

Sprawozdanie – WEAIIB, AiR	
Podstawy Automatyki 2	
Ćwiczenie 8: Zapasy stabilności	
Czwartek, 14:30	Data wykonania: 11.05.2023
Roman Nowak	Data zaliczenia:
	Ocena:

Ćwiczenie ma celu przeanalizowanie wpływu parametrów regulatora PID na stabilność układu - wartości zapasów modułu i fazy

Analizę przeprowadzamy dla czterech obiektów o podanych niżej transmitancjach.

$$G(s) = \frac{1}{s^3 + 3s^2 + 3s + 1},$$

$$G(s) = \frac{1}{s^3 + 2s^2 + 2s + 1},$$

$$G(s) = \frac{2}{s^3 + 3s^2 + 2s + 1},$$

$$G(s) = \frac{1}{2s^3 + s^2 + s}.$$

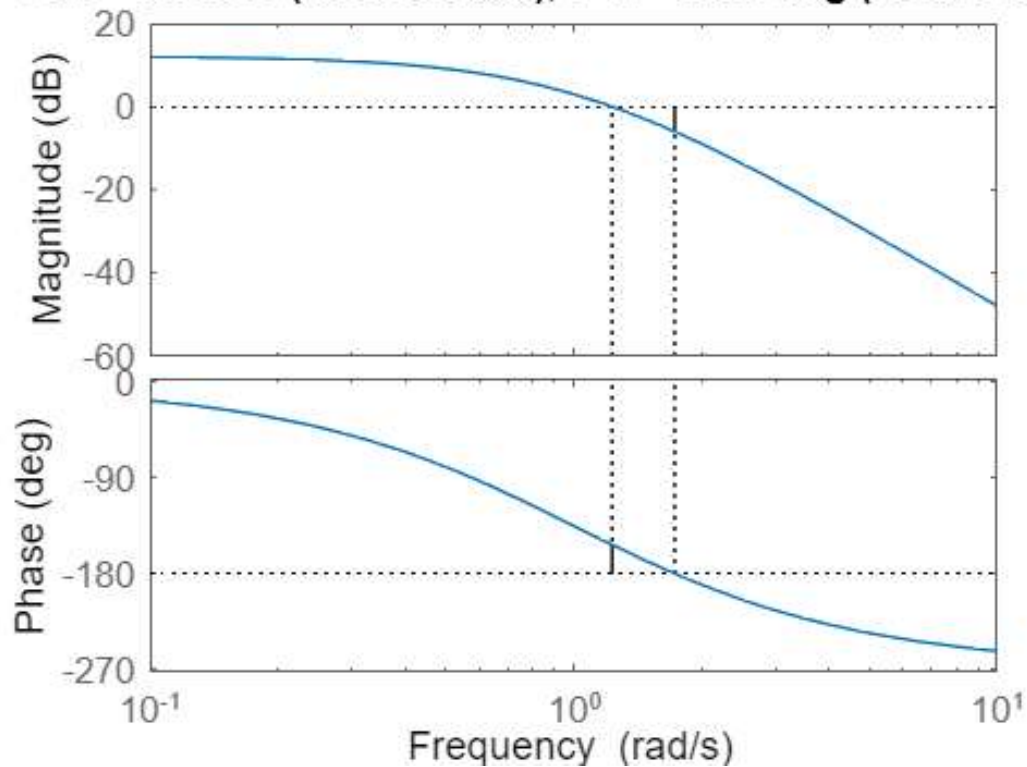
```
G1 = tf([1], [1 3 3 1]);
G2 = tf([1], [1 2 2 1]);
G3 = tf([1], [1 3 2 1]);
G4 = tf([1], [2 1 1 0]);
```

```
k1 = 8.0011 / 2
```

```
k1 = 4.0006
```

```
zapasy(G1, k1, 0, 0);
```

Bode Diagram
Gm = 6.02 dB (at 1.73 rad/s), Pm = 27.1 deg (at 1.23 rad/s)



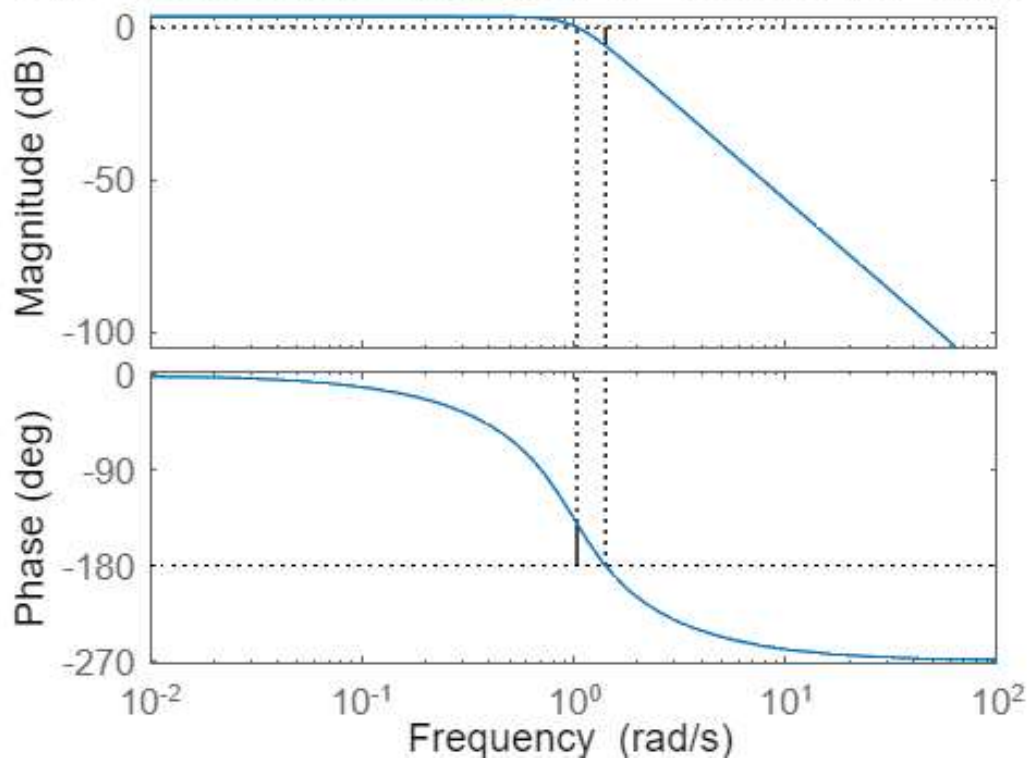
zapas_modulu = 2.0000
zapas_fazy = 27.1360

$k_2 = 3 / 2$

$k_2 = 1.5000$

zapas(G2, k_2 , 0, 0);

Bode Diagram
Gm = 6.02 dB (at 1.41 rad/s), Pm = 39.7 deg (at 1.04 rad/s)

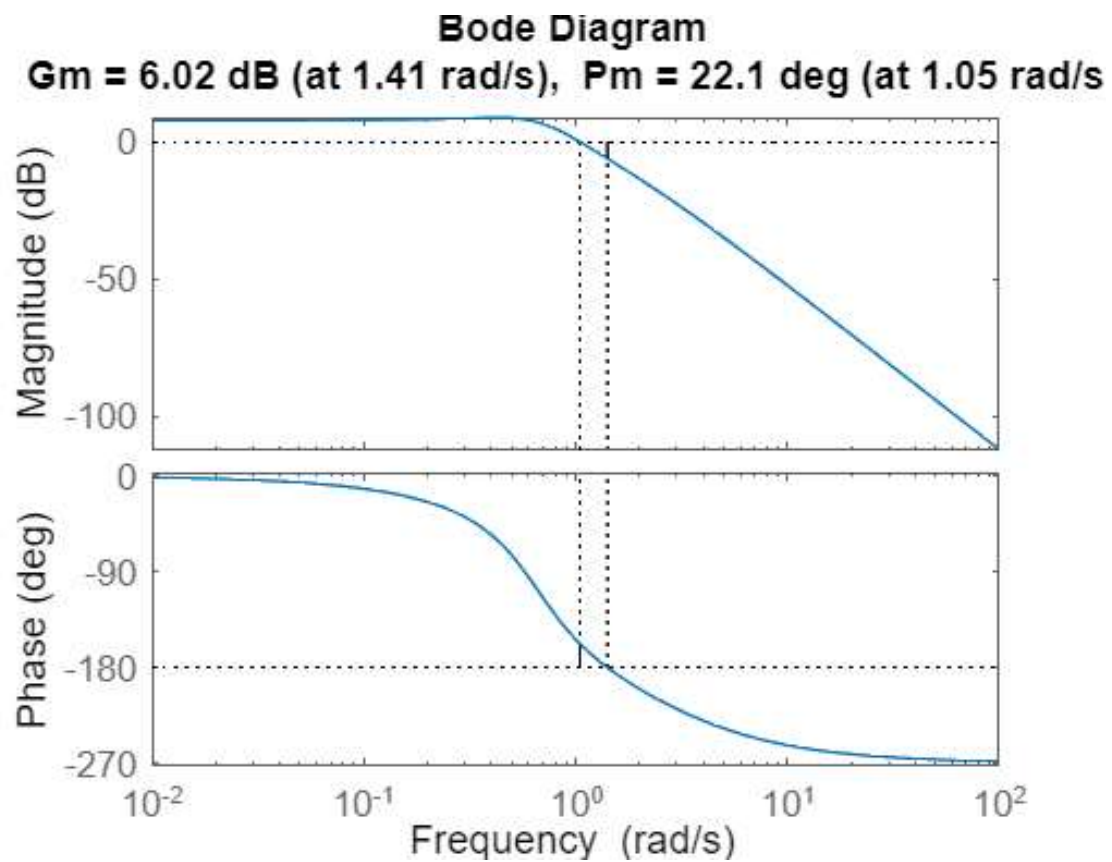


zapas_modulu = 2.0000
zapas_fazy = 39.6836

```
k3 = 5.0029 / 2
```

```
k3 = 2.5015
```

```
zapasy(G3, k3, 0, 0);
```



```
zapas_modulu = 2.0000
```

```
zapas_fazy = 22.0773
```

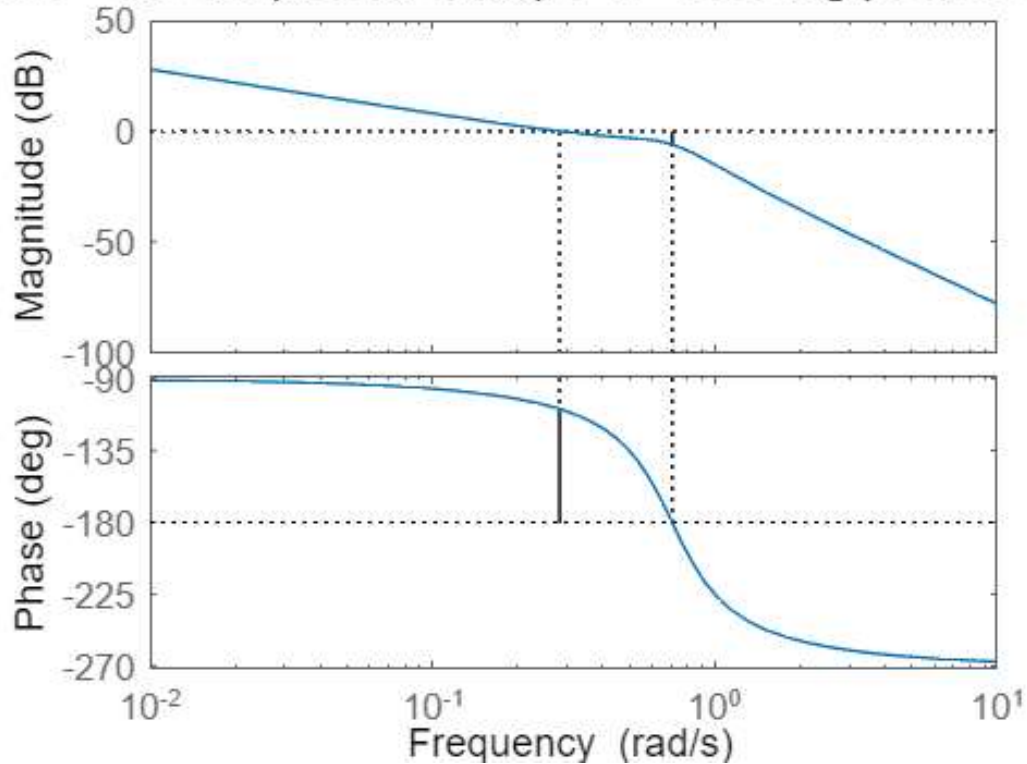
```
k4 = 0.5 / 2
```

```
k4 = 0.2500
```

```
zapasy(G4, k4, 0, 0);
```

