

```
In [58]: from scipy import signal
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.patches as patches
import control
```

```
In [59]: #5.2

S = [1, .97, .87, .71, .5, .26, 0]
plt.title('Pole-Zero Plot of the System')
plt.xlabel('Real Part')
plt.ylabel('Imaginary Part')
plt.axhline(0, color='black', lw=1, ls='--')
plt.axvline(0, color='black', lw=1, ls='--')

for s in S:

    num = [10]

    den = [1, 6.32*s, 10.0]

    sys = control.tf(num, den)
    control.pole_zero_plot(sys, plot=True, label='s = ' + str(s))

plt.grid()
plt.axis('on')
plt.show()

fig, ax = plt.subplots()

for s in S:

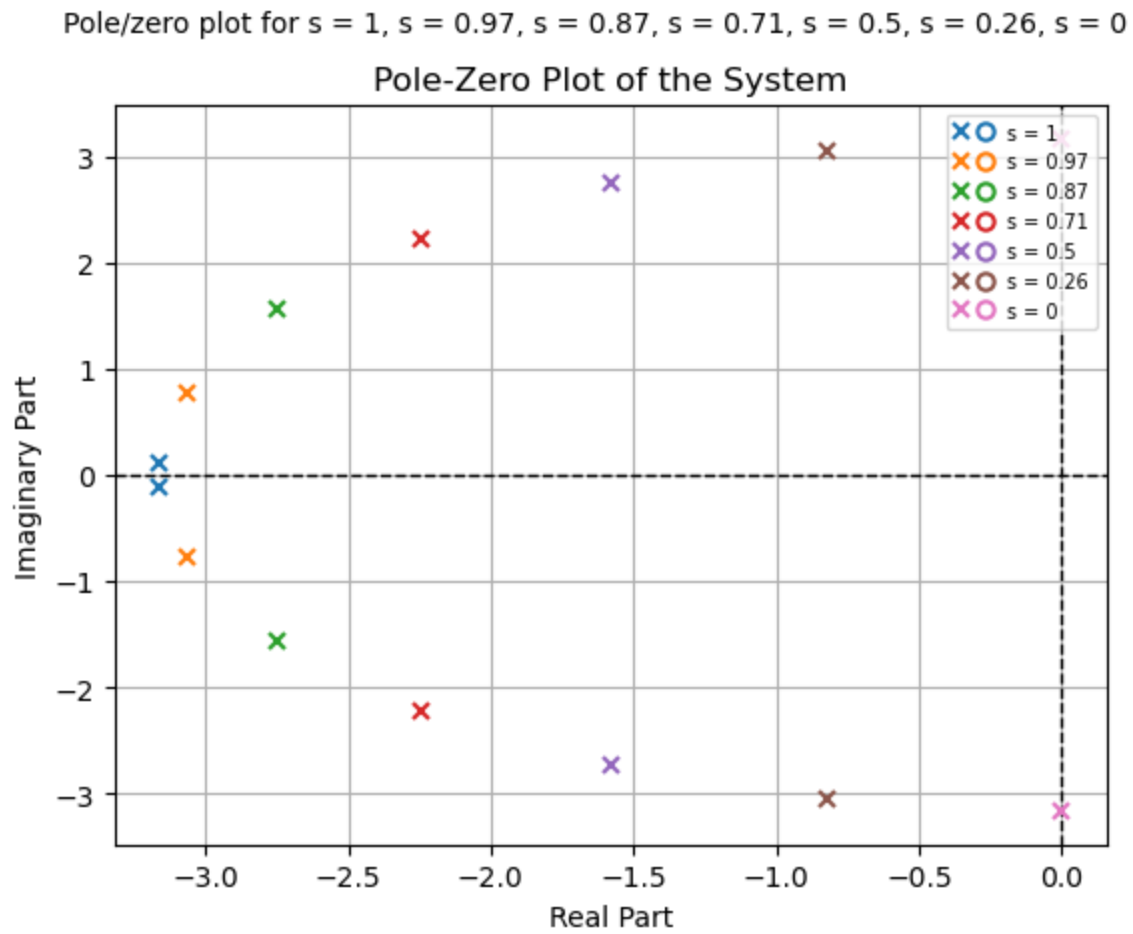
    num = [10]

    den = [1, 6.32*s, 10.0]

    sys = control.tf(num, den)
    control.pole_zero_plot(sys, plot=True, label='s = ' + str(s))

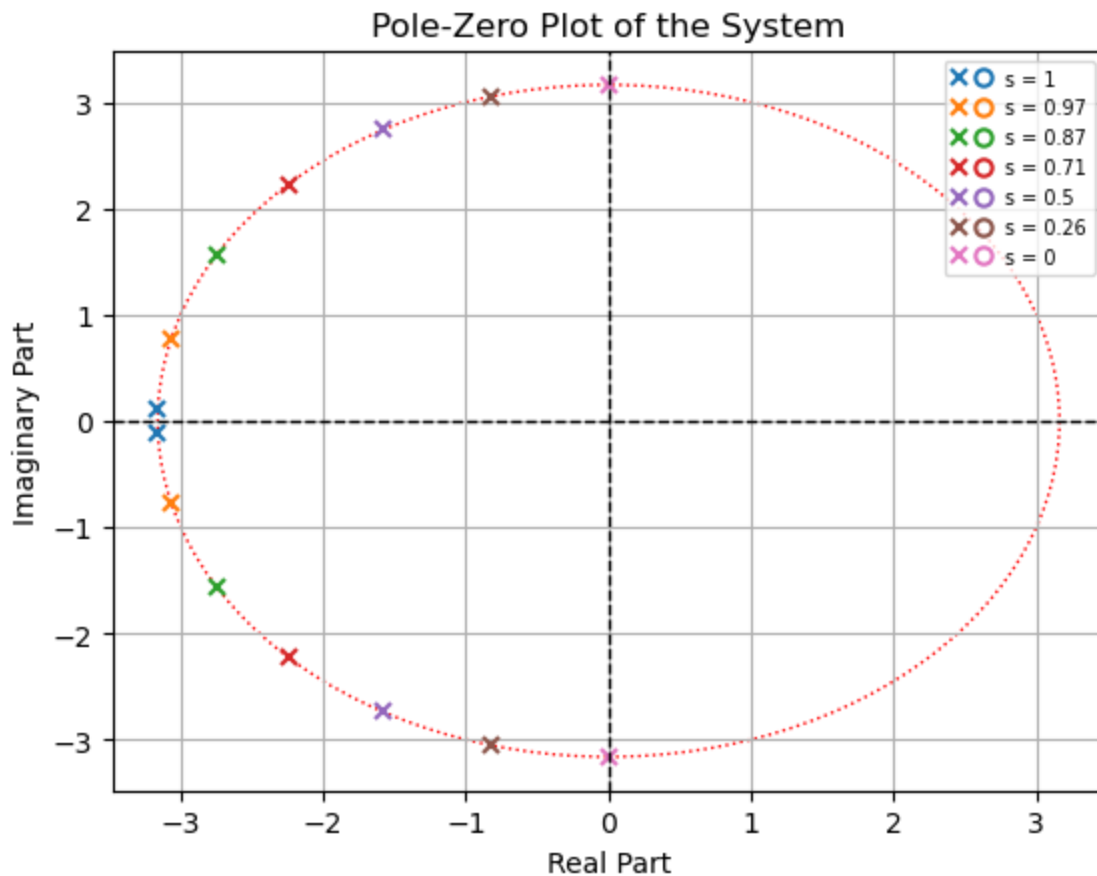
circle = plt.Circle((0, 0), np.sqrt(10), color='r', fill=False, linestyle='dotted')
ax.add_patch(circle)
plt.title('Pole-Zero Plot of the System')
plt.xlabel('Real Part')
plt.ylabel('Imaginary Part')
plt.axhline(0, color='black', lw=1, ls='--')
plt.axvline(0, color='black', lw=1, ls='--')
plt.grid()
plt.show()
```

