



UNSW
SYDNEY

FACULTY OF SCIENCE
SCHOOL OF MATHEMATICS AND
STATISTICS

MATH3041

MATHEMATICAL MODELLING
FOR REAL WORLD SYSTEMS

Semester 1, 2018

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1 Course Staff

There are two lecturers for this course:

Dr Anna Cai, Room 2083, Red Centre. Course convener and the Lecturer for Introduction to Mathematical Modelling and Dynamical Systems Modelling. email: a.cai@unsw.edu.au
phone: 9385 7039

Professor Gary Froyland, Room 3060, Red Centre. Lecturer for topics on Operations Research and Optimization Modelling. email: g.froyland@unsw.edu.au phone: 9385 7050

Consultation appointments may be made using email.

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>

2 Course Information

This six unit of credit course is recommended for all students undertaking study plans or majors in mathematics. The course is also useful for other students who are likely to use quantitative methods in their future careers.

The fundamental aim of this course is to help students to acquire the skills that major employers of science/mathematics graduates have expressed most interest in.

These skills include:

- formulating, modelling and solving problems from diverse and challenging areas,
- flexibility in applying mathematics and problem solving across different applications,
- computational skills,
- written and spoken communication skills
- teamwork skills

Our success in achieving our course objectives will depend to some extent on feedback from students as the course progresses. This feedback would be most useful if it was sent via email so that it can be widely circulated to other students if appropriate. The mathematical modelling problems will broadly fit into the two categories;

- Dynamical Systems Modelling,
- Operations Research and Optimization Modelling.

Some methods in statistics and stochastic modelling may also be employed.

Specialist skills in dynamical systems and linear and integer programming will be taught with emphasis on how to take a real world problem and set the problem up using mathematics, how to solve the mathematical problem efficiently, how to interpret and relate the mathematical results to the real world problem, and how to prepare reports on the problem.

Much of the time in lectures will be devoted to working through examples. Students will be encouraged to contribute to the formulation of problems and their solutions in class.

2.1 Computer Laboratory Class

Commencing in week 2 there will be a one hour computer based laboratory class each week. Here students will usually work through problem sheets at their own pace. The problem sheets have been devised to expose students to different types of mathematical models and different software packages for solving them. Template programs will be made available for some of the problems.

Effective learning is best supported by having students actively engaged in the learning process. The laboratory classes will provide an environment that is conducive to this learning style.

- Dynamical Systems Modelling component uses Mathematica

It can be downloaded for free from <https://www.it.unsw.edu.au/students/software/index.html>

- The Discrete Optimisation modelling component will use FICO Xpress-IVE, a leading professional optimisation software. This will be made available on all M020 computing lab computers, and a free standalone version for students can be downloaded at <http://subscribe.fico.com/xpress-optimization-community-license> (250MB, Win-64 only). Provide your name and email to access the download; be sure to read the (simple) installation instructions (the button below the 'download' button).

2.2 Literature Search Project

The first assessment activity for this course will be a literature search project. The aims of this activity are: to familiarize students with some of the history of mathematical modelling, to help students to develop information technology skills through independent research of a topic, to help students gain communication skills through preparing written reports using mathematical typesetting. Guidelines for the style and length of the report will be provided when the assessment activity is handed out.

This activity will also provide students with early feedback on their research, organizational and written skills.

2.3 Group Projects

A major part of the assessment for this course will be based on two group projects. Each project will be dealing with a real world problem that spans more than one area from dynamical systems and optimisation. Each team will consist of four or five individuals. Each member of the team will be expected to participate in all aspects of the project including; background research, setting up the model, mathematical analysis of the model, writing computer code, and preparation of final reports and presentations.

Each member of the team will complete and submit responses to questions relating to their individual understanding of and contribution to the project.

The team will collectively submit a group written report.

The Group Report should include an executive summary, an introduction, details of calculations, summary and discussion, references, and computer programs (as Appendices). These reports must not exceed fifteen pages (doubled spaced, 12pt font) excluding figures, tables and Appendices. Each member of the team will be awarded the same group mark for the project

based on the written report.

For the first Group Project the team will deliver a twenty minute oral presentation, about 5 minutes for each participant.

The oral presentation will be awarded a common group mark that will take into account the overall quality of the presentation as well as the demonstrated ability of the individual members to work together.

The group mark for the oral presentations will be decided primarily by peer review.

Further details on how to judge oral presentations will be provided in lectures. Groups should practice their oral presentations as a team prior to delivery in class.

