控制系統 HW3

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第 3 題的(c)小題和第 5 題需要進一步討論

1.

$$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{B}u$$

$$y = \mathbf{C}\mathbf{x} + \mathbf{D}u$$

(a)

```
sys_ss =

  A =
       x1
   x1  -10

  B =
       u1
   x1   1

  C =
       x1
   y1   1

  D =
       u1
   y1   0

Continuous-time state-space model.
```

(b)

```
sys_ss =

  A =
         x1    x2
   x1    -8  -2.5
   x2     2     0

  B =
       u1
   x1   2
   x2   0

  C =
         x1    x2
   y1  -1.5  -0.5

  D =
       u1
   y1   1

Continuous-time state-space model.
```

(c)

```
sys_ss =

  A =
        x1    x2    x3
   x1   -3  -1.5    -1
   x2    2     0     0
   x3    0   0.5     0

  B =
       u1
   x1   1
   x2   0
   x3   0

  C =
        x1   x2   x3
   y1    0  0.5    1

  D =
       u1
   y1   0

Continuous-time state-space model.
```

2.

(a)

```
sys_ss =

  A =
       x1  x2
   x1   0   1
   x2   2   8

  B =
       u1
   x1   0
   x2   1

  C =
       x1  x2
   y1   1   0

  D =
       u1
   y1   0

Continuous-time state-space model.


sys_tf =

         1
  -------------
  s^2 - 8 s - 2

Continuous-time transfer function.
```

(b)

```
sys_ss =

  A =
       x1  x2  x3
   x1   1   1   0
   x2  -2   0   4
   x3   5   4  -7

  B =
       u1
   x1  -1
   x2   0
   x3   1

  C =
       x1  x2  x3
   y1   0   1   0

  D =
       u1
   y1   0

Continuous-time state-space model.


sys_tf =

          6 s - 10
  -----------------------
  s^3 + 6 s^2 - 21 s + 10

Continuous-time transfer function.
```

(c)

```
sys_ss =

  A =
       x1  x2
   x1   0   1
   x2  -1  -2

  B =
       u1
   x1   0
   x2   1

  C =
       x1  x2
   y1  -2   1

  D =
       u1
   y1   0

Continuous-time state-space model.
```

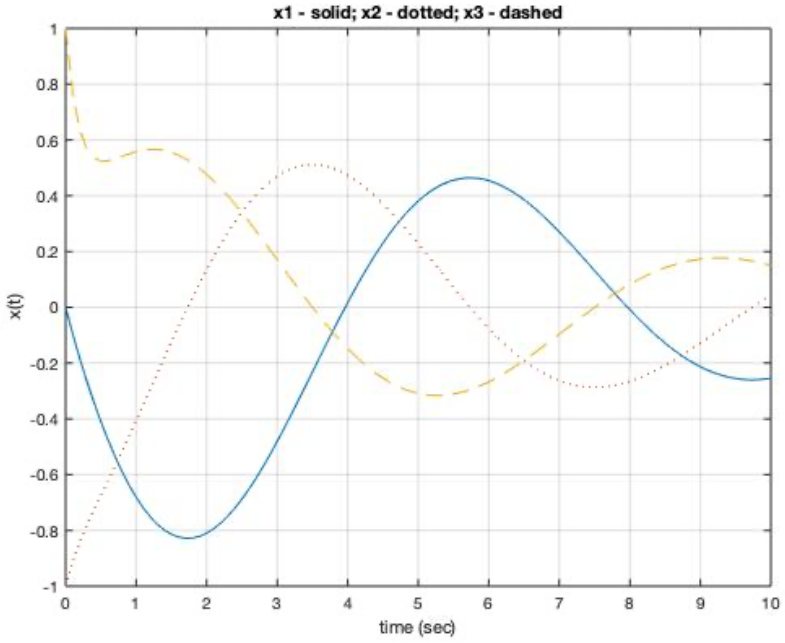
```
sys_tf =

      s - 2
  -------------
  s^2 + 2 s + 1

Continuous-time transfer function.
```

3.

(a)

```
  A =
       x1  x2  x3
   x1   0   1   0
   x2   0   0   1
   x3  -3  -2  -5

  B =
       u1
   x1   0
   x2   0
   x3   1

  C =
       x1  x2  x3
   y1   1   0   0

  D =
       u1
   y1   0

Continuous-time state-space model.


sys_tf =

             1
  ----------------------
  s^3 + 5 s^2 + 2 s + 3

Continuous-time transfer function.
```

(b)



(c)

```
xf_sim =

   -0.2545
    0.0418
    0.1500


xf_phi =

   -0.2545
    0.0418
    0.1500
```

可看出 b 與 c 小題算出的 x 是一致的。

b 小題根據 matlab 說明

`lsim(sys,u,t,x0)` specifies a vector `x0` of initial state values, when `sys` is a state-space model.

