \text{ (given)}$$

$$U = 7 + 2 + 3 + 1 = 13$$

$$\text{Total MCEV Earnings} = 1 + 8 + (-5) + 13 = \boxed{17}$$

$$\text{Operating MCEV Earnings} = 17 - \text{EcV} = 17 - (-5) = \boxed{22}$$

1(b)

(2 points)

Source: EV Practice and Theory; LFV-106; LFV-137

Assess concerns with performing an actuarial appraisal of XYZ using its latest EV results.

EV is similar to actuarial appraisal value (AAV), but there are differences that would make EV results inappropriate if the company plans to use them as-is

- AAV includes contribution of future new business, while EV does not
- AAV can use a different discount rate reflecting more of a market or buyer perspective (generally higher discount rates than EV)
- Expense assumptions in EV are more company-specific than those used in AAV, where assumptions reflect prevailing sentiment of the market

Traditional EV results also omit market-consistent items:

- The RC component of EV's ANW is usually held on a book value basis, not market value

- Traditional EV does not capture TVOG and certain other frictional cost items

1(c)

(4 points)

Source: EV Practice and Theory

The following assumptions appear in XYZ's EV report. Critique the appropriateness of each statement.

A. Persistency, mortality, and expense assumptions are best-estimate with provisions for adverse deviation.

- Not appropriate
- Non-economic EV projection assumptions should be on a best estimate basis (without PAD)

B. Mortality improvement is included in the mortality assumptions. This is common industry practice.

- Appropriate since this statement is true

C. Expenses consist of acquisition expenses (to the extent associated with existing business) and maintenance expenses. Overhead and one-time expenses are excluded.

- Not appropriate
- All expenses should be reflected in EV calculations: acquisition, maintenance, and overhead
- Include expectation for expense inflation
- Include an assumption for unanticipated one-time costs

D. Since non-economic assumptions used to calculate EV should be "entity-specific," the company's experience data was exclusively used to develop persistency, mortality, and expense assumptions. No industry data was used.

- Appropriate for expenses
- Appropriate for persistency and mortality as long as the experience is credible
- If company experience is not credible, should use a combination of company data and industry data, depending on credibility

Question 2

2(a)

(3 points)

Source: Tiller 4th ed. Ch. 5

Create LNT's projected 2018 term life income statements for each of the proposed reinsurance arrangements. Show all work.

The SOA model solution commentary notes that the timing of the reinsurance arrangement tripped up a lot of candidates. The key was to realize that the agreement went in place right at EOY 2018. So all of the projected cash flow for 2018 were essentially unaffected. We just need to layer on the new reinsurance items in the income statement. This is basically like the "at inception" calculations shown in the illustrative examples in the online seminar lessons for Tiller Ch. 5.

Coinsurance items:

- Ceded premium = $100\% \times \text{Policy Reserve} = 9500$ (initial ceded premium)
- Reinsurance allowance = $10\% \times \text{Ceded Prem} = 950$ (upfront initial EA)
- Ceded claims = 0 since no claims will be ceded until 2019 and beyond
- Ceded reserve = $100\% \times 9500 = 9500$ (initial transfer of reserve to reinsurer)

Mod-co items:

- Ceded premium = 9500 (same as coinsurance)
- Reinsurance allowance = 950 (same as coinsurance)
- Mod-co adj = Increase in Ceded Reserve – Mod-co Interest on Beginning Ceded Reserve = $(9500 - 0) - 7\% \times 0 = 9500$ (mod-co interest is zero at inception since no time has elapsed yet—the ceded reserve has just been established)
- Ceded claims = 0 (same as coinsurance)
- Ceded reserve = 0 (never show ceded reserve on mod-co income statement)

Final EOY 2018 income statements:

	Without Reinsurance	With Coinsurance	With Mod-co
Premium			
Gross	4000	4000	4000
Ceded		9500	9500
Net	4000	-5500	-5500
Investment Income	800	800	800
Reinsurance Allowance		950	950
Mod-co Adj			9500
Total Revenue	4800	-3750	5750
Claims			
Gross	1500	1500	1500
Ceded		0	0
Net	1500	1500	1500
Reserve Increase			
Gross	1000	1000	1000
Ceded		9500	
Net	1000	-8500	1000
Expenses	300	300	300
Total Benefits and Expenses	2800	-6700	2800
Net Income	2000	2950	2950

2(b)**(6 points)****Source: Tiller 4th ed. Ch. 5****Calculate the projected 2019 net income for the block under each reinsurance arrangement. Show all work.**

Coinsurance items:

- Ceded premium = $100\% \times GP = 3500$
- Investment income = $8\% \times \text{EOY 2018 Assets} = 8\% \times 4050 = 324$
 - EOY 2018 Assets = Assets before coinsurance (12,600) + net cash flow resulting from coinsurance = $12,600 + (-9500 + 950) = 4050$
- Reinsurance allowance = $10\% \times \text{Ceded Prem} = 350$
- Ceded claims = $100\% \times 500 = 500$

- Change in ceded reserve = $100\% \times 1000 = 1000$

Mod-co items:

- Ceded premium = 3500 (same as coinsurance)
- Investment income = $8\% \times \text{EOY 2018 Assets} = 8\% \times 13,550 = 1084$
 - EOY 2018 Assets = Assets before mod-co (12,600) + net cash flow resulting from mod-co = $12,600 + 950 = 13,550$
- Mod-co adj = Increase in Ceded Reserve – Mod-co Interest on Beginning Ceded Reserve = $1000 - 7\% \times 9500 = 335$
- Reinsurance allowance = 350 (same as coinsurance)
- Ceded claims = 500 (same as coinsurance)
- Change in ceded reserve = 0 (never show for mod-co)

Final EOY 2019 income statements:

	Coinsurance	Mod-co
Premium		
Gross	3500	3500
Ceded	3500	3500
Net	0	0
Investment Income	324	1084
Reinsurance Allowance	350	350
Mod-co Adj		335
Total Revenue	674	1769
Claims		
Gross	500	500
Ceded	500	500
Net	0	0
Reserve Increase		
Gross	1000	1000
Ceded	1000	
Net	0	1000
Expenses	250	250
Total Benefits and Expenses	250	1250
Net Income	424	519

Question 3

3(a)

(1 point)

Source: LFV-645-18: OSFI Draft Guideline A - Life Insurance Capital Adequacy Test (LICAT), Chapter 2 September 2017

List the primary considerations for assessing the available capital elements of an insurer under the Life Insurance Capital Adequacy Test (LICAT).

The primary considerations for assessing the available capital elements of an insurer under LICAT are:

1. Availability
2. Permanence
3. Absence of encumbrances and mandatory servicing costs
4. Subordination

3(b)

(1 point)

Source: LFV-636-18: OSFI Draft Guideline A-4 Internal Target Capital Ratio for Insurance Companies, September 2017

Describe actions the Office of the Superintendent of Financial Institutions (OSFI) may take towards an insurer for not satisfying the Supervisory Target ratios.

