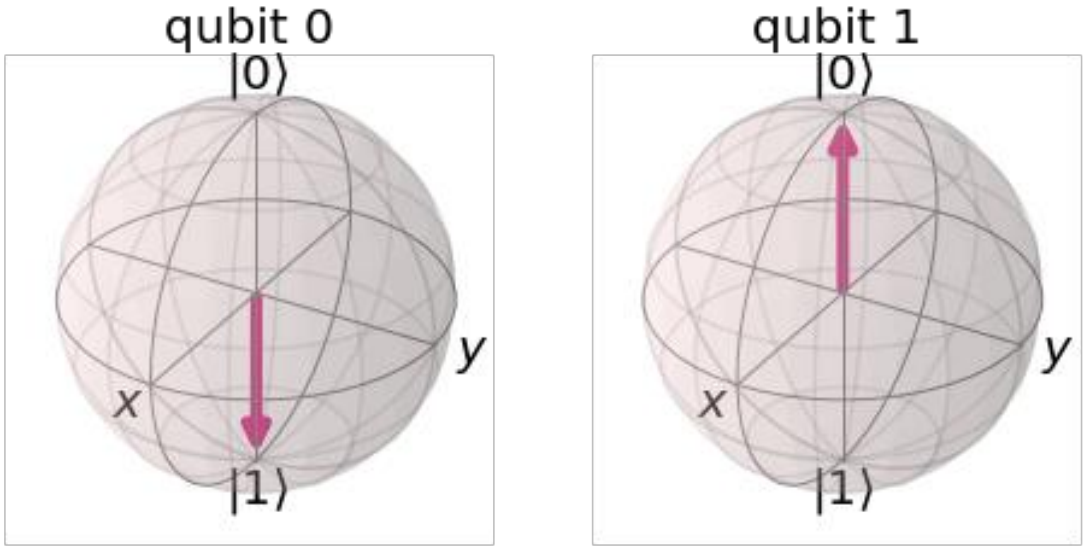
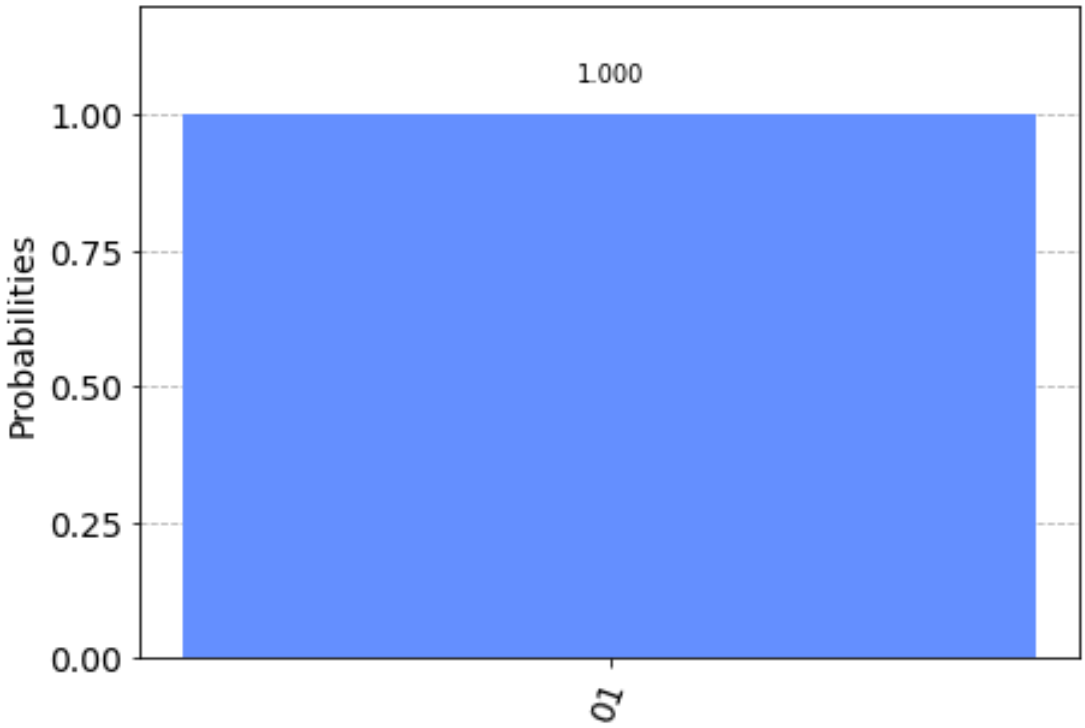
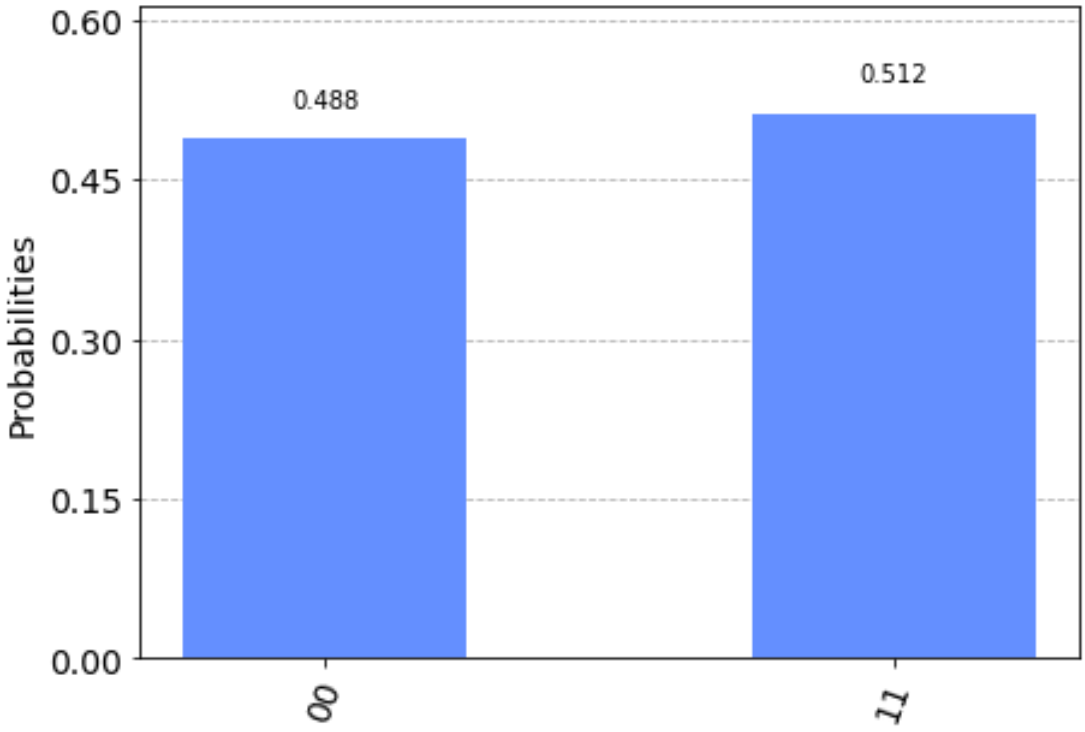
P1

