Quantum Computing

Quantum Programming + useful Packages

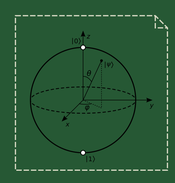
- Quantum Software Development Kits (SDKs)
- IBM Quantum Platform
  - IBM Quantum Composer: Drag and drop to build, visualize, and run circuits – no coding required
    - IBM Quantum Composer Tutorial
  - Hardwares
    - Transpiler
    - Retired QPUs
    - Local Simulators
    - Qiskit Aer Backend
      - Simulation Method Option (statevector, density_matrix, matrix_product_state, unitary, tensor_network)
- Mitiq Package for implementing Error Mitigation techniques
- HamLib: A library of Hamiltonians for benchmarking quantum algorithms and hardware
  - Paper
  - Dataset
- Application-Oriented Performance Benchmarks for Quantum Computing
  - GitHub
  - Paper

Books & Lecture Notes & Code NoteBooks, Lecture videos on Quantum Computing

- Quantum Computation and Quantum Information - Michael A. Nielsen, Isaac L. Chuang (2010)
- Lecture Notes on Quantum Computation John Preskill
  - Lecture Notes
  - Full YouTube Playlist 2020
- Lecture Notes on Quantum Computing 2025 - Chalmers University (Sweden) Master's course
  - Arxiv Link
- Quantum Computing: Lecture Notes Ronald de Wolf (QuSoft, CWI and University of Amsterdam), Netherlands 2023
  - suitable for a Master's course on quantum computation and information from the perspective of theoretical computer science (Arxiv Link)
- Lecture Notes Quantum Computation Peter Shor
- Introduction to Quantum Information Science Artur Ekert
- The Theory of Quantum Information John Watrous
  - Information and errata
- Lecture Notes on Quantum Algorithms Andrew Childs
- Introduction to Quantum Computing From a Layperson to a Programmer in 30 Steps (Hiu Yung Wong)
  - Teaching Slides
  - Teaching Videos
  - Text Book Solutions
- Quantum Computing Architecture and Hardware for Engineers step by step by Hiu Yung Wong
  - Book
  - Videos
  - Slides
- Quantum Computing Architecture and Hardware for Engineers -Step by Step Volume II by Hiu Yung Wong
- Introduction to Classical and Quantum Computing (Thomas G. Wong) PDF
- Quantum Computing Explained David McMahon
- A Methods Focused Guide to Quantum Error Correction and Fault-Tolerant Quantum Computation by Abdullah Khalid
- Web based Interactive learning tutorial
  - Quantum Machine Learning Tutorial
  - Quantum computing for the very curious Andy Matuschak & Michael Nielsen (a nice visual approach to remember what you read)
  - Quantum computing for the determined by Michael Nielsen YouTube Playlist
- Quantum Computing 4 Quantum Chemistry by by Artur Izmaylov
- A practical introduction to quantum computing: from qubits to quantum machine learning and beyond (Organized by CERN Quantum Technology Initiative) by Elias Fernandez-Combarro Alvarez
- Quantum Chemistry and Computing for the Curious: Illustrated with Python and Qiskit by Keeper Sharkey, Alain Chance
  - Book
  - GitHub
  - GitHub (updated version compatible with Qiskit 2.)
  - Find an approximation to the ground state of a chemistry Hamiltonian with Sample-based Quantum Diagonalization (SQD) by Alain Chance

Quantumish Animations, Interactive Visualization Tools & Quantum Game

- Bloch Sphere
  - grok-bloch: It helps user understand the Bloch Sphere
  - IOP: Bloch Sphere representation of quantum states for a spin 1/2 particle
  - Quantum-Bloch-Sphere-Simulator: pure and mixed with various quantum noise channels (tklezm)
    - Link-2
  - Blocher
- Quirk: A drag-and-drop quantum circuit simulator
- Quantum Composer: interactive tool for visualizing and simulating quantum mechanical concepts and systems
- The one-dimensional particle in a box
- Superposition states in a one-dimensional infinite square well
- Quantum Mode Simple (Curated Collection of Quantum Physics Animations)
  - YouTube (animations quantiques)
- SPINS JAVA (Stern-Gerlach measurements on spin-1/2 and spin-1 particles)
- Quantum Playlist (Videos)
- Quantum Animation (Different Potential Well)
- Qutip-Virtual-Lab
- PhET Interactive Simulations
- The Quantum Atlas
- Particle in a box
- Virtual Lab: No-code online laboratory with a real-time simulation of an optical table
  - Quantum Game
- Qubit Touchdown: A Quantum Computing Board Game by Tom Wong
  - YT
  - Game Board PDF
  - Cards PDF
- The Qubit Factory
- Quantum Games
- 3Blue1Brown YouTube channel
  - Grover's Algorithm
    - Video 1
    - Video 2
  - Hamming codes? The origin of error correction
    - Video 1
    - Video 2
  - Fourier
    - Fourier series
    - Fourier Transform
    - uncertainty principle, regarding Fourier transforms



