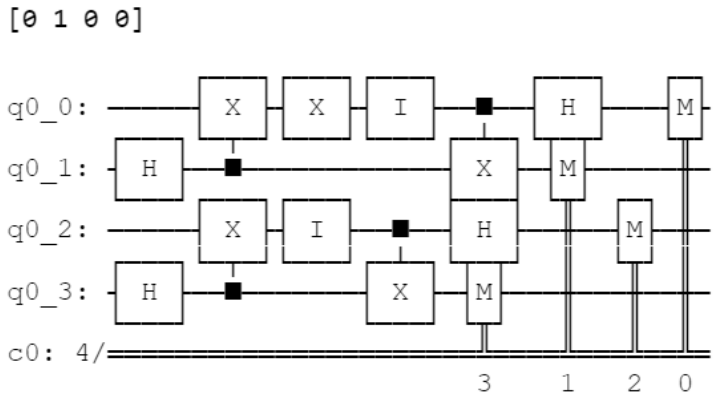
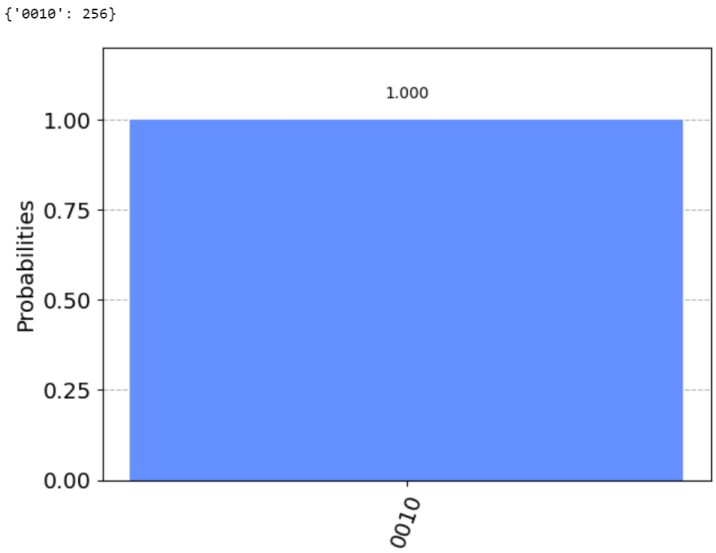
通信專題　　Lab_2　　B08901019 吳冠緯

1. (30 points) Superdense Coding

(a)





Please calculate the corresponding symbol error rate (SER) or package error rate (PER)

Ans.　　SER = PER = 0.0

Please calculate the bit error rate (BER)