(e)

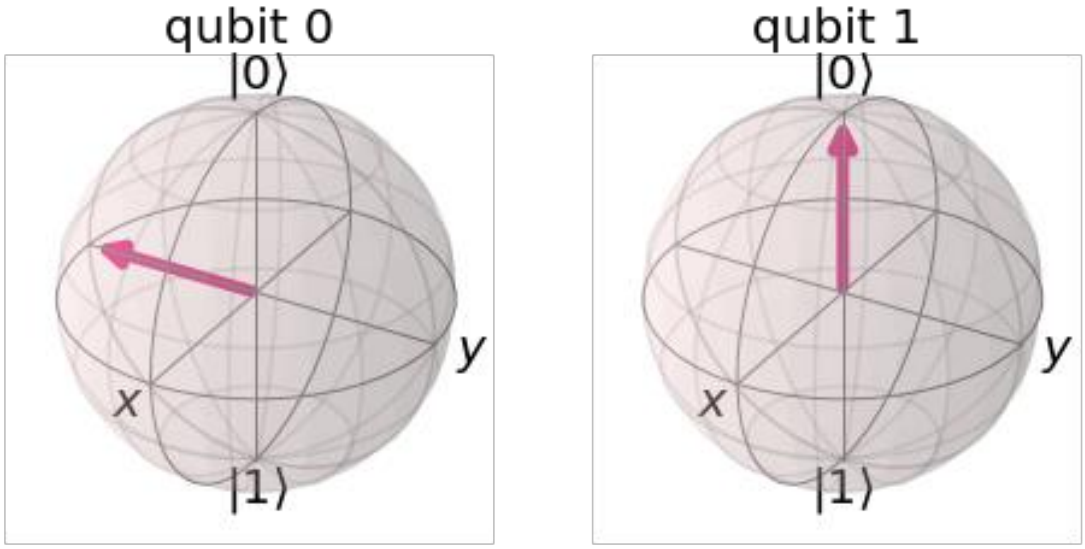

qubit 0
|0⟩
x
y
|1⟩
qubit 1
|0⟩
x
y
|1⟩


1.000
1.00
0.75
0.50
0.25
0.00
Probabilities
01

(f)

