EE3510 HW5 105060012張育菘

CP 8.1

Consider the closed-loop transfer function $T(s) = \frac{25}{s^2 + s + 25}$

Develop an m-file to, obtain the Bode plot and verify that the resonant frequency is 5 rad/s and that the peak magnitude Mpw is 14 dB.

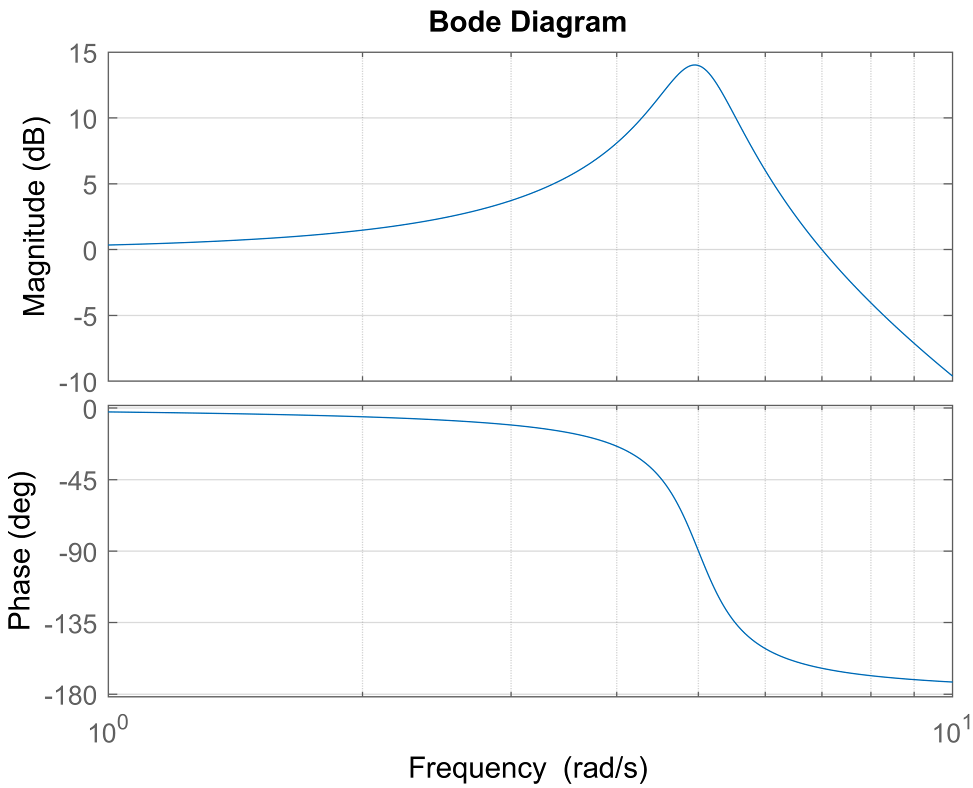
```
close all; clear;
fprintf("CP8.1 \n");
```

```
CP8.1
```

```


num = [25]; den = [1 1 25];
sys = tf(num, den);
w = logspace(0,1,500);

[mag, phase] = bode(sys, w);
[mp, wr_index] = max(mag);
mp_log = 20*log10(mp); wr = w(wr_index);

fprintf("Mpw = %f dB, wr = %f rad/s", mp_log, wr);
```

```
Mpw = 14.021586 dB, wr = 4.958962 rad/s
```

```
figure; bode(sys, w); grid on;
```



