MATH2110

Mathematical Modelling and Differential Equations

Session 2, In person-scheduled-weekday, North Ryde 2022

School of Mathematical and Physical Sciences

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General Information

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Credit points
10

Prerequisites
MATH2010 or MATH235 or MATH2055

Corequisites

Co-badged status

Unit description
This unit builds upon 1000-level mathematical modelling methods and develops new techniques for both formulating and analysing mathematical models of physical systems. Theory and application will be presented in an integrative way, emphasising the utility of mathematical methods in obtaining information and making predictions about real-world processes. The unit will focus particularly on how to interpret and derive differential equations describing (possibly coupled) physical systems that either vary in time or space. Powerful methods, and their theoretical foundations, will be introduced to analyse and solve these differential equations. Complementary numerical techniques will be used in some of the methods, preparing students for analyses of more intricate problems.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

ULO1: Interpret a mathematical model in order to determine the qualitative behaviour of the physical system that it represents.

ULO2: Formulate a simplified mathematical model of a complex physical system.

ULO3: Apply mathematical techniques to quantitatively analyse the behaviour of mathematical models that vary with time and space.

ULO4: Translate solutions and results of mathematical models into implications and predictions for the original physical system being modelled.

ULO5: Utilise software to numerically obtain, present, and communicate results pertaining to the behaviour of a physical system.

General Assessment Information

Late Assessment Submission Penalty

From 1 July 2022, Students enrolled in Session based units with written assessments will have the following late penalty applied. Please see https://students.mq.edu.au/study/assessment-exams/assessments for more information.

Unless a Special Consideration request has been submitted and approved, a 5% penalty (of the total possible mark) will be applied each day a written assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of '0' will be awarded even if the assessment is submitted. Submission time for all written assessments is set at **11:55 pm**. A 1-hour grace period is provided to students who experience a technical concern.

For any late submission of time-sensitive tasks, such as scheduled tests/exams, performance assessments/presentations, and/or scheduled practical assessments/labs, students need to submit an application for Special Consideration.

Assessments where Late Submissions will be accepted

In this unit, late submissions will be accepted as follows:

- Assignment 1 – YES, Standard Late Penalty applies
- Assignment 2 – YES, Standard Late Penalty applies
- Major Project – YES, Standard Late Penalty applies
- Examination – NO, unless Special Consideration is granted

FINAL EXAM POLICY: All students are expected to ensure that they are available until the end of the teaching semester, that is, the final day of the official examination period. The only excuse for not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these special circumstances, you may apply for special consideration via ask.mq.edu.au.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	10%	No	Week 5
Assignment 2	10%	No	Week 11
Major Project	30%	No	Week 7 & Week 12
Examination	50%	No	Final Examination Period

Assignment 1

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 6 hours
Due: **Week 5**
Weighting: **10%**

This assignment will test the ability of students to develop and analyse mathematical problems using concepts and techniques from mathematical modelling and applied mathematics.

On successful completion you will be able to:

- Interpret a mathematical model in order to determine the qualitative behaviour of the physical system that it represents.
- Formulate a simplified mathematical model of a complex physical system.
- Apply mathematical techniques to quantitatively analyse the behaviour of mathematical models that vary with time and space.
- Translate solutions and results of mathematical models into implications and predictions for the original physical system being modelled.
- Utilise software to numerically obtain, present, and communicate results pertaining to the behaviour of a physical system.

Assignment 2

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 6 hours
Due: **Week 11**
Weighting: **10%**

This assignment will test the ability of students to develop and analyse mathematical problems using concepts and techniques from mathematical modelling and applied mathematics.

On successful completion you will be able to:

- Interpret a mathematical model in order to determine the qualitative behaviour of the physical system that it represents.
- Formulate a simplified mathematical model of a complex physical system.
- Apply mathematical techniques to quantitatively analyse the behaviour of mathematical models that vary with time and space.
- Translate solutions and results of mathematical models into implications and predictions for the original physical system being modelled.
- Utilise software to numerically obtain, present, and communicate results pertaining to the behaviour of a physical system.

