Sprawozdanie - WEAIiIB	
Podstawy Automatyki	
Ćwiczenie 7: Zapasy stabilności	
Czwartek godz. 14:30	11.05.2023
Karolina Piotrowska	Data zaliczenia:
	Ocena:

Cel ćwiczenia

Ćwiczenie miało na celu przypomnienie zagadnień z zakresu zapasów stabilności

Wstęp teoretyczny

W ćwiczeniu rozważany jest zamknięty układ regulacji złożony z obiektu o transmitancji G(s) oraz regulatora liniowego ciągłego o transmitancji Gr(s). Rozważamy regulatory P, PI, PD oraz PID w wersji independent. Transmitancja układu jest równa Go(s) = Gr(s)G(s).

Rozważane transmitancje obiektu:

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

Przebieg ćwiczenia

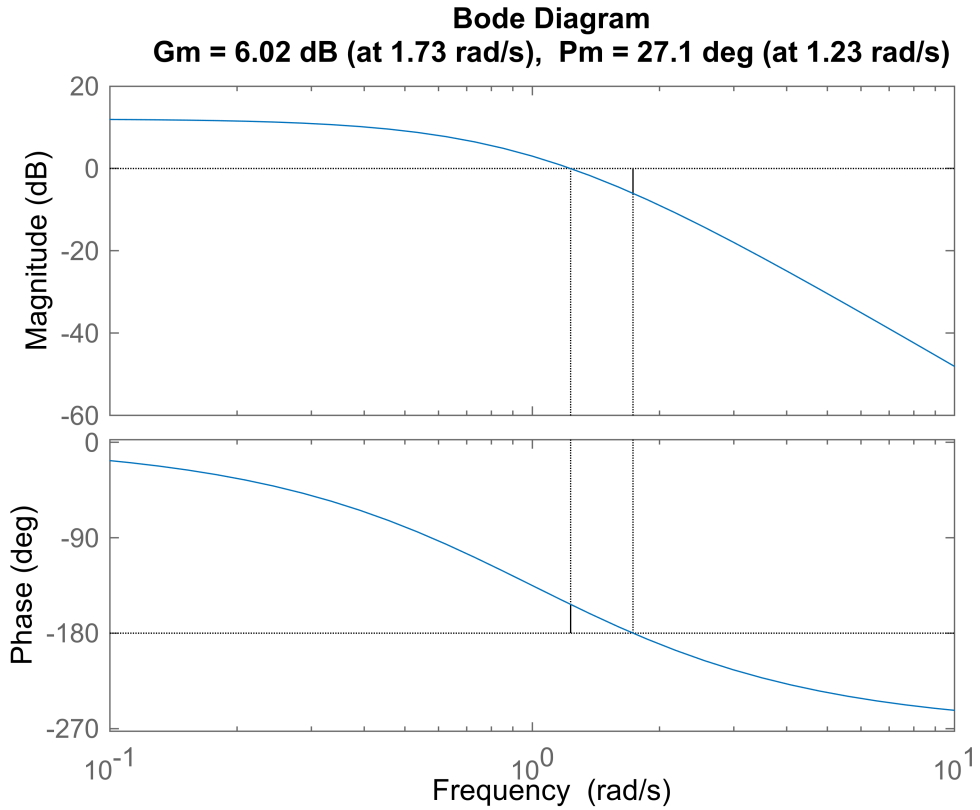
Zadanie 1

Regulator P

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

Gi = [G1 G2 G3 G4];
k = [4.0005 1.5 5/4 1/4];

for i = 1:4
    fprintf('Transmitancja obiektu: ')
    G = Gi(i)
    fprintf('Transmitancja regulatora: ')
    Gr = tf(k(i), 1)
```

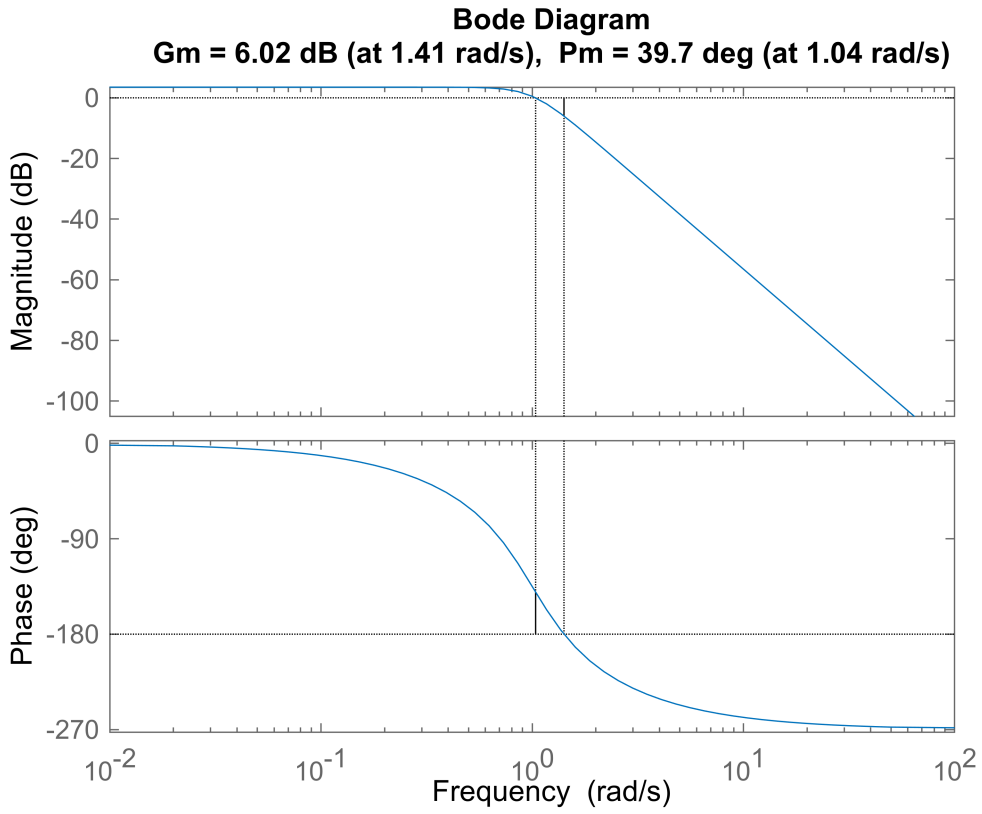
```
    figure
    margin(series(Gr, G))
    [gm, pm, c, d] = margin(series(Gr, G));
    fprintf('Zapas modułu: ')
    fprintf(num2str(gm))
    fprintf('Zapas fazy: ')
    fprintf(num2str(pm))
end
```

