FCIA SYLLABUS: READING LIST

Property and casualty track

Exam F1PC: Pricing

The aim of this exam is for candidates to develop the following skills:

1. Understand the main principles and techniques of pricing that are relevant to P&C insurance (including reinsurance), including techniques to estimate the key components of a technical price.
2. Apply these principles and techniques within the context of P&C insurance.
3. Understand how pricing links to wider business processes (e.g., business planning, estimating unpaid claims, and capital setting.
4. Create and evaluate hypothetical scenarios, including using judgement to assess the implications of possible actions and to develop appropriate proposals or recommendations relating to pricing P&C insurance products.

1. Principal terms

1. Define the principal terms used in pricing P&C insurance products. (A1)

Reading reference	Source
	Principal terms are identified and defined in the readings included in the syllabus for this exam.

2. Regulations and applicable standards (15%)

1. Apply relevant legislation and regulations applicable to actuarial pricing, including automobile insurance legislation in Ontario and Alberta, rate filing requirements, and residual market mechanisms. (A3)
2. Apply actuarial professionalism requirements applicable to pricing analyses. (B3)

Reading reference	Source
Friedland J. 2013. Fundamentals of General Insurance Actuarial Analysis. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapters 1,2, 4,6-9, 26, 28, 30.	https://www.actexmadriver.com/orderselection.aspx?id=453147551
Automobile Insurance Advisory Committee. 2020. *Report on Fundamental Reform of The Alberta Automobile Insurance Compensation System*. Edmonton (AB): Government of Alberta. p. 14-42.	tbf-report-on-fundamental-reform-of-alberta-automobile-insurance-compensation-system.pdf
Financial Services Regulatory Authority of Ontario (FSRAO) Private Passenger Automobile Filing Guidelines – Major. Toronto (ON): FSCO. p. 1-5, 11-21; Appendix B2.	https://www.fsrao.ca/media/7681/download
Insurance Act, Ontario RRO 1990, Reg. 664. Sections 1-5, 16.	https://www.ontario.ca/laws/regulation/900664
Alberta Superintendent of Insurance Interpretation Bulletin	https://open.alberta.ca/dataset/9e781ed4-de90-47b5-b57f-4ab96bdc7325/resource/871511e4-5444-49d3-8824-f6ba81af2869/download/tbf-superintendent-of-insurance-2023-07-bulletin.pdf

Alberta AIRB: Technical Guidance Change in Rates and Rating Programs	https://albertaairb.ca/wp-content/uploads/2023/02/AIRB-Technical-Guidance-2023-02.pdf
Insurance Bureau of Canada (IBC). 2010. *Code of Conduct for Insurers' Use of Credit Information*. Toronto (ON): IBC.	http://assets.ibc.ca/Documents/Consumer%20Protection/Code_of_Conduct.pdf
CIA Standards of Practice. Sections 1240, 1400, 1500, 1600, 1700, 2600.	https://www.cia-ica.ca/docs/default-source/standards/sc010123e.pdf

3. Data (10%)

1. Differentiate the types of data (including claims and expenses) and information required for pricing (including analyses of aggregate rate level, classification, and large account), their sources, and main uses. (A4)
2. Apply the concepts of homogeneity and credibility in selecting data for pricing analyses. (B3)
3. Understand the implications to data requirements of different characteristics of insurance (e.g., long tail vs. short tail, low frequency/high severity vs. high frequency/low severity lines of business). (B2)
4. Evaluate the influence of the insurer's internal environment (such as changes in operations or information technology) on data used for pricing analyses. (B5)
5. Evaluate the influence of external environments (such as economic and judicial decisions and environmental changes) on data used for pricing analyses. (B5)
6. Understand the possible causes of data errors and the effects of inadequate data and information. (B2)
7. Create appropriate data-validation processes. (C6)

Reading reference	**Source**
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapters 4, 5 and Appendix H.	https://www.actexmadriver.com/orderselection.aspx?id=453147551

4. Catastrophe modelling (5%)

1. Describe the practical considerations involved in catastrophe modelling. (C2)
2. Describe a catastrophe model, including the basic structure, key perils modelled, components (including event hazard, exposure, vulnerability, and financial analysis) and outputs (including event distributions and simulations), and their uses. (B2)
3. Apply outputs from the catastrophe-modelling process to the overall rate level indication. (C3)

Reading reference	**Source**
CIA/CAS/SOA Research Paper*: Incorporation of Flood and Other Catastrophe Model Results Into Pricing and Underwriting*.	https://www.cia-ica.ca/docs/default-source/2018/218103e.pdf
Institute of Actuaries of Australia. 2022. *General Insurance and Health Pricing and Portfolio Analytics (GIHPPA)*. Sydney (AU): Institute of Actuaries of Australia. Module 7: Catastrophe modelling.	Documentation will be provided by the CIA at the time of registration for the exam.

