

Quantum Information Processing Devices

E&CE 770

Nov 2005

Calendar Description:

This course introduces the fundamental concepts and the most recent achievements in the physical realization of quantum information devices and systems in three platforms; Nuclear Magnetic Resonance (NMR), quantum photonics and superconducting electrical circuits.

Prerequisite: Permission from Instructors, recommended prerequisite PHYS 467/CS 467.

*Project

Detailed Description:**Lecture Hours**

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| 1. | Introduction to Quantum Information Processing (QIP) | 1.5 |
| | <ul style="list-style-type: none"> - Classical & quantum information - Quantum information principles (qubit processing and measurement) - Quantum circuits - Advantages of quantum information - DiVincenzo criteria for quantum processors - QIP devices | |
| 2. | Nuclear Magnetic Resonance (NMR) QIP | 4.5 |
| | <ul style="list-style-type: none"> - Basics of NMR - Principles of liquid state NMR QIP - Examples of quantum algorithms for NMR - Quantum error correction - Solid state NMR QIP | |
| 3. | Photonic QIPD | 6 |
| | <ul style="list-style-type: none"> - Overview of QED (Quantum Electrodynamics) - Encoding quantum information into optical fields - Linear optics quantum computing - Non linear optics quantum computing - Photonic sources of entanglement - Quantum optical measurement schemes - Prospects of integrated optics in optical quantum computing | |
| 4 | Photonic Quantum Detection | 6 |
| | <ul style="list-style-type: none"> - Quantum description of light (photon streams and number statistics) - Classical, semi-classical and quantum description of homodyne and heterodyne detection - Noise mechanisms in optical detection - Transition from optical detectors to single-photon optical detector - Semiconductor and superconductive single –photon optical detectors - Characterization of single-photon optical detectors | |

5	Superconducting Quantum Circuits	6
	<ul style="list-style-type: none"> - Macroscopic degree of freedom in superconducting mesoscopic circuits - Foundation and operation of flux qubit structures - Foundation and operation of charge number qubit structures - Superconducting cavity-QED electrical circuits - Decoherence in superconducting quantum circuits 	
6	Photonic Quantum Cryptography	6
	<ul style="list-style-type: none"> - Encoding quantum information in propagating optical fields - Quantum communication protocols - Photonic quantum key distribution - Free-space and fiber optical quantum cryptography - Most recent experimental achievement and available commercial systems for photonic QKD and quantum communications 	

Total 30

Text Book: Handouts and recommended texts will be provided.

Project: An individual project is an essential component of this course.

Instructors Team for W06: R. Laflamme (1 & 2), G. Weihs (3), A. H. Majedi (4 & organizer), F. Wilhelm (5), N. Luetkenhaus (6)