MATH331

Waves

S1 Day 2018

Dept of Mathematics

Contents

General Information

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Credit points
3

Prerequisites
MATH235 and (MATH232 or MATH236)

Corequisites

Co-badged status

Unit description
This unit introduces the theory of waves by a systematic study of the underlying partial differential equations. Waves involve the transfer, without bulk motion, of both energy and information. Fundamental properties of waves are first examined in the simplest one-dimensional setting. The treatment is then broadened to two-dimensional and three-dimensional waves, particularly for acoustic and electromagnetic waves. Resonators and waveguides provide some examples of how waves behave in confined regions. In contrast, the scattering and diffraction of waves by obstacles in free space carries information about the scatterer itself; this is the basis of many imaging technologies.

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:

Develop a good understanding and demonstrate knowledge of the basic methods and concepts of theory of wave equations and partial differential equations.
Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments especially in the context of the theory of wave equations. Be able to express yourself clearly and logically in writing in this context.
Present a broad outline of the scope of theory of wave equations and their roles in mathematical modelling of physical phenomena.
Be able to apply the principles, concepts, and techniques learned in this unit to solve practical and abstract problems.
Demonstrate appropriate interpretation of information communicated in mathematical form. Be able to understand what is being said in mathematical expressions and be able to formulate ideas using mathematical form.
Ethical application of mathematical approaches to solving problems and appropriately reference and acknowledge sources in a mathematical context.
Be able to work effectively, responsibly and safely in an individual or team context.

General Assessment Information

HURDLES: This unit has no hurdle requirements. This means that there are no second chance examinations and assessments if you happen to fail at your first attempt.

Students should aim to get at least 60% for the course work in order to be reasonably confident of passing the unit.

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.

Assessment Tasks

Name	Weighting	Hurdle	Due
Three assignments	30%	No	see iLearn site
Test	20%	No	see iLearn site
Final examination	50%	No	University Examination Period

Three assignments

Due: **see iLearn site**
Weighting: **30%**

On successful completion you will be able to:

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- Be able to work effectively, responsibly and safely in an individual or team context.

Test

Due: **see iLearn site**
Weighting: **20%**

Test

On successful completion you will be able to:

- Develop a good understanding and demonstrate knowledge of the basic methods and

concepts of theory of wave equations and partial differential equations.
- Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments especially in the context of the theory of wave equations. Be able to express yourself clearly and logically in writing in this context.
- Be able to apply the principles, concepts, and techniques learned in this unit to solve practical and abstract problems.
- Demonstrate appropriate interpretation of information communicated in mathematical form. Be able to understand what is being said in mathematical expressions and be able to formulate ideas using mathematical form.
- Be able to work effectively, responsibly and safely in an individual or team context.

Final examination

Due: **University Examination Period**
Weighting: **50%**

Final examination

On successful completion you will be able to:

- Develop a good understanding and demonstrate knowledge of the basic methods and concepts of theory of wave equations and partial differential equations.
- Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments especially in the context of the theory of wave equations. Be able to express yourself clearly and logically in writing in this context.
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Delivery and Resources

Classes

Lectures: you should attend two hours of each lecture stream each week, making a total of four

hours.

Required and Recommended Texts and/or Materials

No single textbook is entirely satisfactory for MATH331. The following texts provide useful references for various sections of the course:

- Roger Knobel, *An Introduction to the Mathematical Theory of Waves*, American Mathematical Society, 1999 (QA927.K963/1999)
- Walter A. Strauss, *Partial Differential Equations: An Introduction*, John Wiley and Sons, 1992. (QA374.S86/1992)
- A.N. Tikhonov & A.A. Samarskii, *Equations of Mathematical Physics*, Oxford University Press (also reprinted by Dover) (QA401.T512/1963)
- J. Billingham & A. C. King, *Wave Motion*, Cambridge University Press, 2000.
- R. Harrington, *Time Harmonic Electromagnetic Fields*, McGraw-Hill, 1961 (QA403.H24)
- Charles A. Coulson, *Waves* (2nd ed. revised by A. Jeffrey), London (QA927.C65/1977)

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 and MUSE.

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	Techniques	Methods
1	1-D wave equation, D'Alembert solution	PDEs and waves
2	Semi-infinite string	Travelling and dispersive waves
3	Standing waves on a string	The KdV equation
4	Standing waves on a string; Fourier series	Some vector calculus; Models and conservation laws
5		Models and conservation laws
6	Fourier series, Resonators: rectangular boxes	
7	Fourier series, Resonators: rectangular boxes	Waves in unbounded regions
8	Bessel functions	Waves in confined regions
9	Drum head vibration	Planar waveguide; other waveguides
10	Drum head vibration	Spherically symmetric waves

11	Acoustic scattering from a cylinder	Solution of the Wave Equation in bounded regions
12	Acoustic scattering from a cylinder	Solution of the Wave Equation in unbounded regions
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

- Develop a good understanding and demonstrate knowledge of the basic methods and concepts of theory of wave equations and partial differential equations.
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Assessment tasks

- Three assignments
- Test
- Final examination

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

- Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments especially in the context of the theory of wave equations. Be able to express yourself clearly and logically in writing in this context.
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Assessment tasks

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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

- Develop a good understanding and demonstrate knowledge of the basic methods and concepts of theory of wave equations and partial differential equations.
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Assessment tasks

- Three assignments
- Final examination

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.

This graduate capability is supported by:

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.

This graduate capability is supported by:

Learning outcomes

- Develop a good understanding and demonstrate knowledge of the basic methods and concepts of theory of wave equations and partial differential equations.

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- Final examination

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

- Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments especially in the context of the theory of wave equations. Be able to express yourself clearly and logically in writing in this context.
- Present a broad outline of the scope of theory of wave equations and their roles in mathematical modelling of physical phenomena.
- Demonstrate appropriate interpretation of information communicated in mathematical form. Be able to understand what is being said in mathematical expressions and be able to formulate ideas using mathematical form.
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Assessment tasks

- Three assignments
- Test
- Final examination

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcomes

- Ethical application of mathematical approaches to solving problems and appropriately reference and acknowledge sources in a mathematical context.
- Be able to work effectively, responsibly and safely in an individual or team context.

Assessment tasks

- Three assignments
- Final examination

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcomes

- Ethical application of mathematical approaches to solving problems and appropriately reference and acknowledge sources in a mathematical context.
- Be able to work effectively, responsibly and safely in an individual or team context.

Assessment task

- Test