Bode Diagram

Gm = 6.02 dB (at 0.707 rad/s), Pm = 71.5 deg (at 0.282 rad/



zapas_modulu = 2.0000

zapas_fazy = 71.4778

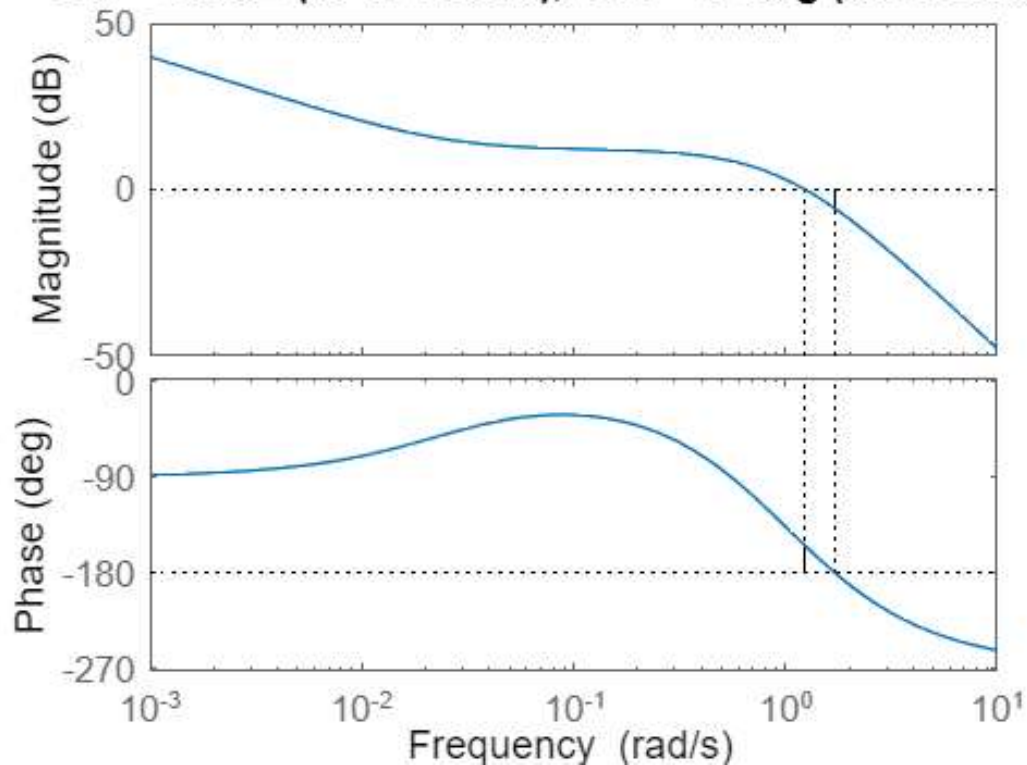
alfa = 0.1

alfa = 0.1000

zapasy(G1, k1, alfa, 0);

Bode Diagram

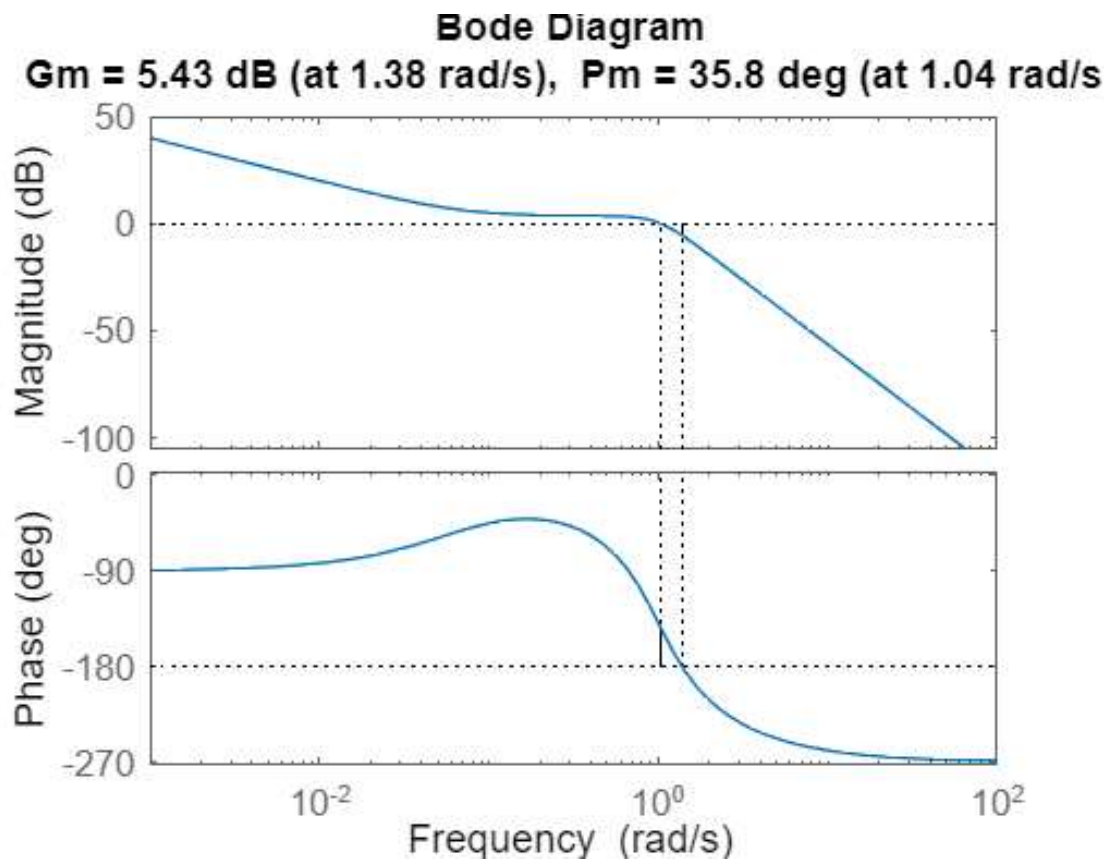
Gm = 5.8 dB (at 1.71 rad/s), Pm = 26 deg (at 1.23 rad/s)



zapas_modulu = 1.9502

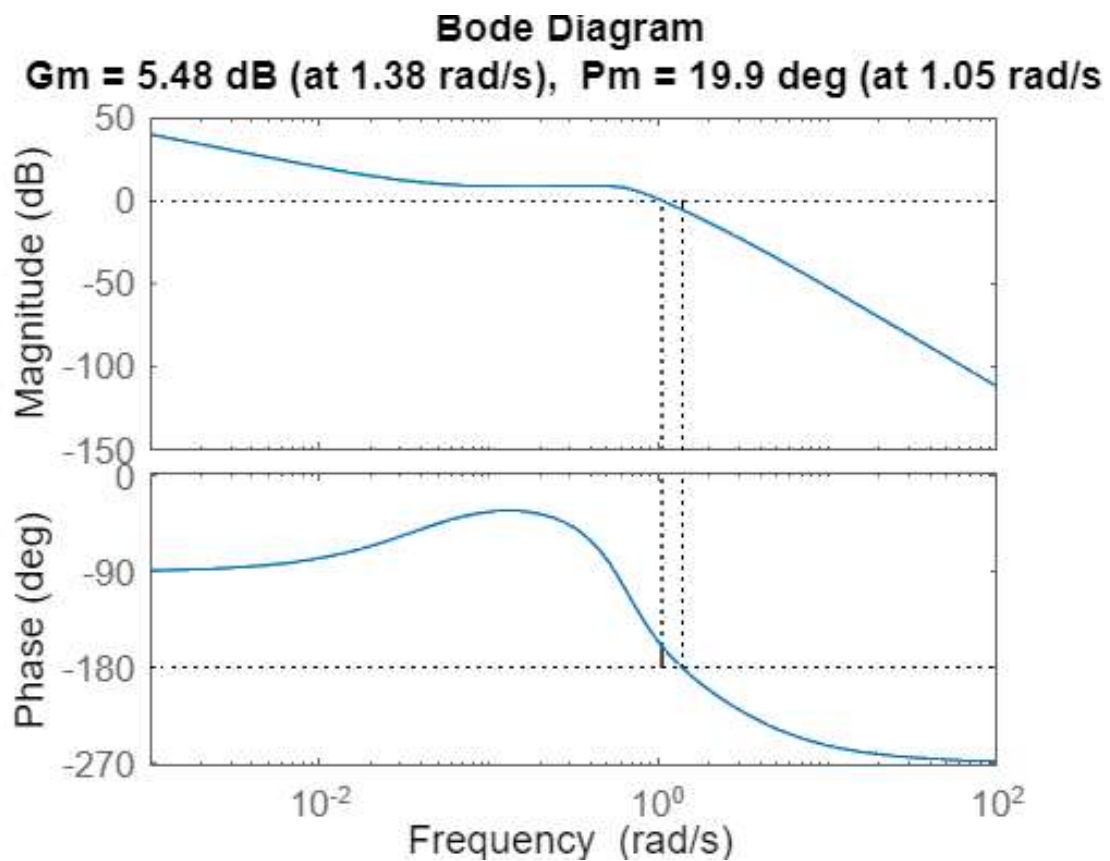
zapas_fazy = 25.9651

```
zapasy(G2, k2, alfa, 0);
```



zapas_modulu = 1.8690
zapas_fazy = 35.8373

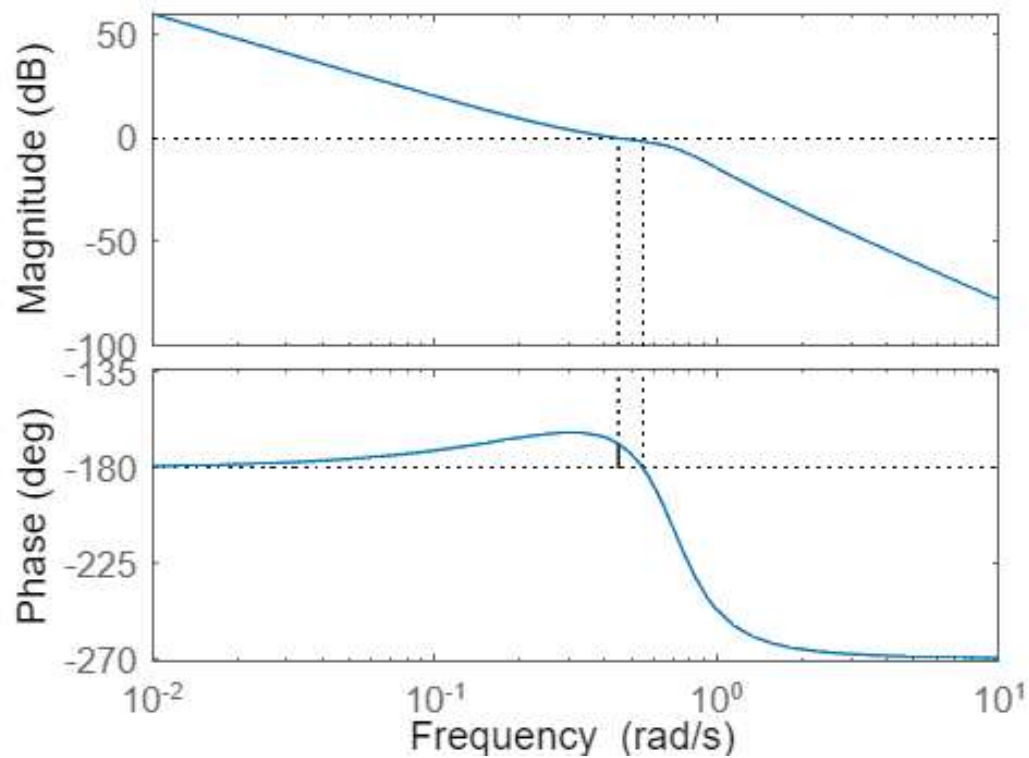
```
zapasy(G3, k3, alfa, 0);
```



zapas_modulu = 1.8802
zapas_fazy = 19.8733

```
zapasy(G4, k4, alfa, 0);
```

Bode Diagram
Gm = 1.58 dB (at 0.548 rad/s), Pm = 11.4 deg (at 0.448 rad/s)



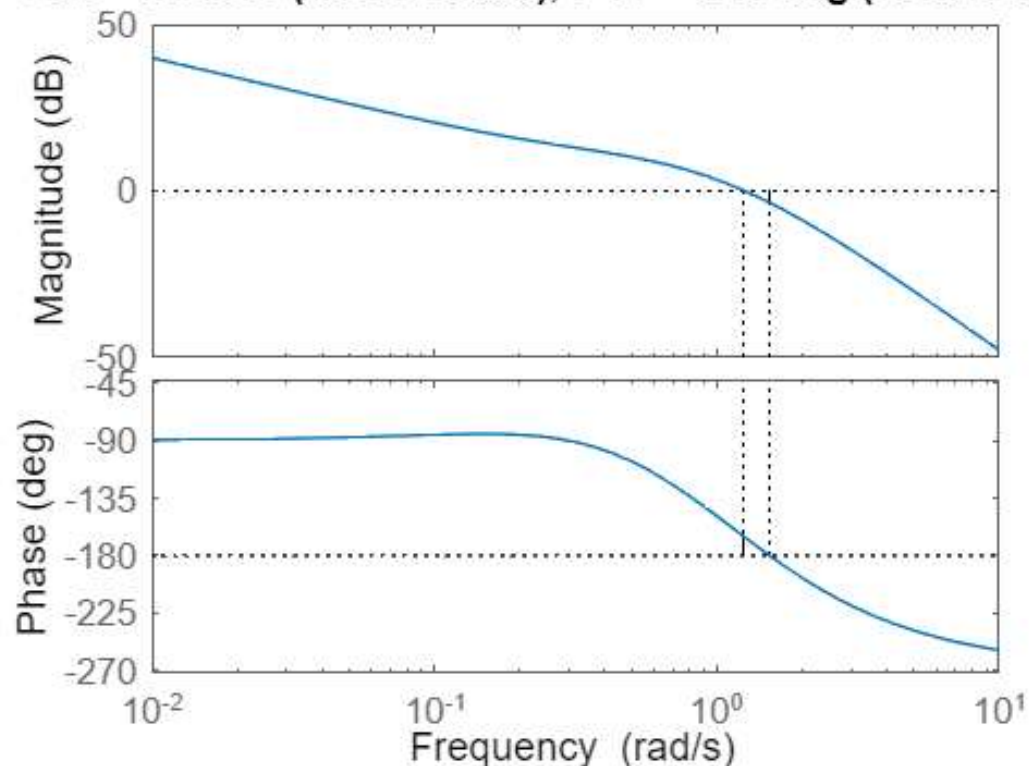
```
zapas_modulu = 1.2000  
zapas_fazy = 11.4055
```

```
alfa = 1
```

```
alfa = 1
```

