Financial Mathematics Exam—February 2014

The Financial Mathematics exam is three-hour exam that consists of 35 multiple-choice questions and is administered as a computer-based test. For additional details, please refer to Exam Rules

The goal of the syllabus for this examination is to provide an understanding of the fundamental concepts of financial mathematics, and how those concepts are applied in calculating present and accumulated values for various streams of cash flows as a basis for future use in: reserving, valuation, pricing, asset/liability management, investment income, capital budgeting, and valuing contingent cash flows. The candidate will also be given an introduction to financial instruments, including derivatives, and the concept of no-arbitrage as it relates to financial mathematics.

The Financial Mathematics Exam assumes a basic knowledge of calculus and an introductory knowledge of probability.

The following learning objectives are presented with the understanding that candidates are allowed to use specified calculators on the exam. The education and examination of candidates reflects that fact. In particular, such calculators eliminate the need for candidates to learn and be examined on certain mathematical methods of approximation.

Please check the Updates section on this exam's home page for any changes to the exam or syllabus.

Each multiple-choice problem includes five answer choices identified by the letters A, B, C, D, and E, only one of which is correct. Candidates must indicate responses to each question on the computer. Candidates will be given three hours to complete the exam.

As part of the computer-based testing process, a few pilot questions will be randomly placed in the exam (paper and pencil and computer-based forms). These pilot questions are included to judge their effectiveness for future exams, but they will NOT be used in the scoring of this exam. All other questions will be considered in the scoring. All unanswered questions are scored incorrect. Therefore, candidates should answer every question on the exam. There is no set requirement for the distribution of correct answers for the multiple-choice preliminary examinations. It is possible that a particular answer choice could appear many times on an examination or not at all. Candidates are advised to answer each question to the best of their ability, independently from how they have answered other questions on the examination.

Since the CBT exam will be offered over a period of a few days, each candidate will receive a test form composed of questions selected from a pool of questions. Statistical scaling methods are used to ensure within reasonable and practical limits that, during the same testing period of a few days, all forms of the test are comparable in content and passing criteria. The methodology that has been adopted is used by many credentialing programs that give multiple forms of an exam.

The ranges of weights shown in the Learning Objectives below are intended to apply to the large majority of exams administered. On occasion, the weights of topics on an individual exam may fall outside the published range. Candidates should also recognize that some questions may cover multiple learning objectives.

LEARNING OBJECTIVES

I. Interest Theory (65-80%)

A. Time Value of Money (5-15%)

1. The candidate will be able to define and recognize the definitions of the following terms:
   interest rate (rate of interest), simple interest, compound interest, accumulation function, future value, current value, present value, net present value, discount factor, discount rate (rate of discount), convertible m-thly, nominal rate, effective rate, inflation and real rate of interest, force of interest, equation of value
2. The candidate will be able to:
   a. Given any three of interest rate, period of time, present value, and future value, calculate the remaining item using simple or compound interest. Solve time value of money equations involving variable force of interest.
   b. Given any one of the effective interest rate, the nominal interest rate convertible m-thly, the effective discount rate, the nominal discount rate convertible m-thly, or the force of interest, calculate any of the other items.
   c. Write the equation of value given a set of cash flows and an interest rate.

B. Annuities/cash flows with payments that are not contingent (5-20%)

1. The candidate will be able to define and recognize the definitions of the following terms:
   annuity-immediate, annuity due, perpetuity, payable m-thly or payable continuously, level payment annuity, arithmetic increasing/decreasing annuity, geometric increasing/decreasing annuity, term of annuity
2. For each of the following types of annuity/cash flows, given sufficient information of immediate or due, present value, future value, current value, interest rate, payment amount, and term of annuity, the candidate will be able to calculate any remaining item
   a. Level annuity, finite term
   b. Level perpetuity
   c. Non-level annuities/cash flows
      i) Arithmetic progression, finite term
      ii) Arithmetic progression, perpetuity
      iii) Geometric progression, finite term
      iv) Geometric progression, perpetuity
      v) Other non-level annuities/cash flows

C. Loans (5-20%)

1. The candidate will be able to define and recognize the definitions of the following terms:
   principal, interest, term of loan, outstanding balance, final payment (drop payment, balloon payment), amortization, sinking fund
2. The candidate will be able to:
   a. Given any four of term of loan, interest rate, payment amount, payment period, principal, calculate the remaining item.
   b. Calculate the outstanding balance at any point in time.

c. Calculate the amount of interest and principal repayment in a given payment.
d. Given the quantities, except one, in a sinking fund arrangement calculate the missing quantity.
e. Perform similar calculations to a-d when refinancing is involved.

