IDG066

Final Exam
20 June 2022

Your Name and Honor Code Signature

1. Write your name and UIN below:

   Name: ________________________________

   UIN: ________________________________

2. Please sign the honor code. Your exam will NOT be graded without your signature.

   "On my honor, as a KIT Engineering Student, I have neither given nor received unauthorized aid on this academic work."

   Signature: ____

Directions

This exam consists of 6 problems for a total of **100 /100** points. The number of total page is 8 pages. **Check your exam now to make sure you have all the problems.** Work as many problems as you can before the end of the exam.

Your work needs to be such that someone could reproduce your answer. **No credit will be given for a problem where this is not the case.**

Show all work in the spaces provided and make certain that you apply the notation we have been using. In order to receive full or partial credit **your work must be clear and neat.**

Grading Grid

Problem 1 _____ out of 20
Problem 2 _____ out of 20
Problem 3 _____ out of 10
Problem 4 _____ out of 20
Problem 5 _____ out of 20
Problem 6 _____ out of 10

Total _______ out of 100

[Problem 1] - (20 points)
Consider "Grover's algorithm". Summary the algorithm with explicit example within one page. Then, give your application example with the algorithm.

[Problem 2] - (20 points)
Consider an operator B.

$$B = \frac{1}{\sqrt{2}}\begin{pmatrix} i & 1 \\ 1 & i \end{pmatrix}$$

Calculate $B \otimes B|0\rangle|0\rangle$. Then, Draw the quantum gate for $B \otimes B|0\rangle|0\rangle$.

[Problem 3] - (10 points)
Consider the gate in Problem 2. Draw the gate using “Qiskit”.
Attach the code and the result.

[Problem 4] - (20 points)
Consider a rotation operator R(γ) and $|\psi\rangle$.

$$R(\gamma) = \begin{pmatrix} \cos\gamma & -\sin\gamma \\ \sin\gamma & \cos\gamma \end{pmatrix}$$

$$|\psi\rangle = \cos\theta \cdot |0\rangle + \sin\theta \cdot |1\rangle$$

Calculate $R(\gamma)|\psi\rangle$ and interpret it with a Bloch sphere.

[Problem 5] - (20 points)
Consider two states.

$$|\beta_{00}\rangle = \frac{|00\rangle+|11\rangle}{\sqrt{2}} \text{ and } |\beta_{01}\rangle = \frac{|01\rangle+|10\rangle}{\sqrt{2}}$$

Then, check if $|\psi\rangle$ is in "Quantum Entanglement".

$$|\psi\rangle = \frac{1}{\sqrt{2}}|\beta_{00}\rangle - \frac{1}{\sqrt{2}}|\beta_{01}\rangle$$

[Problem 6] - (10 points)
Propose your own Quantum Algorithm. Explicitly explain the objective, the mechanism and the gate of your own algorithm.