

# PX447-15 Quantum Computation and Simulation

**26/27**

**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

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

---

- 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

Course availability information is based on the current academic year, so it may change.

This module is Optional for:

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

This module is Option list B for:

- Year 1 of TPXA-F345 Postgraduate Taught Modelling of Heterogeneous Systems (PGDip)
- Year 4 of UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
- Year 4 of UPXA-F3FA Undergraduate Physics with Astrophysics (MPhys)