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Pole/zero plot for  $s = 1, s = 0.97, s = 0.87, s = 0.71, s = 0.5, s = 0.26, s = 0$



In [60]: #5.3/5.4

*# totally want to make it so that the user can select the plot they want to see,  
# but i can only submit ipynb files as a pdf so i remove the if statement and just*

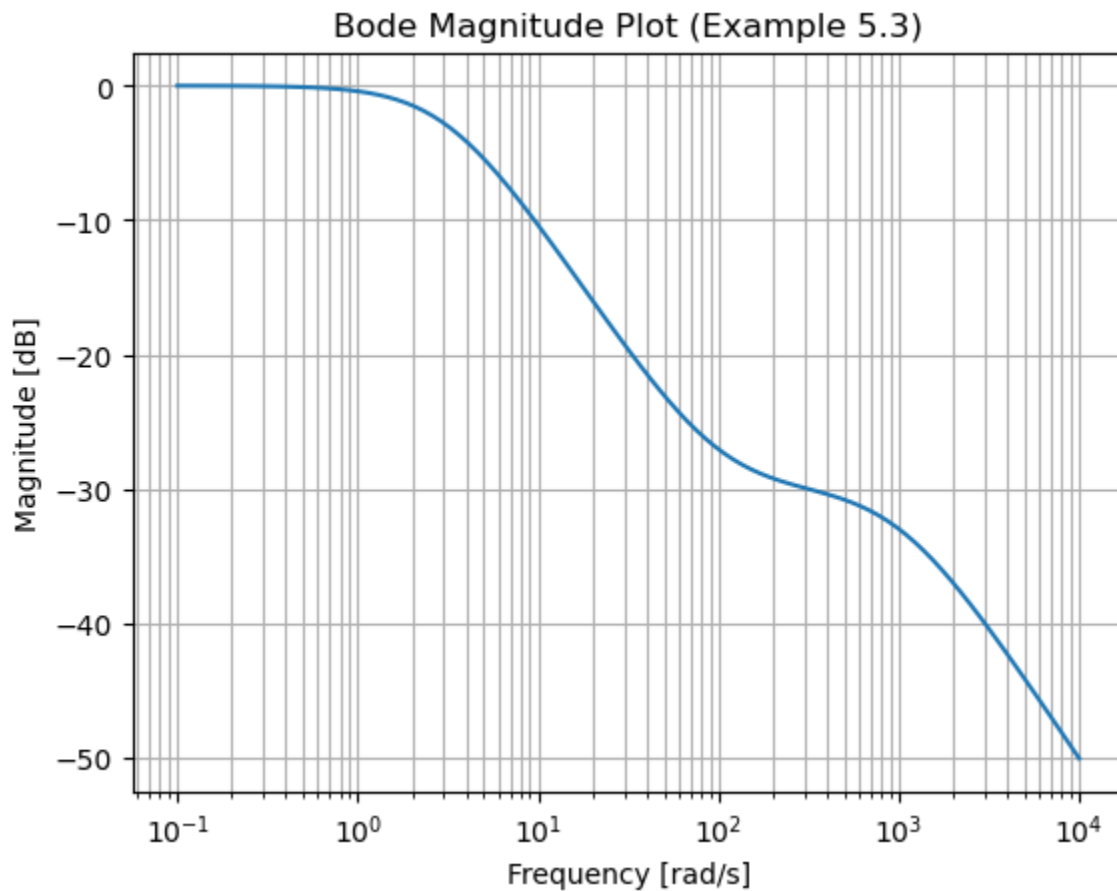
```
sys = signal.TransferFunction([31.6, 3160], [1, 1003.16, 3160])
w, mag, phase = signal.bode(sys)
plt.figure()
plt.semilogx(w, mag)    # Bode magnitude plot
plt.title('Bode Magnitude Plot (Example 5.3)')
plt.xlabel('Frequency [rad/s]')
plt.ylabel('Magnitude [dB]')
plt.grid(which='both', axis='both')
