Lab 3 Report

Applications of Quantum Information Processing

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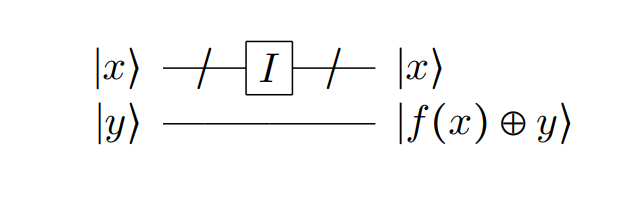
Last edited: 11/3/2021(Wed)

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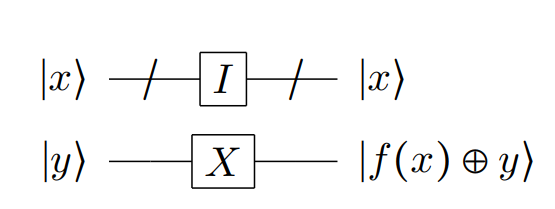
Collaborator: B08901002 Chen-Han Lin, B08901209 Yu-Hsiang Lin

Q1.

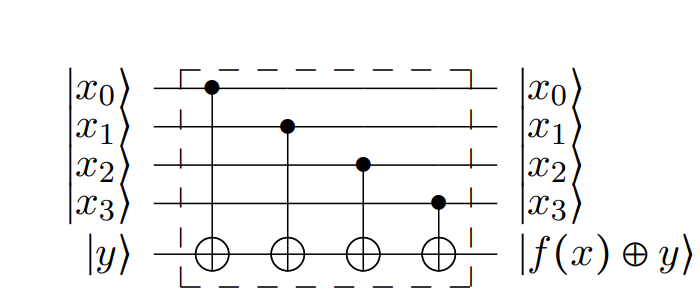
(a)



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x0 | x1 | x2 | x3 | y | result |
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| 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 | 0 |
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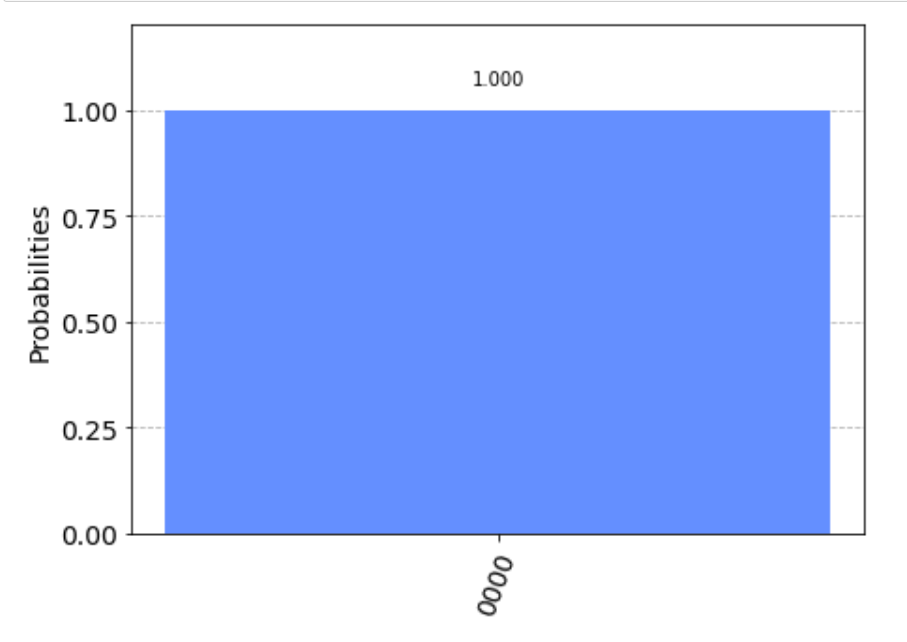
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x0 | x1 | x2 | x3 | y | result |
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| 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 1 | 1 |
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| 0 | 1 | 1 | 0 | 1 | 1 |
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| 1 | 0 | 1 | 1 | 1 | 1 |
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| 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 1 |
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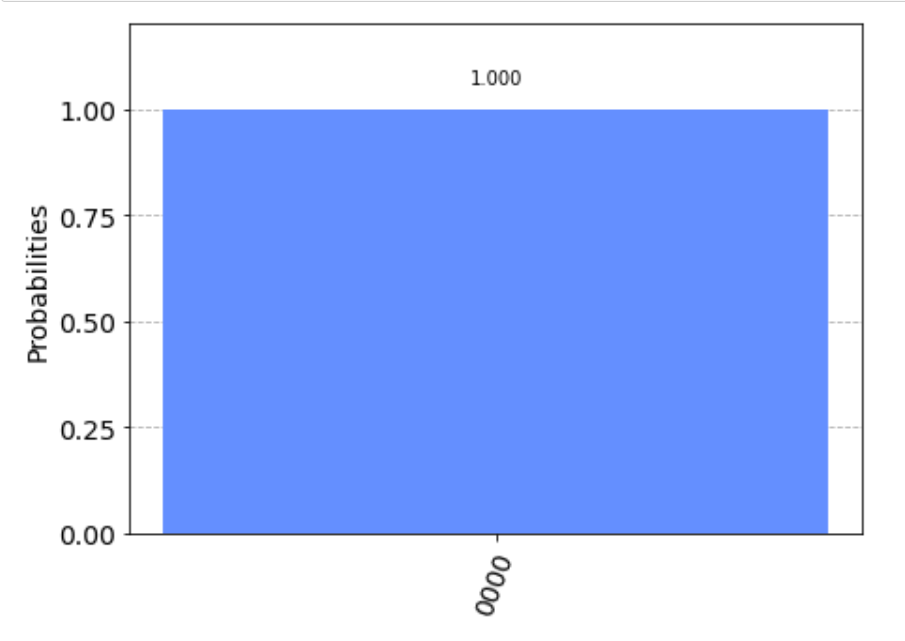
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| x0 | x1 | x2 | x3 | y | result |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 1 | 0 |
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| 0 | 1 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 |
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| 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 1 |
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| 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 |

