

1.

(a)(b)

```
>> answer1
```

```
Estimated x_hat without noise:
```

```
1.0000 - 1.0000i  
-1.0000 - 3.0000i  
3.0000 - 3.0000i
```

```
Estimated x_hat with noise:
```

```
1.8622 - 1.3070i  
-1.6669 - 2.4187i  
3.7618 - 3.2270i
```

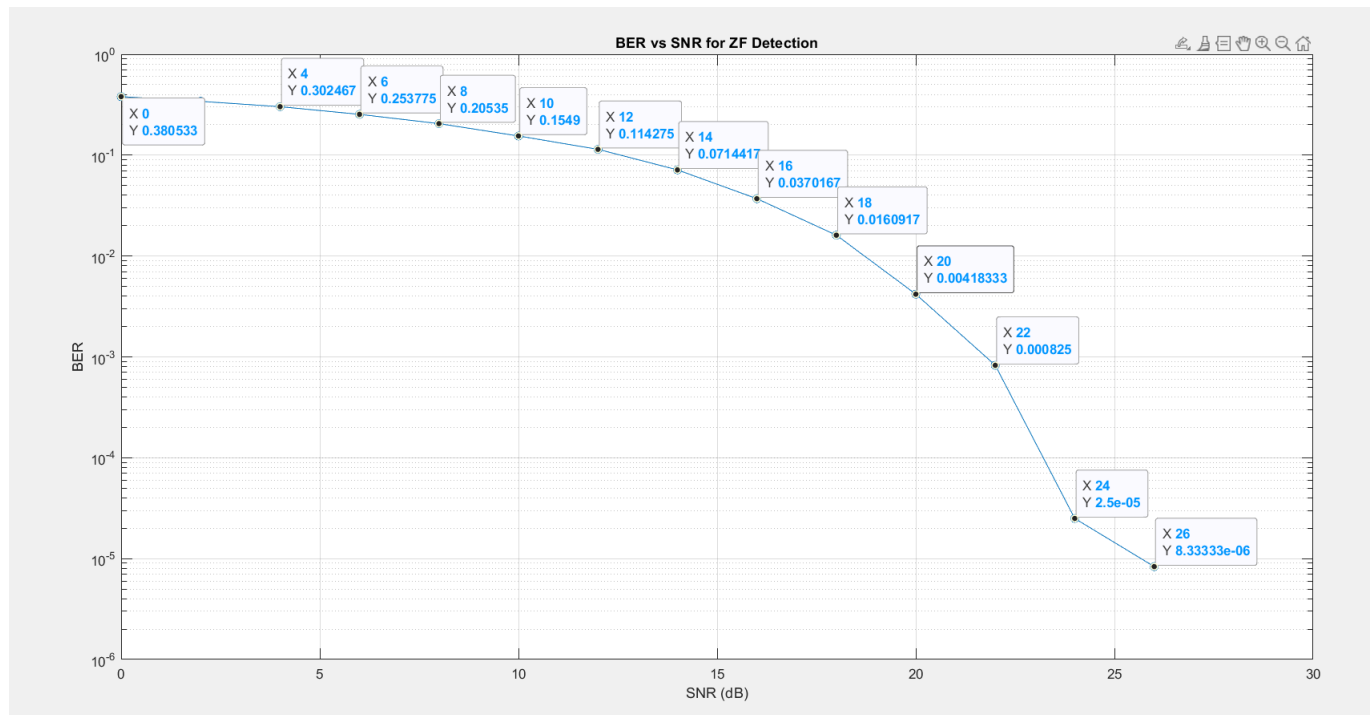
```
Detected x_hat with noise (mapped to 16-QAM):
```

```
1.0000 - 1.0000i  
-1.0000 - 3.0000i  
3.0000 - 3.0000i
```

(c)

我使用的範圍SNR = 0 : 2 : 30

每個點模擬10000次求出BER



2.