plt.figure()
plt.semilogx(w, phase) # Bode phase plot
plt.title('Bode Phase Plot (Example 5.3)')
plt.xlabel('Frequency [rad/s]')
plt.ylabel('Phase [degrees]')
plt.grid(which='both', axis='both')
plt.show()
```

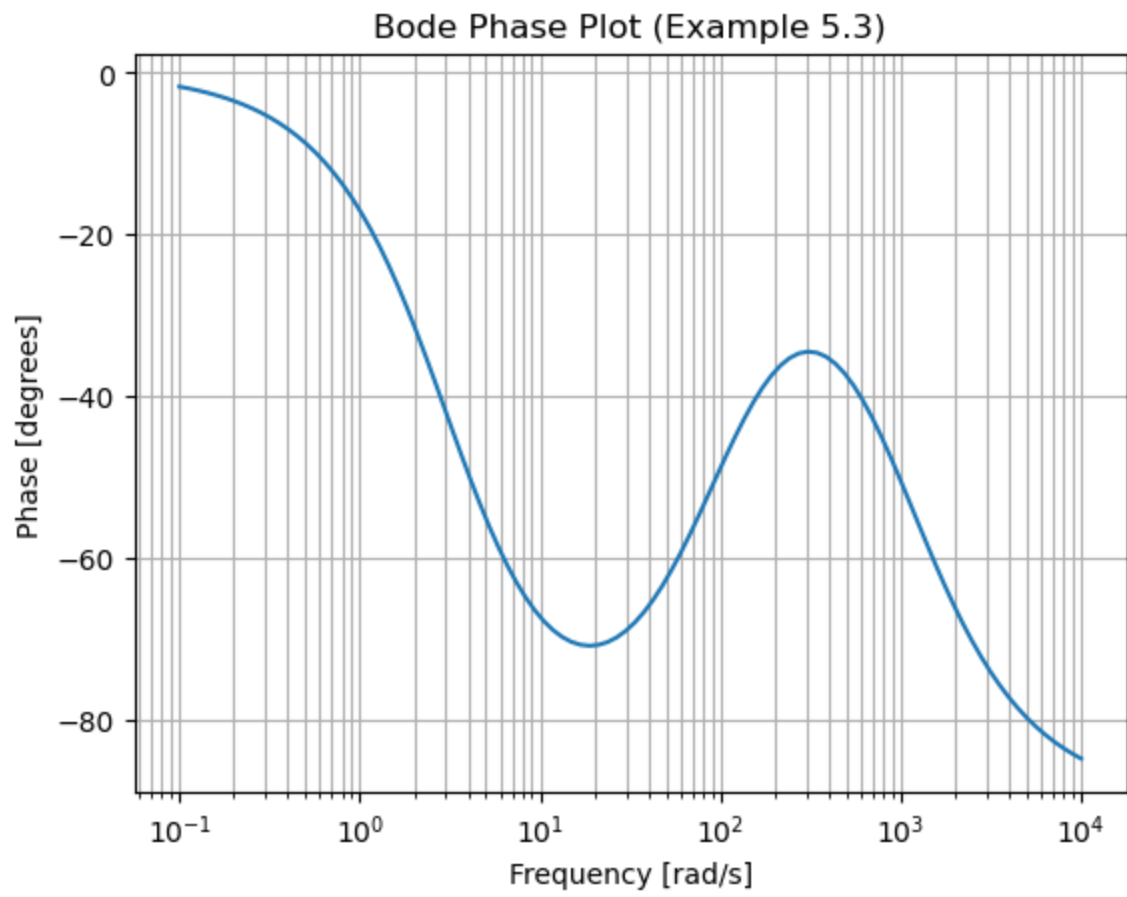
```
S = [0.1, 0.5, 1]
wo = 1e2
fig1, ax = plt.subplots(2, 1, figsize=(10, 8))
for s in S:
```

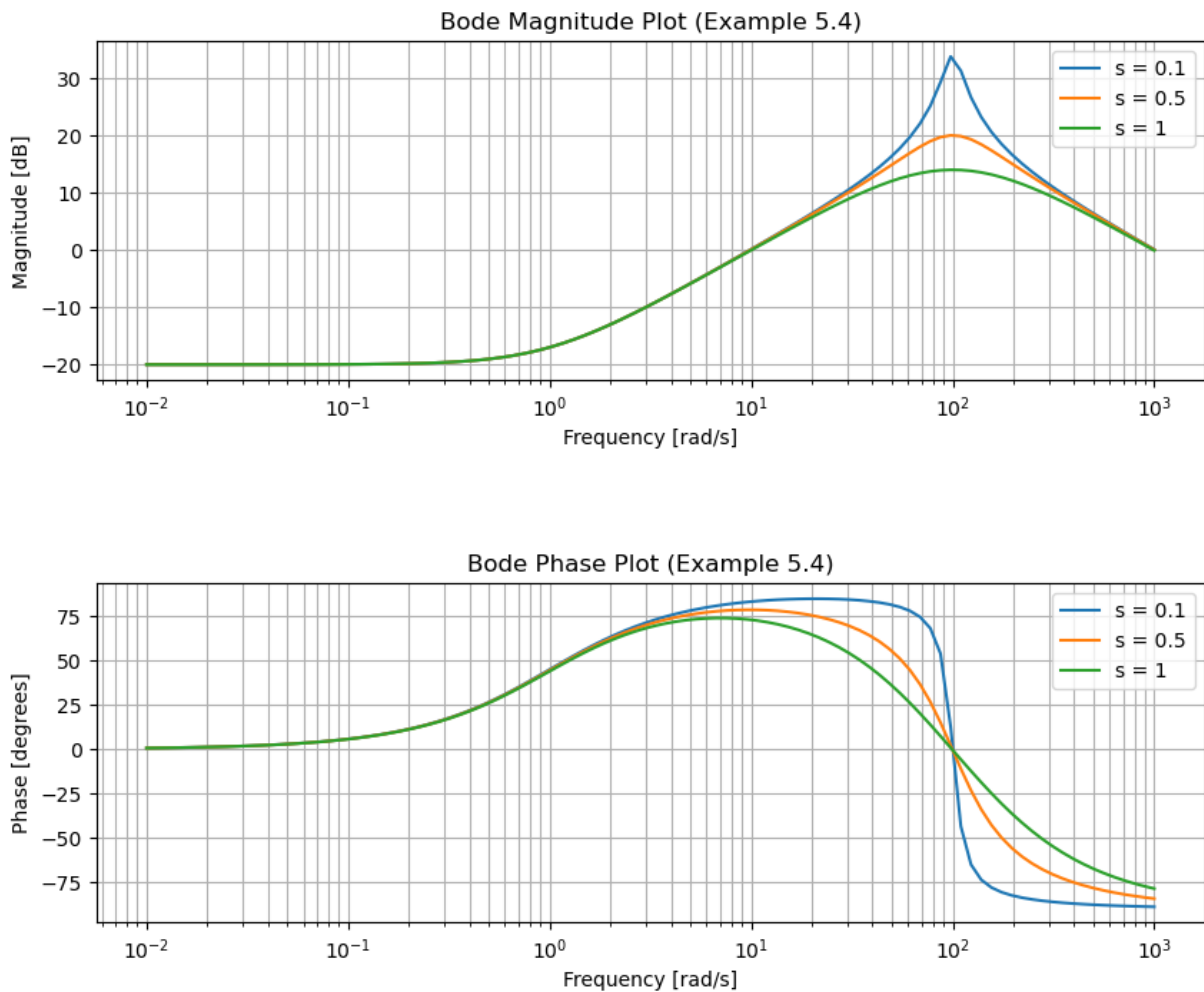
```

a = 2 * s * wo
b = wo**2
sys = signal.TransferFunction([1000, 1000], [1, a, b])
w, mag, phase = signal.bode(sys)
ax[0].semilogx(w, mag) # Bode magnitude plot
ax[1].semilogx(w, phase) # Bode phase plot
