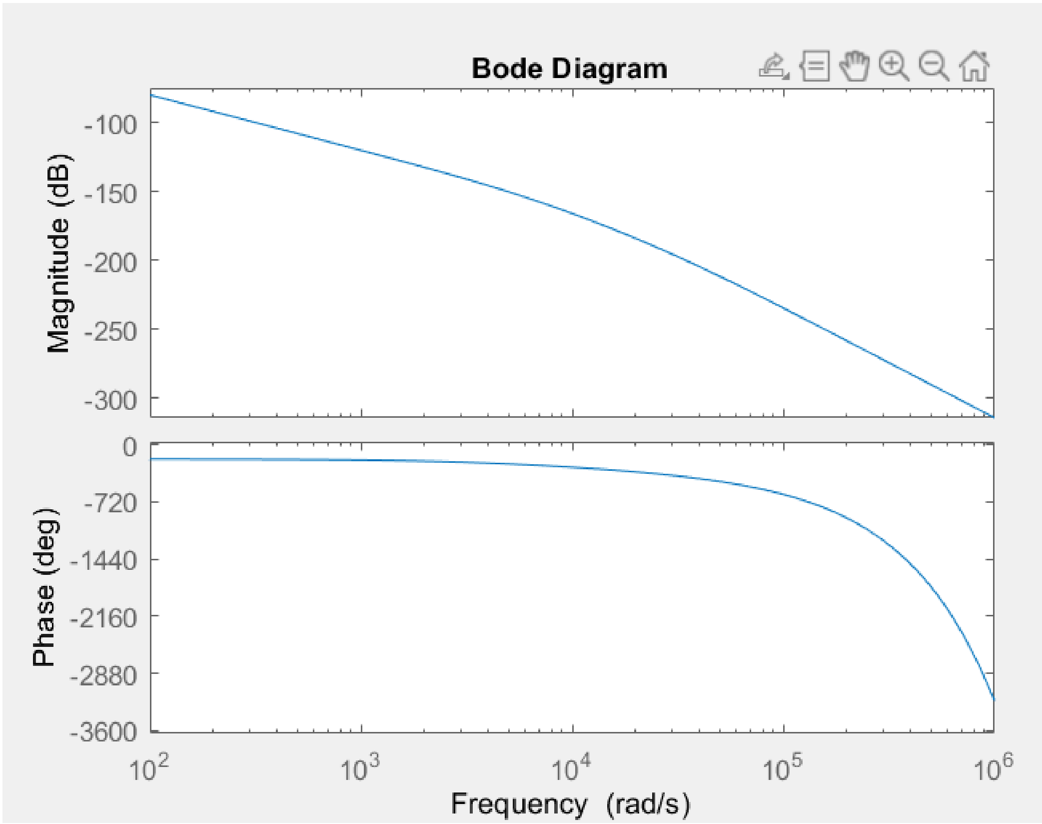
Ratthamnoon Prakitpong
#63205165

a.



