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## PHYC90045 Introduction to Quantum Computing: Outline 2020

| Week | Lectures | Lab session | |
|---|---|---|---|
| 1 | Introduction to quantum computing<br>- overview of quantum computing<br>- complex numbers | Lab 1: Complex numbers<br>- state representation<br>- Quantum User Interface (QUI) | |
| 2 | Single qubit representation and operations<br>- linear algebra and notation<br>- single qubits, operations, measurement | Lab 2:<br>- single qubit states<br>- single qubit operations | |
| 3 | Two and more qubits<br>- operations, measurement, entanglement<br>- teleportation and dense coding | Lab 3:<br>- two qubit gates, entanglement<br>- teleportation<br>- dense coding | Assignment 1 posted on LMS |
| 4 | Simple quantum algorithms<br>- Universality<br>- classical logic and reversible computation<br>- algorithms: Deutsch-Josza, Bernstein-Vazirani, Simon | Lab 4:<br>- logical statements<br>- adders<br>- simple algorithms | |
| 5 | Quantum search (Grover's algorithm)<br>- Grover's algorithm<br>- amplitude amplification<br>- quantum counting | Lab 5:<br>- Grover's algorithm<br>- amplitude amplification | |
| 6 | Quantum factorization (Shor's algorithm)<br>- Quantum Fourier Transform (QFT)<br>- Shor's factoring algorithm | Lab 6:<br>- QFT<br>- Shor's factoring algorithm | Hand in Assignment 1 (details TBA) |
| 7 | Quantum supremacy and noise<br>- Boson Sampling<br>- Instantaneous Quantum Polynomial (IQP) circuits<br>- quantum errors<br>- randomised benchmarking | Lab 7:<br>- quantum errors<br>- noisy circuits<br>- random circuits | |
| 8 | Programming real quantum computers (IBM Q)<br>- introduction to the Quantum Experience<br>- introduction to QISKIT<br>- qubit connectivity, circuit compression techniques | Lab 8:<br>IBM Quantum Experience | |
| 9 | Quantum error correction (QEC)<br>- basic QEC codes<br>- topological QEC codes | Lab 9:<br>Quantum error correction | Assignment 2 Posted on LMS |
| | **Semester break (5-11 Oct)** | | |
| 10 | QUBO problems and Adiabatic Quantum Computation (AQC)<br>- mapping and solving QUBO problems<br>- introduction to AQC | Lab 10:<br>- QUBO problem mapping<br>- QUBO problem solving | |
| 11 | Variational/hybrid quantum algorithms (QAOA and VQE)<br>- Variational Quantum Eigensolver (VQE)<br>- Quantum Approximate Optimisation Algorithm (QAOA) | Lab 11:<br>- problem mapping<br>- VQE/QAOA examples | |
| 12 | Solving linear equations, QC computing hardware<br>- linear algebra and the HHL algorithm<br>- current status of QC hardware | Lab 12:<br>- implementing HHL | Hand in Assignment 2 (details TBA) |