If an insurer does not satisfy the Supervisory Target ratios:

- OSFI mandates an early intervention approach as this is indicative of material safety and soundness concerns, and a vulnerability to adverse business and economic conditions, which require immediate attention
- Insurers will be subject to increased supervisory attention that would include an early warning intervention status (i.e. stage 1)
- The intensity and nature of the supervisory intervention would depend on the circumstances of the particular insurer

3(c)**(3 points)****Source: LFV-645-18: OSFI Draft Guideline A - Life Insurance Capital Adequacy Test (LICAT), Chapter 2 September 2017****Explain causes for the difference in the following components between the three arrangements: (i) Surplus Allowance (B), (ii) Diversified Risk Requirement (E), (iii) Operational Risk (F)**

*This question tests your knowledge of the LICAT formulas by asking you to describe the formulas using qualitative approach. In general, if a formula is involved, **write it out (even if it's in words)**. Case in point, for part (iii), it would be easier to qualitatively breakdown the differences between the three arrangements by talking about the 3 different op risk components.*

(i) The Surplus Allowance (SA) is based on PfADs calculated under CALM, and is the sum of the following two components:

1. PfADs related to scenario assumptions for Rf interest rates (excluding those related to seg funds), calculated net of all reinsurance
2. PfADs for non-economic assumptions (excluding those related to seg funds), calculated net of registered reinsurance only

Therefore, the SA is lower for the two reinsurance arrangements vs no reinsurance, due to the PfADs being ceded.

(ii) Diversified risk requirement (D) is defined by the following formula:

$$D = \sqrt{A^2 + AI + I^2}$$

Where:

- A = the required capital for credit risk and market risk
- I = the required capital for insurance risk

The required capital for credit, market and insurance risk are calculated net of all registered reinsurance, which results in the Diversified Risk Requirement being lower for the two reinsurance arrangements. Both YRT and Modco arrangements are providing the same amount of risk coverage, this implies that they have the same impact on (D).

(iii) Required capital for operational risk is the sum of:

1. Business volume required capital
2. Large increases in business volume required capital
3. General operational risk required capital
 - Business volume required capital (component 1 above) is calculated based on gross premiums, which keeps that component the same for all three arrangements
 - General required capital (component 3 above) consists of two separate sub-components :
 - A 5.75% factor applied to total required capital for credit, insurance and market risk components net of reinsurance and all other credits
 - B 2.5% factor applied to ceded reinsurance premiums.

The reinsurance arrangements have arrangements higher operational risk from sub-component (B) (Mod-co ceded premium higher than YRT) which is partially offset by lower requirement from sub-component (A).

3(d)

(2 points)

Source: LFV-645-18: OSFI Draft Guideline A – Life Insurance Capital Adequacy Test (LICAT), Chapter 2 September 2017

Describe considerations when recognizing ceded liabilities for unregistered reinsurers under LICAT.

This is a very cumbersome question to answer in an exam setting. The model solution looks like a condensed version of the entire LICAT chapter on "Credit for Risk Mitigation and Risk Transfer". I find it hard to believe someone would memorize the contents of that chapter in this manner. Always be mindful the of the time vs the number of points for these types of questions.

- Policy liabilities that are ceded by an insurer under unregistered reinsurance must be valued, in accordance with CALM
- Assumptions about assets supporting liabilities must be consistent with assets used to collateralize reinsurer's obligations
- The assets backing the ceded liability should be assumed to consist of all or a portion of:

1. The assets held by the insurer or vested in trust that are used to support funds withheld from or other amounts due to the unregistered reinsurer
 2. The assets located in Canada for which the insurer has a valid and perfected first priority security interest under applicable law that are used to obtain credit in respect of the unregistered reinsurer
 3. Letters of credit held to secure payment to the insurer by the reinsurer that are used to obtain credit in respect of the unregistered reinsurer. These amounts should be treated as non-interest bearing cash equivalents for the purpose of valuation
- The total value of the policy liabilities ceded to the unregistered reinsurer, if positive, must be deducted from available capital
 - Where an insurer cedes positive policy-by-policy liabilities and negative policy-by-policy liabilities to the same unregistered reinsurer, amount of offsetting liabilities is minimum (total positive liability ceded, total negative liability ceded)
 - Where the total value of the policy liabilities ceded is negative, the insurer should deduct from Tier 1 and include in Tier 2 the reported assets arising from transactions with the reinsurer unless the assets:
 1. Are unencumbered and held in Canada in custody of the insurer
 2. Are not receivables
 3. Do not bear any credit exposure to the unregistered reinsurer or any of its affiliates
 4. Have been transferred to the insurer permanently
 - Deduction from tier 1 limited to value of aggregate negative policy liability ceded to reinsurer

Question 4

4(a)

(1 point)

Source: OSFI Guideline E15: Appointed Actuary - Legal Requirements, Qualifications and External Review (September 2012)

List the qualifications necessary to be an Appointed Actuary for a Canadian life insurance company.

1. Has appropriate Canadian practical experience, which is defined as having worked in Canada for at least three of the last six years, of which at least one year was performing valuation of Canadian actuarial liabilities of an insurance company
2. Has experience with the CIA's Standards of Practice and relevant insurance legislation and regulation
3. Is up to date with respect to the CIA's Continuing Professional Development (CPD) requirement
4. Has not been the subject of an adverse finding by a CIA Disciplinary Tribunal. Where there has been such a finding, the Superintendent may nevertheless conclude that the AA is a suitable person if the circumstances of the case and other information support such a conclusion

4(b)

(5 points)

Source: OSFI Guideline E15: Appointed Actuary - Legal Requirements, Qualifications and External Review (September 2012)

Critique the appropriateness of each of Arthur's actions.

This question requires you to know the qualifications and work of an AA. If you know that information, then this question is pretty straight forward. In the event that you didn't have time to go over the reading, most of these are worded in a way where it sounds more incorrect than correct (e.g. reducing dividends to offset litigation costs).

- January 1: Inappropriate
 - A reviewer may not be an employee of the company or any affiliated companies, and may not have been employed by the company or served as AA of the company during the three years prior to the date of the work being reviewed
 - Retain the current reviewer if he/she hasn't completed his/her two cycles; or choose a new reviewer that fulfills the OSFI's criteria in determining objectivity of the reviewer
- February 28 : Appropriate
 - The review of the AAR can be post-submission
- March 12: Inappropriate
 - There would be no such report to senior management/board of an adverse condition that does not threaten the insurer's financial condition. Informal notification and consultation would usually precede, and may obviate, that report to senior management
 - Communicate with the stakeholders in the company (e.g. investment department) on solving the issue
- May 30/August 1: Inappropriate
 - The AA is required to report, in writing, to the directors on the fairness to participating policyholders of a proposed dividend, bonus or other benefit and whether it is in accordance with the dividend or bonus policy
 - Arthur should have reported to the board in writing on the proposed dividend and then the board can decide whether or not to adopt the new dividend
- August 30: Inappropriate
 - It is inappropriate to allocate expense of non-participating policies to participating policies
 - It prevents the AA to issue fairness opinion on the participating account management policy
 - Arthur should not reduce the dividend to offset the litigation cost

Question 5

5(a)

(2 points)

Source: CIA Educational Note on IFRS: Classification of Contracts under IFRS

Describe considerations for determining if a contract qualifies as an insurance contract for IFRS accounting purposes.

This question is asking you for the entire "step 4 - classification as an insurance contract" section of the study note. I think listing out the 3 main bullet points might give you some partial credit, but the description of each main bullet is where the majority of the credit is given.

