MATH5836 – Course Outline

Information about the course

Course Authority and Lecturer: Dr. Peter Straka, email p.straka@unsw.edu.au
Consultation: Arrange an appointment via email or moodle.
Credit: This course counts for 6 Units of Credit (6UOC).
Prerequisites: MATH3611 is assumed knowledge for this course.
moodle: Further information, lecture notes, and other material will be provided via moodle.
Lectures: Wednesdays 5:00pm -8:00pm

Course aims

Measure theory provides a foundation for many branches of mathematics such as harmonic analysis, ergodic theory, theory of partial differential equations and probability theory. It is a central, extremely useful part of modern analysis, and many further interesting generalizations of measure theory have been developed. It is also subtle, with surprising, sometimes counter-intuitive, results. The aim of this course is to learn the basic elements of Measure Theory, and particular focus will be given to applications in probability theory and statistics.

Tentative Course Schedule

1. Revision of Riemann integration in $\mathbb{R}^d$, problems of the Riemann integral. Lebesgue’s “problem of measure” in $\mathbb{R}^d$, Banach-Tarski theorem.
2. Abstract measure theory - $\sigma$-algebras, measurable sets, measures, outer measures, Lebesgue measure and its properties, completion of measures.
3. Measurable functions, approximation by simple functions.
5. Product measures, Tonelli-Fubini theorem
6. Signed measures, Hahn decomposition theorem, Jordan decompositions, absolute continuity of measures, Lebesgue decomposition, Radon-Nikodym Theorem, Radon-Nikodym derivatives, chain rule, image measures
7. Disintegration of measures and conditional expectations.
8. (If time permits) Measures on infinite dimensional spaces, Gaussian measures.

Assessment

Assessment in this course will consist of two assignments, one end of semester in-class presentation and a final exam. See table below.
<table>
<thead>
<tr>
<th>Assessment</th>
<th>Weight</th>
<th>Date</th>
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<tbody>
<tr>
<td>Final Exam</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Assignment 1</td>
<td>10%</td>
<td>Week 5</td>
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<tr>
<td>Assignment 2</td>
<td>10%</td>
<td>Week 10</td>
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<tr>
<td>Homework Presentations</td>
<td>10%</td>
<td>Throughout semester</td>
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<tr>
<td>End of Semester Presenta</td>
<td>20%</td>
<td>Week 12</td>
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<tr>
<td>total:</td>
<td>100%</td>
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Late assignments will not be accepted. Further information on assessments will be given in class, closer to the time.

**Textbooks**

There is no set textbook for this course, but the following books will be helpful:

- D. L. Cohn: measure theory, Birkhauser 1993
- Billingsley, P. Probability and Measure, P519.1/492
- Halmos, P.R. Measure theory, P517.52/24
- Dudley, Real Analysis and Probability
- Shiryaev, Probability
- Doob, J.L. Measure theory, P517.52/171

**Course Evaluation and Development**

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider the student responses and their implications for course development. It is common practice to discuss informally with students how the course and their mastery of it are progressing.

**Student Learning Outcomes**

Students taking this course will develop an appreciation of the basic concepts of measure theory. These methods will be useful for further study in a range of other fields, e.g. Stochastic calculus, Quantum Theory and Harmonic analysis.

**Relation to graduate attributes:** The above outcomes are related to the development of the Science Faculty Graduate Attributes, in particular: 1. Research, inquiry and analytical thinking abilities, 4. Communication, 6. Information literacy

**Teaching strategies underpinning the course**

New ideas and skills are introduced and demonstrated in lectures, then students develop these skills by applying them to specific tasks in problem sheets and assessments.
Rationale for learning and teaching strategies

We believe that effective learning is best supported by a climate of inquiry, in which students are actively engaged in the learning process. Hence this course is structured with a strong emphasis on problem-solving tasks in assessment tasks, and students are expected to devote the majority of their class and study time to the solving of such tasks.

Rationale for Assignments: Assignments will give an opportunity for students to try their hand at more difficult problems requiring more than one line of argument and also introduce them to aspects of the subject which are not explicitly covered in lectures.

Rationale for Examinations: The final examination will assess student mastery of the material covered in the lectures.

Assessment criteria: The main criteria for marking all assessment tasks will be clear and logical presentation of correct solutions.

Knowledge and abilities assessed: All assessment tasks will assess the learning outcomes outlined above.

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Administrative matters


Plagiarism and academic honesty: Plagiarism is the presentation of the thoughts or work of another as one's own. Issues you must be aware of regarding plagiarism and the university's policies on academic honesty and plagiarism can be found at https://student.unsw.edu.au/plagiarism