```
Transmitancja obiektu:
G =

           1
  --------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  4

Static gain.
```

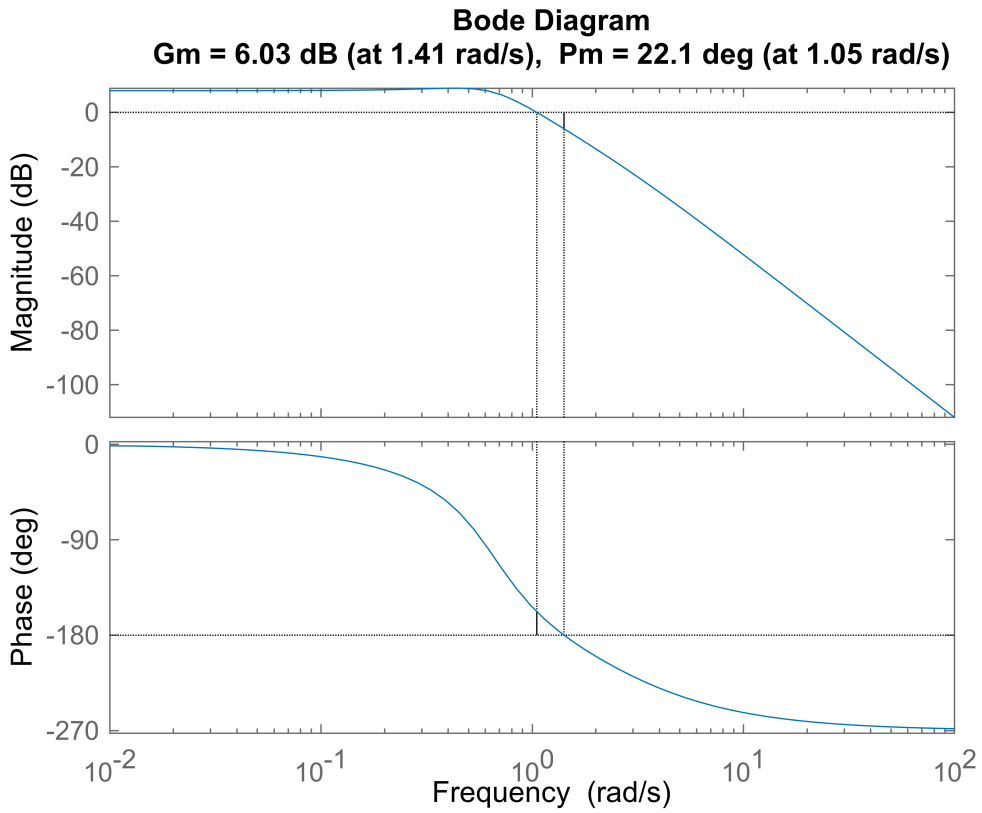



```
Zapas modułu:
2
Zapas fazy:
27.1366
Transmitancja obiektu:
G =

           1
```

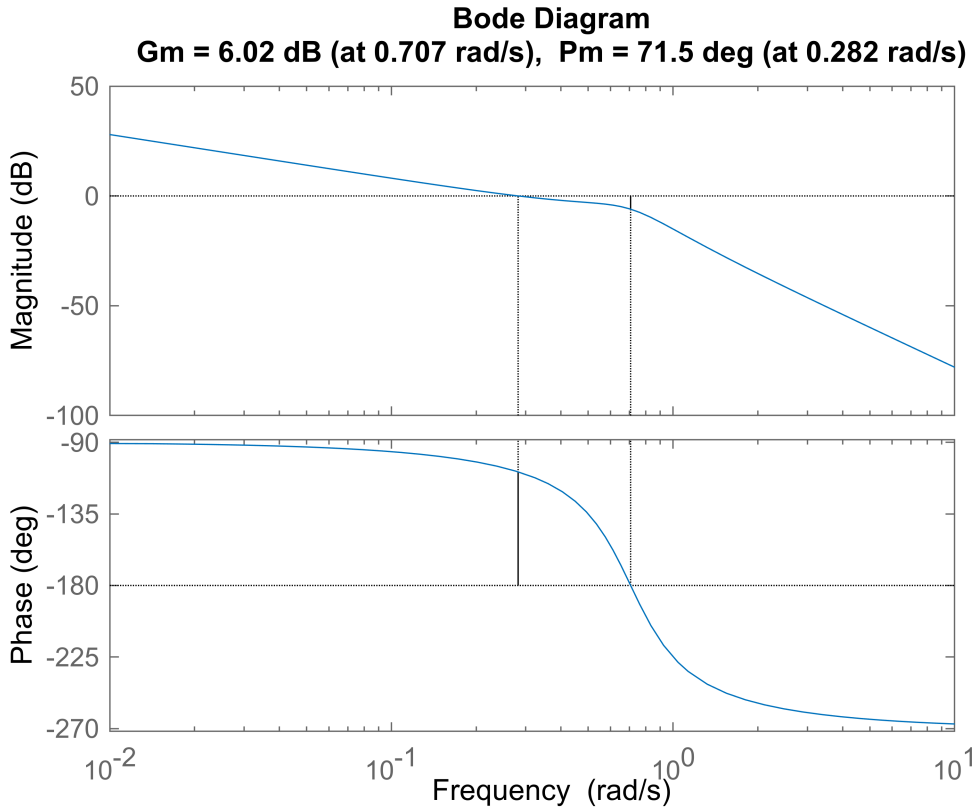
```
  ---------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  1.5

Static gain.
```




```
Zapas modułu:
2
Zapas fazy:
39.6836
Transmitancja obiektu:
G =

           2
  ---------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  1.25

Static gain.
```




```
Zapas modułu:
2.0012
Zapas fazy:
22.0996
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.25

Static gain.
```




```
Zapas modułu:
2
Zapas fazy:
71.4778
```

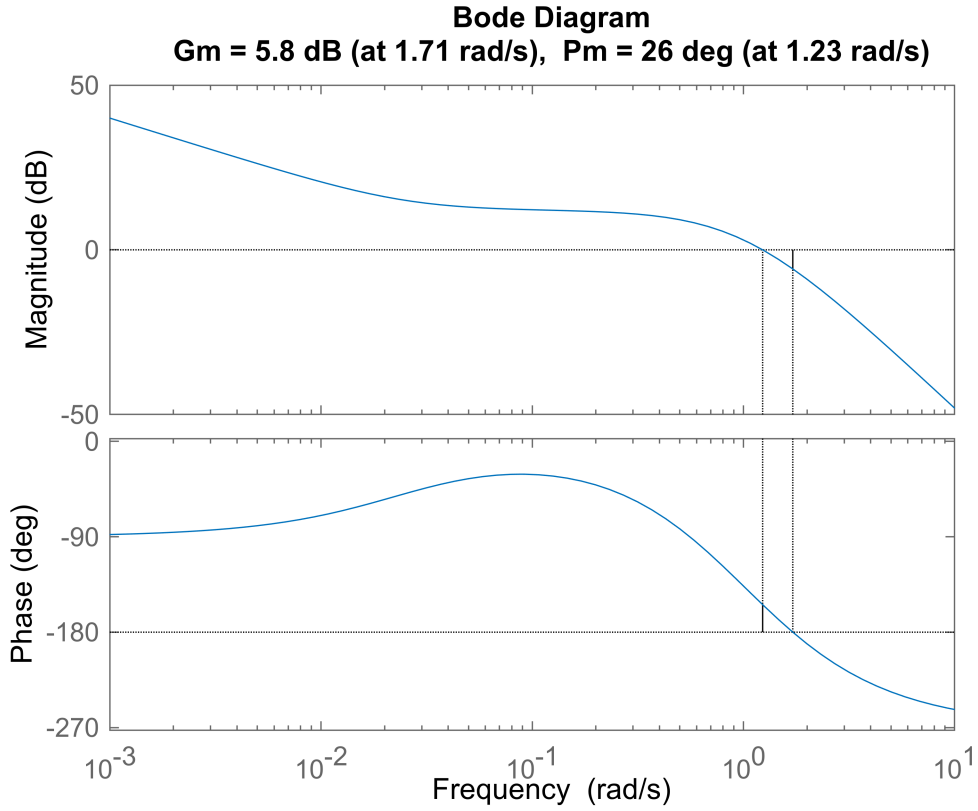
Zadanie 2

Regulator PI

```
for alpha = [0.1 1]
    for i = 1:4
        fprintf('Transmitancja obiektu: ')
        G = Gi(i)
        fprintf('Transmitancja regulatora: ')
        Gr = tf([k(i) alpha], [1 0])

        figure
        margin(series(Gr, G))
        [gm, pm, c, d] = margin(series(Gr, G));
        fprintf('Zapas modułu: ')
        fprintf(num2str(gm))
        fprintf('Zapas fazy: ')
        fprintf(num2str(pm))
    end
end
```

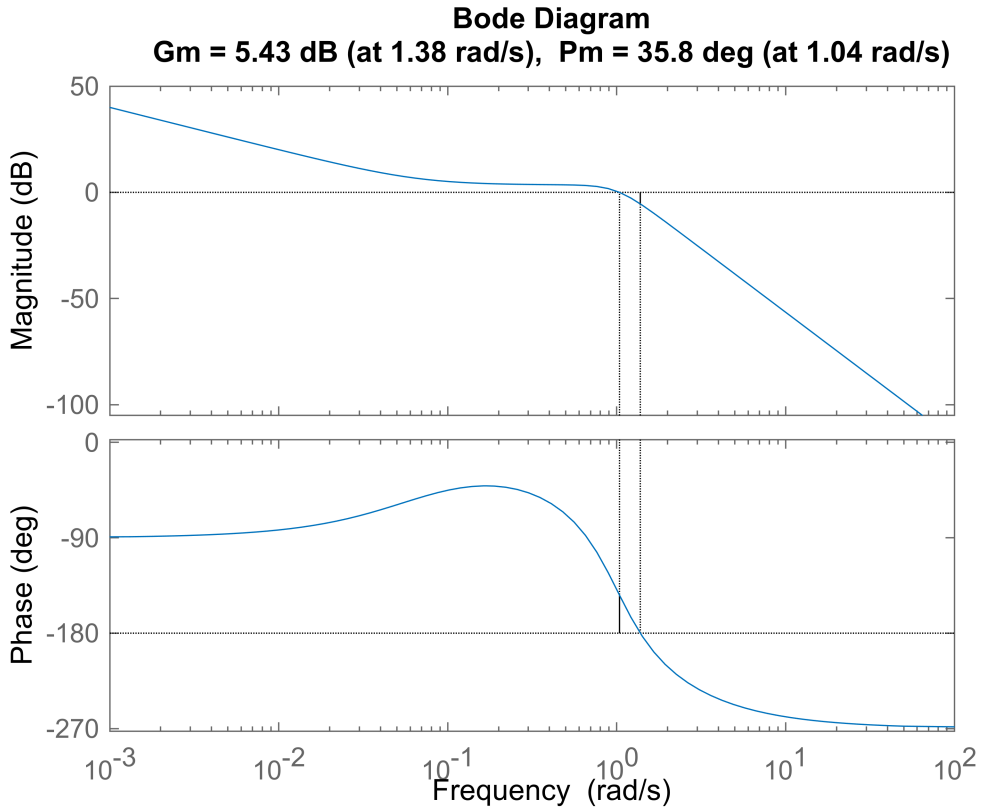
```
Transmitancja obiektu:
```

```
G =

           1
  ---------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  4 s + 0.1
  ---------
      s