ax[0].title.set_text('Bode Magnitude Plot (Example 5.4)')
ax[0].set_xlabel('Frequency [rad/s]')
ax[0].set_ylabel('Magnitude [dB]')
ax[0].grid(which='both', axis='both')
ax[1].title.set_text('Bode Phase Plot (Example 5.4)')
ax[1].set_xlabel('Frequency [rad/s]')
ax[1].set_ylabel('Phase [degrees]')
ax[1].grid(which='both', axis='both')
plt.subplots_adjust(wspace=0.4, hspace=0.6)
ax[0].legend(['s = ' + str(s) for s in S], loc='best')
ax[1].legend(['s = ' + str(s) for s in S], loc='best')
plt.show()

```







```
In [61]: #5.6
rect = patches.Rectangle((10, 33), 306, 14, linewidth=1, edgecolor='r', facecolor='r')

sys = signal.TransferFunction([1000000, 316227.8], [1, 60, 10500, 1e5])
w, mag, phase = signal.bode(sys)
plt.figure()
plt.semilogx(w, mag)    # Bode magnitude plot
plt.title('Bode Magnitude Plot (Example 5.6)')
plt.xlabel('Frequency [rad/s]')
plt.ylabel('Magnitude [dB]')
plt.grid(which='both', axis='both')
plt.figure()
plt.semilogx(w, phase) # Bode phase plot
plt.title('Bode Phase Plot (Example 5.6)')
plt.xlabel('Frequency [rad/s]')
plt.ylabel('Phase [degrees]')
plt.grid(which='both', axis='both')
plt.show()

#modified example 5.6

a = 9486833

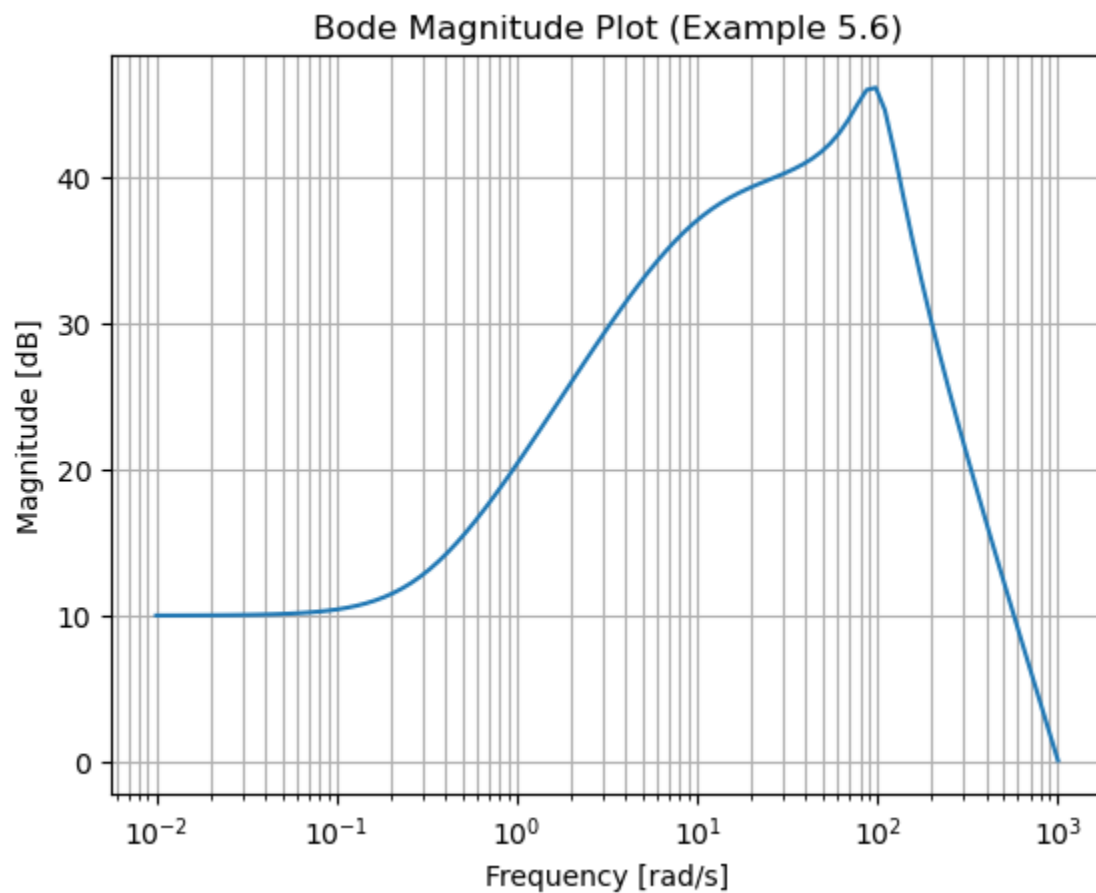
