STAT3006
Advanced Stochastic Processes

The course offers an introduction to modern stochastic processes, including Brownian motion, continuous-time martingales, stochastic integration and Ito's calculus, Markov processes, stochastic differential equations, point processes and their applications. The course will include some applications but will emphasise setting up a solid theoretical foundation for the subject.

The course will provide a sound basis for progression to other honours and post-graduate courses including mathematical finance, stochastic analysis and statistics, and actuarial sciences.

The course aims to round off the rigorous introduction to probabilistic reasoning initiated in STAT3004, as well as to substantially enhance students’ depth of knowledge in the mathematical underpinning of stochastic process theory.

<table>
<thead>
<tr>
<th>Mode of Delivery</th>
<th>On Campus</th>
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<tbody>
<tr>
<td>Prerequisites</td>
<td>STAT3004</td>
</tr>
<tr>
<td>Incompatible Courses</td>
<td>STAT7006</td>
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<tr>
<td>Co-taught Courses</td>
<td>STAT7006 Graduate students attend joint classes with undergraduates but are assessed separately.</td>
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<tr>
<td>Course Convener:</td>
<td>Associate Professor Boris Buchmann</td>
</tr>
<tr>
<td>Phone:</td>
<td>57296</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:boris.buchmann@anu.edu.au">boris.buchmann@anu.edu.au</a></td>
</tr>
<tr>
<td>Office hours for student consultation:</td>
<td>TBA</td>
</tr>
<tr>
<td>Research interests</td>
<td>Probability and Stochastic Processes</td>
</tr>
<tr>
<td>Relevant administrator:</td>
<td>Anna Pickering</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:Anna.Pickering@anu.edu.au">Anna.Pickering@anu.edu.au</a></td>
</tr>
<tr>
<td>Tutor</td>
<td>Adam Nie</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:adam.nie@anu.edu">adam.nie@anu.edu</a></td>
</tr>
<tr>
<td>Office hours for student consultation:</td>
<td>TBA</td>
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SEMESTER 2
2018
COURSE OVERVIEW

Learning Outcomes
On satisfying the requirements of this course, students will have the knowledge and skills to:
1. Explain the fundamental concepts of stochastic processes in continuous time and their position in modern statistical and mathematical sciences and applied contexts;
2. Demonstrate accurate and efficient use of stochastic calculus techniques;
3. Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from stochastic analysis;

Assessment Summary

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Value</th>
<th>Due Date</th>
<th>Date for Return of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assignment 1</td>
<td>12%</td>
<td>Fri, 4pm, Week 4</td>
<td>Week 5</td>
</tr>
<tr>
<td>2. Assignment 2</td>
<td>16%</td>
<td>Fri, 4pm, Week 8</td>
<td>Week 9</td>
</tr>
<tr>
<td>3. Assignment 3</td>
<td>12%</td>
<td>Fri, 4pm, Week 11</td>
<td>Week 12</td>
</tr>
<tr>
<td>4. Final Exam</td>
<td>60%</td>
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Research-Led Teaching
This course provides a concise treatment of stochastic calculus and its applications. It gives a simple and rigorous treatment of one of the corner stones of modern probability theory. With its beginnings in the 20th century, it is the foundation of any current research in the area of probability and stochastic processes. Apart from this, it provides useful tools to any area of research dealing with such processes such as mathematics, statistics, economics, finance, computer science, engineering and biology.

Feedback

Staff Feedback
Students will be given in the following forms in the course:
1. Written comments, both individually and to the whole class.
2. Verbal comments, both individually and to the whole class.

Student Feedback
ANU is committed to the demonstration of educational excellence and regularly seeks feedback from students. One of the key formal ways students have to provide feedback is through Student Experience of Learning Support (SELS) surveys. The feedback given in these surveys is anonymous and provides the Colleges, University Education Committee and Academic Board with opportunities to recognise excellent teaching, and opportunities for improvement.

**Policies**

ANU has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University’s academic standards, and implement them. You can find the University’s education policies and an explanatory glossary at: [http://policies.anu.edu.au/](http://policies.anu.edu.au/)

Students are expected to have read the [Academic Misconduct Rule](http://policies.anu.edu.au/) before the commencement of their course.

Other key policies include:

- Student Assessment (Coursework)
- Student Surveys and Evaluations

**Examination material or equipment**

Two sheets of A4 paper with personal annotations on both sides; paper-based dictionary, no approval (must be clear of all annotations); calculator (non-programmable).

**Required Resource**


**Recommended Resources**


**Recommended Reading:** Karatzas, Ioannis; Shreve Steve (1988) Brownian motion and stochastic calculus. Graduate texts in Mathematics, 113. Springer-Verlag, New York.


