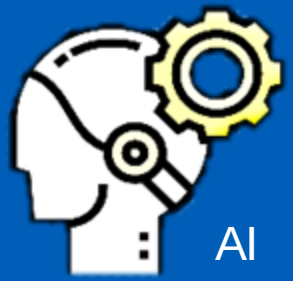
Quantum Mechanics
PHYS-C0252
lecture starts 10:15

First lecture on 1.11.2021

Lecturers: Mikko Möttönen and Tapio Ala-Nissilä
Teaching assistants: Andras “Marci” Gunyho and Niko Savola

QUANTUM TECHNOLOGY WILL CHANGE THE WORLD (FOR BETTER)

CHEMISTRY AND PHARMA



AI

ENERGY

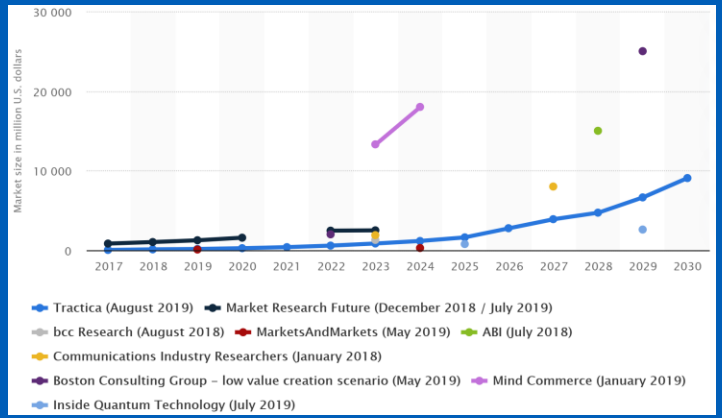
SUSTAINABILITY

FINTECH

CYBER SECURITY

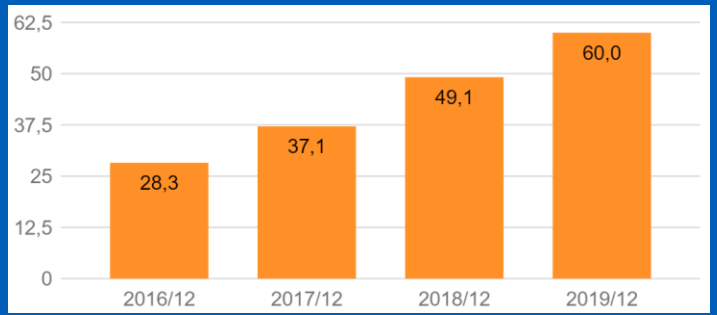
INDUSTRY RAMPING UP

QUANTUM COMPUTING GLOBAL MARKET PROJECTIONS



https://www.statista.com/statistics/936010/quantum-computing-future-market-outlook-forecast/

ANNUAL REVENUE OF QUANTUM TECH INDUSTRY IN FINLAND (MILLIONS OF EUROS)

