The Hong Kong University of Science and Technology

UG Course Syllabus

Bayesian Statistics

MATH 3427

3 credits

Pre-requisites: MATH 2421 or equivalence

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Office Hours: By email appointments

Course Description

This course provides a basic training of Bayesian statistics. Some ideas and principles of Bayesian including Bayesian decision theory, prior and posterior distributions, conjugate priors, Bayesian estimates and Bayesian hypothesis testing, are covered.

Other Bayesian tools such as Bayesian model selection, Bayesian networking, Bayesian data analysis, and Bayesian computational skills will also be discussed. An open-source, freely available software R will be used to implement these computational and data analytics skills.

Intended Learning Outcomes (ILOs)

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

No.	ILOs
1	elaborate the concept and philosophy of Bayesian statistics and its main difference form the frequentist statistical approach.
2	explain the importance of prior distribution (e.g. flat and conjugate priors) in Bayesian inference and how we can conduct posterior inference by using Bayesian estimates and Bayesian hypothesis testing.
3	formulate a Bayesian solution to some real-data problems and interpret the results.
4	apply the conceptual and practical skills in Bayesian statistics to problems in statistics, data science, and other areas.

Assessment and Grading

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

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Homework assignments	20%	Week 4, 7, 10, 13
Final examination	80%	In the exam period

* 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
Homework assignments	ILO1, ILO2, ILO3, ILO4	This task assesses students' ability to explain and apply Bayesian concepts (ILO 1), evaluate their implications (ILO 2) and (ILO 3) and catch up with the lecture materials to handle different statistical problems in Bayesian framework (ILO 4).]
Final examination	ILO1, ILO2, ILO3, ILO4	Final examination is designed to access students' foundational understanding of the concepts for Bayesian Statistics (ILO 1), evaluate student's ability to explain the use of Bayesian statistics (ILO 3) and to comprehend and recall theoretical knowledge discussed in lecture (ILO 2), and synthesize a well-argued solution to real problems (ILO 4)

Grading Rubrics

Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

a. Examination duration: 3 hrs for Final Examination
b. Percentage of assignments and examination.

Assessment	Assessing Course ILOs
20% by homework (3-4 sets)	1, 2, 3, 4
80% by the final exam	1, 2, 3, 4

*All assignments will receive feedback within 10 working days

Related to the policy on GenAI for teaching and learning, there is No restrictions on use of generative AI for an assessment task.

- For Assignment, no late submission will be accepted.
- If a student misses the final exam, s/he must fill in a form to apply for a make-up final exam with evidence officially.

c. Grades will be given by criteria referencing.

Final Grade Descriptors:

[As appropriate to the course and aligned with university standards]

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates mastery of all Bayesian theories and results for statistics covered in the course and can adapt and apply the statistical approaches to new problems and situations. The student can appropriately apply these concepts to real-world problems, interpret the results accurately, and exhibits strong proficiency in using R for analysis.
B	Good Performance	Shows a solid understanding of the theoretical results in Bayesian Statistics discussed in the course. The student can effectively apply these methods to real-world problems and interpret the results with minor errors. Demonstrates good competency in using R for performing analyses.
C	Satisfactory Performance	Possesses adequate knowledge of the core Bayesian concepts covered in the course. The student can address familiar problems and perform basic analyses using R, though with some inconsistencies. Shows basic ability to interpret results.
D	Marginal Pass	Has a threshold understanding of the fundamental statistical concepts in Bayesian context taught in the course. The student can perform simple analyses using R but may struggle with more complex applications. Interpretation of results may be limited and occasionally inaccurate.
F	Fail	Does not have sufficient understanding of even the basics statistical approaches in Bayesian framework covered in the course. The student is unable to effectively apply methods to real-world problems, nor using R for analyses, and fails to interpret results correctly.

Course AI Policy

Students are permitted to consult any person—including the instructor, teaching assistants (TAs), and classmates—for ideas and hints while completing homework assignments. The use of ChatGPT and other generative AI tools is also allowed. However, students are required to write up the solutions independently and are responsible for ensuring that their submissions are correct and comply with University rules and laws, including those regarding plagiarism.

Students are particularly cautioned about the potential inaccuracies and fallacies that may arise from AI-generated answers. Additionally, our final examination will be closed book, meaning that AI tools and resources will not be available during exams. This policy is in place to prevent overreliance on such tools and to ensure that assessments accurately reflect each student's individual understanding and capabilities.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include [specific details, e.g., strengths, areas for improvement]. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Required Texts and Materials

There is no textbook. The lecture notes give a concise (to the point) presentation of the course material, usually enough for most students.

Reference Books:

1. Hoff, Peter D., 2009, "A First Course in Bayesian Statistical Methods", Springer.
2. Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A., and Rubin, D.B., 2013, "Bayesian Data Analysis", Chapman & Hall/ CRC Texts in Statistical Science.

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.