HKU BUSINESS SCHOOL
港大經管學院

Inspire·Empower·Lead

| 1. General Information | |
|---|---|
| Course Subject | FINA |
| Course Number | 3350 |
| Course Title | Mathematical Finance |
| Academic Years | 2023-2024 |
| Grading Method | Letter |

## 2. Instructors

Professor MENG, Rujing
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Subclasses: 2A

| 4. Course Description | |
|---|---|
| Course Description | This course provides students with the necessary mathematical techniques used in continuous-time finance. It covers stochastic calculus, partial differential equation and applied probability. After taking this course, one should be able to fully understand no-arbitrage theory, the Black-Scholes equation, risk-neutral probability and martingales. The purpose of this course is to lay down a solid mathematical foundation for students to learn more advanced topics in financial engineering and risk management, such as exotic options, interest rate derivatives and credit risk models. |
| Prerequisites | FINA2322: Derivatives |
| Mutually exclusive | MATH2906/MATH3906 Financial calculus |
| Free Elective | Yes |

## 5. Course Objectives

1. To fully understand no-arbitrage theory, risk-neutral probability, martingale, and Black-Scholes equation

2. To lay down a solid mathematical foundation for students to learn more advanced topics in financial engineering and risk management, such as exotic options, interest rate derivatives and credit risk models

## 6. Faculty Learning Goals

Goal 1: Acquisition and internalization of knowledge of the programme discipline

Goal 2: Application and integration of knowledge

Goal 3: Inculcating professionalism

Goal 4: Developing global outlook

## 6. Faculty Learning Goals

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| Goal 5: Mastering communication skills |
| Goal 6: Cultivating leadership |

## 7. Course Learning Outcomes

| Course Teaching and Learning Activities | Aligned Faculty Learning Goals | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| CLO1. Understand the concept and properties of a standard Brownian motion. Be able to derive probability distribution of a function of Brownian motion. | ✔ | ✔ | | | | |
| CLO2. Understand stock price model with a lognormal process. Understand the Ito's Lemma. Be able to derive a process for option price by using the Ito's Lemma. | ✔ | ✔ | | | | |
| CLO3. Understand the concept of martingale. Be able to justify whether a process is a martingale or not. | ✔ | ✔ | | | | |
| CLO4. Be able to price an option using risk-neutral probability approach. | ✔ | ✔ | | ✔ | | |
| CLO5. Understand no-arbitrage principle. Be able to derive put-call parity, forward price formula, and the Black-Scholes equation by using the no-arbitrage principle. | ✔ | ✔ | | | | |
| CLO6. Understand heat equation and Green's function. Be able to solve the Black-Scholes equation with an arbitrary payoff. | ✔ | ✔ | | ✔ | | |
| CLO7. Memorize the Black-Scholes formula. Be able to derive Greek letters from the Black-Scholes formula. Understand the asymptotic behavior of the Black-Scholes formula. | ✔ | ✔ | | | | |

## 8. Course Teaching and Learning Activities

| Course Teaching and Learning Activities # | Expected Study Hours | Study Load (% of study) |
|---|---|---|
| T&L1. Lecture | 36 | 30 |
| T&L2. Tutorial | 12 | 10 |
| T&L3. Self-study | 72 | 60 |
| | Total: 120 | Total: 100 |

## 9. Assessment Methods

| Assessment Methods | Description | Weight % | Aligned Course Learning Outcomes |
|---|---|---|---|
| A1. Assignments | | 30% | 1,2,3,4,5,6,7 |
| A2. Exams | | 60% | 1,2,3,4,5,6,7 |
| A3. Class/Tutorial participation | | 10% | 1,2,3,4,5,6,7 |

| 9. Assessment Methods | | | |
|---|---|---|---|
| A4. Final Exam | | 0% | |

| Assessment Rubrics | |
|---|---|
| A1. Assignments | |
| A+,A,A- | Students demonstrate very good to excellent performance in the defined assessment criteria. |
| B+,B,B- | Students demonstrate good to very good performance in the defined assessment criteria. |
| C+,C,C- | Students demonstrate fair to good performance in the defined assessment criteria. |
| D+,D | Students demonstrate fair performance in the defined assessment criteria. |
| F | Students fail to show understanding of core materials in this course. |
| A2. Exams | |
| A+,A,A- | Students demonstrate very good to excellent performance in the defined assessment criteria. |
| B+,B,B- | Students demonstrate good to very good performance in the defined assessment criteria. |
| C+,C,C- | Students demonstrate fair to good performance in the defined assessment criteria. |
| D+,D | Students demonstrate fair performance in the defined assessment criteria. |
| F | Students fail to show understanding of core materials in this course. |
| A3. Class/Tutorial participation | |
| A+,A,A- | Students demonstrate very good to excellent performance in the defined assessment criteria. |
| B+,B,B- | Students demonstrate good to very good performance in the defined assessment criteria. |
| C+,C,C- | Students demonstrate fair to good performance in the defined assessment criteria. |
| D+,D | Students demonstrate fair performance in the defined assessment criteria. |
| F | Students fail to show understanding of core materials in this course. |

| 10. Course Grade Descriptors | |
|---|---|
| A+,A,A- | Students demonstrate very good to excellent performance in the defined assessment criteria. |
| B+,B,B- | Students demonstrate good to very good performance in the defined assessment criteria. |
| C+,C,C- | Students demonstrate fair to good performance in the defined assessment criteria. |
| D+,D | Students demonstrate fair performance in the defined assessment criteria. |
| F | Students fail to show understanding of core materials in this course. |

| 11. Course Content and Tentative Teaching Schedule | | | | | | |
|---|---|---|---|---|---|---|
| Topic/ Session | Date | Time | Content | Readings | Assignments | Other information |

| 11. Course Content and Tentative Teaching Schedule | | | | | | |
|---|---|---|---|---|---|---|
| | | | Lecture 1: Introduction and lattice model I | | | |
| | | | Lecture 2: Lattice model II | | | |
| | | | Lecture 3: Review of probability | | | |
| | | | Lecture 4: Stochastic differential equations | | | |
| | | | Lecture 5: Martingale approach I | | | |
| | | | Lecture 6: Martingale approach II | | | |
| | | | Lecture 7: Partial differential equation approach I | | | |
| | | | Lecture 8: Partial differential equation approach II | | | |
| | | | Lecture 9: Asymptotic analysis | | | |
| | | | Lecture 10: Deriving and hedging with Greeks | | | |

| 12. Required/Recommended Readings & Online Materials | |
|---|---|
| Textbook | **Reference books**<br>• Baxter, Martin, and Andrew Rennie, 1996, Financial calculus: an introduction to derivative pricing, Cambridge University Press.<br>• Buchanan, J. Robert, 2008, An undergraduate introduction to financial mathematics, 2nd edition, NJ : World Scientific Publishing Company.<br>• Hull, John, 2011, Options, Futures, & Other Derivatives, 8th edition, Prentice Hall. |

| 13. Means / Processes for Student feedback on Course | |
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| | Conducting mid-term survey in additional to SETL around the end of the semester |
| | Online response via Moodle site |

| 13. Means / Processes for Student feedback on Course | |
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| ✔ | Others |
| | Course Evaluation at the end of the course |

| 14. Course Policy |
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| The University Regulations on academic dishonesty will be strictly enforced! Please check the University Statement on plagiarism on the web: http://www.hku.hk/plagiarism/ |