The considerations for determining if a contract qualifies as an insurance contract for IFRS accounting purposes consist of the following:

1. Whether an insured event is covered by the contract:
 - A contract must specify at least one insured event that could trigger a benefit payable to policyholder
 - This benefit can be uncertain as to its occurrence, its amount, or its timing
 - The risk transferred by the policyholder to the insurer must be non-financial risk, and policyholder needs to be exposed to the risk regardless of whether the contract exists or not
2. Whether the occurrence of the insured event would result in an adverse effect on the policyholder:
 - The insured event must adversely affect the policyholder and a benefit be triggered as compensation
 - In some cases, the adverse effect is presumed to occur and does not need to be proved
3. Whether the insurance risk contained in the contract is significant:
 - The benefit that insurer payable to the policyholder must be significant, excluding scenarios that lack commercial substance
 - The risk can be significant even when the insured event is extremely unlikely

- The risk can also be significant even when the expected present value of the contingent cash flows is small in proportion to the present value of all contractual cash flows
- The determination of significance is performed on an individual contract basis

5(b)

(3 points)

Source: CIA Educational Note on IFRS: Classification of Contracts under IFRS

Assess whether the following contracts would be classified as insurance contracts under IFRS. Justify your assessment.

*This question leverages the use of the definition of an insurance contract from part (a) (e.g. contract vi). So if you got part (a) correct, part (b) would be a little more straight forward. This question also tests a little of your knowledge of various insurance product features (although the description of each contract is pretty clear on its own). Also, keep in mind that this is asking for whether they're **insurance** contracts only. The key to this question is to **justify** the assessment. Again, for a question like this, leverage the definition you put in part (a) in your justification to maximize your potential score.*

(i) This contract is not an insurance contract and should be considered as an investment contract:

- The insured event that will lead to the uncertainty of the amount and timing of benefit payout is the death of the policyholder. However, the benefit only varies by the time value of money and therefore the risk is associated with financial risk, not insurance risk. Thus, there is no significant insurance risk and is not an insurance contract
- 2 key points to note for this product are that the payments on death are (a) not guaranteed and (b) subject to a MV adjustment

(ii) This contract is an insurance contract:

- The Universal Life contract meets all requirements for an insurance contract. The policyholder account would be considered as a deposit component which can be evaluated on a stand-alone basis. Unbundling the deposit component is permitted but not required. The deposit component could be measured separately, while the insurance component, which depends on the amount of account value, would be measured as a whole

(iii) This contract is not an insurance contract but a stand-alone service contract:

- There is no insured event and no benefit payout under the contract
- This contract does not create financial assets or liabilities and does not transfer insurance risk

(iv) This is an insurance contract:

- The life contingent payout annuity is classified as an insurance contract even with a 5-year guaranteed benefit, as the life contingent portion meets all requirements

(v) This contract is not an insurance contract but rather an investment contract:

- The risk transferred from contract purchaser to insurer is financial risk and does not meet the insurance contract requirement
- *This is essentially a credit default swap (CDS)*

(vi) This contract is an insurance contract:

- There is an insured event that results in a contractual benefit payable. The benefit is uncertain to its occurrence and is not due to financial risk. The policyholder is adversely impacted when the insured event occurred, as expensive gifts would have to be purchased
- *If your golf skills are anything like mine, this contract would be a big waste of money!*

5(c)

(3 points)

Source: LFV-141

XYZ Insurance Company currently sells only 10 year term insurance and segregated funds products.

(i) Recommend the appropriate IFRS 17 measurement approach for each product.

Term product:

- Recommend general accounting model (GAM)
- IFRS 17 requires the general accounting model for long-term insurance contracts
- Must calculate fulfillment cash flows (FCFs) and an explicit risk adjustment to reflect the uncertainty in timing and in amount of future cash flows

- If FCFs with risk adjustment < 0 at issue, set up a CSM such that $FCFs + CSM = 0$ at issue
- Release the CSM into P&L as insurance coverage is provided

Seg fund product:

- Recommend the variable fee approach (VFA), which should be used for contracts with direct participation features
- VFA allows the CSM to be optionally adjusted/updated to offset changes in the variable fee; otherwise VFA is identical to the GAM
- Direct participation feature – an obligation to pay policyholders the fair value of the underlying items less a variable fee for service
 1. Policyholder participates in a share of a clearly identified pool of underlying items
 2. Company expects to pay a substantial share of the FV returns on underlying items
 3. Payments to policyholder will vary with the change in FV of underlying items
- Variable fee = consideration company receives for providing investment-related services (usually a function of financial variables that influence discount rates)

(ii) Describe the effect of discount rate changes on the Contractual Service Margin (CSM) for each of the two products.

Term product:

- Under the GAM, discount rate changes have no effect on the CSM, which should always use the original discount rate
- Discount rate changes only affect the FCFs, and the insurer can reflect those changes in P&L or OCI (insurer's choice)

Seg fund product:

- Under the VFA, the insurer can optionally unlock the CSM to offset changes in the variable fee
- If the insurer chooses to offset changes in the variable fee, the CSM would be increased or decreased to offset any changes in the FCFs resulting from the change in variable fee so that P&L is unaffected in the current period

- If the insurer chooses not to use the CSM in this manner, any changes in the variable fee would be reflected in P&L (insurer may choose this option if using hedges to mitigate P&L volatility caused by variable fee changes)

5(d)

(5 points)

Source: CIA Standards of Practice: Insurance Sections 2100, 2300, 2500, April 2017

(i) Calculate the insurance contract liability at inception for each product under CALM.

To calculate the CALM liability, we need to discount the liability CFs. Since we're given the CALM valuation interest rate, we will use this to discount the liability CFs.

Product A:

$$\text{Discounting Year 2 CF} = \frac{2,000}{1.06^2} = 1,780$$

$$\text{Discounting Year 1 CF} = \frac{1,500}{1.06} = 1,415$$

$$\text{Year 0 CF} = -5,000 \rightarrow \text{premiums are considered a negative liability CF}$$

$$\text{CALM liability} = \text{sum of the 3 CFs} = -5,000 + 1,415 + 1,780 = \boxed{-1,805}$$

Product B:

$$\text{Discounting Year 2 CF} = \frac{1,800}{1.06^2} = 1,602$$

$$\text{Discounting Year 1 CF} = \frac{1,200}{1.06} = 1,132$$

$$\text{Year 0 CF} = -2,500 \rightarrow \text{premiums are considered a negative liability CF}$$

$$\text{CALM liability} = \text{sum of the 3 CFs} = -2,500 + 1,132 + 1,062 = \boxed{234}$$

Source: LFV-141

(ii) Calculate the insurance contract liability at inception for each product under IFRS 17.

This question is constructed to showcase the difference in liabilities under the 2 methodologies. Given that the industry is moving away from CALM and towards IFRS 17, it's no surprise that the IFRS 17 calculation is more intensive.

Formulas:

$$\text{Liability} = \text{FCF} + \text{CSM}$$

$$\text{Fulfillment CFs} = \text{PV}(\text{Outflows}) - \text{PV}(\text{Inflows})$$

- Outflows = claims, expenses, directly attributable acquisition costs, etc.
- Inflows = premiums and considerations paid by contractholder
- Calculate with and without risk adjustment
- Risk adjustment = explicit adjustment for uncertainty in timing/amount of FCFs
- Discount rates
 - Reflect the characteristics of the contract's cash flows (timing, currency, liquidity)
 - Based on current observable interest rates with adjustments

CSM = extra liability that eliminates day 1 gain

- Initial CSM = $-\text{FCFs}$ so that $\text{FCF} + \text{CSM} = 0$
 - If Initial FCF > 0 , set CSM = 0 (“onerous”)
- CSM = expected future profit

Product A Calculations

Since we are given margin-loaded CALM cash flows, we need to remove the 15% margin from the future cash flows that we can calculate the expected cash flows (best estimate):

$$\begin{aligned} \text{CF}_0 &= -5000\text{CF}_1 & &= \frac{1500}{1.15} = 1304.35 \\ \text{CF}_2 &= \frac{2000}{1.15} = 1739.13 \\ \text{ExpCF} &= -5000 + \frac{1304.35}{1.04} + \frac{1739.13}{1.04^2} = -2137.89 \end{aligned}$$

The problem defines the risk adjustment at 10% of undiscounted cash flows, so the risk adjustment at issue is:

$$\text{RA} = 0.10 \times (1304.35 + 1739.13) = 304.35$$

The SOA model solution also accepted the answers where candidates discounted the cash flows in the RA for interest. While discounting is more consistent with the example in the LFV-141 study

note, I think it's usually important to read questions carefully and do things based on how the question instructs you, so I'm not discounting in my solution.