CP 8.4

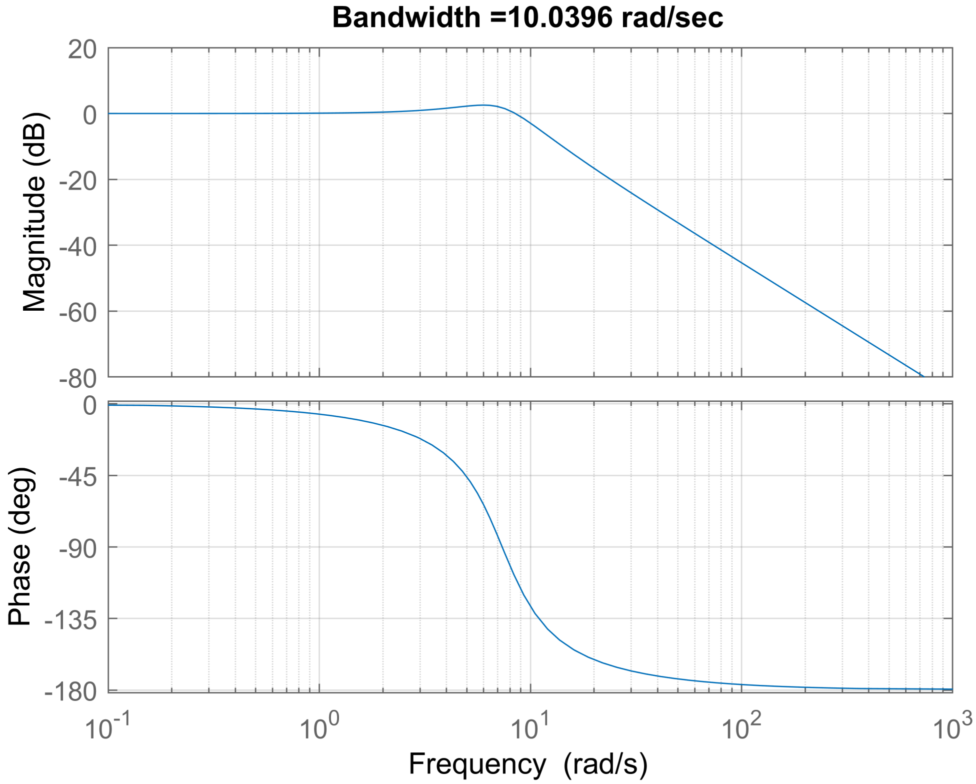
A unity negative feedback system has the loop transfer function $G_c(s)G(s) = \frac{54}{s(s+6)}$.

Determine the closed-loop system bandwidth. Using the bode function obtain the Bode plot and label the plot with the bandwidth.

```
close all; clear;
fprintf("CP8.4 \n");
```

```
CP8.4
```

```
num = [54]; den = [1 6 0];
sys = tf(num, den);
sys_closed = feedback(sys,1);
wb = bandwidth(sys_closed);

title_name = strcat('Bandwidth = ', num2str(wb), ' rad/sec');
figure; bode(sys_closed); grid on;
title(title_name);
```



CP 8.9

Design a filter, G(s), with the following frequency response:

1. For $\omega < 1\,\mathrm{rad}/s$, the magnitude $20\log_{10}|G(j\omega)| < 0\,\mathrm{dB}$.
2. For $1 < \omega < 1000\,\mathrm{rad}/s$, the magnitude $20\log_{10}|G(j\omega)| \geq 0\,\mathrm{dB}$.
3. For $\omega > 1000\,\mathrm{rad}/s$, the magnitude $20\log_{10}|G(j\omega)| < 0\,\mathrm{dB}$.

Try to maximize the peak magnitude as close to $\omega = 40\,\mathrm{rad}/s$ as possible.

Ans.

