

Syllabus

CS 598– Special Topics : Introduction to Quantum Computing and it's Applications

Course Title and Number: CS 598– Introduction to Quantum Computing and it's Applications

Instructor: Prof. Ahmed Banafa

Class Date and Time: Friday 3:15 PM – 6:05 PM

Office Hours: By Appointment in Office 132

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Course Description

Quantum Computing is the area of study focused on developing computer technology based on the principles of quantum theory. Tens of billions of public and private capitals are being invested in Quantum technologies. Countries across the world have realized that quantum technologies can be a major disruptor of existing businesses, they have collectively invested billions of dollars in quantum research and applications. In this class you learn the difference between Quantum Computing and Classic Computing, the concept of Qubits, difficulties facing Quantum Computing, and the principles of Quantum Superposition and Entanglement. Quantum Computing Categories will be discussed in details, applications of Quantum Computing in AI, IoT, Blockchain, Communications, and Encryption will be covered. Also, Quantum Internet, Quantum Cryptography and Quantum Teleportation will be explained, in addition to post-Quantum technologies, they will be introduced and discussed. Industry Guest Speaker(s) will be invited to talk about this futuristic technology. 3 Credit

Prerequisites: Knowledge of Physics

Learning Outcomes

By the end of the course, students should be able to:

- Explain the differences between Classic and Quantum Computing
- Understand the power and limitation of Quantum Computing
- Explain the differences between logical and physical Qubits and become familiar with the concepts of superposition and entanglement and be able to analyze quantum state transformations
- Comprehend the implications of Quantum Computing on Cryptography
- Understand the foundations of post-quantum applications
- Know the principles of Quantum Communication
- Describe Quantum Teleportation and its limits
- Understand the applications of Quantum Computing in AI
- Explain Quantum Internet

- Produce and present a research paper about topics related to Quantum Computing

Textbook



Quantum Computing and Other Transformative Technologies, by Ahmed Banafa, (River Publishers Series in Information Science and Technology), ISBN-13: 978-8770226844. ISBN-10: 8770226849

4 Homework assignments (50 points each)	20%	200 Points
Final Research Paper	10%	100 Points
Test 1	10%	100 Points
Test 2	10%	100 Points
Midterm Exam	15%	150 Points
Final Exam	25%	250 Points
Quizzes and Discussion	05%	050 Points
In-class Presentation	05%	050 Points
		1000 Points

Week 1

Introduction to class policies
 Introduction to Quantum Computing (QC)
 Quantum Computing and Quantum Theory
 Class Discussions
 Class paper and final presentations guidelines

Week 2

Quantum Computing vs Classic Computing
 Physical vs Logical Qubits
 Quantum Superposition
 Quantum Entanglement
 Class Discussions

Week 3

Difficulties facing Quantum Computing
 Interferences
 Error Correction
 Output observance
 Class Discussions

Week 4

Review for Test # 1
 Test # 1

Week 5

Applications of Quantum Computing in AI
 Use of Quantum Computing in Processing Large Sets of Data
 Use of Quantum Computing in Solve Complex Problem Faster

Applying Quantum Computing for Better Business Insights and Models
Blockchain Explained
Blockchain and Quantum Computing
Class Discussions

Week 6

IoT Explained
Quantum Computing and IoT Sensors
Quantum Computing and IoT Network Protocols
Quantum Computing and IoT Cloud Services
Quantum Computing and IoT Applications
Class Discussions

Week 7

Communications Systems
Quantum Computing and Communication Systems Devices
Quantum Computing and Communication Systems Protocols
Challenges facing Quantum Computing and Communication Systems
Class Discussions

Week 8

Review for Midterm
Midterm

Week 9

Cryptography Explained
Quantum Cryptography
Problems with using Quantum Cryptography
Applications of Quantum Cryptography

Week 10

Web 2.0 Architecture
Web 3.0 Architecture
Quantum Internet Architecture
Class Discussions

Week 11

Teleportation Explained
Quantum Teleportation Model
Challenges facing Quantum Teleportation
Applications of Quantum Teleportation
Class Discussions

Week 12

Review for Test # 2
Test#2

Week 13

Future Applications of Quantum Computing
Guest Speaker from the industry
Class Discussions

Week 14

Final Presentations

Week 15

Review for Final Exam
Research Paper due