The FCF with RA = $-2137.89 + 304.35 = -1833.55$

Therefore, this product is profitable, and the CSM = 1833.55 so that the liability at issue is $\text{FCF} + \text{CSM} = \boxed{0}$

Product B Calculations

$$\text{CF}_0 = -2500$$

$$\text{CF}_1 = \frac{1200}{1.15} = 1043.48$$

$$\text{CF}_2 = \frac{1800}{1.15} = 1565.22$$

$$\text{ExpCF} = -2500 + \frac{1043.48}{1.04} + \frac{1565.22}{1.04^2} = -49.52$$

$$\text{RA} = 0.10 \times (1043.48 + 1565.22) = 260.87$$

$$\text{FCF} = -49.52 + 260.87 = 211.35 \Rightarrow \text{onerous!}$$

$$\text{CSM} = 0$$

$$\text{Liability} = \boxed{211.35}$$

Question 6

6(a)

(4 points)

Source: CIA Standards of Practice: Insurance Sections 2100, 2300, 2500. April 2017

Calculate the interest rate risk provision for adverse deviation (PfAD). Show all work.

The model solution is pretty comprehensive, as it shows the 2 alternative approaches, so there isn't much that I can add. It should be noted that the question asks to calculate the interest rate PfAD (which is the difference in liability between the worse case scenario and best estimate scenario). Therefore, it isn't necessary to perform CALM (i.e. have the last liability equal to zero). Both approaches aim to adjust the inforce assets such that it would have reduced the last liability CF to zero, without actually recalculating the liability (since this question is asking for the difference in liability anyway).

	2018	2019	2020	2021
Liab CF	0	-100	-1,200	-1,200
Asset CF				
Bond 1		100	1,100	
Bond 2		100	100	1,100
Net CF	0	100	0	-100

Best estimate scenario:

$$\text{Reinvest net CF (i.e. 100 in 2019) @ reinv rate} = 100 \times 1.05^2 = 110.25$$

$$\text{Surplus at 2021} = 110.25 + (-100) = 10.25$$

$$\text{PV of surplus @ reinv rate} = \frac{10.25}{1.05^3} = 8.85$$

Worst case scenario:

$$\text{Reinvest net CF (i.e. 100 in 2019) @ reinv rate} = 100 \times 1.02^2 = 104.04$$

$$\text{Surplus at 2021} = 104.04 + (-100) = 4.04$$

$$\text{PV of surplus @ reinv rate} = \frac{4.04}{1.02^3} = 3.81$$

$$\text{Inforce assets} = \text{MV bond A} + \text{MV bond B} = 1,100 + 1,200 = 2,300$$

Alternative 1 - take PV of surplus as top up/top down of assets

In other words, adjust the inforce MV of assets by the PV of surplus @ reinv (asset earned rate) under each scenario.

Adjusted inforce assets under best estimate scenario = $2,300 - 8.85 = 2,291.15$

Adjusted inforce assets under worst case scenario = $2,300 - 3.81 = 2,296.19$

Interest rate PfAD = $2,296.19 - 2,291.15 = 5.04$

Alternative 2 - take percentage of inforce assets based on PV surplus

% of inforce assets to adjust under best estimate scenario = $\frac{2,300-8.85}{2,300} = 99.615\%$

% of inforce assets to adjust under worst case scenario = $\frac{2,300-3.81}{2,300} = 99.8343\%$

Adjusted inforce assets under best estimate scenario = $2,300 \times 99.615\% = 2,291.15$

Adjusted inforce assets under worst case scenario = $2,300 \times 99.8343\% = 2,296.19$

Interest rate PfAD = $2,296.19 - 2,291.15 = 5.04$

6(b)

Source: LFV-141

Describe how interest rate risk is reflected under the IFRS 17 framework.

- Fulfillment cash flows Must reflect the time value of money using discount rates
- Discount rates must reflect the characteristics of the contract's cash flows (timing, currency, liquidity)
- Discount rates should be based on current observable interest rates with adjustments to align with the characteristics of the group of insurance contracts
- Insurers can choose to reflect the effect of DR changes in P&L or OCI
- If income volatility results in P&L or OCI due to interest rate changes, it indicates economic mismatches between assets and liabilities
- If the insurer is well matched, changes in assets due to interest rates will generally offset with changes in the liability due to interest rate changes

6(c)**(5 points)**

Source: CIA Educational Note: Currency Risk in the Valuation of Policy Liabilities for Life and Health Insurers, December 2009

Determine the Provision for Adverse Deviation for currency risk under CALM.

For the minimum 5% scenario, the model solution multiplies the ultimate Fx at the end of 5 years by (1-5%) instead of dividing it by 1.05 as it was taught in the online seminar and study note. This results in a slightly different PfAD. However, the general "spirit" is the same (i.e. reduce the ultimate Fx by 5%). The model solution I'm proving below is consistent with how it's taught in the online seminar and study note for consistency.

Base scenario:

$$\begin{aligned} \text{Fx at the end of 5 years} &= 1.3 \times \left(\frac{1.025}{1.0275}\right)^5 = 1.2843 \\ \text{Ultimate liability in USD} &= \frac{10,000}{1.2843} = 7,786.58 \\ \text{Current liability in USD} &= \frac{7,786.58}{1.0275^5} = 6,798.88 \\ \text{Current liability in CAD} &= 6,798.88 \times 1.3 = 8,838.54 \end{aligned}$$

Adverse scenario:

$$\begin{aligned} \text{Fx at the end of 5 years} &= 1.3 \times (1 - 0.03) = 1.261 \\ \text{Ultimate liability in USD} &= \frac{10,000}{1.261} = 7,930.21 \\ \text{Current liability in USD} &= \frac{7,930.21}{1.0275^5} = 6,924.30 \\ \text{Current liability in CAD} &= 6,924.30 \times 1.3 = 9,001.59 \end{aligned}$$

Min 5% scenario:

$$\begin{aligned} \text{Fx at the end of 5 years} &= \frac{1.284}{1.05} = 1.2231 \\ \text{Ultimate liability in USD} &= \frac{10,000}{1.2231} = 8,175.90 \\ \text{Current liability in USD} &= \frac{8,175.90}{1.0275^5} = 7,138.82 \\ \text{Current liability in CAD} &= 7,138.82 \times 1.3 = 9,280.47 \end{aligned}$$

Since the liability under the min 5% scenario (9,280.47) is greater than the adverse scenario (9,001.59), we will use the min 5% scenario as the valuation liability
Therefore:

$$\begin{aligned} \text{Currency PfAD} &= \text{Min 5\% scenario} - \text{Base scenario} \\ &= 9,280.47 - 8,838.54 \\ &= \boxed{441.93} \end{aligned}$$

6(d)

(3 points)

Source: CIA Standards of Practice: Insurance Sections 2100, 2300, 2500. April 2017,
CIA Educational Note: Margins for Adverse Deviations (Mfad) - November 2006,
Final Communication of a Promulgation of Prescribed MI Rates and MfADs

(i) Describe the key non-economic assumptions for the valuation of a Guaranteed Annuity Option.

