PHYS701

Mathematical Methods in Physics

S1 Day 2018

Dept of Physics and Astronomy

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General Information

Unit convenor and teaching staff
Convenor
Dominic Berry
dominic.berry@mq.edu.au
Contact via email
E6B-7 Wally's Walk 2.408
2-5pm Tuesday and Wednesday

Lecturer
Jason Twamley
jason.twamley@mq.edu.au
E6B-7 Wally's Walk 2.612
2-4pm Tuesday-Thursday

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 analytic methods for solving linear differential equations.

Understand numerical methods for solving ordinary or partial differential equations.

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.

Be able to use Mathematica for analysis of differential equations and group theory.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignments	20%	No	triweekly
Mid-Session examination	40%	No	Week 7
End-of-Session Examination	40%	No	University Examination Period

Assignments

Due: **triweekly**
Weighting: **20%**

There will be 4 assignments set, due approximately every 3 weeks.

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.

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. Extensions will only be considered if requested with valid reasons **prior to the due date**.

On successful completion you will be able to:

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- Recognise the relations between symmetries and conservation laws.
- Be able to use Mathematica for analysis of differential equations and group theory.

Mid-Session examination

Due: **Week 7**
Weighting: **40%**

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 analytic methods for solving linear differential equations.
- Understand numerical methods for solving ordinary or partial differential equations.
- 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.

End-of-Session Examination

Due: **University Examination Period**
Weighting: **40%**

There will be a 90 minute end-of-session exam on the group theory part of the unit to be held in university examination period.

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.

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Delivery and Resources

Classes

Mixed Lecture and Tutorial/discussion, as well as work on Mathematica in the PC laboratory.

The timetable for classes can be found on the University web site at:

https://timetables.mq.edu.au/2018/

Required and Recommended Texts

The recommended texts are :

- "Mathematical Methods for Physics and Engineering" by Riley, Hobson and Bence
- "Physical Mathematics" by Kevin Cahill

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. In addition there will be problem solving sessions using Mathematica in the PC laboratory. 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

The first half of this course is on theoretical and numerical methods for solving differential equations, and is given by Dominic Berry. The second half is on group theory, and is given by Jason Twamley.

First lecture: Thursday, 1 March.

Last lecture: Friday, 8 June.

Lecture times and location

All lectures are in EMC-G230 Faculty Tutorial Room

Thursday: 14:00-16:00

Friday: 10:00-12:00

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

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 analytic methods for solving linear differential equations.
- Understand numerical methods for solving ordinary or partial differential equations.
- 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.
- Be able to use Mathematica for analysis of differential equations and group theory.

Assessment tasks

- Assignments
- 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 analytic methods for solving linear differential equations.
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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 analytic methods for solving linear differential equations.
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Assessment tasks

- Assignments
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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:

Assessment task

- Assignments

Changes from Previous Offering

There are three main changes from previous years.

- There is new course content on numerical methods for solving differential equations.
- There are problem solving sessions using Mathematica in the PC laboratory.
- There is no tutorial participation component of the assessment.