

University of Jyväskylä - Course TIEJ6003
INTRODUCTION TO QUANTUM COMPUTING

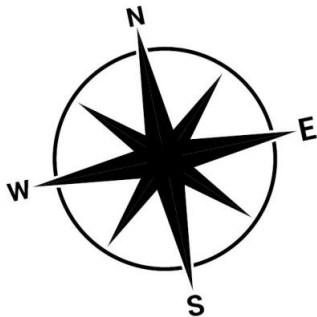
Preface

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The Big Picture: Course Compass



Quantum Computing: The Future is Now

- **Exponential computational power:** Quantum computers promise to solve problems intractable for classical computers.
- **Revolutionizing industries:** Impact on fields like cryptography, materials science, drug discovery, and artificial intelligence.
- **Google's claim to quantum supremacy:** A significant milestone achieved in 2019, demonstrating the potential of quantum computers.
- **Join the quantum revolution:** This course will equip you with the foundational knowledge to be able to join this exciting field.

Planning

Five course days, in each we will meet for a Lecture (theory) followed by a Precept (practice):

(D-1) Introduction to Quantum Mechanics and 2-Level Systems

(D-2) Quantum Building Blocks: Qubits, Gates and Circles

(D-3) Teleportation and Introduction to Quantum Algorithms

(D-4) The Quantum Fourier Transform and Shor's Factorization

(D-5) Quantum Search (Grover) and Quantum Optimization

Non-Mandatory Assignments: Optional take-out exercises will be published daily and will be solved in class the following day.

Evaluation

- By the end of the course, a take-home assignment will be published.
- The nature of the final assignment will be similar to the (optional) daily assignments, that is, theoretical exercises involving calculations and proofs.
- Grade: PASS/FAIL

References

The course is based on chapters in the book of Nielsen and Chuang:

- M. A. Nielsen and I. L. Chuang, *Quantum Computation and Quantum Information: 10th Anniversary Edition*. Cambridge: Cambridge University Press, 2010.

Other sources of reference (mathematical proofs or deeper physics):

- W. Scherer, *Mathematics of Quantum Computing: An Introduction (1st. ed.)*. Cham: Springer Publishing, 2019.
- J.J. Sakurai, *Modern Quantum Mechanics*. Taiwan: Pearson Education Taiwan, 2008.