MATH3901

HIGHER PROBABILITY AND STOCHASTIC PROCESSES

Semester 1, 2015
MATH3801/3901 – Course Outline

Information about the course

Course Authority:  Dr Gery Geenens

Lecturer:  Dr Gery Geenens,
           RC-2053, email:  ggeenens@unsw.edu.au, tel: 02 9385 7032

Consultation:  by appointment

Credit, Prerequisites, Exclusions:
This course counts for 6 Units of Credit (6UOC). It has an ordinary (MATH3801) and a higher version (MATH3901).

Students in MATH3801 exclude MATH3901
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Prerequisites:  MATH2501 or MATH2601 AND MATH 2011 or MATH2111 or MATH2510 or MATH2610 AND MATH2801 or MATH2901.

Lectures and Tutorials:
There are three lectures and a tutorial per week for this course. Lectures are common for both the ordinary and the higher versions. Tutorial classes are different.

Lectures (Weeks 1-12)

<table>
<thead>
<tr>
<th>Monday</th>
<th>1:00 - 2:00</th>
<th>Elec Eng G25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friday</td>
<td>9:00 - 11:00</td>
<td>Red Centre Theatre G001</td>
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</tbody>
</table>

Tutorials (Weeks 2-13)

<table>
<thead>
<tr>
<th>MATH 3801</th>
<th>Friday</th>
<th>3:00 - 4:00</th>
<th>Red Centre RC-2060</th>
<th>TBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3901</td>
<td>Friday</td>
<td>3:00 - 4:00</td>
<td>Red Centre RC-1042</td>
<td>Prof Pierre Del Moral</td>
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<tr>
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<td></td>
<td></td>
<td>Red Centre RC-1040</td>
<td>Pr Pierre Del Moral</td>
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Course aims

This course is an introduction to the theory of stochastic processes. Informally, a stochastic process is a random quantity that evolves over time, like a gambler’s net fortune and the price fluctuations of a stock on any stock exchange, for instance. The main aims of this course are: 1) to provide a thorough but straightforward account of basic probability theory; 2) to introduce basic ideas and tools of the theory of stochastic processes; and 3) to discuss in depth through many examples important stochastic processes, including Markov Chains (both in discrete and continuous
time), Poisson processes, Brownian motion and Martingales. The course will also cover other important but less routine topics, like Markov decision processes and some elements of queueing theory.

**Relation to other mathematics courses**

This course is compulsory for a major in Statistics and/or Honours degree in Statistics. It builds on foundation knowledge of basic probability and will provide a solid background for your honours program which may include MATH5335, MATH5805, MATH5816, MATH5825, MATH5835, MATH5855, MATH5916, MATH5960, MATH5965 and MATH5985.

**Student Learning Outcomes**

Students taking this course will develop an appreciation of the basic problems of stochastic processes and will be expected to be able to

- Recognise which analysis procedure is appropriate for a given research problem
- Apply probability theory to practical problems
- Understand the usefulness of Stochastic Processes in their professional area.

The ability to provide logical and coherent proofs of theoretic results, and the ability to solve problems via abstract methods will be paramount.

Through regularly attending lectures and applying themselves, students will develop competency in mathematical presentation, written and verbal skills.

**Relation to graduate attributes**

The above outcomes are related to the development of the Science Faculty Graduate Attributes, in particular:

- Research inquiry and analytical thinking abilities
- Capability and motivation for intellectual development
- Communication
- Teamwork, collaborative and management skills
- 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 assessments which is a form of feedback of their performance in the course.

Rationale for learning and teaching strategies

Effective learning is best supported by a climate of enquiry, in which students are actively engaged in the learning process. To ensure effective learning, students should participate in class as outlined below.

We believe that effective learning is achieved when students attend all classes and have prepared effectively for classes by reading through previous lecture notes. Furthermore, lectures should be viewed by the student as an opportunity to learn, rather than just copy down lecture notes. The art of logically setting out mathematics is best learned by watching an expert and paying particular attention to detail. This skill is best learned by regularly attending classes.

Finally, effective learning is achieved when students have a genuine interest in the subject and make a serious effort to master the basic material.

Assessment

Assessment in this course will consist of three class tests (worth 5% each), a mid-session exam (worth 25%) and a final examination (worth 60%).

Knowledge and abilities assessed: All assessment tasks will assess the learning outcomes outlined above, specifically, the ability to provide logical and coherent proofs of results and specific problems related to stochastic processes.

Assessment criteria: The main criteria for marking all assessment tasks will be clear and logical presentation of correct solutions. All work submitted for assessment (other than formal examination scripts) will be returned with comments on the assessment where appropriate. The returned assessments should be viewed by the students as a feedback on their performance in how they are mastering the subject.

1) Class tests

There will be three short tests given at the beginning of the tutorials in weeks 6, 10 and 12.

The test will only be 12 minutes in duration, and will consist of one question coming from a list of five or six questions. The list of questions will be provided a week
prior to each test. 
Each test will contribute 5% to the final mark. 

Students absent from the test must provide a medical certificate. **No further test will be offered.** The corresponding weight will be reported to the **final exam.**

**Rationale:** Class tests with prior release of the questions will give an opportunity for students to try their own hand at problems outside the tutorial classes. 

