PHYS701

Mathematical Methods in Physics

S1 Day 2014

Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
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Lecturer
Gavin Brennen
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Tuesday 1-5

Credit points
4

Prerequisites
Admission to MRes

Corequisites

Co-badged status

Unit description
This unit covers topics in mathematical physics including: differential equations and group theory. The aim is to develop effective problem solving strategies, and where possible, the examples will be taken from the physical sciences. In the first topic the primary focus is on ordinary differential equations covering topics from first order equations and how to classify and solve them, through to higher order equations and more general techniques such as reduction of order, Laplace transforms, Green functions and series solutions. The second topic covers discrete groups and continuous Lie groups and Lie algebras. Group representations are introduced with the examples from Abelian and non-Abelian groups. Irreducible representations, unitary representations, Shur's Lemma, and orthogonality relations are covered in the context of discrete groups. Compact and non-compact Lie groups and their generating Lie algebras are presented with several examples making the connection between symmetries and conservation laws, e.g. space-time symmetries and the Poincare group.

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:

Be able to apply Green's functions to solve partial differential equations in 1 or multiple dimensions.
Be able to find series solutions of differential equations about ordinary or singular points.
Be able to use eigenfunctions to find solutions of differential equations, and the properties of common cases.
Understand discrete groups, continuous Lie groups and Lie algebras, and representation theory.
Demonstrate ability to apply methods through explanation of tutorial and assignment questions at the whiteboard.
Be able to infer discrete and continuous symmetries from the properties of physical systems.
Recognise the relations between symmetries and conservation laws.

Assessment Tasks

Name	Weighting	Due
Assignments	35%	Biweekly
Tutorial engagement	15%	Weekly
Final Examination	50%	Exam Weeks

Assignments

Due: **Biweekly**
Weighting: **35%**

The assignments will comprise of 3-4 questions designed to engage the students with the material as it's covered. The difficulty of the questions will be set so that the assignment would take on average around 7 hours to complete.

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- Understand discrete groups, continuous Lie groups and Lie algebras, and representation theory.
- Be able to infer discrete and continuous symmetries from the properties of physical systems.
- Recognise the relations between symmetries and conservation laws.

Tutorial engagement

Due: **Weekly**
Weighting: **15%**

Each tutorial session, several students will present their attempts at either previous assignment questions or tutorial problems at the whiteboard.

Students will be assessed on the degree to which they have engaged with the problem, their ability to explain their thinking, and ability to draw on ideas and techniques from the course. The correctness of the final answer is secondary to these other issues.

Each student will be expected to present at the whiteboard on at least 3 occasions. All students will be expected to engage in the class discussion around these problems.

Grades will be announced periodically as we cycle through the class.

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- Recognise the relations between symmetries and conservation laws.

Final Examination

Due: **Exam Weeks**
Weighting: **50%**

Three hour written examination.

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- Be able to find series solutions of differential equations about ordinary or singular points.
- Be able to use eigenfunctions to find solutions of differential equations, and the properties of common cases.
- Understand discrete groups, continuous Lie groups and Lie algebras, and representation theory.
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Delivery and Resources

Classes

Mixed Lecture and Tutorial/discussion

The timetable for classes can be found on the University web site at: http://www.timetables.mq.edu.au/

Required and Recommended Texts and/or Materials

Recommended Text

"Physical Mathematics" by Kevin Cahill.

It will be used as a frequent reference but will not be followed through in a chapter-by-chapter approach.

Some secondary textbooks are "Mathematical Methods for Physics and Engineering" by Riley, Hobson and Bence, and "Elements of Green's Functions and Propagation" by Barton.

Technologies Used and Required

Unit Web Page

Lecture notes will be available online. The link will be given in the lectures.

Teaching and Learning Strategy

The theoretical aspects of this unit are taught in lectures and tutorials with fortnightly assignments to strengthen the understanding of the material. The material is heavily mathematical in nature, and often abstract, and true understanding can only be achieved through testing and refining understanding through problem solving.

Schedule of topics

A detailed plan of topics to be covered and learning goals for each of them will be available early in the session.

What has changed?

- Prior to 2013 this unit was offered as Mathematical Methods I and II.
- There are many minor changes and improvements from the offering last year. We will therefore appreciate your feedback contributions through the unit questionnaires, and any individual comments you may have.

Unit Schedule

One half of this course is on Green's functions, series solutions, and eigengunction methods, and is given by Dominic Berry. The other half is on group theory, and is given by Gavin Brennen.

First lecture: Wednesday, March 5.

Last lecture: Thursday, June 12.

Lecture times and location

The lecture times may be changed because there are timetable clashes. The current timetable is:

Wednesday: 10:00-12:00 Location: W5A 202

Friday: 13:00-14:00 Location: C3B 306

Friday: 15:00-16:00 Location: W5C 312

Information about any changes will be given in the lectures.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.ht

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Assessment Policy http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

In addition, a number of other policies can be found in the Learning and Teaching Category of 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/support/student_conduct/

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://informatics.mq.edu.au/help/.

When using the University's IT, you must adhere to the Acceptable Use Policy. The policy

applies to all who connect to the MQ network including students.