Womanium Quantum Hackathon 2022

Quantum-Hardware-Education-Challenge---QWorld

TEAM: **"Quantumania"**

<u>Team Members</u>

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Quantum Mechanics for Computer Scientists

Contents:

Unit 4: <u>Quantum Circuits</u>

i) Quantum Algorithms
ii) Single Qubit Operations
iii) Controlled Operations
iv) Measurement
v) Universal Quantum Gates

a. Two-level unitary gates are universal
b. Single qubit and CNOT gates are universal
c. A discrete set of universal operations
d. Approximating arbitrary unitary gates
e. Quantum computational complexity

vi) Simulation of quantum systems
vii) Exercise
viii) Problem Set

Unit 5: <u>Quantum Error Correction</u>

Introduction

a) From classical to quantum error correction
b) The three-bit flip code
c) The physics of error generation

ii)Types of Quantum Errors

a) Coherent quantum errors
b) Environmental decoherence
c) Simple models of loss, leakage, measurement and initialization

ii) Barriers to Quantum Error Correction

a) No-cloning theorem
b) Bit-flip and phase-flips
c) Wavefunction collapse

iii) Quantum redundancy and Stabilizer codes

a) The stabilizer formalism
b) Logical operators of stabilizer codes
c) Examples

iv) Fault-tolerant quantum computation

a) Fault-tolerant quantum logic
b) Fault-tolerant measurement
c) Experimental implementations

v) Exercise
vi) Problem Set

Unit 6: <u>Applications</u>

i) Quantum Simulation of the Schrödinger Equation

a) Problem description
b) Algorithm Explanation
c) Algorithm Implementation

ii) Quantum Random Walks

a) Problem description
b) Example
c) Algorithm Implementation

iii) Quantum Tomography

a) Problem description
b) Example
c) Algorithm Implementation

PS: We have prepared few topics with explanation, codes, problem set and solution just to give the flavour of how we want to execute our idea. Since the time was short so it’s not possible to develop all the units but what we have suggested is to introduce this as a separate course so that people may learn the basics and have a hand on experience of quantum mechanics, and it would be easy for them to understand the Q-bronze, silver and nickel easily without the hesitation of what these quantum notations mean and how they work.