EXEED ecx
YOUR GLOBAL VARSITY

midwest
COLLEGE

Advanced Program in
Quantum Computing
& Quantum Algorithms

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ABOUT
EXEED ECX

Exeed ECX is a spin-off of Exeed College - a prestigious entity of higher learning and executive education from Westford Education Group. Exeed ECX provides a unique learning method through its satellite centres via blended learning. Exeed ECX, with its world-class academics, has accreditation and partnerships with the world's premium universities and awarding bodies. Plymouth Marjon University is a top-ranked, accredited university in the UK that collaborated with Exeed ECX.

Other major universities collaborating with Exeed ECX are Universidad Católica de Murcia (UCAM) in Spain, Acacia University in the USA, and GEX Business School in France. Apart from this, our parent organisation Exeed College has tie-ups with universities across the globe – UCAM (Spain), Liverpool John Moores University (UK) and Carolina University (US) as well as with professional accreditation bodies like Scottish Qualifications Authority (SQA), Chartered Management Institute (CMI), Society for Human Resource Management (SHRM) and Cambridge International Qualification to provide globally recognised qualifications

Exeed ECX, we have combined cutting-edge material with the best online technology and instructional design to improve learning outcomes while encouraging engagement and collaboration.

Acacia
University

Acacia University, located in Arizona, United States, has been a pioneer and leader in distance education since 2000. Stands as a symbol of regeneration, perseverance, and integrity, it aims to provide accessible, quality education to a multi-cultural, global learning community through online/distance learning.

As technology advances and students look for greater flexibility and accessibility with education, it is on a mission to make learning a long-lasting, invigorating experience. It offers academic programs at the bachelor's, master's, doctorate or certificate levels in a multitude of areas.

At Acacia, we are committed to provide unparalleled standards of learning by delivering the highest quality educational programs through smart, innovative forms of learning.

Acacia University Professional Development Programs—a division of Acacia University, USA, provide rigorous online programs to distance learners, working professionals, college students, and those with an insatiable thirst for knowledge.

Airtics Education's Advanced Programs are offered as part of Acacia University Professional Development Programs, and the learners are certified by the University.

ADVANCED PROGRAM IN
QUANTUM COMPUTING
& QUANTUM ALGORITHMS

Overview

The program introduces participants to the fundamentals of quantum computation and quantum algorithms using the popular Python programming language and Qiskit library. It introduces advanced quantum algorithms which are state-of-the-art and used by academia, research and industries.

Course Duration: **6 Months |** Course Modules: **8 Modules**

Module 1

MATHEMATICS FOR QUANTUM COMPUTING

LINEAR ALGEBRA	COMPLEX NUMBERS
PROBABILITY THEORY	

Learning Outcomes

LO1: Get to know about the Mathematical foundation of Quantum Computing starting with Linear Algebra which includes learning of vectors, matrices, operation and linear functions etc

LO2: Be able to perform basic linear algebra operations

LO3: Get introduced to Complex Numbers and concept of probability theory

Module 2

COMPUTER SCIENCE FOR QUANTUM COMPUTING

BASICS OF COMPUTING	CLASSICAL LOGIC GATES
THE BINARY AND DECIMAL NUMBER SYSTEM	QUANTUM COMPUTATIONAL COMPLEXITY

Learning Outcomes

LO1: Explore different number systems used to represent data in machines

LO2: Learn about different classical logical gates

LO3: Describe the differences between quantum and classical computation

LO4: Get introduced to fundamentals of Quantum Computational Complexity

Module 3

PYTHON FOR QUANTUM COMPUTING

VARIABLE AND DATA TYPES	CLASSES AND OBJECTS
CONDITIONAL STATEMENTS	INHERITANCE
ITERATION STATEMENTS	NUMPY
FUNCTIONS	MATPLOTLIB

Learning Outcomes

LO1: To know the basic required python language for Quantum Computing

LO2: Get Understanding of Object orientated programming

LO3: Be capable of using basic functions like conditional statements, different types of loops etc

LO4: To know different data types like Tuples, Dictionaries and be able to convert datatypes

LO5: Be able to work with different libraries like NumPy etc

Module 4

BASIC QUANTUM MECHANICS

YOUNG'S DOUBLE SLIT EXPERIMENT	**POSTULATES OF QUANTUM MECHANICS**
SUPERPOSITION	**DE-BROGLIE WAVELENGTH**
INTERFERENCE	**HAMILTONIAN**
ENTANGLEMENT	**SCHRODINGER EQUATION**
PHOTOELECTRIC EFFECT	**EM SPECTRUM**

Learning Outcomes

LO1: Understanding of the basic experiments and principles of quantum physics

LO2: Explore importance of double slit experiments, wavefunction, symmetric and antisymmetric property and postulates of Quantum Mechanics

