Status	Finished
Started	Wednesday, 22 October 2025, 8:45 PM
Completed	Wednesday, 22 October 2025, 9:31 PM
Duration	46 mins 2 secs
Marks	6.80/8.00
Grade	**2.83** out of 3.33 (**85**%)

Question 1

Correct

Mark 1.00 out of 1.00

Which of the following vectors $|\psi_i\rangle \in \mathbb{C}^2$ are quantum qubit states?

- [ ] a. $$|\psi_1\rangle := \frac{|0\rangle + |1\rangle}{2}$$
- [x] b. $$|\psi_4\rangle = \frac{-2}{3}|0\rangle + \frac{\sqrt{2}+i\sqrt{3}}{3}|1\rangle$$
- [x] c. $$|\psi_2\rangle := \frac{e^{i\pi/5}}{\sqrt{3}}|0\rangle + \frac{\sqrt{2}}{\sqrt{3}}|1\rangle$$
- [ ] d. $$|\psi_0\rangle := \frac{|0\rangle - |+\rangle}{\sqrt{2}}$$
- [x] e. $$|\psi_3\rangle = \frac{3-4i}{5}|0\rangle$$

Votre réponse est correcte.

The correct answers are:

$$|\psi_2\rangle := \frac{e^{i\pi/5}}{\sqrt{3}}|0\rangle + \frac{\sqrt{2}}{\sqrt{3}}|1\rangle$$,

$$|\psi_3\rangle = \frac{3-4i}{5}|0\rangle$$,

$$|\psi_4\rangle = \frac{-2}{3}|0\rangle + \frac{\sqrt{2}+i\sqrt{3}}{3}|1\rangle$$

Question 2

Correct

Mark 1.00 out of 1.00

Which of the following vectors $|\psi_i\rangle \in \mathbb{C}^2$ are quantum qubit states? (The vectors are represented as column matrices in the computational basis)

- [x] a. $$|\psi_2\rangle := \begin{bmatrix} \sqrt{6/7} \\ \sqrt{-1/7} \end{bmatrix}$$
- [x] b. $$|\psi_1\rangle := \begin{bmatrix} 12 \\ -5 \end{bmatrix} \frac{1}{13}$$
- [x] c. $$|\psi_3\rangle := \frac{1}{\sqrt{2}} \begin{bmatrix} e^{i\pi} \\ -e^{7i} \end{bmatrix}$$
- [ ] d. $$|\psi_4\rangle := i \begin{bmatrix} e^{\pi} \\ 0 \end{bmatrix}$$
- [x] e. $$|\psi_0\rangle := \sqrt{2} \begin{bmatrix} 1/2 \\ 1/2 \end{bmatrix}$$

Votre réponse est correcte.

The correct answers are:

$$|\psi_0\rangle := \sqrt{2} \begin{bmatrix} 1/2 \\ 1/2 \end{bmatrix}$$,

$$|\psi_1\rangle := \begin{bmatrix} 12 \\ -5 \end{bmatrix} \frac{1}{13}$$,

$$|\psi_2\rangle := \begin{bmatrix} \sqrt{6/7} \\ \sqrt{-1/7} \end{bmatrix}$$,

$$|\psi_3\rangle := \frac{1}{\sqrt{2}} \begin{bmatrix} e^{i\pi} \\ -e^{7i} \end{bmatrix}$$

Question 3

Correct

Mark 1.00 out of 1.00

Which of the following operators $U_i : \mathbb{C}^2 \to \mathbb{C}^2$ are unitary? (The operators are represented as matrices in the computational basis)

- [x] a. $U_0 := \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$
- [ ] b. $U_3 := \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$
- [x] c. $U_2 := \begin{bmatrix} 0 & 1 \\ e^{i\pi} & 0 \end{bmatrix}$
- [ ] d. $U_4 := \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$
- [x] e. $U_1 := \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}$

Votre réponse est correcte.

The correct answers are:

$U_0 := \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$,

$U_1 := \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}$,

$U_2 := \begin{bmatrix} 0 & 1 \\ e^{i\pi} & 0 \end{bmatrix}$

Question 4

Correct

Mark 1.00 out of 1.00

Which of the following operators $U_i : \mathbb{C}^2 \to \mathbb{C}^2$ are unitary?

- [x] a. $U_2 := |+\rangle\langle 0| + |-\rangle\langle 1|$
- [x] b. $U_4 := |+\rangle\langle +| + |-\rangle\langle -|$
- [x] c. $U_0 := |0\rangle\langle 0| + |1\rangle\langle 1|$
- [ ] d. $U_1 := |0\rangle\langle 0| - 2i\,|1\rangle\langle 1|$
- [ ] e. $U_3 := |+\rangle\langle 0| - |+\rangle\langle 1|$

Votre réponse est correcte.