Continuous-time transfer function.
```

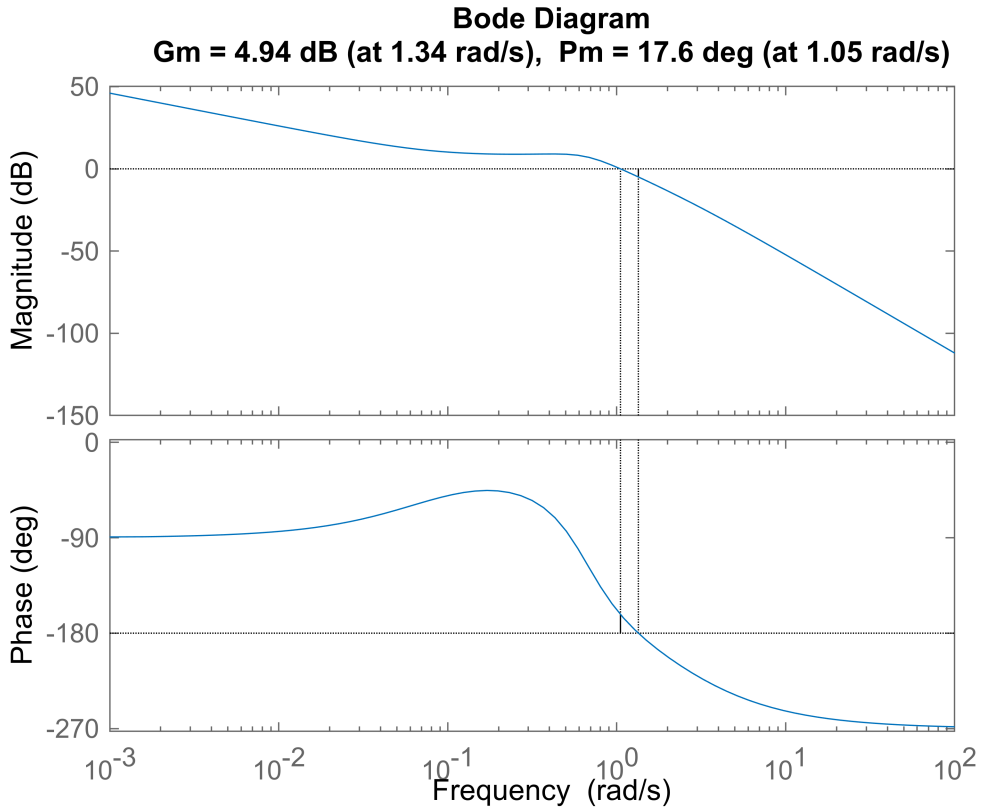



```
Zapas modułu:
1.9502
Zapas fazy:
25.9657
Transmitancja obiektu:
G =

           1
  ---------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  1.5 s + 0.1
  -----------
       s
```

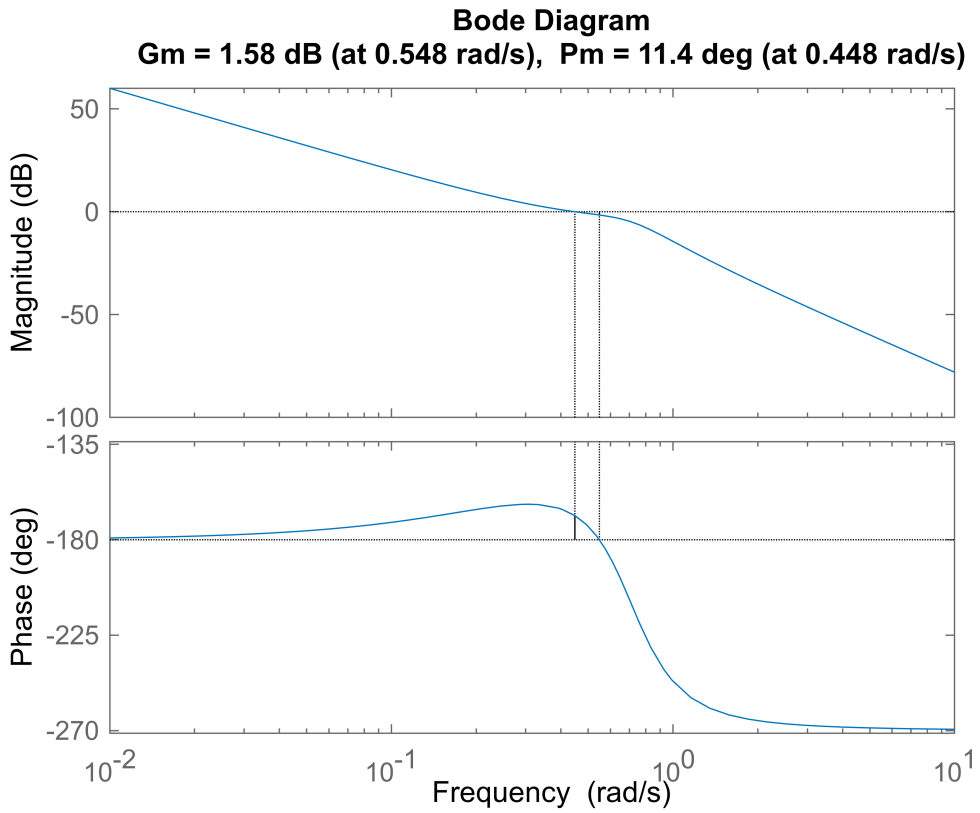
```
Continuous-time transfer function.
```



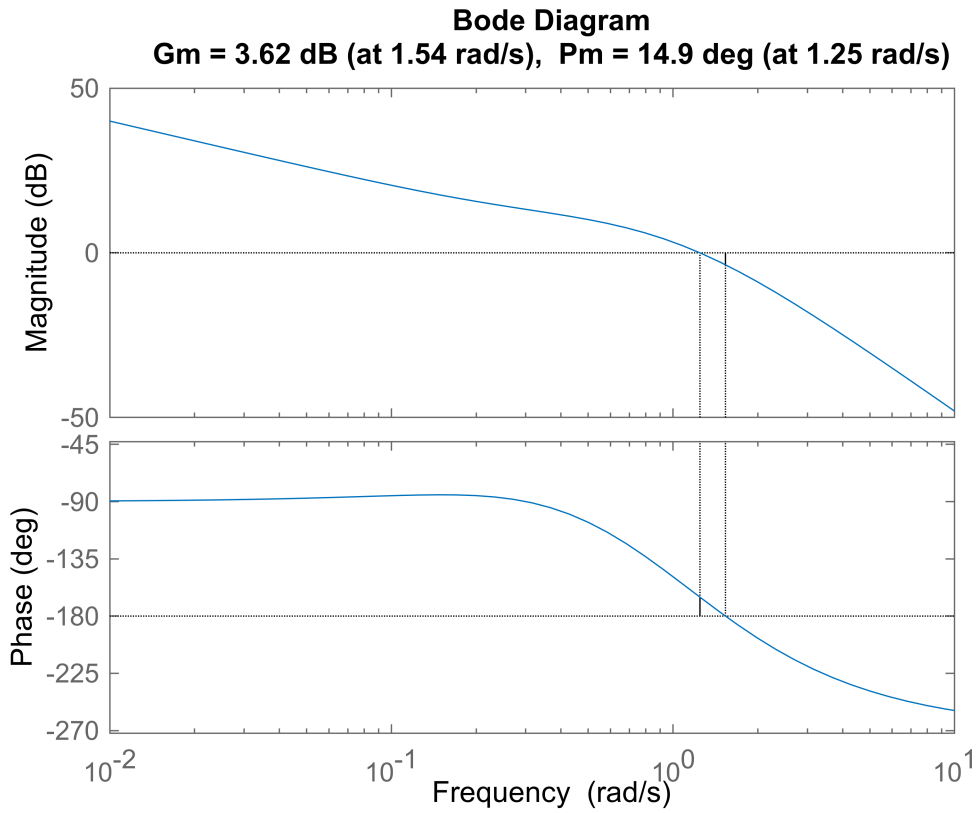

```
Zapas modułu:
1.869
Zapas fazy:
35.8373
Transmitancja obiektu:
G =

            2
  ---------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  1.25 s + 0.1
  ------------
       s

Continuous-time transfer function.
```



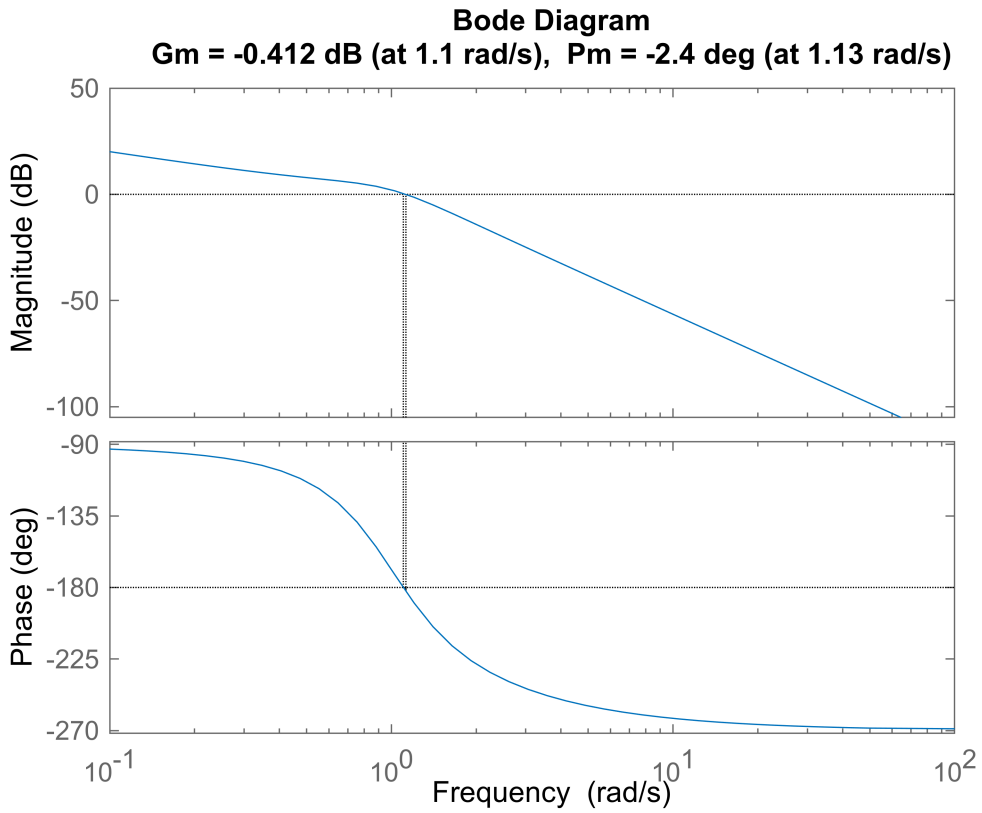

```
Zapas modułu:
1.7652
Zapas fazy:
17.6432
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.25 s + 0.1
  ------------
       s