## COURSE SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Summary of Activities</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Classical Analysis Revised.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Martingales.</td>
<td></td>
</tr>
<tr>
<td>3-4</td>
<td>Brownian Motion: existence, path properties, Markov Property Martingale, Reflection Principle, hitting and exit times, multivariate Brownian motion.</td>
<td></td>
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<tr>
<td>5-7</td>
<td>Brownian Motion Calculus: Ito integration, Ito formula, Ito's formula for Ito processes, multivariate Ito processes. Stratonovich Integral.</td>
<td>Week 5</td>
</tr>
<tr>
<td>8-9</td>
<td>Stochastic Differential Equations: definition, stochastic exponential and logarithm, existence and uniqueness of strong solutions, Markov property, weak solutions, backward and forward equations.</td>
<td>Week 8</td>
</tr>
<tr>
<td>10-11</td>
<td>Diffusions Processes: martingales and Dynkin formula, calculations of expectations and PDEs, tim-homogenous diffusions, exit times from an interval, representations of ODEs, explosion, recurrence transience, diffusions on an interval, stationary distributions, multivariate diffusions.</td>
<td>Week 11</td>
</tr>
<tr>
<td>12</td>
<td>Optional topics: Jump processes, Levy processes, Applications to finance, biology or engineering, Point processes.</td>
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<tr>
<td></td>
<td>Examination period</td>
<td>Final Exam</td>
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</table>

## ASSESSMENT REQUIREMENTS

The ANU is using Turnitin to enhance student citation and referencing techniques, and to assess assignment submissions as a component of the University’s approach to managing
Academic Integrity. For additional information regarding Turnitin please visit the ANU Online website.

Students may choose not to submit assessment items through Turnitin. In this instance you will be required to submit, alongside the assessment item itself, copies of all references included in the assessment item.

As a further academic integrity control, students may be selected for a 15 minute individual oral examination of their written assessment submissions.

Any student identified, either during the current semester or in retrospect, as having used ghost writing services will be investigated under the University’s Academic Misconduct Rule.

Assessment Tasks

Assessment Task 1-3: Assignments

Details of task: Assignments serve as a research-type assessment, so that ideas are reinforced on a regular basis by problem solving.

As designated on the Course Schedule, three assignments will be made available through WATTLE. Due date is Friday, 4pm, in Week 4, 8 and 12, through WATTLE.

Although verbal discussion with others (fellow students, tutors and lecturer) are encouraged, the content must be produced by you as an individual and comply with ANU academic integrity policies.

Value: 12% + 16% + 12%=40%
Estimated return date: 1-2 weeks

Assessment Task 4: Compulsory Final Exam

Details of task: Final exam. Further details will be provided closer to the exam date.

Value: 60%

Results of the Assessment Tasks determine the final raw mark according to the proposed scheme.

Students who meet the requirement for special examinations (eg medical certificate) will be provided with one. Students who do not sit the final exam and do not meet the necessary requirements for a special exam will fail.

Examination(s)
See assessment tasks.

Assignment submission

Online Submission: Unless an exemption has been approved by the Associate Dean (Education) a submission must be through Turnitin. Assignments are submitted using Turnitin in the course Wattle site. You will be required to electronically sign a declaration as part of the submission of your assignment. Please keep a copy of the assignment for your records.

Extensions and penalties

Extensions and late submission of assessment pieces are covered by the Student Assessment (Coursework) Policy and Procedure.

The Course Convener may grant extensions for assessment pieces that are not examinations or take-home examinations. If you need an extension, you must request it in writing on or before the
due date. If you have documented and appropriate medical evidence that demonstrates you were not able to request an extension on or before the due date, you may be able to request it after the due date.

No submission of assessment tasks without an extension after the due date will be permitted. If an assessment task is not submitted by the due date, a mark of 0 will be awarded.

Returning assignments
Marked assignments are returned via email.

Resubmission of assignments
Resubmission of assignments is not allowed under any circumstance.

Referencing requirements
Although formal scholarly referencing may not be necessary for the assignments, you must adhere to academic integrity policies, see Details of Assessment Tasks 1-3.

Scaling
Your final mark for the course will be based on the raw marks allocated for each of your assessment items. However, your final mark may not be the same number as produced by that formula, as marks may be scaled. Any scaling applied will preserve the rank order of raw marks (i.e. if your raw mark exceeds that of another student, then your scaled mark will exceed the scaled mark of that student), and may be either up or down.

Privacy Notice
The ANU has made a number of third party, online, databases available for students to use. Use of each online database is conditional on student end users first agreeing to the database licensor’s terms of service and/or privacy policy. Students should read these carefully.

In some cases student end users will be required to register an account with the database licensor and submit personal information, including their: first name; last name; ANU email address; and other information.

In cases where student end users are asked to submit ‘content’ to a database, such as an assignment or short answers, the database licensor may only use the student’s ‘content’ in accordance with the terms of service – including any (copyright) licence the student grants to the database licensor.

Any personal information or content a student submits may be stored by the licensor, potentially offshore, and will be used to process the database service in accordance with the licensors terms of service and/or privacy policy.

If any student chooses not to agree to the database licensor’s terms of service or privacy policy, the student will not be able to access and use the database. In these circumstances students should contact their lecturer to enquire about alternative arrangements that are available.
**Tutorial Seminar Registration**

Tutorial signup for this course will be done via the Wattle website. Detailed information about signup times will be provided on Wattle or during your first lecture. When tutorials are available for enrolment, follow these steps:

1. Log on to Wattle, and go to the course site
2. Click on the link “Tutorial enrolment”
3. On the right of the screen, click on the tab “Become Member of…..” for the tutorial class you wish to enter
4. Confirm your choice

If you need to change your enrolment, you will be able to do so by clicking on the tab “Leave group…..” and then re-enrol in another group. You will not be able to enrol in groups that have reached their maximum number. Please note that enrolment in ISIS must be finalised for you to have access to Wattle.

**SUPPORT FOR STUDENTS**

The University offers a number of support services for students. Information on these is available online from [http://students.anu.edu.au/studentlife/](http://students.anu.edu.au/studentlife/)