

## 21-378 : Mathematics of Fixed Income Markets

Fall 2015

**Instructor:** Scott Robertson

Office : Wean Hall 8214  
Phone : 412-268-3811  
Email : scottrob@andrew.cmu.edu

**Grader:** Thames Sae Sue

Office : Wean Hall 6207  
Phone : 412-268-3187  
Email : tsaesue@andrew.cmu.edu

**Course Website:** On Blackboard *www.cmu.edu/blackboard*

**Lectures:** Monday, Wednesday, Friday: 10 : 30 AM - 11 : 20 AM in Wean Hall 5302.

**Prerequisite :** 21-270 (Introduction to Mathematical Finance)

**Corequisites :** 21-325 (Probability), 21-370 (Discrete Time Finance).

### Primary Textbook:

*Fixed Income Securities: Tools for Today's Markets*, 3<sup>rd</sup> edition  
Bruce Tuckman, Angel Serrat  
Wiley  
ISBN-13: 9780470891698

### Additional Textbook:

*Fixed Income Securities: Valuation, Risk, and Risk Management*  
Pietro Veronesi  
Wiley  
ISBN-13: 9780470109106

**Office Hours:** Monday 9:00 AM - 10:00 AM, Thursday 12:00 PM - 1:00 PM and/or by appointment.

**Grading:** The course grade is determined as follows:

Midterm Exam : 30%      Final Exam : 40%      Homework : 30%

**Homework:** There will be 6-8 homework assignments (approximately one assignment every two weeks). Homework will consist of both “pen and paper” problems, as well as problems which must be completed using Excel. Homework is due at the beginning of class on the assigned due date. Students may submit their assignments either directly to me or electronically through Blackboard (this is the preferred method, especially for the Excel portion). Collaboration is allowed when completing homework assignments, however any submitted work must be essentially your own. Homework submissions which appear suspiciously similar will not be accepted.

Late homework may be submitted for a deduction. Deductions are according to the following schedule:

- i) Submission by 10:30 AM on the day following the due date : 20% deduction.
- ii) Submission by 10:30 AM two days following the due date : 50% deduction.

Homework submissions will not be accepted later than two days following the the due date. Solutions to the HW will be posted to Blackboard three days after the due date.

**Exams** The mid-term exam will take place during the week of October 12-16. The final exam will take place during finals week at the end of the semester. Exams are closed notes, closed textbook, closed smart phones/tablets/watches, etc.

**Course Objectives :** In this class, students will be introduced to the most common securities traded in fixed income markets and the valuation methods used to price them. Topics covered include discount factors; interest rates basics; pricing of coupon bonds; identifying the yield to maturity, as well as bond sensitivities to interest rates; term structure modeling; forward and swap rates; fixed income derivatives (including mortgage backed securities) and their valuation through backwards induction; fixed income indexes and return attribution.

### Course Outline (tentative)

- **Fixed Income Basics:** discount factors; interest rate basics; compounding conventions; spot and forward rates.
- **Securities with Deterministic Cash Flows:** zero-coupon bonds, coupon-paying bonds, annuities; pricing and hedging of these instruments via arbitrage arguments; computation of flat and full prices, accrued interest.
- **Bond Yields and Price Sensitivities:** yield to maturity; par, premium and discount bonds; sensitivity analysis including computation of duration, DV01 and convexity.
- **Term Structure Modeling:** one period and multi-period compounding; discount processes; Ho-Lee and Black-Derman models; bond price and yield formulas; forward and swap rates; principal component analysis.
- **Fixed Income Derivatives:** swaps, caps, floors; European, Bermudan, American and Asian options; mortgage backed securities, including pass-throughs, IO's, PO's and CMO's; pricing of derivatives through backwards induction; computation of option adjusted spread; prepayment models for mortgages.
- **Return Attribution:** fixed income indexes and relative return (percentage and dollar); allocation of relative return to sector and security selection, yield curve positioning and mortgage backed prepayment sensitivities.