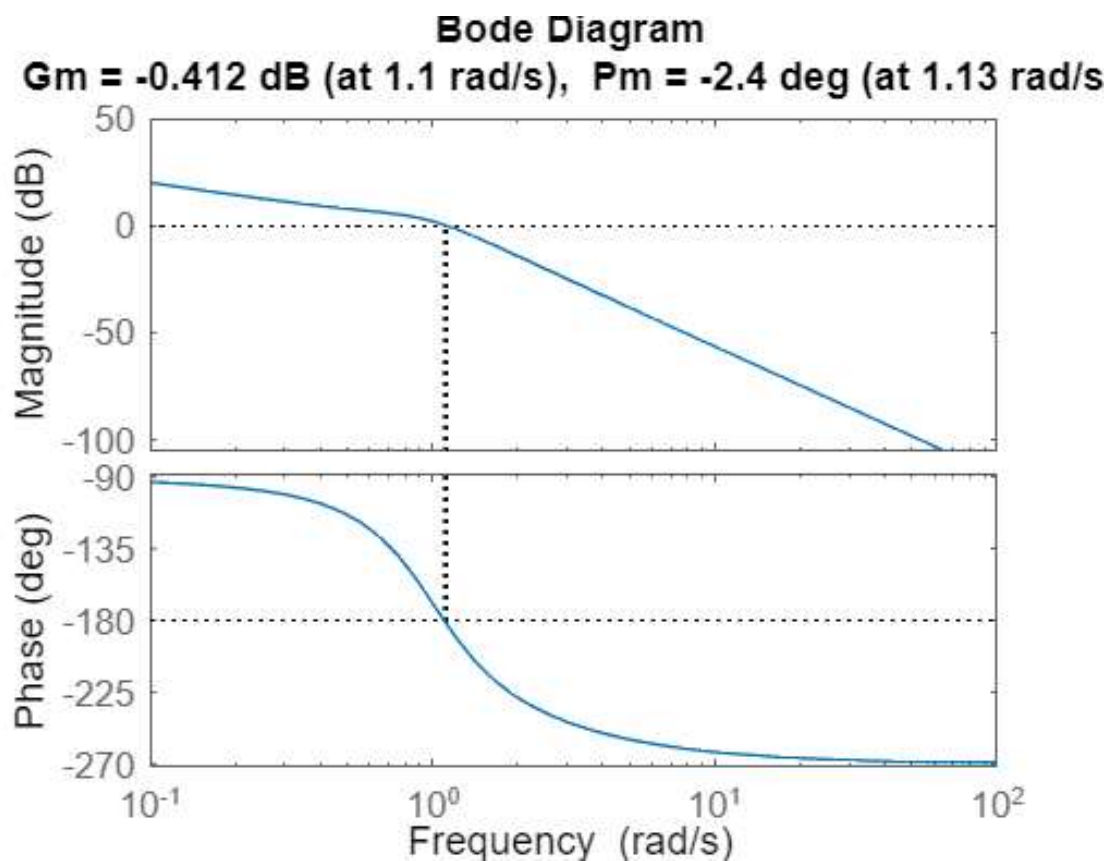
```
zapasy(G1, k1, alfa, 0);
```

Bode Diagram
Gm = 3.62 dB (at 1.54 rad/s), Pm = 14.9 deg (at 1.25 rad/s)




```
zapas_modulu = 1.5175  
zapas_fazy = 14.8847
```

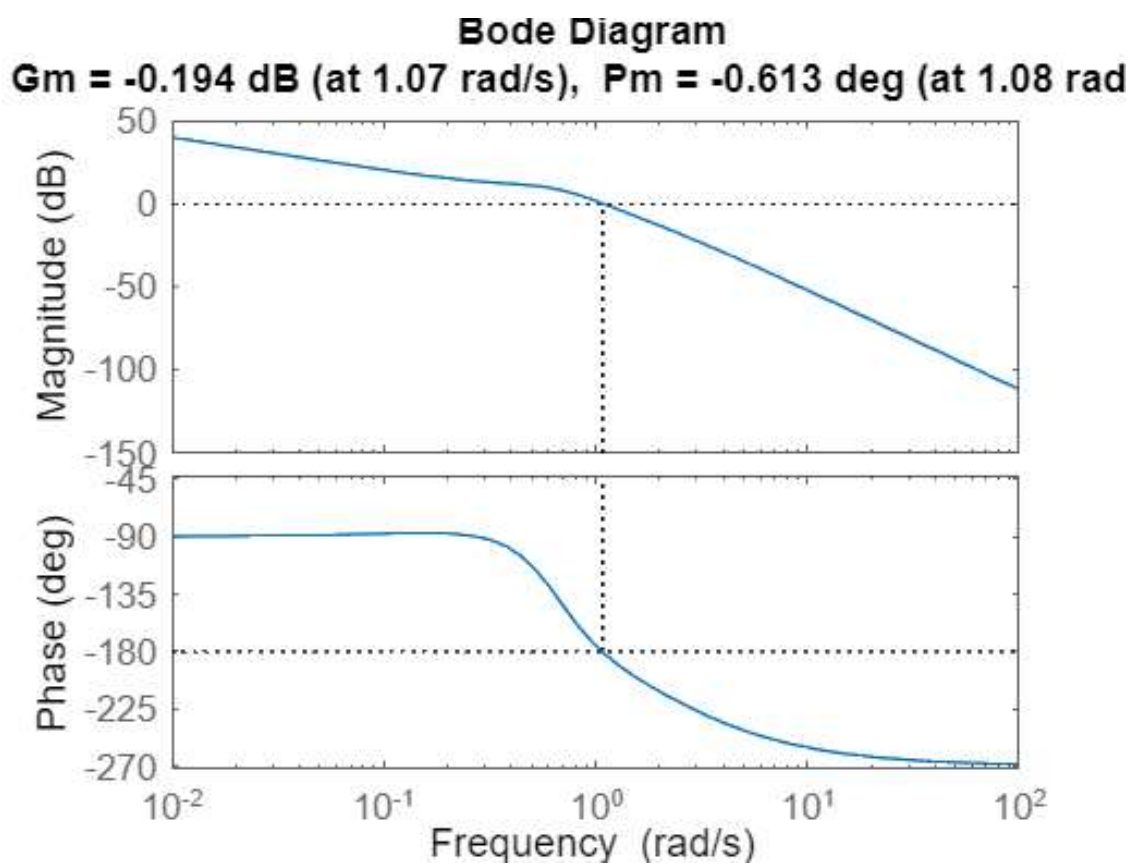
```
zapasy(G2, k2, alfa, 0);
```



Warning: The closed-loop system is unstable.

```
zapas_modulu = 0.9537  
zapas_fazy = -2.4014
```

```
zapasy(G3, k3, alfa, 0);
```

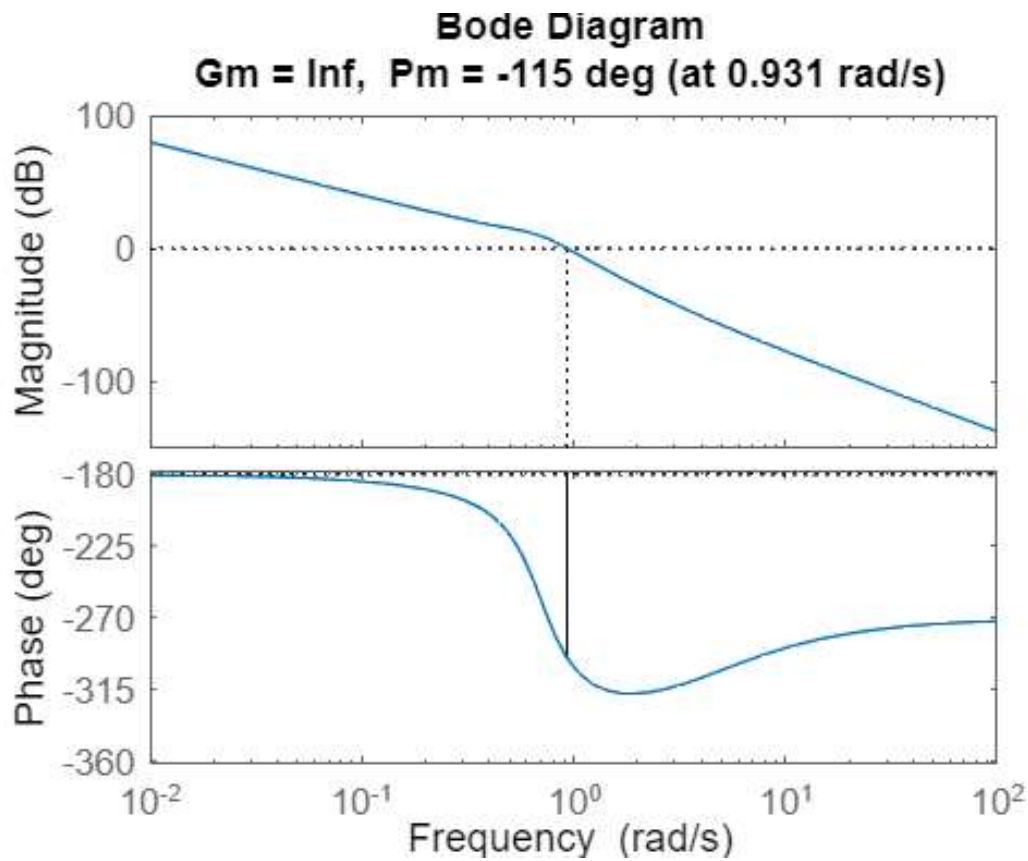


Warning: The closed-loop system is unstable.

zapas_modulu = 0.9779

zapas_fazy = -0.6135

```
zapasy(G4, k4, alfa, 0);
```



Warning: The closed-loop system is unstable.

zapas_modulu = 0

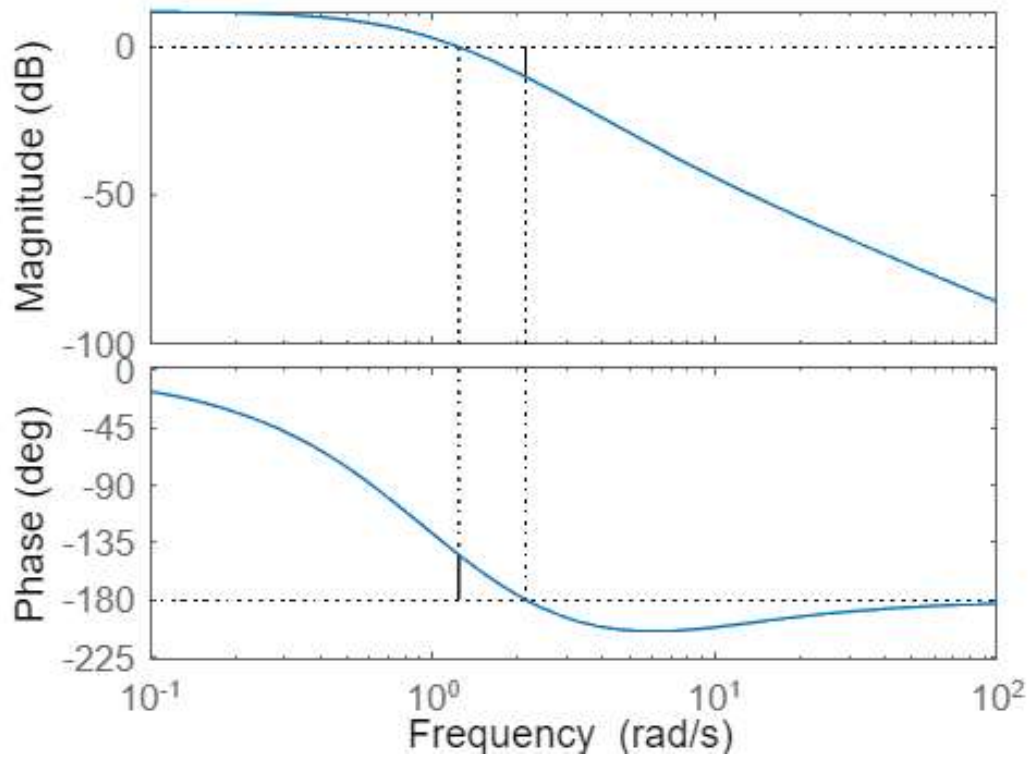
zapas_fazy = -115.1196

```
beta = 0.5
```