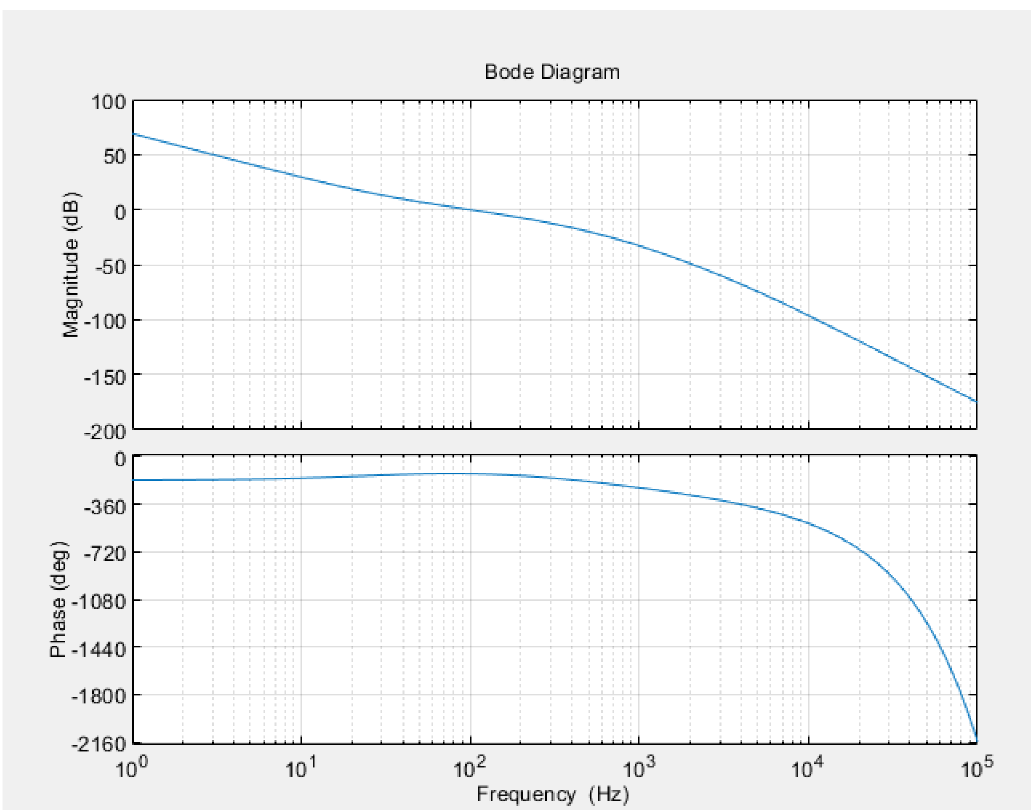

```
wa = 2*pi*10^3;
ws = 10*pi*10^3;
m = 1;
Ga = tf(1,[1/wa 1]);
Gs = tf(1,[1/ws 1]);
Gm = tf(1,[m 0 0]);
fs = 10000;
T = 1/fs;
syms s;
DAC = tf([10],[1], 'InputDelay',T/2);
Kf = 1;
ADC = 0.1;
% a
P = DAC*Ga*Kf*Gm*Gs*0.1;
bode(P);
```

b.

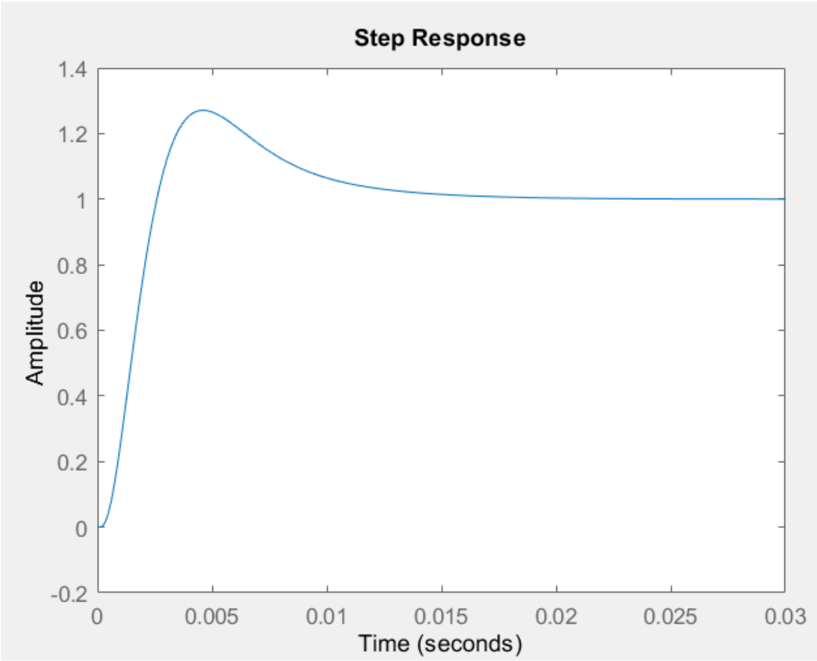
$$T = \frac{1}{\sqrt{a}\omega_m}$$

```
Pm =  49.2877

Kp =      112202

a =     12

t =    4.5944e-04
```