2.4 Group Responsibilities

Each member of a group is responsible for ensuring that they can be contacted by email by all other group members. The composition of the groups for the first group project will be posted on the Course Webpages. If a member of a group has not been in contact with all other members of their group within the first week of the project being handed out then they must contact the lecturer in charge either at the end of this first week or the start of the next. If a member of a group is not pulling their weight then they should be aware that other members of the group will have the opportunity to comment on this in their individual reports. This peer review by your colleagues will be used in part to decide your mark for your individual report.

2.5 Final Exam

The final exam for this subject will cover the content of the lectures. Marks will be awarded for correct working and appropriate explanations and not just the final answer.

2.6 Guest Lectures

Finally we will invite leaders from industry to provide guest lectures to inform students about how mathematics is used in their industry and to provide examples of modelling problems that they have addressed. The purpose of these invited lecturers, together with students' own modelling experiences in this course, will facilitate the transition from undergraduate training to the workplace and/or research.

3 Assessment

- **Individual Literature Search Project (10%).**
The literature search project is due at the end of Week 4.
- **Group Project I (Discrete Optimization) (20%).**
Individual Questionnaire (8%). Group report (12%). The second group reports as well as the individual questionnaires are due shortly after week 6 (to be advised).
- **Group Project II (Dynamical Systems) (20%).**
Individual Questionnaire (5%). Group Report (10%). Group Oral Presentation (5%). The first group reports as well as the individual questionnaires for this Group Project are due at the end of Week 11.

The oral presentations for the group project will be held during lecture times in Week 11 and 12. The due dates stated here may be subjected to change and all submissions are to be made on the

MOODLE website for this course.

- **Final Exam – 2 hours (50%)**
The exam will cover the content of the lectures and may include questions relating to the projects.

4 Course Schedule

There will be four hours per week (1 to 12) for lectures and (2 to 13) computer lab classes running from week one to thirteen. Some of the contact hours will be unstructured time for you to work on your projects. It is anticipated that you will also have to do work outside class contact hours.

The lectures are Mondays (16:00 -18:00) in OMB 151, Fridays (10:00 – 11:00) in OMB G32 and Computer Labs at Tuesdays (14:00-15:00) in M020 of the Red Centre. This class is a tutorial/computer workshop.

4.1 Timetable

Lecture schedule

Weeks 1 – 6 Operations research and optimisation modelling

Weeks 6 – 12 Dynamical systems modelling

5 Resources for Students

5.1 Web Pages

General information about the course, lecture notes in .pdf format, computer laboratory notes, project outlines, general reference material and links will be maintained at the MOODLE Web Site for this course.

5.2 Recommended Reading

Introduction to Mathematical Modelling and Dynamical Systems Modelling

- TBA during lectures

Operations Research and Optimization Modelling

The following texts are available in the UNSW library.

- An introduction to linear optimization (S. Bertsimas)
- Integer Programming (L. Wolsey)
- Model building in mathematical programming (H. P. Williams)

6 Other Matters

6.1 Course Evaluation and Development

The School of Mathematics & Statistics evaluates each course each time it is run. Feedback on the course is gathered, using among other means, UNSW's myExperience process.

Student feedback is taken seriously, and continual improvements are made to the course based in part on such feedback.

Prior to 2011 this course consisted of three modelling components; (i) dynamical systems models, (ii) optimization models and (iii) probabilistic and stochastic models. There has been sustained negative feedback on the third module despite attempts to change the focus. The feedback suggested that it would be better to run the course with just two modules to allow the course to fit more comfortably within a 12 week lecture term and to fit more comfortably with students backgrounds. We followed this recommendation in 2011 and it met with student satisfaction. In 2011 one of the students expressed concerns that: "The course is very different to the conventional math course offered at UNSW, which usually consists of a few class tests and a final exam,... focusses too much on groupwork and research skills and not enough on the actual math." We agree that the course is different to other maths courses but we do not agree that we focus too much on research skills since this is one of the main goals of the course. This course teaches modelling tools but its main goal is to equip you with the modelling skills, research skills, teamwork and presentation skills for dealing with real world problems.

6.2 Additional Assessment

For information about Additional Assessments and other Administrative matters relating to your course please consult the School of Mathematics and Statistics Web page at <http://www.maths.unsw.edu.au/currentstudents/additional-assessment>

6.3 Plagiarism

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.maths.unsw.edu.au/currentstudents/policy-academic-misconduct>