LO3: Get introduced different properties of Quantum bit (qubit) and different equations involved in them

Module 5

INTRODUCTION TO QUANTUM COMPUTING

MOTIVATION TO GO FOR QUANTUM	**CLASSICAL VS QUANTUM COMPUTING**
INTRODUCTION TO QUBITS	**BRAKET NOTATION**
BLOCH SPHERE	**BELL STATES**
UNITARY TRANSFORMATIONS SINGLE & MULTI QUBIT QUANTUM LOGIC GATES	**HILBERT SPACES, PURE & MIXED STATES**

Learning Outcomes

LO1: Get to know the fundamentals of quantum information and computation with an intuitive understanding about the physics and mathematics

LO2: Explore single and multi-qubit quantum logic gates and their software implementation for algorithm building

LO3: Learn the mathematical & the physics of entanglement along with intuition of the quantum hardware setup

Module 6

QUANTUM COMMUNICATION PROTOCOLS

QUANTUM TELEPORTATION	BB84 PROTOCOL
QUANTUM SUPERDENSE CODING	

Learning Outcomes

LO1: Know the comparison between classical communication and quantum communication along with their advantages

LO2: Experimentally understand the quantum teleportation and quantum key distribution protocols with their detailed mathematical derivation

LO3: Get introduced to basic hardware elements required to experimentally prove the quantum communication in global laboratories

Module 7

ESSENTIAL QUANTUM ALGORITHMS

DEUTSCH ALGORITHM	**GROVER'S SEARCH ALGORITHM**
DEUTSCH-JOZSA ALGORITHM	**QUANTUM PHASE ESTIMATION**
BERNSTEIN-VAZIRANI ALGORITHM	**QUANTUM FOURIER TRANSFORM**
SIMON'S ALGORITHM	**SHOR'S ALGORITHM**

Learning Outcomes

LO1: Explore the very first quantum algorithms which proved to provide advantage over classical algorithms

LO2: Learn about quantum version of database search algorithm and visualize its speedup compared to classical algorithms

LO3: Analyse the complex fundamentals of quantum algorithms so as to gain intuitive understanding essential for advanced quantum algorithms

Module 8

ADVANCED QUANTUM ALGORITHMS WITH APPLICATIONS

HHL ALGORITHM	**VARIATIONAL QUANTUM EIGENSOLVER (VQE)**
QUANTUM AMPLITUDE ESTIMATION (QAE)	**QUANTUM APPROXIMATE OPTIMISATION ALGORITHM (QAOA)**
VARIATIONAL QUANTUM ALGORITHMS (VQA)	

Learning Outcomes

LO1: Discover industry and research leading quantum algorithms used by academicians, professionals and researchers globally

LO2: Develop applications and case studies in different areas of the industry – chemistry, finance, optimization and machine learning

LO3: Gain deep understanding about variational algorithms so as to create your own customized quantum models using libraries and without libraries

TRAINING KEY FEATURES

40 hours of live instructor-led training

4 Industry-based projects & 16 Assignments

24/7 support and LMS Access

Hands-on experience with latest tools & applied projects

Live engagement classes by seasoned academics and professionals

3 months internship (unpaid)

Resume building, LinkedIn profile building and GitHub Review

Personal career coaching and Interview preparation

ELIGIBILITY

Candidates from engineering and physical sciences background could opt for this in-demand course. Individuals from a non-scientific background are also eligible for this cutting-edge course.

PREREQUISITES

Prerequisite knowledge on basic linear algebra and python programming will be beneficial.

TOOLS/FRAMEWORKS/LIBRARIES

- Scripting tools: Python Programming
- Environment: Anaconda
- IDE shell: Jupyter notebook, Spyder, Google Colab
- Libraries: NumPy Matplotlib, scikit

APPLICATION & USE CASES

Quantum Finance
Credit Risk Analysis

Quantum Chemistry
Protein Folding

Quantum Optimization
Battery Revenue Optimization

Quantum Machine Learning
Classification problems

CAPSTONE PROJECTS & INTERNSHIP /PROJECTS

AERA Academy provides internships in the respective field for a period of 2-3 months to all eligible and able students on the following projects -

- Implementing Quantum Technology Research papers
- Quantum Kernel Learning
- Processing Stock Market Data
- Develop business case studies on quantum technologies
- Exploring Molecular Reactions using Variational Algorithms

CERTIFICATION

29, August 2023

JOHN SMITH

has successfully completed

ADVANCED PROGRAM IN QUANTUM COMPUTING & QUANTUM ALGORITHMS

This course has been developed and delivered by Airtics Education in partnership with Acacia University - Professional Development Programs

Dr. Amy DiMaio
Provost | Acacia University Professional Development

Rhonda Carlisle
Registar | Acacia University

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