COURSE SPECIFICATION FORM

for new course proposals and course amendments

Department/School:	**Mathematics**	**Academic Session:**	**2017-18**
Course Title:	Quantum Information and Coding	**Course Value:** (UG courses = unit value, PG courses = notional learning hours)	0.5 unit
Course Code:	MT4450	**Course JACS Code:** (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 2	**Status:**	Optional Condonable
Pre-requisites:	MT2800	**Co-requisites:**	-
Co-ordinator:	-		
Course Staff:	-		
Aims:	'Anybody who is not shocked by quantum theory has not understood it' (Niels Bohr). This course aims to provide a sufficient understanding of quantum theory in the spirit of the above quote. Many applications of the novel field of quantum information theory can be studied using undergraduate mathematics. The course relies almost exclusively on tools from linear algebra – prior knowledge of applied mathematics or quantum theory is neither required nor particularly useful.		
Learning Outcomes:	1. demonstrate an understanding of the principles of quantum superposition and quantum measurement; 2. use the basic linear algebra tools of quantum information theory confidently; manipulate tensor-product states and use and explain the concept of entanglement; 3. explain applications of entanglement such as quantum teleportation or quantum secret key distribution; 4. describe the Einstein-Podolsky-Rosen paradox and derive a Bell inequality; solve a range of simple problems involving one or two quantum bits; 5. explain Deutsch's algorithm and its implications for the power of a quantum computer; 6. demonstrate a breadth of understanding appropriate for an M-level course.		
Course Content:	Linear algebra: Complex vector space, inner product, Dirac notation, projection operators, unitary operators, Hermitian operators, Pauli matrices. One qubit: Pure states of a qubit, the Poincaré sphere, von Neumann measurements, quantum logic gates for a single qubit. Tensor products: 2 qubits, 3 qubits, quantum logic gates for 2 qubits, Deutsch's algorithm, the Schmidt decomposition. Mixed states: Partial trace, probability, entropy, von Neumann entropy. Entanglement: The Einstein-Podolsky-Rosen paradox, Bell inequalities, quantum teleportation, measures of entanglement, decoherence. Further applications, such as e.g. the quantum Fourier transform, Shor's factoring algorithm, the BB84 key distribution protocol, Grover's search algorithm, quantum channel capacity, the Holevo bound.		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 150. 3 hours of lectures per week over 11 weeks. Total 33 hours. 117 hours of private study, including work on problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	M.A. Nielsen and I.L. Chuang – Quantum Computation and Quantum Information (Cambridge 2000). Library Ref. 001.64 NIE		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** 100% Written exam. A two hour paper. **Coursework:**		

Updated September 2017