**Class tests schedule:**

<table>
<thead>
<tr>
<th>Test</th>
<th>Questions released</th>
<th>Test date</th>
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<tbody>
<tr>
<td>Test 1</td>
<td>Friday 10 April, 4pm</td>
<td>Friday 17 April, in tutorial (Week 6)</td>
</tr>
<tr>
<td>Test 2</td>
<td>Friday 8 May, 4pm</td>
<td>Friday 15 May, in tutorial (Week 10)</td>
</tr>
<tr>
<td>Test 3</td>
<td>Friday 22 May, 4pm</td>
<td>Friday 29 May, in tutorial (Week 12)</td>
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2) **Mid-session examination**

**Duration:** 50 minutes

**Time:** Monday 27 April 2015, at 1:00 (usual class time, Week 8), venue will be announced closer to date.

**Rationale:** The mid-session exam will assess student mastery of the material covered in the lectures up to and including Week 6 of the course. This is another form of feedback on their performance/understanding of the course.

**Weighting:** 25% of the final mark.

Students absent from the exam must provide a medical certificate. **No further exam will be offered.** The corresponding weight will be reported to the **final exam.**

Further details about the mid-session examination will be available in class and on Moodle closer to date.

3) **Final Examination**

**Duration:** 2 hours for MATH3801, 3 hours for MATH3901

**Time:** examination period, June 2015

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

**Weighting:** 60% of the final mark.

Further details about the final examination will be available in class and on Moodle closer to date.
Resources and support

Slides

A copy of the slides shown during the lectures will be provided on Moodle.

Textbooks

The course is mainly based on the following textbook:

An Introduction to Probability Models by Sheldon Ross (Harcourt - Academic Press)
(Last version: 10th Edition, other recent editions (8 or 9) will do as well)

This textbook may be very helpful for most of the students: more detailed explanations, more examples and exercises can be found in it. However, it is not required to buy it, as the course is thought to be self-contained (no explicit reference to the textbook will be made in the assessment tasks, for instance).

Another textbook addressing the same topics is

Probability and Random Processes (3rd Edition) by G. Grimmett and D. Stirzaker
(Oxford)

It is slightly more advanced and denser than the previous one. It is suitable as additional reading for the interested students.

Finally, let’s also mention

Discrete Stochastic Processes by R. Gallager (Kluwer)

It is a higher-level text and is recommended for the students who want to go a step further than what is presented in lectures.

Course webpage

The course web site will be made available through the Moodle web portal:

http://moodle.telt.unsw.edu.au/

Most course materials, including lectures slides, tutorial and assessment material, will be available there. Students should check regularly for updates and new materials.

Announcements

Announcements may be made in lectures or through the course web site.
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.

Administrative matters

Equity and diversity issues

Equity and diversity issues should be directed to the Student Equity Officers (Disability) in the Student Equity and Diversity Unit (9385-4734). Further information for students with disabilities is available at

http://www.studentequity.unsw.edu.au/

School Rules and Regulations

UNSW assesses students under a standards based assessment policy. For how this policy is applied in the School of Mathematics and Statistics see

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

Students must read and understand the School of Mathematics and Statistics Policies regarding additional assessment policies, attendance requirements, advice concerning special consideration in the event of illness or misadventure, etc., which are available via the School of Mathematics and Statistics Web page at

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

and

https://my.unsw.edu.au/student/resources/Policies.html

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

http://www.lc.unsw.edu.au/plagiarism
Detailed course schedule

Below is the intended course schedule. However, lectures may fall slightly behind or get slightly ahead of this timetable. Any variation from this will be indicated by the lecturer.

<table>
<thead>
<tr>
<th>Week</th>
<th>Commencing</th>
<th>Topic</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2/3/15</td>
<td>Presentation, introduction, probability and random variables</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>9/3/15</td>
<td>Jointly distributed random variables, moment generating function, limit theorems</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>16/3/15</td>
<td>Conditional probability and conditional expectation</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>23/3/15</td>
<td>Discrete-time Markov Chains</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>30/3/15</td>
<td>Discrete-time Markov Chains</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Mid-session break</td>
<td>(Test 1 Questions released)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>13/4/15</td>
<td>Markov decision processes and Exponential distribution</td>
<td>Class test 1</td>
</tr>
<tr>
<td>7</td>
<td>20/4/15</td>
<td>Poisson processes</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>27/4/15</td>
<td>Poisson processes</td>
<td>Mid-session test</td>
</tr>
<tr>
<td>9</td>
<td>4/5/15</td>
<td>Continuous-time Markov Chains</td>
<td>(Test 2 Questions released)</td>
</tr>
<tr>
<td>10</td>
<td>11/5/15</td>
<td>Continuous-time Markov Chains, Queueing theory</td>
<td>Class test 2</td>
</tr>
<tr>
<td>11</td>
<td>18/5/15</td>
<td>Brownian motion and other Gaussian processes</td>
<td>(Test 3 Questions released)</td>
</tr>
<tr>
<td>12</td>
<td>25/5/15</td>
<td>Martingales</td>
<td>Class test 3</td>
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