(a)(b)(d)(e)

```
>> answer2
```

```
signal detected first is:
```

```
1
```

```
the value of the signal detected first is:
```

```
1.0000 - 1.0000i
```

```
signal detected second is:
```

```
2
```

```
the value of the signal detected secondt is:
```

```
-1.0000 - 3.0000i
```

```
signal detected third is:
```

```
3
```

```
the value of the signal detected third is:
```

```
3.0000 - 3.0000i
```

(c)

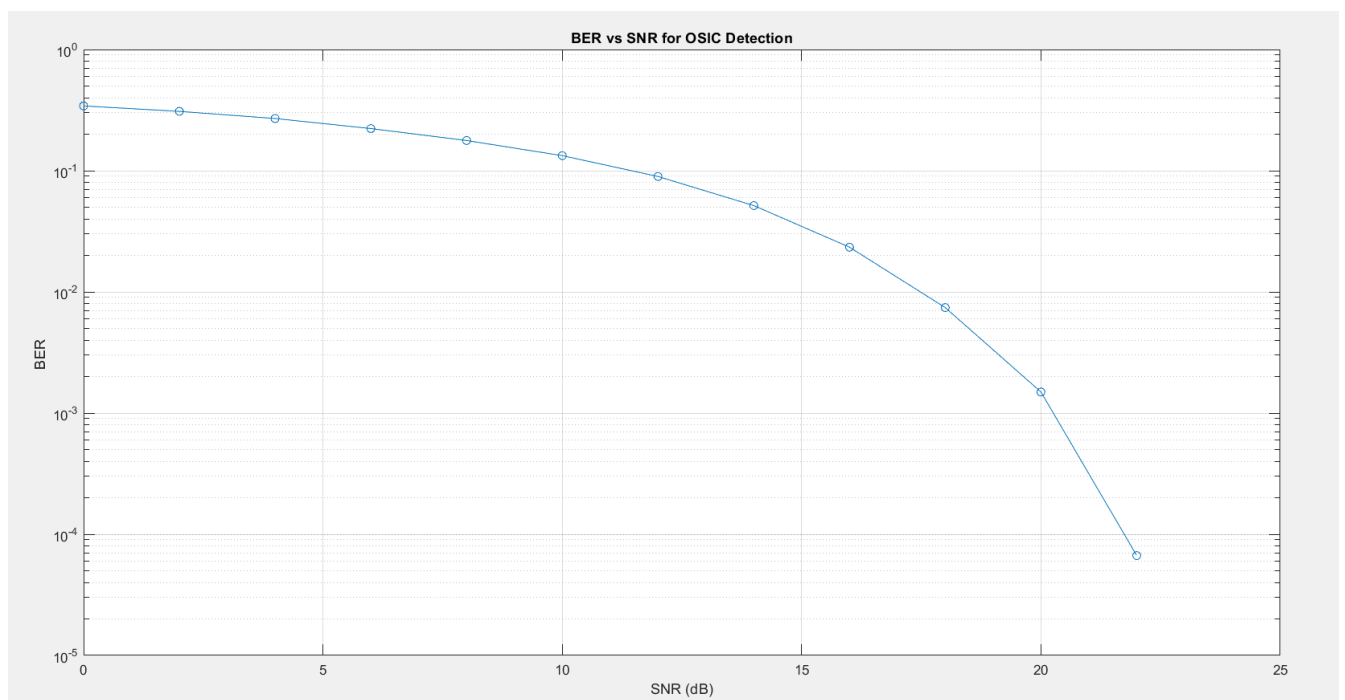
$$y(i) = H(i) x(i) + \text{noise}$$

$$\begin{bmatrix} y^{(1)} \\ y^{(2)} \\ y^{(3)} \end{bmatrix} = \begin{bmatrix} H^{(1,2)} & H^{(1,3)} \\ H^{(2,2)} & H^{(2,3)} \\ H^{(3,2)} & H^{(3,3)} \end{bmatrix} \begin{bmatrix} x^{(2)} \\ x^{(3)} \end{bmatrix} + \begin{bmatrix} n^{(1)} \\ n^{(2)} \\ n^{(3)} \end{bmatrix}$$

(f)

我使用的範圍SNR(dB) = 0 : 2 : 30

每個點模擬10000次求出BER



3.

