NYU TANDON SCHOOL OF ENGINEERING
Finance & Risk Engineering

FRE-GY 7851
Interest Rates Derivative and Risk Management

Instructor Information

- Frederic Siboulet, Adjunct Professor, NYU

Course Information

- FRE-GY 7851
- Interest Rates Derivatives and Risk Management
- Interest rates valuation, risk management, one and two factor models, high dimension discrete and continuous models
- Stochastic calculus, interest rates and fixed income instruments
- Mondays, 18:00-20:40, first half semester
- In person class preferred if possible (depending on COVID or such)

Course Overview and Goals

The course is focused on interest rates and fixed income modeling for cash and derivatives instruments, for valuation, pricing and risk under deterministic and stochastic frameworks. Also looks at the application of machine learning to derivatives pricing.

Upon completion of this course, students will be able to:

- Work in team (2-3 participant) and meet well defined timely objectives
- Deliver a professional looking report, including mathematical formulas
- Program simple pricing formulas and algo using student language choice (or spreadsheet)
- Price cash and derivatives interest rates derivatives and fixed income instruments
- Introduction to rates (spot, forward, compounded, instantaneous) and families of fixed income and interest rates instruments).
- Dual curve discounting with OIS. Understand spot and forward rates, how they come together in a stochastic framework

- Understand deterministic, stochastic frameworks, various numerical methods (partial differential equation and formulae, closed forms option pricing)
- Calculus methods (PDE, Kolmogorov equations, binomial and trinomial trees, martingales and changes of measures, Radon Nikodym derivatives and Girsanov theorem, change of numeraire).
- Application of trees, finite difference methods, stochastic calculus, probabilities and martingale, with change of measure, change of numeraire
- Understand and value first and second order risk sensitivities
- Understand the nuance between rates and equity pricing, in particular with market price of risk (or risk premium).
- The Bond pricing equation, differential equation, non-complete markets,
- Derivatives pricing, risk sensitivities, market price of risk (aka Sharpe ratio for non-traded underlying)
- Spot rate models, single and multi-factors: Vasicek, Cox Ingersoll Ross, Ho Lee, Hull an White I and II
- Forward market models: HJM and BGM
- LIBOR, SOFR and FRTB
- Understand how to apply deep learning for derivatives pricing, and how to bridge modern finance theory with data science

Course Requirements

Class Participation

Participation required, once a week, 2:40 min
Class presentation are sent ahead of the class for student review
Some optional book reading and movies viewing recommendations

Assignments

Four team assignments (twelve days) and one individual assignment (three weeks). The individual assignment is due one week after the end of the half semester (avoiding overlap with other classes' exams).

Some simple coding (or excel work) with programming language up to each student's choice (VBA, MatLab, Mathematica, Python, Java, C++, etc.). All assignment should be typed as a report, including math formula, and (simple) bug free programs should be provided.

Tests & Quizzes

All assignments.

Assigned Readings

Some reading and website research. The class presentation are provided ahead of time, self-contained, and sufficient for the assignments. The class typically goes beyond the content of the presentation, encouraging discussion and critical thinking, and personal exploration of additional public information (ISDA, SIFMA, FINRA, FRB, OCC, SEC, CFTC, PRMIA, GARP, IAFE, RiskMag, Bloomberg, Reuters, S&P, Moody's, Fitch)

Grading of Assignments

The grade for this course will be determined according to the following formula:

Assignments/Activities	% of Final Grade
First team assignment	[12.5%]
Second team assignment	[12.5%]
Third team assignment	[12.5%]
Fourth team assigment	[12.5%]
Individual assigment	[50%]

Letter Grades

Letter grades for the entire course will be assigned as follows:

Letter Grade	Points	Percent

A	4.00	Example: 92.5% and higher
A-	3.67	Example: 90.0 – 92.49%
B+	3.33	Example: 87.5% - 89.99%
B	3.00	Example: 82.5% - 87.49%
B-	2.67	Example: 80% - 82.49%
C+	2.33	Example: 77.5% - 79.99%
C	2.00	Example: 70.0% - 77.49%
F	.00	Example: 69.99% and lower

View Grades

NYU classes for % grade on assignment and Albert for letter grade.

Course Schedule

Seven classes of the first half of each semester.

1. Interest rates overview
2. Interest rates and fixed income instruments
3. Interest rates valuation methods

4. Stochastic interest rates models
5. Heath Jarrow Morton
6. SOFR, LIBOR and FRTB
7. Deep Learning for Interest Rates Derivatives

Topics and Assignments

Tests and Quizzes

- n/a

Course Materials

Required Textbooks & Materials

Any one of the following:

- Wilmott, Quantitative Finance
- Andersen, Interest Rates Modeling
- Mercurio, Interest rates models
- Wlimott, FAQ in Quantitative Finance (at a minimum)

Resources

- **Access your course materials**: NYU Classes (nyu.edu/its/classes)
- **Databases, journal articles, and more**: Bern Dibner Library (library.nyu.edu)
  NYU Virtual Business Library (guides.nyu.edu/vbl)
- **Obtain 24/7 technology assistance:** Tandon IT Help Desk (soehelpdesk@nyu.edu, 646.997.3123)
  NYU IT Service Desk (AskIT@nyu.edu, 212-998-3333)

Policies

Academic Misconduct

A. Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress

academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who breach the School's rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School's Policy on Academic Misconduct.

B. Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:
    1. Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.
    2. Fabrication: including but not limited to, falsifying experimental data and/or citations.
    3. Plagiarism: Intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.
    4. Unauthorized collaboration: working together on work that was meant to be done individually.
    5. Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission have been received from the course instructor(s) or research adviser involved.
    6. Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.

Disability Disclosure Statement

Academic accommodations are available for students with disabilities. Please contact the **Moses Center for Students with Disabilities** (212-998-4980 or mosescsd@nyu.edu) for further information. Students who are requesting academic accommodations are advised to reach out to the Moses Center as early as possible in the semester for assistance.

Inclusion Statement

The NYU Tandon School values an inclusive and equitable environment for all our students. I hope to foster a sense of community in this class and consider it a place where individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities will be treated with respect. It is my intent that all students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. If this standard is not being upheld, please feel free to speak with me.