(b)

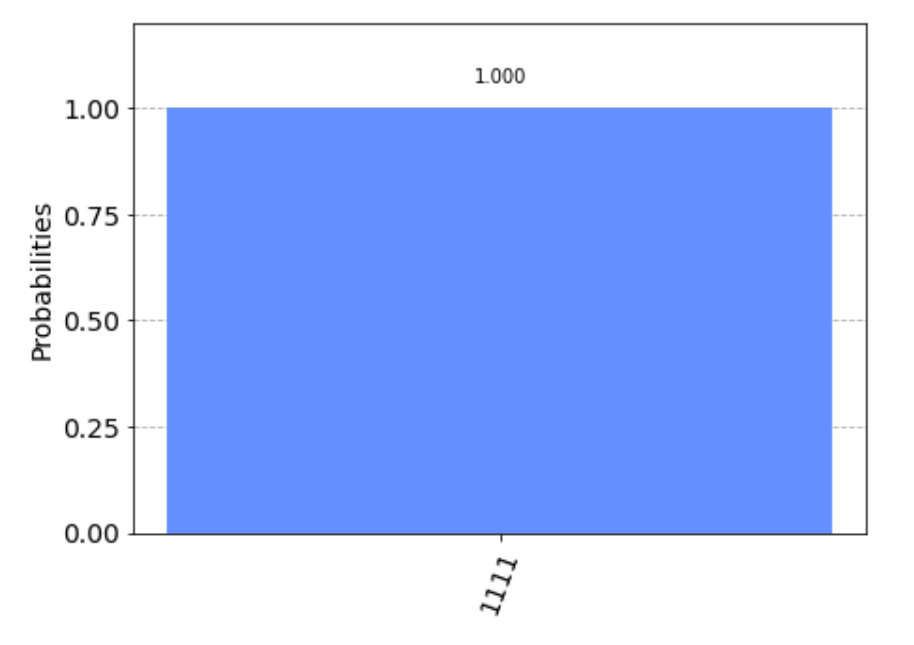
All 0



All 1



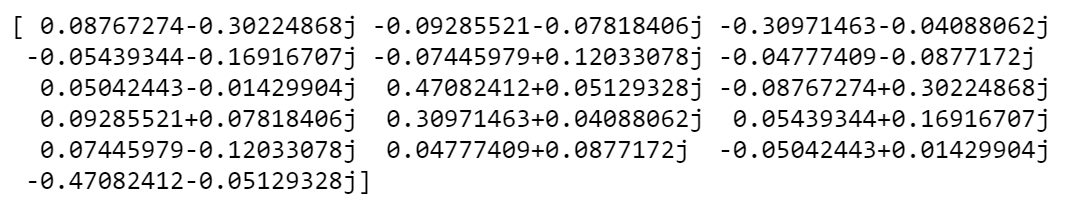
Balanced



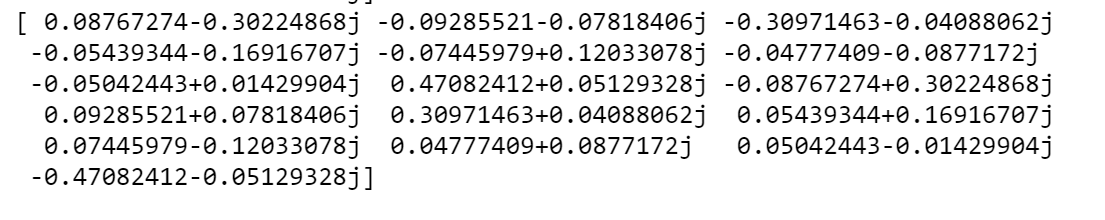
Q2

(a)