$G(s) = K\dfrac{\sum_i (s+z_i)}{\sum_j (s+p_j)}$, K < 0 for initial condition 1.

zeros: 1, 1000; poles: two poles between 1 ~ 1000

$$\Longrightarrow \text{My design of this system } G(s) = 0.6\,\frac{(s+1)(s+1000)}{(s+20)(s+80)}$$

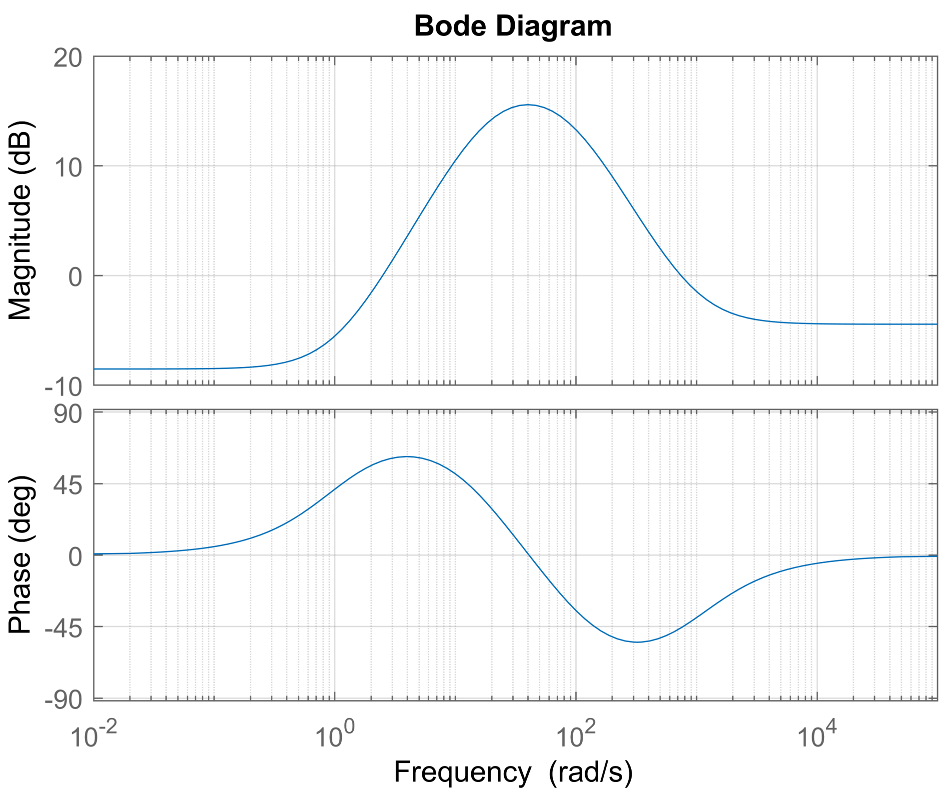
```
close all; clear;
fprintf("CP8.9 \n");
```

```
CP8.9
```

```
K = 0.6;
a1 = [1 1]; a2 = [1 1000]; a = conv(a1, a2); a = K*a;
b1 = [1 20]; b2 = [1 80]; b = conv(b1, b2);

sys = tf(a, b);
w = logspace(0,3,10000);

[mag, phase] = bode(sys, w);
[mp, wp_index] = max(mag);
wp = w(wp_index);

fprintf("peak magnitude at wp = %f rad/s", wp);
```

```
peak magnitude at wp = 40.064551 rad/s
```

```
figure; bode(sys); grid on;
```



CP 9.3

Using the nichols function, obtain the Nichols chart with a grid for the following transfer functions:

