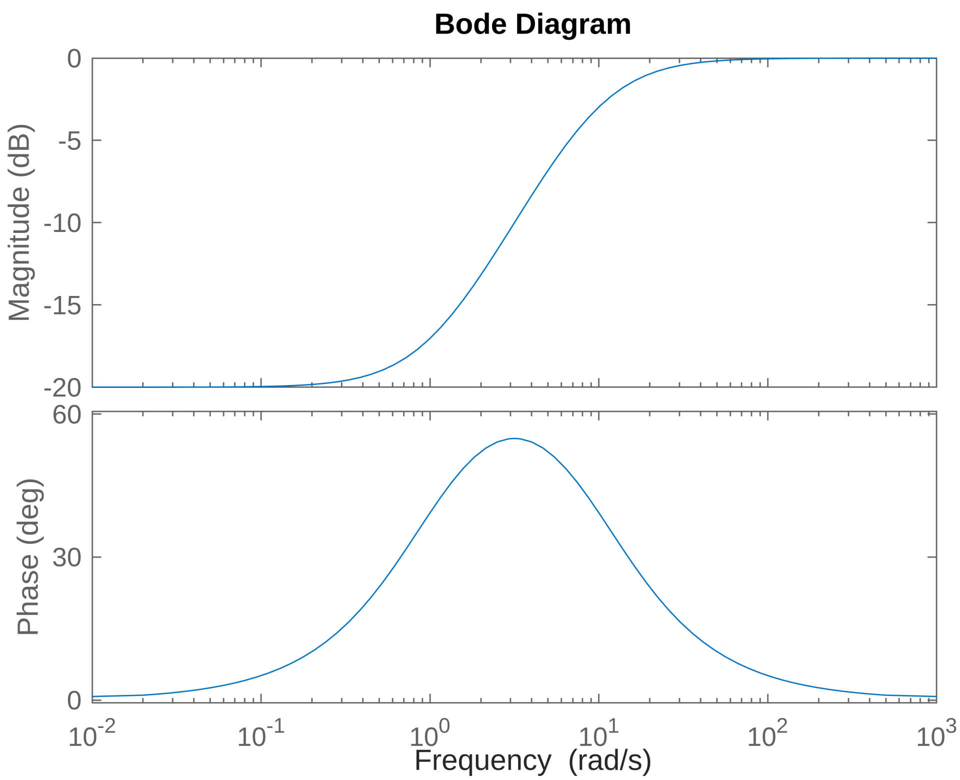
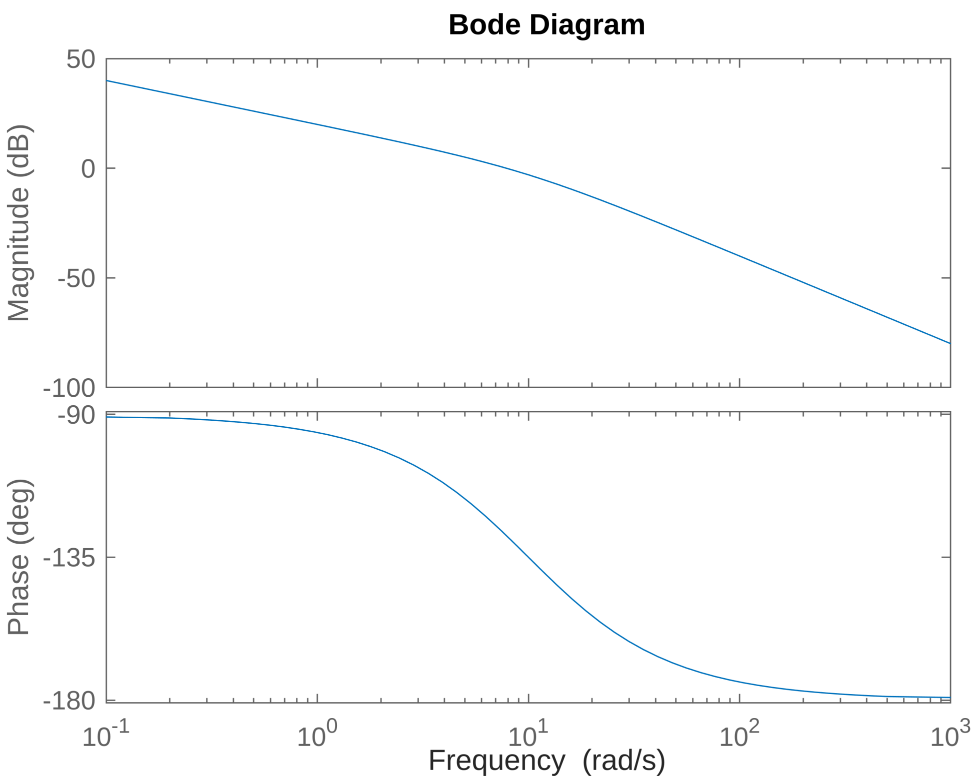
```
s = tf('s');
bode((s+1)/(s+10));
```




```
omega = 10;
zeta = 0.5;
H = omega^2 / (s*(s+2*zeta*omega))
```