Before the gate [y,x2,x1,x0]

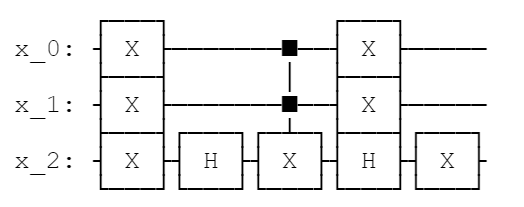


After the gate [y,x2,x1,x0]



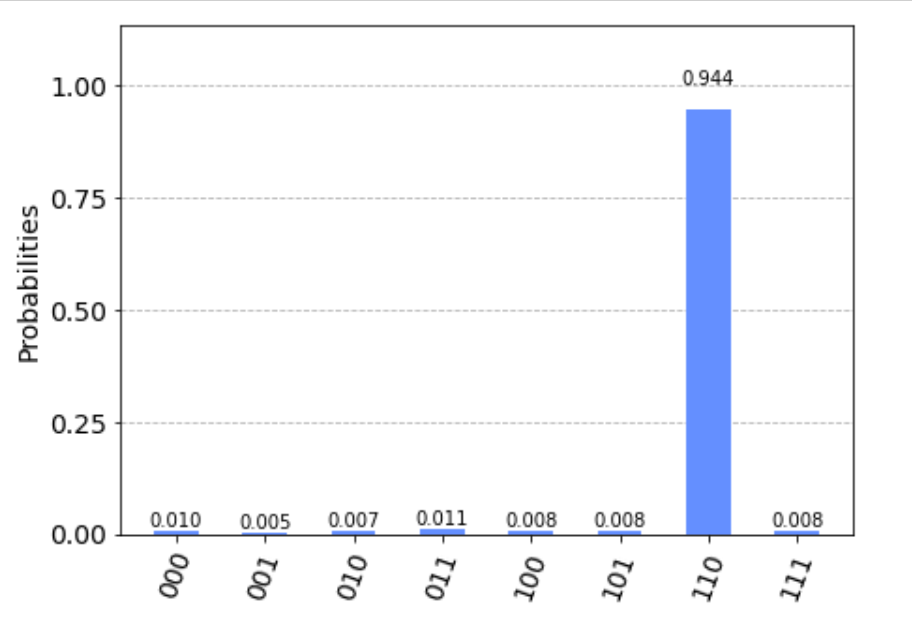
We find that number 6 and 14 number are the minus sign, which corresponds to [x2,x1,x0] = [1,1,0], which is [x0,x1,x2] = [0,1,1].

(b)



(c)

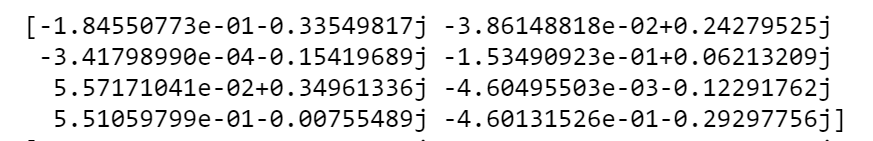
After iterations, the result is shown below



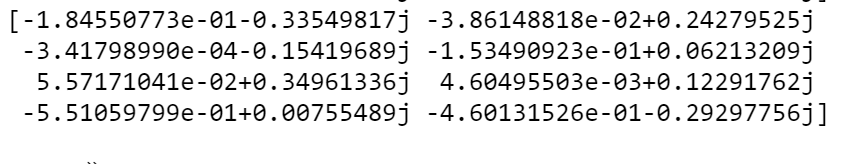
Which we get 011 with high probability, but not always.

(d)

Before the gate [x2,x1,x0]



