Syllabus of FINM 37601 Mathematical Market Microstructure: An Optimization Approach

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Introduction: This course provides a balanced view on theoretical framework for solving optimal execution strategy design problems and practical aspects of implementing such strategies in liquid product trading. We will touch on both quadratic optimization framework on trade scheduling problems with parametric models of market impacts and dynamic programming approach to optimal executions with stochastic modeling of market microstructure processes, as well as some discussion on recent applications of machine learning techniques to trading algorithm design. We will give brief overviews on market design and basic definitions of market microstructure variables. We will introduce the basic concept of "market microstructure time scale". An overview of traditional market microstructure theories in the context of information-based price formation process will be given. We will review basic aspects of continuous-time stochastic control and optimization theories, with applications to two major financial problems: optimal execution strategy design and market making in liquid products.

Pre-requisites: No pre-required courses; however, understanding of chapter one of H. Pham's Continuous-time Stochastic Control and Optimization with Financial Applications, or the first four chapters of S. Shreve's Stochastic Calculus for Finance II will be helpful. We will discuss basic aspects of stochastic calculus up to the first three chapters of Pham's book in class.

Outline of lectures:
- Lecture I: An introduction to market design and algorithmic trading within a global context;
- Lecture II: Market microstructure theory and practices;
- Lecture III: On the optimal design of execution algorithms;
- Lecture IV: Stochastic programming and its applications to trading algorithms and market making (part I);
- Lecture V: Stochastic programming and its applications to trading algorithms and market making (part II), and a discussion on recent developments with machine learning techniques in trading strategy research.

Assignment (100% of final score): There will be three assignments distributed throughout the lectures; weights of assignments toward final grade will be determined when lectures start.

Final exam: There will be NO final exam for this course.