The Mathematics of Quantum Information Theory

Bruno Nachtergaele

Course description:

This course provides an introduction to the mathematical formulation of quantum theory with an eye toward quantum probability and quantum information theory and applications to quantum computation. Topics covered include observables and states, quantum dynamics, quantum gates and circuits, quantum channels, entropy and related inequalities, entanglement, Bell's inequalities, teleportation, quantum coding theorems, and error correction.

Lecture Notes: Lecture notes will be made available on a week-by-week basis, which will supplement the reading materials listed below.

Prerequisites: A foundation in linear algebra and elementary probability and analysis will generally suffice. No physics prerequisites will be assumed.

Class schedule: The course is tentatively scheduled for TR 10:30–11:50am.

Grading: Grades will be based on a written report or an oral presentation summarizing the reading of one or more research paper(s) or book chapters. Students will be asked to choose from a list of proposed topics.

Optional homework problems will be included in the lecture notes each week. A final exam based on problems discussed in the courses will be given to any student who requests it.

Reading:

We will cite appropriate original sources and review articles for specific topics. In addition, the following two texts are pleasant and useful reading:

1. Michael A. Nielsen and Isaac L. Chuang, Quantum computation and quantum information, Cambridge University Press, Cambridge, 2000.

2. Greg Kuperberg, A concise introduction to quantum probability, quantum mechanics, and quantum computation, https://www.math.ucdavis.edu/ greg/intro-2005.pdf