5. Pricing – overall rate level indication (25%)

1. Calculate and evaluate the overall rate level indication using the following techniques: (C5)
    a. Loss ratio.
    b. Pure premium.
    c. Burning cost.
    d. Frequency severity.
    e. Loss curve.
2. For each of the above techniques:
    a. Understand the assumptions and mechanics, including the application of credibility. (C2)
    b. Analyze assumption changes and determine their influence on the results of the overall rate level indication. (C4)
    c. Evaluate the technique with varying data quality and completeness, and in different situations. (D5)
    d. Describe the strengths and limitations of each technique and the impact of these limitations on results. (D2)
    e. Select the appropriate technique and assumptions given a specific use case. (D5)
3. Define and calculate various components of a technical premium, including: (C3)
    a. Expected claims and adjustment expenses.
    b. Expense loading(s).
    c. Reinsurance costs and benefits.
    d. Profit margin.
    e. Investment return.
    f. Capital requirements and return on capital.
4. Create experience investigations and evaluate the results considering: (D6)
    a. Data inaccuracy, scarcity, or incompleteness.
    b. Varied exposure measures.
    c. Risk relativities.
    d. Seasonality of claims.
    e. Net margin changes.
    f. Large losses and catastrophe events.
    g. Analysis by peril or type of claim.
5. Adapt pricing techniques to allow for frequency and severity distributions. (C3)
    a. Reflect the differences between short-tail vs. long-tail business and occurrence vs. claims-made coverages in pricing analyses. (C3)
6. Respond to practical considerations, including operational and regulatory constraints, that influence insurance pricing. (C5)
7. Evaluate how the pricing of competitor products influences price setting. (B5)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapters 3,6-7,12-13, 26-27, 30-32.	https://www.actexmadriver.com/orderselection.aspx?id=453147551
Institute of Actuaries of Australia. 2022. *General Insurance and Health Pricing and Portfolio Analytics (GIHPPA)*. Sydney (AU): Institute of Actuaries of Australia. Module 4: Pricing process (Section 4.8).	Documentation will be provided by the CIA at the time of registration for the exam.

6. Pricing – segmentation (25%)

1. Understand how the concepts of segmentation, adverse selection, product hierarchy, and regulations influence pricing. (B2)
2. Demonstrate the need to price for different levels of risk and the consequences for portfolio performance if no risk-based pricing is employed. (C3)
3. Apply and evaluate different pricing techniques for segmentation analysis, including: (C5)
    a. Simple tabular analysis.
    b. Generalized linear models (GLMs).
    c. Machine-learning models and neural networks.
4. Describe data mining and non-parametric approaches. (C2)
5. For each of the techniques in 6.3:
    a. Understand the assumptions and mechanics of the technique, including the application of credibility and off-balance considerations. (C2)
    b. Validate the underlying data and the output of the model or technique. (C5)
    c. Evaluate the appropriateness and limitations of various segmentation techniques for a given use case, including the application of a credibility-weighting technique. (D5)
6. For GLMs and multivariate modelling:
    a. Apply GLMs to the rating of personal-lines business and small commercial risks. (C3)
    b. Understand the different types of multivariate models. (C2)
    c. Apply multivariate models in pricing. (C3)
    d. Select the appropriate error structures and link functions. (C4)
    e. Analyze residual charts, parameter estimates, and other GLM and multivariate model output. (C4)
    f. Analyze and correct errors for given GLM and multivariate model outputs. (C4)
7. Apply calculations relating to a range of pricing matters, including:
    a. Allowance for excesses and deductibles. (C3)
    b. Treatment of granular rating factors such as geography, vehicle characteristics, and occupations. (C3)
    c. Treatment of natural hazards and catastrophes. (C3)
8. Adopt a pricing technique to allow for government-mandated or monitored rates. (C3)
9. Recognize and allow for the key features that relate to long-tail business pricing, including:
    a. Linkage with outstanding claims analysis. (C3)
    b. Exposure analysis. (C3)
    c. Setting and application of economic assumptions. (C3)
    d. Other product-specific features. (C3)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapters 6, 33.	https://www.actexmadriver.com/orderselection.aspx?id=453147551
American Academy of Actuaries. 2021. *Big Data and Algorithms in Actuarial Modeling and Consumer Impacts*. Washington (DC): American Academy of Actuaries. p. 6-34, 50-55.	https://www.actuary.org/sites/default/files/2021-11/BigData_and_Algorithms_in_Actuarial_Modeling_and_Consumer_Impacts.pdf

SOA Research Report: *Machine-Learning Methods for Insurance Applications: A Survey*.	https://www.soa.org/globalassets/assets/Files/resources/research-report/2019/machine-learning-methods.pdf
Goldburd M, Khare A, Tevet D, Guller D. 2020. *Generalized Linear Models for Insurance Rating*. 2nd ed. Arlington (VA): Casualty Actuarial Society, Chapters 1-9. (CAS Monograph Series; No. 5).	https://www.casact.org/sites/default/files/2021-03/8_GLM.pdf
Institute of Actuaries of Australia. 2022. *General Insurance and Health Pricing and Portfolio Analytics (GIHPPA)*. Sydney (AU): Institute of Actuaries of Australia. Module 4: Pricing process (Section 4.7), Module 5: Pricing for portfolio UW business.	Documentation will be provided by the CIA at the time of registration for the exam.

7. Pricing – large account pricing (5%)

1. Describe the particular considerations when pricing large commercial risks, including considerations related to credibility. (B2)
2. Describe alternative approaches to pricing large commercial risks. (A2)
3. Apply appropriate pricing techniques for large accounts. (C3)
4. Evaluate the appropriateness and limitations of various pricing techniques for a given scenario, product, or set of data. (D5)
5. Perform and evaluate calculations relating to a range of pricing matters, including:
    a. Allowance for aggregate deductibles and limits. (C5)
    b. Allowance for loss-responsive policy conditions. (C5)
    c. Treatment of self-insured retentions. (C5)
    d. Claims-sharing arrangements. (C5)
    e. Incorporation of underwriting views in a rigorous pricing framework. (C5)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapters 34, 36.	https://www.actexmadriver.com/orderselection.aspx?id=453147551

8. Pricing – reinsurance (10%)

1. Describe the similarities and differences between pricing direct and reinsurance business. (B2)
2. Calculate appropriate premiums for each of the following types of reinsurance:
    a. Proportional reinsurance. (C3)
    b. Non-proportional reinsurance. (C3)
    c. Property catastrophe reinsurance. (C3)
    d. Stop loss. (C3)
3. Describe the data required to determine appropriate premiums for each of the above types of reinsurance. (A2)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapter 10.	https://www.actexmadriver.com/orderselection.aspx?id=453147551
CIA/CAS/SOA Research Paper*: Incorporation of Flood and Other Catastrophe Model Results Into Pricing and Underwriting*.	https://www.cia-ica.ca/docs/default-source/2018/218103e.pdf sections 5-8

