PHYS714

Quantum Information and Technology

S2 Day 2019

Dept of Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff
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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:

Be familiar with the basic theoretical concepts and elements needed for quantum information processing

Be able to solve basic analytical and numerical problems in quantum information theory

Understand the workings, true potential and limitations of a quantum computer

Have an overview over the currently existing atom-based implementations of a quantum computer and their technical limitations

Assessment Tasks

Name	Weighting	Hurdle	Due
Final examination	40%	No	University Examination Period
Assignments	60%	No	TBA

Final examination

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

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 after results are released. Please see FSE101 in iLearn for dates. 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. Second chance exams for hurdle assessments will also be scheduled in this period.

On successful completion you will be able to:

- Be familiar with the basic theoretical concepts and elements needed for quantum information processing
- Be able to solve basic analytical and numerical problems in quantum information theory

Assignments

Due: **TBA**
Weighting: **60%**

Six take home assignments to be worked on individually. The assignments are partially based on solving course-relevant problems, numerically exploring a topic discussed in the course and/or more literature-research based tasks. Each assignment is worth 10%.

On successful completion you will be able to:

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Delivery and Resources

Lectures in a standard lecture room or (if necessary) in the PC lab.

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)
- John Preskill's Notes on Quantum Information (http://www.theory.caltech.edu/~preskill/ph219/index.html#lecture)
- more texts with reference to individual chapters to be announced during the course

Unit Schedule

The unit will start with a seven-week introduction to the theory of quantum information. The rest of the unit will be devoted to the discussion/description of different experimental platforms for quantum information processing. The platforms discussed will focus on atomic qubits involving either natural atoms (trapped Rydberg atoms and ions) or artificial atoms in the solid state (NV centres and rare-earth ion systems).

Lectures: Tuesday 10am-12pm @ 4 Western Road 302 Wednesday 2pm-4pm @ 4 Western Road 302

NOTE: There are no labs in the 2019 offering!

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 published on platform other than eStudent, (eg. iLearn, Coursera etc.) 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 or if you are a Global MBA student contact globalmba.support@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

If you are a Global MBA student contact globalmba.support@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 familiar with the basic theoretical concepts and elements needed for quantum information processing
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Assessment tasks

- Final examination
- Assignments

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

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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

- Understand the workings, true potential and limitations of a quantum computer
- Have an overview over the currently existing atom-based implementations of a quantum computer and their technical limitations

Assessment task

- Assignments

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

- Be able to solve basic analytical and numerical problems in quantum information theory

Assessment tasks

- Final examination

- Assignments