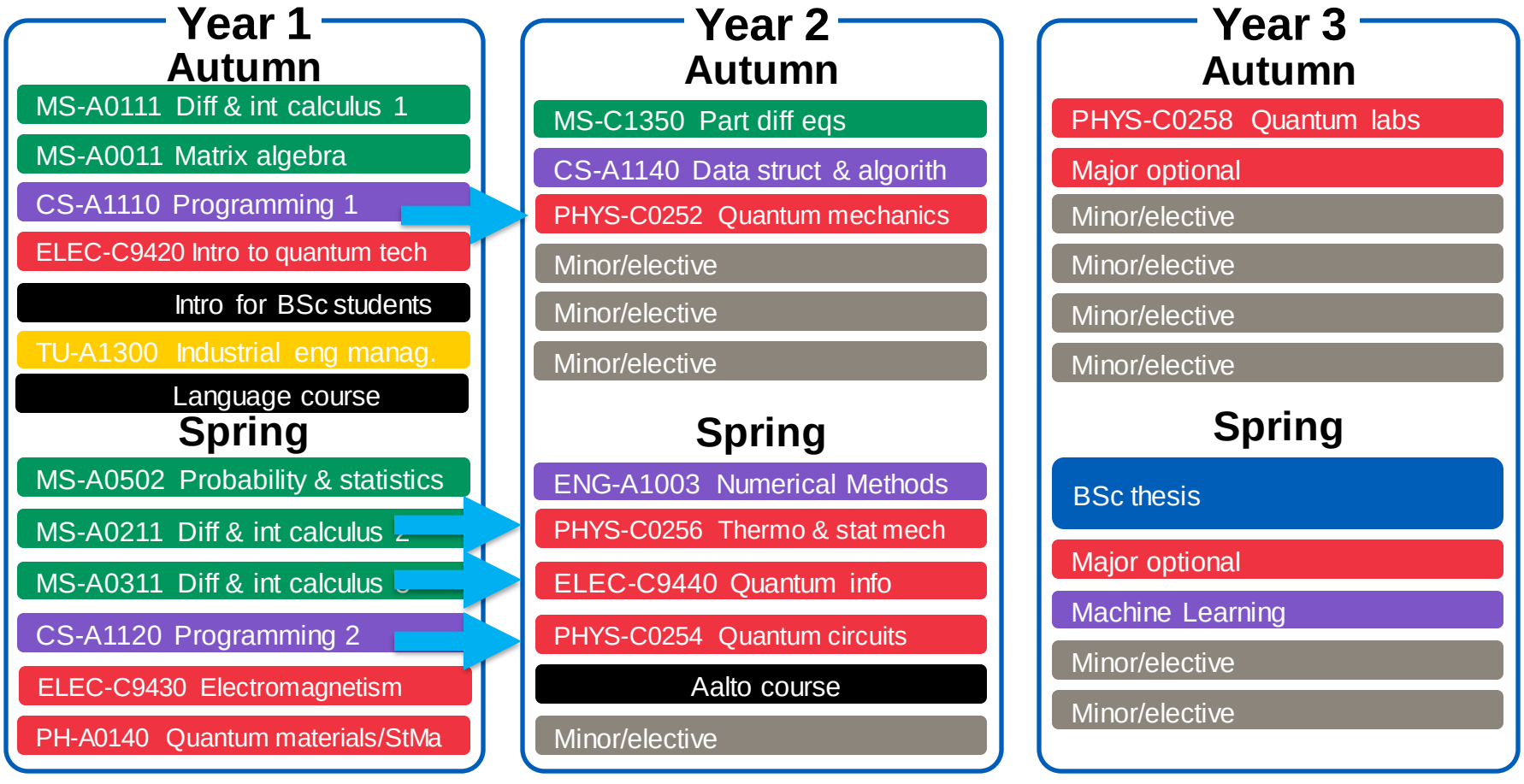


many scientific questions to be answered

finally job opportunities in quantum

what an amazing time to study quantum technology!

Quantum technology - timetable



Intended Learning Outcomes (ILOs)

1. Is familiar with the **structure** and postulates **of quantum mechanics**
2. Can differentiate between the terms **quantum-mechanical state and wavefunction**
3. Can **solve** the eigenstates and eigenvalues of the **Schrödinger equation** in simple situations and knows how to generalize the computation to situations where analytical solution is challenging.
4. Can **integrate the quantum evolution** and the expectation values of physical quantities for simple systems.
5. Can apply **creation and annihilation operators** to analyze one-dimensional harmonic oscillator.
6. Can solve **the eigenstates of the one-dimensional harmonic oscillator**.
7. Can predict **measurement probabilities** from a given quantum state.
8. Can apply **perturbation theory** to compute eigensolutions in a situation where analytical solutions is challenging.

PEAK AT SYLLABUS

https://mycourses.aalto.fi/course/view.php?id=33562

Course content, rough

Hilbert space and Dirac notation
Operators, eigenvalues and eigenfunctions
Properties of (Hermitian) operators
Postulates of quantum mechanics (inc. superposition & meas)
Expectation values and variance
Continuous-variable bases: coordinate representation, momentum basis
Quantization of a physical system
Schrödinger equation and temporal evolution
Qubit (two-level system)
Two-system and entanglement
Commutator and conserved quantities
Solving 1D harmonic oscillator using creation and annihilation operators
Free particles and plane waves
Particle in a box
Particles in different potential wells: infinite and finite wells in 1D
Scattering and tunneling through barriers
Bloch's theorem
Bosons and fermions
Perturbation theory (non-degenerate)
Time-dependent perturbation theory
Time dependence of operators: different pictures

Particalities

- In-person v.s. online
  - Future lectures and exercises organized in person (U9/U3)
  - We aim to have Zoom streaming (and recorded videos) for those who cannot attend
  - Exams are organized in person (bad experience from online exam)
- Excercises
  - Deadline for returning solutions every Wednesday night (problems based on the lectures of the previous week)
  - Problem sets for excercises published by previous Monday
  - Trying out Zoom also on excercise sessions
  - Bonus 5 or 6 points (one full problem) to the next exam

Practicalities continue

- Zulip chat to ask for help. TAs will try to answer in a reasonable time frame.
- Additions?
- Questions?
  - Grading scale