Module no. M13	ALGORITHMS FOR QUANTUM COMPUTING
Module code and mode of delivery	Module Code: EEP55C30 Delivery mode: See below
Module ECTS Weighting	10 ECTS
Semester of delivery	1 and 2
Module Contact Hours	Scheduled hybrid lectures (synchronous online and in-situ f/f) 22 hours, Independent student reading/Reflection using asynchronous materials in VLE 55 hours, Tutorials (f/f in-situ as appropriate) 22 hours, Continuous assessment 16 hours, Summative assessment 10 hours.
Module Coordinator	Prof Biswajit Basu
Module teaching staff and academic titles	Prof Biswajit Basu
Module description—content	Quantum control algorithms is an emerging area in response to the development of quantum computers which have been made feasible due to the recent breakthrough in hardware technologies. This would revolutionize applications related to simulation, optimization, security, medical application and drug design to name a few. The module considers theoretical development and application - oriented problem solving in the areas of: estimation, stochastic simulation, optimization, control and machine learning. The course will emphasize the interplay between theory and application with practical coding.
Module learning aims/objectives	1. To enable students to develop algorithms for quantum computers. 2. To develop capabilities to apply the quantum algorithms for solving problems in science and engineering. 3. To develop skills for identifying and develop quantum algorithms which have performance superior to traditional ones.
Module learning outcomes	On successful completion of the module students should be able to: **MLO13.1** Describe the basic elements and advantages/disadvantages of a Quantum circuit. **MLO13.2** Transform classical calculations into quantum operations.

	MLO13.3 Use Dirac notation to perform calculations with quantum algebra. **MLO13.4** Apply period finding algorithms for solving related problems. **MLO13.5** Design and apply algorithms for Quantum Wavelet and Fourier Transforms. **MLO13.6** Solve problems and perform stochastic simulations using Quantum random walk. **MLO13.7** Solve optimization problems using quantum computing algorithms. **MLO13.8** Solve problems in Quantum Machine Learning.
Module assessment, separate components and their weighting to be mapped into SITS	The module contains a mixture of tutorials and conventional lab sessions where students will be able to seek assistance on their assignments. There will be 22 lecture hours (I.e. 2 lecture hours per week from the start of the semester). The guideline for a 5 ECTS module is for 125 hours of student effort including class hours. ASSESSMENT MODE(S) Assessment will be based on 60% Continuous Assessment and 40% final exam. Continuous Assessment will be a mixture of algorithm design assignments and in-class tests. The students on the course will be guided through adapting assignments to complement their chosen project if possible. SYLLABUS • Introduction to Quantum mechanics and Quantum computers • Linear Algebra and Dirac notation, Quantum gates and circuits • Algorithms with super-polynomial speed-up • Period finding algorithms • Shor's algorithm, Factorization algorithm, Grover's algorithm • Quantum Fourier Transform and applications • Quantum Wavelet Transform and applications • Quantum random walk and applications • Quantum search algorithms and applications • Introduction to Quantum Machine Learning • Introduction to Quantum Cryptography Reading List: 1. An introduction to quantum computing (2010) by Kaye, Laflamme and Mosca. OUP 2. Quantum computation and quantum information (2010) by Nielsen and Cheung, CUP.
Academic Start Year	12th September 2022

Academic Year of Date	2022-2023