### Math 9814 / Fall 2015 / Spruill

# Introduction to Pricing Financial Instruments

## Course Overview

### Purpose:

This survey course builds the intuition for, and describes the mathematical foundation of, modern methods to price, hedge, and measure the risk of individual financial instruments across asset classes. You will gain an understanding of what purpose these instruments serve, how they are related to other instruments, what factors influence their value, and to some degree how they are traded. More broadly, you will see the fundamental importance (and, in some cases, the limitations) of the no-arbitrage assumption in modern finance, and will gain an understanding of other assumptions upon which the field commonly relies.

The focus of the course is not primarily mathematical rigor; nor is it programming or software design. Nevertheless, these things—addressed more fully in your other courses—will be integrated in presentations of key concepts, and in your assignments.

### Instructor:

Bob Spruill will teach the course. He can best be contacted through QuantNet, where his screen name is bob.

The instructor will be available on a limited basis for individual meetings, primarily after class.

### TA:

Guangxi (Susan) Yang

### Course Texts:

Class notes posted on QuantNet

Reference: John Hull—*Options, Futures, and Other Derivatives*, Seventh Edition

### Assignments:

* Weekly group homework consisting of problems and programming assignments (~50%)
* Final exam (~50%)

### Homework Details:

Each week, a homework assignment including some exercises, coding, or derivations will be given. Homework must be completed and turned in by each homework group. Groups will have one week from the date the assignment is set to complete it. Submissions that are 1 week late or less will receive reduced grades; submissions will not be accepted more than 1 week late, except by special arrangement with the instructor and TA.

All code submitted must be in Excel VBA. A set of pricing utility functions and classes (the “sandBox”) will be provided, which you may freely use *without modification*. Any VBA code you submit that references this sheet must work with the provided version of the sandBox. As the weeks go on, newer versions may from time to time be provided; all efforts will be made to ensure that later versions are backward compatible.

Homework may be discussed collaboratively through QuantNet, including sharing of results. However, each group’s submitted work must be its own—no copy / pasting or sharing of code (aside from the common sandBox utilities) is permitted.

### Topics:

Each of the Roman numerals below represents topics in the order they will be covered, depending upon the pace that seems best for the group. If time permits, other topics may be added. Additionally, a guest lecturer may join at times during the course; material covered by the guest lecturer is fair game for homework and final exam questions.

I. Discount Factors and Interest Rates

zero-coupon bond, discount factors, zero rates, compounding, forward rates, interpolation

Reference: Hull Chapter 4

II. Yield and Duration

fixed-coupon bond, yield, duration and DV01

Reference: Hull Chapter 4

III. Floating-Rate Instruments

FRA, FRN, IR Swaps, bootstrapping swap curves, dollar duration

Reference: Hull Chapters 4, 7

IV. Pricing with Credit Risk

hazard rate and risky discount factor, credit spread, recovery and loss given default, duration under credit risk, spread duration and DV01, CDS

Reference: Hull Chapters 22, 23

V. Forwards and Futures

forward contracts, forward prices of instruments paying discrete and continuous cash flows, futures, basis risk, minimum-variance hedge ratio

Reference: Hull Chapters 2, 3, 5

VI. Options in Discrete Time

put-call parity, binomial asset pricing model, statistical versus risk-neutral measures, European versus American options

Reference: Hull Chapters 8, 11

VII. Options in Continuous Time

geometric Brownian motion and the lognormal distribution, risk-neutral expectation, the Black-Scholes valuation formula of a European call option, intrinsic value and time value, the American put option

Reference: Hull Chapters 12, 13

VIII. Option Greeks

continuous-time self-financing replication, the Black-Scholes PDE, definitions of standard Greeks, analytic Greeks for the Black-Scholes model, numerical estimation of Greeks, interpretations and practical uses

Reference: Hull Chapters 10, 17

IX. Other Option Payoffs

option combinations, binaries, asset-or-nothing calls, barrier options, pricing of path-dependent options on trees, lookback options

Reference: Hull Chapters 10, 24

X. FX Derivatives

FX Forwards revisited, vanilla FX options, choice of pricing currency in FX product pricing, single / double one-touch / no-touch options

Reference: Hull Chapters 16, 25

XI. Interest Rate Options

choice of numeraire in pricing, forward-start options, caps and floors, swaptions

Reference: Hull Chapter 28