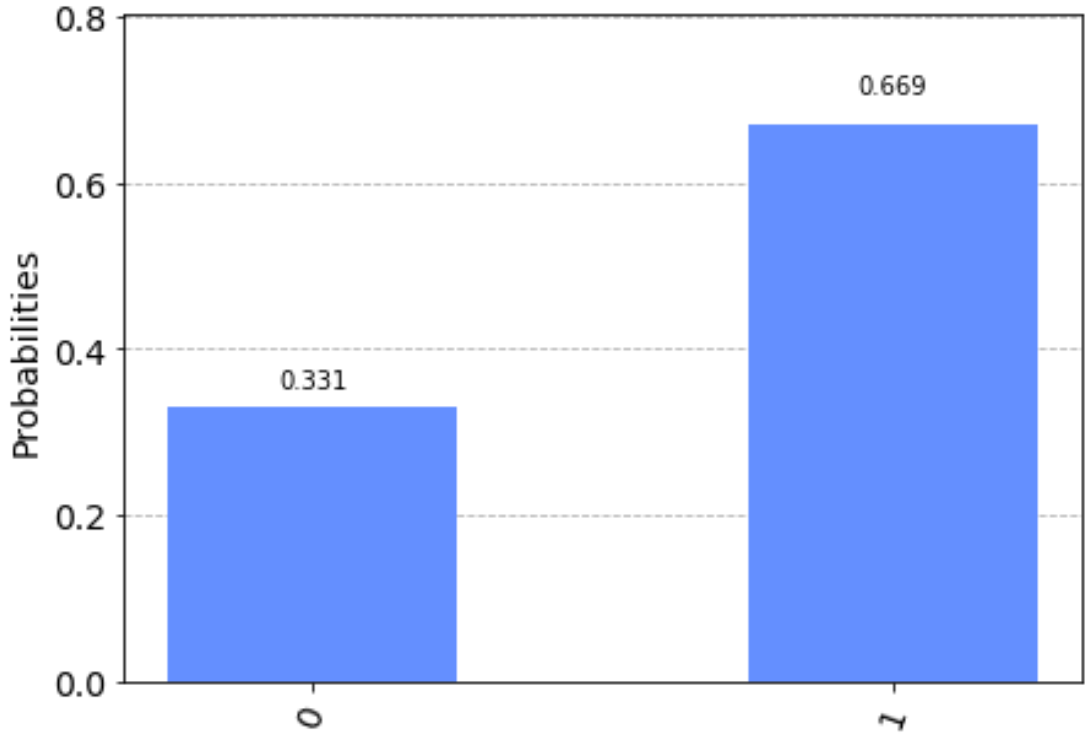


(g) 1 繞 x 軸旋轉 90 度



(h)

```
initial=[(2**(1/2)+1)/(6**(1/2)),(-(2**(1/2))+1)/(6**(1/2))]
angle=math.asin(initial[1])
qc.u3(2*angle,0,0,q[0])
qc.h(q[0])
```



計算過程

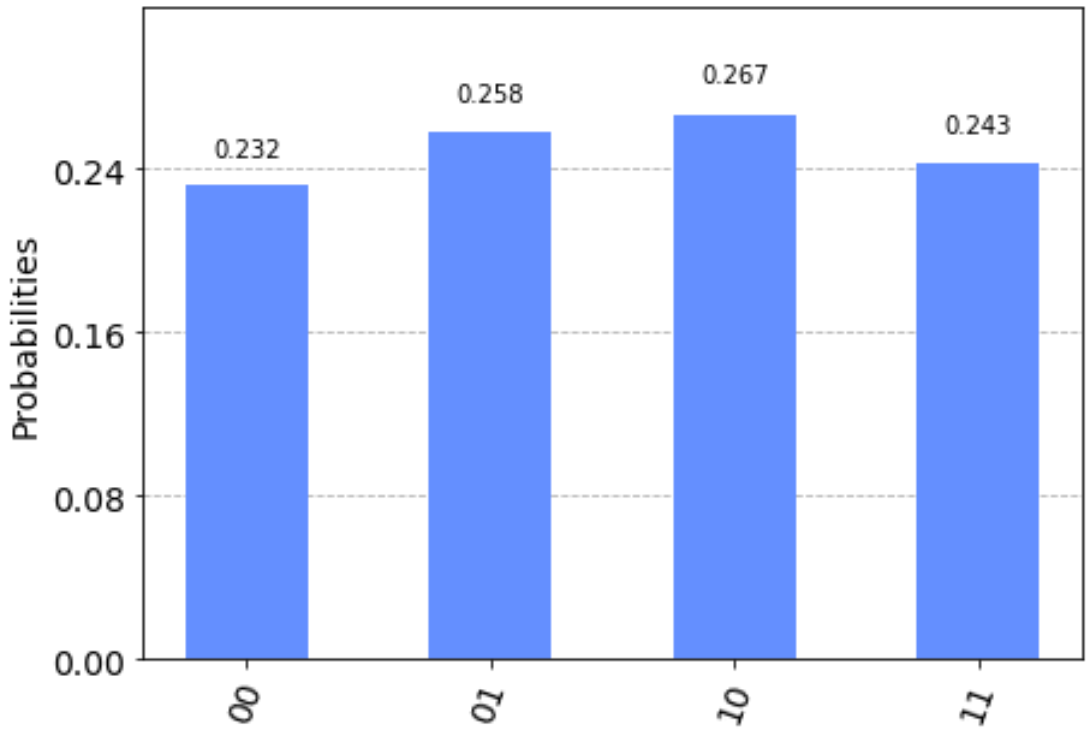
$$\langle + | \psi \rangle = \frac{\sqrt{2}}{3} \qquad \langle - | \psi \rangle = \frac{1}{\sqrt{3}}$$

$$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} \frac{\sqrt{2}}{3} \\ \frac{1}{\sqrt{3}} \end{pmatrix}$$

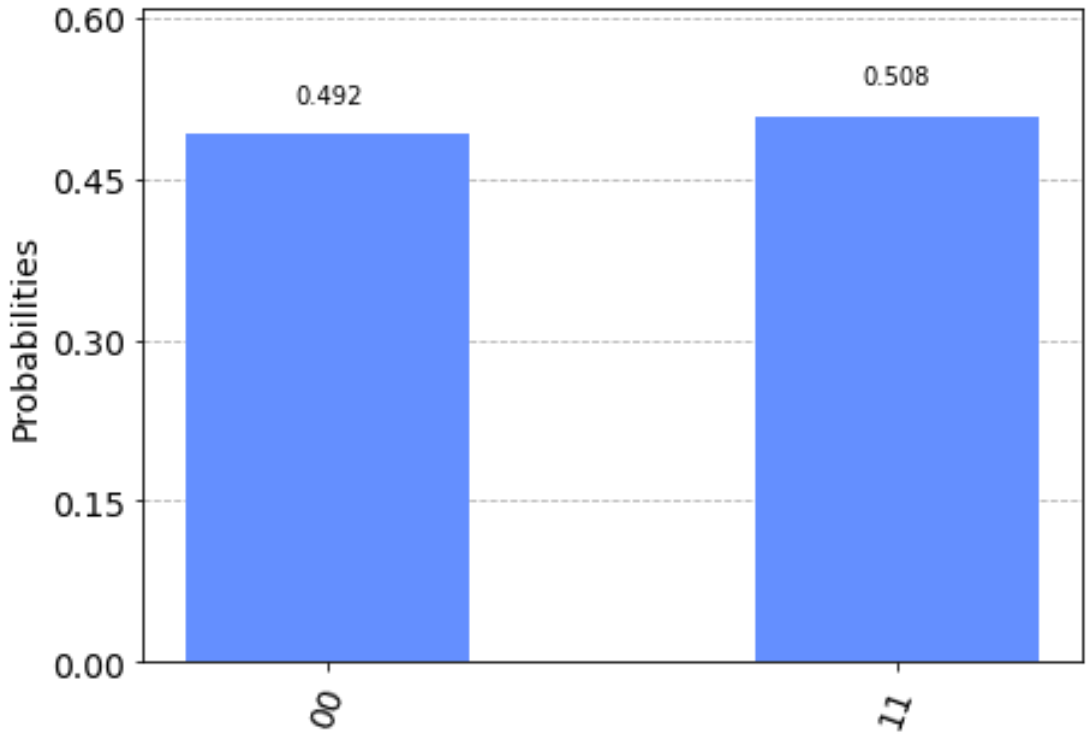
$$\Rightarrow \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} \frac{\sqrt{2}+1}{\sqrt{6}} \\ \frac{-\sqrt{2}+1}{\sqrt{6}} \end{pmatrix}$$