Although the question provides a high level description of the GAO, it does take a little bit of background product knowledge to be able to provide a comprehensive solution to this question.

- Annuity mortality (longevity) assumption
 - The GAO provides policyholder the option to convert their accumulative value of GIC into a Life Contingent Payout annuity, the number of payments depends on the life status of the policy holder, the longer life expectancy, the higher cost of the GAO
- FMI assumption
 - The best estimate assumption mortality assumption would include mortality improvements

- Policyholder behaviour assumption
 - Option utilization and anti-selection, those who are healthier tends to utilize this option, as they see themselves more liable to receive more payments, plus it is a high face amount policy, according to the mortality study, higher face amount policy tends to have lower mortality rate
- Expense assumption
 - Administrative costs would be incurred for exercising this option

(ii) Describe the considerations for determining the MfAD for each assumption.

*This question is pretty straight forward. The key word in the question is **considerations**. If you picked up on this, you should think of the list of considerations associated with each of the non-economic assumptions described in the SoP. The model solution did not mention FMI MfADs, even though it was listed as one of the key assumptions in part (i).*

- Annuity mortality (longevity) assumption
 - The low and high MfADs are respectively a subtraction of 2% and 8% of the best estimate assumption (*Instructor's note: The annuity mortality MfAD range is -2% to -8% according to the current SoP. The -5% to -15% range stated in the SOA model solution is the old MfAD range as per the "Margins for Adverse Deviation" reading (published in 2006). Since both readings are on the syllabus, both would be considered acceptable on the exam.*)
 - Considerations leading to a margin of at least the average of the high and low margins included:
 - * Low credibility: the credibility of the company's experience and studies on GAO is possibly low
 - * Exposure to back-to-back arrangements
 - * Potential anti-selection: Policyholder who is healthier tends to utilize the GAO option
 - * Favorable medical developments may emerge
- FMI assumption
 - The MfAD for FMI is prescribed by the CIA and varies by attained age
 - The MfAD scale starts from 1.00% and grades down to 0.00% depending on the attained age
 - The MI MfAD is added to the best estimate MI assumption

- Policyholder behaviour assumption
 - SOP does not specifically discuss a standard range of margins for adverse deviations for policyholder options
 - It would be reasonable to assume a margin in the 5% to 20% range of the best estimate option utilization assumption
- Expense assumption
 - The low and high MfADs are respectively 2.5% and 10% of the best estimate assumption
 - Considerations leading to a margin of at least the average of the high and low margins included:
 - * Allocation of administrative costs is not based on a recent expense study
 - * Allocation of administrative costs is appropriate for best estimate assumption
 - * Frequency of exercising this option
- Sensitivity testing could be helpful when multiple assumptions interact to achieve a reasonable level of margin in aggregate

Question 7

7(a)

(3 points)

Source: CIA Standards of Practice: Insurance Sections 2100, 2300, 2500, April 2017, Initial Communication of Updated Promulgations of the Ultimate Reinvestment Rates and Calibration Criteria...June 2017

(i) Calculate the Insurance contract liability

Part (i) asks to calculate the best estimate liability, while part (ii) asks for the interest rate pfa (i.e. you need to calculate the valuation liability). The key to this question is to recognize that the reinvestment strategy of using free CFs to buy 1 year risk-free ZCB is another way of saying use the risk free rate to discount the liability CFs.

To determine the insurance contract liability (i.e best estimate liability), we need to first determine the risk-free yield curve for the CALM base scenario. Since the liability CFs are only for 3 years into the future from the balance sheet date (i.e. time 0), the CALM base scenario is simply defined as the Rf forward rates for the projection period. Because the reinvestment strategy is to buy 1 year risk-free ZCB, we will discount the free CFs at each period using the Rf. Lastly, since we are not given any inforce asset info, then the free CFs at each period is simply equal to the liability CFs.

Base scenario risk-free yield curve = 4.55% → 1-year forward rates for the projection period.

$$\text{PV liab CF @ time 0} = -1,000$$

$$\text{PV liab CF @ time 1} = \frac{500}{1.0455} = 478.24$$

$$\text{PV liab CF @ time 2} = \frac{500}{1.0455^2} = 457.43$$

$$\text{PV liab CF @ time 3} = \frac{700}{1.0455^3} = 612.53$$

$$\text{Best estimate liability} = -1,000 + 478.24 + 457.43 + 612.53 = \boxed{548.20}$$

(ii) Calculate the interest rate risk PfAD

The interest rate risk PfAD is defined as the insurance contract liability calculated under the worst prescribed scenario minus the base scenario. The worst prescribed scenario is given as PS 1 and the base scenario is calculated in part (i). Similar to part (i), we are only interested in the first 3 years of projection, so PS 1 can be defined as:

- Time 0 (balance sheet date): R_f = available on the market
 - $R_f = 4.55\%$
- Time 1: $R_f = 90\%$ of R_f at balance sheet date
 - $R_f = 90\% \times 4.55\% = 4.095\%$
- Time 20: $R_f = 10\%$ of R_f at balance sheet date + 90% of Ult-Low
 - $R_f = 10\% \times 4.55\% + 90\% \times 1.30\% = 1.625\%$
- R_f between time 1 and 20 is determined by using linear interpolation
 - Time 2: $R_f = \frac{4.095\% \times (20-2) + 1.625\% \times (2-1)}{20-1} = 3.965\%$

Using the same discounting approach as in part (i), except we are using different R_f forward rates:

$$\text{PV liab CF @ time 0} = -1,000$$

$$\text{PV liab CF @ time 1} = \frac{500}{1.0455} = 478.24$$

$$\text{PV liab CF @ time 2} = \frac{500}{1.0455 \times 1.04095} = 459.43$$

$$\text{PV liab CF @ time 3} = \frac{700}{1.0455 \times 1.04095 \times 1.03965} = 618.67$$

$$\text{Valuation liability} = -1,000 + 478.24 + 459.43 + 618.67 = 556.33$$

Therefore, the interest rate risk PfAD = $556.33 - 548.20 = \boxed{8.13}$

7(b)**(3 points)**

Source: Initial Communication of Updated Promulgations of the Ultimate Reinvestment Rates and Calibration. . . June 2017

(i) Explain the approach proposed by the Actuarial Standards Board for assessing the criteria shown in Table I.

Calibration criteria is satisfied if the stochastic risk-free interest rates produced are less than or equal to each of the left-tail calibration criteria and greater than or equal to each of the right-tail calibration criteria.

(ii) Determine whether the output from the model satisfies each criteria. Show all work.

This question is probably one of the few types of questions that can be asked from this study note. I've identified and illustrated something similar in my online seminar example for this lesson. A few tricky things to note about this question: (1) you must calculate the slopes before ranking them (i.e. the slopes are not calculated based on the ranked LT and ST rates), (2) the model solution does not provide the definition used for calculating percentiles.

