



# MATH7907

## Advanced Methods in Mathematics 1

Session 1, Special circumstances 2021

*Department of Mathematics and Statistics*

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#### **Disclaimer**

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#### **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 Justin Tzou <a href="mailto:justin.tzou@mq.edu.au">justin.tzou@mq.edu.au</a> Contact via E-mail Please refer to iLearn
Credit points 10
Prerequisites Admission to MRes
Corequisites
Co-badged status
Unit description This unit is based on an area of current mathematical research. The specific area may vary from year to year depending on the interests of the students and lecturer.

## Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at <https://students.mq.edu.au/important-dates>

## Learning Outcomes

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

**ULO1:** Demonstrate advanced disciplinary knowledge and skills in a particular area of mathematics.

**ULO2:** Apply advanced mathematical skills to related areas of mathematics or other disciplines.

**ULO3:** Use abstract mathematical frameworks to synthesize diverse examples or phenomena from within a particular area of mathematics.

**ULO4:** Communicate effectively the results of advanced mathematical reasoning.

## General Assessment Information

**ATTENDANCE and PARTICIPATION:** Please contact the unit convenor as soon as possible if

you have difficulty attending and participating in any classes. There may be alternatives available to make up the work. If there are circumstances that mean you will miss a class, you can apply for Special Consideration via [ask.mq.edu.au](http://ask.mq.edu.au).

**ASSIGNMENT SUBMISSION:** Assignment submission will be online through the iLearn page.

Submit assignments online via the appropriate assignment link on the iLearn page. A personalised cover sheet is not required with online submissions. Read the submission statement carefully before accepting it as there are substantial penalties for making a false declaration.

- Assignment submission is via iLearn. You should upload this as a single scanned PDF file.
- Please note the quick guide on how to upload your assignments provided on the iLearn page.
- Please make sure that each page in your uploaded assignment corresponds to only one A4 page (do not upload an A3 page worth of content as an A4 page in landscape). If you are using an app like Clear Scanner, please make sure that the photos you are using are clear and shadow-free.
- It is your responsibility to make sure your assignment submission is legible.
- If there are technical obstructions to your submitting online, please email us to let us know.

You may submit as often as required prior to the due date/time. Please note that each submission will completely replace any previous submissions. It is in your interests to make frequent submissions of your partially completed work as insurance against technical or other problems near the submission deadline.

**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. Overdue applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

## Assessment Tasks

Name	Weighting	Hurdle	Due
<a href="#">Assignment 1</a>	25%	No	end of Week 5
<a href="#">Assignment 2</a>	25%	No	end of Week 8

Name	Weighting	Hurdle	Due
<a href="#">Assignment 3</a>	25%	No	end of Week 11
<a href="#">Assignment 4</a>	25%	No	June 14

## Assignment 1

Assessment Type [1](#): Problem set

Indicative Time on Task [2](#): 10 hours

Due: **end of Week 5**

Weighting: **25%**

The assignments reinforce and build on material from lectures, as well as leading students towards more advanced topics. They are designed to promote a more independent style of learning than in standard undergraduate units.

On successful completion you will be able to:

- Demonstrate advanced disciplinary knowledge and skills in a particular area of mathematics.
- Apply advanced mathematical skills to related areas of mathematics or other disciplines.
- Use abstract mathematical frameworks to synthesize diverse examples or phenomena from within a particular area of mathematics.
- Communicate effectively the results of advanced mathematical reasoning.

## Assignment 2

Assessment Type [1](#): Problem set

Indicative Time on Task [2](#): 10 hours

Due: **end of Week 8**

Weighting: **25%**

The assignments reinforce and build on material from lectures, as well as leading students towards more advanced topics. They are designed to promote a more independent style of learning than in standard undergraduate units.

On successful completion you will be able to:

- Demonstrate advanced disciplinary knowledge and skills in a particular area of

mathematics.

- Apply advanced mathematical skills to related areas of mathematics or other disciplines.
- Use abstract mathematical frameworks to synthesize diverse examples or phenomena from within a particular area of mathematics.
- Communicate effectively the results of advanced mathematical reasoning.

## Assignment 3

Assessment Type <sup>1</sup>: Problem set

Indicative Time on Task <sup>2</sup>: 10 hours

Due: **end of Week 11**

Weighting: **25%**

The assignments reinforce and build on material from lectures, as well as leading students towards more advanced topics. They are designed to promote a more independent style of learning than in standard undergraduate units.