P2

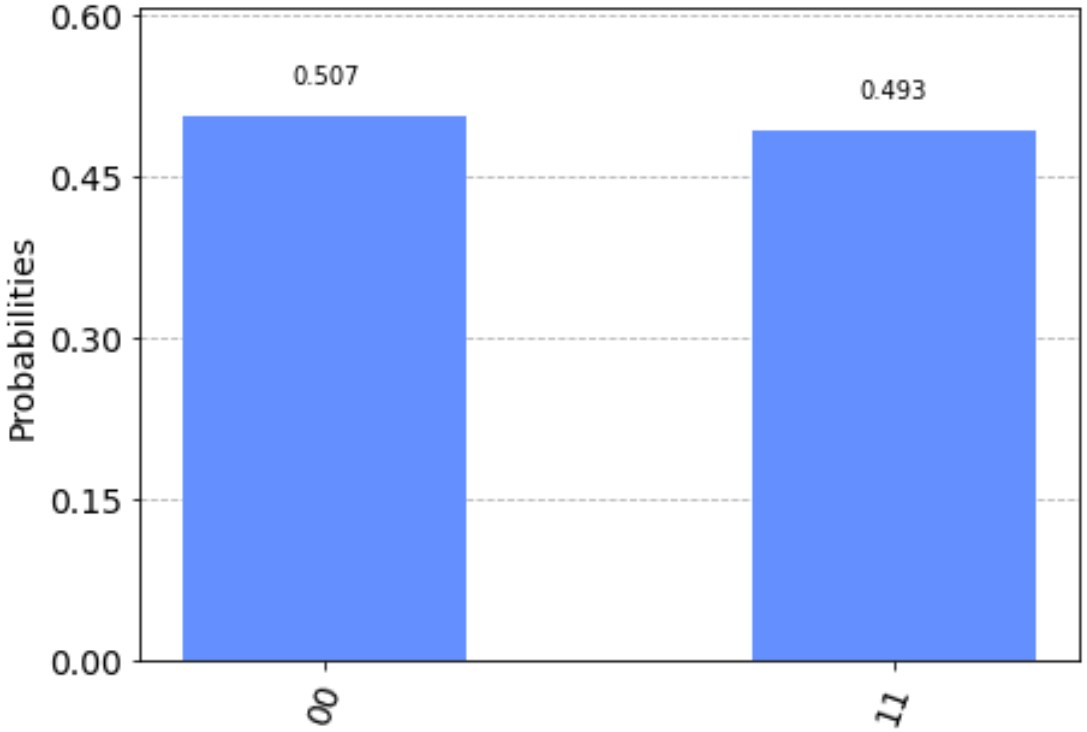
(a)


0.232
0.258
0.267
0.243
Probabilities
0.24
0.16
0.08
0.00
00
01
10
11

(b)


0.492
0.508
Probabilities
0.60
0.45
0.30
0.15
0.00
00
11

(c)與(b)結果相同



(d)

Prepare $\Phi+$

```
qc2.h(q2[0])
qc2.cx(q2[0],q2[1])
statevector
```

```
[0.70710678+0.j 0.       +0.j 0.       +0.j 0.70710678+0.j]
```

Prepare $\Phi-$

```
qc2.x(q2[0])
qc2.h(q2[0])
qc2.cx(q2[0],q2[1])
statevector
```

```
[ 0.70710678+0.00000000e+00j  0.       +0.00000000e+00j
  0.       +0.00000000e+00j -0.70710678-8.65956056e-17j]
```

Prepare $\Psi+$

```
qc2.h(q2[0])
qc2.x(q2[1])
qc2.cx(q2[0],q2[1])
statevector
```

```
[0.       +0.j 0.70710678+0.j 0.70710678+0.j 0.       +0.j]
```

Prepare $\Psi-$

```
qc2.x(q2[0])
qc2.h(q2[0])
qc2.x(q2[1])
qc2.cx(q2[0],q2[1])
statevector
```

```
[ 0.       +0.00000000e+00j -0.70710678-8.65956056e-17j
  0.70710678+0.00000000e+00j  0.       +0.00000000e+00j]
```

(e)

Swap:

```
[0.70710678+0.j 0.        +0.j 0.70710678+0.j 0.        +0.j]
```

Cx*3:

```
[0.70710678+0.j 0.        +0.j 0.70710678+0.j 0.        +0.j]
```

CNot*3

	1	2	3	
0 0	0 0	0 0	0 0	
0 1	0 1	1 1	1 0	
1 0	1 1	0 1	0 1	
1 1	1 0	1 0	1 1	

swap

0 0	0 0
0 1	1 0
1 0	0 1
1 1	1 1

相同

P3

(a)