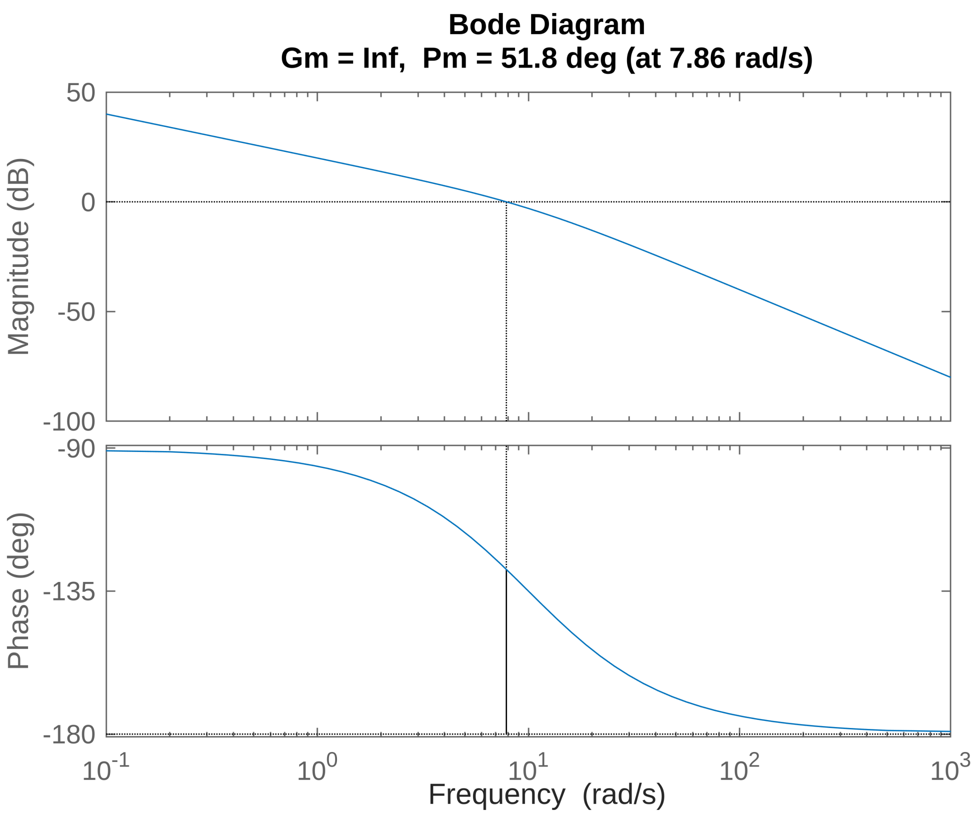
```
H =

      100
  ----------
  s^2 + 10 s

Continuous-time transfer function.
Model Properties
```

```
bode(H)
```



Bode Diagram
Magnitude (dB)
Phase (deg)
Frequency (rad/s)


```
margin(H)
```



Bode Diagram
Gm = Inf, Pm = 51.8 deg (at 7.86 rad/s)
Magnitude (dB)
Phase (deg)
Frequency (rad/s)

