Course Title: Quantum Algorithms  

Course Number: COT 5600  

Number of Credits: 3  

Catalog Description: This course introduces basic concepts in quantum theory, applications of quantum computing, and a review of quantum algorithms.

Textbook: “Quantum Computation and Quantum Information” (10th Ed)  
Nielsen and Chuang  

References: "Quantum Computing for Computer Scientists" (8th Ed)  
Yanofsky and Mannucci  
ISBN: 9780521879965

Prerequisites: COT 5407 or COT 6405 or permission of the instructor

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]
## Outline

<table>
<thead>
<tr>
<th>Topic</th>
<th>No. of Lecture Hours</th>
<th>Outcome</th>
</tr>
</thead>
</table>
| • 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 |
<table>
<thead>
<tr>
<th>Course Outcomes Emphasized in Laboratory Projects / Assignments</th>
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</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
</tr>
<tr>
<td>1 Quantum mechanics &amp; linear algebra exercises</td>
</tr>
<tr>
<td>Outcomes: 1</td>
</tr>
<tr>
<td>2 Quantum circuit design</td>
</tr>
<tr>
<td>Outcomes: 2</td>
</tr>
<tr>
<td>3 Implementation of a simple quantum algorithms</td>
</tr>
<tr>
<td>Outcomes: 3</td>
</tr>
<tr>
<td>4 Implementation of an advanced quantum algorithm</td>
</tr>
<tr>
<td>Outcomes: 4, 5</td>
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