

# ILA – Life ALM and Modeling Exam

Spring 2023

## Important Exam Information:

### [Exam Registration](#)

Candidates may register online or with an application.

### [Order Study Notes](#)

Study notes are part of the required syllabus and are not available electronically but may be purchased through the online store.

### Syllabus Readings

Readings listed in this syllabus may include study notes, online readings and textbooks. Candidates are responsible for all readings in their entirety, including sections such as Appendices, unless it is stated otherwise in the syllabus.

### [Introductory Study Note](#)

The Introductory Study Note has a complete listing of all study notes as well as errata and other important information.

### Case Study

A case study will not be provided for this examination.

### [Past Exams](#)

Past Exams from 2000-present are available on SOA website.

### [Updates](#)

Candidates should be sure to check the Updates page on the exam home page periodically for additional corrections or notices to the current syllabus.

## 1. Topic: Stochastic, Generalized Linear, Multi-State, Projection and Transition Matrix Models

### Learning Objectives

The candidate will understand, evaluate and use stochastic, generalized linear, multi-state, projection and transition matrix models. The candidate will demonstrate an understanding of their underlying methodologies, strengths, limitations, and applications.

### Learning Outcomes

The Candidate will be able to:

- a) With respect to stochastic models:
  - Explain and apply the stochastic modeling methodology, including measurement metrics (e.g., CTE)
  - Describe and apply the theory and uses of real world versus risk neutral assumptions
  - Describe and apply the techniques of Monte Carlo simulation (including variance reduction and importance sampling)
  - Describe and evaluate Random Number Generator models, and explain their uses, advantages, and theory
  - Describe and evaluate how stochastic models may be used to understand mortality and policyholder behavior risks and inform the use of reinsurance
  - Describe the technique of nested stochastic projections and explain why they are needed, and evaluate implementation issues
- b) With respect to generalized linear models:
  - Describe and apply the basic principles of GLMs, and evaluate where GLMs might be useful in a Life Insurance context
- c) With respect to multi-state and transition matrix models:
  - Describe and apply the methodologies for constructing multi-state and transition models in an insurance context
- d) With respect to projection models:
  - Describe and apply the modeling methodology in an LTC product context

### Resources

- LAM-135-19: Stochastic Modeling, Theory and Reality from an Actuarial Perspective, sections I.A, I.B-I.B.3.a, I.B.4 & I.D-I.D.3
- LAM-137-19: Multi-state Transition Models with Actuarial Application, sections 1 & 2
- LAM-138-19: A Practitioner's Guide to Generalized Linear Models, 1.1-1.108, 1.118-1.130 & 3.1-3.14
- LAM-141-19: Case Study: LTC Insurance First Principles Modeling
- LAM-142-19: Case Study: LTC Insurance First Principles Modeling: Mortality Assumptions
- LAM-143-19: Case Study: LTC Insurance First Principles Modeling: Lapse Assumptions
- [Stochastic Modeling is on the Rise](#), Product Matters, Nov 2016

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- [Stochastic Analysis of Long-Term Multiple-Decrement Contracts](#), Actuarial Practice Forum, Jul 2008 (excluding Attachments)
- [Beware of Stochastic Model Risk!](#), Risk & Rewards, Aug 2019
- [Common Misunderstandings of Risk-Neutral Valuation](#), Financial Reporter, Jun 2019

