

# COMP 3033 QUANTUM COMPUTING AND COMMUNICATION

**Credit Points** 10

**Legacy Code** 301437

**Coordinator** Weisheng Si ([https://directory.westernsydney.edu.au/search/name/Weisheng Si/](https://directory.westernsydney.edu.au/search/name/Weisheng%20Si/))

**Description** This subject introduces how computing and communication can be performed by harnessing quantum phenomena such as superposition and entanglement. From a computer science perspective, this subject directly starts with the mathematical models delivered by those quantum phenomena while skipping the details of Quantum Mechanics. Based on these mathematical models, this subject introduces the concept of qubits and quantum circuits, and then discusses the design of quantum algorithms and communication protocols. This subject is highly practical: quantum programming will be done weekly with a user-friendly quantum simulator. Students completing this subject will develop skills for designing quantum algorithms and protocols which are highly needed in job markets.

**School** Computer, Data & Math Sciences

**Discipline** Programming

**Student Contribution Band** HECS Band 2 10cp

Check your HECS Band contribution amount via the Fees ([https://www.westernsydney.edu.au/currentstudents/current\\_students/fees/](https://www.westernsydney.edu.au/currentstudents/current_students/fees/)) page.

**Level** Undergraduate Level 3 subject

**Pre-requisite(s)** COMP2014 OR  
COMP2015 OR  
COMP2016 OR  
COMP2023  
AND  
MATH1028 OR  
MATH1030 OR  
COMP1014

**Assumed Knowledge**

Students should have gained knowledge and skills in basic probability theory and intermediate-level computer programming. The basics of probability are essential for understanding quantum states. Computer programming skills of using objects and simple algorithms are needed to compose quantum programs.

Linear Algebra, which is the foundation for the mathematical models in quantum computing, will be covered within the subject. Therefore, a prior knowledge on it is recommended, but not required.

## Learning Outcomes

On successful completion of this subject, students should be able to:

1. Apply the mathematical models enabled by Quantum Mechanics.
2. Compose quantum circuits to implement programming logics.
3. Design quantum algorithms that are faster than classical algorithms.
4. Design secure quantum communication protocols.
5. Apply techniques for correcting quantum errors.

6. Conduct quantum programming on a quantum simulator and some real quantum computers in clouds.

## Subject Content

1. Introduction to qubit, superposition, entanglement, and measurement.
2. Quantum programming on quantum simulators and real quantum computers.
3. Introduction to Complex Numbers for quantum computing.
4. Introduction to Linear Algebra for quantum computing.
5. Quantum gates and quantum circuits.
6. Basic quantum algorithms such as Deutsch's Algorithm and Deutsch-Jozsa's Algorithm
7. Quantum algorithms with applications: Grover's algorithm and Shor's algorithm
8. Quantum communication protocols such as BB84 Protocol and Ekert Protocol
9. Quantum Error Correction
10. Using Quantum Algorithms and Protocols to help achieve UN's SDGs (Sustainable Development Goals)

## Assessment

The following table summarises the standard assessment tasks for this subject. Please note this is a guide only. Assessment tasks are regularly updated, where there is a difference your Learning Guide takes precedence.

Type	Length	Percent	Threshold	Individual/ Group Task
Practical	2 hours (per lab)	20	N	Individual
Applied Project	30 hours	20	N	Individual
Quiz	30 minutes per quiz; 12 quizzes in total	20	N	Individual
Final Exam	2 hours	40	N	Individual

Teaching Periods

## Autumn (2022)

### Penrith (Kingswood)

**Day**

**Subject Contact** Weisheng Si ([https://directory.westernsydney.edu.au/search/name/Weisheng Si/](https://directory.westernsydney.edu.au/search/name/Weisheng%20Si/))

View timetable ([https://classregistration.westernsydney.edu.au/even/timetable/?subject\\_code=COMP3033\\_22-AUT\\_KW\\_D#subjects](https://classregistration.westernsydney.edu.au/even/timetable/?subject_code=COMP3033_22-AUT_KW_D#subjects))

### Parramatta - Victoria Rd

**Day**

**Subject Contact** Weisheng Si ([https://directory.westernsydney.edu.au/search/name/Weisheng Si/](https://directory.westernsydney.edu.au/search/name/Weisheng%20Si/))

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## Autumn (2023)

### Parramatta - Victoria Rd

**On-site**

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