Ψ1 state vector:

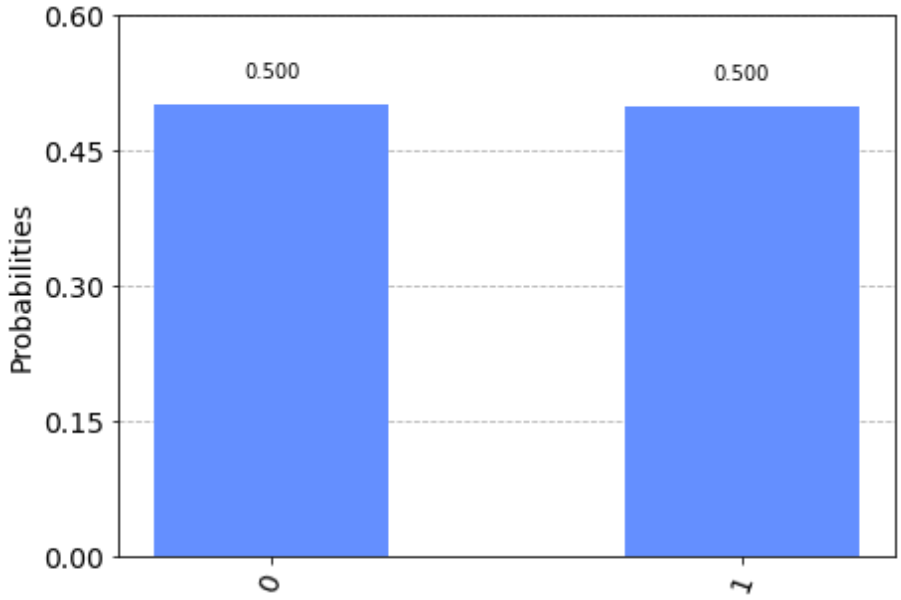
[0.70710678+0.j 0.70710678+0.j]

Ψ2 state vector；

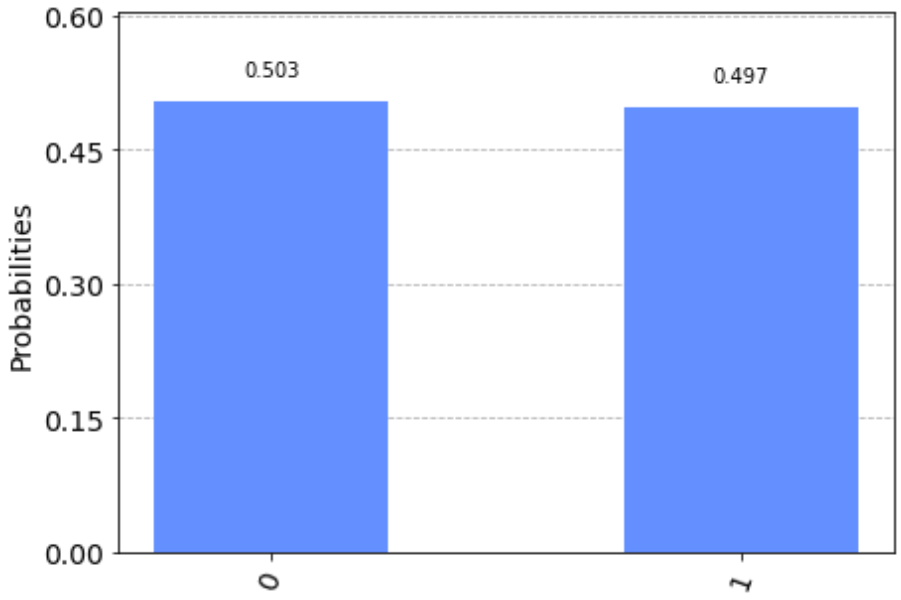
[-1.29893408e-16-0.70710678j -1.29893408e-16-0.70710678j]

Measurement outcome

Ψ1



Ψ2



(b) Ψ1 state vector:

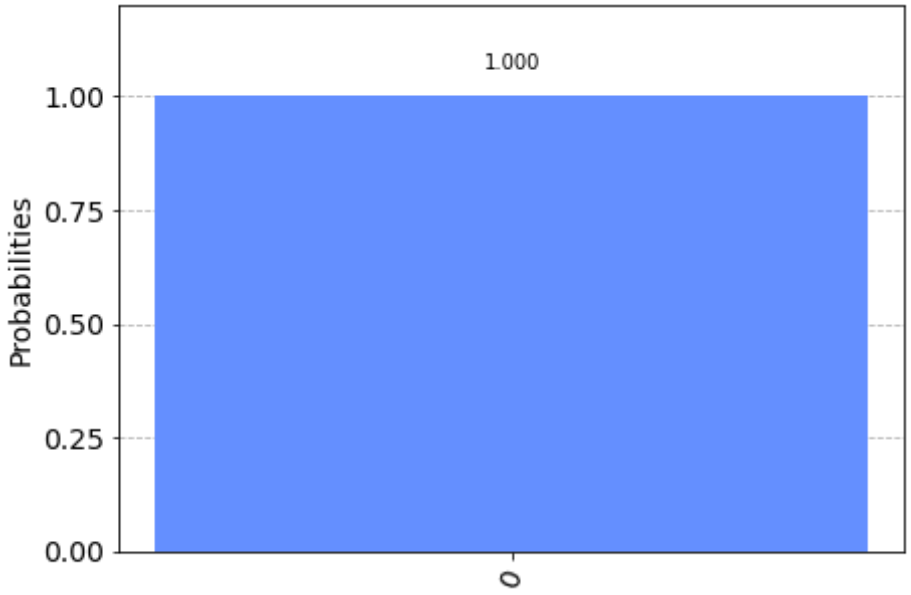
```
[1.+0.j 0.+0.j]
```

Ψ2 state vector:

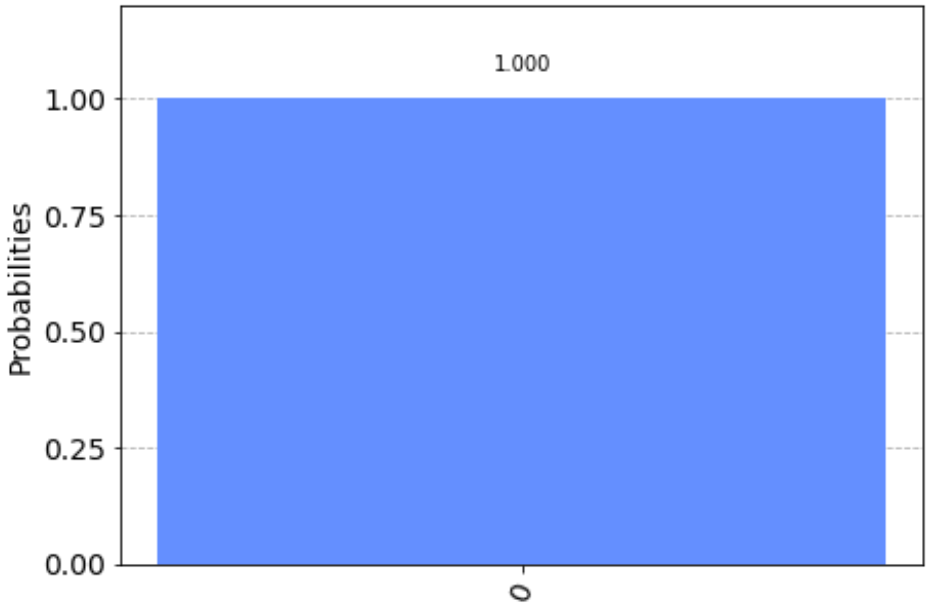
```
[-1.8369702e-16-1.j  0.0000000e+00-0.j]
```

Measurement outcome

Ψ1



Ψ2



(c)

Ψ1 state vector:

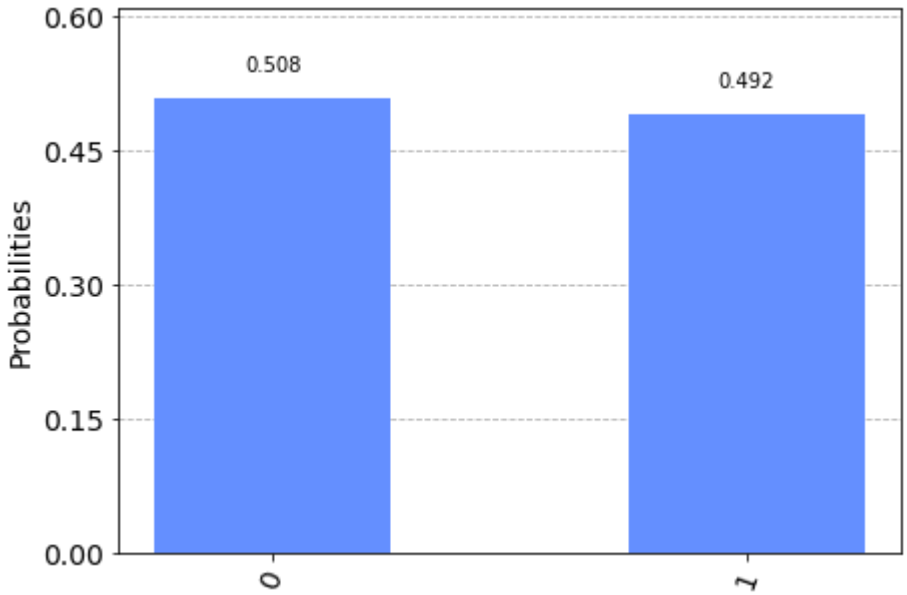
```
[0.70710678+0.j 0.70710678+0.j]
```

Ψ2 state vector:

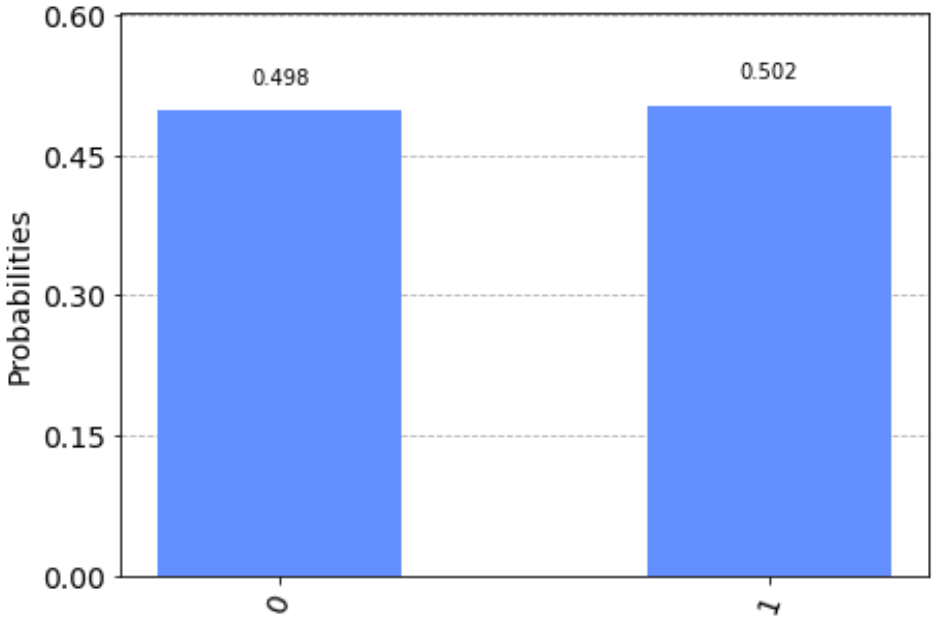
```
[ 0.70710678+0.00000000e+00j -0.70710678-8.65956056e-17j]
```