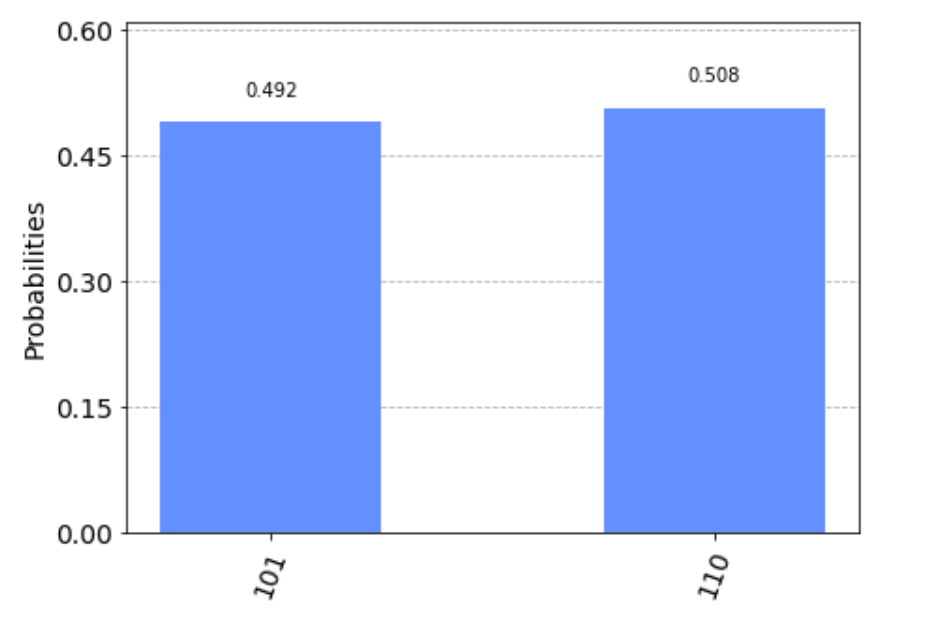
After the gate [x2,x1,x0]



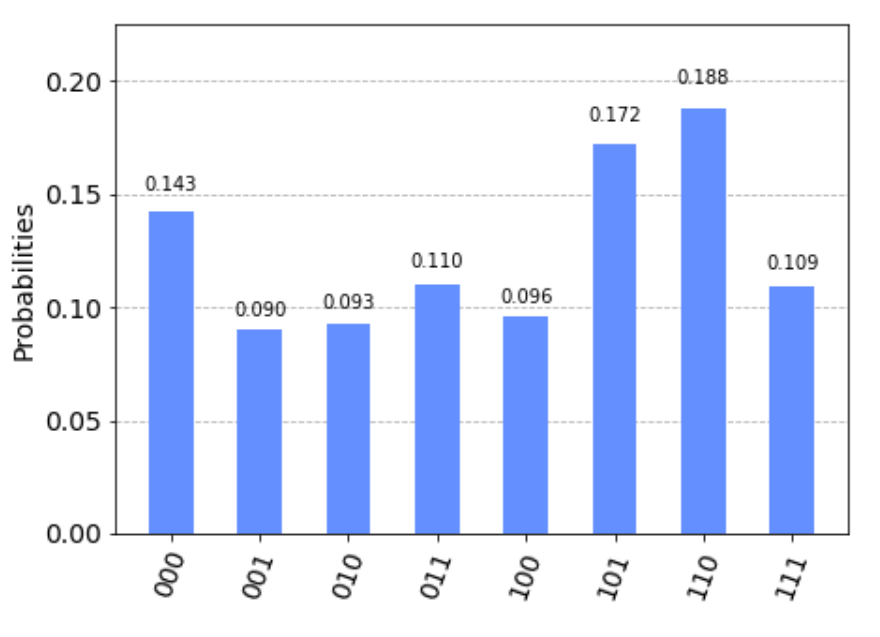
We find that number 5 and 6 number are the minus sign, which corresponds to [x2,x1,x0] = [1,0,1] and [1,1,0], which is [x0,x1,x2] = [1,0,1] and [0,1,1].

(e)

On qasm\_simulator, we need 4 iterations of queries.