(a) $G(s) = \dfrac{1}{s + 0.2}$

(b) $G(s) = \frac{1}{s^2 + 2s + 1}$

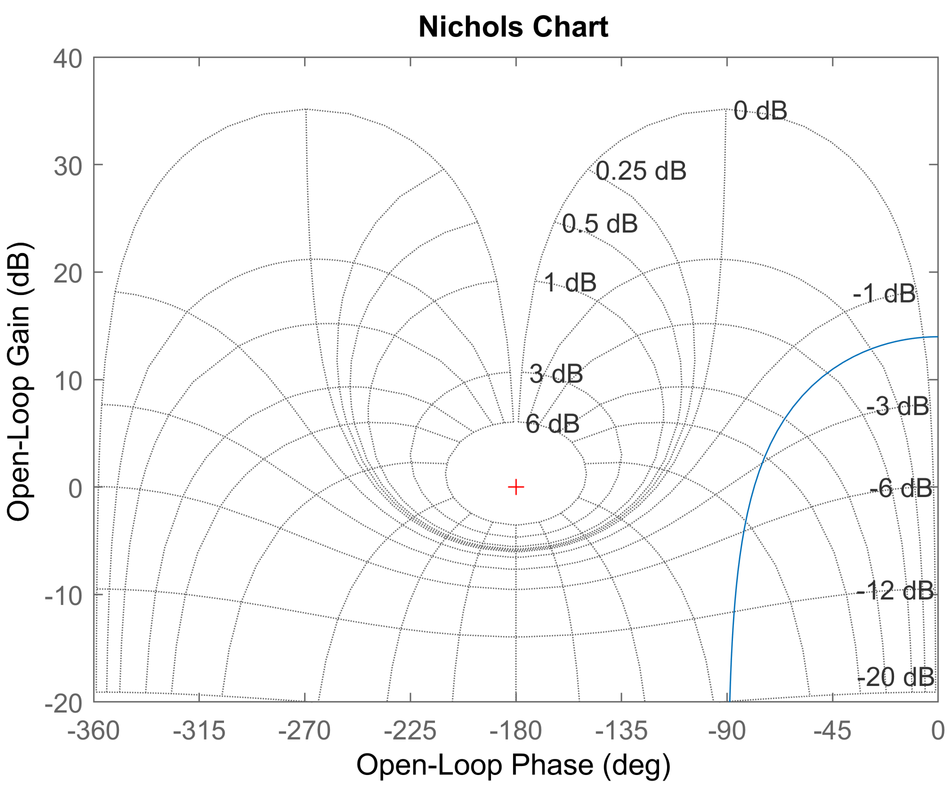
(c) $G(s) = \frac{6}{s^3 + 6s^2 + 11s + 6}$

Determine the approximate phase and gain margins from the Nichols charts and label the charts accordingly.

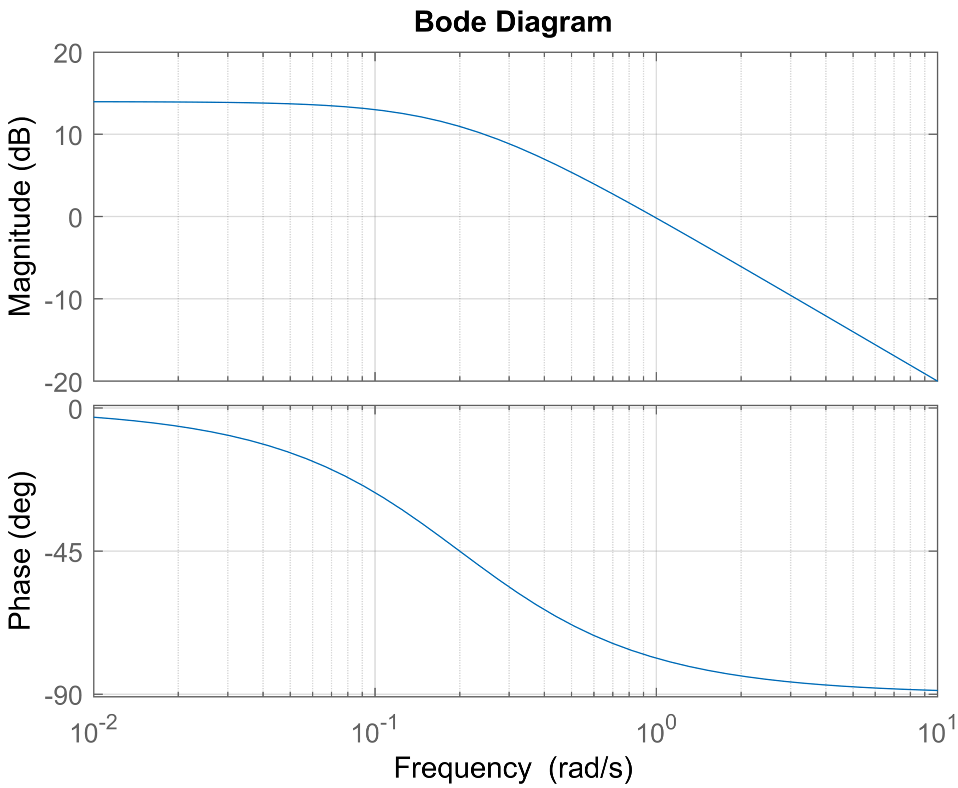
```
close all; clear;
fprintf("CP9.3 \n");
```

```
CP9.3
```

