MATH336

Partial Differential Equations

S2 Day 2018

Dept of Mathematics

Contents

General Information

Unit convenor and teaching staff

Lecturer
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Wednesday 3-4pm

Lecturer
Ji Li
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Tuesday 10-11am

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.

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. Your final grade is determined by adding the marks obtained for your examinations and assignments.

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. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. 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 (bit.ly/FSESupp) for dates, and approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

LATE SUBMISSION: Late submission of assignments will not be accepted, apart from those for where extensions have been granted through the Disruption to Studies process.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	10%	No	Week 4
Assignment 2	10%	No	Week 8
Assignment 3	10%	No	Week 12
Mid-term Test	10%	No	Week 7
Final Exam	60%	No	Exam Period

Assignment 1

Due: **Week 4**
Weighting: **10%**

Assignment based on work from Weeks 1-3.

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 8**
Weighting: **10%**

Assignment based on work from Weeks 4-7.

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 3

Due: **Week 12**
Weighting: **10%**

Assignment based on work from Weeks 8-11.

On successful completion you will be able to:

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

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

Final examination based on all course material.

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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Delivery and Resources

Classes

Lectures: You should attend both two-hour lectures each week, making a total of four hours.

Required and Recommended Texts and/or Materials

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

- W. A. Strauss Partial Differential Equations, an Introduction. Wiley 2008

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://web.science.mq.edu.au/it/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), first order PDE methods: characteristic lines, changing of coordinates.	First order PDE: general case, constant coefficients, function coefficients.
2	Introductory modelling: flows, vibrations, and diffusions.	Second order linear PDE: general forms and classifications: hyperbolic, parabolic, and elliptic.
3	Second order linear PDE: canonical forms, and reduction of the general forms to canonical forms.	Finite-difference methods: numerical stability, application to canonical equations.

4	Finite-difference methods: numerical stability, application to canonical equations.	Advanced numerical methods: irregularly shaped domains, finite element method.
5	Initial and boundary conditions: reducing simple PDE to ODE expressions.	Waves equation with initial conditions: d'Alembert's 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	Fourier series: coefficients; even, odd, and periodic functions; completeness; convergence.	Inhomogeneous wave and heat equations.
10	Laplace equations, maximal principle, fundamental solutions.	Laplace equations in specific domains: rectangles, disc, wedges, annuli.
11	Laplace equations in general domains : Green's identity, Green's functions.	Laplace equations in upper-half space: Green's identity, Green's functions.
12	Reflection of waves: Dirichlet problem on the half-line, finite interval.	Wave with a source: inhomogeneous wave equation on the whole line with initial conditions.
13	Revision	Revision

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 shown in *iLearn*, 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.

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

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).
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Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- Mid-term Test
- 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

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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

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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.

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Learning outcomes

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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.

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Learning outcomes

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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

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- 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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