MATH336

Partial Differential Equations

S2 Day 2019

Dept of Mathematics and Statistics

Contents

General Information

Unit convenor and teaching staff
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Lecturer
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Credit points
3

Prerequisites
MATH235 and (MATH232 or MATH236)

Corequisites
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:

Knowledge of the principles and concepts of a basic theory of partial differential equations.

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

Understanding of the breadth of the theory of partial differential equations and its role in other fields.

Ability to 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.

Preparing students to further studies in the areas of partial differential equations and advanced analysis.

General Assessment Information

HURDLES: This unit has no hurdle requirements.

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 miss a class, you can apply for a Special Consideration.

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-term Test	10%	No	Week 7
Assignment 2	15%	No	Week 12

Name	Weighting	Hurdle	Due
Final Exam	60%	No	Exam Period

Assignment 1

Due: **Week 6**
Weighting: **15%**

Assignment based on work from Weeks 1-5.

On successful completion you will be able to:

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
- Ability to use the ideas and techniques of the theory of partial differential equations to a model broad range of phenomena in science and and engineering (in particular using the heat and wave equations).
- Understanding of the breadth of the theory of partial differential equations and its role in other fields.
- Ability to 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.
- Preparing students to further studies in the areas of partial differential equations and advanced analysis.

Mid-term Test

Due: **Week 7**
Weighting: **10%**

Class test based on work from Weeks 1-6.

On successful completion you will be able to:

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- Understanding of the breadth of the theory of partial differential equations and its role in

other fields.
- Ability to 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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Assignment 2

Due: **Week 12**
Weighting: **15%**

Assignment based on work from Weeks 6-11.

On successful completion you will be able to:
- Knowledge of the principles and concepts of a basic theory of partial differential equations.
- Ability to use the ideas and techniques of the theory of partial differential equations to a model broad range of phenomena in science and and engineering (in particular using the heat and wave equations).
- Understanding of the breadth of the theory of partial differential equations and its role in other fields.
- Ability to 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.
- Preparing students to further studies in the areas of partial differential equations and advanced analysis.

Final Exam

Due: **Exam Period**
Weighting: **60%**

Final examination based on all course material.

On successful completion you will be able to:

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
- Ability to use the ideas and techniques of the theory of partial differential equations to a model broad range of phenomena in science and and engineering (in particular using the heat and wave equations).
- Understanding of the breadth of the theory of partial differential equations and its role in other fields.
- Ability to 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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Delivery and Resources

Classes

Lectures: You should attend both two-hour lectures each week, making a total of four hours per 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.
3	Finite-difference methods: numerical stability, application to canonical equations.	Finite-difference methods: numerical stability, application to canonical equations.
4	Finite-difference methods: numerical stability, application to canonical equations.	Second order linear PDE: canonical forms, and reduction of the general forms to canonical forms.
5	Causality and Domains of Dependence	Wave equation with initial conditions: energy methods.
6	Wave equation with initial conditions: energy methods.	The diffusion equation, maximal principle, uniqueness, stability.
7	The diffusion equation on the whole line and half line.	Mid-term test
8	Boundary value problems for heat equations: Dirichlet, Neumann, and Robin conditions.	Boundary value problems for heat equations: Dirichlet, Neumann, and Robin conditions.
9	Boundary value problems for heat equations: Dirichlet, Neumann, and Robin conditions.	Fourier series: coefficients; even, odd, and periodic functions; completeness; convergence.
10	Inhomogeneous wave and heat equations.	Laplace equations, maximal principle, fundamental solutions.
11	Laplace equations in specific domains: rectangles, disc, wedges, annuli.	Laplace equations in specific domains: rectangles, disc, wedges, annuli.
12	Laplace equations in general domains : Green's identity, Green's functions.	Reflection of waves: Dirichlet problem on the half-line, finite interval.

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.)*

Undergraduate 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 improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

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.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
- Ability to use the ideas and techniques of the theory of partial differential equations to a model broad range of phenomena in science and and engineering (in particular using the heat and wave equations).
- Understanding of the breadth of the theory of partial differential equations and its role in other fields.
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- Preparing students to further studies in the areas of partial differential equations and advanced analysis.

Assessment tasks

- Assignment 1
- Mid-term Test
- Assignment 2
- Final Exam

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
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Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
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Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
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Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
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Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
- Ability to use the ideas and techniques of the theory of partial differential equations to a model broad range of phenomena in science and and engineering (in particular using the heat and wave equations).
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Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Knowledge of the principles and concepts of a basic theory of partial differential equations.
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