PHYS701

Mathematical Methods in Physics

S1 Day 2016

Dept of Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
Dominic Berry
dominic.berry@mq.edu.au
Contact via dominic.berry@mq.edu.au
E6B 2.408
Wednesday 2-5pm

Lecturer
Gavin Brennen
gavin.brennen@mq.edu.au
Contact via gavin.brennen@mq.edu.au
E6B 2.611
Wednesday 2-5pm

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	30%	Biweekly
Tutorial engagement	10%	Weekly
Mid-Session Examination	30%	Week 7
End-of-session examination	30%	University Examination Period

Assignments

Due: **Biweekly**
Weighting: **30%**

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.

Informal group discussion regarding the assignment problems is encouraged, but students should present their own solutions and should explicitly acknowledge those they have worked with on the assignment.

Extension Requests: Given the importance we place on assignments as a key aid to learning we expect assignments to be submitted on time. In turn, we undertake to return your assignments (provided they were submitted on time), marked and with feedback within two weeks of their due date. This will allow us to provide you feedback in time to aid your ongoing learning through the course. Extensions will only be considered if requested with valid reasons **prior to the due date**.

If for any reason a student is unable to submit an assignment by the due date, the student should contact the relevant staff member as soon as possible, explain the situation, and request an extension. If such contact is not made, then the student will be penalised 20% for each working day that the assignment is late (i.e. an assignment due on a Friday and handed in on a Monday is penalised as if it is one day late). As complete solutions for an assignment are usually handed out to the class a week after the assignment is due, an extension beyond a week is generally not possible, and in any case would receive a grade of zero.

On successful completion you will be able to:

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- 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: **10%**

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.

On successful completion you will be able to:

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- Be able to infer discrete and continuous symmetries from the properties of physical systems.
- Recognise the relations between symmetries and conservation laws.

Mid-Session Examination

Due: **Week 7**
Weighting: **30%**

There will be a 90 minute mid-session exam on the differential equations part of the unit to be held in week 7.

On successful completion 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.

End-of-session examination

Due: **University Examination Period**
Weighting: **30%**

There will be a 90 minute end-of-session exam on the group theory part of the unit to be held in the University Examination Period.

On successful completion you will be able to:

- 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.

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

The recommended text is "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.

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.

Unit Schedule

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

First lecture: Thursday, 3 March.

Last lecture: Friday, 10 June.

Lecture times and location

All lectures are in EMC-G230 Faculty Tutorial Room

Thursday: 14:00-16:00

Friday: 12:00-14:00

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.html

New Assessment Policy in effect from Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy_2016.html. For more information visit http://students.mq.edu.au/events/2016/07/19/new_assessment_policy_in_place_from_session_2/

Assessment Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/grading/policy.html

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

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.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/

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

PG - Discipline Knowledge and Skills

Our postgraduates will be able to demonstrate a significantly enhanced depth and breadth of knowledge, scholarly understanding, and specific subject content knowledge in their chosen fields.

This graduate capability is supported by:

Learning outcomes

- Be able to apply Green's functions to solve partial differential equations in 1 or multiple dimensions.
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- Recognise the relations between symmetries and conservation laws.

Assessment tasks

- Assignments
- Tutorial engagement
- Mid-Session Examination
- End-of-session examination

PG - Critical, Analytical and Integrative Thinking

Our postgraduates will be capable of utilising and reflecting on prior knowledge and experience, of applying higher level critical thinking skills, and of integrating and synthesising learning and knowledge from a range of sources and environments. A characteristic of this form of thinking is the generation of new, professionally oriented knowledge through personal or group-based critique of practice and theory.

This graduate capability is supported by:

Learning outcomes

- Be able to apply Green's functions to solve partial differential equations in 1 or multiple dimensions.
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Assessment tasks

- Assignments
- Tutorial engagement
- Mid-Session Examination
- End-of-session examination

PG - Research and Problem Solving Capability

Our postgraduates will be capable of systematic enquiry; able to use research skills to create new knowledge that can be applied to real world issues, or contribute to a field of study or practice to enhance society. They will be capable of creative questioning, problem finding and problem solving.

This graduate capability is supported by:

Learning outcomes

- 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.

- 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.

Assessment tasks

- Assignments
- Tutorial engagement
- Mid-Session Examination
- End-of-session examination

PG - Effective Communication

Our postgraduates will be able to communicate effectively and convey their views to different social, cultural, and professional audiences. They will be able to use a variety of technologically supported media to communicate with empathy using a range of written, spoken or visual formats.

This graduate capability is supported by:

Learning outcome

- Demonstrate ability to apply methods through explanation of tutorial and assignment questions at the whiteboard.

Assessment task

- Tutorial engagement

Changes from Previous Offering

There is now a mid-session examination, as well as an end-of-session examination.

Requirements in order to complete the unit satisfactorily

To pass the course unit you must:

- achieve a satisfactory standard overall
- achieve a satisfactory standard in both halves of the unit, including both exams.