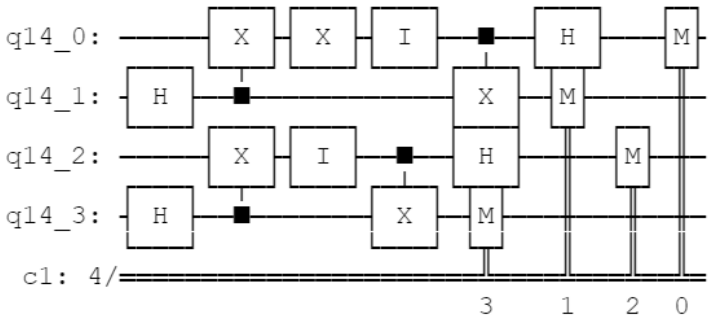
Ans.　　BER = 0.0

What is the relation between SER and BER

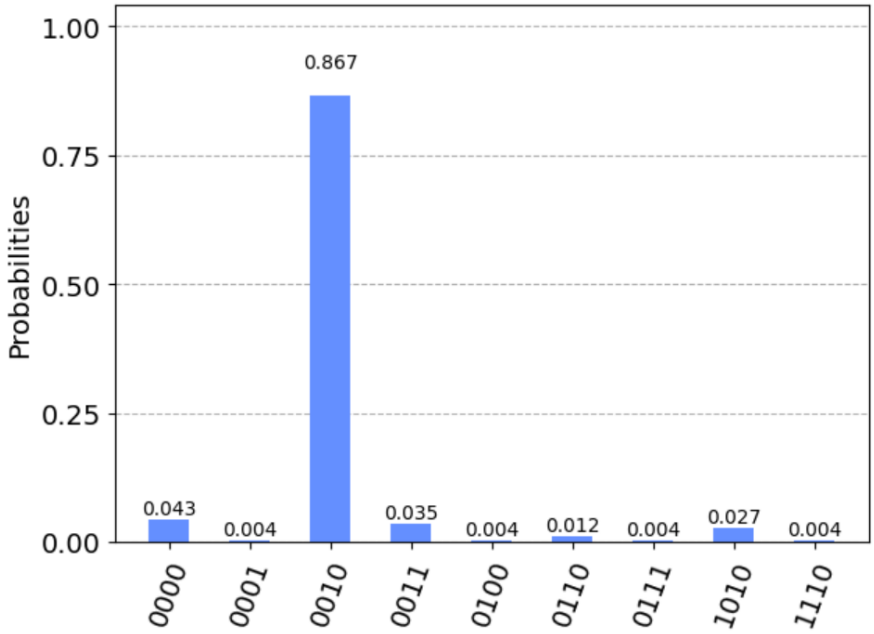
Ans.　　SER = BER = 0.0

(b)

```
[0 1 0 0]
```




```
{'0000': 11, '0001': 1, '0010': 222, '0011': 9, '0100': 1, '0110': 3, '0111': 1, '1010': 7, '1110': 1}
```

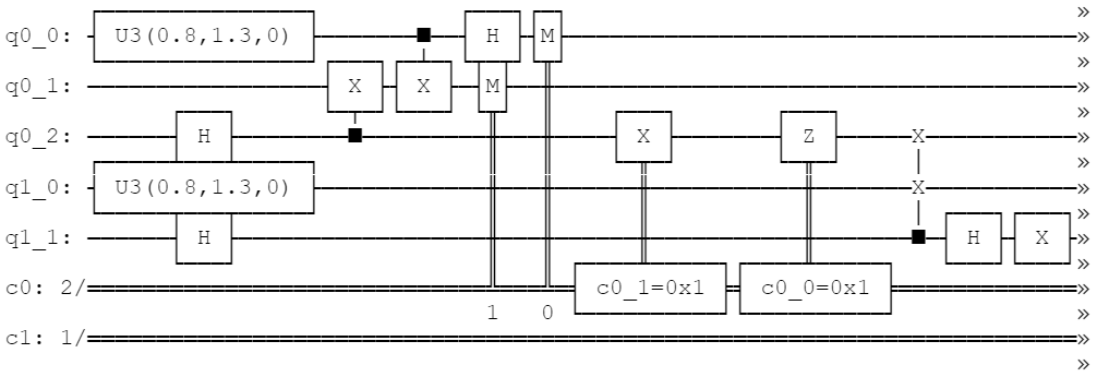


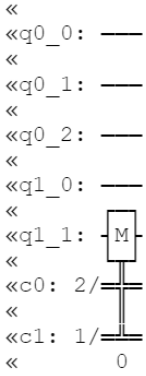

```
SER =  0.0703125
BER =  0.037109375
```

