Exercise 3A

Due No due date **Points** 100 **Questions** 10 **Time Limit** 60 Minutes
Allowed Attempts 3

Instructions

We use the conventions in Bronze-Qiskit.

The default programming language for coding is python.

You may write pieces of code during the exam.

Take the Quiz Again

Attempt History

	Attempt	Time	Score
LATEST	Attempt 1	25 minutes	100 out of 100

Correct answers are hidden.

Score for this attempt: **100** out of 100
Submitted Sep 25 at 10:35am
This attempt took 25 minutes.

Question 1 — 10 / 10 pts

The rotation on the unit circle with angle θ is denoted $R(\theta)$.

What is the matrix form of $R(\theta)$?

Hint: Apply each candidate matrix to states $|0\rangle$ and $|1\rangle$ to verify whether the result is the rotated state.

- $\begin{pmatrix} \cos\theta & \sin\theta \\ \sin\theta & -\cos\theta \end{pmatrix}$
- $\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$
- $\begin{pmatrix} \sin\theta & \cos\theta \\ -\cos\theta & \sin\theta \end{pmatrix}$
- $\begin{pmatrix} \sin\theta & -\cos\theta \\ \cos\theta & \sin\theta \end{pmatrix}$
- $\begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$

Question 2

10 / 10 pts

The rotation operator $R\left(\frac{3\pi}{7}\right)$ is applied to a qubit initially in state $|0\rangle$ n times.

If the final state is $|0\rangle$, which one of the followings can be a value of n?

- 6
- 9
- 10
- 21
- 14

Question 3

10 / 10 pts

If $R(\theta) = \begin{pmatrix} -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \end{pmatrix}$, what is θ?

- $\frac{7\pi}{4}$
- $\frac{\pi}{4}$
- $\frac{5\pi}{4}$
- $-\frac{\pi}{4}$
- $\frac{3\pi}{4}$

Question 4

10 / 10 pts

The reflection on the unit circle having the line of reflection with angle θ is denoted $Ref(\theta)$.

What is the matrix form of $Ref(\theta)$?

- $\begin{pmatrix} \cos 2\theta & \sin 2\theta \\ \sin 2\theta & -\cos 2\theta \end{pmatrix}$
- $\begin{pmatrix} \sin 2\theta & \cos 2\theta \\ -\cos 2\theta & \sin 2\theta \end{pmatrix}$
- $\begin{pmatrix} \cos 2\theta & -\sin 2\theta \\ \sin 2\theta & \cos 2\theta \end{pmatrix}$
- $\begin{pmatrix} \cos 2\theta & \sin 2\theta \\ -\sin 2\theta & \cos 2\theta \end{pmatrix}$
- $\begin{pmatrix} \sin 2\theta & -\cos 2\theta \\ \cos 2\theta & \sin 2\theta \end{pmatrix}$

Question 5

10 / 10 pts

What is the matrix form of the reflection having the line of reflection $y = -x$?

- (selected) $\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$
- $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$
- $\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

Question 6

10 / 10 pts

Which of the followings is identical to $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$,

where $Z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$.

Hint: Test each candidate whether it maps the state $\begin{pmatrix} x \\ y \end{pmatrix}$ *to the state* $\begin{pmatrix} -x \\ y \end{pmatrix}$.

- ZXZ
- ZX

- XZ
- ZZ
- XZX

Question 7

10 / 10 pts

If $Ref(\theta) = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$, what is θ?

- π
- $\frac{\pi}{4}$
- $\frac{\pi}{8}$
- $\frac{\pi}{3}$
- $\frac{\pi}{2}$

Question 8

10 / 10 pts

Which one of the following pairs of quantum states is perfectly distinguishable?

- $\begin{pmatrix} \frac{1}{\sqrt{3}} \\ \\ \frac{\sqrt{2}}{\sqrt{3}} \end{pmatrix}$ and $\begin{pmatrix} -\frac{\sqrt{2}}{\sqrt{3}} \\ \\ -\frac{1}{\sqrt{3}} \end{pmatrix}$

- $\begin{pmatrix} \frac{1}{\sqrt{2}} \\ \\ \frac{1}{\sqrt{2}} \end{pmatrix}$ and $\begin{pmatrix} -\frac{1}{\sqrt{2}} \\ \\ -\frac{1}{\sqrt{2}} \end{pmatrix}$

- (selected) $\begin{pmatrix} \frac{1}{\sqrt{3}} \\ \\ -\frac{\sqrt{2}}{\sqrt{3}} \end{pmatrix}$ and $\begin{pmatrix} -\frac{\sqrt{2}}{\sqrt{3}} \\ \\ -\frac{1}{\sqrt{3}} \end{pmatrix}$

- $\begin{pmatrix} \frac{1}{\sqrt{3}} \\ \\ -\frac{\sqrt{2}}{\sqrt{3}} \end{pmatrix}$ and $\begin{pmatrix} \frac{1}{\sqrt{3}} \\ \\ \frac{\sqrt{2}}{\sqrt{3}} \end{pmatrix}$

- $\begin{pmatrix} \frac{1}{\sqrt{2}} \\ \\ -\frac{1}{\sqrt{2}} \end{pmatrix}$ and $\begin{pmatrix} -\frac{1}{\sqrt{2}} \\ \\ \frac{1}{\sqrt{2}} \end{pmatrix}$

Question 9

10 / 10 pts

Which one of the following operators maps the state $\begin{pmatrix} \cos\theta \\ \sin\theta \end{pmatrix}$ to the state $\begin{pmatrix} \cos(-\theta) \\ \sin(-\theta) \end{pmatrix}$?

- (selected) Z
- $-X$
- X
- $-H$
- H

Question 10

10 / 10 pts

Let $|u_1\rangle = \begin{pmatrix} \cos\theta_1 \\ \sin\theta_1 \end{pmatrix}$ and $|u_2\rangle = \begin{pmatrix} \cos\theta_2 \\ \sin\theta_2 \end{pmatrix}$ be two different quantum states, where $\theta_1, \theta_2 \in (0, \pi)$

If the probabilities of being in states $|0\rangle$ for $|u_1\rangle$ and $|u_2\rangle$ are the same, which one of the followings is correct for θ_1 and θ_2?

- $\theta_1 + \theta_2 = \frac{\pi}{2}$
- $|\theta_1 - \theta_2| = \frac{\pi}{2}$
- $\theta_1 + \theta_2 = \pi$
- $\theta_1 + \theta_2 = \frac{3\pi}{2}$
- $|\theta_1 - \theta_2| = \frac{\pi}{4}$

Quiz Score: **100** out of 100