Quantum Computing Interactive Courses

- PennyLane
  - PennyLane Codebook (Exercise-based introduction to quantum computing using PennyLane)
  - Quantum Dataset
    - What Is A Quantum Dataset?
    - Conventional Datasets for QML
  - Topics
    - The PennyLane Guide to Fault-Tolerant Quantum Computing (FTQC)
    - The PennyLane Guide to Hamiltonian Simulation
- IBM Quantum & Qiskit
  - Basics of quantum information (Basics, single and multiple systems + quantum teleportation, superdense coding, and the CHSH game)
  - Fundamentals of quantum algorithms quantum query algorithms, Phase estimation procedure, Integer Factorization (Shor's algorithm) & Unstructured search (Grover's algorithm)
  - General Formulation of Quantum Information (Density Matrices - Channels - General measurements - Purifications and fidelity - Quantum state discrimination and tomography)
  - Foundations of quantum error correction stabilizer formalism, Calderbank-Shor-Steane (CSS) codes, toric code and surface codes
    - Understanding Quantum Information and Computation Full YouTube playlist by John Watrous
      - Understanding Quantum Information and Computation John Watrous - Arxiv Link
  - Variational Algorithm Design (near-term, hybrid-quantum-classical algorithms)
  - Quantum Business Foundations Essentials of quantum computing and applications for business
  - Quantum Computing in Practice This course focuses on today's quantum computers and how to use them to their full potential.
  - Quantum Machine Learning (data encoding, quantum kernels, and variational quantum circuits)
  - Quantum chemistry with VQE This course is designed for intermediate learners of quantum computing techniques.
  - Quantum Diagonalization Algorithms
  - Qiskit in classrooms (Explore a suite of instructional materials designed to incorporate quantum computing into traditional STEM courses.)
    - Quantum Mechanics
    - Computer Science
  - Qiskit Ecosystem (Aer, Nature, Finance, QML, Optimization, Algorithms, ...)
  - Summary of Quantum Operations (Gates)

Quantum Computing Resources by Abbas (Omid) Hassasfar

Click here to get in touch

Cloud Access to Hardware Quantum Processing Units (QPUs)

- IBM quantum processing units (QPUs)
- Amazon Braket Quantum Computers
- Quantum computing providers on Azure Quantum
- QC Ware
- Xanadu
- DWave
- Quantinuum
- Pasqal
- Atom Computing
- Rigetti
- IQM
- OxfordQuantumCircuits
- IonQ
- Quera

Real-World Landscape, Industry Insights & Practical Perspectives

Funding, Use cases, Benchmarks

- Quantum Initiatives Worldwide (2025) by QURECA
- Quantum Benchmarks (Metriq)
- The Quantum Decade (IBM Institute for Business Value)

Infographics

- Quantum Computers: What We Need and What We Have
- IQM: The Journey of the Quantum Algorithm
- IQM - Quantum Computing Cheat Sheet For Circuit Magicians
- Nature - QUANTUM LEAPS, BIT BY BIT
- Quantum Information - APS
- ON THE VERGE OF THE QUANTUM REVOLUTION - Chalmers University of Technology

Coursera

- Hands-on quantum error correction with Google Quantum AI

Typesetting Quantum Circuit Diagrams

- Quantikz LaTeX package
- Q-circuit

Quantum Mechanics Books & Free online courses

- The Theoretical Minimum: Quantum Mechanics by Leonard Susskind
  - Book
  - YouTube Full Playlist
- Quantum Mechanics: Concepts and Applications by Nouredine Zettili
- Introduction to Quantum Mechanics by David J. Griffiths , Darrell F. Schroeter
- Modern Quantum Mechanics by J. J. Sakurai, Jim Napolitano
- MIT Open CourseWare (Lecture Videos included)
  - Barton Zwiebach
    - Quantum Physics I
    - Quantum Physics II
    - Quantum Physics III
  - Quantum Physics I Allan Adams, Matthew Evans, Barton Zwiebach