# Quantum Computing

## Quantum Programming on real Quantum Hardware + 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
    - Quantum Processing Units (QPUs)
    - Transpiler
    - Retired QPUs
    - Local Simulators
    - Qiskit Aer backend
      - Simulation Method Option (statevector, density_matrix, matrix_product_state, unitary, tensor_network)
- Amazon Braket
- Mitiq Package for implementing Error Mitigation techniques

## 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 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 4 Quantum Chemistry by by Artur Izmaylov
- 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

## QWORLD

- QPrep
  QPrep is QWorld's workshop series focusing on Python programming and linear algebra, to serve as a preparation before joining QBronze.
- QBronze
  Introductory tutorial on quantum computing and quantum programming.
  - Outline
- QNickle
  Nickel is QWorld's intermediate level tutorial on conventional quantum algorithms.
  - Outline
- QSilver
  Silver is QWorld's intermediate level tutorial on quantum computing and programming focusing on complex numbers, QFT and Shor's Algorithm.
  - Outline
- QCobalt (Quantum Annealing )
  Basics of combinatorial optimization problems, introduces the mathematical foundations for QUBO and Ising formulations and continues with D-Wave's Ocean SDK.
  - Outline
- QMerccury
  QWorld's Quantum Key Distribution (QKD)
- QZinc
  QWorld's Quantum Error Correction (QEC)
- QTitanium
  QWorld's Topological Quantum Computing (TQC)
- QBook101
  Google Colab based

## 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 (blezm)
    - Link-2
  - Blocher
- Quirk: A drag-and-drop quantum circuit simulator
- Virtual Lab: No-code online laboratory with a real-time simulation of an optical table
  - Quantum Game
- 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 Made 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 Qubit Factory
- Particle in a box
- Qubit Touchdown: A Quantum Computing Board Game by Tom Wong
  - YT
  - Game Board PDF
  - Cards PDF
- The Quantum Atlas

## Quantum Computing Interactive Courses

### PennyLane

- PennyLane Codebook (Exercise-based introduction to quantum computing using PennyLane)
- Quantum Dataset
  - What Is A Quantum Dataset?
- 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)

## 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

## 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

## Quantum Computing Resources by Abbas (Omid) Hassasfar

Click here to get in touch

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