beta = 0.5000

```
zapasy(G1, k1, 0, beta);
```

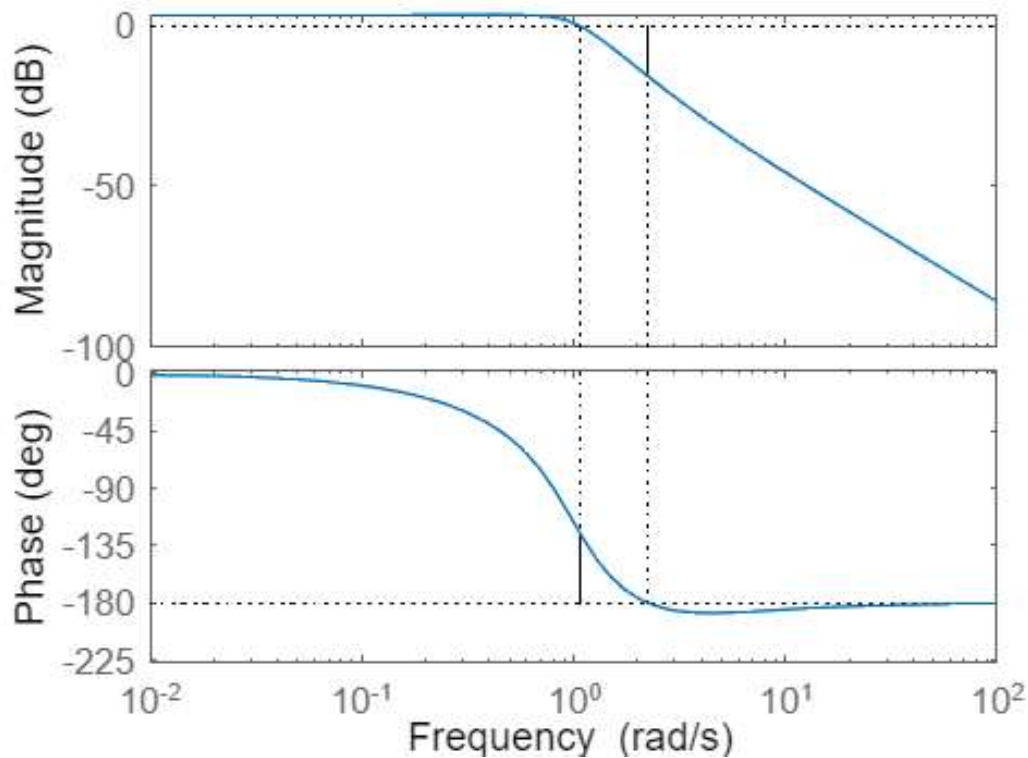

Bode Diagram
Gm = 10.1 dB (at 2.14 rad/s), Pm = 35.4 deg (at 1.24 rad/s)



```
zapas_modulu = 3.1993
zapas_fazy = 35.4024
```

```
zapasy(G2, k2, 0, beta);
```

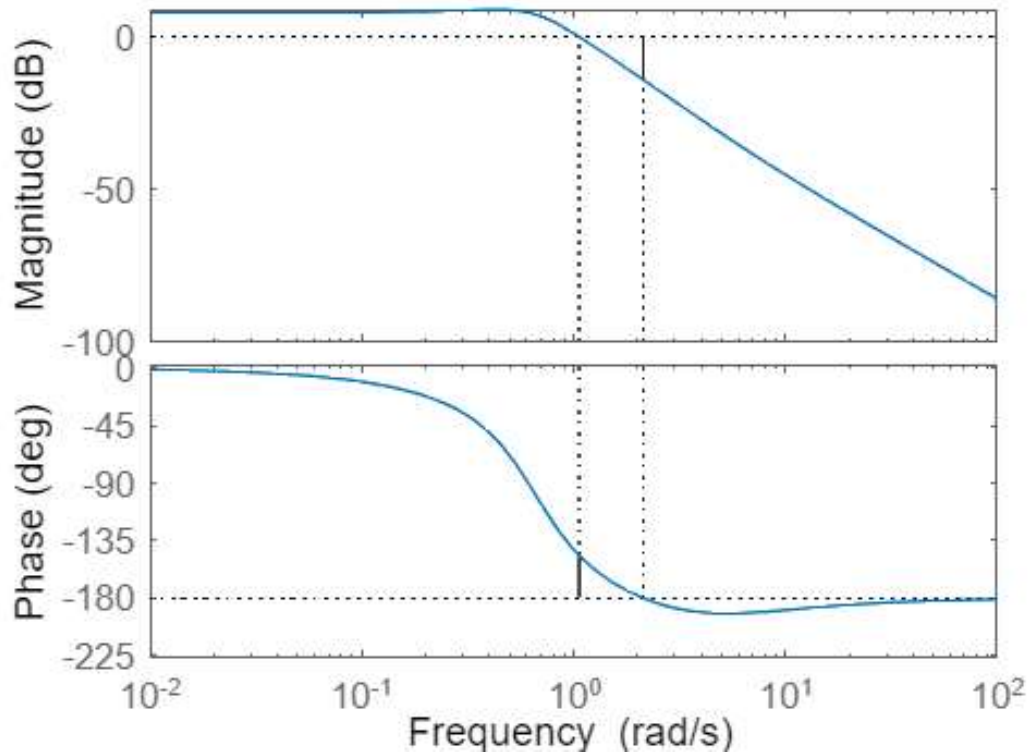
Bode Diagram
Gm = 15.6 dB (at 2.24 rad/s), Pm = 54.5 deg (at 1.07 rad/s)



```
zapas_modulu = 6.0002
zapas_fazy = 54.4706
```

```
zapasy(G3, k3, 0, beta);
```

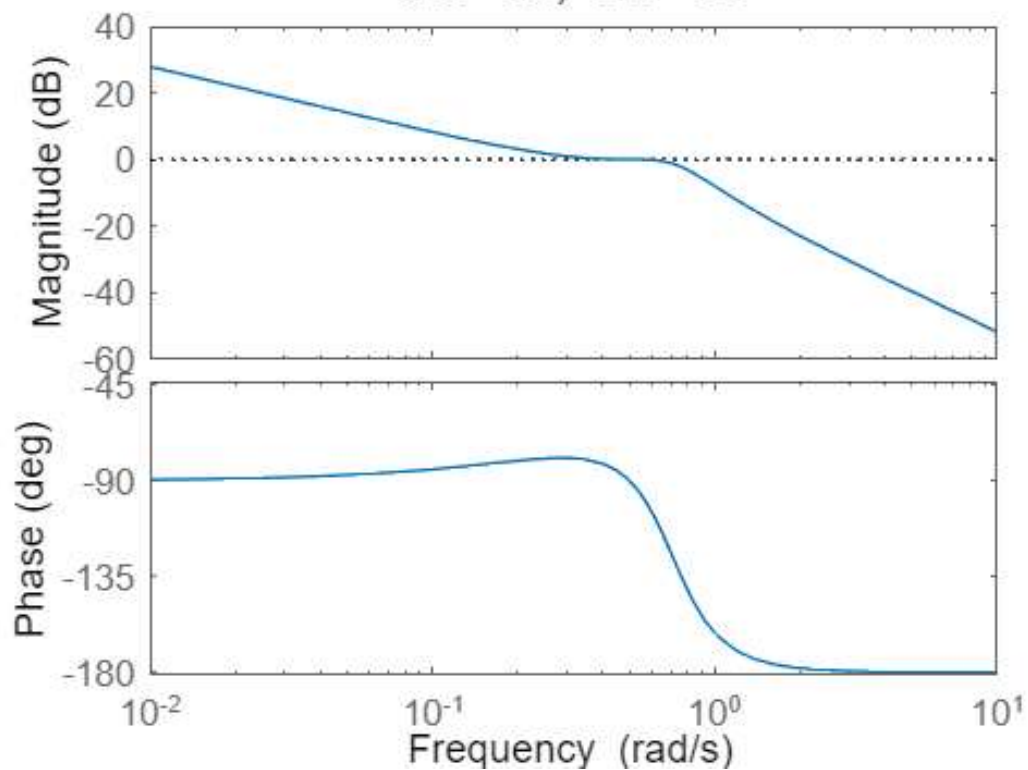
Bode Diagram
Gm = 14 dB (at 2.12 rad/s), Pm = 33.2 deg (at 1.06 rad/s)



```
zapas_modulu = 4.9928
zapas_fazy = 33.2205
```

```
zapas(y(G4, k4, 0, beta);
```

Bode Diagram
Gm = Inf, Pm = Inf

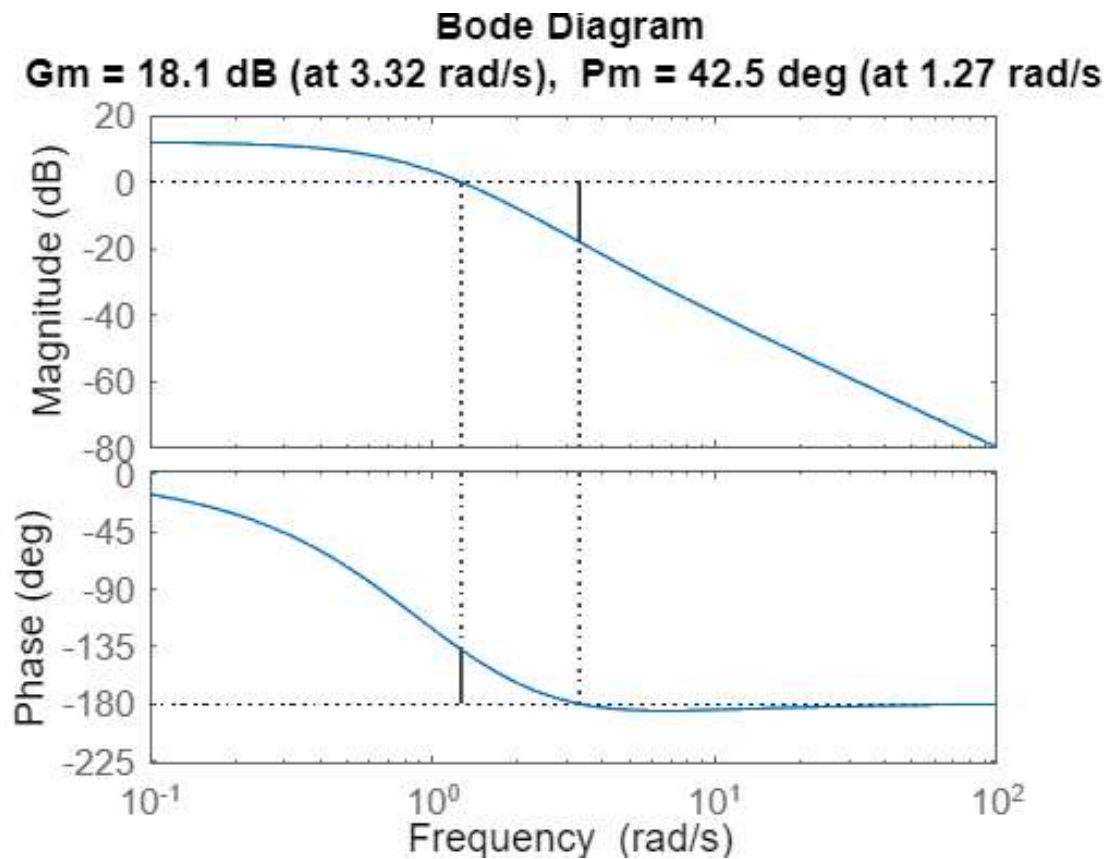


```
zapas_modulu = Inf
zapas_fazy = Inf
```

```
beta = 1
```