Continuous-time transfer function.
```



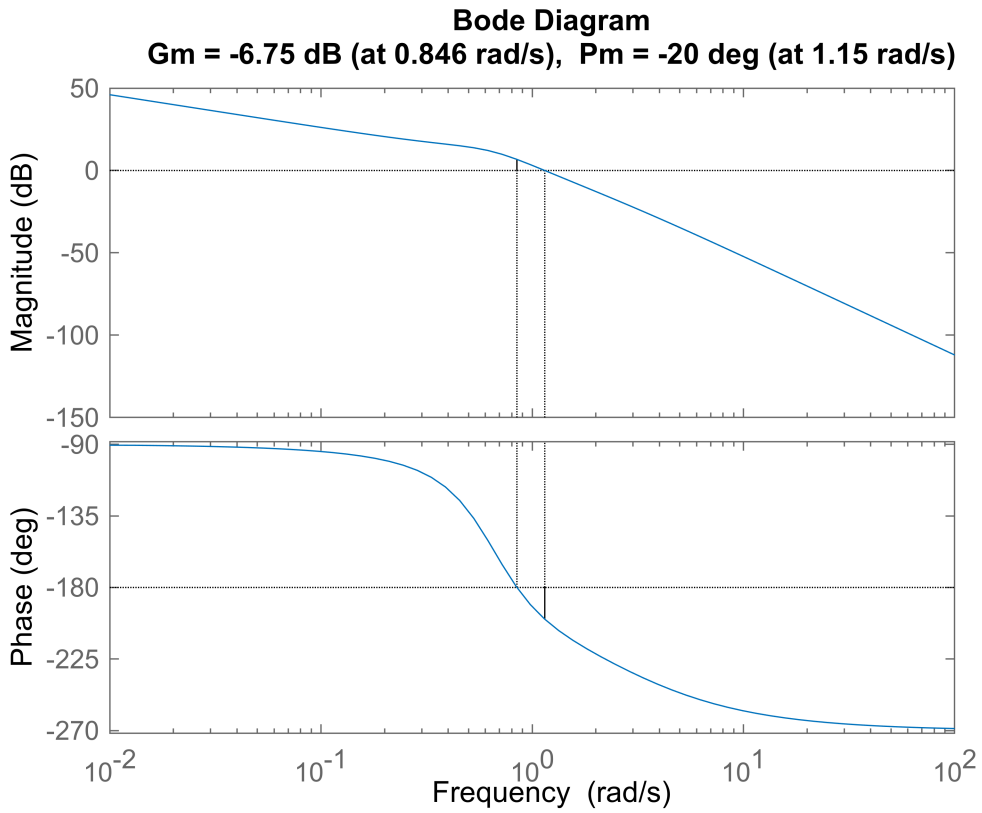

```
Zapas modułu:
1.2
Zapas fazy:
11.4055
Transmitancja obiektu:
G =

            1
  ----------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  4 s + 1
  -------
     s

Continuous-time transfer function.
```



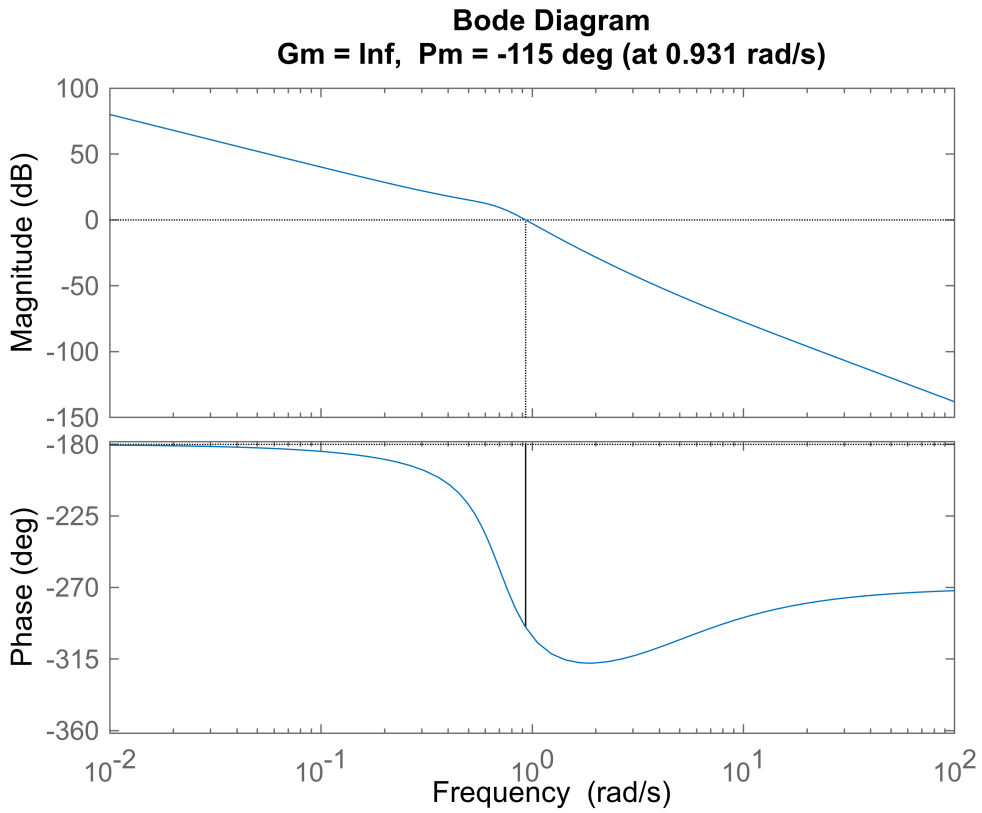

```
Zapas modułu:
1.5175
Zapas fazy:
14.885
Transmitancja obiektu:
G =

            1
  ---------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  1.5 s + 1
  ---------
      s

Continuous-time transfer function.
```




```
Warning: The closed-loop system is unstable.
Zapas modułu:
0.95367
Zapas fazy:
-2.4014
Transmitancja obiektu:
G =

            2
  ----------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  1.25 s + 1
  ----------
      s

Continuous-time transfer function.
```




```
Warning: The closed-loop system is unstable.
Zapas modułu:
0.45982
Zapas fazy:
-19.9681
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.25 s + 1
  ----------
      s

Continuous-time transfer function.
```




```
Warning: The closed-loop system is unstable.
Zapas modułu:
0
Zapas fazy:
-115.1196
```

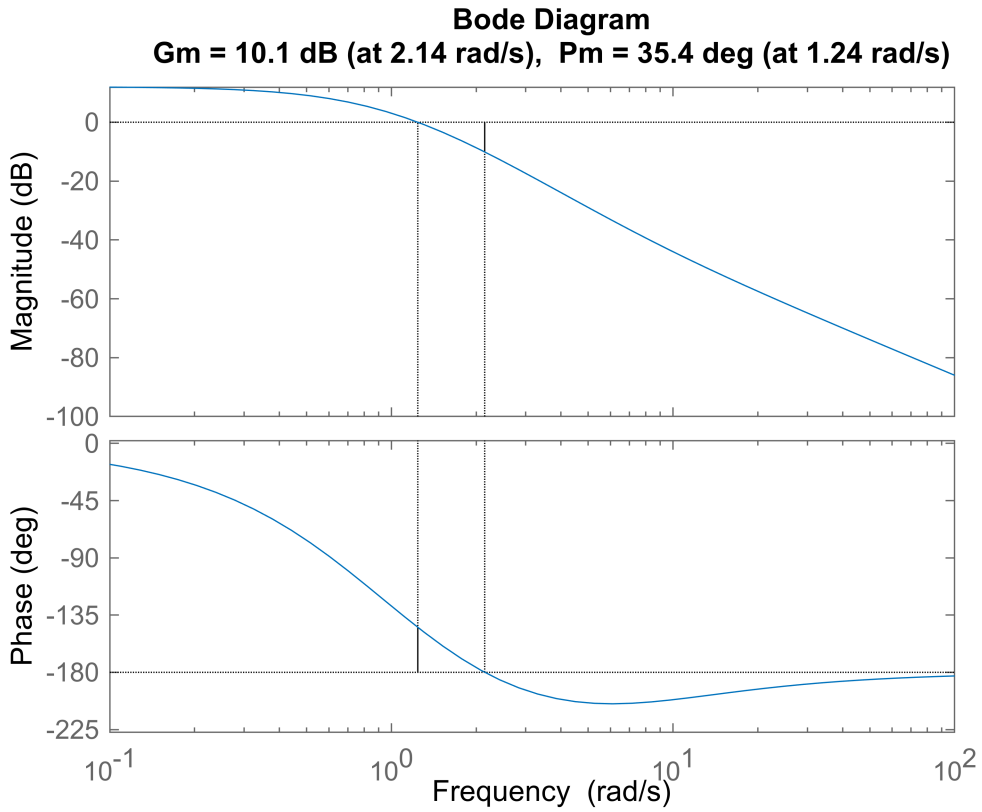
Zadanie 3

Regulator PD

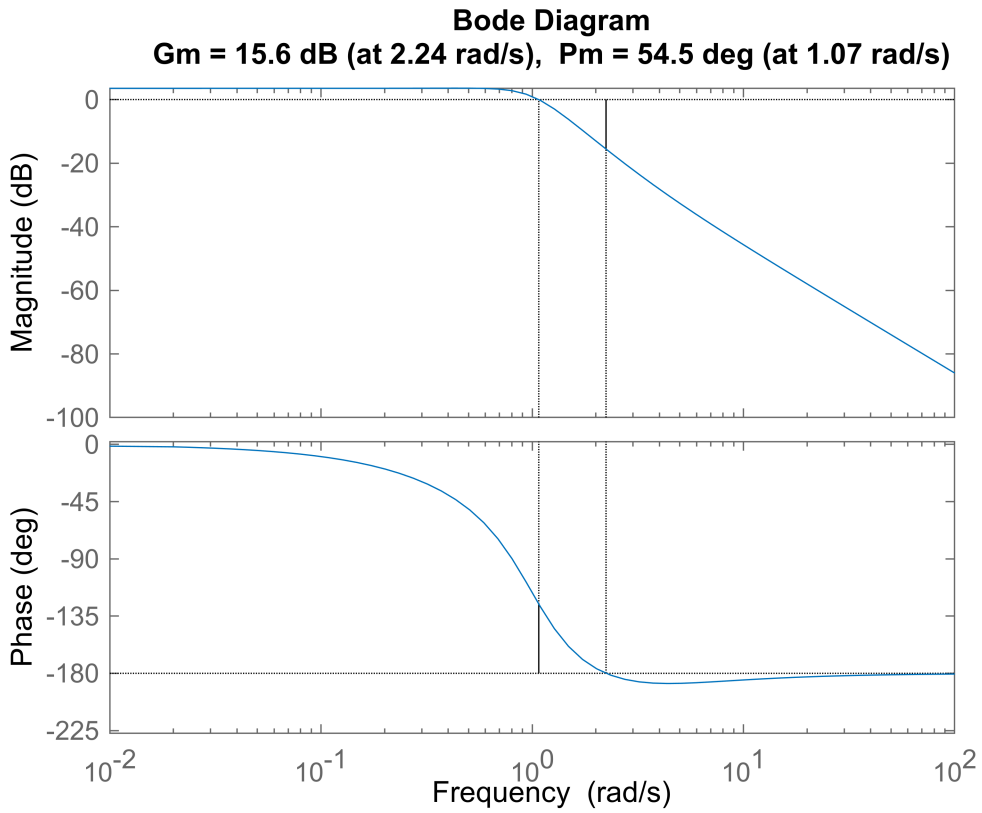
```
for beta = [0.5 1]
    for i = 1:4
        fprintf('Transmitancja obiektu: ')
        G = Gi(i)
        fprintf('Transmitancja regulatora: ')
        Gr = tf([beta k(i)], 1)