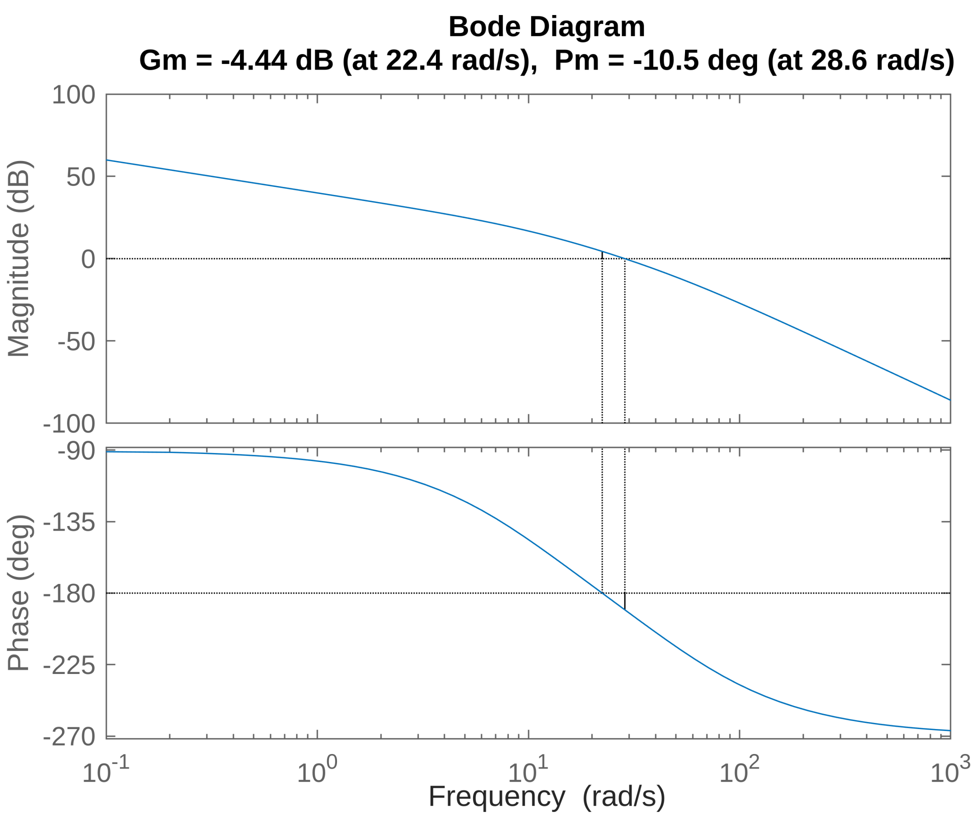
Exercise 7.2

Consider a third order system:

```
clc;
s = tf('s');
G = (50*10^3) / (s*(s+10)*(s+50))
```

```
G =

         50000
  --------------------
  s^3 + 60 s^2 + 500 s

Continuous-time transfer function.
Model Properties
```

```
margin(G)
```