Slope = long term Rf - short term Rf

Run	Long term Rf	Short term Rf	Slope
1	3.50%	3.25%	0.25%
2	2.50%	2.75%	-0.25%
3	8.75%	7.50%	1.25%
4	9.00%	8.00%	1.00%
5	4.75%	5.00%	-0.25%

Rearrange the runs from lowest Rf to highest Rf

Run	Long term Rf	Short term Rf	Slope
2	2.50%	2.75%	-0.25%
1	3.50%	3.25%	0.25%
5	4.75%	5.00%	-0.25%
3	8.75%	7.50%	1.25%
4	9.00%	8.00%	1.00%

It should be noted that there is no universal definition of percentile (or quartiles in this case). In particular, there is no explicit method to handle rounding. The model solution that I've provided below has a consistent method of handling rounding. This results in using a different term for the calibration criteria comparison, but ultimately yields the same answers since both the 4th and 5th term passed/failed the calibration criteria.

Since we're given the calibration criteria for the 25th and 75th percentile, we'll need to identify them using the table above:

- The 25th percentile term = $25\% \times (5+1) = 1.5$
 - We will round up $\rightarrow 2$
 - We will choose the 2nd term to represent the 25th percentile
- The 75th percentile term = $75\% \times (5+1) = 4.5$
 - We will round up $\rightarrow 5$ (for consistency)
 - We will choose the 5th term to represent the 75th percentile

Therefore:

Percentile	Long term Rf	Short term Rf	Slope
25 th	3.50%	3.25%	-0.25%
75 th	9.00%	8.00%	1.00%

To determine if the output of the model satisfies the calibration criteria, we will use the definition given in part (i):

- 25th percentile
 - LT: is 3.50% lower than 5.00%? Yes \rightarrow
 - ST: is 3.25% lower than 3.00%? No \rightarrow
 - Slope: is -0.25% lower than 0.00%? Yes \rightarrow
- 75th percentile
 - LT: is 9.00% greater than 8.00%? Yes \rightarrow
 - ST: is 8.00% greater than 7.25%? Yes \rightarrow
 - Slope: is 1.00% greater than 1.50%? No \rightarrow

7(c)**(1 point)**

Source: CIA Education Note, Investment Returns for Non-Fixed Income Returns for Assets, March 2011

(i) Describe the considerations the Chief Actuary would have used in setting this rate of return.

Another straight forward regurgitation question from the study note.

Select a benchmark return based on a broad-based market index, such as the S&P 500 and TSX for North American equities

- When selecting the benchmark, consider the investment objectives and the benchmark's historic returns
- The equity return will vary depending on the class and characteristics of the investments
- The selected best estimate return should not be more favourable than the historic benchmark return

(3 points)

Source: CIA Education Note, Investment Returns for Non-Fixed Income Returns for Assets, March 2011, CIA Standards of Practice: Insurance Sections 2100, 2300, 2500, April 2017

(ii) Calculate the CALM Liability using the new reinvestment strategy. Show all work.

The key point to note are the adjustments (MfADs and MV correction) made to the equity growth rate assumption. Be mindful that the MV correction can be interpreted as a decrease in the growth rate. Other than that, the rest of the solution follows the same methodology as in part (a).

According to the SoP, the growth rate for equities are subject to a MfAD of 20% and an additional MV correction of 30% for diversified North American portfolio, when the value of the portfolio is the greatest (typically at the valuation date).

Therefore:

- Best estimate equity growth rate = 6%
- MfAD = 20%
- MV correction at valuation date = -30%

- Valuation equity growth rate:
 - $6\% \times (1-20\%) - 30\% = -25.2\%$, at time 0
 - $6\% \times (1-20\%) = 4.8\%$, at time 1+

The reinvestment rate:

- Time 0 = $90\% \times 4.55\% + 10\% \times (-25.2\%) = 1.575\%$
- Time 1 = $90\% \times 4.095\% + 10\% \times 4.8\% = 4.1655\%$
- Time 2 = $90\% \times 3.965\% + 10\% \times 4.8\% = 4.0485\%$

$$\text{PV liab CF @ time 0} = -1,000$$

$$\text{PV liab CF @ time 1} = \frac{500}{1.01575} = 492.25$$

$$\text{PV liab CF @ time 2} = \frac{500}{1.01575 \times 1.041655} = 472.56$$

$$\text{PV liab CF @ time 3} = \frac{700}{1.01575 \times 1.041655 \times 1.040485} = 635.85$$

$$\text{Valuation liability} = -1,000 + 492.25 + 472.56 + 635.85 = \boxed{600.66}$$

Question 8

8(a)

(2 points)

Source: CIA Educational Note: Valuation of Universal Life Policy Liabilities, CIA Educational Note: Best Estimates Assumptions for Expenses

Explain differences in the unit expense valuation assumptions for Universal Life (UL) Insurance products versus Whole Life Insurance products.

*The main difference between UL and WL products pertaining to expenses is the additional admin/systems expenses for UL products. These additional expenses are for various items such as keeping track of flexible premiums, investment options etc. The key point to getting full credit is to discuss the differences in the **unit expenses** between these two products. The model solution does a good job of breaking down the differences.*

- Compared to Whole Life products, UL products have additional complexities resulting from the following additional items to consider:
 - Policyholder options, and the rate at which options are exercised
 - Exempt testing
 - Costs for policy-owner reporting / annual statements
 - Automatic policy modifications (e.g. fund bonuses, COIs varying by duration etc)
 - Additional expenses if COIs are adjustable
- As a result of these additional product features, the following unit expenses arise only in UL products and not WL products:
 - Investment expenses need to be allocated
 - Loadings to recover acquisition expenses may be higher
 - If expense charges adjustable, the company would need to quantify how any change in admin expenses are passed along
 - MfADs may be different/higher due to changes in policyowner behavior, options, and anti-selection
 - Also need to account for explicit expense charges

- Acquisition, administration, and claim expenses usually vary by line of business and within a line of business by product type. Therefore, unit measures usually are established at the product line level

8(b)

(5 points)

Source: CIA Educational Note: Valuation of Universal Life Policy Liabilities, CIA Educational Note: Best Estimates Assumptions for Expenses

(i) Recommend changes, if any, to the valuation expense assumptions used for the new enhanced UL product given the information above, with respect to best estimate assumptions.

This question is a little tricky because they give you a lot of information about this new product. However, not all of the information is relevant to answering the question. For example, the option to double the index growth rate (yay gambling!) has very little to no impact on changes to the best estimate expense assumption. This is because the expense arises from keeping track of the index, which is already in place for the existing product, applying a scalar to that index return should incur little to no extra expense. Another key point to scoring full credit on this question is the analysis of the recent expense study and how that pertains to the projected expense assumptions for the new product. Finally, this question is fairly open-ended, which gives the student freedom in their responses. Since this is worth 5 points, the graders will be expecting a good amount of verbiage in the solution. With these types of questions, I recommend keeping your solutions organized and easy to read (e.g. major talking points and then bullet points for details like in the model solution). This makes the grader's job easier and prevents your responses from deviating.