The correct answers are:

$U_0 := |0\rangle\langle 0| + |1\rangle\langle 1|$,

$U_2 := |+\rangle\langle 0| + |-\rangle\langle 1|$,

$U_4 := |+\rangle\langle +| + |-\rangle\langle -|$

Question 5

Partially correct

Mark 0.80 out of 1.00

Select the statements which are true.

- [x] a. Let $A : \mathbb{C}^d \to \mathbb{C}^d$ be a linear operator. There exist vectors $|\psi_i\rangle \in \mathbb{C}^d$ such that $A = \sum_{i=0}^{d-1} |\psi_i\rangle\langle i|$.
- [x] b. Let $|\psi_i\rangle \in \mathbb{C}^d$ be vectors respecting $\langle\psi_i|\psi_j\rangle = \delta_{ij}$. The linear operator $U = \sum_{i=0}^{d-1} |\psi_i\rangle\langle i|$ is unitary.
- [ ] c. Let $\{|\psi_i\rangle\}_{i=0}^{d-1}$ be a set of vectors in $\mathbb{C}^d$. There exists a unitary operator $U : \mathbb{C}^d \to \mathbb{C}^d$ such that $U|i\rangle = |\psi_i\rangle$.
- [x] d. Let $|\psi_i\rangle \in \mathbb{C}^d$ be vectors respecting $\langle\psi_i|\psi_j\rangle = \delta_{ij}$. The linear operator $U = \sum_{i=0}^{d-1} |i\rangle\langle\psi_i|$ is unitary.
- [x] e. Let $U : \mathbb{C}^d \to \mathbb{C}^d$ be a linear operator. If U is unitary, there exist vectors $|\psi_i\rangle \in \mathbb{C}^d$ respecting $\langle\psi_i|\psi_j\rangle = \delta_{ij}$ such that $U = \sum_{i=0}^{d-1} |\psi_i\rangle\langle i|$.
- [ ] f. Let $|\psi_0\rangle := \frac{3|0\rangle - i4|1\rangle}{5}$ and $|\psi_1\rangle := \frac{4|0\rangle + 3i|1\rangle}{5}$ be qubit states. There exists a unitary operator $U : \mathbb{C}^2 \otimes \mathbb{C}^2 \to \mathbb{C}^2 \otimes \mathbb{C}^2$ such that $U|\psi_i\rangle|0\rangle = |\psi_i\rangle|\psi_i\rangle$ for every $i \in \{0, 1\}$.

Votre réponse est partiellement correcte.

You have correctly selected 4.

The correct answers are:

Let $A : \mathbb{C}^d \to \mathbb{C}^d$ be a linear operator. There exist vectors $|\psi_i\rangle \in \mathbb{C}^d$ such that $A = \sum_{i=0}^{d-1} |\psi_i\rangle\langle i|$.,

Let $U : \mathbb{C}^d \to \mathbb{C}^d$ be a linear operator. If U is unitary, there exist vectors $|\psi_i\rangle \in \mathbb{C}^d$ respecting $\langle\psi_i|\psi_j\rangle = \delta_{ij}$ such that $U = \sum_{i=0}^{d-1} |\psi_i\rangle\langle i|$., Let $|\psi_i\rangle \in \mathbb{C}^d$ be vectors respecting $\langle\psi_i|\psi_j\rangle = \delta_{ij}$. The linear operator $U = \sum_{i=0}^{d-1} |\psi_i\rangle\langle i|$ is unitary.

Let $|\psi_i\rangle \in \mathbb{C}^d$ be vectors respecting $\langle\psi_i|\psi_j\rangle = \delta_{ij}$. The linear operator $U = \sum_{i=0}^{d-1} |i\rangle\langle\psi_i|$ is unitary.

Let $|\psi_0\rangle := \frac{3|0\rangle - i4|1\rangle}{5}$ and $|\psi_1\rangle := \frac{4|0\rangle + 3i|1\rangle}{5}$ be qubit states. There exists a unitary operator $U : \mathbb{C}^2 \otimes \mathbb{C}^2 \to \mathbb{C}^2 \otimes \mathbb{C}^2$ such that $U|\psi_i\rangle|0\rangle = |\psi_i\rangle|\psi_i\rangle$ for every $i \in \{0, 1\}$.

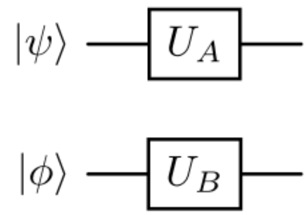
Question 6

Incorrect

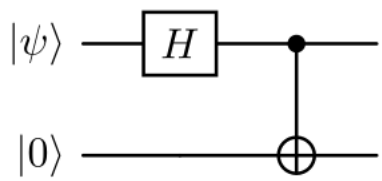
Mark 0.00 out of 1.00

Select the statements which are true.