SER > BER

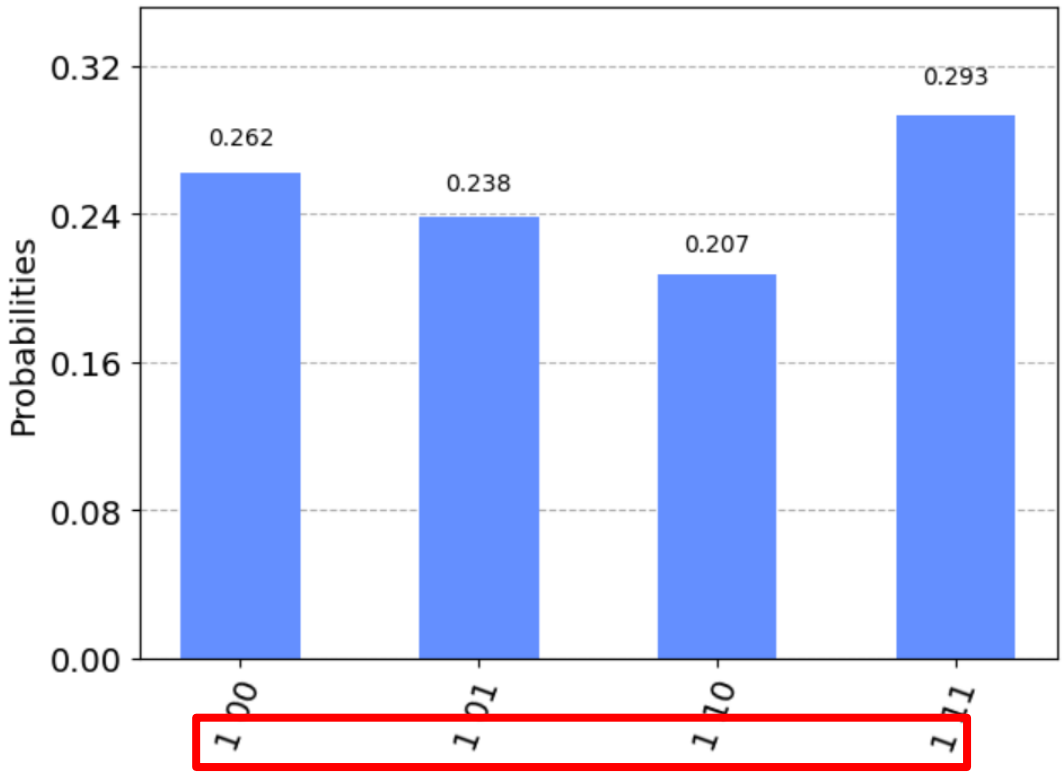
2. (45 points) Quantum Teleportation

(a) A



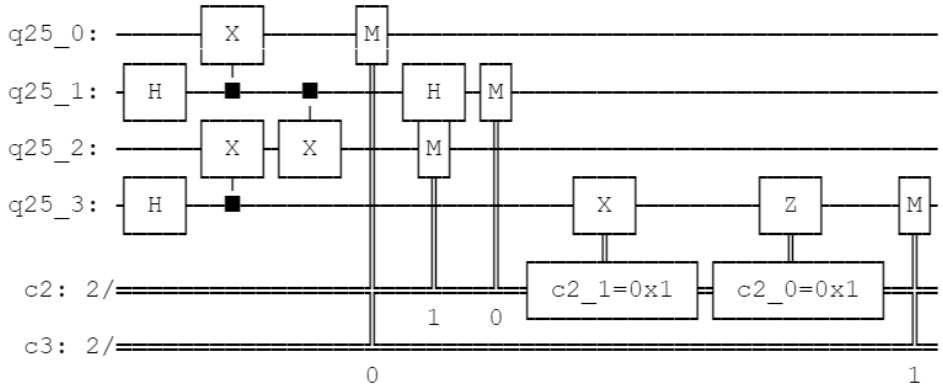



```
{'1 11': 75, '1 01': 61, '1 10': 53, '1 00': 67}
```

