PHYS714
Quantum Information and Technology
S2 Day 2014
Physics and Astronomy

Contents

General Information 2
Learning Outcomes 3
Assessment Tasks 3
Delivery and Resources 4
Unit Schedule 4
Learning and Teaching Activities 5
Policies and Procedures 5
Graduate Capabilities 6

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# General Information

<table>
<thead>
<tr>
<th>Unit convenor and teaching staff</th>
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<tr>
<td>Lecturer</td>
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<tr>
<td>Gabriel Molina-Terriza</td>
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<tr>
<td><a href="mailto:gabriel.molina-terriza@mq.edu.au">gabriel.molina-terriza@mq.edu.au</a></td>
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<tr>
<td>Contact via <a href="mailto:gabriel.molina-terriza@mq.edu.au">gabriel.molina-terriza@mq.edu.au</a></td>
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<tr>
<td>E6B 2.409</td>
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<tr>
<th>Unit Convenor</th>
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<tr>
<td>Jason Twamley</td>
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<td><a href="mailto:jason.twamley@mq.edu.au">jason.twamley@mq.edu.au</a></td>
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<td>Thursdays 10--11am; other times by appointment.</td>
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<th>Laboratory Lecturer</th>
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<tr>
<td>Thomas Volz</td>
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<td><a href="mailto:thomas.volz@mq.edu.au">thomas.volz@mq.edu.au</a></td>
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<tr>
<th>Credit points</th>
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<tr>
<td>4</td>
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<thead>
<tr>
<th>Prerequisites</th>
<th>Admission to MRes</th>
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| Corequisites                     |  |
|----------------------------------|  |

| Co-badged status                |  |
|----------------------------------|  |

<table>
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<tr>
<th>Unit description</th>
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<td>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.</td>
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Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at [https://students.mq.edu.au/important-dates](https://students.mq.edu.au/important-dates)

Learning Outcomes

1. Learn to formulate and solve problems in Quantum Information and Technology using a variety of physics skills
2. General knowledge of the physics, control and description of the science of current day quantum science and technology platforms
3. Experimental experience with cutting edge quantum technology practical laboratories

Assessment Tasks

<table>
<thead>
<tr>
<th>Name</th>
<th>Weighting</th>
<th>Due</th>
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<tbody>
<tr>
<td>Final Examination</td>
<td>25%</td>
<td>29/11/14</td>
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<tr>
<td>Assignments</td>
<td>25%</td>
<td>14/11/14</td>
</tr>
<tr>
<td>Laboratory</td>
<td>25%</td>
<td>14/11/14</td>
</tr>
<tr>
<td>Final Project</td>
<td>25%</td>
<td>14/11/14</td>
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Final Examination

Due: 29/11/14
Weighting: 25%

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

This Assessment Task relates to the following Learning Outcomes:

- Learn to formulate and solve problems in Quantum Information and Technology using a variety of physics skills
- General knowledge of the physics, control and description of the science of current day quantum science and technology platforms

Assignments

Due: 14/11/14
Weighting: 25%

Three Take Home Assignments
This Assessment Task relates to the following Learning Outcomes:

- Learn to formulate and solve problems in Quantum Information and Technology using a variety of physics skills
- General knowledge of the physics, control and description of the science of current day quantum science and technology platforms

**Laboratory**

Due: **14/11/14**  
Weighting: **25%**

4-6 weeks of Laboratories focused on state of the art quantum technologies

This Assessment Task relates to the following Learning Outcomes:

- General knowledge of the physics, control and description of the science of current day quantum science and technology platforms
- Experimental experience with cutting edge quantum technology practical laboratories

**Final Project**

Due: **14/11/14**  
Weighting: **25%**

A three week final project (theory), focusing on developing problem solving and the concepts covered in the course. The assessment comprises of a written report (<10 pages).

This Assessment Task relates to the following Learning Outcomes:

- Learn to formulate and solve problems in Quantum Information and Technology using a variety of physics skills
- General knowledge of the physics, control and description of the science of current day quantum science and technology platforms
- Experimental experience with cutting edge quantum technology practical laboratories

**Delivery and Resources**

Lectures in standard lecture room.

Laboratory Practicals uses proprietary lab setup

**Unit Schedule**

Lectures: Tues 11-1pm EMC G230, Thurs 11-12 EMC G230,  
Tutes: Tues 2-3pm only alternative weeks  
Labs: (4 weeks at most): Friday 10-1pm
Learning and Teaching Activities

Lectures
Lectures

Personal Reading
Reading for Assignments etc.

Experimental Lab Work
Lab practicals

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


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.
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

• Learn to formulate and solve problems in Quantum Information and Technology using a variety of physics skills
• General knowledge of the physics, control and description of the science of current day quantum science and technology platforms
• Experimental experience with cutting edge quantum technology practical laboratories

Assessment tasks

• Final Examination
• Assignments
• Laboratory
• Final Project
Learning and teaching activities

• Lectures
• Reading for Assignments etc.
• Lab practicals

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

• Learn to formulate and solve problems in Quantum Information and Technology using a variety of physics skills
• General knowledge of the physics, control and description of the science of current day quantum science and technology platforms
• Experimental experience with cutting edge quantum technology practical laboratories

Assessment tasks

• Final Examination
• Assignments
• Laboratory
• Final Project

Learning and teaching activities

• Lectures
• Reading for Assignments etc.
• Lab practicals

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 outcomes

- General knowledge of the physics, control and description of the science of current day quantum science and technology platforms
- Experimental experience with cutting edge quantum technology practical laboratories

Assessment tasks

- Laboratory
- Final Project

Learning and teaching activities

- Lab practicals

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

- Learn to formulate and solve problems in Quantum Information and Technology using a variety of physics skills
- Experimental experience with cutting edge quantum technology practical laboratories

Assessment tasks

- Final Examination
- Assignments
- Laboratory
- Final Project

Learning and teaching activities

- Reading for Assignments etc.
- Lab practicals

PG - Engaged and Responsible, Active and Ethical Citizens

Our postgraduates will be ethically aware and capable of confident transformative action in relation to their professional responsibilities and the wider community. They will have a sense of connectedness with others and country and have a sense of mutual obligation. They will be able to appreciate the impact of their professional roles for social justice and inclusion related to national and global issues
This graduate capability is supported by:

**Learning outcomes**
- General knowledge of the physics, control and description of the science of current day quantum science and technology platforms
- Experimental experience with cutting edge quantum technology practical laboratories

**Assessment task**
- Final Project

**Learning and teaching activity**
- Lectures
- Lab practicals

**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:

**Learning outcomes**
- Learn to formulate and solve problems in Quantum Information and Technology using a variety of physics skills
- General knowledge of the physics, control and description of the science of current day quantum science and technology platforms
- Experimental experience with cutting edge quantum technology practical laboratories

**Assessment tasks**
- Final Examination
- Final Project

**Learning and teaching activities**
- Lectures
- Reading for Assignments etc.
- Lab practicals