Subject Description Form

Subject Code	AMA567
Subject Title	Quantum Computing for Data Science
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	To provide a comprehensive introduction to quantum information and quantum computation. To present fundamental concepts and principles of quantum physics, quantum information and quantum computation. To present several well-known quantum algorithms. To provide a starting point for students who are interested in pursuing research in the emerging and fast-developing field of quantum computing.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) master the basics of quantum mechanics, (b) understand the basic concepts of quantum information and the basic principles of quantum computing, (c) familiarise with several standard quantum algorithms and apply them to develop more new quantum algorithms.
Subject Synopsis/ Indicative Syllabus	Quantum Mechanics: Dirac's bra-ket notation, pure states, density matrices, Pauli matrices, quantum measurements, projective measurements, POVM measurements, composite quantum systems, quantum evolution, partial trace, quantum entanglement Quantum Information: Qubits, quantum noise, quantum operations, quantum channel, decoherence, master equations, Shannon entropy, von Neumann entropy, quantum teleportation, super-dense coding Quantum Algorithms: Quantum gates, quantum circuits, controlled operations, universal quantum gates, quantum Fourier transform, phase estimation, amplitude amplifications, Grover's search algorithm, Deutsch-Jozsa algorithm, Shor's quantum factoring algorithm.
Teaching/Learning Methodology	The subject will mainly be delivered through lectures and tutorials. The theoretical background of quantum information and their applications to quantum computational algorithms are both emphasized.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)			
		a	b	c	
1. Assignments	20%	✓	✓	✓	
2. Project	20%	✓	✓	✓	
3. Midterm test	20%	✓	✓	✓	
4. Examination	40%	✓	✓		
Total	100%				

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Assignments: help students review basic mathematics, grasp the important concepts and results in quantum information theory.

Project: train students' ability to organize learned algorithms for real problems

Midterm test: a part of continuous assessment for the theoretical part covered in the subject.

Examination: an overall examination of the theory and algorithms studied in the whole semester.

Student Study Effort Required

Class contact:	
▪ Lecture	26 Hrs.
▪ Tutorial	13 Hrs.
Other student study effort:	
▪ Assignments/Projects	58 Hrs.
▪ Self-study	30 Hrs.
Total student study effort	127 Hrs.

Reading List and References

Textbook:

1. Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Computation*, Cambridge University Press, 2010.

References:

1. Mikio Nakahara and Tetsuo Ohmi, *Quantum Computing: Froom Linear Algebra to Physical Realizations*, CRC Press, 2008

	2. Scott Aaronson, *Quantum Computing Since Democritus*, Cambridge University Press, 2013. 3. Mark M. Wilde, *Quantum Information Theory*, Cambridge University Press, 2017. 4. Alexander S. Holevo, *Quantum Systems, Channels, Information: A mathematical Introduction*, Walter de Gruyter GmbH, 2012. 5. 張永德，量子信息物理基礎，科學出版社，2005.
