# Important Exam Information:

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<thead>
<tr>
<th>Link</th>
<th>Description</th>
</tr>
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<tr>
<td><strong>Exam Registration</strong></td>
<td>Candidates may register online or with an application.</td>
</tr>
<tr>
<td><strong>Order Study Notes</strong></td>
<td>Study notes are part of the required syllabus and are not available</td>
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<tr>
<td></td>
<td>electronically but may be purchased through the online store.</td>
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<tr>
<td><strong>Introductory Study Note</strong></td>
<td>The Introductory Study Note has a complete listing of all study notes</td>
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<tr>
<td></td>
<td>as well as errata and other important information.</td>
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<tr>
<td><strong>Case Study</strong></td>
<td>A case study will not be used for this examination.</td>
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<td><strong>Past Exams</strong></td>
<td>Past Exams from 2000-present are available on SOA website.</td>
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<td><strong>Updates</strong></td>
<td>Candidates should be sure to check the Updates page on the exam home page</td>
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<td>periodically for additional corrections or notices.</td>
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<tr>
<td><strong>Formula Package</strong></td>
<td>A Formula Package will be provided with the exam. Please see the</td>
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<tr>
<td></td>
<td>Introductory Study Note for more information.</td>
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<td><strong>Table</strong></td>
<td>A Cumulative normal distribution table will be provided with the exam.</td>
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*Recognized by the Canadian Institute of Actuaries*
1. **Topic: Stochastic Calculus**

### Learning Objectives

The candidate will understand the foundations of quantitative finance.

### Learning Outcomes

The Candidate will be able to:

- a) Understand and apply concepts of probability and statistics important in mathematical finance
- b) Understand the importance of the no-arbitrage condition in asset pricing
- c) Understand the Ito integral and stochastic differential equations
- d) Understand and apply Ito’s Lemma
- e) Understand the Black Scholes Merton PDE (partial differential equation)
- f) Understand and apply Jensen’s Inequality
- g) Understand the distinction between complete and incomplete markets
- h) Define and apply the concepts of martingale, market price of risk, and measures in single and multiple state variable contexts
- i) Demonstrate understanding of the differences and implications of real-world versus risk-neutral probability measures, and when the use of each is appropriate
- j) Understand and apply Girsanov’s theorem in changing measures
- k) Understand the importance of the Feynman-Kac Theorem

### Resources

  - Ch. 1-15 (excluding section 8.2.4)
  - **Note:** Candidates should verify that their copy of the Hirsa & Neftci textbook is the 3rd edition, second printing by checking that page iv, *Notices* section, begins with "Knowledge and best practice in this field...". If the *Notices* section begins “No responsibility is assumed...” it is the first printing and should be replaced.
- *Problems and Solutions in Mathematical Finance: Stochastic Calculus*, Chin, Eric, Nel, Dian and Olafsson, Sverrir, 2014
  - **Note:** Candidates should study the following problems in Chin, Nel, and Ólafsson alongside the matching chapters of *An Introduction to the Mathematics of Financial Derivatives*, Hirsa and Neftci to reinforce the standard techniques used in stochastic calculus. Please note that formulas from Chin, Nel, and Ólafsson are not included in the formula package.
<table>
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<tr>
<th>Chin et al. Chapter</th>
<th>Pages</th>
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<th>Corresponding Hirs &amp; Neftci Chapter</th>
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<td>1</td>
<td>1 to 3</td>
<td>Definitions 1.1 to 1.7&lt;br&gt;Note that statement (b) of Definition 1.7 involves integration using a measure-theoretic approach. An equally valid statement can be made using a Riemann-Stieltjes integral for continuous distributions or a sum for discrete distributions.)</td>
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<td>18 to 19</td>
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<td>Q1 to Q13, except Q11</td>
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<td>71 to 74</td>
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<td>186 to 187</td>
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<td>281 to 285</td>
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2. **Topic: Fixed Income Markets**

**Learning Objectives**

The candidate will understand the fundamentals of fixed income markets and traded securities.