        figure
        margin(series(Gr, G))
        [gm, pm, c, d] = margin(series(Gr, G));
        fprintf('Zapas modułu: ')
        fprintf(num2str(gm))
        fprintf('Zapas fazy: ')
        fprintf(num2str(pm))
    end
end
```

```
Transmitancja obiektu:
```

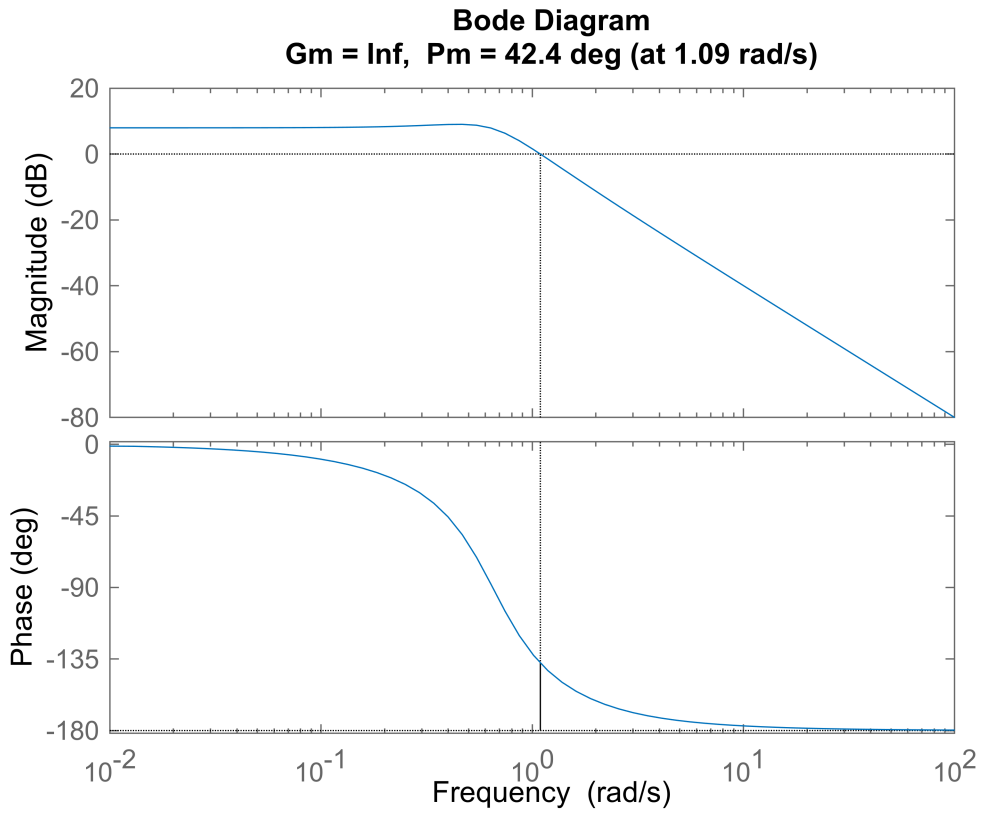
```
G =

           1
  ---------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s + 4

Continuous-time transfer function.
```



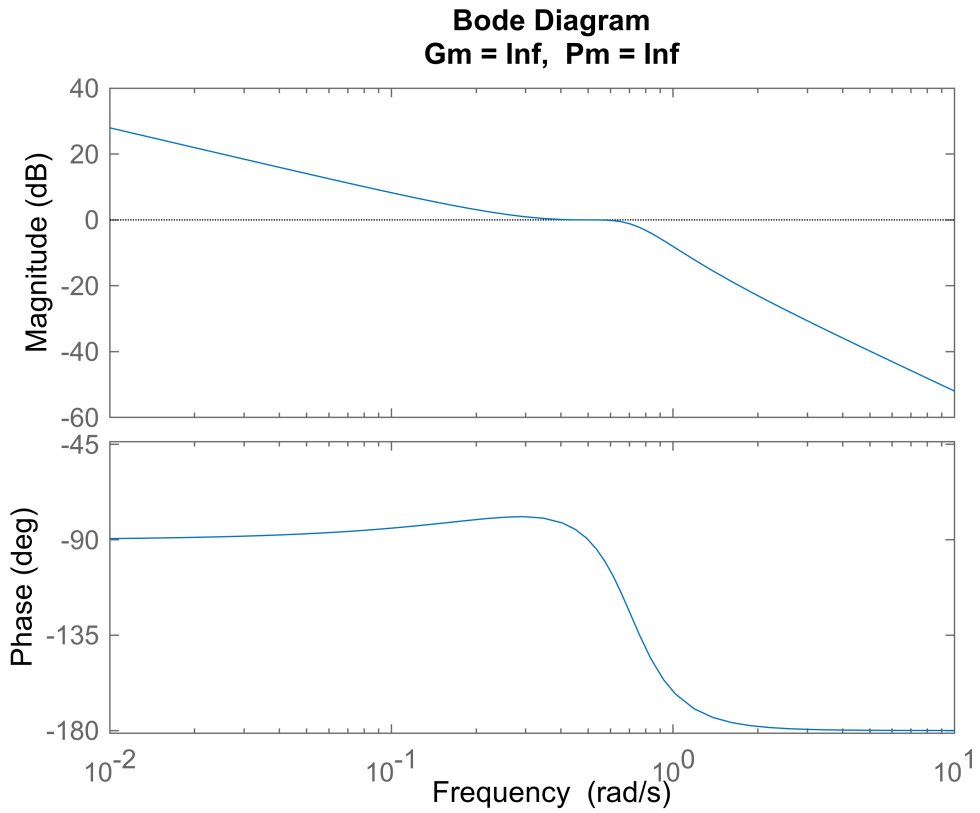

```
Zapas modułu:
3.1994
Zapas fazy:
35.403
Transmitancja obiektu:
G =

           1
  ---------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s + 1.5

Continuous-time transfer function.
```



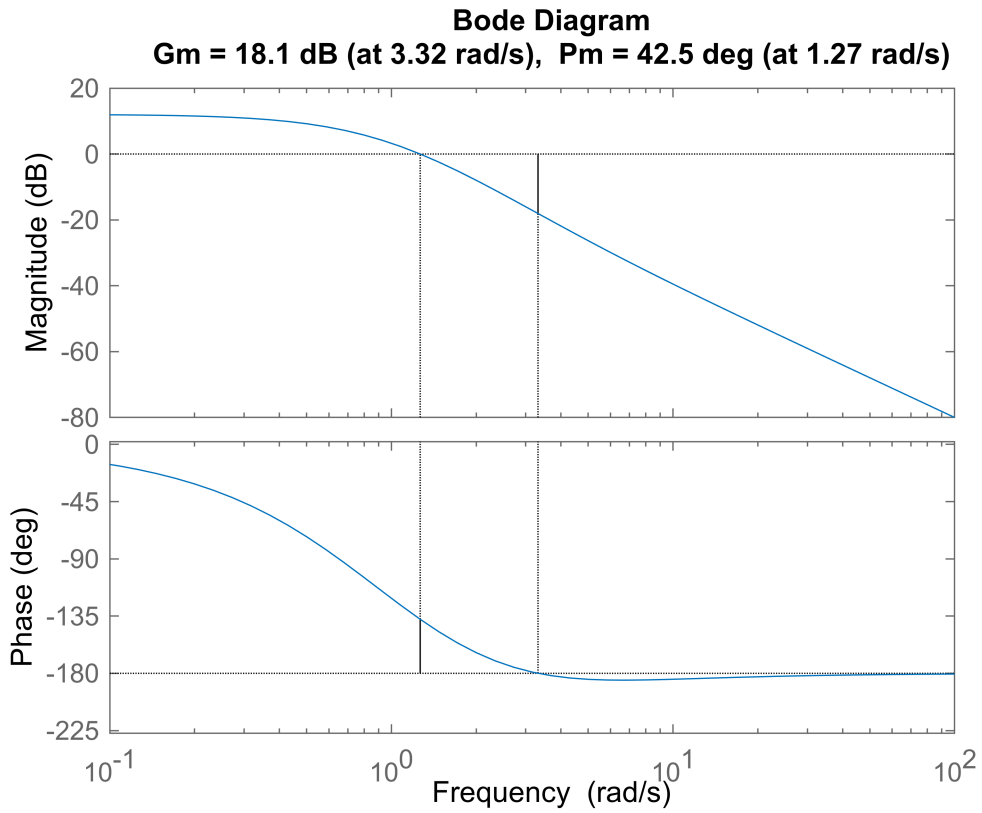