beta = 1

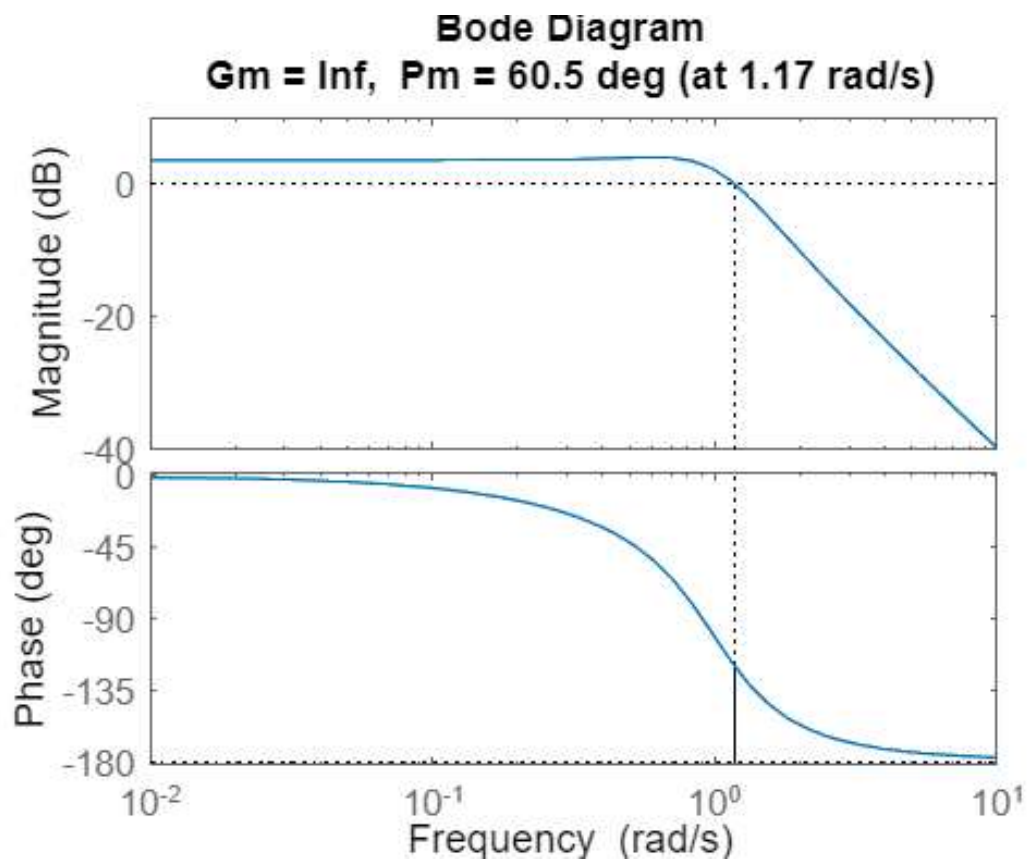
```
zapasy(G1, k1, 0, beta);
```



zapas_modulu = 7.9956

zapas_fazy = 42.5031

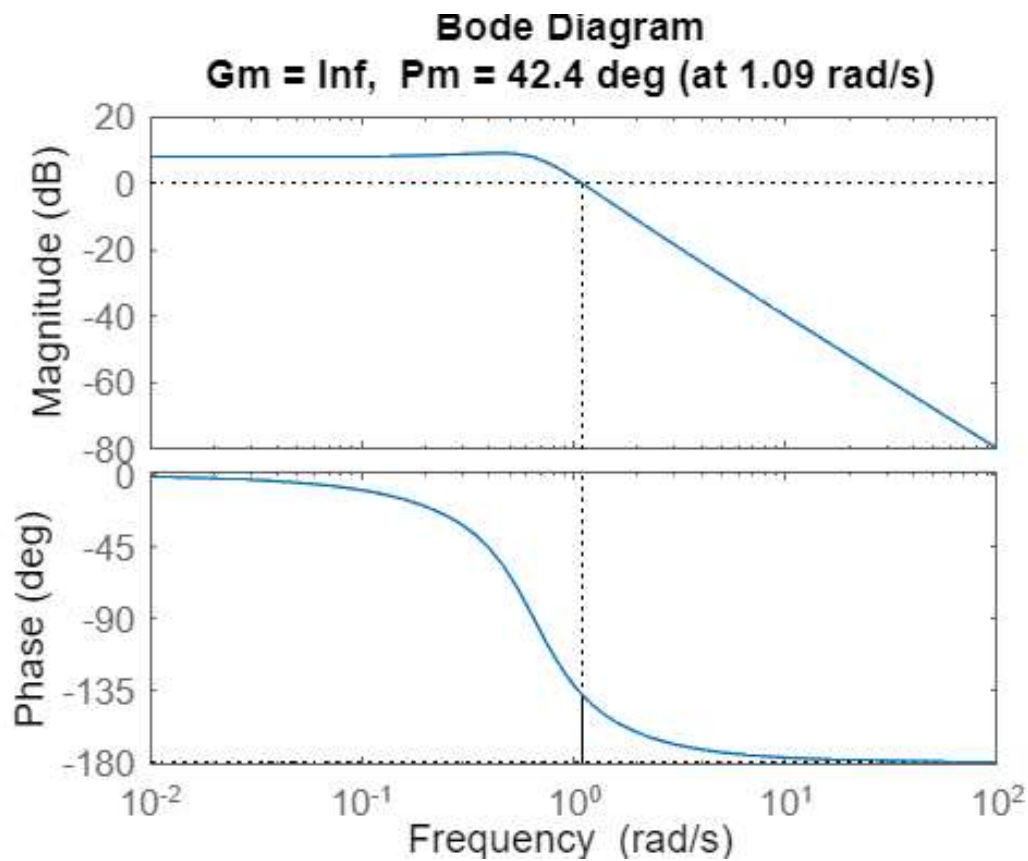
```
zapasy(G2, k2, 0, beta);
```



zapas_modulu = Inf

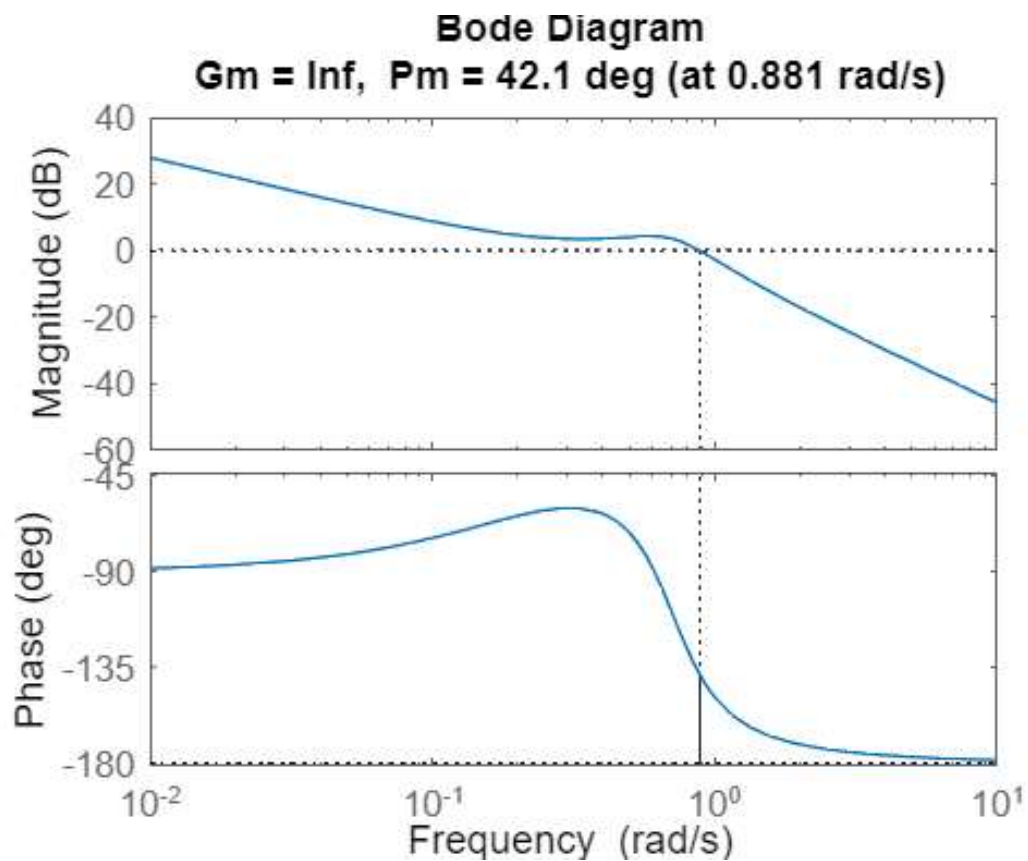
zapas_fazy = 60.5323

```
zapasy(G3, k3, 0, beta);
```



```
zapas_modulu = Inf  
zapas_fazy = 42.4144
```

```
zapasy(G4, k4, 0, beta);
```



```
zapas_modulu = Inf  
zapas_fazy = 42.0872
```

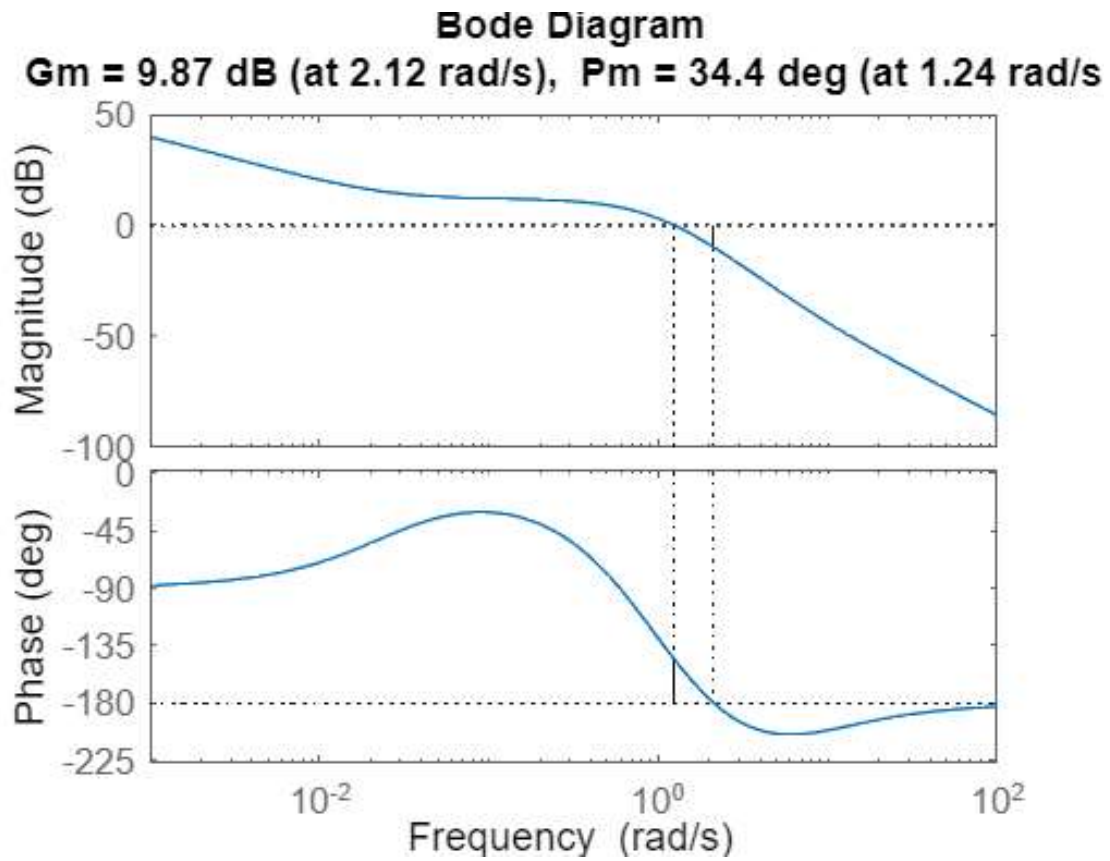
```
alfa = 0.1
```

```
alfa = 0.1000
```

```
beta = 0.5
```

```
beta = 0.5000
```

```
zapasy(G1, k1, alfa, beta);
```

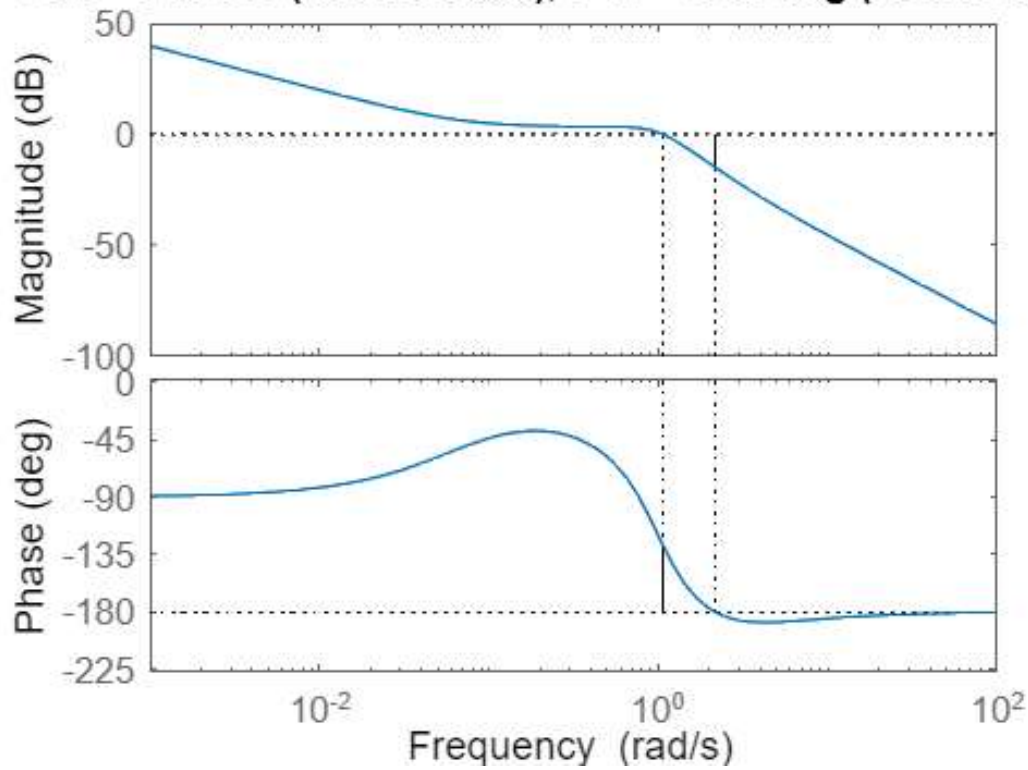


```
zapas_modulu = 3.1160
```

```
zapas_fazy = 34.3903
```

```
zapasy(G2, k2, alfa, beta);
```