On successful completion you will be able to:

- Demonstrate advanced disciplinary knowledge and skills in a particular area of mathematics.
- Apply advanced mathematical skills to related areas of mathematics or other disciplines.
- Use abstract mathematical frameworks to synthesize diverse examples or phenomena from within a particular area of mathematics.
- Communicate effectively the results of advanced mathematical reasoning.

## Assignment 4

Assessment Type <sup>1</sup>: Problem set

Indicative Time on Task <sup>2</sup>: 10 hours

Due: **June 14**

Weighting: **25%**

The assignments reinforce and build on material from lectures, as well as leading students towards more advanced topics. They are designed to promote a more independent style of learning than in standard undergraduate units.

On successful completion you will be able to:

- Demonstrate advanced disciplinary knowledge and skills in a particular area of mathematics.
  - Apply advanced mathematical skills to related areas of mathematics or other disciplines.
  - Use abstract mathematical frameworks to synthesize diverse examples or phenomena from within a particular area of mathematics.
  - Communicate effectively the results of advanced mathematical reasoning.
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<sup>1</sup> 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 [Learning Skills Unit](#) for academic skills support.

<sup>2</sup> 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

### CLASSES

You should attend the two-hour lecture each week.

### REQUIRED AND RECOMMENDED TEXTS AND MATERIALS

Lecture notes written during lecture time will be designed to be fully sufficient for the purposes of this course. However, the following references and resources may be useful:

- *Advanced Mathematical Methods for Scientists and Engineers*, C.M. Bender and S.A. Orszag, McGraw-Hill (1978).
- *Asymptotic Analysis*, J.D. Murray, Springer-Verlag (1984).
- *Multiple Scale and Singular Perturbation Methods*, J. Kevorkian and J.D. Cole, Springer-Verlag (1996).
- *Introduction to Perturbation Methods*, M.H. Holmes, Springer-Verlag (1998).

Not all of the material in the above texts will be covered; however, not all material covered in lectures will be contained in the texts.

### TECHNOLOGY USED AND REQUIRED

You are expected to have access to an internet-enabled computer with a web browser and Adobe Reader software. Difficulties with your home computer or internet connection do not constitute a reasonable excuse for lateness of, or failure to submit, assessment tasks.

MATLAB, or a free alternative such as GNU Octave (<https://www.gnu.org/software/octave/>), may be required to complete some assignment problems. For Macquarie University students, MATLAB can be downloaded here: <https://web.science.mq.edu.au/it/matlab/>

## Unit Schedule

The exact pace and timetable will depend on the particular interests of the students in the class. However, we expect to cover the following topics:

- Introduction
  - introduction to asymptotic series
  - perturbed algebraic equations
- Regular perturbations
  - eigenvalues of perturbed boundary value problems; solvability conditions
  - boundary value problems on perturbed domains
  - nonlinear initial value problems
  - stability analysis of solutions of parabolic PDEs
- Singular perturbations
  - matched asymptotic methods for boundary value problems
    - boundary layers
    - internal layers
    - nested layers
  - WKB method; turning points
- Depending on the interests of the students, we will cover the application of asymptotic methods in one or more of the following areas of research:
  - weakly nonlinear analysis of parabolic PDEs with applications in
    - crime hotspots
    - vortex dynamics in Bose-Einstein condensates
  - matched asymptotic methods for singularly perturbed parabolic PDEs in one spatial dimension
    - analysis of slow dynamics and stability of fully nonlinear localised patterns of reaction-diffusion systems
  - hybrid asymptotic-numerical techniques for singularly perturbed parabolic and elliptic PDEs in two and three spatial dimensions
    - analysis of slow dynamics and stability of fully nonlinear localised spot patterns of reaction-diffusion systems
    - optimizing the principal eigenvalue of the Laplacian on a punctured two-dimensional domain

- narrow escape and narrow capture models of intracellular

## Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central \(https://policies.mq.edu.au\)](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](#)
- [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 \(https://students.mq.edu.au/support/study/policies\)](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 \(https://policies.mq.edu.au\)](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](http://ask.mq.edu.au) or if you are a Global MBA student contact [globalmba.support@mq.edu.au](mailto: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](http://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 Enquiry Service

For all student enquiries, visit Student Connect at [ask.mq.edu.au](http://ask.mq.edu.au)

If you are a Global MBA student contact [globalmba.support@mq.edu.au](mailto:globalmba.support@mq.edu.au)

## Equity 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.

## IT Help

For help with University computer systems and technology, visit [http://www.mq.edu.au/about\\_us/offices\\_and\\_units/information\\_technology/help/](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 assessment section