MATH3902

Nonlinear Dynamics and Chaos

Session 1, Special circumstances 2021

Archive (Pre-2022) - Department of Mathematics and Statistics

Contents

Notice

As part of Phase 3 of our return to campus plan, most units will now run tutorials, seminars and other small group activities on campus, and most will keep an online version available to those students unable to return or those who choose to continue their studies online.

To check the availability of face-to-face activities for your unit, please go to timetable viewer. To check detailed information on unit assessments visit your unit's iLearn space or consult your unit convenor.

General Information

Unit convenor and teaching staff

Convenor/Lecturer
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Convenor/Lecturer
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Credit points
10

Prerequisites
(MATH2010 or MATH235) and (MATH2020 or MATH2110 or MATH232 or MATH236)

Corequisites

Co-badged status

Unit description
The remarkable fact that determinism does not guarantee regular or predictable behaviour is having a major impact on many fields of science and engineering, as well as mathematics. The discovery of chaos, or of chaotic motions, in simple dynamical systems changed our understanding of the foundations of physics and has found many practical applications. Dynamical systems involve the study of maps and systems of differential equations. In this unit, the diversity of nonlinear phenomena is explored through the study of second-order differential equations and second-order systems, in which nonlinearity is usually ignored in simpler treatments.

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: Explain the principles and basic concepts of Nonlinear Dynamical Systems, both of discrete systems and continuous ones through Differential Equations. In particular, gain an appreciation of the characteristics of 'chaotic' behaviour.

ULO2: Competently use modern computing software to model a range of phenomena in science and engineering, displaying the complexity that can occur with nonlinear systems.

ULO3: Demonstrate an understanding of the breadth of the theory of Nonlinear Systems, and how the distinction between periodic and non-periodic orbits is related to the very numbers used to model or describe the state of a system.

ULO4: Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the Dynamical Systems, and to produce appropriate computer graphics to aptly illustrate the phenomena involved.

General Assessment Information

LATE SUBMISSION OF WORK: All assessment tasks must be submitted by the official due date and time. In the case of a late submission for a non-timed assessment (e.g. an assignment), if special consideration has NOT been granted, 20% of the earned mark will be deducted for each 24-hour period (or part thereof) that the submission is late for the first 2 days (including weekends and/or public holidays). For example, if an assignment is submitted 25 hours late, its mark will attract a penalty equal to 40% of the earned mark. After 2 days (including weekends and public holidays) a mark of 0% will be awarded. Timed assessment tasks (e.g. tests, examinations) do not fall under these rules.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	15%	No	Week 4
Assignment 2	15%	No	Week 8
Assignment 3	10%	No	Week 12
Final Examination	60%	No	Final Examination Period

Assignment 1

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 9 hours
Due: **Week 4**
Weighting: **15%**

The assignment will test the ability of the students to develop and analyse mathematical problems using concepts and techniques learnt in lectures.

On successful completion you will be able to:

- Explain the principles and basic concepts of Nonlinear Dynamical Systems, both of discrete systems and continuous ones through Differential Equations. In particular, gain an appreciation of the characteristics of ‘chaotic’ behaviour.
- Competently use modern computing software to model a range of phenomena in science and engineering, displaying the complexity that can occur with nonlinear systems.
- Demonstrate an understanding of the breadth of the theory of Nonlinear Systems, and how the distinction between periodic and non-periodic orbits is related to the very numbers used to model or describe the state of a system.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the Dynamical Systems, and to produce appropriate computer graphics to aptly illustrate the phenomena involved.

Assignment 2

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 9 hours
Due: **Week 8**
Weighting: **15%**

The assignment will test the ability of the students to develop and analyse mathematical problems using concepts and techniques learnt in lectures.

On successful completion you will be able to:

- Explain the principles and basic concepts of Nonlinear Dynamical Systems, both of discrete systems and continuous ones through Differential Equations. In particular, gain

an appreciation of the characteristics of ‘chaotic’ behaviour.

- Competently use modern computing software to model a range of phenomena in science and engineering, displaying the complexity that can occur with nonlinear systems.
- Demonstrate an understanding of the breadth of the theory of Nonlinear Systems, and how the distinction between periodic and non-periodic orbits is related to the very numbers used to model or describe the state of a system.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the Dynamical Systems, and to produce appropriate computer graphics to aptly illustrate the phenomena involved.

Assignment 3

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 9 hours
Due: **Week 12**
Weighting: **10%**

The assignment will test the ability of the students to develop and analyse mathematical problems using concepts and techniques learnt in lectures.

On successful completion you will be able to:

- Explain the principles and basic concepts of Nonlinear Dynamical Systems, both of discrete systems and continuous ones through Differential Equations. In particular, gain an appreciation of the characteristics of ‘chaotic’ behaviour.
- Competently use modern computing software to model a range of phenomena in science and engineering, displaying the complexity that can occur with nonlinear systems.
- Demonstrate an understanding of the breadth of the theory of Nonlinear Systems, and how the distinction between periodic and non-periodic orbits is related to the very numbers used to model or describe the state of a system.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the Dynamical Systems, and to produce appropriate computer graphics to aptly illustrate the phenomena involved.

Final Examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 18 hours
Due: **Final Examination Period**

Weighting: **60%**

This will be an invigilated exam, held during the final exam period. It will test the ability of students to utilise concepts and techniques learnt in lectures. The final examination is a hurdle requirement. To satisfy the hurdle requirement students must score at least 50% on the final examimnation.

On successful completion you will be able to:

- Explain the principles and basic concepts of Nonlinear Dynamical Systems, both of discrete systems and continuous ones through Differential Equations. In particular, gain an appreciation of the characteristics of 'chaotic' behaviour.
- Competently use modern computing software to model a range of phenomena in science and engineering, displaying the complexity that can occur with nonlinear systems.
- Demonstrate an understanding of the breadth of the theory of Nonlinear Systems, and how the distinction between periodic and non-periodic orbits is related to the very numbers used to model or describe the state of a system.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the Dynamical Systems, and to produce appropriate computer graphics to aptly illustrate the phenomena involved.

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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 (online): Concepts are introduced, explained and illustrated. There will be two formal contact hours per week, consisting of two lectures.

Small group teaching activity: Led by an SGTA instructor, students will discuss problems related to the previous week's lecture content, and work through similar problems.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policie

s.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
- Grade Appeal Policy
- Complaint Management 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

Student Support

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

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to help you improve your marks and take control of your study.

- Getting help with your assignment
- Workshops
- StudyWise
- 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

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

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.

Changes since First Published

Date	Description
11/02/2021	Updated General information, staff details and Delivery and Resources sections