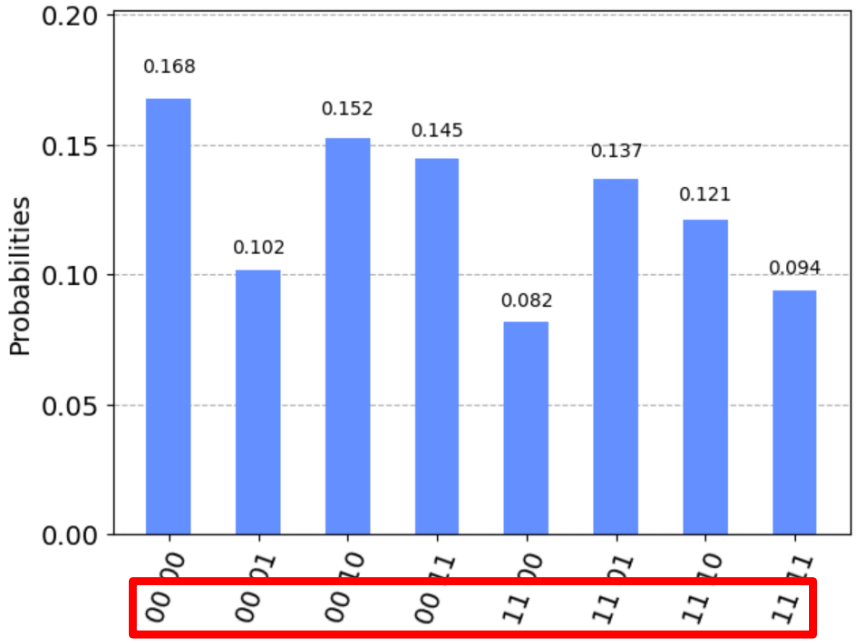


(iii) The result of swap test is all '1'

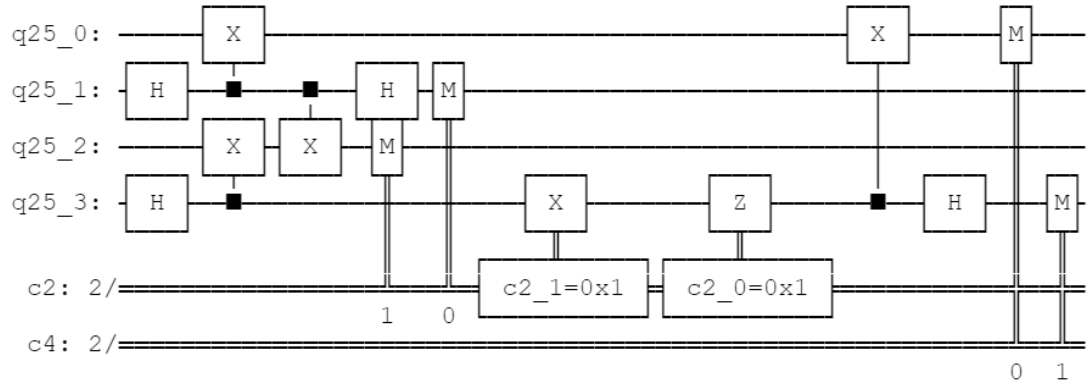
(b)



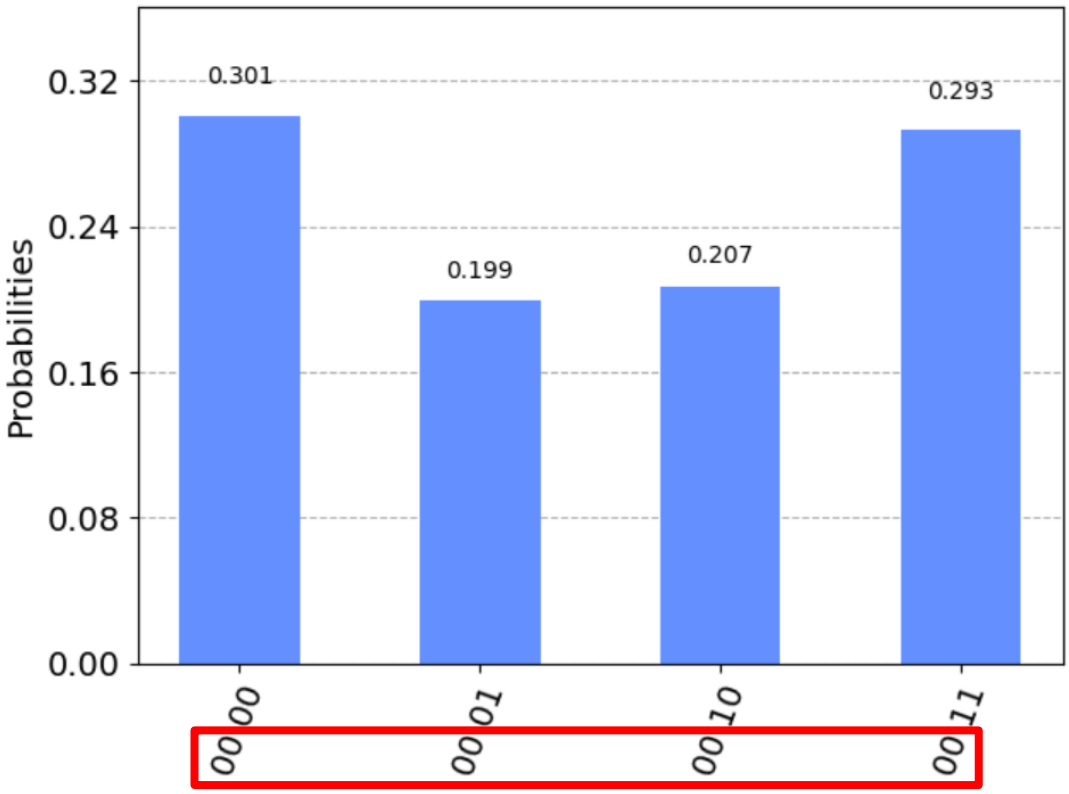
{'00 01': 26, '00 10': 39, '11 01': 35, '00 11': 37, '11 00': 21, '00 00': 43, '11 10': 31, '11 11': 24}



