COURSE: QIC 750 / ECE 676 / PHYS 768 / PHYS 468

COURSE TITLE: Implementations of Quantum Information Processing

INSTRUCTORS: Prof. Michal Bajcsy (**mbajcsy@uwaterloo.ca**) Prof. Michael Reimer (**michael.reimer@uwaterloo.ca**)
Office: QNC 4126 RAC 1113
Office hours: by appointment (via email)

LECTURE HOURS: Monday 8:30-11:20, E5 5106 (originally in EIT 3151)

TA: Hyeran Kong (**hrkong57@gmail.com**)
TA OFFICE HOURS: TBA

DESCRIPTION:
This course gives an introduction to physical implementations of quantum computers with an emphasis on common and connecting themes.

PREREQUISITE: Quantum mechanics, linear algebra

SYLLABUS:

1. ***Review of modern Quantum Mechanics***
Time-evolution and the Hamiltonian; The quantum harmonic oscillator; The 2-level system (spin 1/2); Density matrices. The Bloch Sphere

2. ***Spin-based Quantum Computing***
Nuclear magnetic resonance; The Rabi problem and RWA

3. ***Superconducting Qubits***
Quantized circuits. Charge and Flux qubits. Circuit Quantum Electrodynamics. Jaynes-Cummings Hamiltonian: Coupling between a HO and TLS.

4. ***Photonic Quantum Information***
Optical elements. Polarization, time-bin and dual-rail encoding; quantum key distribution; CNOT gate

5. ***Ion Traps***
Trapping ions. Optical and Microwave qubits. Raman transitions. Cirac-Zoller gate.

6. ***Special Topics***
Students will give presentations on topics of interest to themselves drawn from the literature

TEXTBOOK: There will be no required textbook, but lecture notes will be provided.

GENERAL REFERENCES:

- Course Notes, Frank Wilhelm
- Modern Quantum Mechanics, J.J. Sakurai. Addison-Wesley Publishing, (1994).

GRADING SCHEME:

- Homework: 30%
- Oral presentation: 20%
- Term Project: 50%