D. Bonds (5-20%)
1. The candidate will be able to define and recognize the definitions of the following terms:
price, book value, amortization of premium, accumulation of discount, redemption value, par value/face value, yield rate, coupon, coupon rate, term of bond, callable/non-callable
2. Given sufficient partial information about the items listed below, the candidate will be able to calculate the any of the remaining items.
a. Price, book value, amortization of premium, accumulation of discount
b. Redemption value, face value
c. Yield rate
d. Coupon, Coupon rate
e. Term of bond, point in time that a bond has a given book value, amortization of premium, or accumulation of discount

E. General Cash Flows and Portfolios (5-20%)
1. The candidate will be able to define and recognize the definitions of the following terms:
yield rate/rate of return, dollar-weighted rate of return, time-weighted rate of return, current value, duration (Macaulay and modified), convexity (Macaulay and modified), portfolio, spot rate, forward rate, yield curve, stock price, stock dividend
2. The candidate will be able to:
a. Calculate the portfolio yield rate
b. Calculate the dollar-weighted and time-weighted rate of return
c. Calculate the duration and convexity of a set of cash flows.
d. Calculate either Macaulay or modified duration given the other.
e. Use duration and convexity to approximate the change in present value due to a change in interest rate
f. Calculate the price of a stock using the dividend discount model

F. Immunization (5-15%)
1. The candidate will be able to define and recognize the definitions of the following terms:
cash flow matching, immunization (including full immunization), Redington immunization
2. The candidate will be able to:
a. Construct an investment portfolio to fully immunize a set of liability cash flows.
b. Construct an investment portfolio to match present value and duration of a set of liability cash flows
c. Construct an investment portfolio to exactly match a set of liability cash flow

II. Financial Economics (20-35%)

A. General Derivatives (0-5%)

1. The candidate will be able to define and recognize the definitions of the following terms:
   derivative, underlying asset, over the counter market, short selling, short position, long position, ask price, bid price, bid-ask spread, lease rate, stock index, spot price, net profit, payoff, credit risk, dividends, margin, maintenance margin, margin call, mark to market, no-arbitrage, risk-averse
2. The candidate will be able to evaluate an investor's margin position based on changes in asset values

B. Options (0-5%)

1. The candidate will be able to define and recognize the definitions of the following terms:
   call option, put option, expiration, expiration date, strike price/exercise price, European option, American option, Bermudan option, option writer, in-the-money, at-the-money, out-of-the-money, covered call, naked writing, put-call parity
2. The candidate will be able to evaluate the payoff and profit of basic derivative contracts.

C. Forwards and Futures (0-10%)

1. The candidate will be able to define and recognize the definitions of the following terms:
   forward contract, futures contract, outright purchase, fully leveraged purchase, prepaid forward contract, synthetic forwards, cost of carry, implied repo-rate
2. The candidate will be able to:
   a. Determine forward price from prepaid forward price.
   b. Explain the relationship between forward price and futures price.
   c. Explain the relationship between forward price and future stock price.
   d. Use the concept of no-arbitrage to determine the theoretical value of futures and forwards
   e. Given sufficient partial information about call premium, put premium, forward price, strike price and interest rate, calculate any remaining item using the put-call parity formula

D. Swaps (0-5%)

1. The candidate will be able to define and recognize the definitions of the following terms:
   swap, swap term, prepaid swap, notional amount, swap spread, deferred swap, simple commodity swap, interest rate swap
2. The candidate will be able to use the concept of no-arbitrage to determine the theoretical values of swaps.

E. Hedging and Investment Strategies (5-15%)

1. The candidate will be able to define and recognize the definitions of the following terms:
   hedging, arbitrage, diversifiable risk, non-diversifiable risk, spreads (option, bull, bear, vertical, box, ratio), collar width, collared stock, zero-cost collar, straddle, strangle, written straddle, butterfly, convertible bond, mandatorily convertible bond
2. The candidate will be able to:
   a. Explain how derivative securities can be used as tools to manage financial risk.

b. Explain the reasons to hedge and not to hedge.
c. Evaluate the payoff and profit of hedging strategies.

