MATH 3043 – Honors Real Analysis

Fall 2024 Course Syllabus

Lecture

Instructor: **Prof. IP, Ivan Chi-Ho**
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Tutorial

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Meeting Time and Venue

Lecture:	Monday, Wednesday	09:00 – 10:20	LTH
T1A:	Tuesday	19:00 – 19:50	Rm 1032, LSK Bldg

Course Description

This course covers everything about Lebesgue and Abstract Measure Theory at the level of a standard Ph.D. qualifying exam.

Topics include: Lebesgue measures, measure spaces, Lebesgue integrals, convergence theorems, product measures, Fubini's theorem, absolute continuity, bounded variations, Rademacher's Theorem, signed measures, Radon-Nikodym's theorem.

Prerequisite: Grade A- or above in MATH2043, or by instructor's approval.
Exclusion: MATH3033
Credits: 4

Intended Learning Outcomes

Upon completion of this course, students are expected:

1. Develop an understanding of the core ideas and concepts of Lebesgue measure theory.
2. Be equipped with workable knowledge in real analysis for further studies and research in partial differential equations, geometric analysis, probability theory and related fields.
3. Develop logical reasoning and critical thinking skills.

Assessment and Grading

The assessment consists of 4 Homeworks, Midterm and Final Examination.

Homework. There will be 4 homework sets during the semester, with 10 questions each. Students should submit each homework in form of a LaTeX-typed PDF on the Canvas system before the deadline. Four questions will be selected randomly for grading.

Examinations. There will be a 3-hour midterm exam during Week 6-8 (exact date to be confirmed), anda 3-hour final exam arranged by ARO.

Grading Scheme. This course will be assessed using **criterion-referencing** and grades will **not** be assigned using a curve.

The course total is calculated by a weighted formula, where students will choose the weightings during the Final Exam, such that the total is 100%. The default weights are 20%, 30% and 50% respectively.

	Weight	Assessment ILOs
Homework	20%	1,2,3
Midterm Examination	10–50%	1,2,3
Final Examination	30–70%	1,2,3

Final Grade Descriptors. Letter grades will be assigned depending on overall performance.
Obtaining a total point of 75% or above, or top 10%, will guarantee an A+.
Obtaining a total point of 50% or above will guarantee an A-range.
Obtaining a total point of 35% or above will guarantee an B-range.
Obtaining a total point of 25% or above will guarantee a passing grade.

Grades	**Short Description**	**Elaboration on subject grading description**
A	Excellent Performance	Demonstrates a comprehensive grasp of both Lebesgue and abstract measure theory, on both the conceptual understanding and computational aspect.
B	Good Performance	Shows good knowledge and understanding of measure theory, but did not master the subject completely.
C	Satisfactory Performance	Possesses adequate knowledge of measure theory, but may not be on par with the passing level of a Ph.D. qualifying exam.
D	Marginal Pass	The student is only able to recall some fragments of topics and is able to complete some of the easiest computations.
F	Fail	The student does not have sufficient understanding of even some fragments of topics, and is not even able to complete some of the easiest computations.

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.

Late submission Policy. To ensure fairness for students who submit assignments on time, a penalty for late submission is listed as follows, according to the timestamp of Canvas:

- Late submission between 0 to 24 hours, 50% penalty will be applied.
- Late submission for more than 24 hours will not be accepted.

Make-up Exam Policy. Make-up Midterm Exam will only be considered with at least a 4-hour notice and with proper support documents. Make-up Final will follow the make-up exam policy set by ARO.

Communication and Feedback. Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include comments and corrections. Students who have further questions about the feedback including marks should consult the instructor or TA within five working days after the feedback is received through email or discord.

Course AI Policy. The use of Generative AI is permitted but will be useless in this course. Students should be critical of the response generated by AI and do not blindly copy the generated responses to your homework.

Student Learning Resources

Required Text: *Real Analysis: Measure Theory, Integration, and Hilbert Spaces* by E. Stein and R. Shakarchi

Lecture Slides and **Lecture Videos** will be available on canvas after class.

Additional References:

1. *Lecture Notes* written by Prof. Frederick Fong
2. *Real Analysis*, by H. Royden, P. Fitzpatrick
3. *Real and Complex Analysis*, by W. Rudin
4. *Lebesgue Integration on Euclidean Space*, by F. Jones

Tentative Schedule

Lecture 1–3	Lebesgue Measure
Lecture 4–6	Hausdorff Measure
Lecture 7–9	Measurable Functions
Lecture 10–12	Lebesgue Integration
Lecture 13–14	Fubini's Theorem
Lecture 15–19	Lebesgue Differentiation Theorem
Lecture 20–21	Hilbert Spaces
Lecture 22–25	Abstract Measure and Signed Measure