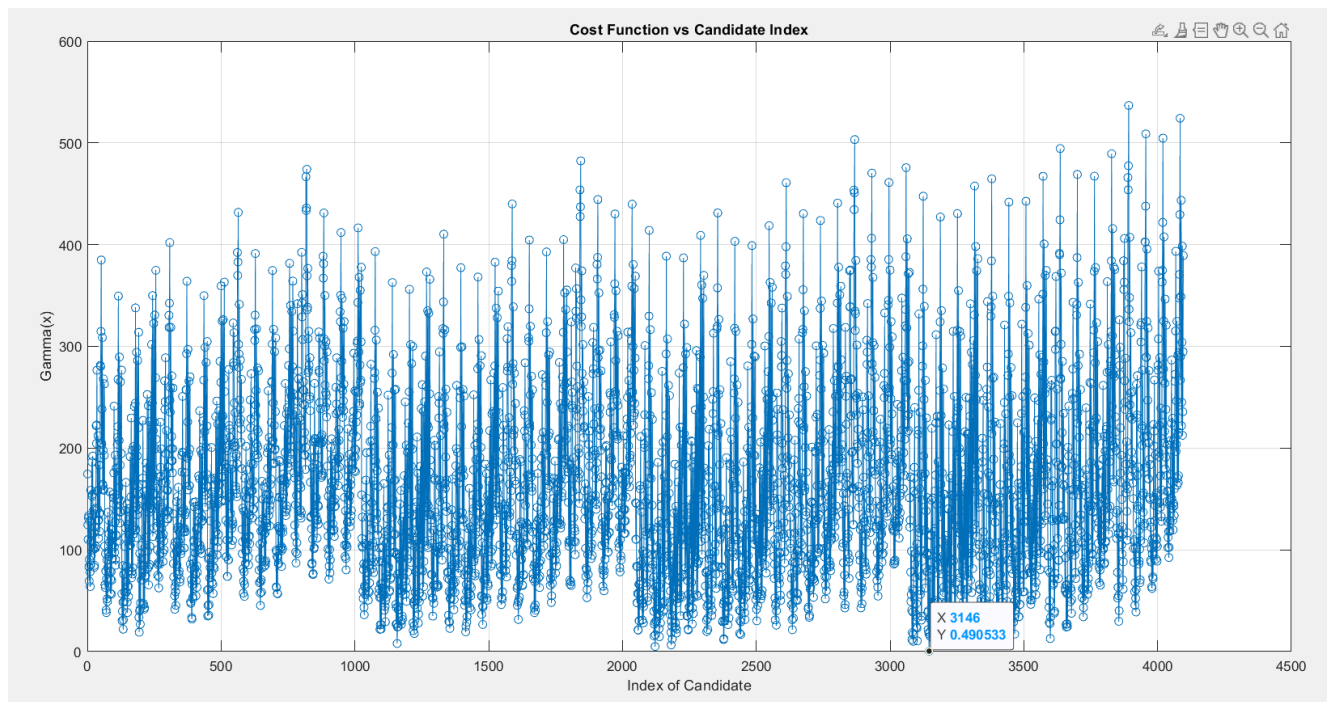
(a)~(d)

這是全部4096個possibility作圖:

可以發現最小的點是 X:3146 Y:0.490533

X的值不重要, 他只是產生的所有4096個可能裡面的某個index而已,
我們的目標是detect出X的index代表的qam constellation。

Y是cost function, 最小的cost function的值就是0.490533



```
>> answer3
Minimum cost function value: 0.49053
ML solution:
  1.0000 - 1.0000i
 -1.0000 - 3.0000i
  3.0000 - 3.0000i

z vector:
  2.9758 - 2.6369i
 -0.6009 - 7.0571i
 -1.8811 + 1.6136i

detected result (x_8B) is :
  1.0000 - 1.0000i  -1.0000 - 3.0000i   3.0000 - 3.0000i

cost function of x_8B is :
  0.4905

x_8B is the same as x_ML. This indicates the 8-best algorithm found the optimal solution.
>>
```

由上圖可以看到(z-vector也附在裡面), 偵測出來的跟實際ML solution一樣, 但這其實運氣好, 畢竟k-best無法保證最佳解。

原因是在pruning的過程中, 可能會因為k-best的決策而把通往最佳解的路徑提前prune掉。

以下, 是對所有leaf nodes作圖。

同前所述, X不重要, 重要的是我找出來的Y(minimum), 確實是0.490533, 這個和前面ML-solution找出來的結果一致。