`[y,tOut,x] = lsim(__)` returns the state trajectories x, when `sys` is a state-space model. X is an array with as many rows as there are time samples and as many columns as there are states in `sys`.

b 小題使用 lsim fuc. 得到 x，帶入 t = 10，算出來的 x 為 xf_sim。

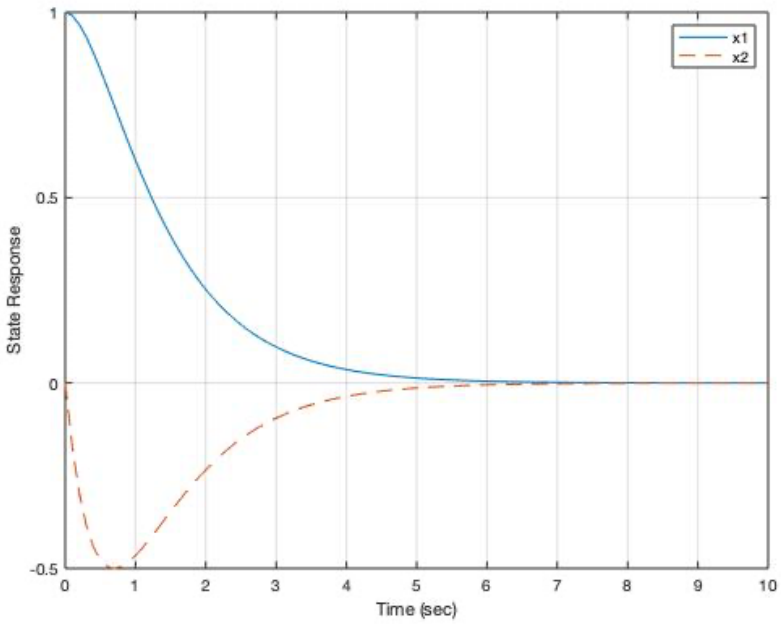
C 小題根據講義

```
function [phi] = statetrans(A)
    t = sym('t');
    phi = expm(A * t);
end
```

$$\mathbf{X}(s) = \mathbf{\Phi}(s)\mathbf{x}(0).$$

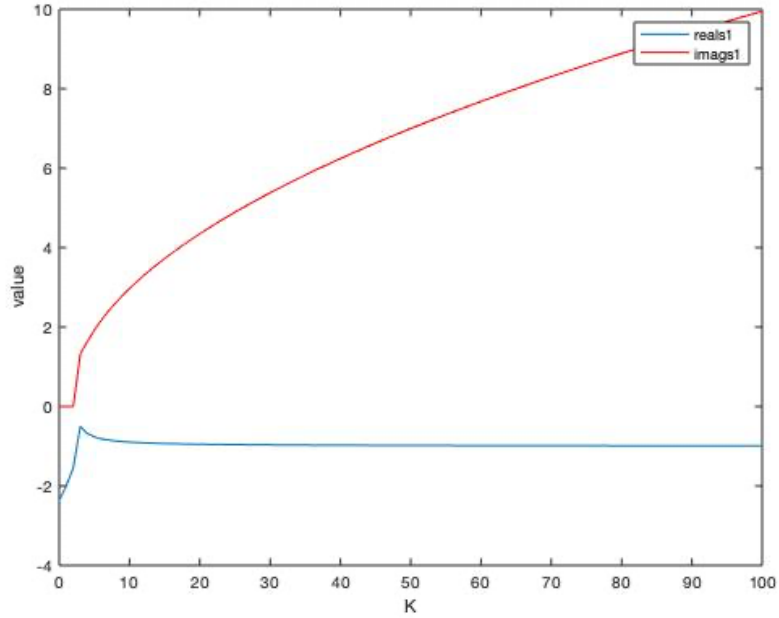
經過 expm fun. 算出的 state transition matrix，與 x0 相乘，得到的 x 為 xf_phi。

4.

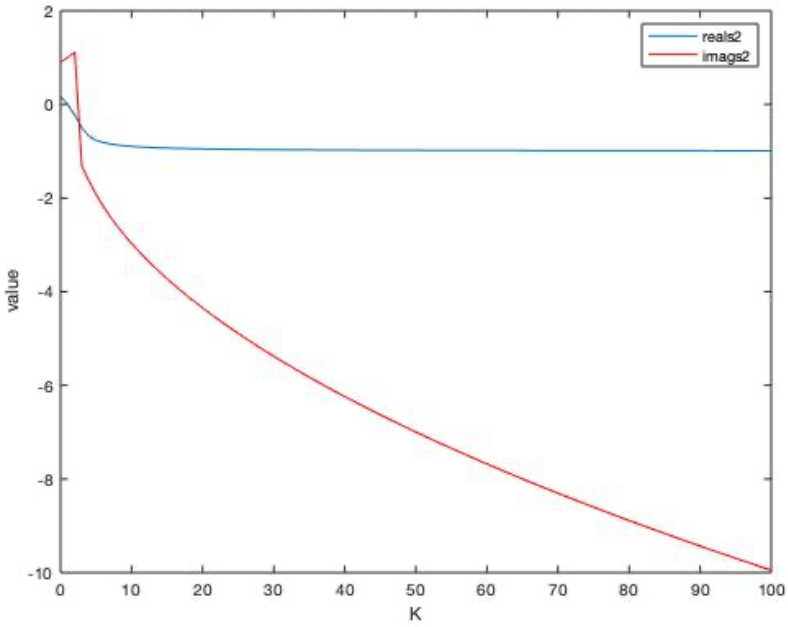


5.

