FACULTY OF SCIENCE
SCHOOL OF MATHEMATICS AND STATISTICS

MATH3801
PROBABILITY AND STOCHASTIC PROCESSES

MATH3901
HIGHER PROBABILITY AND STOCHASTIC PROCESSES

Term 1, 2019

MATH3801/3901 – Course Outline

Basic information

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

Credit, Prerequisites, Exclusions:

This course counts for 6 Units of Credit (6UOC)

It has an ordinary (MATH3801) and a higher version (MATH3901)

$\rightsquigarrow$ MATH3801 exclude MATH3901; MATH3901 exclude MATH3801.

Prerequisites: MATH2501/2601 **AND** (MATH2011/2111 or MATH2510/2610) **AND** MATH2801/2901.

Lectures and tutorials:

Four hours of lecture per week and one hour of tutorial per week (every week). Lectures and tutorials run from the 19th of February (**Week 1**) to the 26th of April (**Week 10**).

Note: Friday in Week 9 is Good Friday (public holiday), so there could be an extra lecture in Week 11 if necessary (to be confirmed closer to date).

Lectures are common for both the ordinary and the higher versions; tutorial classes are different.

Lectures:

Tuesday	9:00 - 11:00	Red Centre Theatre
Friday	11:00 - 1:00	Red Centre Theatre

Tutorials:

MATH3801 - Group 1	Thursday	10:00 - 11:00	Webster 256
MATH3801 - Group 2	Friday	9:00 - 10:00	Red Centre RC-1041
MATH3901 - Group 1	Thursday	2:00 - 3:00	Red Centre RC-4082
MATH3901 - Group 2	Friday	2:00 - 3:00	Old Main Building G32

Course aims

Abstract:

This course is an introduction to the theory of stochastic processes. Informally, a stochastic process is a random quantity that evolves over time, like the growth of a bacterial population, an electrical current fluctuating due to thermal noise, or the movement of a gas molecule, for instance. Stochastic processes find applications in many disciplines in science (notably biology, chemistry, ecology, and physics) as well as technology and engineering fields such as image processing, signal processing, information theory, computer science and telecommunications. Furthermore, seemingly random changes in financial markets have motivated the extensive use of stochastic processes in finance. The main aims of this course are: 1) to provide a thorough account of basic probability theory; 2) to introduce the ideas and tools of the theory of stochastic processes; and 3) to discuss in depth important classes of stochastic processes, including Markov Chains (both in discrete and continuous time), Poisson processes, the 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. By the end of the course they are 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.

The above outcomes are related to the development of the Faculty of Science 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.

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 attend all classes and have prepared effectively for classes by reading through previous lecture notes. 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 will consist of ① **class tests** (worth 15%), ② **a mid-session exam** (worth 25%) and ③ **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 solutions to 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 4, 8 and 10.

Students must sit the test in the tutorial group in which they are officially enrolled.

The test will only be 10 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**. Hence altogether the class tests are worth 15% of 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:

Test	Questions released	Test date
Test 1	Fr 8/3, 2pm	Th 14/3 or Fr 15/3, in tutorial (Week 4)
Test 2	Fr 5/4, 2pm	Th 12/4 or Fr 13/4, in tutorial (Week 8)
Test 3	Th 18/4, 3pm	Fr 26/4, in tutorial (Week 10)

② Mid-session Examination

Time: Friday 29 March (Week 6), 11am. Usual class time, usual class room.

Duration: 50 minutes

Rationale: The mid-session exam will assess student mastery of the material covered in the lectures up to and including Week 4 of the course. This is another form of feedback on their performance/understanding of the course.

Weighting: 25% of the final mark.

Students are allowed a **one-sided (A4) handwritten formula sheet of their own**.

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

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

③ Final Examination

Time: examination period, May

Duration: 2 hours

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

Weighting: 60% of the final mark.

Students are allowed a **two-sided (A4) handwritten formula sheet of their own**.

Further details (including examinable material) about the final examination will be available in class and on Moodle closer to date.

Additional Assessment:

Students absent from the exam must provide a medical certificate. They will be allowed to sit a deferred 'Additional Assessment' Exam (in all likelihood in July).

All students whose final mark will be **in the range 45-49**, will be offered to sit the concessional Additional Assesment exam as well.

Resources and support

Slides

A copy of the slides shown during the lectures are available from Moodle.

Textbooks

The course mainly developed from 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.

Moodle

All enrolled students have access to the Moodle page of the course from:

`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.

Administrative matters

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`

The set of general policies, procedures and guidelines currently in place relating to UNSW students is to be found at

`https://student.unsw.edu.au/policy`

Plagiarism is the presentation of the thoughts or work of another as one's own. Plagiarism is a serious academic misconduct. Students must be aware of UNSW's policies on academic integrity and plagiarism, available at

`https://student.unsw.edu.au/plagiarism`

Students are also reminded that careful time management is an important part of study, and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for all assessment tasks.

Detailed course schedule

Below is the intended course schedule.

Week	Commencing	Topic	Assessment
1	18/2/19	Introduction, probability and random variables	-
2	25/2/19	Random vectors, Moment generating function	-
3	4/3/19	Conditional probability and conditional expectation	(*Test 1 questions released*)
4	11/3/19	Discrete-time Markov Chains	**Class test 1** in tutorial
5	18/3/19	Branching processes, Exponential distributions	-
6	25/3/19	Poisson processes	**Mid-session test**
7	1/4/19	Continuous-time Markov Chains, Birth and Death processes	(*Test 2 Questions released*)
8	8/4/19	Queueing theory	**Class test 2** in tutorial
9	15/4/19	Brownian Motion and Gaussian processes	(*Test 3 Questions released*)
10	22/4/19	Martingales	**Class test 3** in tutorial