- Given the information on historical growth and projected future growth
 - The huge success on traditional block is a good indicator of future growth (and productivity gains) for UL
 - Assess how prior experience can guide future experience
 - May expect to see decrease in unit expenses from growth, but will need to see expense study that bears this out
 - May project improvements in economies of scale beyond the valuation date
- Since BDC management has successfully reduced unit expenses over the past few years:
 - Need management to have a clear plan to reduce expenses and a prior history of successfully reducing

- Future productivity gains are assumed for only a temporary period
- Look at productivity improvements in different LOBs to ensure net productivity assumption is reasonable in aggregate
- With regard to BDC plans to market the new UL product aggressively:
 - Need to determine whether the expenses from the marketing campaign are non-recurring
- With the information given on the new features of the UL product:
 - For the option to go reduced paid-up - need to estimate usage rates and change unit expenses after election
 - Investment expenses will be higher because of new investment options
 - Might need different type of annual statement to cover all options
 - Seg funds/separate accounts:
 - * Expenses and revenue from related management expense charges are included in valuation CFS
 - * Regulatory expense increase because of seg fund investment option
- Marketing and product development expenses should be excluded
- For the option to switch COI schedules: it may be influenced by the investment or mortality outcomes but the impact is little for expenses

(2 points)

Source: CIA Educational Note: Valuation of Universal Life Policy Liabilities, CIA Educational Note: Best Estimates Assumptions for Expenses, CIA Use of Actuarial Judgment in Setting Assumptions and Margins for Adverse Deviations, CIA Educational Note: Margins for Adverse Deviations (MfAD) - November 2006

(ii) Recommend changes, if any, to the valuation expense assumptions used for the new enhanced UL product given the information above, with respect to MfADs.

The margin range is between 2.5% and 10% of the best estimate assumptions, as per the SoP. However, given the following considerations, it should be set to at least the midpoint of that range:

- Since this is a new product, there has not been any expense study yet, therefore there is higher risk in the estimation of future

- The new product is doubling the return on the index, and the best estimate assumption from the original product may not be a good representation of the new product in the future
- The new design of this product may affect the distribution of inforce, and the estimation based on existing distribution (of the UL product to be replaced) may be affected

Another factor to consider is whether the insurer is slow to protect itself against changes, which is not the case for BDC Company, since it was able to successfully handle the changes in the traditional block in recent years.

Question 9

9(a)

(2 points)

Source: OSFI Draft Guideline - Life Insurance Capital Adequacy Test (LICAT), Chapters 1 - 3, 5 - 9, 11, Sept 2017

(i) Identify the types of provisions for adverse deviations (PfADs) that can be included in the Surplus Allowance under LICAT.

The solution is taken straight out of the study note, so there's not much to consider except for pure memorization.

The PfADS that can be included in the Surplus Allowance under LICAT are based on PfADS calculated under CALM, and is the sum of the following two components:

1. PfADs related to scenario assumptions for Rf interest rates (excluding those related to seg funds), calculated net of all reinsurance
2. PfADs for non-economic assumptions (excluding those related to seg funds), calculated net of registered reinsurance only

PfADs associated with economic assumptions other than those for Rf interest rates (e.g. credit spreads, Fx and investment expenses), operational risk and seg funds are excluded from Surplus Allowance.

Source: CIA Draft Educational Note: Life Insurance Capital Adequacy Test (LICAT) and Capital Adequacy Requirements for Life and Health Insurance (CARLI), June 2017

(ii) Explain the reasons for the exclusion of certain types of PfADs in the Surplus Allowance.

*It should be noted that this pertains only to **economic** PfADs. Again, this is taken directly from the study note.*

In general, economic PfADs would be included in the surplus allowance only when the corresponding required capital component in the base solvency buffer (BSB) reflects a terminal provision (versus only a one-year shock). If an economic PfAD is not listed as included in this section, it would be excluded from the surplus allowance.

9(b)**(2 points)**

Source: OSFI Draft Guideline - Life Insurance Capital Adequacy Test (LICAT), Chapters 1 - 3, 5 - 9, 11, Sept 2017

(i) Determine the shock level for the mortality level risk component. Show all work.

The first step you should do is to determine whether the product(s) is life-supported or death-supported, which the SOA model solution neglected to do.

The shock level for the mortality level risk component can be determined using the following steps:

1. Designation of life or death-supported business
 - The absolute increases in deaths (i.e. mortality) result in increases in the PV of CFs → the block of business is life-supported
2. Define the equation for level risk
 - For life-supported business, the level risk for the insurance risk component is calculated as:

(1 + Factor) × best estimate mortality rate, where Factor is the lesser of (i) or (ii):

 - (i) 11% + 20% of the ratio of the calculated volatility component to the following year's net expected claims; or
 - (ii) 25%
 - The shock level for the mortality level risk component is denoted by the "Factor" in this equation. In other words:

$$\text{Factor} = \text{MIN} \left[11\% + 20\% \times \left(\frac{\text{Volatility component}}{\text{The following year's net expected claims}} \right), 25\% \right],$$

Where the following year's net expected claims = 30,000 → (given)

3. Calculate volatility component

- The volatility risk component, denoted RC is defined as:

$$RC = 2.7 \times A \times \frac{E}{F}, \text{ where:}$$

A = SD of next year's projected net death claims = 3,889 → (given)

E = Total NAAR = 1,000,000 → (given)

F = Total face = 3,500,000 → (given)

- Therefore, $RC = 2.7 \times 3,889 \times \frac{1}{3.5} = 3,000$

4. Plug RC into equation in step 2 and solve for "Factor"

$$\begin{aligned} \text{Factor} &= \text{MIN} \left[11\% + 20\% \times \frac{3,000}{30,000}, 25\% \right] \\ &= \text{MIN}[11\% + 2\%, 25\%] \\ &= \boxed{13\%} \end{aligned}$$

(4 points)**(ii) Determine the overall risk requirement for mortality risk. Show all work.**

The overall risk requirement for mortality risk can be determined using the following steps:

1. Define the equation for the mortality risk component

- The required capital for mortality risk is defined as:

$$RC_{\text{mort}} = \sqrt{RC_{\text{vol}}^2 + RC_{\text{cat}}^2} + RC_{\text{level}} + RC_{\text{trend}}$$

2. Calculate RC_{vol}

$$RC_{\text{vol}} = 3,000 \rightarrow \text{as per part (i)}$$

3. Calculate RC_{cat}

- RC_{cat} is defined as: PV shock CF - PV B/E CF, where the catastrophe risk shock is an absolute increase in the number of deaths per 1000 one year after the balance sheet date, and varies by location. For Canada, this increase is 1.0
- PV shock CF of an increase in deaths by 1 per 1000 = 17,500 → (given)

- PV B/E CF = 16,000 → (given)

$$RC_{\text{cat}} = 17,500 - 16,000 = 1,500$$

4. Calculate RC_{level}

- RC_{level} is defined as: PV shock CF - PV B/E CF, where the level risk shock is 13%, as per part (i)
- Since it is appropriate to approximate the mortality risk component by adjusting the shocked impact proportionally, therefore:

$$\begin{aligned} RC_{\text{level}} &= \text{PV of 13\% increase shock CF} - \text{PV B/E CF} \\ &= 13\% \times \frac{(\text{PV shock CF} - \text{PV B/E CF})_{(\text{for a 10\% increase in mortality assumption})}}{10\%} \\ &= 13\% \times \frac{2,000}{10\%} \\ &= 2,600 \end{aligned}$$

5. Calculate RC_{trend}

- RC_{trend} is defined as: PV shock CF - PV B/E CF, where the trend risk shock is a permanent 75% decrease to the best estimate assumption for MI for 25 years, and then 100% decrease thereafter (i.e. no MI)
- Since it is appropriate to approximate the mortality risk component by adjusting the shocked impact proportionally, therefore:

$$\begin{aligned} RC_{\text{trend}} &= \text{PV of 75\% decrease shock CF} - \text{PV B/E CF} \\ &= 75\% \times \frac{(\text{PV shock CF} - \text{PV B/E CF})_{(\text{for a 10\% reduction in FMI for first 25 years})}}{10\%} \\ &= 75\% \times \frac{400}{10\%} \\ &= 3,000 \end{aligned}$$

6. Plug the values from steps 2-5 into the equation in step 1

$$\begin{aligned} RC_{\text{mort}} &= \sqrt{3,000^2 + 1,500^2} + 2,600 + 3,000 \\ &= \boxed{8,954} \end{aligned}$$

(1 point)

(iii) Explain the difference between the Life Insurance Capital Adequacy Test (LICAT) Total Ratio and LICAT Core Ratio.

