第 15 組:控制系統

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1.

(i)由圖可知:

峰值(Cmax)約等於 1.25

峰值時間(Tp)約等於 0.6

假設ζ值會滿足峰值(Cmax) 約等於 1.25

將ζ=0.404 代入公式:峰值(Cmax)=$1-e^{-\left(\zeta\pi/\sqrt{1-\zeta^2}\right)}$

會滿足峰值(Cmax)約等於 1.25

再將ζ=0.404 代入公式:峰值時間(Tp)= $T_p=\dfrac{\pi}{\omega_n\sqrt{1-\zeta^2}}$

求得ω_n約等於 5.72

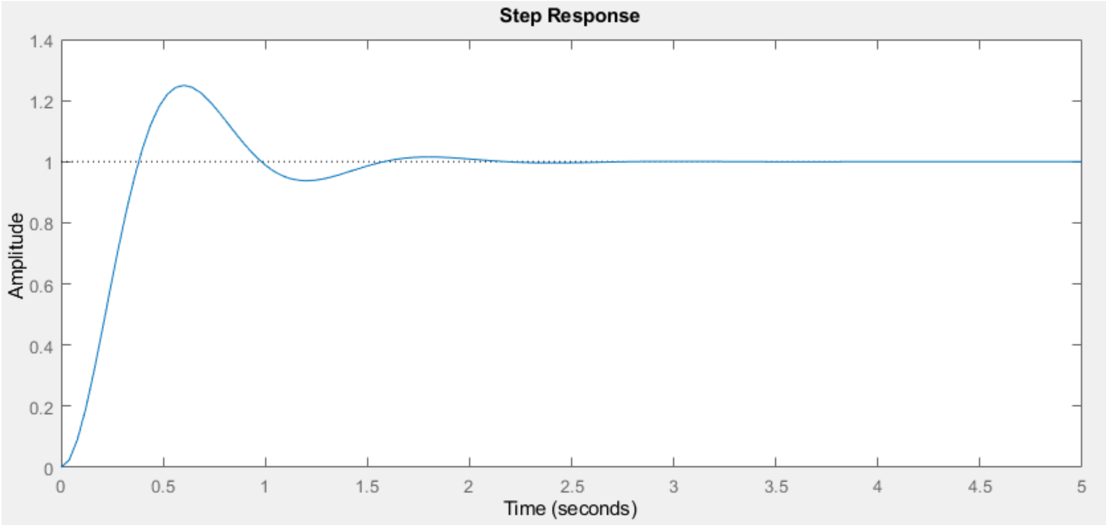
再將ζ與ω_n代入公式: $G(s)=\dfrac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$

