MATH3906

Partial Differential Equations

Session 2, Special circumstance 2020

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 ot her small group learning activities on campus for the second half-year, while keeping an online ver sion available for those students unable to return or those who choose to continue their studies onli ne.

To check the availability of face-to-face and onlin e activities for your unit, please go to timetable vi ewer. To check detailed information on unit asses sments visit your unit's iLearn space or consult yo ur unit convenor.

General Information

Unit convenor and teaching staff
Convenor/Lecturer
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Lecturer
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Credit points
10

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

Corequisites
MATH3901 or MATH3902 or MATH3905 or MATH3909 or MATH331 or MATH332 or MATH335 or MATH339

Co-badged status

Unit description
Partial differential equations form one of the most fundamental links between pure and applied mathematics. Many problems that arise naturally from physics and other sciences can be described by partial differential equations. Their study gives rise to the development of many mathematical techniques, and their solutions enrich both mathematics and their areas of origin. This unit explores how partial differential equations arise as models of real physical phenomena, and develops various techniques for solving them and characterising their solutions. Special attention is paid to three partial differential equations that have been central in the development of mathematics and the sciences - Laplace's equation, the wave equation and the diffusion equation. This unit also introduces the idea of implementing computational methods for solving partial differential equations on mathematical software using ideas from numerical analysis.

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: Have knowledge of the principles and concepts of a basic theory of partial differential equations.

ULO2: Use the ideas and techniques of the theory of partial differential equations to model a broad range of phenomena in science and engineering (in particular using the heat and wave equations).

ULO3: Understand the breadth of the theory of partial differential equations and its role in other fields.

ULO4: Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the theory of partial differential equations.

ULO5: Demonstrate efficient use of Fourier analysis techniques in the theory of partial differential equations.

ULO6: Further studies in the areas of partial differential equations and advanced analysis.

General Assessment Information

HURDLES: This unit has no hurdle requirements.

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: All assignments must be submitted by the official due date and time. No marks will be given to late work unless an extension has been granted following a successful application for Special Consideration. Please contact the unit convenor for advice as soon as you become aware that you may have difficulty meeting any of the assignment deadlines. It is in your interests to make frequent submissions of your partially completed work. Note that later submissions completely replace any earlier submission, and so only the final submission made before the due date will be marked.

FINAL EXAM POLICY: You are advised that it is Macquarie University policy not to set early examinations for individuals or groups of students. 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.

SUPPLEMENTARY EXAMINATIONS:

IMPORTANT: If you receive special consideration for the final exam, a supplementary exam will be scheduled in the interval between the regular exam period and the start of the next session. If you apply for special consideration, you must give the supplementary examination priority over any other pre-existing commitments, as such commitments will not usually be considered an acceptable basis for a second application for special consideration. Please ensure you are familiar with the policy prior to submitting an application. You can check the supplementary exam information page on FSE101 in iLearn (https://bit.ly/FSESupp) for dates, and approved applicants will receive an individual notification sometime in the week prior to the exam with the exact date and time of their supplementary examination.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	15%	No	Week 6
Mid-semester test	10%	No	Week 8
Assignment 2	15%	No	Week 11
Final exam	60%	No	Exam Period

Assignment 1

Assessment Type [1]: Problem set

Indicative Time on Task [2]: 9 hours
Due: **Week 6**
Weighting: **15%**

Assignment based on material from lectures in previous weeks.

On successful completion you will be able to:

- Have knowledge of the principles and concepts of a basic theory of partial differential equations.
- Use the ideas and techniques of the theory of partial differential equations to model a broad range of phenomena in science and engineering (in particular using the heat and wave equations).
- Understand the breadth of the theory of partial differential equations and its role in other fields.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the theory of partial differential equations.
- Demonstrate efficient use of Fourier analysis techniques in the theory of partial differential equations.
- Further studies in the areas of partial differential equations and advanced analysis.

Mid-semester test

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 8 hours
Due: **Week 8**
Weighting: **10%**

Test based on material from lectures in previous weeks. Students will submit scanned solutions on iLearn. They will be given a certain window during which they must submit the test.