Measurement outcome

Ψ1

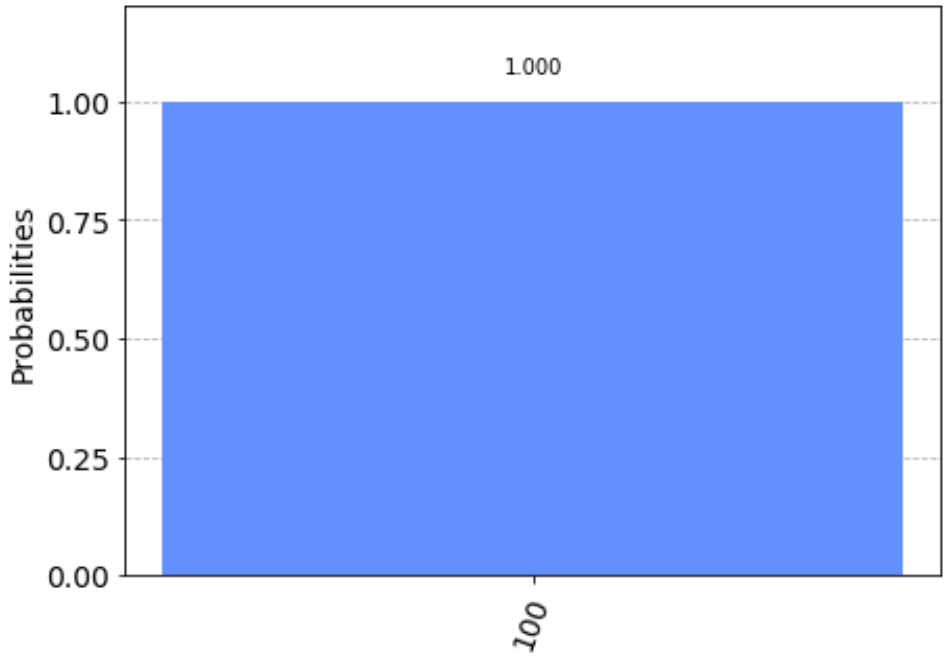


Ψ2

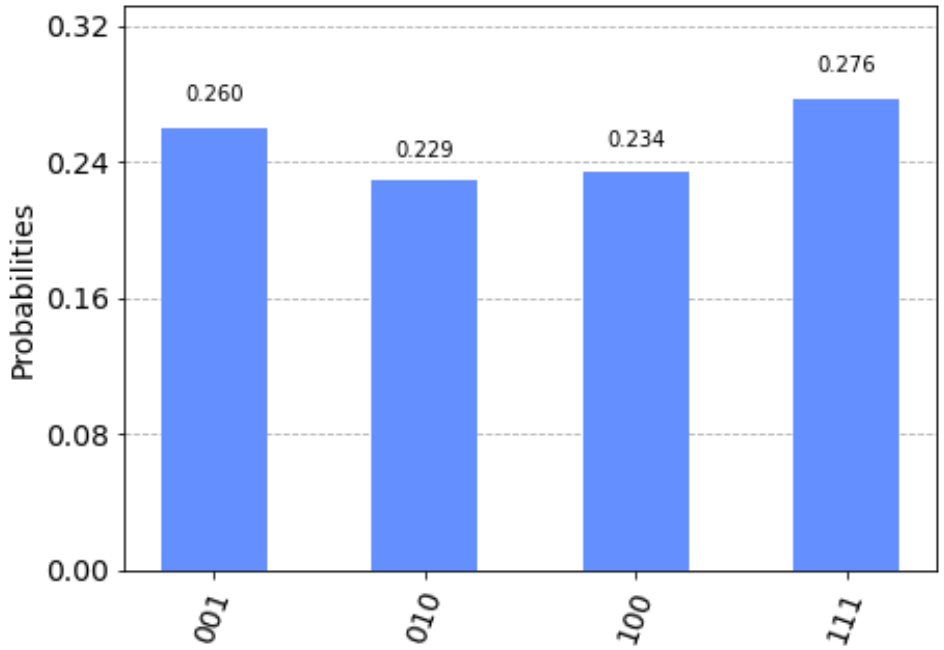


P4

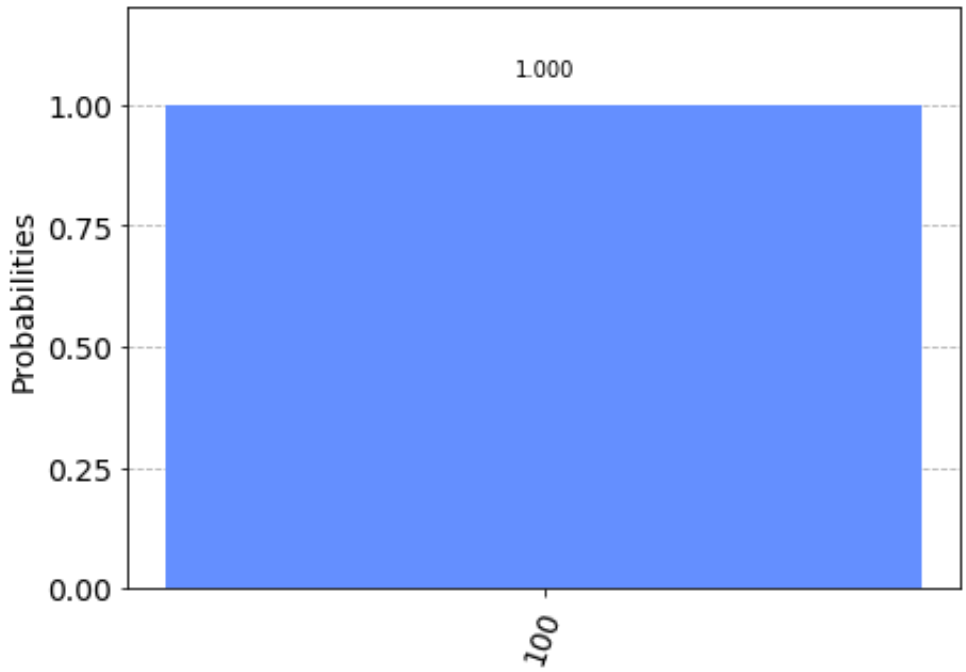
Ψ1=0 Ψ2=0 (same state)



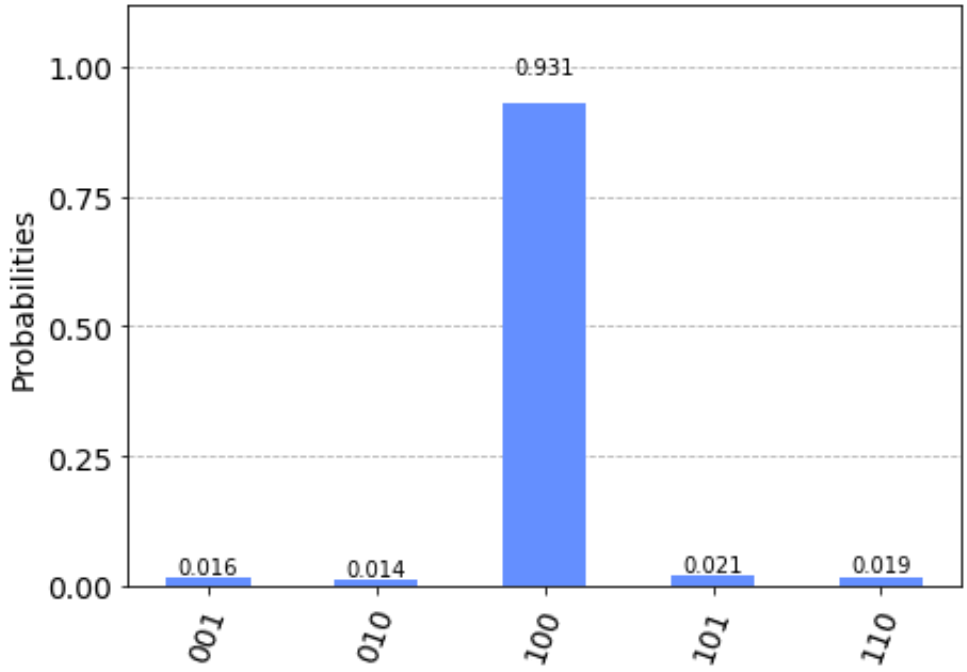
