QUANTUM COMPANIES — GUIDE

Quantum careers and skills

Roles, skills, salaries and hiring trends for quantum computing, sensing, networking and cryptography. University programs, certifications and transition paths from classical tech.

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The quantum industry hires across research, engineering, software, sales and operations. Understand the role taxonomy, required skills and entry paths.

Role taxonomy

Category	Roles	Typical background	Key skills
Quantum research	Quantum scientist, algorithm researcher, error correction researcher	PhD (physics, CS, math, chemistry)	Quantum algorithms, QEC, many-body physics, numerical methods, Python/C++
Quantum hardware	Quantum device engineer, fabrication engineer, cryogenic engineer, microwave engineer	PhD/MSc (physics, EE, materials)	Cleanroom fabrication, superconducting/ion-trap/photonic devices, dilution refrigerators, RF/microwave design
Control systems	Control systems engineer, FPGA engineer, RF engineer, DAC/ADC designer	MSc/BSc (EE, physics)	FPGA (Verilog/VHDL), high-speed DAC/ADC, real-time control, low-latency feedback, Python/C++
Quantum software	Quantum software engineer, compiler engineer, SDK developer, runtime engineer	BSc/MSc (CS, physics)	Python, Qiskit/Cirq/PennyLane/Braket/Q#, compiler passes, transpilation, optimization, CI/CD
Applications	Quantum application scientist, solutions architect, computational chemist, optimization specialist	PhD/MSc (chemistry, materials, finance, CS)	VQE, QAOA, quantum ML, error mitigation, domain modeling, benchmarking
Quantum sensing	Sensor physicist, systems engineer, applications engineer	PhD/MSc (physics, EE)	NV/OPM/SQUID, atom interferometry, atomic clocks, vacuum systems, data acquisition
Quantum networking	Quantum network engineer, QKD engineer, protocol researcher	PhD/MSc (physics, CS, EE)	QKD protocols (BB84, MDI, CV), quantum repeaters, entanglement distribution, photonics
Post-quantum crypto	Cryptographic engineer, security researcher, migration consultant	MSc/BSc (CS, math)	FIPS 203/204/205, lattice crypto, hash-based sigs, TLS/PKI, HSM integration, standards
Components/supply chain	Cryogenics engineer, laser engineer, vacuum engineer, sales engineer	MSc/BSc (EE, physics, ME)	Dilution refrigerators, ultra-stable lasers, UHV, procurement, vendor management
Commercial	Technical sales, product manager, business development, quantum consultant	MSc/BSc + MBA or experience	Technical fluency, customer discovery, roadmap planning, proposal writing, procurement

In-demand skills (2024–2025)

Core quantum

- **Frameworks**: Qiskit (IBM), Cirq (Google), PennyLane (Xanadu), Braket SDK (AWS), Azure Quantum SDK, Q# (Microsoft), CUDA-Q (NVIDIA).
- **Algorithms**: VQE, QAOA, QPE, quantum ML, quantum error correction (surface code, LDPC,

bosonic codes), error mitigation (ZNE, PEC, CDR, M3).

- **Compilers**: Transpilation, routing, scheduling, gate decomposition, pulse-level control (OpenPulse, Qua).
- **Simulation**: State vector, tensor network (MPS/PEPS), Clifford, stabilizer, noise modeling.

Hardware & control

- **Cryogenics**: Dilution refrigerator operation, pulse-tube coolers, cryogenic wiring, thermal modeling.
- **RF/Microwave**: Vector network analyzers, AWGs, microwave components, impedance matching, superconducting circuits.
- **FPGA/Real-time**: Xilinx/AMD, Intel/Altera, RFSoC, Verilog/VHDL, high-speed DAC/ADC (>10 GS/s), latency < 100 ns.
- **Laser/Photonics**: Ultra-stable lasers (Hz linewidth), frequency combs, EOM/AOM, integrated photonics, silicon nitride, lithium niobate.
- **Vacuum/UHV**: Ion pumps, NEG, bakeout, residual gas analysis, trap loading, optical tweezers.

Software engineering

- **Python ecosystem**: NumPy, SciPy, JAX, PyTorch, TensorFlow, Ray, Dask, asyncio, pytest, mypy, ruff.
- **Cloud/DevOps**: Kubernetes, Docker, Terraform, GitHub Actions, AWS/GCP/Azure, cost optimization, observability (Prometheus, Grafana).
- **Performance**: C++/Rust, CUDA, SIMD, memory profiling, distributed computing (MPI, Ray).

Education & certification paths

University programs (selected)

Region	Programs
US	MIT (QCQE), Berkeley (QSA), Chicago (EPiQC), Princeton (QSE), Maryland (JQI), Caltech (IQIM), Colorado (JILA), Duke (QC), Harvard (QI), Stanford (Q-FARM), USC (QCI), Yale (YQI)
Canada	Waterloo (IQC, Perimeter Institute), Sherbrooke (Institut quantique), UBC (Stewart Blusson QMI), Toronto (CQIQC)
EU	Delft (QuTech), Munich (MCQST), Paris (QIP), Copenhagen (QDev), Basel (QSIT), Barcelona (ICFO), Vienna (IQOQI), Oxford (QCS), Cambridge (QIP), Bristol (QETLabs)
Asia	Tokyo, RIKEN, NUS (Centre for Quantum Technologies, Singapore), Seoul National University

Online courses & certifications

- **Qiskit Global Summer School** (free, annual, IBM) — quantum algorithms, QEC, hardware.
- **Qubit by Qubit** (high school/undergrad intro, sponsored by IBM/Google) — year-long course.
- **edX / Coursera**: MIT xPRO "Quantum Computing Fundamentals", TU Delft "Quantum Computing and Quantum Internet", Chicago "Quantum Computing for Everyone".
- **Vendor courses**: IBM Quantum Learning (free courses and badges), Azure Quantum documentation and Q# tutorials.
- **Professional**: IEEE Quantum Initiative courses, QED-C workforce development working group.