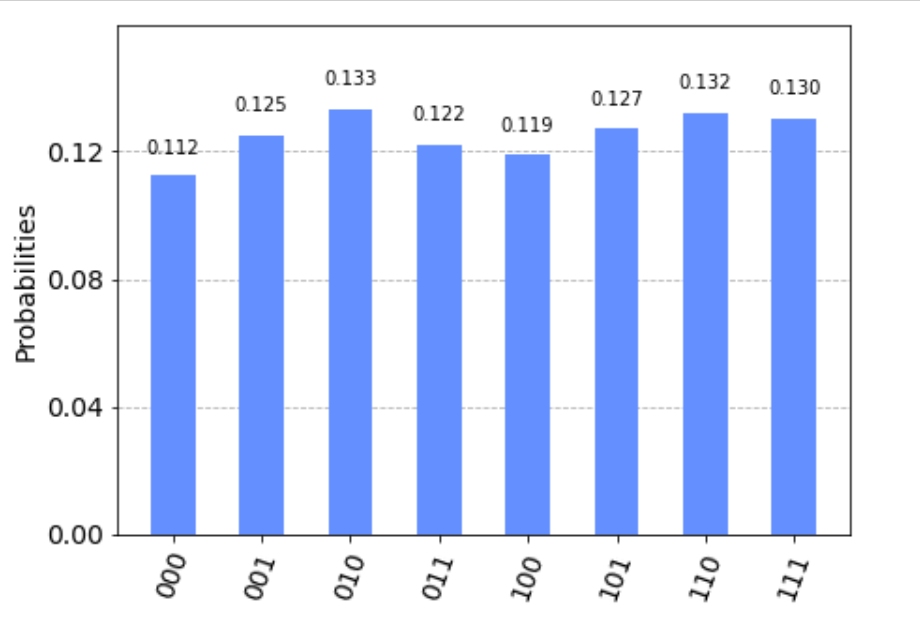


On real device,



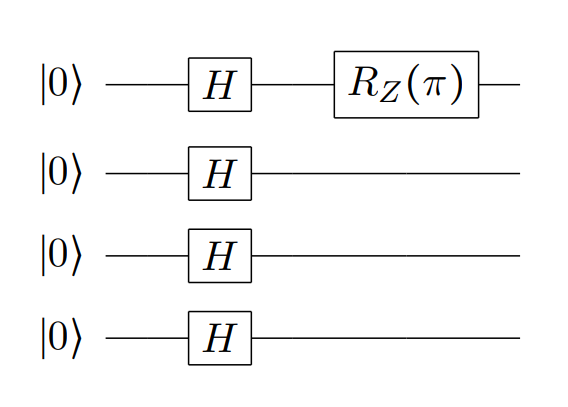
We get the highest probability on 101 and 011, but the error is really huge.

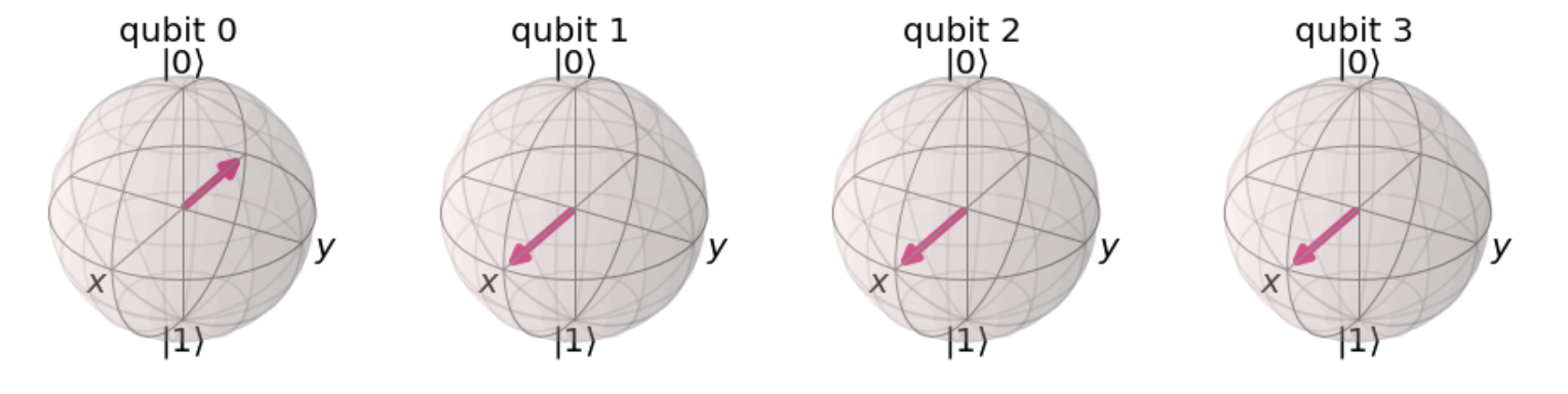
(f)