9. Portfolio analytics (5%)

1. Create a portfolio analytics framework for a P&C insurer. (C6)
2. Create framework(s) to monitor: (C6)
    a. Exposures (e.g., retention, closing, mix of business).
    b. Pricing actions (e.g., product and underwriting initiatives).
    c. Claims experience; and
    d. Compliance.
3. Understand the rationale and practical considerations that apply in measuring price elasticity and cross-selling opportunities. (B2)
4. Understand the rationale and practical considerations that apply in exposure management. (B2)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapter 37.	https://www.actexmadriver.com/orderselection.aspx?id=453147551
Institute of Actuaries of Australia. 2022. *General Insurance and Health Pricing and Portfolio Analytics (GIHPPA)*. Sydney (AU): Institute of Actuaries of Australia. Module 9: Portfolio analytics.	Documentation will be provided by the CIA at the time of registration for the exam.

Note: Candidates are strongly encouraged to review the Appendices of Fundamentals of General Insurance Actuarial Analysis, which includes the consolidated exhibits for the insurers used in the examples of the main text as well as six additional detailed examples.

Exam F2PC: Estimating Unpaid Claims and Financial Reporting under IFRS 17 – *Insurance Contracts*

The aim of this exam is for candidates to develop the following skills:

1. Understand the main principles and techniques for estimating unpaid claims and claims-related expenses (hereafter referred to simply as "claims") that are relevant to P&C insurance (including reinsurance).
2. Apply these principles and techniques within the context of P&C insurance.
3. Evaluate the considerations involved in selecting a best estimate of unpaid claims.
4. Understand how estimating unpaid claims links to wider business processes (e.g., business planning, pricing, financial reporting, and capital setting).
5. Describe IFRS 17 – *Insurance Contracts* (hereafter referred to as "IFRS 17") and calculate actuarial values for financial reporting under IFRS 17.
6. Create appropriate proposals and recommendations related to estimates of unpaid claims and IFRS 17 financial reporting in P&C insurance business.
7. Evaluate hypothetical scenarios, including using judgement to assess the implications of possible actions.

1. Principal terms

1. Define principal terms used in the estimation of unpaid claims and IFRS 17 financial reporting for P&C insurers. (A1)

Reading reference	Source
	Principal terms are identified and defined in the readings included in the syllabus for this exam

2. Regulations and applicable standards (15%)

1. Apply legislation (e.g., the *Insurance Companies Act*) and regulations (e.g., Office of the Superintendent of Financial Institutions guidelines) relevant to the Appointed Actuary's valuation for financial reporting purposes. (A3)
2. Apply actuarial professionalism requirements applicable to the estimation of unpaid claims and IFRS 17 financial reporting. (B3)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapters 1, 2, 4, 6, 7, 8, 9, 26, 28, 30.	https://www.actexmadriver.com/orderselection.aspx?id=453147551
Office of the Superintendent of Financial Institutions (OSFI). 2003 [last revised 2012 Sep]. Guideline E-15: *Appointed Actuary: Legal Requirements, Qualifications and Peer Review*. Ottawa (ON): OSFI. This document will be rewritten during the summer.	https://www.osfi-bsif.gc.ca/Eng/Docs/e15_final.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2023. *IFRS 17 Property and Casualty Memorandum to the Appointed Actuary – 2023*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/Docs/PC_AA_Memo_2023.pdf
Insurance Companies Act, SC 1991, c. 47. Sections 357-370, 464, 625-632, 664, 665, 667(1), 667(2). (Updated to December 12, 2017.)	https://laws-lois.justice.gc.ca/eng/acts/i-11.8/page-55.html#h-265344

CIA Standards of Practice. 1240, 1400, 1500, 1600, 1700, 2100, 2200, 2400.	https://www.cia-ica.ca/docs/default-source/standards/sc010123e.pdf

3. Data (10%)

1. Differentiate the types of data (including claims and exposures) and information required for estimating unpaid claims, their sources, and main uses. (A4)
2. Build development triangles. (C3)
3. Differentiate the types of data and information required for IFRS 17 financial reporting, their sources, and main uses. (A4)
4. Apply the concepts of homogeneity and credibility of data in estimating unpaid claims and for IFRS 17 financial reporting. (B3)
5. Understand the implications to data requirements of different characteristics of insurance (e.g., long tail vs. short tail, low frequency/high severity vs. high frequency/low severity lines of business). (B2)
6. Organize data by calendar year, accident year, policy year, underwriting year, and report year, and understand when each is appropriate. (C3)
7. Evaluate the influence of the insurer's internal environment (such as changes in operations or information technology) on data used for estimation of unpaid claims and IFRS 17. (B5)
8. Evaluate the influence of external environments (such as economic and judicial decisions) on data used for estimation of unpaid claims and IFRS 17. (B5)
9. Understand the possible causes of data errors and the effects of inadequate data and information. (B2)
10. Create appropriate data-validation processes. (C6)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapters 4, 5 and Appendix H.	https://www.actexmadriver.com/orderselection.aspx?id=453147551