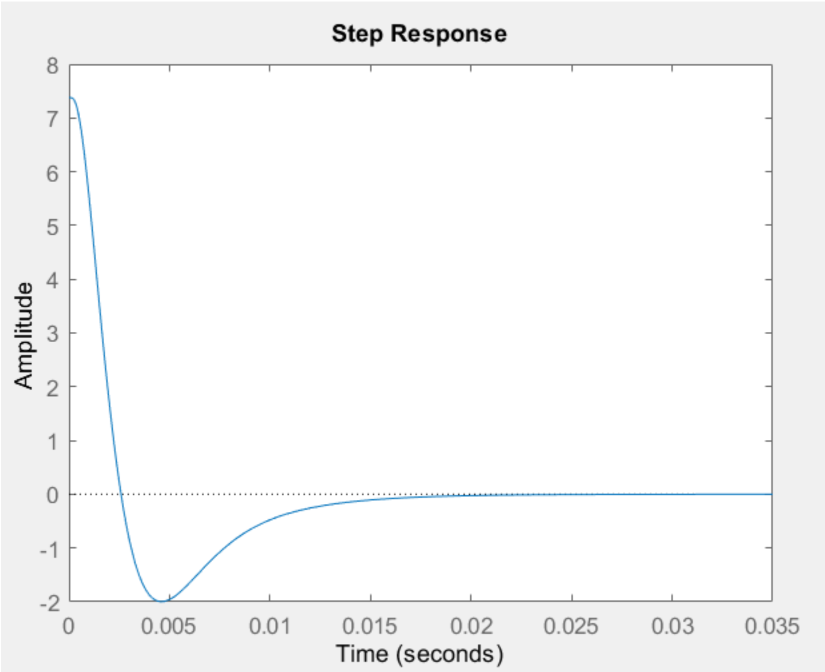
```
% b
w = 100*2*pi; % convert from hz to rad/s
phi = 45; % deg
phi = phi * pi/180;
a = 12; % guess and check, start from a=10
%lecture notes rule of thumb a=10 for pm~=55deg
t = 1/(sqrt(a)*w);
Kp = 112202; % at 100Hz, this K make gain ~= 0db
C = tf([Kp*a*t Kp], [t 1]);
L = C*P;
[Gm,Pm,Wcg,Wcp] = margin(L);
disp(Pm);
disp(Kp);
disp(a);
disp(t);
options = bodeoptions;
options.FreqUnits = 'Hz';
bode(L, options);
grid on;
```



c.
Gxr:

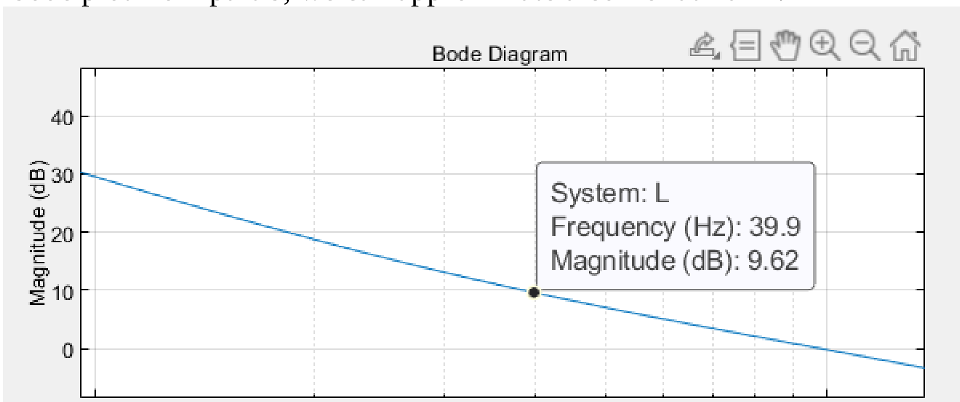


Gxd:

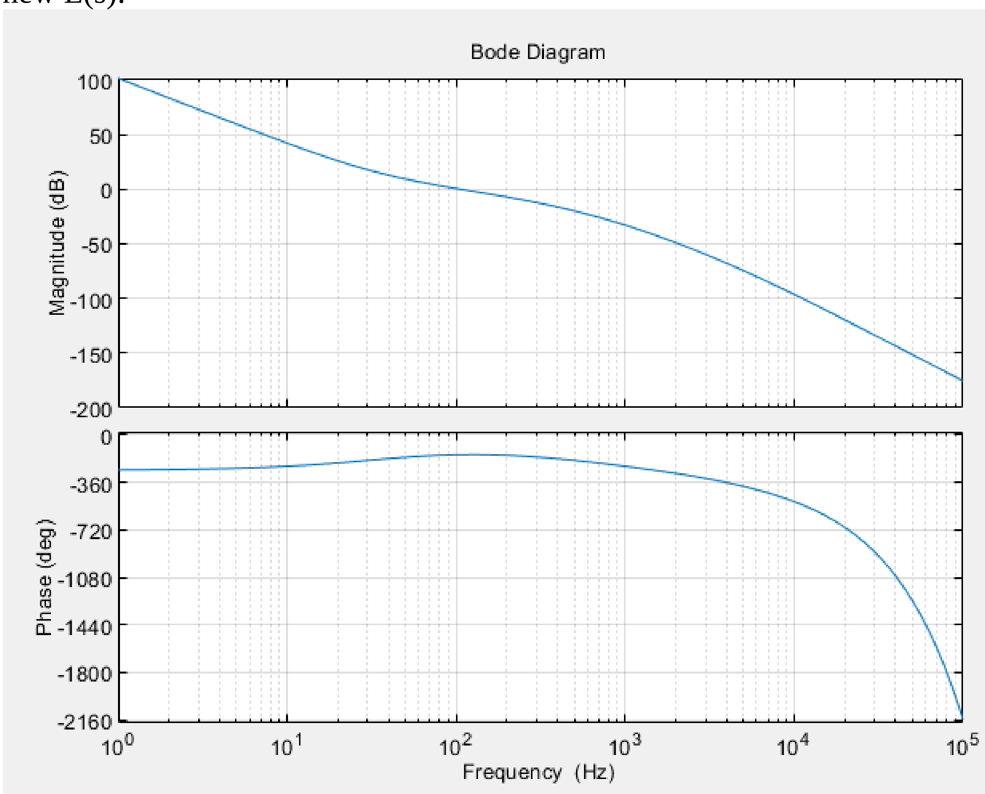



```
% c
Gxr = L/(1+L);
Gxd = Gm/(1+L);
step(Gxr);
step(Gxd);
```

d.
Going back to bode plot from part b, we can approximate a corner at 40Hz.



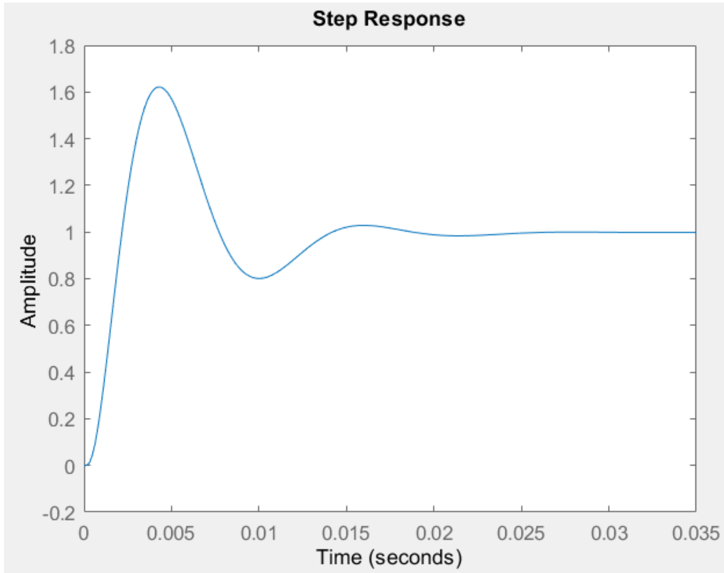
Bode plot of new L(s):