Text References

Knowledge and understanding of the financial mathematics concepts are significantly enhanced through working out problems based on those concepts. Thus, in preparing for the Financial Mathematics exam, whichever of the source textbooks candidates choose to use, candidates are encouraged to work out the textbook exercises related to the listed readings.

Suggested Textbooks for Learning Objectives in Section I, Interest Theory

There is not a single textbook required for the learning objectives in Section I. The texts listed below are representative of the textbooks available to cover the material on which the candidate may be tested. Not all topics may be covered at the same level in each text. The candidate may wish to use one or more texts in his/her preparation for the examination.

Broverman, S.A., *Mathematics of Investment and Credit* (Fifth Edition), 2010, ACTEX Publications:

Chapter 1 (1.1-1.7)
Chapter 2 (2.1 -2.4 excluding 2.4.2 and 2.4.3)
Chapter 3 (3.1-3.3, excluding 3.2.1 and 3.2.2)
Chapter 4 (4.1-4.3.1)
Chapter 5 (5.1-5.3 excluding 5.1.4 and 5.3.2)
Chapter 6 (6.1-6.3 excluding 6.2)
Chapter 7 (7.1-7.2)
Chapter 8 (8.1, 8.3.1 and 8.4.1–8.4.2)

Daniel, J.W., and Vaaler, L.J.F., *Mathematical Interest Theory* (Second Edition), 2009, The Mathematical Association of America: **[Candidates may also use the First Edition of *Mathematical Interest Theory* (Publisher: Prentice Hall). The same chapter references apply.]**
Chapter 1 (1.3-1.12, 1.14)
Chapter 2 (2.2-2.7)
Chapter 3 (3.2-3.9, 3.11, 3.13)
Chapter 4 (4.2-4.6)
Chapter 5 (5.2-5.4)
Chapter 6 (6.2-6.6, 6.9)
Chapter 7 (7.1)
Chapter 8 (8.3)
Chapter 9 (9.1-9.5)

Kellison, S.G., *The Theory of Interest* (Third Edition), 2008, Irwin/McGraw-Hill:
Chapter 1 (1.2-1.10)
Chapter 2 (2.3-2.6)
Chapter 3 (3.2-3.8)
Chapter 4 (4.2-4.9)
Chapter 5 (5.2-5.6)
Chapter 6 (6.2-6.7, 6.10)
Chapter 7 (7.2-7.7)
Chapter 9 (9.4)

Chapter 10 (10.2-10.5)
Chapter 11 (11.2-11.8)

Ruckman, C.; and Francis, J., *Financial Mathematics: A Practical Guide for Actuaries and other Business Professionals* (Second Edition), 2005, BPP Professional Education:
Chapter 1
Chapter 2
Chapter 3 (3.1-3.9)
Chapter 4 (4.1-4.7)
Chapter 5
Chapter 6 (6.1-6.3 excluding 6.1.6-6.1.7)
Chapter 7 (7.1-7.9)
Chapter 8 (8.1-8.3)

Chan, Wai-Sum, and Tse, Yiu-Kuen, *Financial Mathematics for Actuaries*, Updated Edition, 2013, McGraw-Hill Education (Asia) **[Candidates may also use the 2011 Edition of *Financial Mathematics for Actuaries* with *Supplementary Notes for Financial Mathematics for Actuaries* for Chapter 8. The same chapter references apply.]**
Chapter 1
Chapter 2
Chapter 3
Chapter 4
Chapter 5
Chapter 6
Chapter 7
Chapter 8

Textbook for Learning Objectives in Section II, Financial Economics

McDonald, R.L., *Derivatives Markets* (Third Edition), 2013, Pearson:
Chapters 1–3
Chapter 4 (4.1–4.4)
Chapter 5 (5.1–5.4 and Appendix 5.B)
Chapter 8 (8.1–8.3)
Chapter 15 (Sections 15.3 and 15.4 only)

OTHER RESOURCES:

Notation and terminology used for Exam FM

All released exam papers, since 2000, can be found here.

Exam FM/2 Sample Questions and Solutions

Samples Questions and Solutions for *Derivatives Markets*

Review of Calculator Functions for the Texas Instruments BA-35

Review of Calculator Functions for the Texas Instruments BA II Plus