PHYS714

Quantum Information and Technology

S2 Day 2018

Dept of Physics and Astronomy

Contents

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General Information

Unit convenor and teaching staff
Unit Convenor
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Tuesdays 3-5pm; other times by appointment.

Lecturer
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Lecturer
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Lab Demonstrator
Xavier Vidal Asensio
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Credit points
4

Prerequisites
Admission to MRes

Corequisites

Co-badged status

Unit description
This unit introduces students to the growing field of quantum information science and technology. A general formalism is introduced involving the concept of Hilbert space, states represented by density matrices, open systems evolution via operator sum decompositions, and generalised measurement theory. Much of the unit covers the physics and quantum information aspects of leading physical implementations for a quantum engineered device, including: atomic, (neutral and trapped ion), photonic, superconducting and semiconductor devices. There is a laboratory component based on photonic systems with experiments on quantum correlations in single photons, tests of quantum nonlocality, and generation of entangled photons.

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:

Formulate and solve problems in Quantum Information and Technology using a variety of physics skills.

Understand the science of current day quantum science and technology platforms.

Perform experiments in cutting edge quantum technology practical laboratories.

Assessment Tasks

Name	Weighting	Hurdle	Due
Final examination	20%	No	University Examination Period
Midsemester Examination	20%	No	Week 8
Assignments	20%	No	TBA
Explorer Investigation	20%	No	Week 7
Final Project	20%	No	Week 13

Final examination

Due: **University Examination Period**
Weighting: **20%**

Final Examination [problem based], covering the concepts in the course.

If you receive special consideration for the final exam, a supplementary exam will be scheduled in the week of December 17-21 2018. 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. 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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Midsemester Examination

Due: **Week 8**
Weighting: **20%**

Midsemester Examination covering the concepts in the first half of the course.

On successful completion you will be able to:

- Formulate and solve problems in Quantum Information and Technology using a variety of physics skills.
- Understand the science of current day quantum science and technology platforms.

Assignments

Due: **TBA**
Weighting: **20%**

Four take home assignments to be worked on individually.

On successful completion you will be able to:

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Explorer Investigation

Due: **Week 7**
Weighting: **20%**

Each student will undertake a minimum of 3 days of lab practical exploring various aspects of experimental quantum technologies. Students will gain experience in the preparation, manipulation and detection of quantum signals or equivalent in various types of quantum technologies, e.g. quantum optics, diamond quantum systems, cavity QED etc. Students will write a short report based on their required lab tasks and the report is assessed for clarity, depth and comprehension of the lab techniques involved in their practical.

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Final Project

Due: **Week 13**
Weighting: **20%**

A three week final project, focusing on developing problem solving and the concepts covered in the course. The assessment comprises of a written report (<10pages). The project can range over the various topics covered in the course, and can involve theory or experiment or both.

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Delivery and Resources

Lectures in a standard lecture room or in the PC lab. The practicals will be either in the Diamond Lab or Quantum Optics Labs.

Suggested textbooks are:

- Quantum Information, Computation and Communication, Jonathan A. Jones and Dieter Jaksch (introductory)
- Quantum Computation and Quantum Information, Isaac Chuang and Michael Nielsen (advanced)

Unit Schedule

The unit will start with a six-week introduction to the theory of quantum information. There will also be a two-week experimental project during this time, which will be due in week 7. There will then be 4 weeks on the theoretical background of the experimental platforms for quantum information. This will be followed by 3 weeks of more advanced topics in quantum information. There will be a midsemester exam in week 8 and a final examination in the university examination period.

Lectures: Thursday 4-6pm 3 Innovation Road G230, Friday 10am-12pm 3 Innovation Road G230

Labs: Thursday 1-4pm, Friday 12-3pm, or Friday 3-6pm for 2 weeks

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 - Capable of Professional and Personal Judgment and Initiative

Our postgraduates will demonstrate a high standard of discernment and common sense in their professional and personal judgment. They will have the ability to make informed choices and decisions that reflect both the nature of their professional work and their personal perspectives.

This graduate capability is supported by:

Assessment tasks

- Explorer Investigation
- Final Project

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

- Formulate and solve problems in Quantum Information and Technology using a variety of physics skills.
- Understand the science of current day quantum science and technology platforms.
- Perform experiments in cutting edge quantum technology practical laboratories.

Assessment tasks

- Final examination

- Midsemester Examination
- Assignments
- Explorer Investigation
- Final Project

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

- Formulate and solve problems in Quantum Information and Technology using a variety of physics skills.
- Understand the science of current day quantum science and technology platforms.
- Perform experiments in cutting edge quantum technology practical laboratories.

Assessment tasks

- Final examination
- Midsemester Examination
- Assignments
- Explorer Investigation
- Final Project

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:

Assessment tasks

- Final examination
- Midsemester Examination
- Assignments
- Explorer Investigation
- Final Project

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

- Perform experiments in cutting edge quantum technology practical laboratories.

Assessment tasks

- Explorer Investigation
- Final Project

Changes from Previous Offering

This year the unit has a midsemester examination, and the number of assignments has been increased.