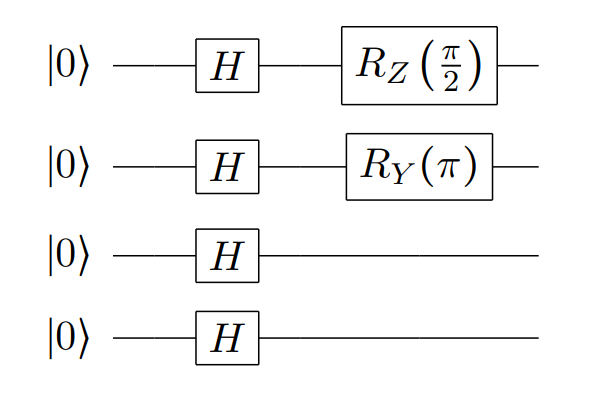


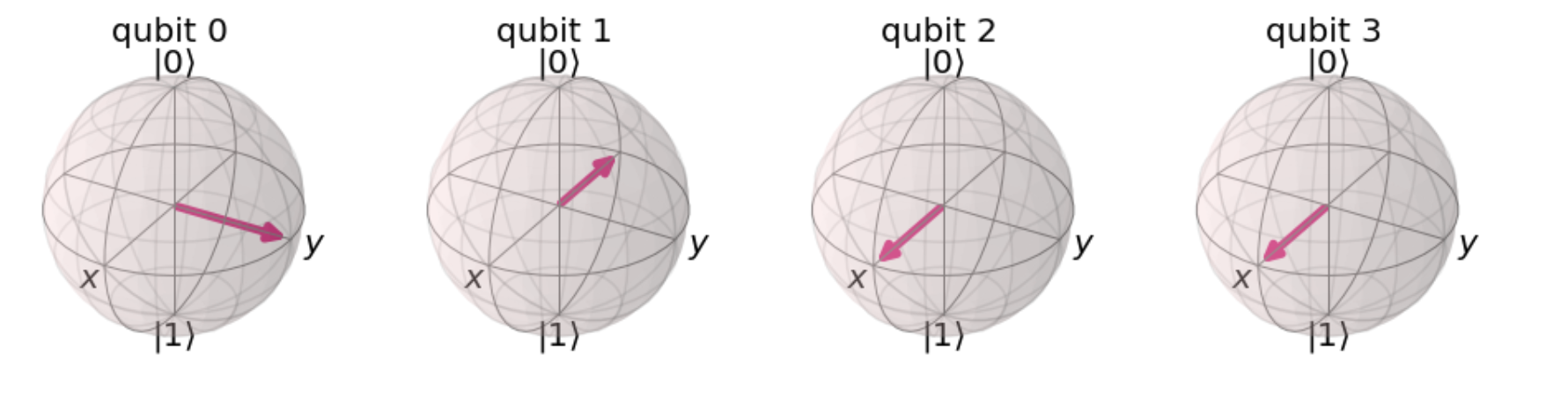
We will always get the same probability of all qubit states. The reason is we flip the half amount of qubits rather than one, which cause nothing difference. In other words, grover search cannot search for too much targets.

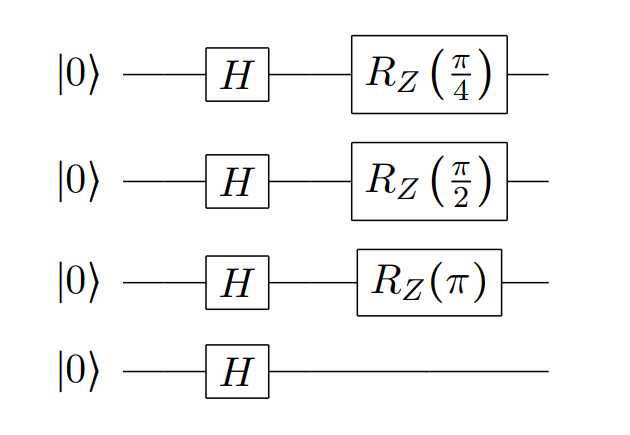
Q3.

