PX447-15 Quantum Computation and Simulation

21/22

Department
Physics
Level
Undergraduate Level 4
Module leader
Animesh Datta
Credit value
15
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

We live in what is often dubbed ‘the information age’. Underlying this is immense computational capability. But what are the limits of computation? What do the laws of physics have to say about that?

This module will introduce quantum computation and show that the laws of quantum mechanics can provide additional computational capabilities. We will show how this can be used to solve certain problems more efficiently. We shall study what quantum computers can offer for simulations in physics and chemistry.

Module web page

Module aims

To provide insights into quantum computation and simulation

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

1. Computation is physical, why quantum computation?
2. Introduction to classical computation: Bits, gates, and Boolean circuits
3. Quantum mechanics as matrix algebra: Quantum states and measurements
4. Quantum computation: Qubits, quantum gates, and quantum circuits
5. Quantum Fourier transform: Phase estimation, order-finding
6. Quantum search algorithm: Grover’s algorithm
7. Quantum simulation: Application to physics and/or chemistry problems

Learning outcomes

By the end of the module, students should be able to:

- Explain the basics of quantum computation
- Understand some quantum algorithms
- Commence postgraduate research in quantum computation

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

Interdisciplinary

Quantum computing started as an idea in physics but quickly developed into a major interdisciplinary endeavour involving mathematicians, computer scientists and others. This module looks, from the physicist's perspective, at how quantum states and operations on quantum states encode and process information.

Subject specific skills

Knowledge of mathematics, physics, theory of computation. Skills in modelling, reasoning, thinking.

Transferable skills

Analytical, communication, problem-solving, self-study

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Private study	120 hours (80%)
Total	150 hours

Private study description

Working through lecture notes, solving problems, wider reading, discussing with others taking the module, revising for exam, practising on sample exam papers

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B1

	Weighting	Study time	Eligible for self-certification
Assessment component			
Centrally-timetabled examination (On-campus) Answer 3 questions	100%		No

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- Answerbook Pink (12 page)
- Students may use a calculator

Reassessment component is the same

Feedback on assessment

Personal tutor, group feedback

Past exam papers for PX447

Availability

Courses

This module is Optional for:

- Year 4 of UPXA-F303 Undergraduate Physics (MPhys)

This module is Option list B for:

- Year 4 of UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)