**FE8822**

**Numerical Methods for Financial Instrument Pricing**

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| --- | --- | --- | --- | --- | --- |
| **Academic Year** | : | 2019/2020 | **Mini Term** | : | 4 |
| **Pre-requisites** | : | FE8705 Object Oriented Programming I  FE8706 Object Oriented Programming II  FE8507 Stochastic Modelling in Asset Pricing  FE6516 Stochastic Calculus in Finance | | | | |
|  |  |  | | | | |

**Course Description and Scope**

This course is all about the numerical methods combined with programming practices, for the implementation of the major derivative pricing models, i.e. Lattice, Monte Carlo, numerical integration and finite differences. Each method is introduced with general mathematical concepts, and code examples for the “vanilla-flavored” options and extends for the “exotic types” of options. With more advanced topics and more complex implementation, programming design constructs like object class design and polymorphism are re-introduced in concrete problem context and their very appropriate fit for use would be appreciated and learnt as a pattern in mind. This would offer an accelerated learning path to be well-versed in Python and C++. This courses trains for a confident mind to take on quant computational problems from evaluating/picking the right method, to the writing of well-structured programs.

**Course Learning Goals, Objectives & Assessment**

|  |  |  |  |
| --- | --- | --- | --- |
| **Learning Goals¹** | **Course Learning Objective²** | **Assessment Method**³  **(For each learning goal, briefly describe the assignment(s) to be used for assessing the achievement of the stated objectives)** | **NBS Standard Rubrics**4  (For each learning goal, state the actual rubric to be used for grading the assignment(s) described) |
| Acquisition of Knowledge | * Know main numerical methods used in finance derivatives. * Master skills in programming Object-oriented/functional | * In- and after-class assignments |  |
| Quantitative Literacy Skills | * Read technical paper, build intuition to implement models | * Open-end project in assignments |  |
| Ethical Reasoning | * Sound judgement towards bugs and mistakes (many occurs in paper and software) and voice out * Decide which method is suitable with good convergence for with financial instruments | * Overall in studying |  |
| Oral Communication | * Actively participate in-class projects. * Exchange ideas and learn from teammates. * Present results in oral & written | * In-class and after-class assignments |  |
| Written Communication |  |
| Teamwork & Interpersonal Skills |  |
| Motivation & Development of Self & Others |  |

**Learning & Teaching Methods**

Lecture, tutorial, in-class projects and discussion within 6 x 3.5hr sessions.

**Course Assessments**

|  |  |  |
| --- | --- | --- |
| **Components** | **Marks** | **Individual/Group** |
| Weekly assignment (usually start from in-class and continue to post-class) | 55 | Individual/Group (may differ from one assignment to another) |
| Class participation/teamwork | 5 | Individual/Group |
| Exam (2 hr open book exam with written and programming) | 40 | Individual |
|  |  |  |
| **Total** | **100** |  |

**Readings and References**

* Capiński, M., & Zastawniak, T. (2012). Numerical Methods in Finance with C (Mastering Mathematical Finance). Cambridge: Cambridge University Press.
* Joshi, M. (2015). C++ design patterns and derivatives pricing. New York: Cambridge University Press.
* Peña, A. (2014). Advanced quantitative finance with C++. Birmingham, UK: Packt Pub.
* Schlögl, E. (2014). Quantitative finance. Boca Raton: CRC Press/Taylor & Francis Group.

**Other Resources**

* Online resources for QuantLib (Quantlib.org and YouTube video)
* Online resources for Python (general programming, reference.)

**Course Instructors**

|  |  |  |  |
| --- | --- | --- | --- |
| **Instructor** | **Office Location** | **Phone** | **Email** |
| Yang Ye |  | +65 9382 6762 | yy@runchee.com |

**\***Please indicate the course coordinator with a “#” next to instructor name (if applicable)

**Proposed Weekly Schedule**

|  |  |  |  |
| --- | --- | --- | --- |
| **Week** | **Topic** | **Learning Objectives** | **Readings/Activity** |
| 1 | Foundations of Numerical Computations  Python OO programming – I |  |  |
| 2 | Numerical solution of Systems of Linear and Nonlinear Equations  Linear Programming  Python OO programming – II |  |  |
| 3 | Numerical Optimization techniques  Calibration methods  Interpolation methods |  |  |
| 4 | Simulation of Stochastic Differential Equations  Pricing of financial derivatives with Lattice (Binomial and Trinomial Trees) |  |  |
| 5 | Pricing of financial derivatives Monte Carlo simulations |  |  |
| 6 | Pricing of financial derivatives Finite Difference methods |  |  |

**Academic Integrity Policy**

NTU’s Student Academic Integrity Policy requires all members of the NTU community to uphold the values of academic integrity in all academic undertakings. The policy defines the following acts as academic dishonesty:

* plagiarism,
* academic fraud and
* facilitating academic dishonesty.

All students are expected to read and observe the policy guidelines detailed at this website: <http://www.ntu.edu.sg/ai/Pages/academic-integrity-policy.aspx> . The academic integrity website also highlights the penalties that will be imposed on students who are found to have violated the policy, and the processes that will be followed when we deal with cases of academic dishonesty.

***Appendix***

***For instructor reference only***

***(Do not print for students)***

***Further description of each Assessment Plan component:***

*¹NBS Learning Goals*

Acquisition of Knowledge | Ethical Reasoning | Quantitative Literacy Skills | Oral Communication | Written Communication | Teamwork & Interpersonal Skills | Motivation & Development of Self & Others

*²Course Learning Objectives*

Related to the expected learning goal(s) | Are observable and measurable

*³Assessment Method*

Assignments specially designed to assess students’ achievement of the stated objectives, e.g., the use of an article critique for assessing critical thinking skills, an analysis of a dilemma for assessing ethical reasoning,  etc.

*4NBS Standard Rubrics*

Criteria in rubrics must relate closely to the stated objectives | Strongly encouraged to use the NBS standard rubrics, and you may add on other criteria relevant to your assessment | NBS Office of Accreditation (AO) can assist you with rubrics that are aligned to the NBS learning goals¹