



LEARNAMYTE

A place to think, speak, learn, practice and upskill.

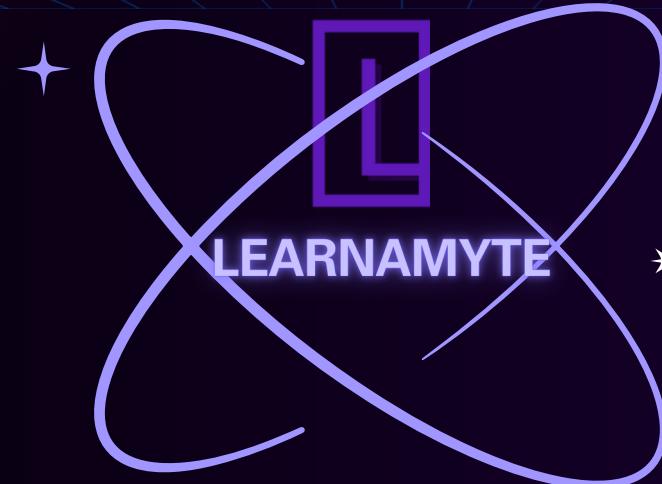
# FUNDAMENTALS OF QUANTUM INFORMATION AND COMPUTATION

# WHAT IS QIC?

Quantum Information and Computation is the science of harnessing quantum mechanics to process information in ways impossible for classical computers. It explores qubits, entanglement, and quantum circuits, shaping the future of technology, security, and computation.

## COURSE SNAPSHOT

- 4 Weekend Sessions
- Online (Live)
- Certificate of Completion
- Expert Instructor
- Capstone project
- Interactive Community



## WHY QUANTUM MATTERS?

- Transforms computation beyond classical limits.
- Drives innovation in cryptography, AI, and materials science.
- Equips you with future-ready skills in a rapidly growing industry.

## WHO SHOULD JOIN?

- Students of Physics, CS, Engineering.
- AI/ML/Data Science professionals exploring quantum applications.
- Curious learners who want to stay ahead of the curve.



# MODULES

**FOUNDATIONS OF QUANTUM MECHANICS**

**MATHEMATICAL TOOLS FOR QUANTUM COMPUTING**

**QUANTUM INFORMATION BASICS**

**QUANTUM GATES AND CIRCUITS**

**QUANTUM PROGRAMMING (QISKit LAB)**

**QUANTUM PARALLELISM & ALGORITHMS**

**QUANTUM COMMUNICATION**

**NOISE, DECOHERENCE & ERROR CORRECTION**

**QUANTUM HARDWARE**

## FOUNDATIONS OF QUANTUM MECHANICS

- Historical motivation: Classical vs Quantum
- Dual nature of light: Young's Double Slit, Blackbody Radiation, Photoelectric Effect
- Wave-particle duality: De Broglie wavelength
- Core principles: Heisenberg Uncertainty Principle
- Schrödinger's Equation & solutions for basic systems
- Postulates of Quantum Mechanics

## MATHEMATICAL TOOLS FOR QUANTUM COMPUTING

- Linear Algebra: Vectors, inner/outer product, matrices, eigenvalues, diagonalization, spectral theorem
- Complex Numbers: Euler's formula, polar form, unit circle
- Probability & Statistics: Random variables, distributions, expectation, conditional probability, Bayes theorem
- Tensor products (essential for multi-qubit systems)

## QUANTUM INFORMATION BASICS

- Hilbert space & Dirac notation
- Operators: Unitary, Hermitian, Projectors, Commutators
- Qubits: State vectors, Bloch sphere representation
- Pure vs Mixed states, Density matrices
- Entanglement & the EPR paradox

## QUANTUM GATES AND CIRCUITS

- Single-qubit gates (Pauli, Hadamard, Phase, Rotation gates)
- Multi-qubit gates (CNOT, Toffoli, Swap)
- Measurement theory
- Quantum entanglement in circuits: Bell states, GHZ, W states
- Quantum teleportation & superdense coding

## QUANTUM PROGRAMMING (QISKit LAB)

- Basics of Qiskit, statevector simulation, circuit building
- Implementing gates, measurement, teleportation
- Simulation of entangled states, GHZ/W states
- Hands-on: Deutsch-Jozsa & Grover's algorithm

## QUANTUM PARALLELISM & ALGORITHMS

- Quantum parallelism & no-cloning theorem
- Quantum phase kickback
- Quantum Fourier Transform (QFT)
- Quantum Phase Estimation (QPE)

## QUANTUM COMMUNICATION

- Classical information theory: Shannon entropy
- Quantum information: von Neumann entropy
- Randomness & Quantum RNGs
- Quantum key distribution (BB84, E91)
- Quantum secret sharing

## NOISE, DECOHERENCE & ERROR CORRECTION

- Sources of quantum noise
- Quantum noise channels: Bit-flip, Phase-flip, Depolarizing, Amplitude damping (AD, GAD)
- Effect of noise on quantum states
- Basics of quantum error correction (Shor, Steane codes)
- Role in quantum cryptography

## QUANTUM HARDWARE

- Superconducting qubits (IBM, Google)
- Trapped ions (IonQ)
- Quantum annealers (D-Wave)
- NV centers in diamond
- Cold atom quantum computers
- Photonic quantum computers



# CAPSTONE PROJECT

*THE COURSE OFFERS YOU A CAPSTONE PROJECT. A HANDS-ON CHALLENGE THAT BRIDGES THEORY WITH PRACTICE.*

*EMPLOYERS VALUE CANDIDATES WHO CAN DEMONSTRATE APPLIED SKILLS. A CAPSTONE IS PROOF OF PROBLEM-SOLVING AND INNOVATION.*

*YOUR CAPSTONE IS NOT JUST AN ASSIGNMENT; IT'S YOUR FIRST STEP INTO THE WORLD OF QUANTUM INNOVATION.*

*CAPSTONES MIRROR HOW LEADING INDUSTRIES LIKE IBM, GOOGLE, AND MICROSOFT EVALUATE PROBLEM-SOLVING IN QUANTUM RESEARCH.*



LEARNAMYTE

## ABOUT US

At Learnamyte, we believe that learning is not just a skill; it's an identity. Education is more than the transfer of knowledge; it is the shaping of who we become.

As we grow, what we see, hear, and feel shapes how we think. What we think influences what we do. And what we do ultimately defines who we are.

That is why we embrace a cycle of reading, writing, learning, and repeating, building habits that transform knowledge into action, and action into identity.

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CONTACT US



+91 6382489221



TEAM@LEARNAMYTE.COM