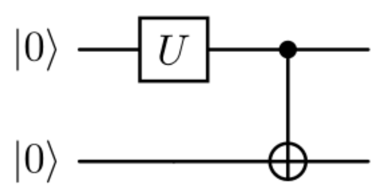
a. For any qubit unitary operators U_A and U_B, qubit states $|\psi\rangle$ and $|\phi\rangle$, the output of the quantum state below is separable.



b. For any quantum state $|\psi\rangle \in \mathbb{C}^2$ the quantum circuit below outputs an entangled state.



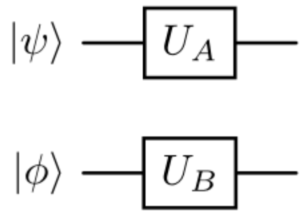
c. Let $U : \mathbb{C}^2 \to \mathbb{C}^2$ be a unitary operator such that $U|0\rangle \neq e^{i\theta_0}|0\rangle$ for every $\theta_0 \in \mathbb{R}$ and $U|0\rangle \neq e^{i\theta_1}|1\rangle$ for every $\theta_1 \in \mathbb{R}$. The output of the quantum state below is an entangled state.



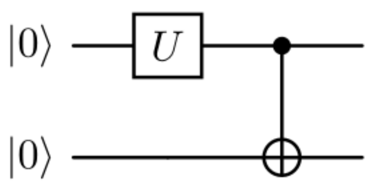
Votre réponse est incorrecte.

The correct answers are:

For any qubit unitary operators U_A and U_B, qubit states $|\psi\rangle$ and $|\phi\rangle$, the output of the quantum state below is separable.



Let $U : \mathbb{C}^2 \to \mathbb{C}^2$ be a unitary operator such that $U|0\rangle \neq e^{i\theta_0}|0\rangle$ for every $\theta_0 \in \mathbb{R}$ and $U|0\rangle \neq e^{i\theta_1}|1\rangle$ for every $\theta_1 \in \mathbb{R}$. The output of the quantum state below is an entangled state.

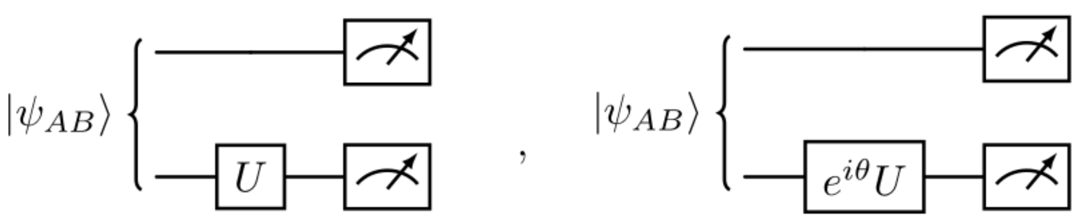


Question 7

Correct

Mark 1.00 out of 1.00

For every two-qubit state $|\psi_{AB}\rangle$ and every qubit unitary operator U and any $\theta \in \mathbb{R}$, the probability of obtaining the outcome 00 is the same in the two circuits below.



- [x] True
- [ ] False

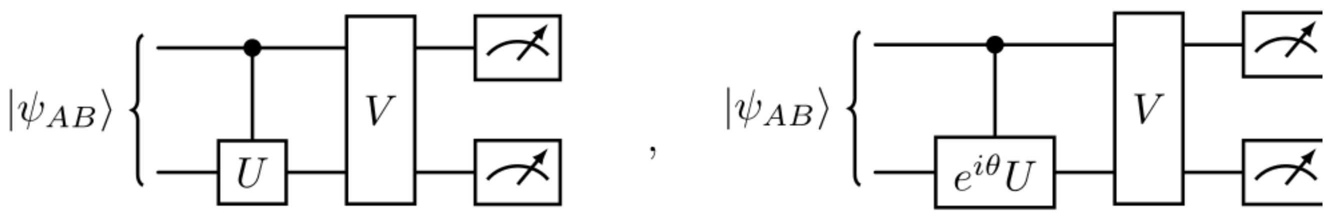
The correct answer is 'True'.

Question 8

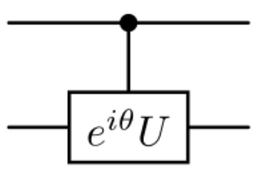
Correct

Mark 1.00 out of 1.00

For every two-qubit state $|\psi_{AB}\rangle$, for every two-qubit unitary V and every single-qubit unitary operator U, the probability of obtaining the outcome 00 is the same in the two circuits below.



Recall:



$$= \quad |0\rangle\langle 0| \otimes \mathbb{1} + |1\rangle\langle 1| \otimes e^{i\theta}U.$$

- ○ True
- ◉ False ✓

The correct answer is 'False'.