Knight Foundation School of Computing and Information Sciences

Course Title: Quantum Algorithms **Date:** 11/7/2022

Course Number: COT 5600

Number of Credits: 3

Catalog Description: Introduction to quantum theory and a survey of standard and advanced quantum algorithms; implementation of algorithms on a simulated or real quantum system.
Textbook: "Quantum Computation and Quantum Information" (10th Ed) Nielsen and Chuang ISBN-13: 978-1-107-00217-3
References: Online reference materials
Prerequisites: COT 5407 or COT 6405
Corequisites: None

Type: Elective

Prerequisites Topics:

- Linear algebra
- Data structures
- Algorithm analysis

Course Outcomes:

1. Describe fundamental concepts of quantum computing [Understanding]
2. Discuss quantum computer architecture [Understanding]
3. Analyze standard quantum algorithms [Analyzing]
4. Summarize advanced quantum algorithms [Understanding]
5. Design and evaluate implementation of quantum algorithms [Creating]

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Outline

Topic	No. of Lecture Hours	Outcome
• Overview of Quantum Computing o Basic quantum mechanics o Classical vs Quantum systems o Quantum computer architectures o Complex Numbers o Linear Algebra – vector and matrix operations	4	1
• Quantum States and Quantum Gates o Dirac notation, Bloch sphere, Hilbert space o Quantum superposition o Single qubit gates o Multiple qubit gates o Quantum entanglement, Bell state	4	2
• Standard Quantum Algorithms o Deutsch-Jozsa Algorithm o Bernstein-Vazirani Algorithm o Simon's Algorithm o Grover's Algorithm o Quantum Fourier Transform o Shor's Algorithm	12	3
• Advanced Quantum Algorithms o Quantum Counting o Quantum Walk Search Algorithm o Quantum Teleportation o Quantum error correcting code o Quantum Key Distribution	6	4, 5
• Challenges in Quantum Technology o Quantum measurement o Cloning theorem o Scalability in real quantum systems	4	

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Course Outcomes Emphasized in Laboratory Projects / Assignments

	Outcome	Number of Weeks
1	Quantum mechanics & linear algebra exercises Outcomes: 1	2
2	Quantum circuit design Outcomes: 2	2
3	Implementation of simple quantum algorithms Outcomes: 3	3
4	Implementation of an advanced quantum algorithm Outcomes: 4, 5	5