‘00’ 0.567
‘11’ 0.434



```
{'00 01': 51, '00 11': 75, '00 00': 77, '00 10': 53}
```



All the results reverse to '00'

3. **(30 points) The BB84 Protocol**

(a)

```
Successfully interception probability is :  0.51
2.34
```

For size (n) = 10, sample half (50%) of the bits from the keys (both Alice's and Bob's results). From the output of my code, there is an average of 2.34 bits for the sampled results and the probability that Eve successfully intercepting is 0.51, so the value of c will be approximately calculated as 0.51^(1/2.34) = 0.7499…

(b)

Use Ry(3pi/4) and Ry(-3pi/4) gates

```
Successfully interception probability is :  0.62
2.1
```

For size (n) = 10, sample half (50%) of the bits from the keys (both Alice's and Bob's results). From the output of my code, there is an average of 2.1 bits for the sampled results and the

probability that Eve successfully intercepting is 0.62, so the value of c will be approximately calculated as 0.62^(1/2.1) = 0.7964…

(c) C

4. (Bonus 10 points)

Use U3(pi/2, 0, pi/2) and U3(pi/2, pi/2, 0) gates

```
Successfully interception probability is :  0.4
2.2
```

For size (n) = 15, sample half (50%) of the bits from the keys (both Alice's and Bob's results). From the output of my code, there is an average of 2.2 bits for the sampled results and the probability that Eve successfully intercepting is 0.4, so the value of c will be approximately calculated as 0.4^(1/2.2) = 0.6593…

For c, 1/3 + (2/3)(1/2) = 2/3 is smaller than 1/2 + (1/2)(1/2) = 3/4, and the exponential term (k in c^k) which is approximately equal to n/2 and n/3. So after sampling with a 50% ratio, the value of k for c = 2/3 will be smaller than that for c = 3/4.

Fixed:

Phi should be in the middle of x-axis and y-axis, which is equal to (pi/2)/2 = pi/4, and for the -x-axis and -y-axis, (pi/4) + pi = 5pi/4

Theta should let the x-part, y-part, and z-part have the same length, thus [the midway basis] : [x-part + y-part] : [distance to xy-plane] = $\sqrt{(1)^2 + \left(\frac{1}{\sqrt{2}}\right)^2} : 1 : \frac{1}{\sqrt{2}}$

Thus the cos(theta) should has a value of $\frac{1}{\sqrt{3}}$ **, which means theta = arccos(**$\frac{1}{\sqrt{3}}$**)**

```
Successfully interception probability is :  0.47
2.2
```

For size (n) = 15, sample half (50%) of the bits from the keys (both Alice's and Bob's results). From the output of my code, there is an average of 2.2 bits for the sampled results and the probability that Eve successfully intercepting is 0.47, so the value of c will be approximately calculated as 0.47^(1/2.2) = 0.7095…

實驗心得：

這次的實驗比較不像第一次實驗，有大部分的比例是在熟悉基礎的操作和知識，這次實驗反而比較多都是在模擬和探索量子通信理論在應用層面上實際的主題。這次題目提及的，與量子通信安全相關的部分我也覺得十分有趣且重要，理解上花了較多時間，也透過實作更了解其背後的意涵。