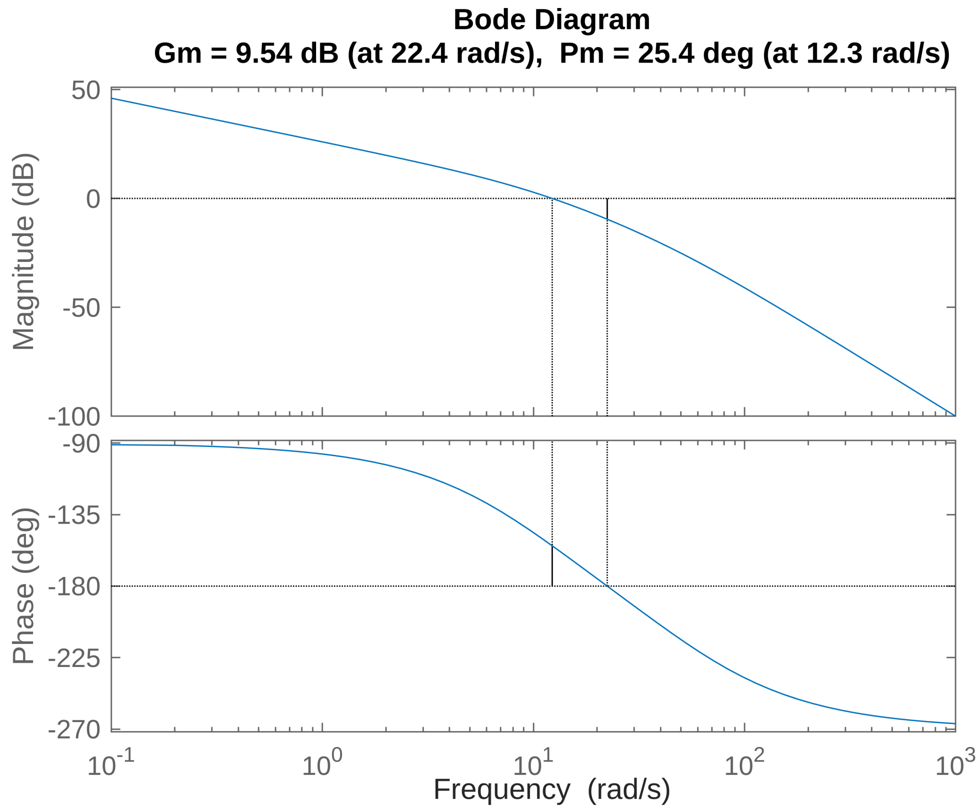


Design a LEAD compensator to make Phase Margin > 50 deg and bandwith > 20 rad/s

Lead compensator' design:

Determine K so open loop crossover is factor 2 below closed loop bandwith:

```
K = 0.2;
% Evaluate phase margin of uncompensated system with K parameter
margin(K*G)
```



So we need about 25 + 10 degrees more phase margin to satisfy the requirements.

Determine alpha from this:

```
phi_max = 50+10-25.4;
alpha = (1-sind(phi_max)) / (1+sind(phi_max))
```

```
alpha = 0.2756
```

Determine T like:

```
omegamax = 12.3; %Crossover frequency
T = 1/(omegamax * sqrt(alpha))
```

```
T = 0.1549
```

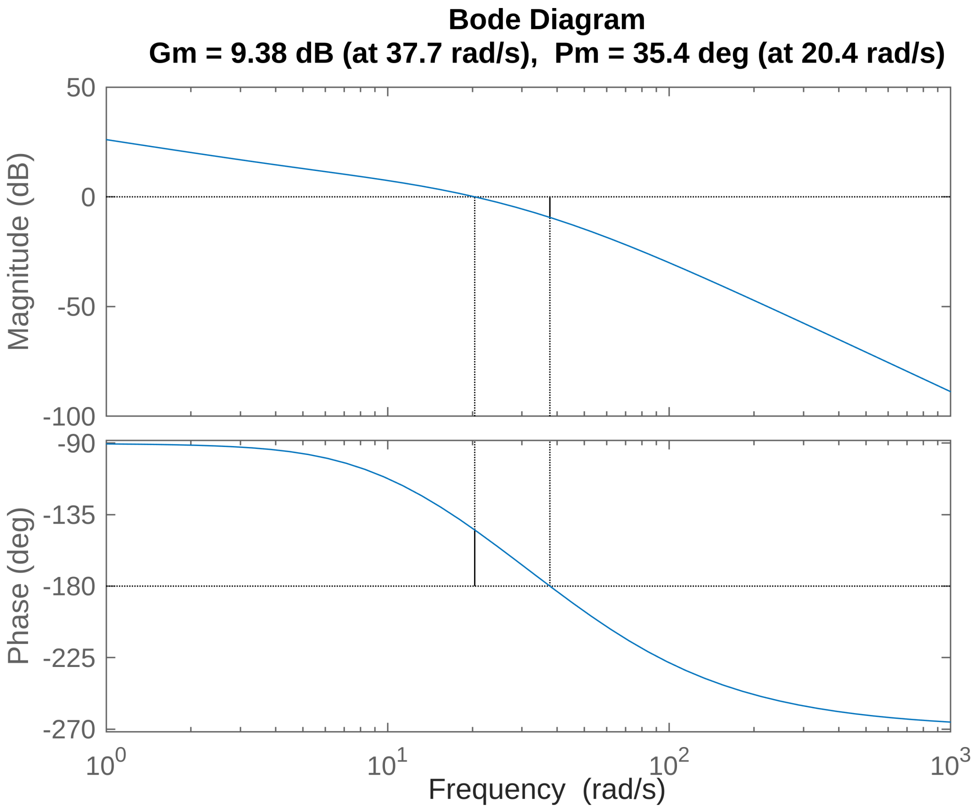
```
Lead_comp = K * ((T*s+1)/(alpha*T*s+1))
```

```
Lead_comp =
 
  0.03097 s + 0.2
  ---------------
   0.04268 s + 1
 
Continuous-time transfer function.
Model Properties
```