```
Zapas modułu:
6.0002
Zapas fazy:
54.4706
Transmitancja obiektu:
G =

            2
  ----------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s + 1.25

Continuous-time transfer function.
```



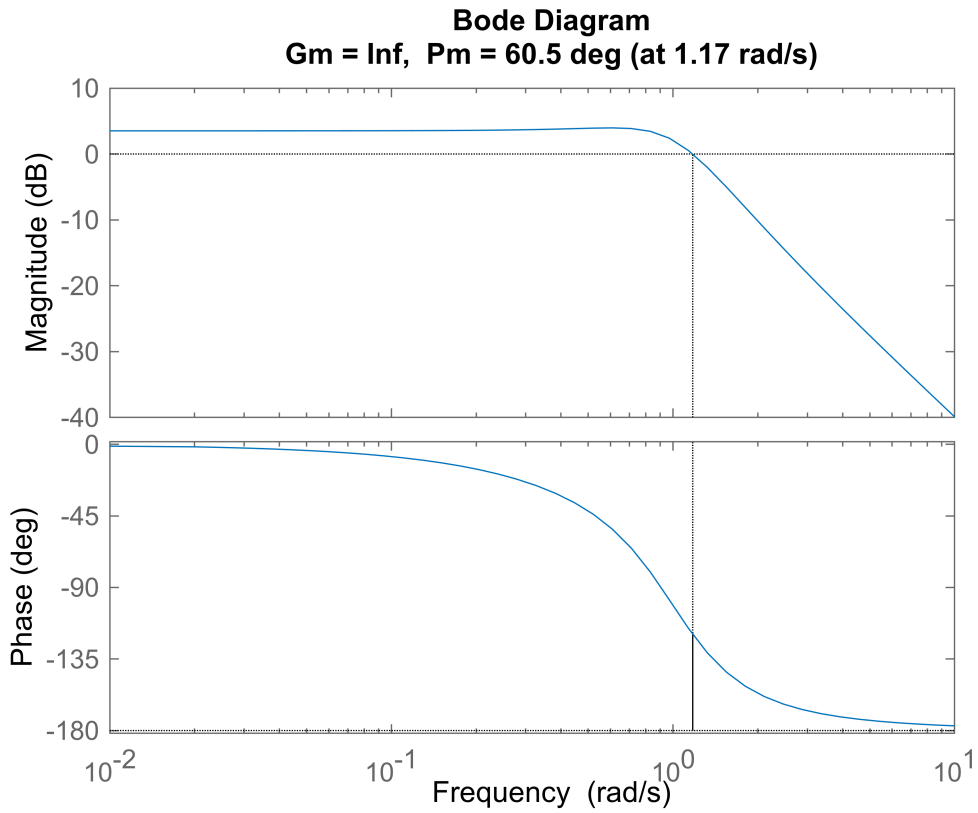

```
Zapas modułu:
Inf
Zapas fazy:
42.4408
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s + 0.25

Continuous-time transfer function.
```



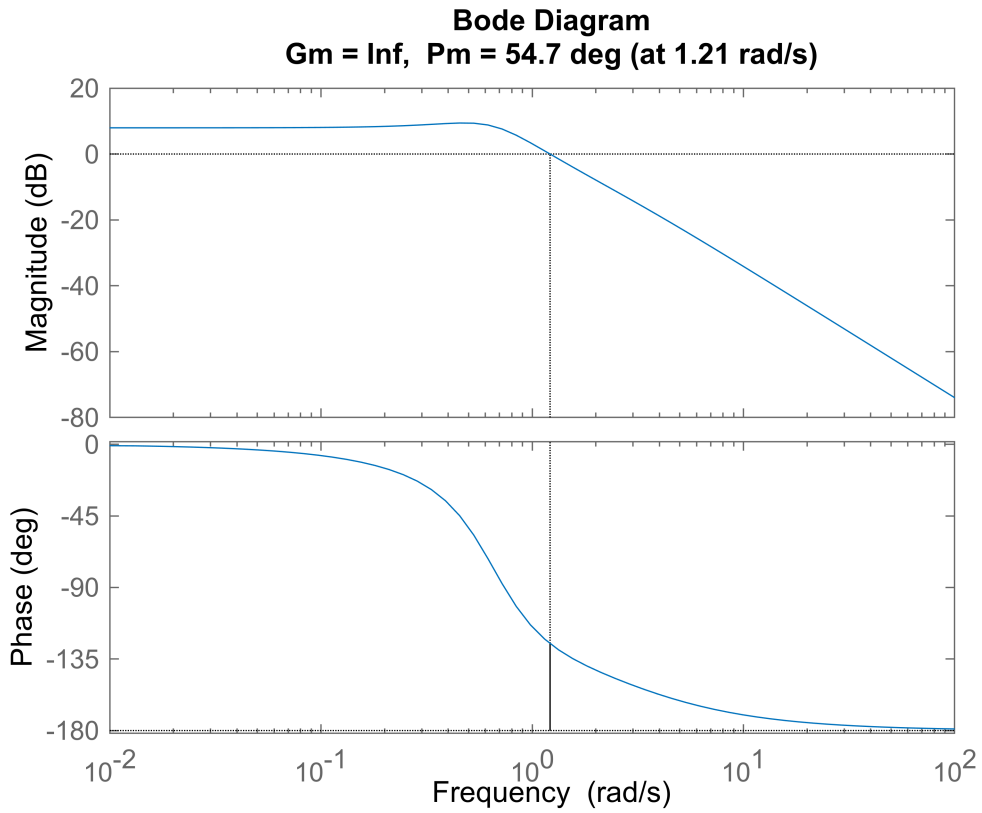

```
Zapas modułu:
Inf
Zapas fazy:
Inf
Transmitancja obiektu:
G =

            1
  ---------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s + 4

Continuous-time transfer function.
```



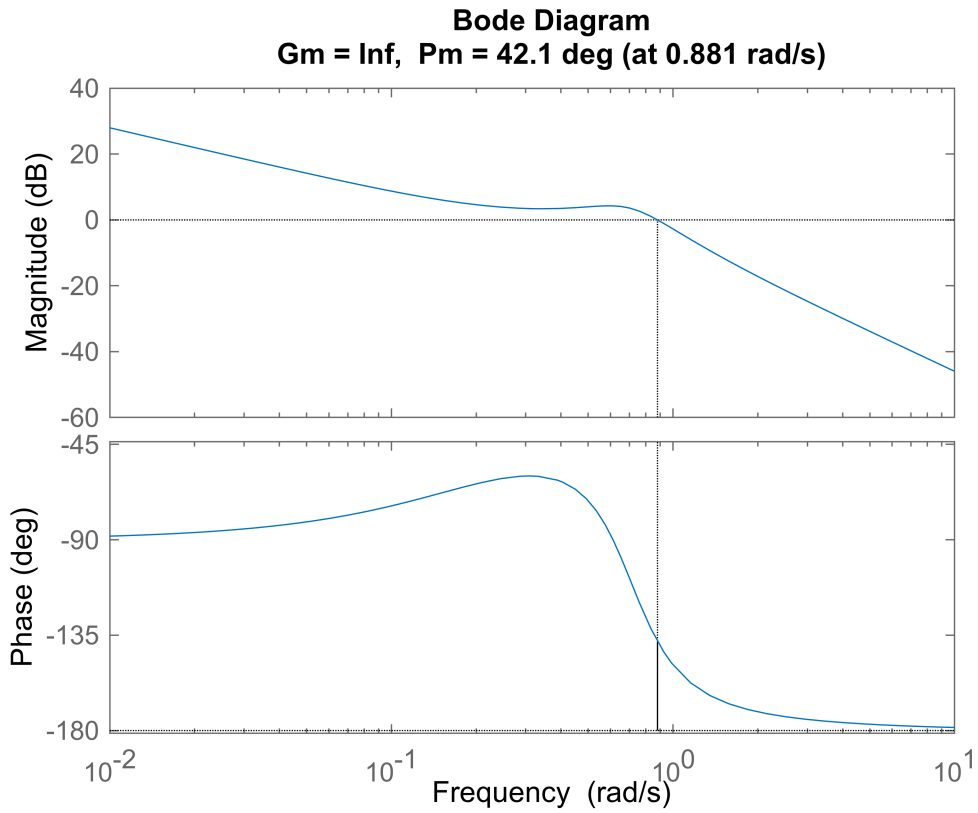

```
Zapas modułu:
7.996
Zapas fazy:
42.5038
Transmitancja obiektu:
G =

            1
  ---------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s + 1.5

Continuous-time transfer function.
```




```
Zapas modułu:
Inf
Zapas fazy:
60.5323
Transmitancja obiektu:
G =

            2
  ----------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s + 1.25

Continuous-time transfer function.
```




```
Zapas modułu:
Inf
Zapas fazy:
54.7073
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s + 0.25

