Master of Science in Quantitative Finance

COURSE CODE: **QF 635**
COURSE TITLE: **Market Microstructure and Algorithmic Trading**

Instructor : Nicholas Liew
Title : Adjunct Faculty
Email :

PRE-REQUISITE/CO-REQUISITE/MUTUALLY EXCLUSIVE COURSE(S)
Knowledge in quantitative finance and trading strategies. Basic knowledge in Python or other programming languages. Students will bring their own laptop to classes to participate in classroom coding exercises.

COURSE AREA
Quantitative Finance

GRADING BASIS
Graded

COURSE UNIT
1 CU

FIRST OFFERING TERM
Academic Year: AY2023-24
Academic Term: Term 3

COURSE DESCRIPTION
We are in a digital world where financial trading is highly dominated by algorithmic trading and high-frequency trading firms. Quantitative strategies, powerful servers and ultra-fast connectivity technology allowing automated trading at extremely high speed to achieve trading objectives with minimal human intervention.

This course is intended to equip students with the market-microstructure knowledge and programming skills to be part of this exciting era of algorithmic trading. The classes, conducted in Python, are to teach students the key building blocks in the development of a real-time algorithmic trading system. With growing interests in digital assets and ease of test-net trading access to conduct classroom coding exercises, the course will teach the application in the cryptocurrency market.

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LEARNING OBJECTIVES

By the end of this course, students will be able to:

- Explain different types of algorithmic trading and high-frequency trading strategies.
- Understand market microstructures and mechanics of order book construction.
- Specify requirements and design of a real-time trading system.
- Study exchange connectivity and application programming interface (API).
- Model market and order data.
- Program in Python and apply its powerful financial and trading packages.
- Build a modern trading framework based on asynchronous event processing.
- Formulate and quantify trading ideas to form a quantitative strategy.
- Develop trading strategy by combining elements of prices, analytics, orders and risks.
- Apply back-testing to evaluate strategy performance.
- Appreciate the different roles in an electronic trading house.

ASSESSMENT METHODS

Basis of Assessment

Class participation and discussion	20%
Group Assignment	50%
Final exam	30%

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GROUP ASSIGNMENT

Students will form teams of four to work collaboratively on a group assignment to develop an algo trading strategy. Each group will research, design, code and evaluate the performance of a trading strategy. Final submission shall include a short presentation in class, a report and a Gitlab repository link to running codes.

CLASS PARTICIPATION

The course is highly hands-on to provide students the coding experience as a practitioner in an algorithmic trading workspace. Everyone will apply for a test trading account on a Crypto exchange to practice course materials in the classroom. Test account allows students to develop and run trading strategies without risking capital.

FINAL EXAMINATION

Final examination is an open-note exam to assess student's ability to apply the materials covered in class to solve real-world problems. The format of the exam paper is mainly short questions with the expectation to write some pseudo code.

ACADEMIC INTEGRITY

All acts of academic dishonesty (including, but not limited to, plagiarism, cheating, fabrication, facilitation of acts of academic dishonesty by others, unauthorized possession of exam questions, or tampering with the academic work of other students) are serious offences.

All work presented in class must be the student's own work. Any student caught violating this policy may result in the student receiving zero marks for the component assessment or a fail grade for the course. This policy applies to all works (whether oral or written) submitted for purposes of assessment.

When in doubt, students are encouraged to consult the instructors of the course. Details on the SMU Code of Academic Integrity may be accessed at http://www.smuscd.org/resources.html.

RECOMMENDED READINGS

MARKET LIQUIDITY: THEORY, EVIDENCE, AND POLICY BY THIERRY FOUCAULT, MARCO PAGANO AND AILSA RÖELL (2013)

FLASH BOYS: A WALL STREET REVOLT BY MICHAEL LEWIS (2015)

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TENTATIVE SCHEDULE

Class No.	Topic
	PART I - Introduction to Market Microstructure
1	Demystifying Algorithmic Trading ● Trading Mechanism of Financial Securities ● Type of trading strategies and trading frequencies ● Automated, systematic, rules, quantitative, statistical, technical ● General architecture, system setup and latency consideration Classroom Exercises ➔ Setting up Python development environment ➔ Setting up a test-net account ➔ Python programming basics
2	Market Structures ● Market Participants ● Securities Markets ● Limit order markets and Dealer Markets ● Trading Exchanges ● Why Market Structure Matter Classroom Exercises ➔ Functions, collections, flows ➔ REST calls
3	Limit Order Book ● Order Types ● Central Limit Order Book ● Characteristics of a Limit Order Book ● Price and Size Ticks ● Adverse Selection Effect ● Market Impact Classroom Exercises ➔ Classes and objects ➔ Order book modelling ➔ API order

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	PART 2 – Algorithmic Trading
4	Trading System ● System requirements and design ● Network types and latencies ● Connectivity and co-location ● Trading protocols Classroom Exercises ➔ Storage of sensitive information ➔ Create a method to send order ➔ Develop a simple periodic buy and sell strategy ➔ Develop a range trading strategy
5	Algorithmic Trading ● Type of Strategies ● High Frequency Trading (HFT) ● Risk of Algorithmic Trading ● System Preventive Measures ● Concurrency and multithreading Classroom Exercises ➔ Async structure: event loop, async/await, coroutine, tasks ➔ Exceptions handling ➔ Market access gateway ➔ Order book update frequency
6	Orders, Positions and Risk Management ● Order Lifecycle ● Positions Management ● Risk Measures ● Circuit breakers Classroom Exercises ➔ Real-time subscription to market depth stream ➔ Real-time subscription to order execution stream ➔ Callback concept ➔ A simple trading gateway

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	PART 3 - Strategy Structure and Development
7	Structures of a Trading Strategy • Components of a trading strategy • General structure of different strategy types • Tick-by-tick vs periodic analytics • Working with timer • Filters (SMA, EWMA) • Momentum analytics and signal generation Coding Exercises ➔ Trading framework by combining async and periodic structures ➔ Strategy class ➔ A pricing making strategy
8	Price Discovery, Liquidity, Market Fragmentation • Price Discovery Process • Market Liquidity • Market Fragmentation Coding Exercises ➔ Development of a technical trading strategy
9	Strategy Evaluation • Objective of backtesting (optimisation, performance evaluation) • Backtesting approach • Accessing predictive power of trading signals • Trades analysis and performance metrics • Transaction costs Coding Exercise ➔ Group coding assignment
	PART 4 - Presentations of Group Assignments
10	Presentations Closing notes: • Future trends in algorithmic trading • Research and modeling ideas • The roles in a professional setting