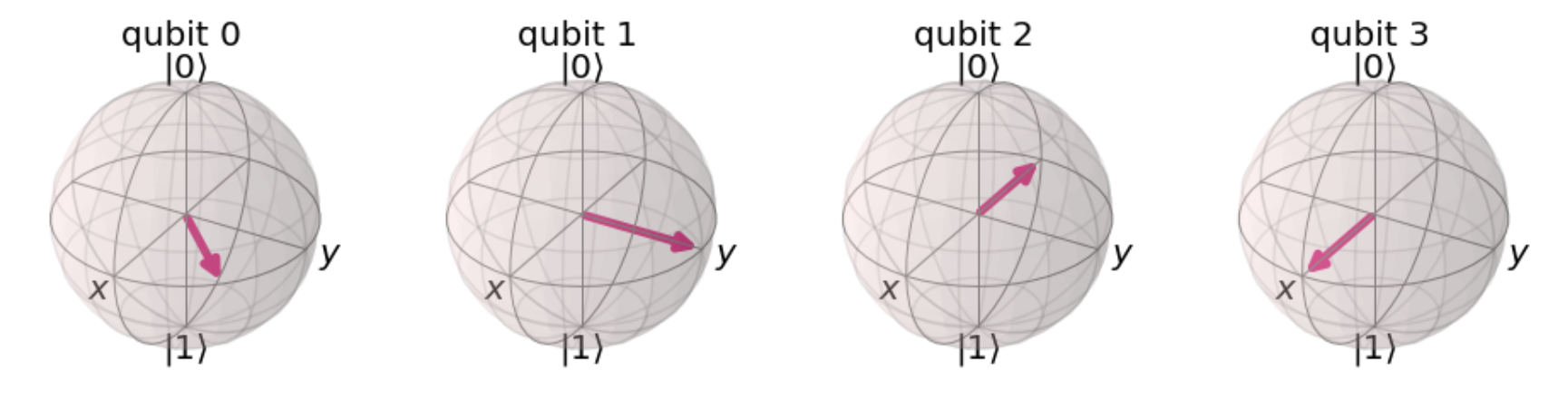




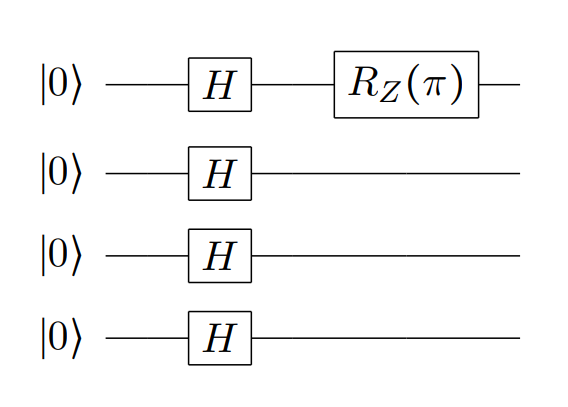


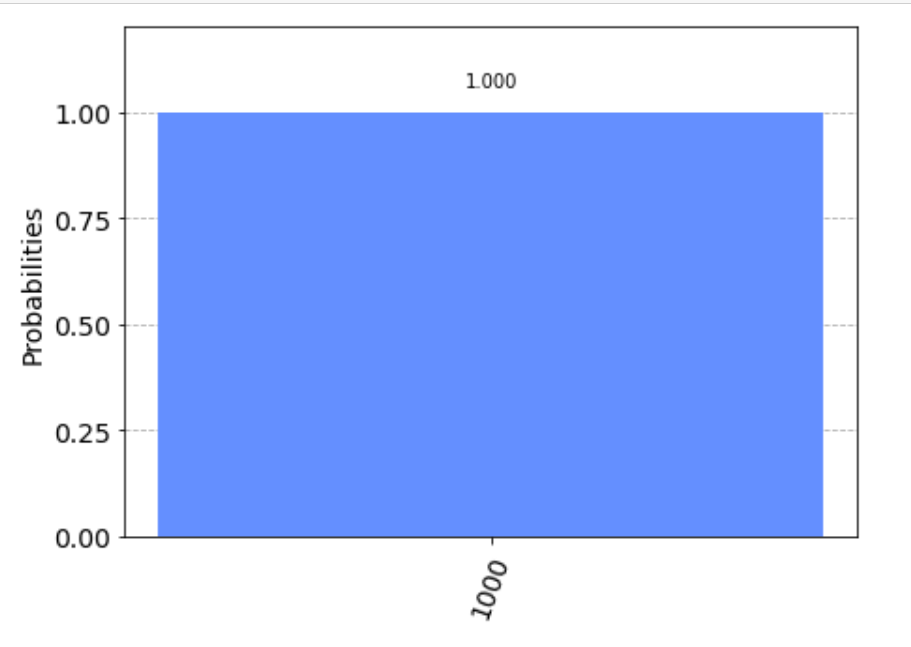


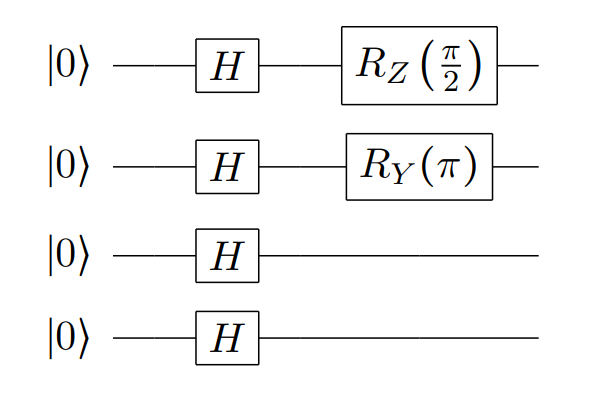


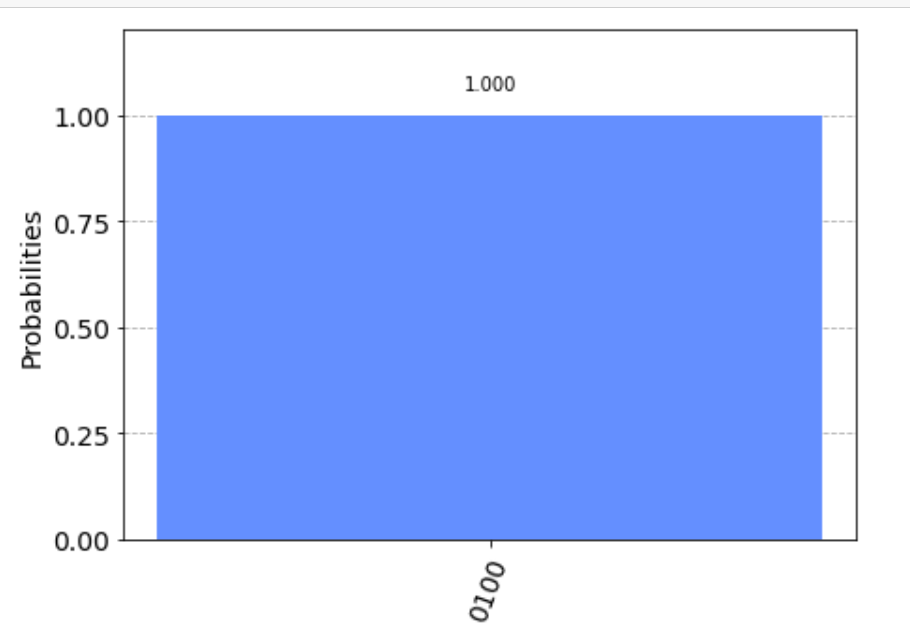


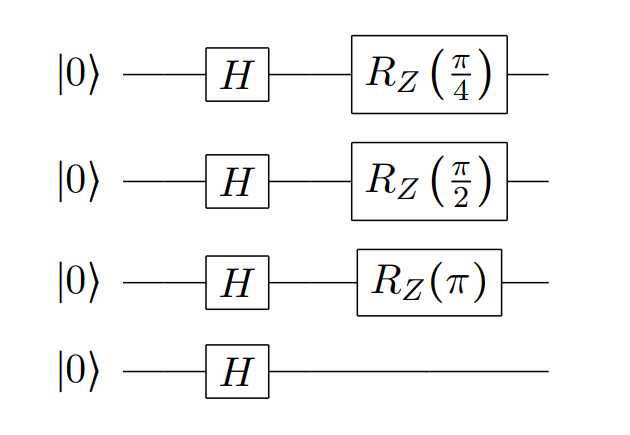
After applying QFT\_dagger, we get

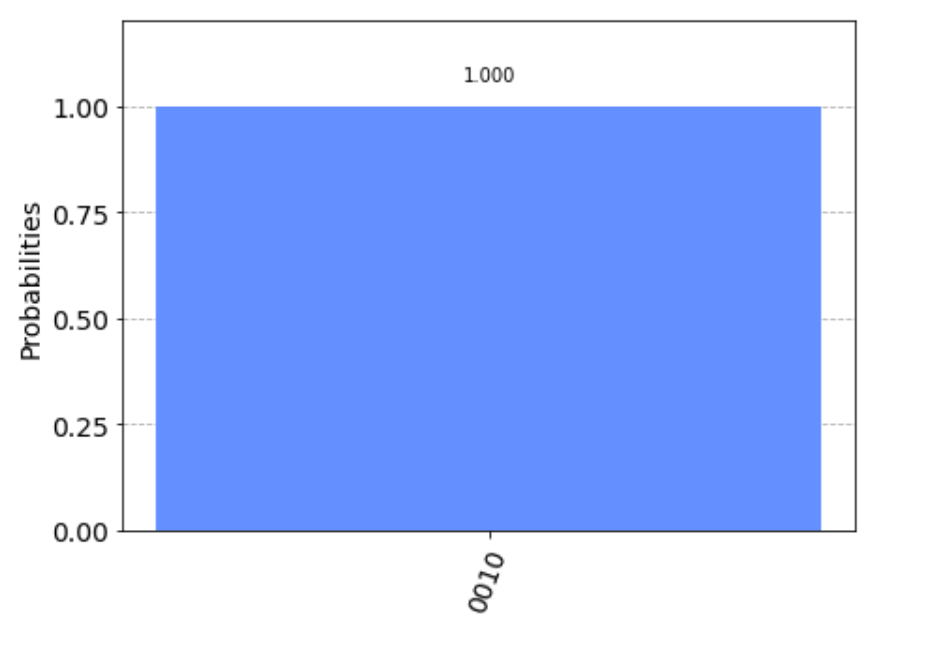












Q4.

Appendix

Code: <https://github.com/yuanchiachang/CommLab/blob/main/Lab3/src>

Reference :

[1] https://qiskit.org/textbook/ch-algorithms/deutsch-jozsa.html

[2] https://qiskit.org/textbook/ch-algorithms/grover.html

[3] https://qiskit.org/textbook/ch-algorithms/quantum-fourier-transform.html

[4] https://qiskit.org/textbook/ch-algorithms/shor.html