Exercise 2A

Due No due date **Points** 100 **Questions** 11 **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.

Attempt History

	Attempt	Time	Score
KEPT	Attempt 3	3 minutes	100 out of 100
LATEST	Attempt 3	3 minutes	100 out of 100
	Attempt 2	4 minutes	90 out of 100
	Attempt 1	28 minutes	90 out of 100

ⓘ Correct answers are hidden.

Score for this attempt: **100** out of 100
Submitted Sep 19 at 12:23pm
This attempt took 3 minutes.

Question 1

10 / 10 pts

If $x = \frac{1}{2}$, which one of the following vectors can be a valid quantum state?

- $\begin{pmatrix} x \\ x \\ x \end{pmatrix}$

- $\begin{pmatrix} x \\ x \\ x \\ x \\ x \end{pmatrix}$
- $\begin{pmatrix} x \\ x \end{pmatrix}$
- $\begin{pmatrix} x \\ x \\ x \\ x \end{pmatrix}$
- (x)

Question 2

10 / 10 pts

We have a three state quantum system. If the system is in the quantum state

$$|u\rangle = \begin{pmatrix} \frac{1}{3} - \frac{1}{\sqrt{3}} \\ \\ \frac{1}{3} + \frac{1}{\sqrt{3}} \\ \\ x \end{pmatrix} \in \mathbb{R}^3 \quad ,$$

what is the probability of being in the third state?

- $\frac{1}{2}$
- $\frac{1}{6}$
- $\frac{1}{8}$
- $\frac{1}{3}$
- $\frac{1}{9}$

Question 3

10 / 10 pts

If $|u\rangle \in \mathbb{R}^2$ is a quantum state on the unit circle with angle $\frac{2\pi}{3}$, what is $|u\rangle$?

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

Question 4

5 / 5 pts

What is H^4, where H is the Hadamard operator?

- $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

- $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & -\frac{1}{2} \end{pmatrix}$
- $\begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \end{pmatrix}$

Question 5

5 / 5 pts

We have a qubit in state $|0\rangle$. We apply the operators H, X, X, H, X in order,

where H and X are the Hadamard and NOT operators, respectively.

What is the final state?

- $|0\rangle$
- $-|1\rangle$
- $|1\rangle$
- $-|0\rangle$
- $|+\rangle$

Question 6

10 / 10 pts

We apply a series of quantum operators to a single qubit that is in state $|0\rangle$ at the beginning.

If we observe the state 0 at the end, which one of the following combinations is not possible,

where M stands for a measurement and we apply the operators from the left to the right?

- H, X, H, M
- X, X, M
- H, H, M
- M, X, M, X, M
- X, H, X, H, M

Question 7

10 / 10 pts

We have five qubits, say $q_0, \ldots, q_4$, initially in zero states.

We apply the X operators to both qubits q_0 and q_4.

For the rest of qubits, we apply either identity operator or X operator.

After making a measurement, we read the values from the qubits $q_0, \ldots, q_4$ as $b_0, \ldots, b_4$, respectively.

If $b = b_4 \cdots b_0$ is a binary number, which one of the following decimal numbers is not possible for the value of b?

- 17
- 31

- 25
- 13
- 23

Question 8

10 / 10 pts

What is $(XH)^5|0\rangle$?

- $|+\rangle$
- $-|-\rangle$
- $-|+\rangle$
- $|1\rangle$
- $|-\rangle$

Question 9

10 / 10 pts

If $|u\rangle = \begin{pmatrix} x \\ -2x \\ 2x \\ x \end{pmatrix}$ is the quantum state of a quantum system with four states,

what is the probability of being in the state with amplitude $-2x$?

- 0.8
- 0.2

- (selected) 0.4
- 0.0
- 0.6

Question 10

10 / 10 pts

Which one of the following operators is not a quantum operator?

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

Question 11

10 / 10 pts

We have a single qubit and a single classical bit.

We execute the following program 1024 times in Qiskit.

```
Start in state |1⟩
Repeat 3 times:
    if the classical bit is 0:
        apply a Hadamard operator
    make a measurement
```

What is the expected value to observe state 0?

- 256
- 768
- 512
- 128
- 896

Quiz Score: **100** out of 100