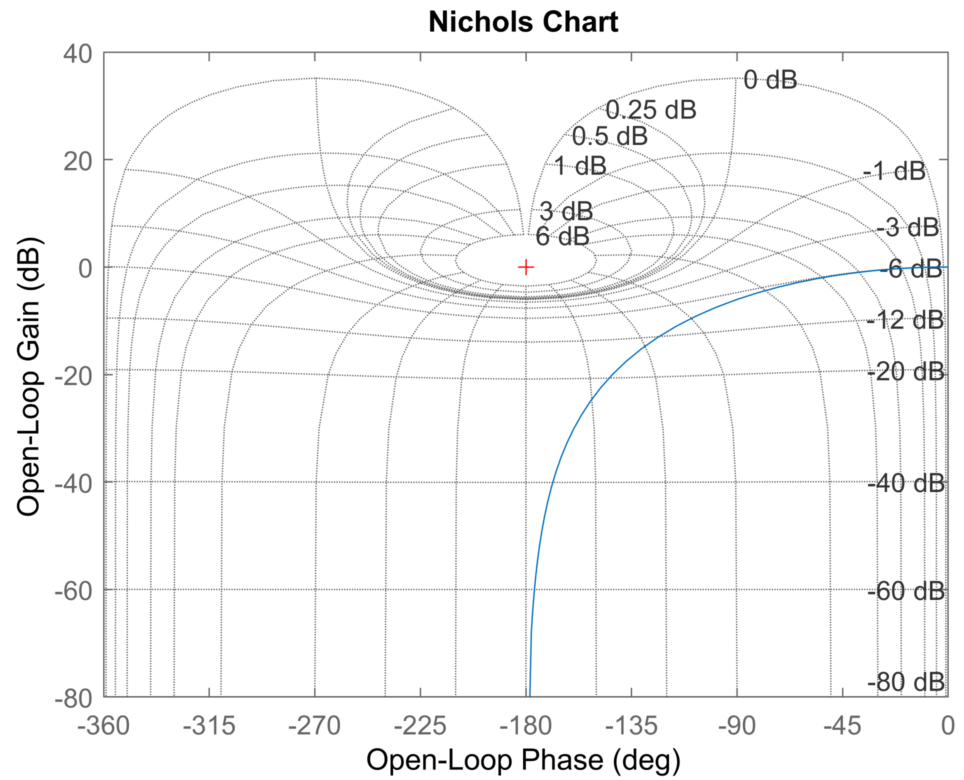
```

% a
a1 = [1]; b1 = [1 0.2];
sys1 = tf(a1, b1);
figure; nichols(sys1); ngrid;
```