4. Estimating unpaid claims – basic topics (25%)

1. Describe the purpose of estimating unpaid claims for P&C insurers, including:
    a. The reasons for calculating estimates of unpaid claims and how these might influence the approach (such as financial reporting, financial planning and analysis, and pricing) (A2); and
    b. The key stakeholders and their interests in the results of estimates of unpaid claims. (A2)
2. Use development triangles (including claims, allocated loss-adjustment expense, counts, ratios, and average values) as a diagnostic tool. (D4)
3. Analyze the range of general issues that can affect estimation of unpaid claims using triangle-based techniques and identify how to deal with such issues. (D4)
4. Calculate and evaluate estimates of unpaid claims using the following techniques: (C5)
    a. Development.
    b. Expected claim.
    c. Bornhuetter-Ferguson.
    d. Cape Cod.
    e. Benktander.
    f. Frequency severity.
    g. Berquist-Sherman.
5. For each of the above techniques:

a. Understand the assumptions and mechanics. (C2)
b. Analyze assumption changes and determine their influence on the results of estimates of unpaid claims. (C4)
c. Evaluate the technique when used with varying data quality and completeness and in different situations. (D5)
d. Describe the strengths and limitations of each technique and the impact of limitations on results. (D2)
e. Select the appropriate technique and assumptions given specific circumstances. (D5)

6. Apply processes to integrate more complex factors potentially relevant for the estimation of unpaid claims of a given claims portfolio.
    a. Reflect the circumstances under which claims periods defined by underwriting period, accident period, and reporting period approaches may be used. (C3)
    b. Distinguish between incurred but not yet reported (IBNYR) and incurred but not enough reported (IBNER) components of an estimate of unpaid claims. (C3)
    c. Apply and evaluate the earned premium concept in various contexts of the estimation of unpaid claims. (C5)
    d. Understand the drivers of exposure changes for claims portfolios (such as shifts in types of exposures or seasonality) and adjust projection techniques to allow for such changes in estimating unpaid claims. (D4)
    e. Apply an allowance for claims inflation in the estimation of unpaid claims. (C3)
    f. Measure and respond appropriately to changes in the internal environment (such as changes in claims-processing systems or the mix of business) and the external environment (such as judicial decisions). (D4)
    g. Execute on the concepts of a best estimate and a risk adjustment. (D6)
7. Determine whether to discount for investment income and adjust for adverse deviation and calculate such adjustments to a best estimate of unpaid claims. (D5)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapters 3, 11-22, 26-27.	https://www.actexmadriver.com/orderselection.aspx?id=453147551

5. Estimating unpaid claims – advanced topics (20%)

1. Describe, calculate, and evaluate approaches to allow for various other items in an actuary's estimation of unpaid claims, including:
    a. Salvage and subrogation recovery items. (C5)
    b. Claims-management expenses (including allocated and unallocated loss-adjustment expenses) and other costs. (C5)
    c. Latent claims and potential claims features that have not manifested in the reported claims data. And (C5)
    d. Discounted cash flows such as no-fault automobile accident benefits and other recurring benefits. (C5)
2. Calculate estimates of unpaid claims for reinsurance.
    a. Understand reinsurance cover considerations when differentiating losses-occurring basis and a risks-attaching basis and considerations for catastrophe covers. (B2)
    b. Evaluate the approaches to estimating unpaid claims for reinsurance contracts held by analyzing claims gross and net of reinsurance held vs. claims gross of reinsurance held and claims ceded to reinsurance. (C5)

c. Calculate and evaluate estimates of unpaid claims for reinsurance held using appropriate techniques and assumptions that reflect the characteristics of reinsurance contracts held (e.g., contract terms and conditions, data availability). (C5)

d. Determine the effect on relevant earnings patterns and estimation of unpaid claims of non-annual covers, non-uniform risks, common renewal dates, unclosed business, adjustment premiums, risks attaching at future dates, reinstatement premiums, and other loss-responsive mechanisms. (C3)

e. Calculate and evaluate estimates of unpaid claims for various layers of claims. (C5)

3. Develop estimates of unpaid claims using credibility models (C3), including:
   a. Testing the results for reasonableness. (C4)
   b. Describing the strengths and weaknesses of such methods. (B2)
4. Evaluate stochastic processes for estimating unpaid claims.
   a. Describe the likely sources of uncertainty in estimates of unpaid claims. (B2)
   b. Describe the uses of stochastic techniques for estimating unpaid claims. (B2)
   c. Describe the following types of stochastic techniques, including data required, key assumptions, and mechanics: (B2)
      i. Analytic.
      ii. Simulation-based.
   d. Differentiate Mack, bootstrapping, and Markov chain Monte Carlo approaches for estimating unpaid claims and quantifying uncertainty in such estimates. (C4)
   e. Describe the features of aggregate claims distributions, as well as the inherent risk correlations and diversification that apply. (C2)
   f. Extend a frequency-severity technique to include stochasticity. (C3)
   g. Describe the issues, advantages, and disadvantages of each of the techniques, including sensitivity to assumptions. (C2)
   h. Describe the approach to aggregating the results of stochastic estimates of unpaid claims across multiple lines of business and discuss methods of correlation. (C2)
5. Describe machine-learning approaches with individual claim case reserves, including the advantages and challenges with such approaches. (C2)
6. Evaluate the results of estimates of unpaid claims for adequacy and reasonableness. (D5)
   a. Understand how alternative estimates of unpaid claims can arise and highlight some of the professional issues in resolving them. (D2)
   b. Describe the factors an actuary should consider and evaluate the typical diagnostics used in assessing the reasonableness of the results of estimates of unpaid claims. (D4)
   c. Describe the factors an actuary should consider in assessing the reasonableness of changes in the results of estimates of unpaid claims over time. (D2)
   d. Analyze current experience to monitor performance and recommend estimates of unpaid claims for interim valuations. (D4)
7. Communicate an estimate of unpaid claims.
   a. Describe what is meant by a “best-estimate reserve.” (A2)
   b. Describe the uses, advantages, and disadvantages of estimating ranges of unpaid claims using the following approaches: (B2)
      i. Stochastic models.
      ii. Scenario tests.
      iii. Use of alternative sets of assumptions.
   c. Defend the issues to be considered when communicating ranges in estimates of unpaid claims and uncertainties. (D5)