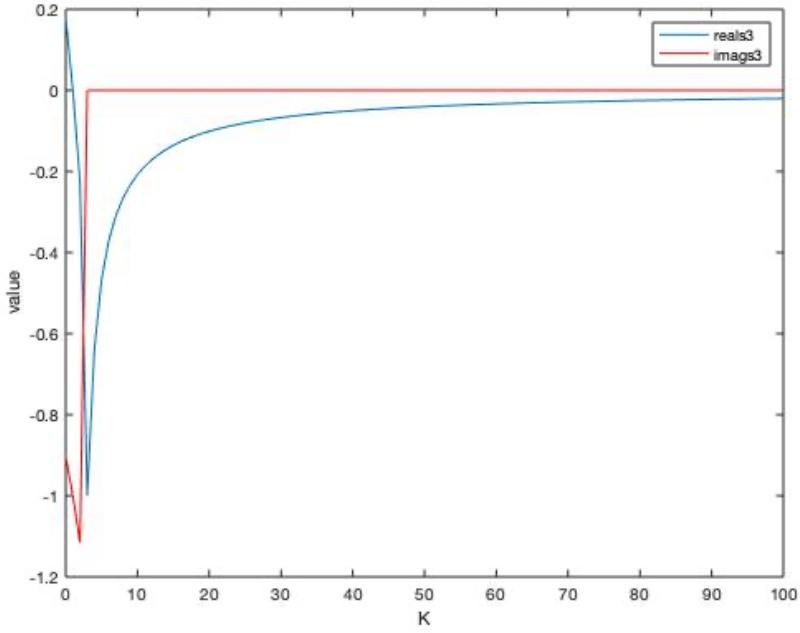
第 1 個 root



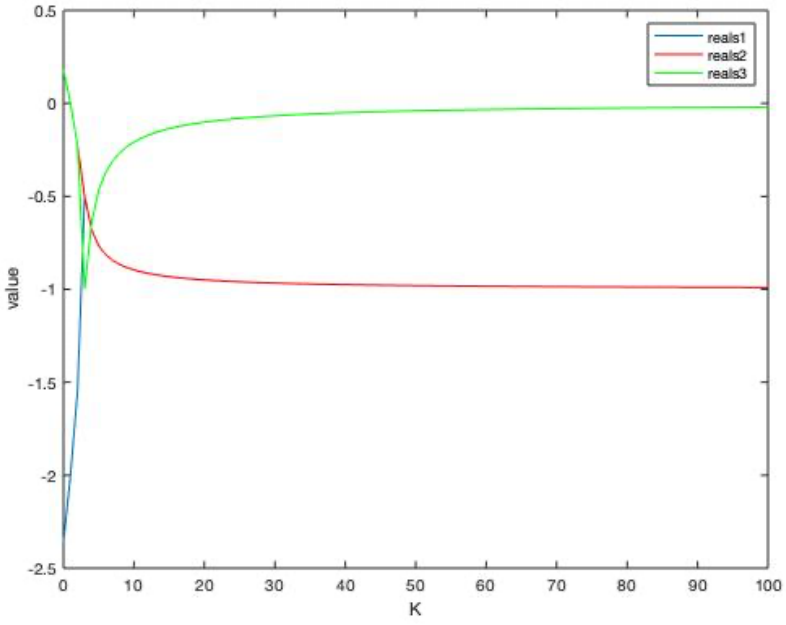
第 2 個 root

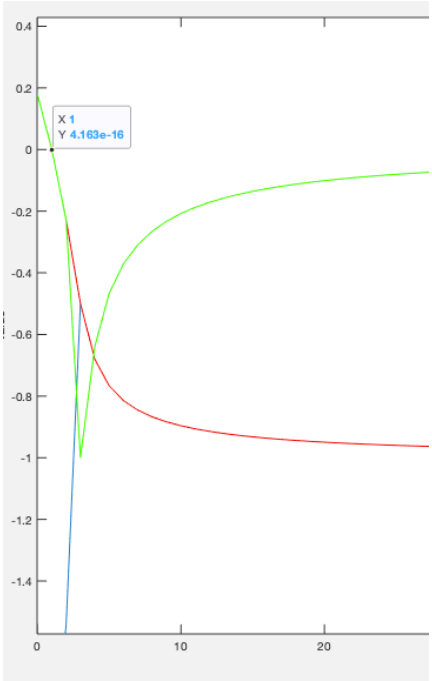


第 3 個 root



3 個 root 的 real part





Characteristic Value 要在左半平面就要讓 root 的 real part 小於 0，從上圖可看出，所有 roots 的 real part 大約在 K > 1 時會小於 0，也就是在 s plane 的左半平面，所以 K 的範圍是>1。