- *QUANTUM INFORMATION / QUANTUM COMPUTATION* -

PHYSICS 472K - Syllabus

Spring 2015

Instructor : Channon Price, x6106, cpprice@alaska.edu

Office hours : MTWRF 8:00 am - 9:00 am or by prior appointment; please consult my calendar at the above email address.

Class hours : MWF 1:00 pm - 2:00 pm (REIC 207), 20 February to 30 March. (Note: UAF 2015 Spring Break is 16-20 March.)

Prerequisites : PHYS 220; PHYS 301; or permission of instructor.

Texts : Reading handouts to be distributed by the class website [see below].

Description : The UAF Catalog listing for PHYS 472K is: Application topics provide expanded exposure to subjects in physics. Three topics are offered within the fall and spring semesters of each academic year as compressed 14-lecture, one credit courses. Prerequisites: PHYS 220; PHYS 301; or permission of instructor.)

Grading : 1 credit. Homework (65%); final exam (35%). The course will be graded plus/minus.

Schedule : See the attached course schedule. Assignments will be made during the course.

Learning Outcomes : Students who complete this module will learn why information is a physical quantity, how entanglement encodes information, why states cannot be duplicated with perfect fidelity, about Bell's inequalities and the Bell states, about experimental tests of entanglement, about the CNOT and Hadamard gates, about the Quantum Fourier Transform, Shor's factoring algorithm, and Grover's search algorithm, about interaction-free measurement and the quantum Zeno's paradox, about quantum teleportation, about quantum encryption, and about the present state of realizations of hardware for quantum logic and quantum computers.

Remarks : The course materials (reading handouts, homework problems, additional enrichments) will be made available on the course website http://137.229.43.8/physics/phys472K.html

Disability Services : The Physics Department will work with the Office of Disabilities Services (208 WHIT, x7043) to provide reasonable accomodation to students with disabilities.

Tentative PHYS 472K Course Schedule

Lecture 1: Introduction to Quantum Information and Entanglement

Lecture 2: Physics of Information
Landauer's Principle, Reversible Computation, Maxwell's Demon

Lecture 3: Quantum Information
Heisenberg Uncertainty Principle, No-Cloning Theorem, Bell's Theorem

Lecture 4: Physics of Entanglement
Enhanced correlation, separability vs. entanglement, concurrence, Bell states

Lecture 5: Quantum gates
CNOT gate, Hadamard gate, T gate, universal quantum gates

Lecture 6: Circuit representation; quantum Fourier tranform

Lecture 7: QFT conclusion; Shor's algorithm

Lecture 8: Some quantum communications protocols
Superdense coding, quantum teleportation

Lecture 9: Quantum cryptography

Lecture 10: Quantum parallelism I
Deutsch and Deutsch-Josza algorithms

Lecture 11: Quantum parallelism II
Oracles; Grover search algorithm

Lecture 12: Counterfactual interrogation
Quantum Zeno effect; quantum non-demolition measurements *e.g.* Elitzur-Vaidman bomb tester

Lecture 13: Physical Realizations
Operational requirements; QSHO, optical cavities, Fabry-Perot interferometers,
ion traps, NMR, other potential systems

Lecture 14: Final exam