Draw the compensated frequency response and check gain and phase margins:

```
H = Lead_comp * G;
```

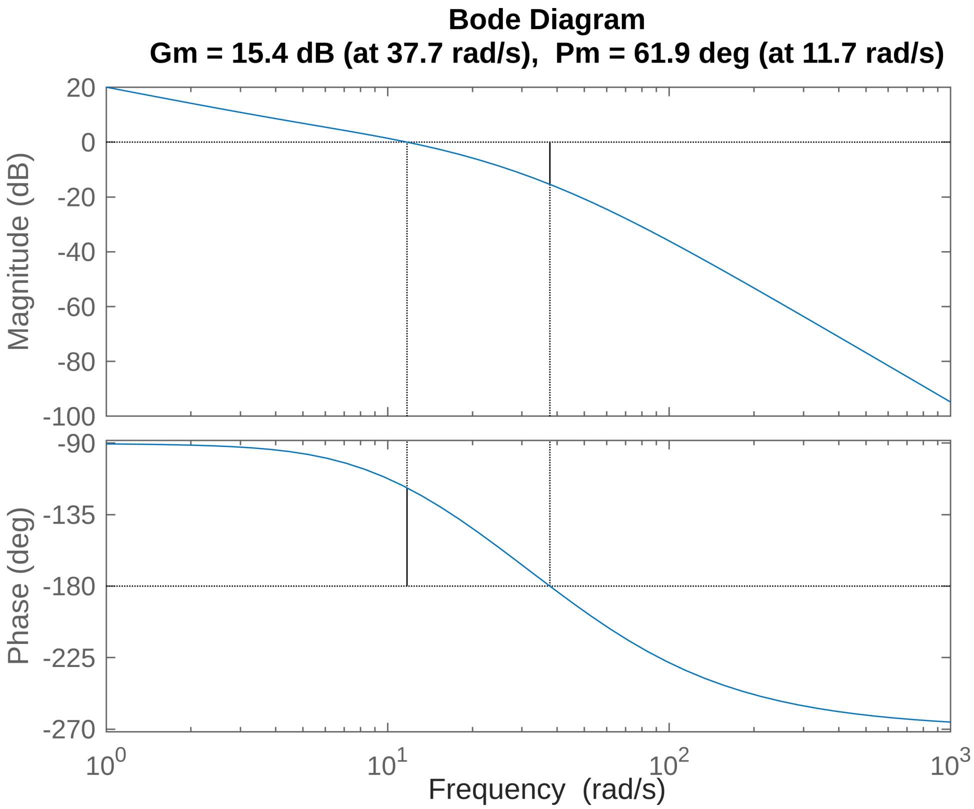
```
margin(H) %Not good enough
```




```
K1 = 0.1;
alpha1 = alpha;
T1 = T;
Lead_comp1 = K1 * ((T1*s+1)/(alpha1*T1*s+1))
```

```
Lead_comp1 =

  0.01549 s + 0.1
  ---------------
   0.04268 s + 1

Continuous-time transfer function.
Model Properties
```

```
H1 = Lead_comp1 * G;
margin(H1) % After a few iterations, it is now good.
```


Bode Diagram
Gm = 15.4 dB (at 37.7 rad/s), Pm = 61.9 deg (at 11.7 rad/s)
Magnitude (dB)
20
0
-20
-40
-60
-80
-100
Phase (deg)
-90
-135
-180
-225
-270
10^0
10^1
10^2
10^3
Frequency (rad/s)