sys = signal.TransferFunction([a, a * .3], [1, 160, 91500, 900000])
w, mag, phase = signal.bode(sys)
```

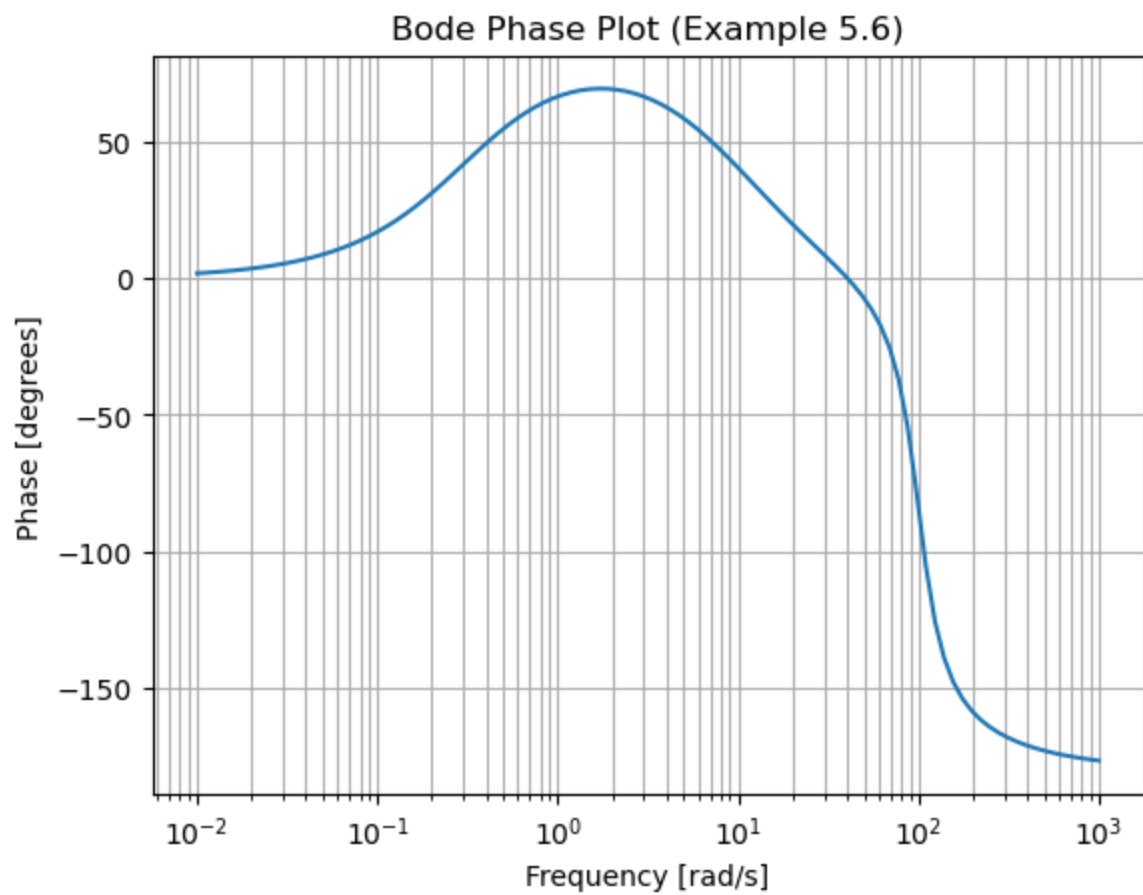


```
plt.figure()
plt.semilogx(w, mag)    # Bode magnitude plot
print(mag.max())
plt.title('Bode Magnitude Plot (Example 5.6)')
plt.xlabel('Frequency [rad/s]')
plt.ylabel('Magnitude [dB]')
plt.grid(which='both', axis='both')

plt.gca().add_patch(rect)
plt.figure()
plt.semilogx(w, phase)  # Bode phase plot
plt.title('Bode Phase Plot (Example 5.6)')
plt.xlabel('Frequency [rad/s]')
plt.ylabel('Phase [degrees]')
plt.grid(which='both', axis='both')

plt.show()
```





46.74885550891884