Reading reference	Source
Friedland J. 2013. *Fundamentals of General Insurance Actuarial Analysis*. 2nd ed. Schaumburg (IL): Society of Actuaries. Chapter 10, 23, Appendix G.	https://www.actexmadriver.com/orderselection.aspx?id=453147551

Townsend C. 2022. *A Risky Business: An Actuary's Guide to Quantifying and Managing Risk in Society*. London (UK): Palgrave MacMillan. Chapter 16.	https://link.springer.com/chapter/10.1007/978-3-031-11673-5_16
Taylor G, McGuire G. 2016. *Stochastic Loss Reserving Using Generalized Linear Models*. Arlington (VA): Casualty Actuarial Society. (CAS Monograph Series; No. 3). (Including errata.)	https://www.casact.org/sites/default/files/2021-03/7_Taylor.pdf, https://www.casact.org/sites/default/files/2021-02/03-Taylor-Errata.pdf
Meyers G. 2015. *Stochastic Loss Reserving Using Bayesian MCMC Models*. Arlington (VA): Casualty Actuarial Society. (CAS Monograph Series; No. 1).	https://www.casact.org/sites/default/files/2021-03/7_Meyers_2015.PDF
Sahasrabuddhe R. 2010 [revised 2013 Jan 2]. "Claims development by layer: the relationship between claims development patterns, trend and claim size models." *E-Forum*. Arlington (VA): Casualty Actuarial Society. (Including errata.)	https://www.casact.org/sites/default/files/2021-03/7_Sahasrabuddhe.pdf https://www.casact.org/sites/default/files/2021-03/7_Sahasrabuddhe_Errata.pdf
Shapland MR. 2016. *Using the ODP Bootstrap Model: A Practitioner's Guide*. Arlington (VA): Casualty Actuarial Society. (CAS Monograph Series; No. 4). (Including errata.)	https://www.casact.org/sites/default/files/2021-03/7_Shapland.pdf https://www.casact.org/sites/default/files/2021-02/Errata-ODP-Bootstrap-Monograph_4.pdf
Wuthrich MV. 2016 [revised 2017 Mar 29]. *Machine Learning in Individual Claims Reserving*. Zurich (CH): Swiss Finance Institute. (Swiss Finance Institute Research Paper Series; No. 16-67). SSRN.	https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID2874758_code623849.pdf?abstractid=2867897&mirid=1

6. IFRS 17 financial reporting (30%)

1. Describe IFRS 17 – Accounting for Insurance Contracts, including its purpose, scope, classification of contracts, and contract boundaries. (A2)
2. Apply both IFRS 17 measurement approaches: (C3)
    a. General measurement approach.
    b. Premium allocation approach.
3. Reflect considerations related to the level of aggregation when accounting for business under IFRS 17 including determination of the unit of account and setting of portfolios and groups of contracts. (C3)
4. Estimate future cash flows for the liability for remaining coverage and the liability for incurred claims under both the general measurement approach and the premium allocation approach. (C4)
5. Determine discount rates using the top down and bottom-up approaches referred to in IFRS 17. (C3)
6. Determine risk adjustment for non-financial risk, including:
    a. Reflect the criteria for and measurement of the risk adjustment under the general measurement approach and the premium allocation approach. (C4)
    b. Apply multiple methods, including: (C4)
        i. Quantile.
        ii. Cost of capital.
        iii. Margin.
    c. Adjust for the role of diversification and allocation in the determination and the application of the risk adjustment. (C4)
    d. Determine the risk adjustment for reinsurance contracts held. (C4)
7. Determine key actuarial components of IFRS 17 financial statements, including:
    a. Contractual service margin. (C4)
    b. Liability for remaining coverage. (C4)
    c. Liability for incurred claims. (C4)
    d. Risk adjustment for non-financial risk. (C4)
    e. Discounting. (C4)
    f. Onerous contracts. (C4)
    g. Loss component. (C4)

8. Describe the components (financial statements, key exhibits, and schedules) of the Canadian regulatory return (P&C-1 and P&C-2) and how they interrelate. (B2)
9. Calculate key financial metrics and evaluate an insurer's financial performance and strength based on such ratios. (D5)
10. Describe the Appointed Actuary's role with respect to IFRS 17 financial reporting. (B2)

