The Hong Kong University of Science and Technology

UG Course Syllabus

[Course Title] Statistical Modeling for Financial Engineering

[Course Code] IEDA4000E

[No. of Credits] 3

[Pre-requisites] IEDA 2540 and MATH 2111

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Course Description

This course provides a comprehensive introduction to statistical modeling techniques in financial engineering. Students will learn to apply exploratory data analysis, distributional modeling, and statistical inference to financial datasets. The course covers classical models for financial time series and risk, including copula models, ARIMA, GARCH, and factor models. It also introduces selected modern time-series and AI methods, including recurrent neural networks such as LSTM and transformer-based models, with an emphasis on their connections to and comparison with classical statistical approaches. Practical Python lab sessions give students hands-on experience in analyzing real financial datasets, estimating and validating models, evaluating forecasts, and addressing the challenges of modeling in complex financial markets.

Intended Learning Outcomes (ILOs)

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

1. Analyze financial data rigorously using appropriate statistical methods and representations of uncertainty.
2. Select and apply distributional modeling and statistical inference techniques to financial data.
3. Develop and interpret time-series, volatility, and dependence models for financial engineering applications.
4. Apply selected modern machine learning and AI methods for financial time-series modeling, including LSTM and transformer-based models, and compare them with classical statistical approaches.
5. Implement reproducible statistical models and analyses in Python using real-world financial datasets.
6. Evaluate model assumptions, predictive performance, robustness, and limitations in financial applications.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. General rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Assignments	10%	18/09, 02/10, 30/10, 13/11, 27/11*
Midterm Exam	25%	16/10*
Group Project	30%	Proposal: 23/10 Presentation: 27/11 Report: 30/11
Final Exam	35%	TBD*
Participation (Bonus)	5%	

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks:

Assessed Task	Mapped ILOs	Explanation
Assignments	ILO 1, 2, 3, 4, 5, 6	Written questions assess students' understanding of statistical models for financial data (ILO1), including fitting distributional models, performing inference, and selecting among competing models (ILO2, ILO6). Time-series and dependence modeling exercises assess students' ability to develop and interpret classical models (ILO3), while later assignments assess the application of modern time-series and AI methods (ILO4). Python-based exercises assess reproducible implementation using financial data (ILO5).
Midterm Exam	ILO 1, 2, 3, 6	Problems assess students' understanding of statistical concepts and uncertainty (ILO1), their ability to fit and interpret distributional models and carry out statistical inference (ILO2), and their understanding of classical time-series and dependence models covered in the first part of the course (ILO3). Questions on model choice, assumptions, and diagnostics assess students' ability to evaluate model performance and limitations (ILO6).
Group Project	ILO 1, 2, 3, 4, 5, 6	Students conduct an end-to-end analysis of real financial data, from exploratory analysis and model selection (ILO1, ILO2) to fitting and comparing classical and, where appropriate, modern time-series models (ILO3, ILO4). The project requires reproducible Python analysis (ILO5), while the report and presentation assess students' ability to justify model choices, evaluate model performance and limitations, and synthesize their findings (ILO6), demonstrating higher-order skills of analysis, evaluation, and synthesis.
Final Exam	ILO 1, 2, 3, 4, 6	Problems require students to select, apply, and interpret appropriate statistical models for different financial settings (ILO1, ILO2, ILO3). Students also compare classical and modern time-series approaches (ILO4) and assess model assumptions, diagnostics, predictive performance, and limitations (ILO6).
Participation (Bonus)	N/A	Encourages active engagement in lectures and tutorials and supports students' progress toward the course ILOs.

Grading Rubrics:

The following general rubrics outline the main assessment criteria used in the course. More detailed, task-specific rubrics will be provided when individual assessed tasks are released.

- Assignments are graded primarily based on completion, genuine effort, and demonstration of the problem-solving process, rather than solely on correctness. Minor errors will not necessarily reduce the grade if the work shows appropriate reasoning and substantive effort.

Criterion	**General Guideline**
Completion and effort	Complete and substantive attempt
Reasoning and methodology	Appropriate statistical reasoning and approach
Computational work	Reproducible Python analysis where required
Submission requirements	Compliance with instructions, including the AI Use Statement

- Exams are graded primarily based on correctness, including correct methods, calculations, and interpretation. Partial credit may be awarded for substantially correct reasoning or approaches.

Criterion	**General Guideline**
Correctness	Accuracy of answers and calculations
Methodology	Appropriate selection and application of methods
Reasoning	Clear and justified solution steps
Interpretation	Correct interpretation of results

- The group project is evaluated holistically based on the project scope, quality of execution, statistical and computational analysis, interpretation of results, and the overall quality of the written report and presentation.

Criterion	**General Guideline**
Project scope	Relevance, clarity, and appropriate level of ambition
Technical execution and modeling	Completeness, technical rigor, reproducibility, and sound use of statistical and computational methods
Evaluation and insight	Model comparison, validation, robustness, limitations, and quality of interpretation and conclusions
Writing and presentation	Clarity, organization, professionalism, and overall quality of the final deliverables

Final Grade Descriptors:

Grades	**Short Description**	**Elaboration on subject grading description**
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic

		judgments. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

Students are encouraged to use generative AI tools responsibly in homework assignments and the group project, including for concept clarification, modeling, coding, interpretation, and writing support.

Students remain fully responsible for all submitted work and must understand, verify, and be able to explain the analyses, code, results, and written content. Any errors or inappropriate use of AI-generated content remain the responsibility of the student or project group.

Each homework and project submission must include a brief AI Use Statement identifying the tool(s) used, how they were used, which parts of the work were affected, and how the outputs were checked or validated. If no generative AI was used, students should state this explicitly.

The midterm and final examinations are closed-book assessments, except that students may bring an instructor-approved cheat sheet and use an approved calculator. The use of generative AI tools, electronic resources, additional notes, or other unauthorized assistance is not permitted during examinations unless explicitly stated otherwise by the instructor.

Communication and Feedback

Assessment marks will be communicated via Canvas within two weeks of submission. Feedback on assignments may include written comments, solution sets, and discussion of common errors in lectures or tutorials. Students with questions about feedback or marks should consult the instructor within five working days after receiving the feedback.

Resubmission Policy

No resubmission will be accepted after the submission deadline, unless prior approval has been granted by the instructor due to exceptional circumstances.

Required Texts and Materials

No required textbook. Students are expected to have access to Python and Google Colab for computational exercises and assignments.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The

University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

Additional Resources

(Optional textbook) David Ruppert and David S. Matteson, Statistics and Data Analysis for Financial Engineering, 2nd Edition, Springer.