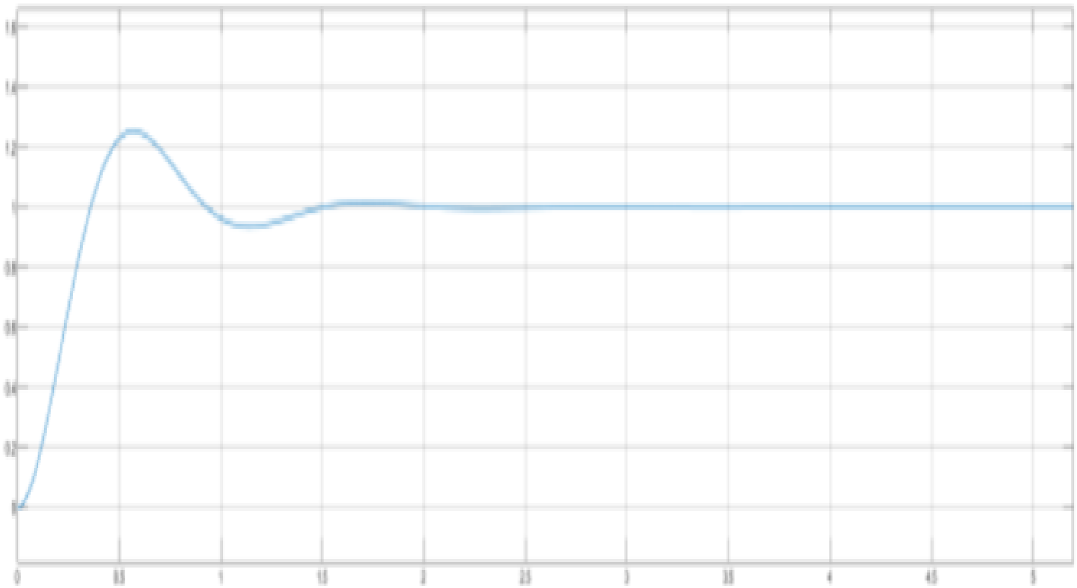
2*ζ*ω_n約等於 4.622

所以我們得出的轉移函數答案為

G(s)=32.72/(s^2+4.622+32.72)

(ii)驗證:和原先的步階響應圖對比:





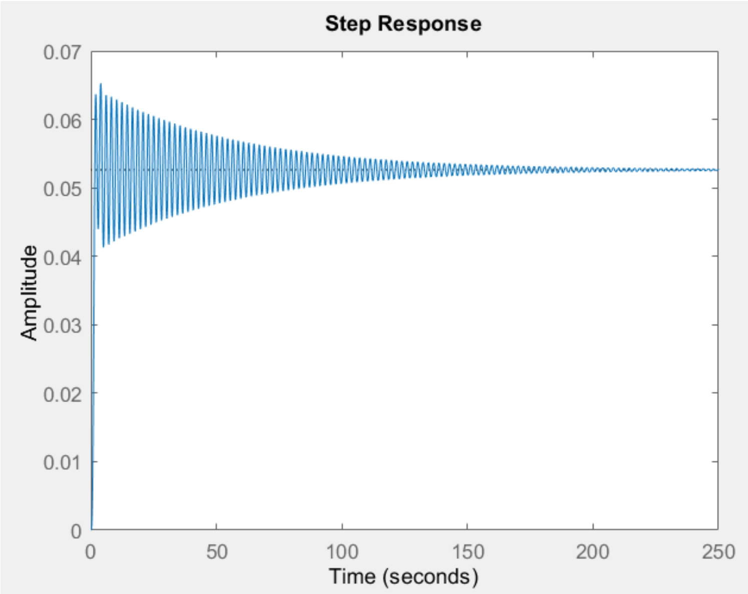
圖一 系統 A 之步階響應

從圖形的相似程度可驗證假設的正確性。

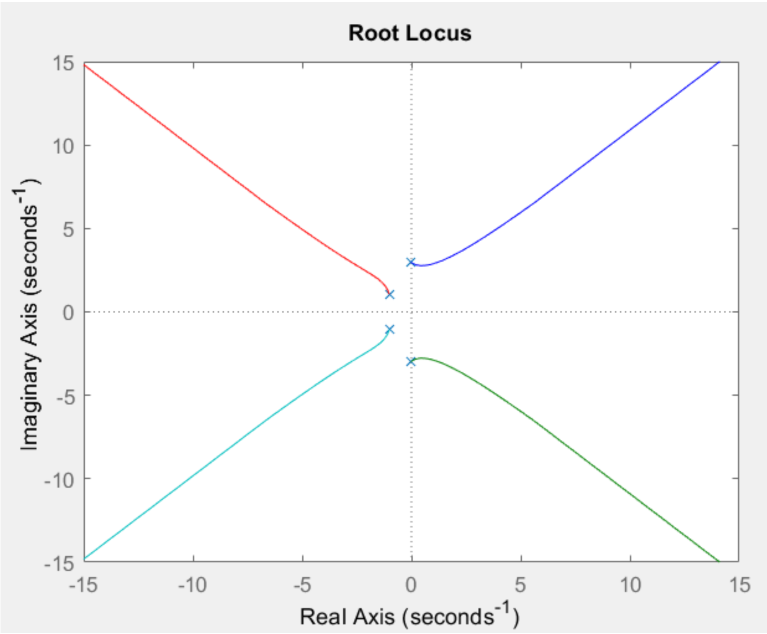
2.