Reading reference	Source
CIA Educational Note: *Assessing Eligibility for the Premium Allocation Approach Under IFRS 17 for Property & Casualty and Life & Health Insurance Contracts*.	https://www.cia-ica.ca/docs/default-source/2022/222091e.pdf
CIA Educational Note: *IFRS 17 – Actuarial Considerations Related to Reinsurance Contracts Issued and Held*.	https://www.cia-ica.ca/docs/default-source/2022/222129e.pdf
CIA Educational Note: *IFRS 17 Risk Adjustment for Non-Financial Risk for Property and Casualty Insurance Contracts*.	https://www.cia-ica.ca/docs/default-source/2022/222089e.pdf
CIA Educational Note: *IFRS 17 Discount Rates and Cash Flow Considerations for Property and Casualty Insurance Contracts*.	https://www.cia-ica.ca/docs/default-source/2022/222098e.pdf
CIA Educational Note: *IFRS 17 – Actuarial Considerations Related to Liability for Remaining Coverage in P&C Insurance Contracts*.	https://www.cia-ica.ca/docs/default-source/2022/222092e.pdf
CIA Educational Note: *2023 Guidance to the Appointed Actuary and Valuation Actuaries of Property and Casualty Insurers*.	https://www.cia-ica.ca/docs/default-source/2023/223134e.pdf
CIA Educational Note: *Application of IFRS 17 Insurance Contracts*. Chapters 1, 2, 5, 6, 7, 9.	https://www.cia-ica.ca/docs/default-source/2021/221117e.pdf
Canadian Council of Insurance Regulators. [modified 2021 Jun]. *Final 2023 IFRS 17 P&C Insurance Return*: *Core Financial Statement Return (PC1)*. Ottawa (ON): Office of the Superintendent of Financial Institutions. Sections 20.10, 20.11, 20.12, 20.14, 20.16, 20.18, 20.22, 20.42, 20.45, 20.54.	https://www.osfi-bsif.gc.ca/Eng/Docs/pc_irfs17_core.xlsx
Canadian Council of Insurance Regulators. [modified 2022 Jun]. *Final 2023 IFRS 17 P&C Insurance Return*: *Supervisory Annual Return (PC3)*. Ottawa (ON): Office of the Superintendent of Financial Institutions. Sections 10.60, 60.45.	https://www.osfi-bsif.gc.ca/Eng/Docs/pc_irfs17_an.xlsx
Canadian Council of Insurance Regulators. [revised 2023 Feb]. *Final 2023 IFRS 17 P&C Insurance Return* [instructions]. Ottawa (ON): Office of the Superintendent of Financial Institutions. (Annual Statement Instructions PC1-PC3, 2023 for specific return pages listed in the syllabus.)	https://www.osfi-bsif.gc.ca/Eng/fi-if/rtn-rlv/fr-rf/ic-sa/pc-sam/Pages/pc_irfs17.aspx
Revised CIA Educational Note: *Subsequent Events*. This is currently being revised.	https://www.cia-ica.ca/docs/default-source/2015/215083e.pdf
CIA Report: *Materiality*.	https://www.cia-ica.ca/docs/default-source/2007/207099e.pdf

Note: Candidates are strongly encouraged to review the Appendices of *Fundamentals of General Insurance Actuarial Analysis*, which includes the consolidated exhibits for the insurers used in the examples of the main text as well as six additional detailed examples.

Exam F3PC: Enterprise Risk Management (ERM), Economic Capital Modelling, and Stress and Scenario Testing

The aim of this exam is for candidates to develop the following skills:

1. Understand the main principles and techniques of enterprise risk management (ERM) and economic capital modelling that are relevant to P&C insurance.
2. Apply these principles and techniques within the context of P&C insurance.
3. Understand how ERM and economic capital modelling links to wider business processes (e.g., business planning, pricing, estimating unpaid claims, and capital setting).
4. Create and evaluate hypothetical scenarios, including using judgement to assess the implications of possible actions and to develop appropriate proposals or recommendations for P&C insurers.

1. Principal terms

1. Define principal terms used in ERM, economic capital modelling, and stress and scenario testing. (A1)

Reading reference	Source
	Principal terms are identified and defined in the readings included in the syllabus for this exam.

2. ERM concepts, framework, and process (10%)

1. Apply the concept of ERM. (D3)
2. Apply the framework for risk management and control within an insurer. (D3)
3. Describe regulatory requirements related to ERM, including own-risk and solvency assessment (ORSA). (A2)
4. Describe the perspectives of credit-rating agencies. (B2)
5. Reflect data issues in general and special considerations with respect to ERM. (C3)
6. Demonstrate how to determine and articulate: (C3)
    a. Risk appetite
    b. Risk identification.
    c. Risk assessment.
    d. Risk monitoring.
    e. Risk limits.
    f. Risk mitigation.
    g. Risk capacity.
    h. Risk tolerances.
    i. Desired risk profile.
    j. Risk objectives.
    k. Risk reporting.
7. Assess the implications of financial and other risks and opportunities for strategic planning. (C4)
8. Describe the risk management control cycle, including the relevance of external influences and emerging risks. (C2)
9. Utilize methods to identify risks and their causes and implications. (D4)

Reading reference	Source

Hardy MR, Saunders D. 2022. *Quantitative Enterprise Risk Management*. Cambridge (UK): Cambridge University Press. Chapter 1.	https://www.cambridge.org/highereducation/books/quantitative-enterprise-risk-management/C861F6558943791EBF7DC55AD9B554B5#overview
Office of the Superintendent of Financial Institutions (OSFI). 2018. *Corporate Governance* [guideline]. Ottawa (ON): OSFI. Part III.	https://www.osfi-bsif.gc.ca/Eng/Docs/CG_Guideline.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2017 [effective 2018 Jan 1]. Guideline E-19: *Own Risk and Solvency Assessment*. Ottawa (ON): OSFI. (Including Appendix.)	https://www.osfi-bsif.gc.ca/Eng/Docs/e1918.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2009. Guideline E-18: *Stress Testing*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/Docs/e18.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2022. Draft Revised Guideline B-10: *Third Party Risk Management*. Ottawa (ON): OSFI. (Excluding Appendix.)	https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/gl-ld/Pages/b10_dft_2022.aspx
Office of the Superintendent of Financial Institutions (OSFI). 2022. Guideline B-13: *Technology and Cyber Risk Management*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/Docs/B13-final.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2022. Draft Guideline B-15: *Climate Risk Management*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/gl-ld/Pages/b15-dft.aspx
Wong-Fupuy C, McGuignan M. 2020. *Best's Credit Rating Methodology*. Oldwick (NJ): AM Best. Part 1: Introduction...	https://www3.ambest.com/ambv/ratingmethodology/OpenPDF.aspx?rc=250950
Global Methodology for Rating Life and P&C Insurance Companies and Insurance Organizations	https://www.dbrsmorningstar.com/research/350346/global-methodology-for-rating-life-and-pc-insurance-companies-and-insurance-organizations
Hall G, Jones M, Madigan K, Zheng S. 2020. *Stochastic Data Quality Management in the P&C Insurance Sector*. Arlington (VA): Casualty Actuarial Society. (CAS Monograph Series; No. 9).	https://www.casact.org/sites/default/files/2021-02/09-hall-jones-madigan-zheng_0.pdf
Insurance Bureau of Canada (IBC). 2018. *Handbook on Economic Capital Modelling*. Toronto (ON): IBC. Chapter 4.	Set up an account at: https://vip.ibc.ca/IWG-Handbook/request.asp
Airmic. 2021. *Risk Appetite: The Facts, the Myths, and the Links with Culture, Maturity and Sustainability*. London (UK): Airmic. (Airmic Explained Guides). Section 2.	https://www.airmic.com/sites/default/files/Airmic-EXPLAINED-guide-Risk-Appetite-Revised.pdf