Another question that's straight out of the study note. Given that it's worth only 1 point, there isn't a need to provide that much information in your solution.

The LICAT total ratio and core ratio measures capital adequacy and is one of several indicators for assessing an insurer's financial condition. Ratios should not be used in isolation for ranking and rating insurers.

- Total Ratio focuses on policyholder and creditor protection:

$$\text{Total Ratio} = \frac{\text{Available Capital} + \text{Surplus Allowance} + \text{Eligible Deposits}}{\text{BSB}}$$

- Core Ratio focuses on financial strength:

$$\text{Core Ratio} = \frac{\text{Tier 1 Capital} + 70\% \times (\text{Surplus Allowance} + \text{Eligible Deposits})}{\text{BSB}}$$

(3 points)

(iv) Determine the LICAT Total and Core Ratios and assess whether they meet minimum and supervisory levels.

$$\begin{aligned} \text{Available Capital} &= \text{Net tier 1 capital} + \text{Net tier 2 capital} \\ &= 12,000 \text{ (given)} + 7,000 \text{ (given)} \\ &= 19,000 \end{aligned}$$

$$\text{Surplus allowance} = 1,000 \rightarrow \text{(given)}$$

$$\text{Eligible deposits} = 500 \rightarrow \text{(given)}$$

$$\text{BSB} = 1.05 \times (\text{Aggregate required capital} - \text{Credits})$$

Where:

$$\text{Aggregate required capital} = \text{Credit risk RC} + \text{Market risk RC}$$

$$+ \text{Insurance risk RC (lapse risk} + \text{mortality risk)} + \text{Op risk RC}$$

$$= 1,000 \rightarrow \text{(given)} + 2,000 \rightarrow \text{(given)}$$

$$+ 3,000 \rightarrow \text{(given)} + 8,954 \text{ (calculated in part (ii))} + 3,000 \rightarrow \text{(given)}$$

$$= 17,954$$

$$\text{Credits} = 0 \rightarrow \text{since there are no diversification benefits between risks}$$

$$\text{BSB} = 1.05 \times 17,954 = 18,852$$

Using the formulas defined in part (iii):

$$\begin{aligned}\text{Total ratio} &= \frac{19,000 + 1,000 + 500}{18,852} \\ &= \boxed{109\%} \\ \text{Core ratio} &= \frac{12,000 + 70\% \times (1,000 + 500)}{18,852} \\ &= \boxed{69\%}\end{aligned}$$

The supervisory and minimum target ratios are as follows:

	Total ratio	Core ratio
Supervisory target	100%	70%
Minimum	90%	55%

The total ratio of 109% meets the supervisory target, but the core ratio of 69% only meets the minimum target, but not the supervisory target.

Question 10

10(a)

(2 points)

Source: CIA Educational Note: Future Income and Alternative Taxes

Determine whether the given situations create a "permanent" or "temporary" tax difference for Canadian insurers. Justify your response:

- (i) **Income from Canadian subsidiaries**
 - (ii) **Real estate re-valuation**
 - (iii) **Net capital gains on real estate**
 - (iv) **Differences between GAAP and tax reserves**
- Permanent differences - difference in income in reporting periods between tax and GAAP are not fully reversed over the lifetime of the item
 - Temporary differences - difference in income in reporting periods between tax and GAAP, which are fully reversed over the lifetime of the item (i.e. timing differences)
- (i) This is a permanent difference. Income in reporting periods between tax and GAAP are not fully offset or reversed over the lifetime
 - (ii) This is a temporary difference. GAAP uses market value or amortized cost for real estate; while it is valued at depreciated cost for tax purpose
 - (iii) This is a permanent difference. Only a portion of net capital gains on real estate is included in taxable income
 - (iv) This is temporary difference. Period to period differences in GAAP and tax income are fully offset (or reversed) over the lifetime of the item

10(b)**(3 points)****Source: CIA Educational Note: Future Income and Alternative Taxes****Determine whether the following are considered sources of recovery for tax losses which can be used in the valuation of policy liabilities. Justify your response.**

Although anything on the syllabus is fair game on the exam, I don't really understand the point of these types of pure regurgitation questions. This simply forces candidates to memorize chunks of information that takes focus away from the main concept of the study note, but I digress.

- (i) Expected releases of provisions for adverse deviation (PfAD) in the insurance contracts
 - This is not considered a source of recoverability. Income is expected to be zero and PfADs are not released
- (ii) Taxable investment income on current surplus
 - This is considered a source of recoverability for income earned from current surplus (net of MfADs). This item does not include planned future capital injections
- (iii) Taxable income arising from annuity contracts
 - This is considered a source of recoverability. Income emerges as annuity business runs off
- (iv) Future new business arising from the sale of new insurance contracts
 - This is not considered a source of recoverability. Uncertainty of future profits and management decisions associated with future new business
- (v) Renewals of group life and health business
 - This is not considered a source of recoverability. Cashflows for group and health business is beyond the term of liabilities
- (vi) Expected gains from future mortality improvements on insurance contracts
 - This is not considered a source of recoverability. Income is expected to zero from future mortality improvement

10(c)**(4 points)****Source: CIA Educational Note: Future Income and Alternative Taxes****Calculate the insurance contract liability after carve-out as at year-end 2018. Show all work.**

This question is similar to the example walkthrough I did in the online seminar (scenario 3). I used the same approach to this question, as I did with the walkthrough. It should be noted that the ICLACO equation is: $ICLACO = ICLBCO - FTCO$ (the SOA model solution adds the FTCO, which is incorrect).

Formulas:

$$ICLIFT = \text{Stat reserves}$$

$$\text{After-tax discount rate} = \text{Discount rate} \times (1 - \text{tax rate})$$

$$\text{Taxable income from temp differences} = \Delta ICLIFT - \Delta MTAR$$

$$\text{Future tax CF} = \text{Taxable income from temp differences} \times \text{tax rate}$$

$$DFTP = \text{PV of Future tax CF @ after-tax discount rate}$$

$$\text{After-tax discount rate} = 5\% \times (1 - 40\%) = 0.03$$

	2018	2019	2020
Taxable income from temp differences	0	-50	-150
Future tax CF	0	-20	-60
DFTP	-75.97	-58.25	0

More formulas:

$$ICLBCO = ICLIFT + DFTP$$

$$FTCO = t_x \times \frac{[MTAR - (ICLIFT + DFTP)] + (GAAP_A - T_{XA})}{1 - t_x}$$

$$ICLACO = ICLBCO - FTCO$$

$GAAP_A - T_{XA} = 0 \rightarrow$ since GAAP asset values are equal to tax asset values (given)

	2018	2019	2020
ICLBCO	1,124.03	1,041.75	0
FTCO	-82.68	-61.17	0
ICLACO	1,206.71	1,102.91	0

Therefore, the ICLACO at year-end 2018 is 1,206.71