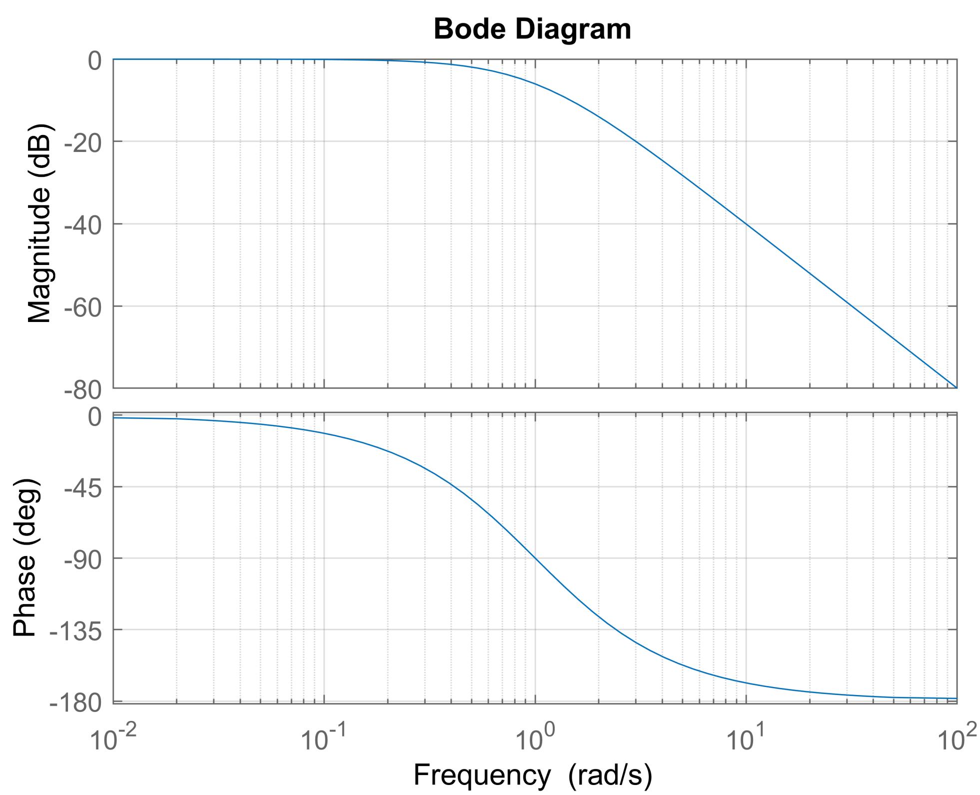

```
figure; bode(sys1); grid on;
```



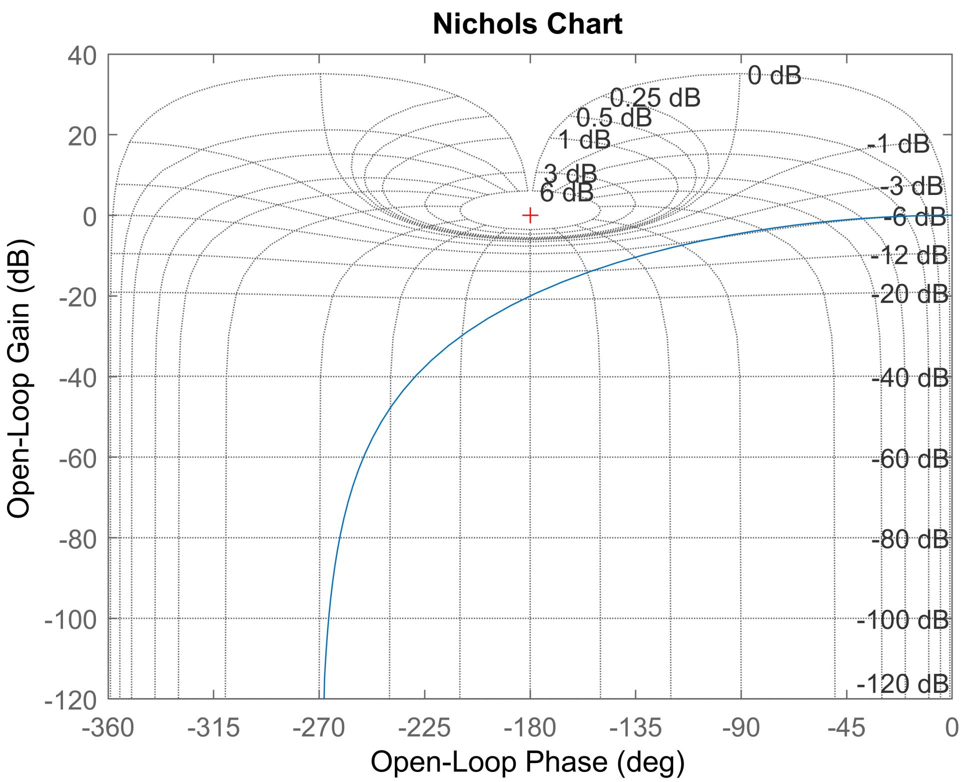

```
% b
a2 = [1]; b2 = [1 2 1];
sys2 = tf(a2, b2);
figure; nichols(sys2); ngrid;
```



