

Quantum Computation and Quantum Information

A joint course for the PhD in “Mathematics and Models” (DISIM) and “Physics and Chemistry” (DSFC) – Università degli Studi dell’Aquila.

Target: PhD students in:

- Mathematics (missing knowledge in Quantum Mechanics, Information Theory and Computer Science).
- Physics (missing knowledge on Computer Science and Information Theory).
- Chemistry (missing knowledge on Hilbert Space algebra, Computer Science and Information Theory).

Reference Book: “Quantum Computing and Quantum Information”, M.A. Nielsen, I.L.Chuang, Cambridge University Press 2010. (NC hereafter)

Days	Topics	Details	Material	Teacher
20 nov 11.30-13.30 Aula 1.5	Introduction to Quantum Mechanics and Qubits	<ul style="list-style-type: none"> - Linear vector spaces - The postulates of QM - Qubit and its formalism - The density matrix - Generalized measurement - Quantum channels 	NC chapters 1.2 + 1.5 2.1-2.4 11.3.-11.33	Simone Paganelli (Univaq)
21 nov 11.30-13.30 Aula C 1.16				
22 nov 14.30-16.30 Aula 1.6				
27 nov 11-13 Aula 1.5	Introduction to Quantum Information	<ul style="list-style-type: none"> - Pure state entanglement - Majorization criterion - Local operations and classical communication - Entanglement distillation and dilution for pure states - Mixed state entanglement - Entanglement measurements - Turing machines: deterministic, non-deterministic, probabilistic and quantum. - Computational classes (P, NP, BPP, BQP) and proprieties. 	NC chapters 2.5 3.1-3.3 12.5	Ugo Marzolino (R. Boskovic Institute, Zagreb)
29 nov 14.30-16.30 Aula 1.6				
4 dec 11.30-13.30 Aula 1.5	Quantum Circuits and Algorithms	Single and double qubit gates with examples. Analytical solution of a simple Hamiltonian that will be solved in the tutorial. Simple algorithms	NC chapters 1.3,1.4 + online material on IBM-Q websites	Leonardo Guidoni (Univaq)
6 dec 14.30-16.30 Aula 1.6				
Lab. of Comp. Physics 11 dec 11.30-13.30 11 dec 14.30 16.30 12 dec 11.30-13.30	Hands on Tutorial on the IBM-Q and Quantum Experience	General overview on perspective of quantum computation and practical Implementation of algorithms on the IBM-Q quantum computer and simulator (python-based).	Online material on IBM-Q website + qiskit tutorial	Federico Mattei (IBM-Italia)