Ψ1=|-> Ψ2= |+>(orthogonal state)



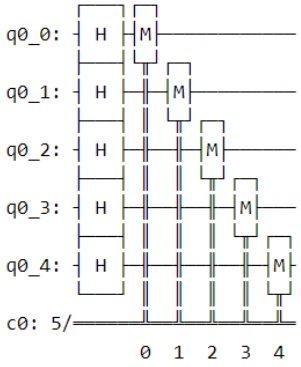
Ψ1=[-1,0]　Ψ2=0(無法分辨 global phase)



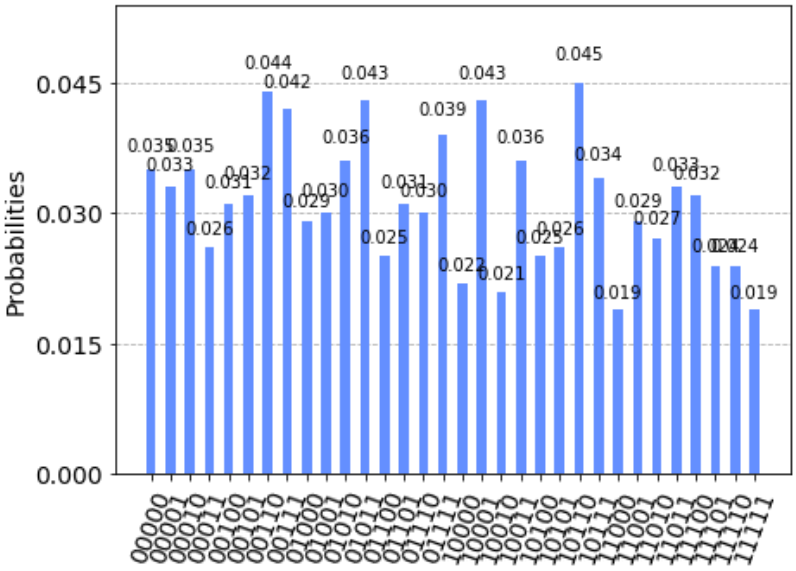
Ψ1=|0>　Ψ2=[3^(1/2)/2,-j/2]



P5



(a) simulator



(b) IBM Quantum Experience