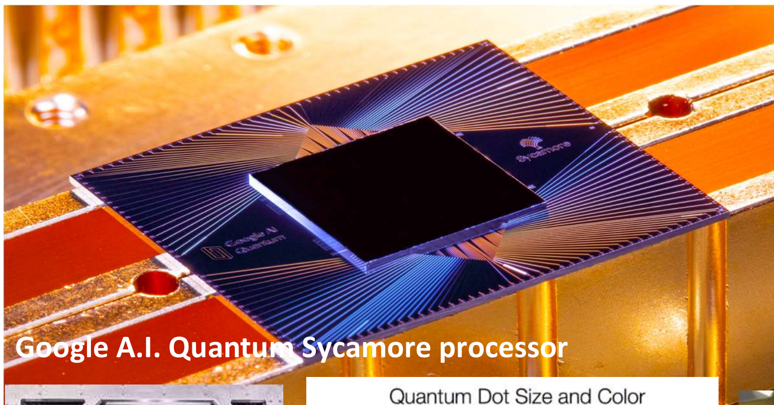
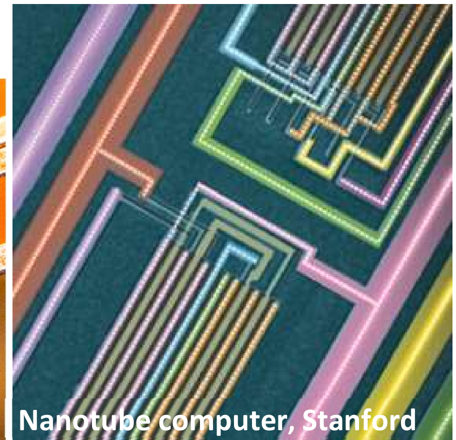
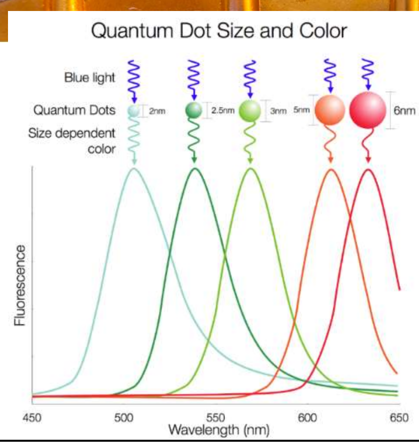
QUANTUM MECHANICS & QUANTUM COMPUTING BASICS

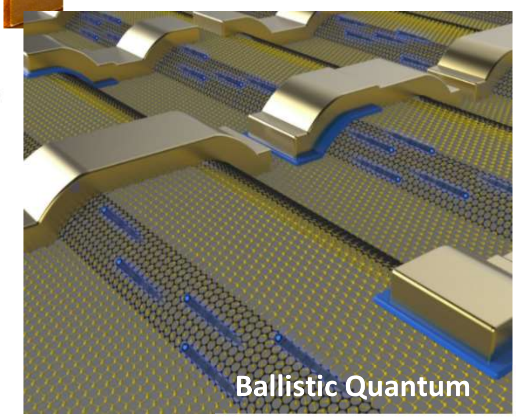
EE P 598 B
Summer Quarter


Google A.I. Quantum Sycamore processor


Nanotube computer, Stanford


IBM Quantum Computer




Ballistic Quantum

- **Qubit versus bit || Quantum Entanglement**
- **Problems that a quantum computer can solve?**
- **Bell's Theorem**
- **What is Quantum Supremacy?**

- **Grover's Algorithm for sorting**
- **Nanotubes, graphene**
- **Bloch's theorem**
- **Quantum of Conductance**

This course is designed for students who are interested in applied quantum mechanics. Students will be introduced to the basic physical and mathematical aspects of quantum mechanics. The focus will be on applying principles of quantization, uncertainty principle and superposition principle to understand how to engineer better emitters of light, conductors and computers. Learn about quantum dots, quantum wells, graphene, nanotubes, qubits, quantum information and Grover's Algorithm.

Instructor: M. P. Anantram
E-mail: anant@uw.edu

EE 598: Quantum Mechanics and Quantum Computing Basics for Engineers

"Think quantum"

Format: The student can decide whether to attend in the lecture hall or via zoom.

Description

The course aims to provide students with a comprehensive introduction to quantum mechanics, quantum computing, and low-dimensional quantum materials. By the end of the course, students are expected to:

1. Develop a working knowledge of qubits, which are the fundamental units of quantum information processing and quantum computing.
2. Understand quantization in low-dimensional structures such as quantum dots, wells, and wires.
3. Explore applications of quantum concepts in nanodevices and nanomaterials.
4. Gain insight into the basics of quantum information, including its manipulation and processing.

Overall, the course provides students with a broad understanding of quantum mechanics and its practical applications, particularly in the context of emerging technologies. Through theoretical learning and hands-on projects, students will be equipped to engage with and contribute to advancements in quantum technology.

Instructor

Name: M. P. Anantram (Anant)
Email: anant@uw.edu
Phone: 206-221-5162
Availability: Potential students are encouraged to email the instructor for any inquiries or further information regarding the course.

Primary Learning Objectives:

1. **Think Quantum:** Develop a mindset conducive to understanding quantum concepts and reading relevant literature.
2. **Schrodinger's Wave Equation:** Interpret and utilize solutions of Schrodinger's wave equation.
3. **Quantum Calculations:** Perform simple quantum calculations and numerically solve Schrodinger's equation in one dimension.
4. **Quantum Tunneling:** Calculate quantum tunneling probabilities.
5. **Quantization in Technology:** Understand and calculate the role of quantization in technologically relevant examples such as quantum dots, nanowires, and quantum wells.
6. **Method of Separation of Variables:** Learn and apply the method of separation of variables in quantum problems.
7. **Basics of Spin:** Gain understanding of the basics of spin in quantum mechanics.
8. **Basics of Qubits and Quantum Computing:** Learn fundamental concepts of qubits, quantum information, quantum computing, and algorithms.
9. **Software Usage:** Utilize software tools to reinforce concepts learned in the course.

Grading Criteria:

- **Homeworks/Mini Projects (75%):** Regular assignments and mini-projects, likely in groups, aimed at reinforcing understanding and application of course concepts.
- **Final Project (25%):** A culminating project, potentially in groups, allowing students to demonstrate a deeper understanding of quantum mechanics and quantum computing concepts.

Detailed List of Topics:

1. Schrodinger Equation
2. Properties of Wavefunction
3. Operators and Expectation Values
4. Hilbert Space
5. Projection Operators and Uncertainty Principle
6. **Quantum Information and Computing** – this is the largest module of the course
7. Tunneling
8. Quantum Dots, Quantum Well, and Nanowires
9. Spins
10. Topics of current interest

Book:

Quantum Mechanics for Engineers and Material Scientists: An Introduction

https://doi.org/10.1142/13356 | February 2024

World Scientific

Pages: 740

Authors: M P Anantram (University of Washington, Seattle, USA) and Daryoush Shiri (Chalmers University of Technology, Sweden)

ISBN: 978-981-12-7532-6 (softcover) and ISBN: 978-981-12-7440-4 (ebook)

PS: Book royalties will be returned either to the student or to the University of Washington as per ETHICS ADVISORY, UW Internal Audit, 2010 - 01