Major Project

Assessment Type [1]: Project
Indicative Time on Task [2]: 20 hours
Due: **Week 7 & Week 12**
Weighting: **30%**

The students will be assigned a mathematical modelling task in groups. They will be required to develop and analyse a mathematical model to draw conclusions. The students will be required to submit individual written reports.

On successful completion you will be able to:

- Interpret a mathematical model in order to determine the qualitative behaviour of the physical system that it represents.
- Formulate a simplified mathematical model of a complex physical system.
- Apply mathematical techniques to quantitatively analyse the behaviour of mathematical models that vary with time and space.
- Translate solutions and results of mathematical models into implications and predictions for the original physical system being modelled.
- Utilise software to numerically obtain, present, and communicate results pertaining to the behaviour of a physical system.

Examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **Final Examination Period**
Weighting: **50%**

This will be held during the final exam period. It will test the ability of students to utilise the concepts taught in the course to develop mathematical models, and apply appropriate techniques to analyse and interpret these models.

On successful completion you will be able to:

- Interpret a mathematical model in order to determine the qualitative behaviour of the physical system that it represents.
- Formulate a simplified mathematical model of a complex physical system.
- Apply mathematical techniques to quantitatively analyse the behaviour of mathematical models that vary with time and space.
- Translate solutions and results of mathematical models into implications and predictions for the original physical system being modelled.
- Utilise software to numerically obtain, present, and communicate results pertaining to the behaviour of a physical system.

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[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

Lectures:

In lectures, concepts are introduced, explained and illustrated. The content of the unit will be explained and example problems will be solved, and applications discussed. There will be two hours of lectures each week.

Small Group Teaching Activities:

The students will participate in weekly small group teaching activities (SGTAs). The students will work through example problems that require applying the mathematical and computational techniques introduced in the lectures. There will be two hours of SGTAs each week.

Required Materials:

This subject requires the use of several items of software. Each of these is available to you at no cost, either because the software is open source or otherwise freely available, or because Macquarie University has arranged access for students. You will need the following:

- **Matlab**: Macquarie University provides Matlab access on a wide range of computing platforms. You will be required to sign up with Mathworks using your student email account. Access and installation instructions may be found at: https://staff.mq.edu.au/intranet/science-and-engineering/services-and-resources/it-support-services/miscellaneous/matlab
- **LaTeX**: LaTeX is a free mathematical typesetting program. Access and installation instructions may be found at: https://www.latex-project.org/get/
    - Students may also use the free online LaTeX compiler, Overleaf, which is found at: https://www.overleaf.com

Unit Schedule

WEEK	UNIT SCHEDULE (guide only)	ASSESSMENT DUE
	Introduction to modelling; Derive mathematical models; Compartment modelling	
	Compartment modelling continued; Dimensional analysis	Projects released; Exercise 1
	First-order ODEs; Logistic equation; phase lines & stability	Assignment 1 released; Exercise 2
	Harvesting & bifurcations; Numerical methods	Exercise 3
	Systems of first-order ODEs; Solutions to linear systems	Assignment 1 Due; Exercise 4
	Stability of linear systems; Classifications & phase planes	Exercise 5
	Nonlinear systems of ODEs; Linear stability; Constructing phase planes	Project Presentation Slides Due; Exercise 6
	MID-SESSION BREAK	
	Population models; Lotka-Volterra Predator-Prey	Exercise 7
	Infectious disease models; SIR model	Assignment 2 released; Exercise 8

WEEK	UNIT SCHEDULE (guide only)	ASSESSMENT DUE
	Second-order ODEs; Mass-spring systems	Exercise 9
	Boundary value problems; Nonlinear effects	Assignment 2 Due; Exercise 10
	Nonlinear effects continued; Power series	Project Written Report Due; Exercise 11
	Revision	Exercise 12

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policies.mq.edu.au). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Assessment Procedure
- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

Students seeking more policy resources can visit Student Policies (https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.edu.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

The Writing Centre

The Writing Centre provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Macquarie University offers a range of Student Support Services including:

- IT Support
- Accessibility and disability support with study
- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues

Student Enquiries

Got a question? Ask us via AskMQ, or contact Service Connect.

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.