3. Risk categories and risk identification (10%)

1. Explain what is meant by risk and uncertainty, including different definitions and concepts of risk. (B2)
2. Describe risk taxonomy, including an awareness of how individual risks might be categorized in different ways. (B1)
3. Describe common risks faced by P&C insurers, including: (B2)
    a. Insurance risk (e.g., pricing, catastrophe, and reserving).
    b. Credit risk.
    c. Market risk.
    d. Liquidity risk.
    e. Operational risk.
    f. ESG and climate-related risks.
    g. Foreign exchange risk.
    h. Regulatory risk.
    i. Political risk.
    j. Reputational risk.
    k. Strategic risk.

4. Analyze the relationship between systemic risk vs. non-systemic and specific risk vs. concentration of risk. (B4)

Reading reference	Source
Hardy MR, Saunders D. 2022. *Quantitative Enterprise Risk Management*. Cambridge (UK): Cambridge University Press. Chapters 2, 8, 12, 13.	https://www.cambridge.org/highereducation/books/quantitative-enterprise-risk-management/C861F6558943791EBF7DC55AD9B554B5#overview
Insurance Bureau of Canada (IBC). 2018. *Handbook on Economic Capital Modelling*. Toronto (ON): IBC. Chapters 6-10.	Set up an account at: https://vip.ibc.ca/IWG-Handbook/request.asp
Boller P, Grégoire C, Kawano T. 2016. "Chapter 4 – Operational risk." In: *IAA Risk Book*. Ottawa (ON): International Actuarial Association.	https://www.actuaries.org/IAA/Documents/Publications/RiskBook/Ch4_Operational_Risk_2016-03-08.pdf
International Association of Insurance Supervisors (IAIS). 2019. *Holistic Framework for Systemic Risk in the Insurance Sector*. Basel (CH): IAIS. Chapter 1.	https://www.iaisweb.org/uploads/2022/01/191114-Holistic-Framework-for-Systemic-Risk.pdf

4. Economic capital modelling and aggregation of risks (25%)

1. Describe the extent to which each of the risks in 3.3 can be amenable to quantitative analysis. (B2)
2. Demonstrate an understanding of the use of correlation measures.
    a. Describe enterprise-wide risk-aggregation techniques that incorporate the use of correlation. (C5)
    b. Apply different correlation measures based on their relative merits and implications. (C4)
3. Apply copulas as part of the process of modelling multivariate risks and evaluate different types of copulas for a given situation. (C5)
4. Reflect the importance of the tails of distributions, tail correlations, and low frequency/high severity events. (C4)
5. Describe how extreme-value theory can be used to help model risks that have a low probability. (C2)
6. Demonstrate how model and parameter risk can be incorporated into an economic capital model. (C4)
7. Use economic capital models in the overall ERM decision-making process. (C4)
    a. Describe the development and use of models for decision-making purposes in ERM. (B2)
    b. Demonstrate how the decision-making process considers the organization's risk appetite and corporate governance and builds on the results of stochastic modelling, scenario analysis, stress testing, and analysis of model and parameter risk. (D4)
    c. Evaluate different types of models for a given purpose. (D5)

Reading reference	Source
Insurance Bureau of Canada (IBC). 2018. *Handbook on Economic Capital Modelling*. Toronto (ON): IBC. Chapters 1, 2, 3, 5, 11, 12, 13, 14.	Set up an account at: https://vip.ibc.ca/IWG-Handbook/request.asp
Hardy MR, Saunders D. 2022. *Quantitative Enterprise Risk Management*. Cambridge (UK): Cambridge University Press. Chapters 3, 4, 5, 6, 7, 14.	https://www.cambridge.org/highereducation/books/quantitative-enterprise-risk-management/C861F6558943791EBF7DC55AD9B554B5#overview
CIA Educational Note: *Use of Models*.	https://www.cia-ica.ca/docs/default-source/2017/217007e.pdf

5. Risk measurement and assessment (30%)

1. Using common risk measures (such as VAR, TVAR, and probability of ruin), determine risk exposures and tolerances using these measures. (C3)
2. Understand the key considerations in deriving and applying economic capital modelling techniques using deterministic and stochastic models. (D2)
3. Recommend a specific choice of model based on the results of both quantitative and qualitative analysis of financial and insurance data. (D5)
4. Describe approaches, including parameterization and validation, for the assessment of capital requirements for the following risk types: (C2)
    a. Catastrophe.
    b. Underwriting and pricing.
    c. Reserving.
    d. Credit.
    e. Climate related.
    f. Liquidity.
    g. Operational.
5. Describe the practical considerations (including data availability, parameterization, and validation procedures) that should be borne in mind when undertaking capital modelling. (D2)
6. Calculate regulatory capital requirement (P&C-4). (C4)
7. Demonstrate an understanding of regulators' guidance and context for different approaches to responsible investment and, specifically, the integration of environmental, social, and governance (ESG) factors in the investment process. (C3)
8. Demonstrate an understanding of the underlying issues that constitute factors within each of the ESG areas. (C3)
9. Demonstrate an understanding of the ESG market: relevance, size, scope, key drivers and challenges, and risks and opportunities. (C3)