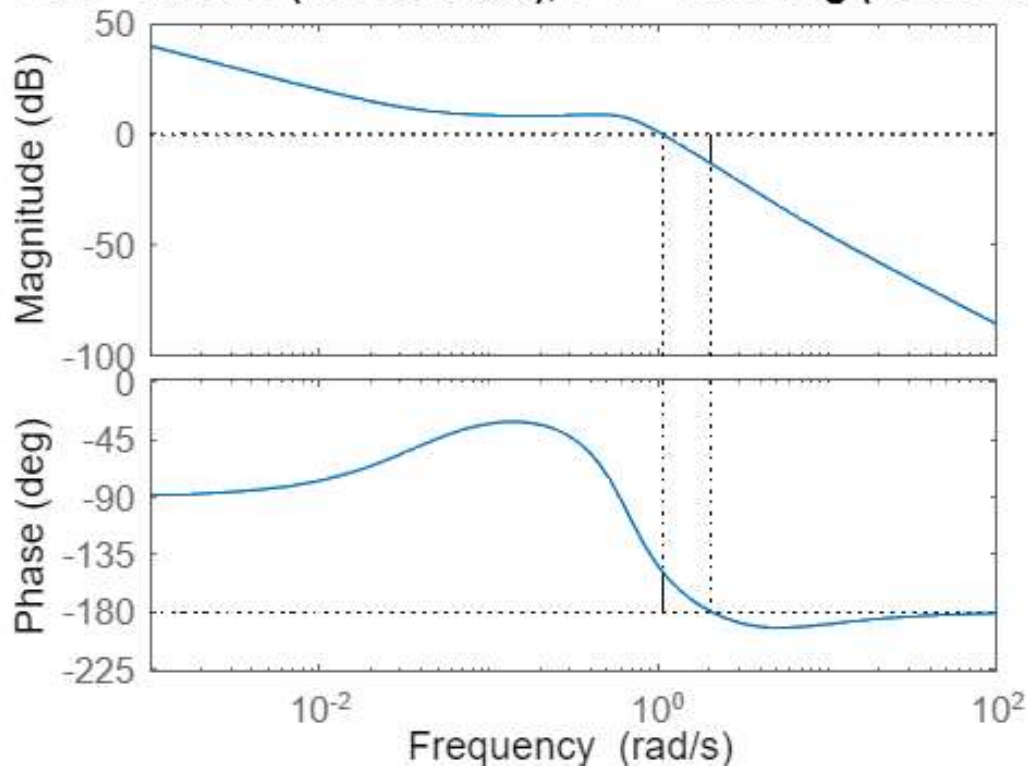
Bode Diagram
Gm = 14.8 dB (at 2.15 rad/s), Pm = 52.6 deg (at 1.06 rad/s)



zapas_modulu = 5.5245
zapas_fazy = 52.5602

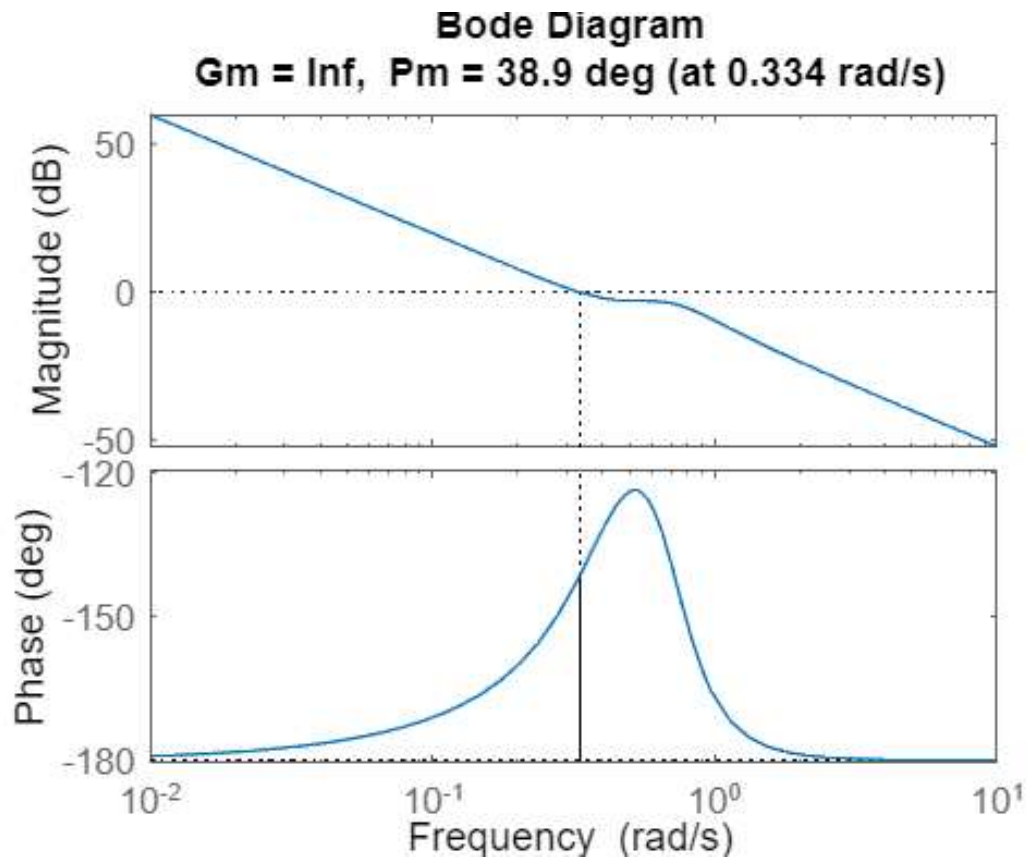
```
zapasy(G3, k3, alfa, beta);
```

Bode Diagram
Gm = 13.4 dB (at 2.05 rad/s), Pm = 31.4 deg (at 1.06 rad/s)



zapas_modulu = 4.6619
zapas_fazy = 31.3695

```
zapasy(G4, k4, alfa, beta);
```

zapas_modulu = 0
zapas_fazy = 38.8882

alfa = 1

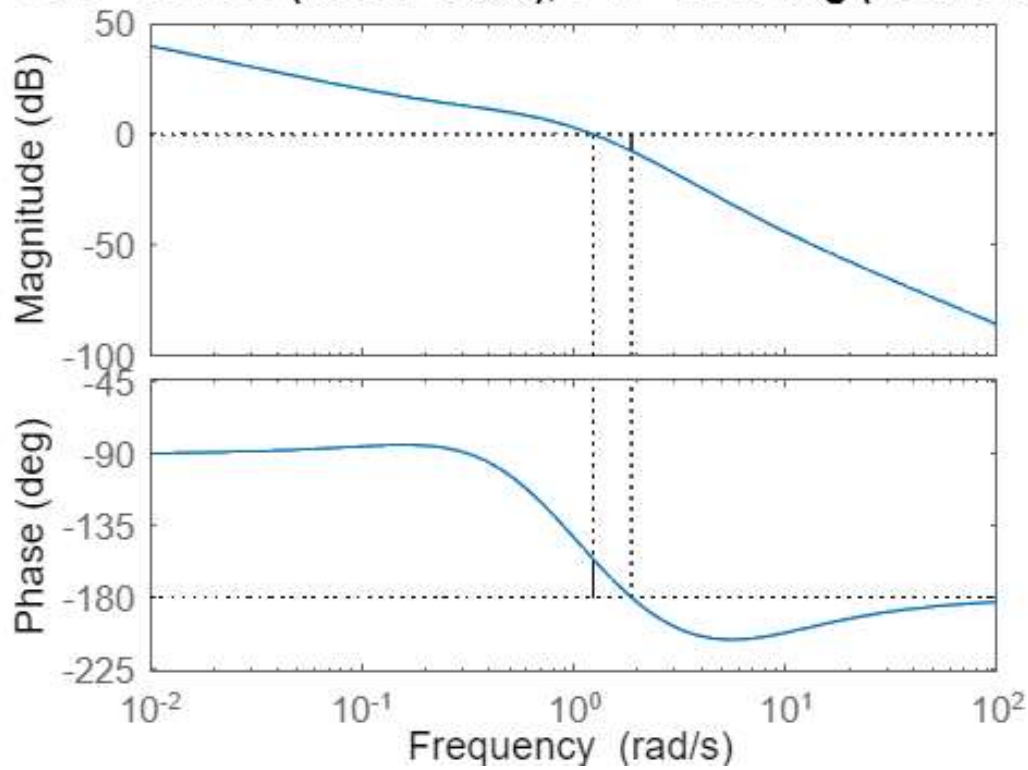
alfa = 1

beta = 0.5

beta = 0.5000

zapasy(G1, k1, alfa, beta);

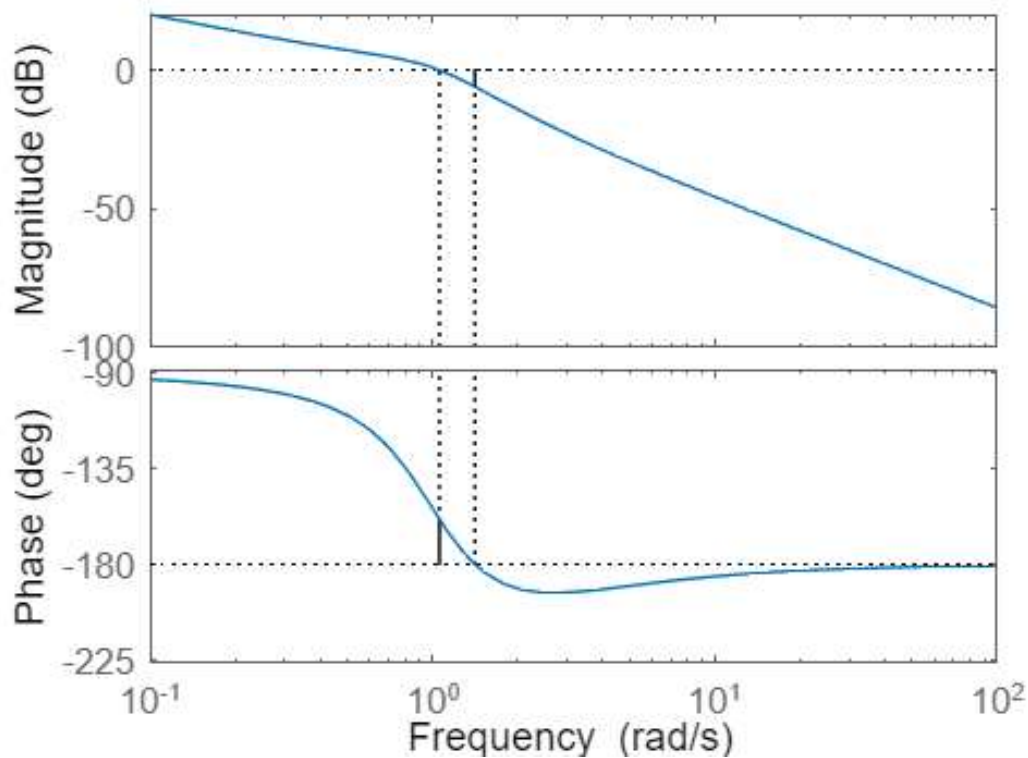
Bode Diagram
Gm = 7.55 dB (at 1.87 rad/s), Pm = 24.3 deg (at 1.23 rad/s)



zapas_modulu = 2.3852
 zapas_fazy = 24.3104

```
zapasy(G2, k2, alfa, beta);
```

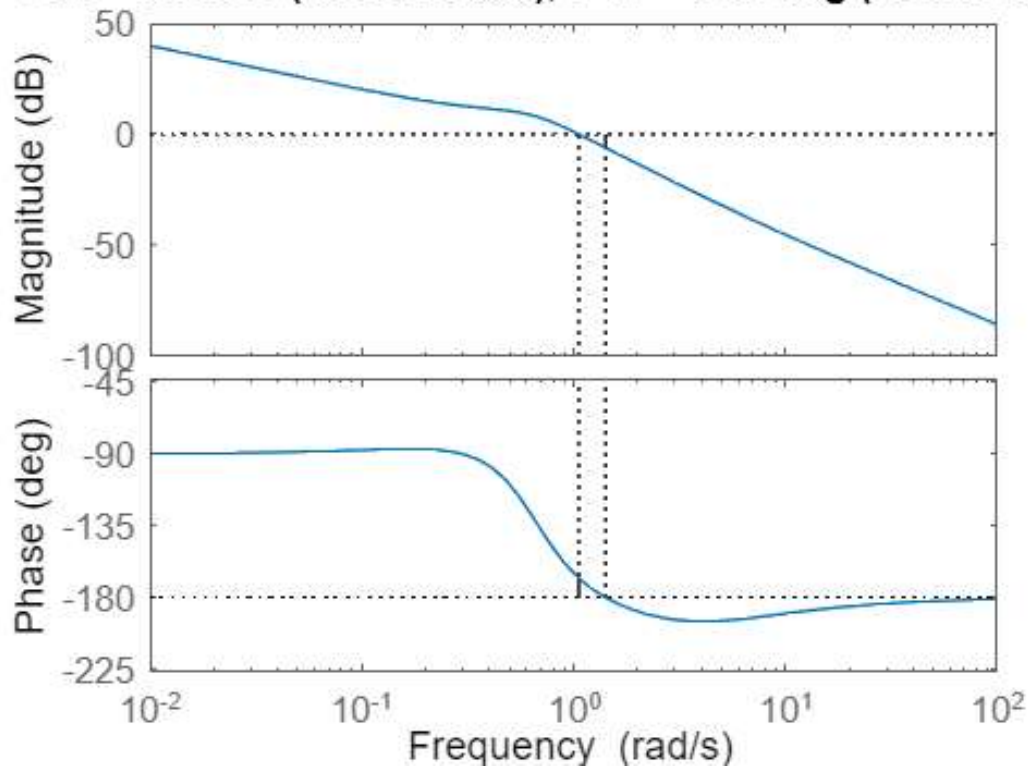
Bode Diagram
Gm = 6.02 dB (at 1.41 rad/s), Pm = 21.3 deg (at 1.06 rad/s)