Continuous-time transfer function.
```



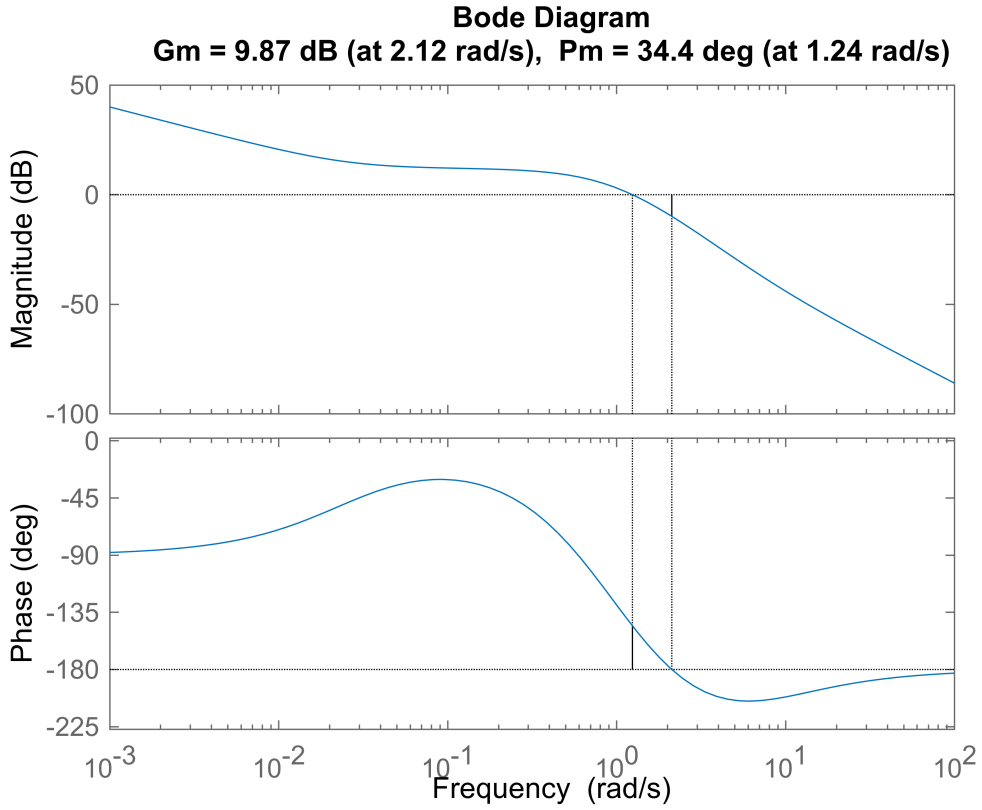

```
Zapas modułu:
Inf
Zapas fazy:
42.0872
```

Zadanie 4

Regulator PID

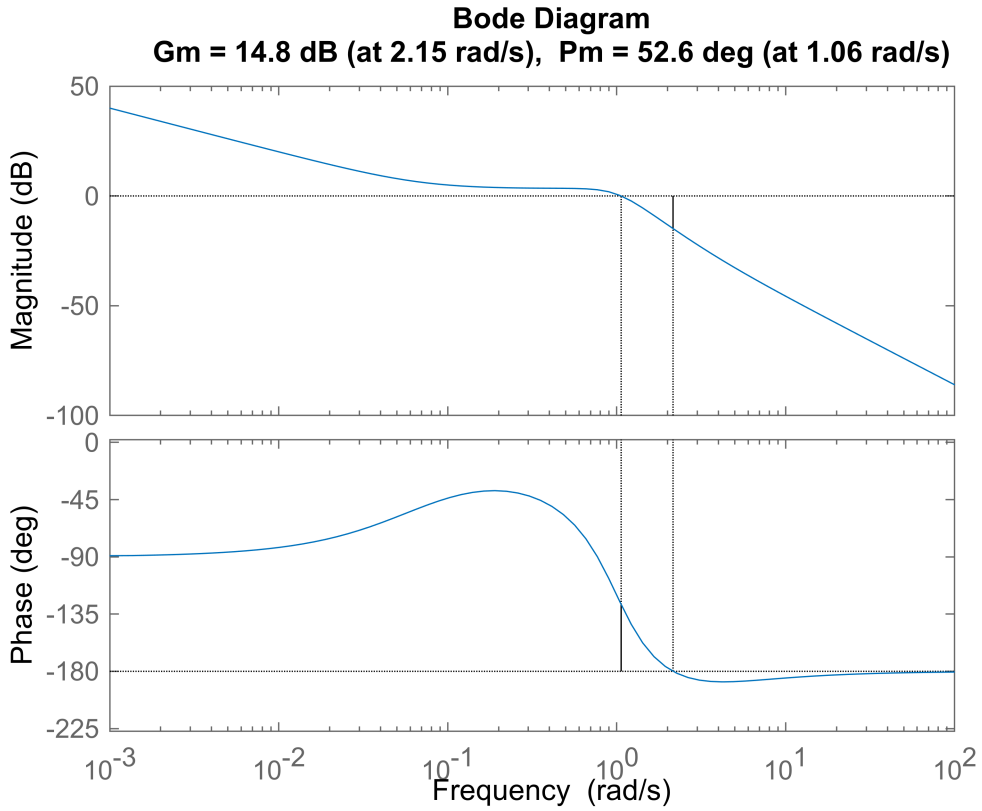
```
for alpha = [0.1 1]
    for beta = [0.5 1]
        for i = 1:4
            fprintf('Transmitancja obiektu: ')
            G = Gi(i)
            fprintf('Transmitancja regulatora: ')
            Gr = tf([beta k(i) alpha], [1 0])

            figure
            margin(series(Gr, G))
            [gm, pm, c, d] = margin(series(Gr, G));
            fprintf('Zapas modułu: ')
            fprintf(num2str(gm))
            fprintf('Zapas fazy: ')
            fprintf(num2str(pm))
        end
    end
end
```

```
Transmitancja obiektu:
G =

           1
  ---------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s^2 + 4 s + 0.1
  -------------------
           s