On successful completion you will be able to:

- Have knowledge of the principles and concepts of a basic theory of partial differential equations.
- Use the ideas and techniques of the theory of partial differential equations to model a

broad range of phenomena in science and engineering (in particular using the heat and wave equations).
- Understand the breadth of the theory of partial differential equations and its role in other fields.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the theory of partial differential equations.
- Demonstrate efficient use of Fourier analysis techniques in the theory of partial differential equations.
- Further studies in the areas of partial differential equations and advanced analysis.

Assignment 2

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 9 hours
Due: **Week 11**
Weighting: **15%**

Assignment based on material from lectures in previous weeks.

On successful completion you will be able to:

- Have knowledge of the principles and concepts of a basic theory of partial differential equations.
- Use the ideas and techniques of the theory of partial differential equations to model a broad range of phenomena in science and engineering (in particular using the heat and wave equations).
- Understand the breadth of the theory of partial differential equations and its role in other fields.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the theory of partial differential equations.
- Demonstrate efficient use of Fourier analysis techniques in the theory of partial differential equations.
- Further studies in the areas of partial differential equations and advanced analysis.

Final exam

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **Exam Period**
Weighting: **60%**

This will be held during the final exam period. It will test the ability of students to synthesise the concepts taught in the course in order to analyse and solve partial differential equations.

On successful completion you will be able to:

- Have knowledge of the principles and concepts of a basic theory of partial differential equations.
- Use the ideas and techniques of the theory of partial differential equations to model a broad range of phenomena in science and engineering (in particular using the heat and wave equations).
- Understand the breadth of the theory of partial differential equations and its role in other fields.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning especially in the context of the theory of partial differential equations.
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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

Classes

Lectures: there are two two-hour lectures each week.

Required and Recommended Texts and/or Materials

The following texts are not required, but can provide useful references for various sections of the course:

- Partial Differential Equations, an Introduction, W. A. Strauss. Wiley 2008
- Introduction to Partial Differential Equations, P. J. Olver. Springer 2013.

Technology Used and Required

Students are expected to have access to an internet enabled computer with a web browser and Adobe Reader software. Several areas of the university provide wireless access for portable computers. There are computers for student use in the Library.

The computational aspect of this course will use Matlab software. This software is available at https://staff.mq.edu.au/intranet/science-and-engineering/services-and-resources/it-support-services/miscellaneous/matlab

Difficulties with your home computer or internet connection do not constitute a reasonable excuse for lateness of, or failure to submit, assessment tasks.

Unit Schedule

Week	Lecture 1	Lecture 2
1	Introduction to PDE (partial differential equations). Method of characteristics for first-order PDE	Method of characteristics for first-order PDE
2	Introductory modelling: flows, vibrations, and diffusions.	Second order linear PDE: general forms and classifications: hyperbolic, parabolic, and elliptic. Reduction of the general forms to canonical forms.
3	Causality and Domains of Dependence	Wave equation with initial conditions: energy methods.
4	Wave equation with initial conditions: energy methods.	Reflection of waves: Dirichlet problem on the half-line, finite interval.
5	The diffusion equation, maximal principle, uniqueness, stability.	The diffusion equation on the whole line and half line.
6	Boundary value problems for heat equations: Dirichlet, Neumann, and Robin conditions.	Boundary value problems for heat equations: Dirichlet, Neumann, and Robin conditions.
7	Boundary value problems for heat equations: Dirichlet, Neumann, and Robin conditions.	Fourier series: coefficients; even, odd, and periodic functions; completeness; convergence.
8	Inhomogeneous wave and heat equations.	Mid-term test

9	Finite-difference methods: numerical stability, application to canonical equations.	Finite-difference methods: numerical stability, application to canonical equations.
10	Finite-difference methods: numerical stability, application to canonical equations.	Finite-difference methods: numerical stability, application to canonical equations.
11	Laplace equations, maximal principle, fundamental solutions.	Laplace equations in specific domains: rectangles, disc, wedges, annuli.
12	Laplace equations in specific domains: rectangles, disc, wedges, annuli.	Laplace equations in general domains : Green's identity, Green's functions.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). 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 *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

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

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/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.