Self-study curriculum

1. **Prerequisites**: Linear algebra, probability, Python, basic quantum mechanics (Sakurai, Nielsen & Chuang Ch. 1–2).
2. **Hands-on**: IBM Quantum Learning / Cirq Tutorials / PennyLane Demos — run on simulators, then IBM Quantum / AWS Braket / Azure Quantum free tiers.
3. **Projects**: Implement VQE for H ,, QAOA for MaxCut, surface code decoder, error mitigation comparison.
4. **Portfolio**: GitHub repo with notebooks, benchmarks, blog posts explaining results.
5. **Community**: Qiskit Slack, PennyLane Forum, Unitary Fund Discord, Quantum Computing Stack Exchange.

Hiring trends (2024)

- **Hardware scaling**: 200+ qubit devices !’ need for cryogenic technicians, RF engineers, fabrication process engineers.
- **Error correction focus**: Surface code, LDPC codes, decoder ASIC/FPGA, real-time feedback !’ FPGA/RT engineers in high demand.
- **Software maturation**: Compiler optimization, runtime services, hybrid job orchestration !’ senior Python/Go/Rust engineers.
- **PQC migration**: CNSA 2.0 / OMB M-26-15 compliance !’ cryptographic engineers, PKI architects, HSM integrators.
- **Sensing commercialization**: NV/OPM production, SWaP reduction, field deployment !’ systems engineers, test technicians.
- **Defense/space**: ITAR-cleared roles for cold-atom inertial, quantum comms — US citizenship often required.

Salary benchmarks (rough estimates)

Rough US estimates from self-reported data. Ranges vary widely by employer, location and equity — treat as directional, not offers.

| Role | Entry (0–2 yr) | Mid (3–6 yr) | Senior (7+ yr) | |---|---|---|---| | Quantum researcher (PhD) | $130k–$160k | $160k–$200k | $200k–$300k+ | | Quantum software engineer | $130k–$160k | $160k–$220k | $220k–$300k+ | | Quantum hardware engineer | $120k–$150k | $150k–$190k | $190k–$250k+ | | Control systems / FPGA engineer | $120k–$150k | $150k–$180k | $180k–$230k+ | | Cryogenic technician | $70k–$90k | $90k–$110k | $110k–$130k+ | | Quantum applications scientist | $120k–$150k | $150k–$190k | $190k–$250k+ | | PQC / cryptographic engineer | $130k–$160k | $160k–$210k | $210k–$280k+ | | Technical sales / solutions architect | $120k–$150k base | $150k–$180k base | $180k–$220k base | | Product manager (quantum) | $140k–$170k | $170k–$210k | $210k–$280k+ |

Equity common in startups (0.1–1% for early employees). Public companies (IonQ, Rigetti, D-Wave) offer RSUs.

Transition guide: Classical SE !’ Quantum SE

| Step | Action | Timeline | |---|---|---| | 1 | Complete the IBM Quantum Learning basics (circuits, gates, VQE, QAOA) | 4–6 weeks | | 2 | Run 3 projects on IBM Quantum / AWS Braket free tier;

push to GitHub | 4–8 weeks | | 3 | Contribute 1 PR to Qiskit / PennyLane / Cirq (docs, test, small feature) | 2–4 weeks | | 4 | Take structured course (edX MIT xPRO, Qiskit Summer School) | 8–12 weeks | | 5 | Apply to quantum software roles at IBM, AWS, Azure, Xanadu, Quantinuum, Riverlane, Classiq, Strangeworks, Horizon Quantum, Algorithmiq | Ongoing |

Sources

- QED-C Workforce Development — fetched 2026-11-01.
- IEEE Quantum Initiative Education — fetched 2026-11-01.
- IBM Quantum Learning — fetched 2026-11-01.
- Unitary Fund Jobs Board — fetched 2026-11-01.
- Quantum Computing Report Jobs — fetched 2026-11-01.
- NIST NICE Framework — fetched 2026-11-01.

Frequently asked questions

Do I need a PhD to work in quantum?

For research scientist and hardware engineer roles, yes (physics, EE, CS, materials). For software engineer, DevOps, technical sales, product management and applications roles, a BSc/MSc with demonstrated quantum programming experience is often sufficient.

What programming languages are used?

Python dominates (Qiskit, Cirq, PennyLane, Braket SDK, Q#). C++/Rust for performance-critical compilers and control systems. Julia for numerical research. Verilog/VHDL for FPGA control firmware.

What are typical salaries?

Rough US estimates from self-reported data: quantum researcher (PhD) $130k–$200k+, quantum software engineer $140k–$220k, quantum hardware engineer $130k–$200k, control systems engineer $130k–$180k, cryogenic technician $80k–$120k, technical sales $120k–$180k base + commission. Treat as directional; check current self-reported salary data.

How do I transition from classical software engineering?

Start with Qiskit/Cirq tutorials. Build a portfolio: VQE for chemistry, QAOA for optimization, error mitigation demo. Contribute to open-source (Qiskit, PennyLane, OpenQASM). Take a structured course (Qubit by Qubit, Qiskit Global Summer School, edX). Apply for quantum software engineer roles at cloud providers and SDK vendors.