(i) 要實現高頻振動形式，則裝置本身需要有近虛軸的複數極點作為轉移函數的一部分，因此假設 4 極點的系統中，其中兩接近虛軸的共軛極點為-0.03+3j, -0.03-3j，另外兩個共軛極點設為-1+j, -1-j。此時高頻振動裝置的單位步階響

應圖如圖一



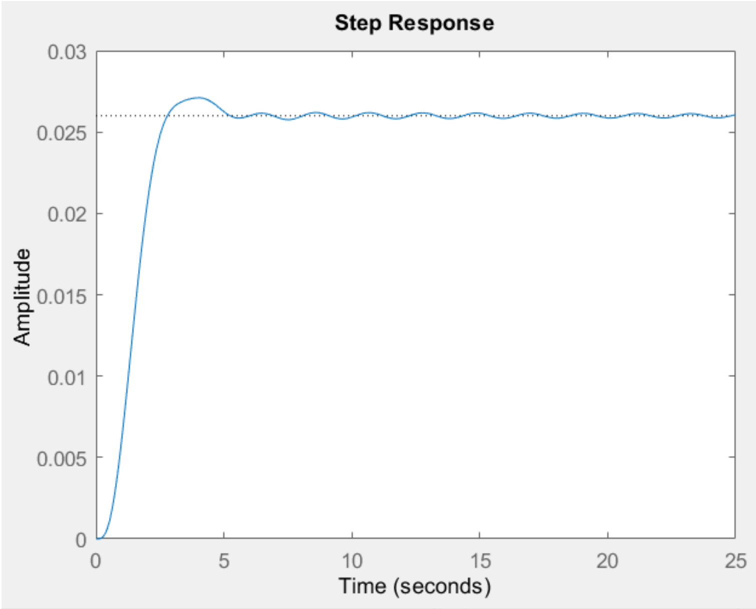
根軌跡如圖二



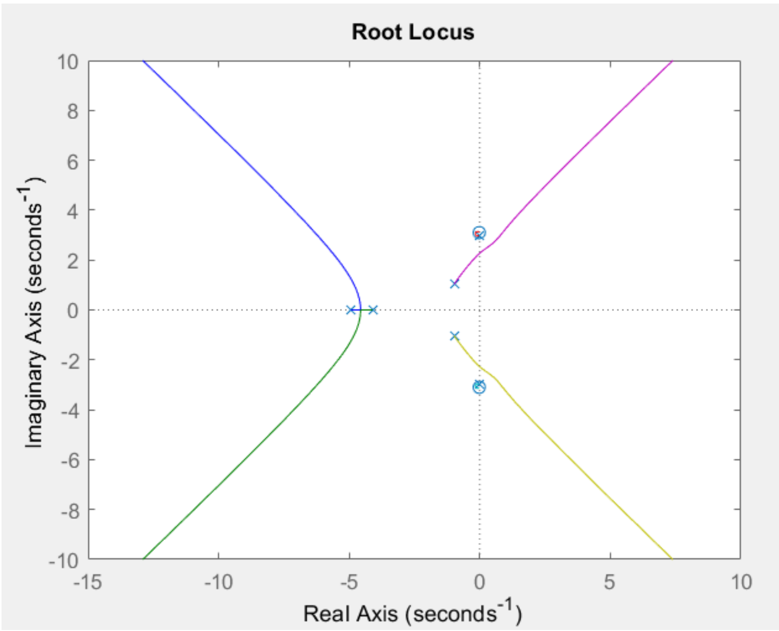
(ii)所設計的凹陷濾波器有兩實極點兩零點，其有兩個零點要靠近原裝置極點，能視為和原裝置極點互消，使裝置高頻響應可忽略，假設為-0.02+3.1j、-0.02-3.1j；另外兩個實

極點則為-4, -6。

互消後的單位步階響應圖如圖三



根軌跡如圖四

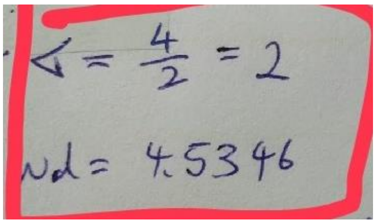


3.