zapas_modulu = 2.0000
 zapas_fazy = 21.2510

```
zapasy(G3, k3, alfa, beta);
```

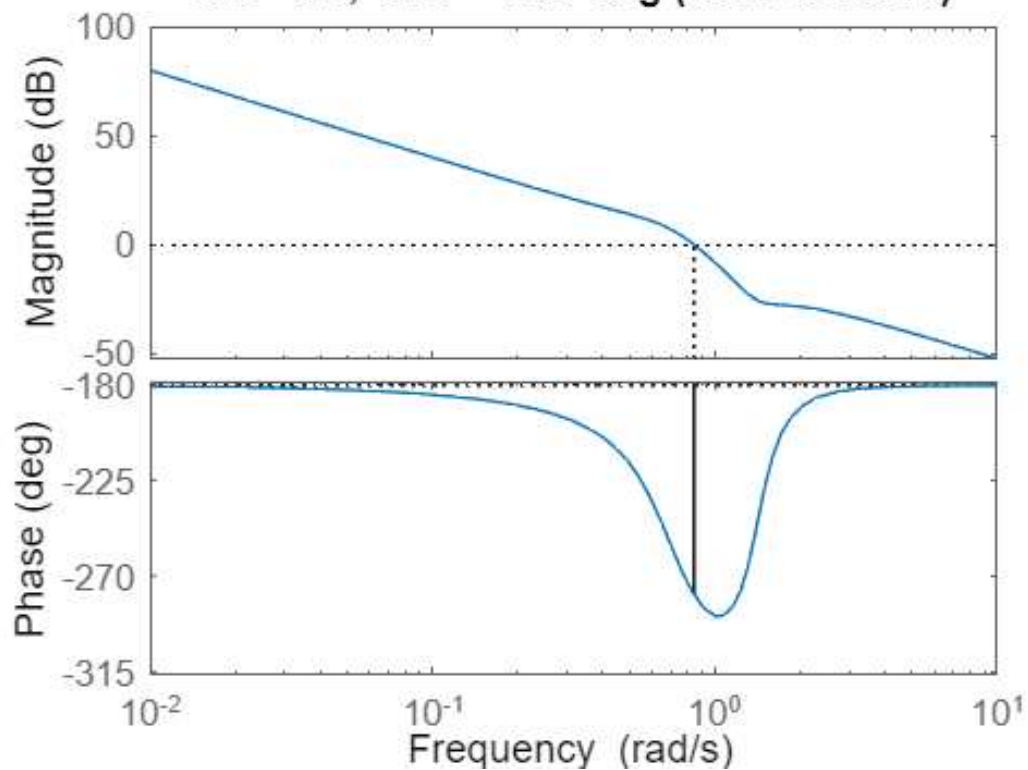
Bode Diagram
Gm = 6.02 dB (at 1.41 rad/s), Pm = 12.1 deg (at 1.06 rad/s)



```
zapas_modulu = 1.9989
zapas_fazy = 12.1106
```

```
zapaszy(G4, k4, alfa, beta);
```

Bode Diagram
Gm = Inf, Pm = -98.7 deg (at 0.845 rad/s)



Warning: The closed-loop system is unstable.

```
zapas_modulu = 0
zapas_fazy = -98.6901
```

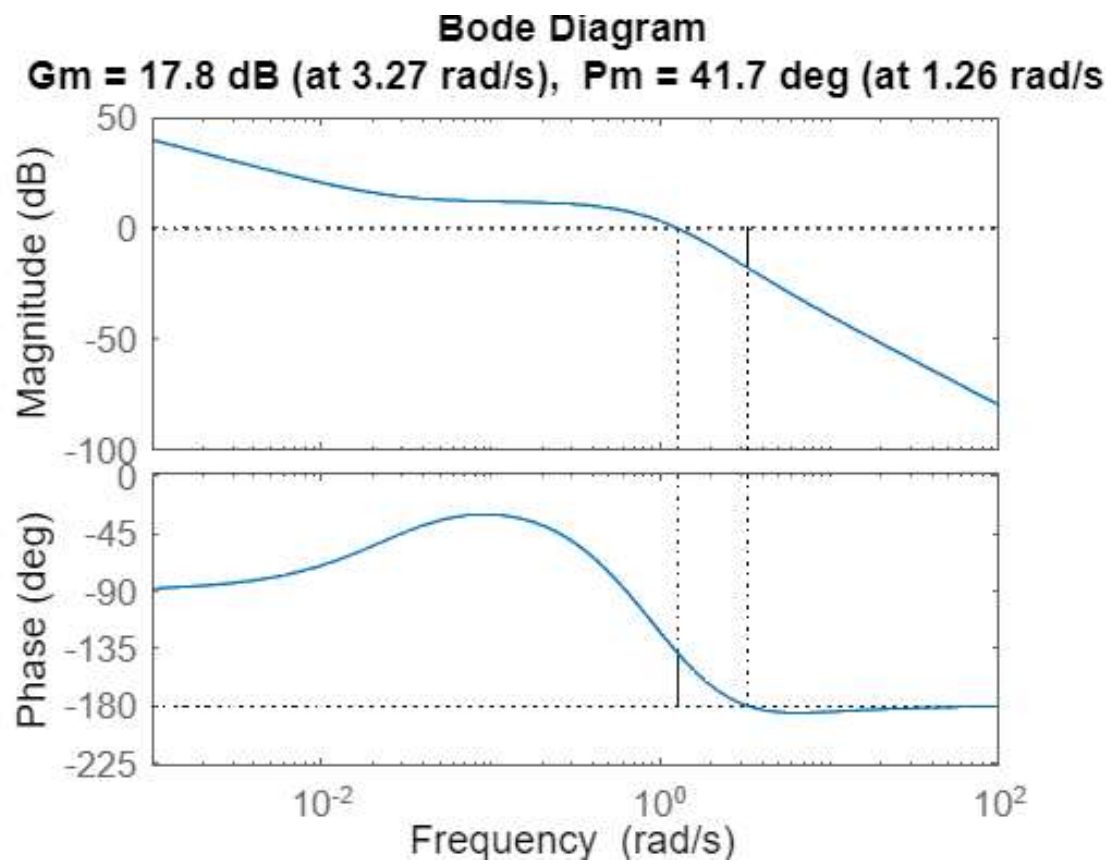
```
alfa = 0.1
```

```
alfa = 0.1000
```

```
beta = 1
```

```
beta = 1
```

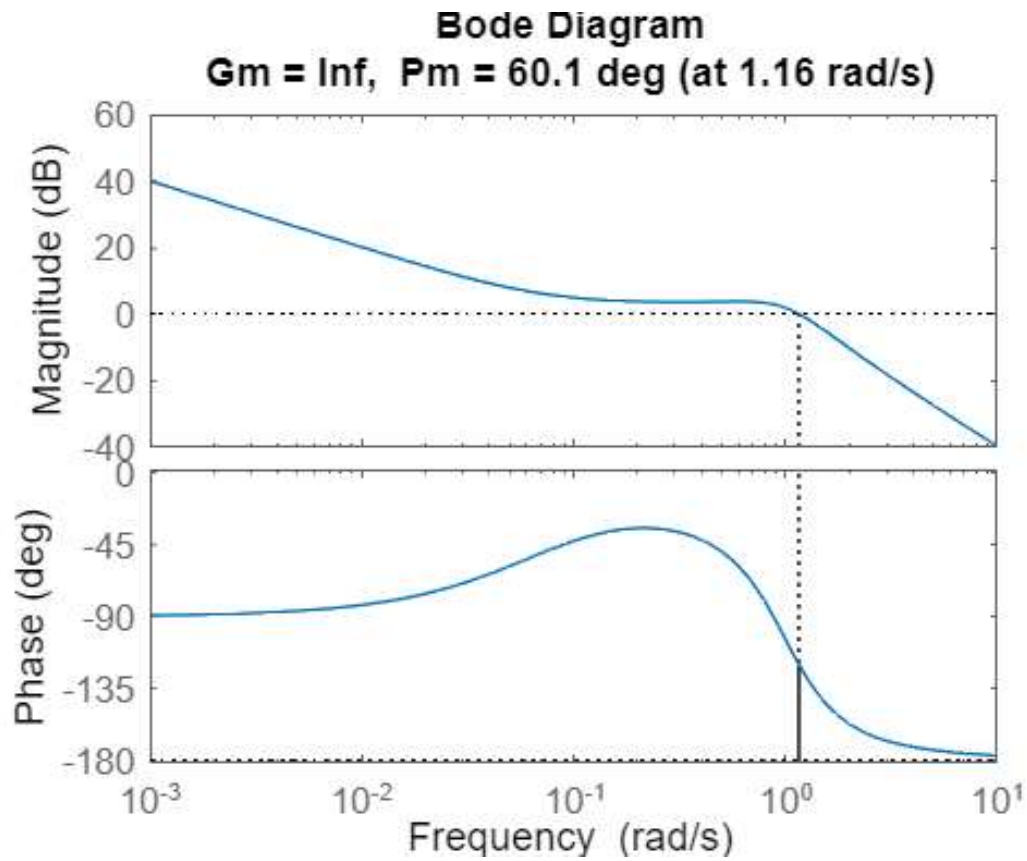
```
zapasy(G1, k1, alfa, beta);
```



```
zapas_modulu = 7.7778
```

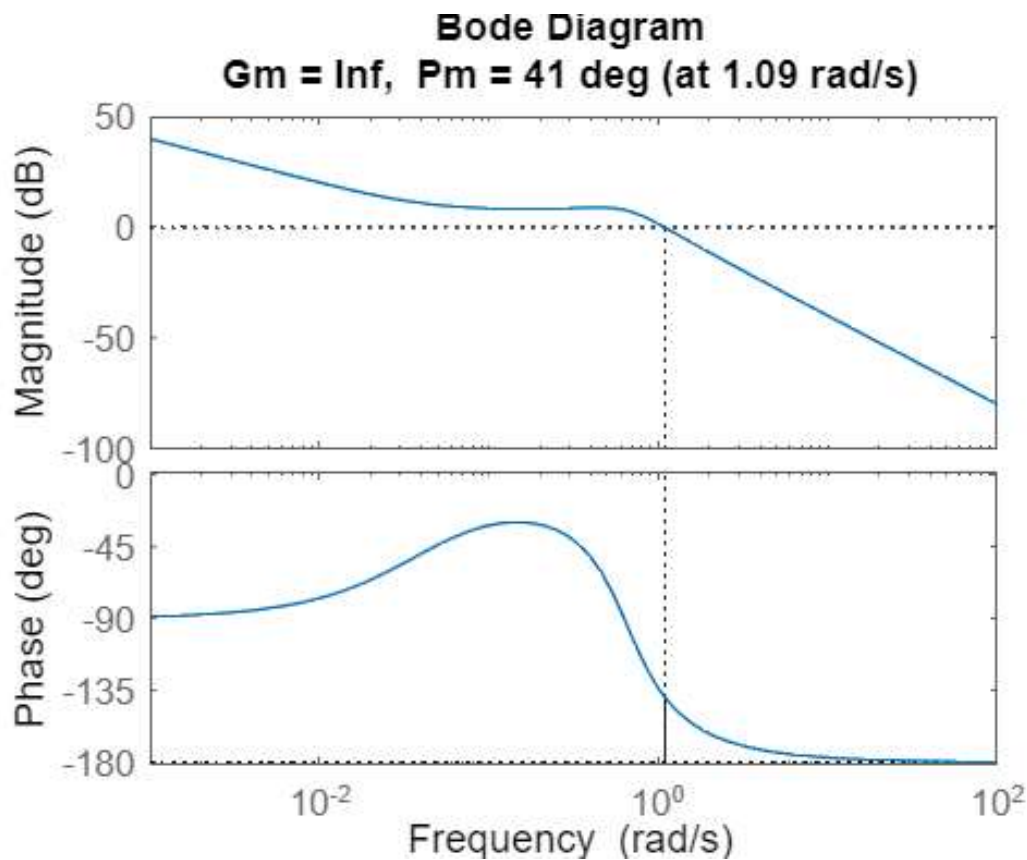
```
zapas_fazy = 41.6767
```

```
zapasy(G2, k2, alfa, beta);
```



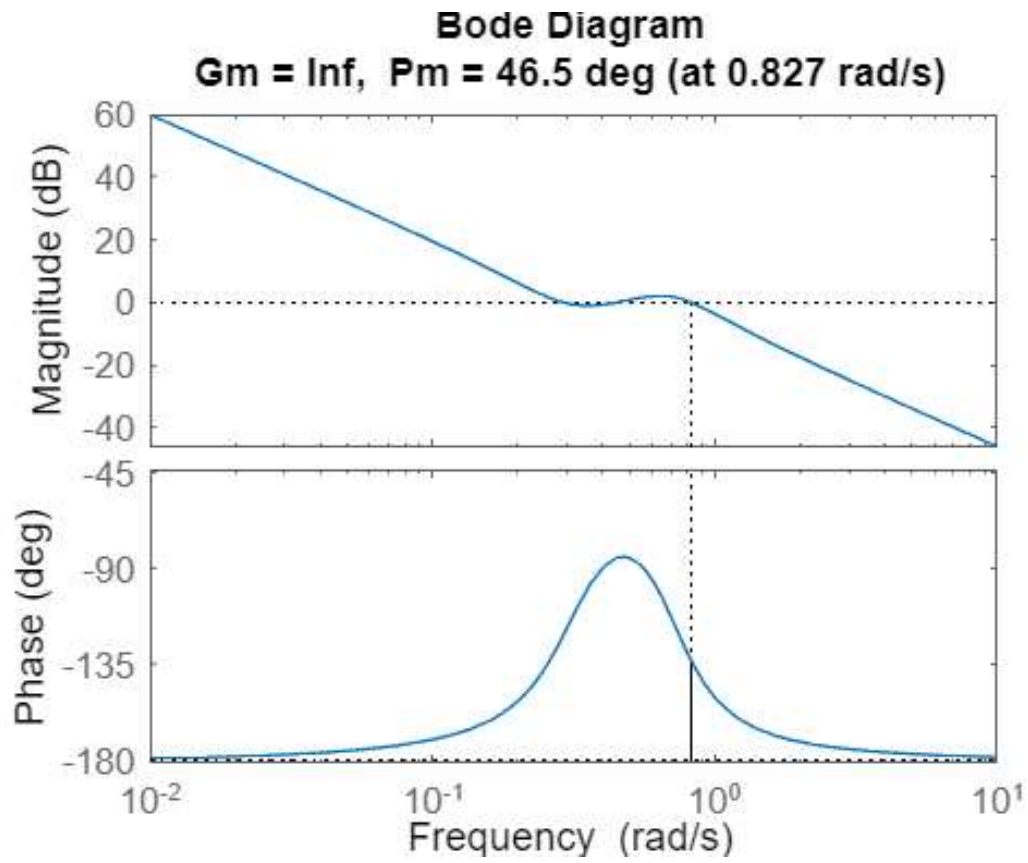
```
zapas_modulu = Inf
zapas_fazy = 60.0626
```

```
zapasy(G3, k3, alfa, beta);
```



```
zapas_modulu = Inf
zapas_fazy = 40.9998
```

```
zapasy(G4, k4, alfa, beta);
```