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| <b>2. Topic: Issues Common to Models (Including Model Governance and Data Issues)</b>  |
| <b>Learning Objectives</b>   |
| The candidate will understand and be able to assess issues and concerns common to actuarial models and their development and management.   |
| <b>Learning Outcomes</b>   |
| The Candidate will be able to:<br><br>a) Describe Model Efficiency concepts and explain and apply both the representative scenarios and replicating liabilities techniques for improving Model Efficiency<br><br>b) Explain and apply the technique for the compression of model data using the "Cluster Analysis Spatial Approach"<br><br>c) Describe and evaluate best practices for actuarial model governance over process and controls<br><br>d) Describe and evaluate key components of model risk management<br><br>e) Describe and apply model validation techniques and methods<br><br>f) Describe issues and techniques related to sound spreadsheet model management<br><br>g) Describe best practices documentation and governance over assumptions used in models<br><br>h) Describe and evaluate the guidance in the Actuarial Standards of Practice<br><br>i) Describe and evaluate issues related to open and closed coding of models, and methods for addressing those issues and concerns<br><br>j) Describe and evaluate considerations around the governance of expert judgment in actuarial modelling<br><br>k) Describe and evaluate considerations related to modeling investments, discount rates, inflation and catastrophic mortality<br><br>l) Describe and evaluate considerations related to centralizing the actuarial modeling function |
| <b>Resources</b>   |
| <ul style="list-style-type: none"><li>• LAM-116-14: Life Insurance Forecasting and Liability Models: An Examination of the Trade-Offs Involved with Certain Modeling Decisions</li><li>• LAM-132-19: Cluster Analysis: A Spatial Approach to Actuarial Modeling</li><li>• LAM-133-19: Model Risk Mitigation and Cost Reduction Through Effective Documentation</li><li>• LAM-134-19: Supervisory Guidance on Model Risk Management, SR Letter 11-7, Board of Governors of the Federal Reserve System, 2011</li><li>• LAM-135-19: Stochastic Modeling, Theory and Reality from an Actuarial Perspective, section II.B.I</li><li>• LAM-144-19: Framework for Use of Discount Rates in Actuarial Work</li><li>• LAM-149-21: Application of Professional Judgement by Actuaries, 2020</li><li>• <a href="#">Standards of Practice, Canadian Institute of Actuaries Actuarial Standards Board, 1440-1490</a></li><li>• <a href="#">ASOP 56: Modeling</a>, sections 3 &amp; 4</li></ul>  |

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- [Model Validation for Insurance Enterprise Risk and Capital Models](#), 2014 (excluding Appendices)
- [The Effect of Deflation or High Inflation on the Insurance Industry](#), Feb 2012 (excluding pp. 11-14)
- [Interesting Challenges for Insurers](#), Product Matters, Jun 2012
- [Model Efficiency Study Results](#), Nov 2011
- [Model Efficiency in the U.S. Life Insurance Industry](#), The Modeling Platform, Apr 2016
- [Actuarial Modeling Systems: How Open We WANT Them to be vs. How Closed We NEED Them to be](#), The Modeling Platform, Nov 2017
- [Data Visualization for Model Controls](#), Financial Reporter, Mar 2017
- [The Importance of Centralization of Actuarial Modeling Functions, Part 1: Focus on Modularization and Reuse](#), The Modeling Platform, Nov 2019
- [Assumption Governance](#), The Actuary, Jan 2021

### 3. Topic: Asset-Liability Management

#### Learning Objectives

The candidate will understand the principles of Asset-liability Management ("ALM") and be able to describe and evaluate various techniques for addressing the mitigation of risk.

#### Learning Outcomes

The Candidate will be able to:

a) With respect to Asset-Liability Models:

- Describe and apply the fundamental elements of the theory and practice of ALM, including assessing the dangers of mismatched assets and liabilities
- Describe and demonstrate how ALM can be used to identify and manage product and asset risks, including:
  - Major product risks for which ALM can be a useful tool for their management
  - Using ALM to manage interest rate risk, equity risk, and risks from optionality
- Describe how common insurance contracts and variations generate embedded options in an insurer's balance sheet, and assess basic strategies for managing exposures created by such embedded options
- Describe and apply the basic concepts of cash flow matching, immunization, duration/convexity matching, segmentation
- Describe and apply Key Rate Durations (KRD) and their use in evaluating interest rate sensitivities of portfolios, including understanding the derivation of KRDs, the profiles of KRDs for selected major asset types, and assessing KRDs in a portfolio context
- Describe and evaluate the Goldman Sachs' ALM/Strategic Asset Allocation approach for integrating ALM into an enterprise's risk and financial management framework
- Describe and evaluate ALM modeling considerations in the context of modeling risk aggregation, dependency, correlation of risk drivers and diversification

b) With respect to asset adequacy analysis and cash flow testing, describe and evaluate actuarial practice with respect to:

- Modeling and selecting assets and related assumptions (incl. modeling assets with contingent cash flow risks)
- Handling liability cash flow contingencies and risks
- Setting up projection model parameters and assumptions
- Describe how Interest Rate Forwards and Futures and Swaps can be used in ALM, and apply the mathematics in given situations

#### Resources

- LAM-117-14: Key Rate Durations: Measures of Interest Rate Risk
- LAM-118-14: Revisiting the Role of Insurance Company ALM w/in a RM Framework

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- LAM-130-15: Diversification: Consideration on Modelling Aspects & Related Fungibility and Transferability, CRO, Oct 2013, pp. 1-18
- LAM-131-19: Ch. 22 of *Life Insurance Accounting, Asset/Liability Management*
- LAM-140-19: Asset Adequacy Analysis Practice Note, 2017, questions: 3, 5, 10-16, 18-20, 27, 29-31, 39, 42-60, 65-68, 71-82, 85 & 89
- LAM-146-19: Ch. 16 of *ALM Management of Financial Institutions*, Tilman, 2003
- LAM-147-19: Ch 2 of *ALM Management of Financial Institutions*, Tilman, 2003

#### 4. Topic: Economic Scenario Generator and Equity-Linked Models

##### Learning Objectives

The candidate will understand the basic design and function of Economic Scenario Generators and Equity-Linked Insurance Models.

##### Learning Outcomes

The Candidate will be able to:

- a) With respect to Economic Scenario Generators:
  - Describe the need for ESGs and explain the structure of ESG models and components
  - Describe and apply basic default free interest rate models, including one-factor continuous time models
  - Assess the propriety of a particular ESG model and related assumptions for particular applications
- b) With respect to Equity-Linked models:
  - Describe and apply methods for modeling long-term stock returns and certain guarantee liabilities (GMMB, GMDB, GMAB)
  - Describe and evaluate the Actuarial and Hedging risk metrics for GMAB and GMDB models
  - Describe and apply methods for modeling Guaranteed annuity options and Guaranteed Minimum Income Benefits (GMIB), and EIA guarantees

##### Resources

- *Investment Guarantees*, Hardy, Mary, 2003
  - Ch. 1: Investment Guarantees
  - Ch. 2: Modeling Long-Term Stock Returns
  - Ch. 6: Modeling the Guarantee Liability
  - Ch. 7: A Review of Option Pricing Theory (pp. 115-125)
  - Ch. 8: Dynamic Hedging for Separate Account Guarantees (pp. 133-143)
  - Ch. 12: Guaranteed Annuity Options
  - Ch. 13: Equity-Indexed Annuities
- LAM-139-19: Simulation of a Guaranteed Minimum Annuity Benefit, Freedman, 2019; [Excel Model - Stochastic Simulation of a GMAB Option \(Accompanies Simulation of a GMAB\)](#)
- LAM-148-19: Introduction to Economic Scenario Generators - Selecting and Specifying ESGs
- [Economic Scenario Generators: A Practical Guide](#), 2016, Ch. 1, 2, 4.1, 5, 6, 9, 10, 11.1 & 11.3



**5. Topic: Asset and Portfolio Management Topics**

**Learning Objectives**

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

**Learning Outcomes**

The Candidate will be able to:

- a) Describe the portfolio management process in an insurance company, and the role of Investment Policy, the Investment Actuary, and external portfolio managers
- b) Describe and evaluate how a company's objectives, needs and constraints affect investment strategy and portfolio construction (including capital, funding objectives, risk appetite and risk return tradeoff, tax and accounting, accounting considerations, and constraints such as regulation, rating agency ratings and liquidity)
- c) Describe and assess the role of and significant considerations related to the design and function of asset allocation strategies
- d) Describe and assess Fixed Asset Portfolio management methods, and immunization (including derivatives) and cash matching strategies, including:
  - i. Considerations such as managing funds against a bond market index, the classification of possible strategies, the impact of risk factors and tracking risk, and the use of indexing and active strategies
  - ii. Considerations such as managing funds against liabilities, the use of dedication strategies and immunization strategies, the assessment of risk minimization for immunized portfolios, and the use of cash flow matching and combo strategies
  - iii. The use of derivative enabled strategies, and the use of futures, swaps, and options
- e) Describe and assess Alternative Investment Portfolios (including real estate) in the context of an insurance company portfolio
- f) Describe and apply methods and processes for evaluating portfolio performance, including performance attribution, sources of earnings analysis on investment income, benchmarks, metrics, and risk adjusted performance appraisals (including total return vs reported earnings)
- g) Describe the principles of Liquidity Risk Management in an insurance company portfolio management context
- h) Describe and apply conventional yield metrics used in bond performance evaluation
- i) Describe the attributes of US Treasuries, Agency Debt Securities, Municipal bonds, Corporate bonds, Private Money Market securities, Floating Rate Agreements, Agency Mortgage Backed securities, Agency Collateralized Mortgage securities, Interest Rate Swaps and Swaptions, Credit Derivatives and High Yield Bonds, and the markets they are traded in
- j) Describe how an insurance company can hedge against the cost of borrowing through forward rate futures, and perform related calculations
- k) Describe the role of LIBOR and SOFR in an insurance company investment management context

## Resources

- *Managing Investment Portfolios*, Maginn, John L. and Tuttle, Donald L., 3<sup>rd</sup> Edition, 2007
  - Ch. 3: Managing Institutional Investor Portfolios (section 4.1)
  - Ch. 5: Asset Allocation (sections 2-4)
  - Ch. 6: Fixed-Income Portfolio Management (sections 1-5)
  - Ch. 8: Alternative Investments Portfolio Management (section 3)
  - Ch.12: Evaluating Portfolio Performance (section 4)
- *Handbook of Fixed Income Securities*, Fabozzi, Frank J., 9<sup>th</sup> Edition, 2021
  - Ch. 4: Bond Pricing, Yield Measures and Total Return (pp. 76-94)
  - Ch. 7: U.S. Treasury Securities (pp. 171-184)
  - Ch. 8: Agency Debt Securities (pp. 185-196)
  - Ch. 9: Municipal Bonds (pp. 201-206 & 209-221)
  - Ch. 10: Corporate Bonds (pp. 235-262, excluding exhibits 10-1 & 10-2)
  - Ch. 13: Commercial Paper (pp. 301-310)
  - Ch. 14: Floating-Rate Securities
  - Ch. 21: An Overview of Mortgages and the Mortgage Market
  - Ch. 22: Agency Mortgage Passthrough Securities
  - Ch. 23: Agency Collateralized Mortgage Obligations (pp. 499-508 & 520-528)
  - Ch. 60: Financial Positions in the Bond Market (pp. 1485-1488)
  - Ch. 64: Interest-Rate Swaps (pp. 1575-1580 & 1588-1589)
  - Ch. 68: Credit Derivatives (pp. 1657-1671)
- LAM-150-23: LIBOR's Demise and a \$200 Trillion Question
- LAM-151-23: High-Yield Bond Market Primer
- LAM-152-23: Liquidity Risk Management: Best Risk Management Practices
- LAM-153-23: Managing your Advisor: A Guide to Getting the Most Out of the Portfolio Management Process
- LAM-154-23: Ch. 7 (sections 7.2-7.5 & 7A) of *Derivatives Markets*, McDonald, 3<sup>rd</sup> Edition
- LAM-155-23: Secured Overnight Financing Rate (SOFR)