Reading reference	**Source**
Insurance Bureau of Canada (IBC). 2018. *Handbook on Economic Capital Modelling*. Toronto (ON): IBC. Chapters 3, 7, 8, 9, 12.	Set up an account at: https://vip.ibc.ca/IWG-Handbook/request.asp
Hardy MR, Saunders D. 2022. *Quantitative Enterprise Risk Management*. Cambridge (UK): Cambridge University Press. Chapters 3, 12, 13.	https://www.cambridge.org/highereducation/books/quantitative-enterprise-risk-management/C861F6558943791EBF7DC55AD9B554B5#overview
Boller P, Grégoire C, Kawano T. 2016. "Chapter 4 – Operational risk." In: *IAA Risk Book*. Ottawa (ON): International Actuarial Association.	https://www.actuaries.org/IAA/Documents/Publications/RiskBook/IAARiskBook_OperationalRisk_2016-03.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2017 [revised 2022 Jul; effective 2023 Jan 1]. Guideline A-4: *Regulatory Capital and Internal Capital Targets*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/gl-ld/Pages/a4_gd23.aspx
Office of the Superintendent of Financial Institutions (OSFI). 2022 [effective 2023 Jan 1]. Guideline A: *Minimum Capital Test*. Ottawa (ON): OSFI., excluding 1.2.2, 2.1.1.1., 2.1.2., 2.1.3, 2.4, Appendix 2-A, 3., 4.6., 5.2.2., 5.3.4.1., 5.3.4.2., 6.1.1., 6.2.1., 6.2.2., 6.2.3., 6.3. Candidates are not responsible for risk factors relating to insurance, market or credit risk.	https://www.osfi-bsif.gc.ca/Eng/Docs/mct23.pdf
Office of the Superintendent of Financial Institutions (OSFI).2023 P&C Minimum Capital Test and Branch Adequacy of Assets Test PC4 Instructions and Quarterly Return worksheets 10.00, 20.00, 40.00, 40.05, 40.11, 50.00, 60.00, 60.05, 60.20, 60.40, 60.50, 70.00	https://www.osfi-bsif.gc.ca/Eng/fi-if/rtn-rlv/fr-rf/Pages/mct23_inst.aspx https://www.osfi-bsif.gc.ca/Eng/Docs/mct23-rtrn.xlsx

6. Stress and scenario testing (10%)

1. Describe the use of scenario analysis and stress testing (including reverse stress testing) in the risk-measurement process, including the advantages and disadvantages of each. (B2)
2. Describe the Appointed Actuary's responsibilities related to financial condition testing (FCT). (A2)
3. Explain the primary categories of risk associated with climate change from a P&C insurer's perspective, including:
    a. Transition risk. (A2)
    b. Physical risk and environmental risks. (A2)
    c. Liability risk. (A2)
4. Describe the actuary's role with respect to climate-change risk. (B2)

Reading reference	Source
Office of the Superintendent of Financial Institutions (OSFI). 2023. Guideline E-15: *Appointed Actuary: Legal Requirements, Qualifications and Peer Review*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/eng/fi-if/rg-ro/gdn-ort/gl-ld/Pages/e15_final.aspx
Office of the Superintendent of Financial Institutions (OSFI). 2009. Guideline E-18: *Stress Testing*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/Docs/e18.pdf
CIA Educational Note: *Financial Condition Testing*. (excluding Appendix A - Life Insurers)	https://www.cia-ica.ca/docs/default-source/2023/223010e.pdf
CIA Standards of Practice. Section 2500.	https://www.cia-ica.ca/docs/default-source/standards/si010123e.pdf

7. Capital management (15%)

1. Apply key elements of ORSA and FCT, specifically risk identification and assessment, quantification of risk to capital requirements, the Appointed Actuary's role, board oversight and senior management responsibility, monitoring, reporting, and internal controls. (D4)
2. Demonstrate an understanding of capital calculations.
    a. Utilize the concept of economic measures of value and capital and their uses in corporate decision-making processes. (D5)
    b. Evaluate different risk measures and capital-assessment approaches. (D5)
    c. Demonstrate the ability to develop a capital model for a representative financial firm. (D6)
3. Compare techniques for allocating capital across an organization. (C4)

Reading reference	Source
Hardy MR, Saunders D. 2022. *Quantitative Enterprise Risk Management*. Cambridge (UK): Cambridge University Press. Chapter 18.	https://www.cambridge.org/highereducation/books/quantitative-enterprise-risk-management/C861F6558943791EBF7DC55AD9B554B5#overview
Office of the Superintendent of Financial Institutions (OSFI). 2017 [effective 2018 Jan 1]. Guideline A-4: *Regulatory Capital and Internal Capital Targets*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/Docs/a4_gd18.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2017 [effective 2018 Jan 1]. Guideline E-19: *Own Risk and Solvency Assessment*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/Docs/e1918.pdf
CIA Educational Note: *Financial Condition Testing* (excluding Appendix A – Life Insurers)	https://www.cia-ica.ca/docs/default-source/2023/223010e.pdf

CIA Standards of Practice. Section 2500 and Part 8000.	https://www.cia-ica.ca/docs/default-source/standards/sc063023e.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2022 [effective 2025 Jan 1]. Guideline B-2: *Property and Casualty Large Insurance Exposures and Investment Concentration*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/Docs/b2_pc.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2022 [effective 2025 Jan 1]. Guideline B-3: *Sound Reinsurance Practices and Procedures*. Ottawa (ON): OSFI.	https://www.osfi-bsif.gc.ca/Eng/Docs/b3_snd.pdf
Office of the Superintendent of Financial Institutions (OSFI). 2023. Earthquake Exposure Sound Practices.	https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/gl-ld/Pages/b9.aspx