ECE 595 Applied Quantum Computing: I, II, III

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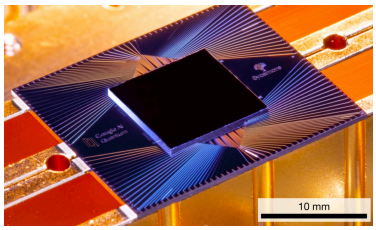

Google AI team: Nature (2019)

Since the beginning of the 21st century, explosive advancement in our ability to apply counterintuitive principles of quantum mechanics for engineering real-world computing platforms and algorithms, is redefining information processing and computer science; as epitomized recently by Google's demonstration of *quantum supremacy*—where a quantum chip has been shown to outperform classical supercomputers, in principle !!

This course aims to train students starting from the fundamental principles of quantum mechanics to understand how they can be leveraged for building quantum hardware and software, so that they can contribute to move this emerging technology forward with applications in artificial intelligence and data sciences. An important aspect will be a focus on *providing hands-on experience programming real quantum systems.* Particularly, we will focus on following three-levels:

Applied Quantum Computing I-Fundamentals (1-credit): Learn the essential foundations required to understand computing models built from the principles of quantum mechanics

Applied Quantum Computing II-Hardware (1-credit): Learn how present-day material platforms are built to perform quantum information processing tasks

Applied Quantum Computing III-Algorithm and Software (1-credit): Learn domain-specific quantum algorithms and how to run them on present-day quantum hardware.

Pre-requisite & Topics: No prior knowledge of quantum mechanics is assumed. Starting from a minimal set of engineering and science prerequisites (*undergraduate- Linear Algebra*, *differential equation* and *Physics*) we will focus to develop a physical and intuitive understanding of quantum computing.

Part I- Topics	Part II- Topics	Part III- Topics
Postulates of Q-mechanics	From postulates to hardware	Q-Fourier transform & search algos
Gate-based Q-computing	Superconducting Q-platforms	Hybrid Q-classical algos
Q-errors & error correction	Atomic/ionic Q-platforms	Q-annealing & optimization
Adiabatic Q-computing	Spin-based Q-platforms	Q-simulation & chemistry
Q-applications & NISQ-era	Challenges	Q-machine learning