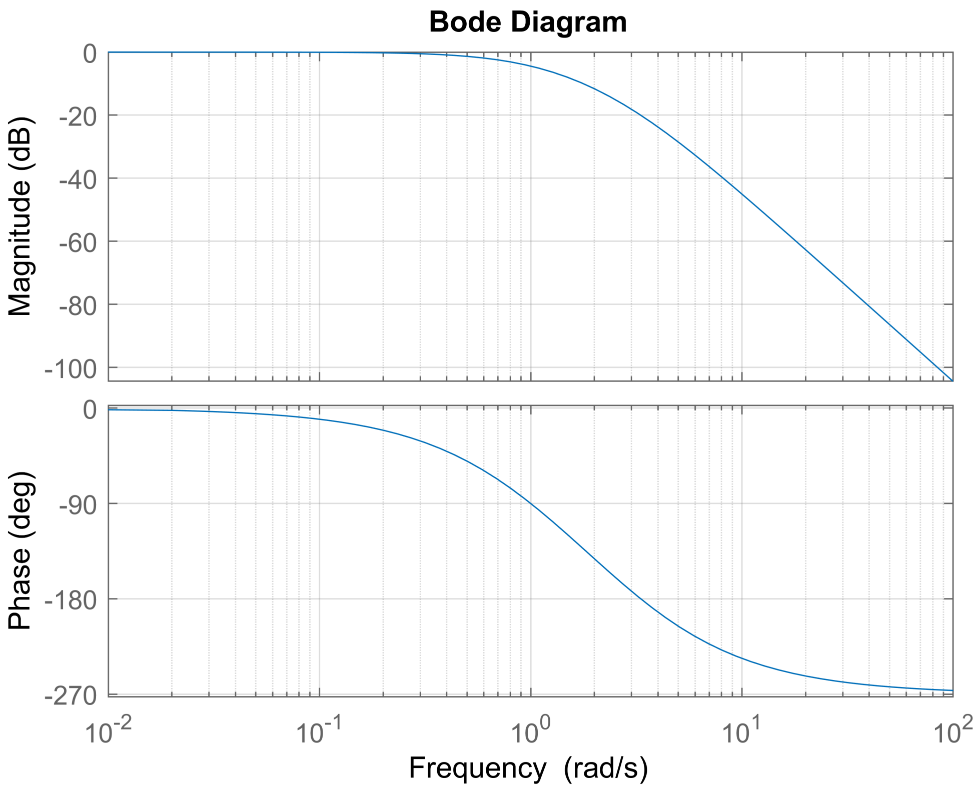

```
figure; bode(sys2); grid on;
```



```
% c
a3 = [6]; b3 = [1 6 11 6];
sys3 = tf(a3, b3);
figure; nichols(sys3); ngrid;
```




```
figure; bode(sys3); grid on;
```



(a) $G.M. = \infty$ and $P.M. = 120^{\circ}$

(b) $G.M. = \infty$ and $P.M. = \infty$

(c) $G.M. = 20\text{dB}$ and $P.M. = \infty$