**Learning Outcomes**

The Candidate will be able to:

a) Understand the characteristics of fixed rate, floating rate, and zero-coupon bonds  
b) Bootstrap a yield curve  
c) Understand measures of interest rate risk including duration, convexity, slope, and curvature  
d) Understand the characteristics and uses of interest rate forwards, swaps, futures, and options  
e) Describe the issues in modeling low to negative interest rates

**Resources**

  - Ch. 1  
  - Ch. 2 (including Appendix)  
  - Ch. 3 (excluding Appendix)  
  - Ch. 4  
  - Ch. 5.1-5.7 (excluding Case Study)  
  - Ch. 6 (including Appendix)  
- **QFIQ-116-17: Low Yield Curves and Absolute/Normal Volatilities**
3. **Topic: Interest Rate Models and Hedging**

**Learning Objectives**

The candidate will understand:

- The quantitative tools and techniques for modeling the term structure of interest rates.
- The standard yield curve models.
- The tools and techniques for managing interest rate risk.

**Learning Outcomes**

The Candidate will be able to:

a) Understand and apply the concepts of risk-neutral measure, forward measure, normalization, and the market price of risk, in the pricing of interest rate derivatives

b) Understand and apply various one-factor interest rate models

c) Calibrate a model to observed prices of traded securities

d) Describe the practical issues related to calibration, including yield curve fitting

e) Demonstrate understanding of option pricing theory and techniques for interest rate derivatives

f) Apply the models to price common interest sensitive instruments including: callable bonds, bond options, caps, floors and swaptions

g) Understand and apply the techniques of interest rate risk hedging

h) Understand the application of Monte Carlo simulation to risk neutral pricing of interest rate securities

i) Understand and apply the Heath-Jarrow-Morton approach including the Libor Market model

j) Understand and apply multifactor interest rate models including the two-factor Hull-White model

**Resources**

  - Ch. 16-21

  - Ch. 14
  - Ch. 15.1-15.6 (excluding Appendices)
  - Ch. 16.1-16.8 (excluding Appendix)
  - Ch. 17 (including Case Study)
  - Ch. 18.1-18.6 (excluding Appendix)
  - Ch. 19.1-19.8 (excluding Appendix)
  - Ch. 20
  - Ch. 21.1-21.9 (excluding Appendix)
  - Ch. 22.1-22.4
4. **Topic: Equity Option Pricing and Hedging**

### Learning Objectives

The candidate will understand:

- How to apply the standard models for pricing financial derivatives.
- The implications for option pricing when markets do not satisfy the common assumptions used in option pricing theory.
- How to evaluate risk exposures and the issues in hedging them.

### Learning Outcomes

The Candidate will be able to:

- a) Demonstrate an understanding of option pricing techniques and theory for equity derivatives
- b) Identify limitations of the Black-Scholes-Merton pricing formula
- c) Demonstrate an understanding of the different approaches to hedging – static and dynamic
- d) Demonstrate an understanding of how to delta hedge, and the interplay between hedging assumptions and hedging outcomes
- e) Analyze the Greeks of common option strategies
- f) Appreciate how hedge strategies may go awry
- g) Describe and explain some approaches for relaxing the assumptions used in the Black-Scholes-Merton formula
- h) Compare and contrast the various kinds of volatility, e.g., actual, realized, implied and forward, etc.
- i) Define and explain the concept of volatility smile and some arguments for its existence
- j) Compare and contrast “floating” and “sticky” smiles
- k) Describe and contrast several approaches for modeling smiles, including: stochastic volatility, local-volatility, jump-diffusions, variance-gamma, and mixture models
- l) Explain various issues and approaches for fitting a volatility surface

### Resources

- *The Volatility Smile*, Derman, Emanuel and Miller, Michael B., 2016
  - Ch. 1 (background)
  - Ch. 2-7
  - Ch. 8-10
  - Ch. 14
  - Ch. 17-19
• QFIQ-115-17: Which Free Lunch Would You Like Today, Sir?: Delta Hedging, Volatility Arbitrage and Optimal Portfolios
5. Topic: Additional Quantitative Techniques

### Learning Objectives

The candidate will understand important quantitative techniques relating to financial time series, volatility modeling, and stochastic modeling.

### Learning Outcomes

The Candidate will be able to:

- a) Understand and apply various techniques for analyzing conditional heteroscedastic models including ARCH and GARCH
- b) Demonstrate an understanding of the concept of a factor model in the context of financial time series
- c) Apply various techniques for analyzing factor models including principal component analysis (PCA) and statistical factor analysis
- d) Compare and contrast various approaches for setting volatility assumptions for a hedging model
- e) Demonstrate an understanding of the general uses and techniques of stochastic modeling

### Resources

  - Ch. 1, 2 (background only)
  - Ch. 3, Sections 3.1–3.8, 3.14
  - Ch. 4.6
- *Economic Scenario Generators: A Practical Guide*, SOA, 2016, Ch. 1, 5-7, 9, 10