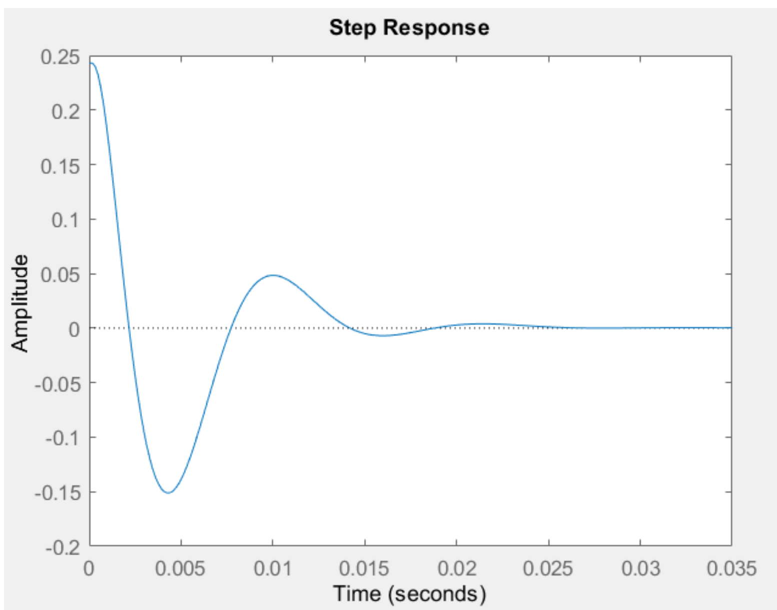

```
% d
wi = 40*2*pi; % hz to rad/s
Ti = 1/wi;
C = tf([Ti 1],[Ti 0])*C;
L = C*P;
bode(L, options);
grid on;
```

Phase margin is still >40 deg, which fits the given specification.

e.
Gxr:



Gxd:




```
% e
Gxr = L/(1+L);
Gxd = Gm/(1+L);
step(Gxr);
step(Gxd);
```

	Without integral	With integral
Gxr	RiseTime: 0.0017 SettlingTime: 0.0139 SettlingMin: 0.9299 SettlingMax: 1.2706 Overshoot: 27.0596 Undershoot: 1.0957e-12 Peak: 1.2706 PeakTime: 0.0046	RiseTime: 0.0014 SettlingTime: 0.0172 SettlingMin: 0.8009 SettlingMax: 1.6219 Overshoot: 62.1955 Undershoot: 1.6925e-12 Peak: 1.6219 PeakTime: 0.0043
Gxd (Overshoot given by MATLAB doesn't make sense, but we can visually inspect)	RiseTime: 0.0017 SettlingTime: 0.0139 SettlingMin: -1.9971 SettlingMax: 0.5750 Overshoot: Inf Undershoot: Inf Peak: 7.3795 PeakTime: 5.0050e-05	RiseTime: 0.0014 SettlingTime: 0.0172 SettlingMin: -0.1512 SettlingMax: 0.0484 Overshoot: 5.4466e+17 Undershoot: 8.7602e+17 Peak: 0.2431 PeakTime: 5.0050e-05

In both cases, settling time increased. In Gxd, overshoot decreased. In Gxr, overshoot increased. These are the results of the properties of an integrator.