%OS=25, Ts=2, e(∞)=0, 依據題目可算出 zeta=0.404 ，

arccos(0.404)=66.2。

補償主極點:



然後求出補償零點

$$180^{\circ}-\tan^{-1}(\frac{4.535}{2})+180^{\circ}-\tan^{-1}(\frac{4.535}{2-1.71})+\tan^{-1}(\frac{4.535}{100-2})$$

$$= 113.8^{\circ}+93.65^{\circ}+2.64^{\circ}=210.09$$

$$= 210.09^{\circ}-180^{\circ}=30.09^{\circ}$$

$$\tan(30.09)=\frac{4.535}{Z_c-2} \quad ， Z_c=-9.8$$

$$PD_{controller}=G_{PD}(s)=(s+9.8)$$

$$PI_{controller}=G_{PI}=\frac{s+0.5}{s}$$

$$G_{PID}=\frac{K(s+0.5)(s+9.8)}{s} = s+10.3+\frac{4.9}{s}$$

$$G_c(s)=-[(\frac{R_2}{R_1}+\frac{C_1}{C_2})+R_2C_1s+\frac{\frac{1}{R_1C_2}}{s}]$$

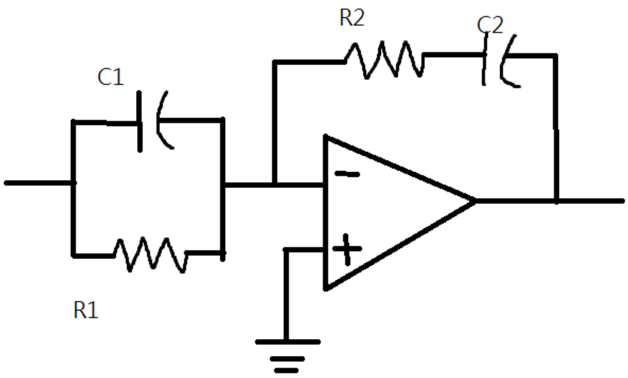
$$\left(\frac{R_2}{R_1}+\frac{C_1}{C_2}\right)=10.3$$

