Subject Description Form

Subject Code	AMA4800
Subject Title	Algorithmic and High Frequency Trading
Credit Value	3
Level	4
Pre-requisite	Introduction to Differential Equations (AMA2008) or Mathematics II (AMA2112) or Advanced Mathematical Methods for Economics and Finance (AMA273) or Mathematical Methods for Data Science (AMA3001) or Further Mathematical Methods for Finance (AMA3723) or equivalent **and** Applied Probability Models for Investment (AMA358) or Stochastic Processes for Investment (AMA3658) or equivalent
Objectives	To introduce students some basic concepts and methods in stochastic modeling of market microstructure and high frequency financial data. To provide a comprehensive view of some key mathematical foundations of algorithmic trading strategies and enable students to master implementations of these practical algorithms using the financial data and software.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) Develop quantitative skills to interpret and analyze market microstructure and trading behavior; b) Develop theoretical knowledge to identify, define and formulate some mathematical problems from high frequency trading data; c) Master basic stochastic control methods to solve classical optimal liquidation problems and develop skills to present analysis results to trading strategies and decision making; d) Produce basic numerical implementations of some practical algorithmic trading strategies using the historical financial data and software.
Subject Synopsis/ Indicative Syllabus	<u>Introduction to Market Microstructure:</u> Electronic market, market participants, trading types, trading costs, limit order books, measuring liquidity, asset prices and returns intraday, inter-arrival times, latency and tick size, market fragmentation, daily volume and volatility, intraday activity, trading and market quality <u>Stochastic Models:</u> The optimal liquidation problem, the optimal limit order placement problem, introduction to stochastic analysis, introduction to dynamic programming principle, dynamic programming equation, introduction to some numerical methods

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<tr><td></td><td>Optimal Liquidation and Algorithmic Trading:
Liquidation without penalties, liquidation with temporary and permanent price impact, liquidation with only limit orders, liquidation with limit and market orders, several types of algorithmic trading strategies, introduction to implementations of algorithmic trading using the Bloomberg database, algorithmic analysis tools</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>The subject will mainly be delivered through lectures and lab-based tutorials. The lectures will be conducted to introduce the theoretical background of algorithmic trading, mathematical foundations of stochastic models as well as the practical use of software and Bloomberg database in the syllabus, which are reinforced by learning activities involving demonstration, computer lab tutorial exercise and mini-project using Bloomberg terminal.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="4">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td></tr>
<tr><td>1.Assignments/Project</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Midterm Test</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>3. Examination</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100%</td><td colspan="4"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
This subject focuses on both the mathematical foundation and practical implementation of <u>algorithmic and high frequency trading</u>. Some of the algorithms are based on important mathematical models such as stochastic models and related optimal control methods. Thus, <u>Exam-based assessment</u> is the most appropriate assessment method, including 20% midterm test and 50% examination.
As this subject also emphasizes the practical side of market making and trading strategies based on high frequency data, a mini-project that takes the weight of 20% is appropriate for assessing the intended learning outcomes (d). Moreover, 10% worth of assignments are included as a component of continuous assessment so as to keep students in progress.
Continuous Assessment comprises of assignments, mini-project and test. A written examination is held at the end of the semester.</td></tr>
<tr><td>Student Study Effort Required</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>26 Hrs.</td></tr>
<tr><td>▪ Tutorial</td><td>13 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Assignments/Projects</td><td>52 Hrs.</td></tr>
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	▪ Self-study	40 Hrs.
	Total student study effort	131 Hrs.

Reading List and References

Textbook:

Cartea, A., Jaimungal, S., Penalva, J.	Algorithmic and High-Frequency Trading	Cambridge 2015

References:

Leshik, E., Cralle, J.	An Introduction to Algorithmic Trading: Basic to Advanced Strategies	Wiley & Sons, 2011
Aldridge, I.	High Frequency Trading: A Practical Guide to Algorithmic Strategies and Trading Systems	Wiley & Sons 2010
De Jong, F., Rindi, B.	The Microstructure of Financial Markets	Cambridge 2009
Georgakopoulos	Quantitative Trading with R	Palgrave Macmillan 2015
Williams, R.	An Introduction to Trading in the Financial Markets: Technology, Networks and Data	Elsevier 2011
Shreve, S.	Stochastic Calculus for Finance II: Continuous Time Models	Springer 2010