zapas_modulu = 0
zapas_fazy = 46.4855

alfa = 1

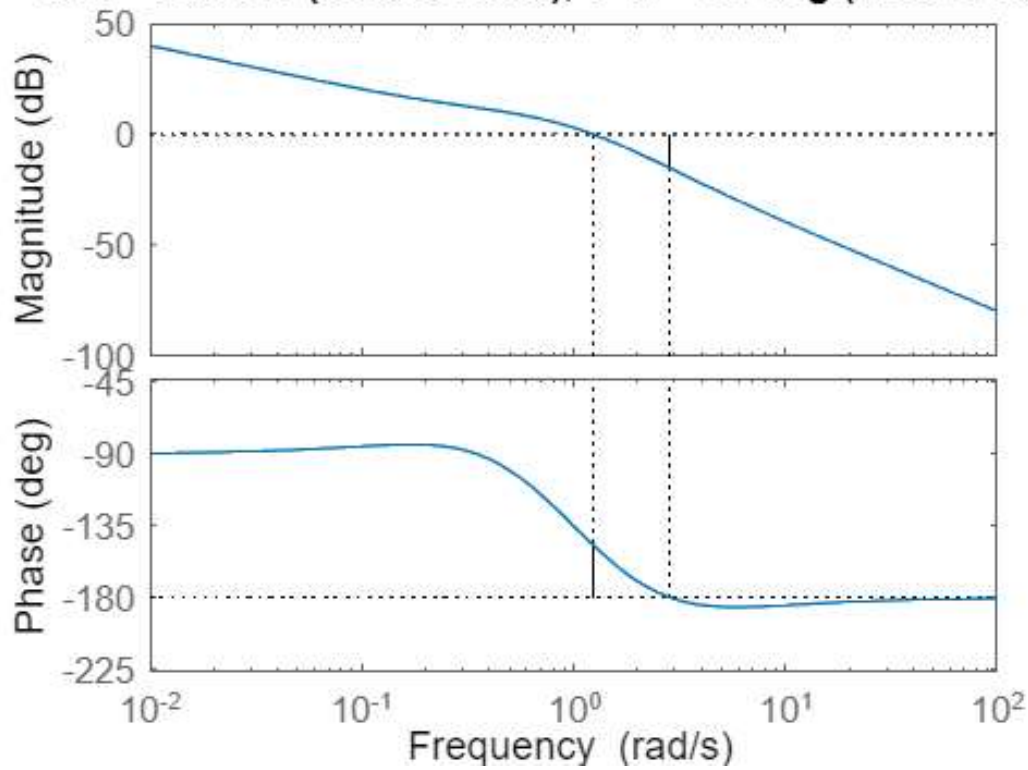
alfa = 1

beta = 1

beta = 1

zapasy(G1, k1, alfa, beta);

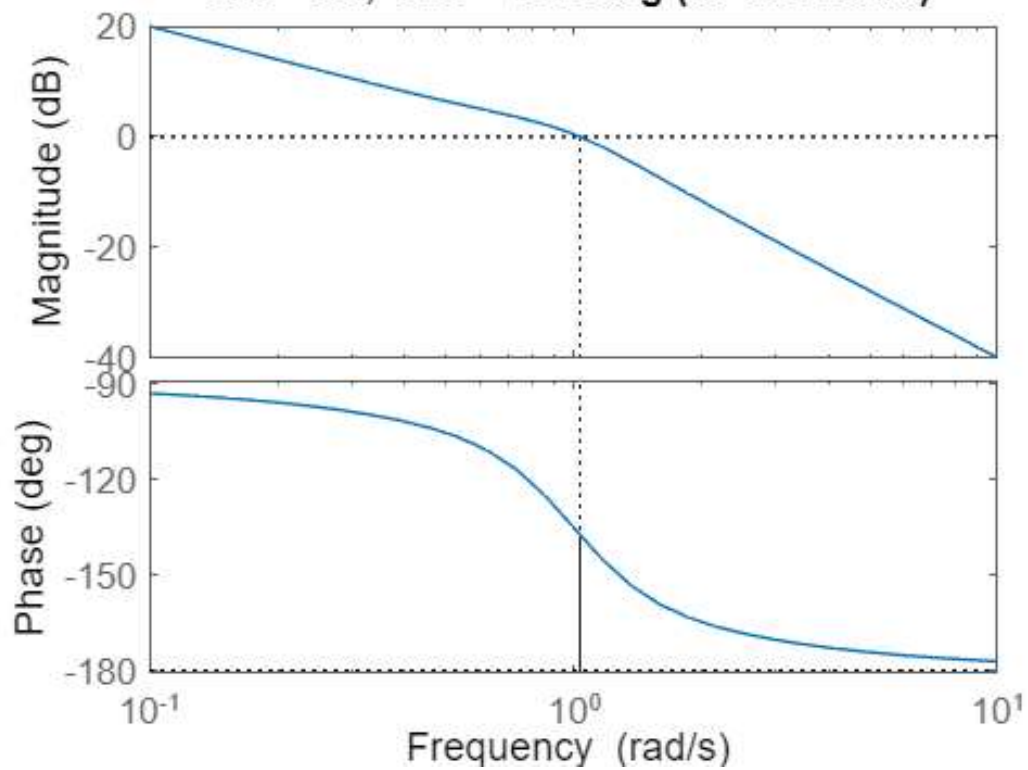
Bode Diagram
Gm = 15.3 dB (at 2.85 rad/s), Pm = 33 deg (at 1.24 rad/s)



```
zapas_modulu = 5.8400
zapas_fazy = 32.9823
```

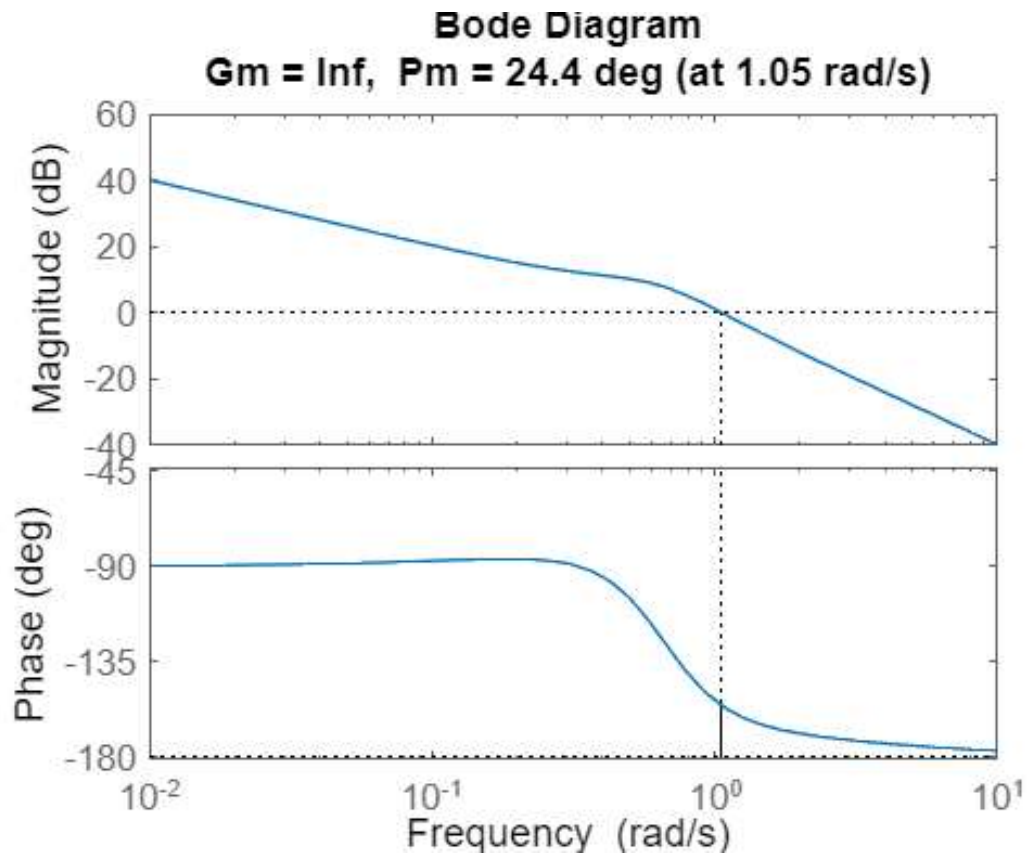
```
zapasy(G2, k2, alfa, beta);
```

Bode Diagram
Gm = Inf, Pm = 42.5 deg (at 1.04 rad/s)



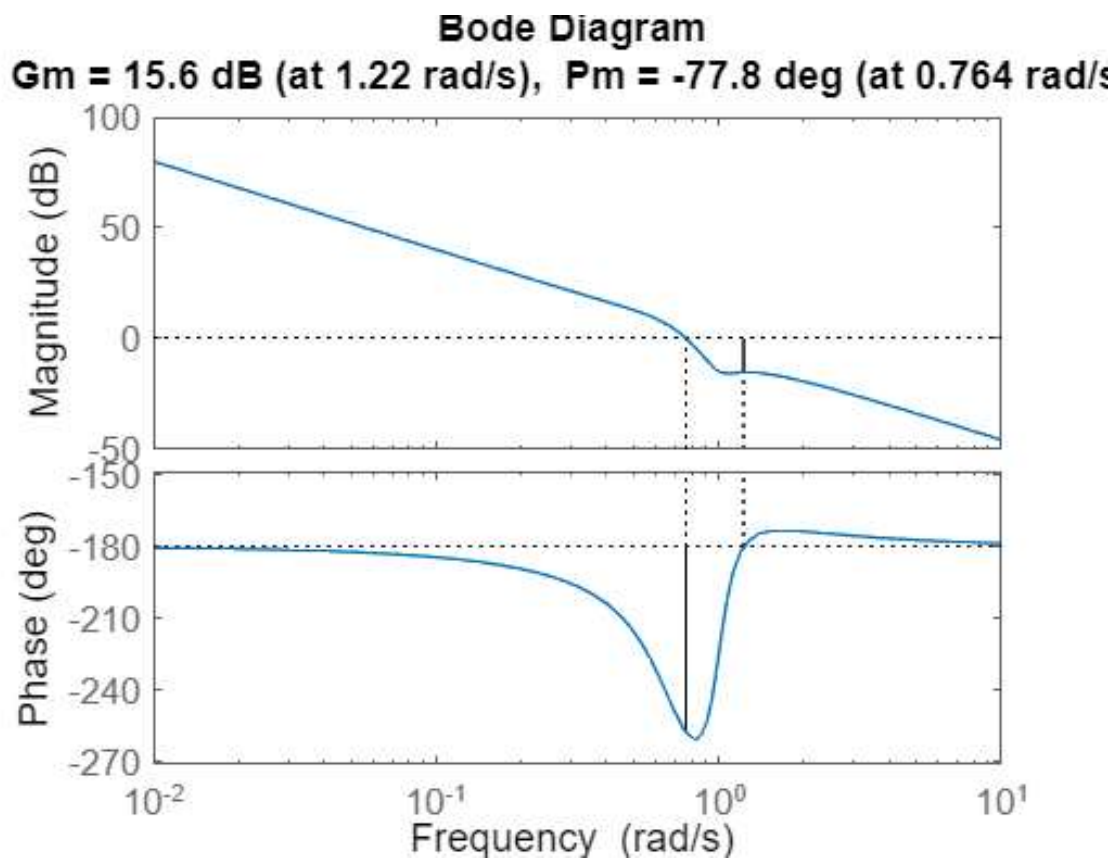
```
zapas_modulu = Inf
zapas_fazy = 42.4687
```

```
zapasy(G3, k3, alfa, beta);
```



```
zapas_modulu = Inf
zapas_fazy = 24.3700
```

```
zapaszy(G4, k4, alfa, beta);
```



Warning: The closed-loop system is unstable.

```
zapas_modulu = 6.0000
zapas_fazy = -77.7540
```

```
function [] = zapasy(G, k, alfa, beta)
```

```
Gr = tf([k], [1]) + tf([0 alfa], [1 0]) + tf([beta 0], [0 1]);  
margin(series(G, Gr))  
[Gm, Pm] = margin(series(G, Gr));  
zapas_modulu = Gm  
zapas_fazy = Pm  
end
```

Wnioski

Udało się przeanalizować wpływ parametrów regulatora PID na wartości zapasów stabilności fazy. Wzrost wzmocnienia pogarsza stabilność, wzrost stałej całkowania zazwyczaj pogarsza stabilność, wzrost stałej różniczkowania poprawia stabilność jeśli jest niewielkie, jednak stała równa 1 była zbyt duża.