1. **Title of the module**

COMP8220 (CO822) Introduction to Quantum Computing & Quantum Cryptography

1. **School or partner institution which will be responsible for management of the module**

School of Computing

1. **The level of the module (Level 4, Level 5, Level 6 or Level 7)**

Level 7

1. **The number of credits and the ECTS value which the module represents**

15 credits (7.5 ECTS)

1. **Which term(s) the module is to be taught in (or other teaching pattern)**

Autumn or Spring

1. **Prerequisite modules**

COMP3830 (CO383) - Problem Solving with Algorithms

COMP3220 (CO322) - Foundations of Computing I and

COMP3250 (CO325) - Foundations of Computing II

*or*

PHYS3110 (PH311) - Mathematics I and

PHS3120 (PH312) - Mathematics II

1. **The programmes of study to which the module contributes**

BSc Computer Science, including all variants, both with and without Year in Industry. Also the MPhys in Physics.

1. **The intended subject specific learning outcomes.  
   On successfully completing the module students will be able to:**

8.1 Demonstrate a systematic understanding of underlying concepts, tools, and techniques relating to quantum information processing and quantum technologies.

8.2 Demonstrate a critical awareness of quantum computing algorithms and their applications.

8.3 Creatively apply the basic tools and techniques of quantum computation and quantum information in a problem-solving scenario

8.4 Properly assess the impact of quantum technologies on science, computer security, and every-day life.

8.5 Understand how different physical systems can be used, experimentally and in practice, to represent quantum information for the purposes of computation and/or cryptography

1. **The intended generic learning outcomes.  
   On successfully completing the module students will be:**

9.1 Able to exploit library and online resources to support investigations.

9.2 Able to apply mathematical techniques where appropriate.

9.3 Able to apply appropriate scientific principles and methodology.

9.4 Able to deal with highly inter-disciplinary concepts and apply the tools of diverse fields to solving

problems

1. **A synopsis of the curriculum**

This module will give students an overarching introduction to quantum information processing *(QIP)*. At the end of the course the students will have a basic understanding of quantum computation, quantum communication, and quantum cryptography; as well as the implications to other fields such as computation, physics, and cybersecurity.

We will take a multi-disciplinary approach that will encourage and require students to engage in topics outside of their core discipline. The module will cover the most essential mathematical background required to understand QIP. This includes: linear algebra, basic elements of quantum theory (quantum states, evolution of closed quantum systems, Born’s rule), and basic theory of computing. The module will introduce students to the following theoretical topics: quantum algorithms, quantum cryptography, quantum communication & information. The module will also address experimental quantum computation & cryptography.

1. **Reading list (Indicative list, current at time of publication. Reading lists will be published annually)**

Phillip Kaye, Raymond Laflamme, and Michele Mosca. 2007. *An Introduction to Quantum Computing*. Oxford University Press, Inc., New York, NY, USA. ISBN 0198570007

Scott Aaronson. *Quantum Computing since Democritus.* 2013. Cambridge University Press. ISBN 9780521199568

Nielsen, M.A. and Chuang, I.L. *Quantum Computation and Quantum Information. 2010.* Cambridge University Press. ISBN 9780511992773

1. **Learning and teaching methods**

Total contact hours: 22

Private study hours: 128

Total study hours: 150

1. **Assessment methods**
   1. Main assessment methods

1 hour written exam (60%)

Two take-home exercise worksheets (20% and approximately 15 hrs each)

* 1. Reassessment methods

Like for like.

1. **Map of module learning outcomes (sections 8 & 9) to learning and teaching methods (section12) and methods of assessment (section 13)**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Module learning outcome** | *8.1* | *8.2* | *8.3* | *8.4* | *8.5* |  | *9.1* | *9.2* | *9.3* | *9.4* |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |
| Lectures | x | x | x | x | x |  |  | x | x | x |
| *Private study* | x | x | x | x | x |  | x | x | x | x |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |
| *Assessments* | x | x | x | x | x |  | x | x | x | x |
| *Examination* | x | x | x | x | x |  |  | x | x | x |

1. **Inclusive module design**

The School recognises and has embedded the expectations of current equality legislation, by ensuring that the module is as accessible as possible by design. Additional alternative arrangements for students with Inclusive Learning Plans (ILPs)/declared disabilities will be made on an individual basis, in consultation with the relevant policies and support services.

The inclusive practices in the guidance (see Annex B Appendix A) have been considered in order to support all students in the following areas:

a) Accessible resources and curriculum

b) Learning, teaching and assessment methods

1. **Campus(es) or centre(s) where module will be delivered**

Canterbury

1. **Internationalisation**

The topics addressed by this module relate to a field which is of international importance, given the global role of computers in today's technological innovation. The topics covered by this module are international in nature, being identical worldwide and independent of traditional spoken language.

**DIVISIONAL SUPPORT OFFICE USE ONLY**

**Revision record – all revisions must be recorded in the grid and full details of the change retained in the appropriate committee records.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Date approved | Major/minor revision | Start date of the delivery of revised version | Section revised | Impacts PLOs (Q6&7 cover sheet) |
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Revised FSO Jan 2018