$$R_2C_1=1$$

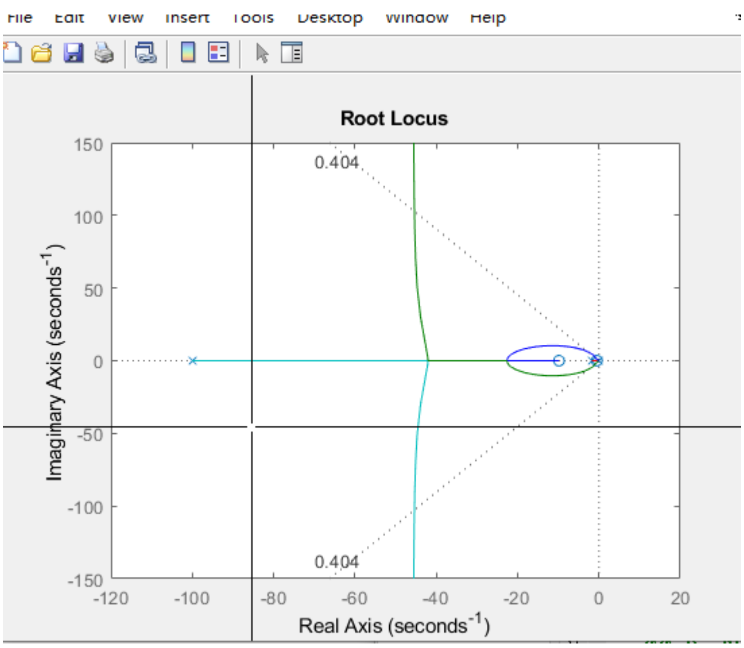
$$\frac{1}{R_1C_2}=4.9$$

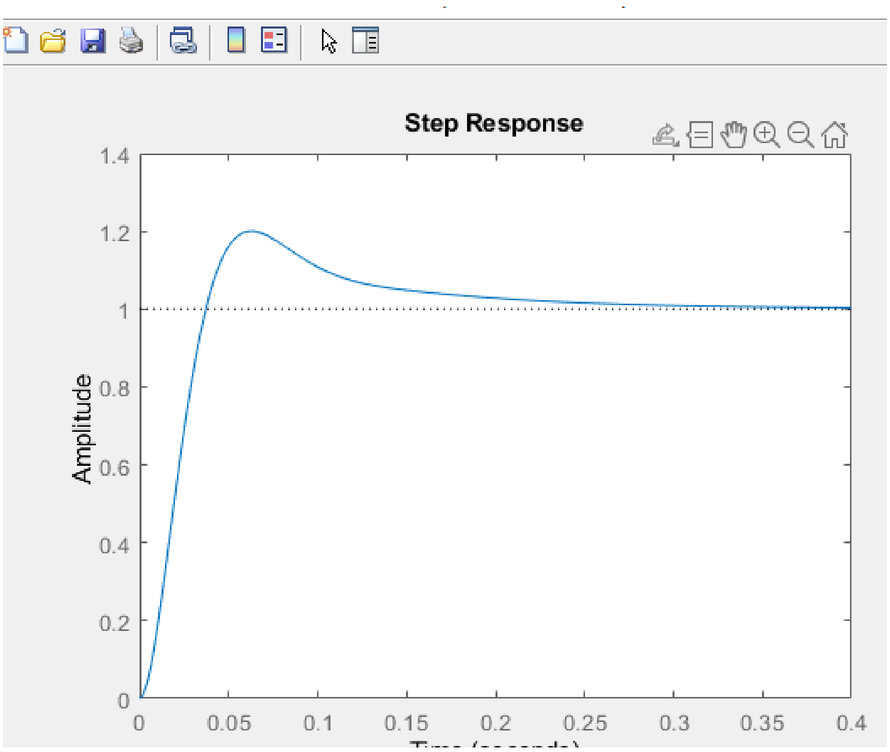
Assume: $C_2=0.1\mu F$

$R_1=2040.8k\Omega$ $R_1=2040.8k\Omega$
$C_1=0.49\mu F$ $C_1=0.49\mu F$
$R_2=202.14k\Omega$ $R_2=202.14k\Omega$



根軌跡





4.

作業程式碼:

```
%% 作業一
num=[32.72];            %轉移函數分子
den=[1 4.622 32.72];    %轉移函數分母
G=tf(num,den);          %轉移函數G
figure(1)               %選定圖片編號1的視窗
step(G,5)               %畫出G的步階響應圖
```

```
%% 作業二
pole=poly([-0.03+3j,-0.03-3j,-1+j,-1-j]); %%裝置極點
G1=tf(1,den);
T1=feedback(G1,1);
figure(1);
step(T1);
figure(2);
rlocus(T1);

Nzero=poly([-0.02+3.1j,-0.02-3.1j]);        %%凹陷濾波器零點
Npole=poly([-4,-5]);                        %%凹陷濾波器極點
G2=tf(Nzero,Npole);
T2=feedback(G1*G2,1);
figure(3);
step(T2);
figure(4);
```

%% 作業 3

```
clc
clear

%% 根軌跡
s=tf('s');
num = [6.63]
den = poly([0 -100 -1.71])
Ps=tf(num,den);

%% Run SISO tool to analyze Plant transfer function

%% PID method
Ps1=Ps
%% Run SISO tool to analyze Plant transfer function

%% Export the PD compensator for analysis
PD=(s+9.82)
```

```
%% Export the PD compensator for analysis
PD=(s+9.82)
Ps2=Ps1*PD

%% Apply PD compensation
%%  Export the PID compensator value for analysis
PID=(s+0.5)/s
Ps3=Ps2*PID
rlocus(Ps3)
sgrid(0.404,0)
[K,pole]=rlocfind(Ps3)

Ts3 = feedback(K*Ps3,1)

%%
step(Ts3)
%% Finally we will calculate our steady-state error (refer to equations)
```


```
Ps2=Ps1*PD

%% Apply PD compensation
%%  Export the PID compensator value for analysis
PID=(s+0.5)/s
Ps3=Ps2*PID
rlocus(Ps3)
sgrid(0.404,0)
[K,pole]=rlocfind(Ps3)

Ts3 = feedback(K*Ps3,1)

%%
step(Ts3)
%% Finally we will calculate our steady-state error (refer to equations)
```


```

kp=dcgain(Ps3); % dcgain is a function that will carry out our limit s
ess=1/(1+kp) % this is the equation for the steady state error for a s
```