Continuous-time transfer function.
```

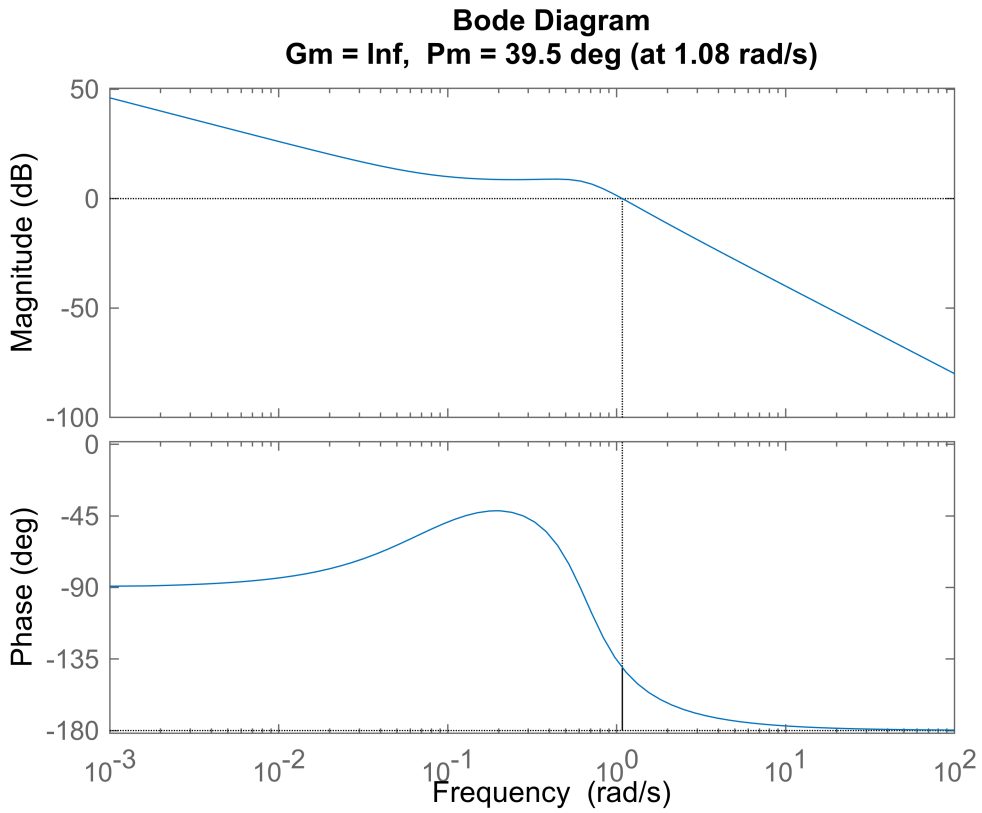



```
Zapas modułu:
3.1161
Zapas fazy:
34.3909
Transmitancja obiektu:
G =

           1
  ---------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s^2 + 1.5 s + 0.1
  ---------------------
           s
```

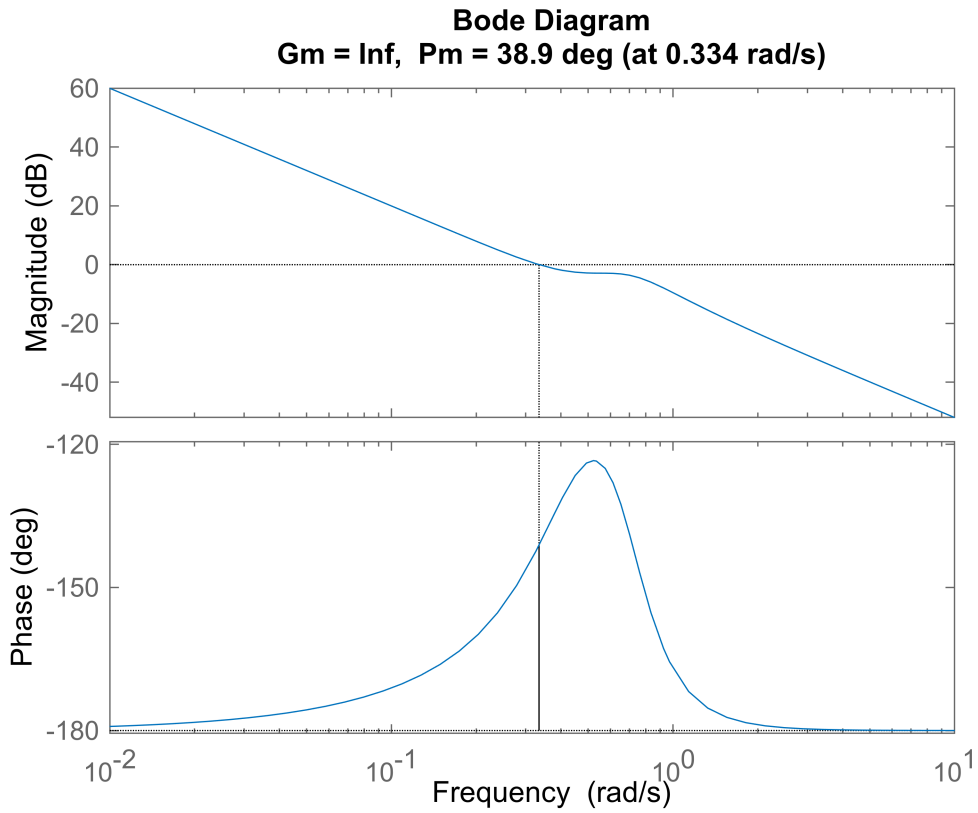
```
Continuous-time transfer function.
```



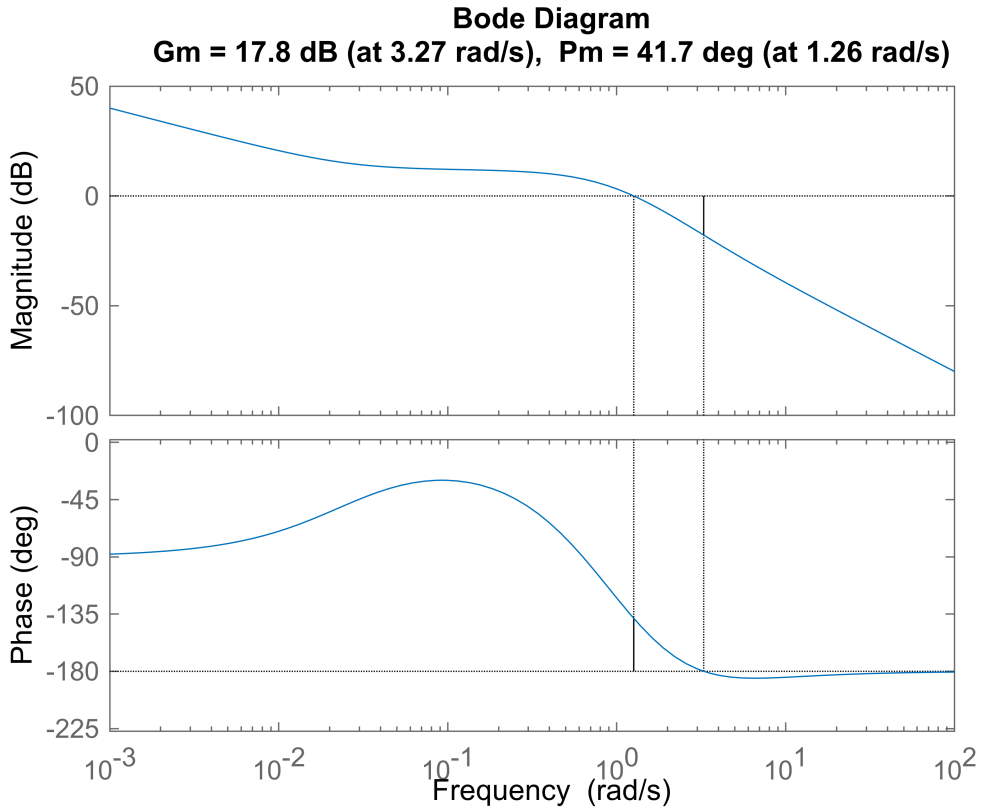

```
Zapas modułu:
5.5245
Zapas fazy:
52.5602
Transmitancja obiektu:
G =

            2
  ---------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s^2 + 1.25 s + 0.1
  ----------------------
            s

Continuous-time transfer function.
```



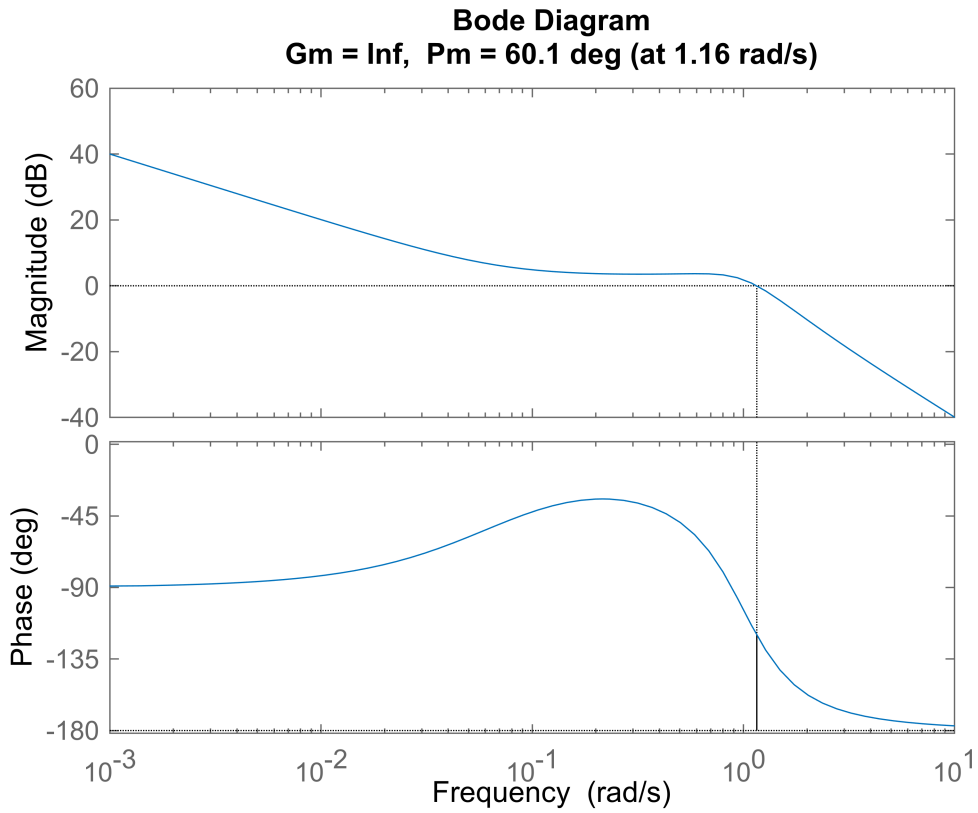

```
Zapas modułu:
Inf
Zapas fazy:
39.5159
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s^2 + 0.25 s + 0.1
  ----------------------
            s

Continuous-time transfer function.
```



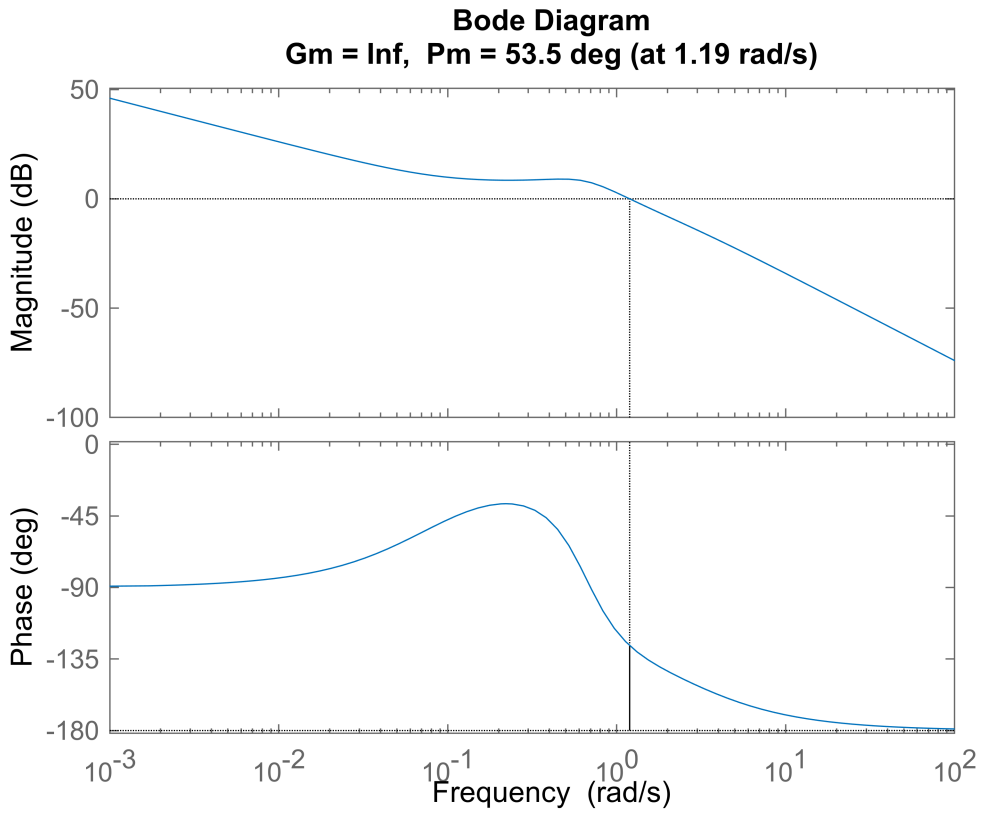

```
Zapas modułu:
0
Zapas fazy:
38.8882
Transmitancja obiektu:
G =

            1
  ---------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s^2 + 4 s + 0.1
  ---------------
         s

Continuous-time transfer function.
```



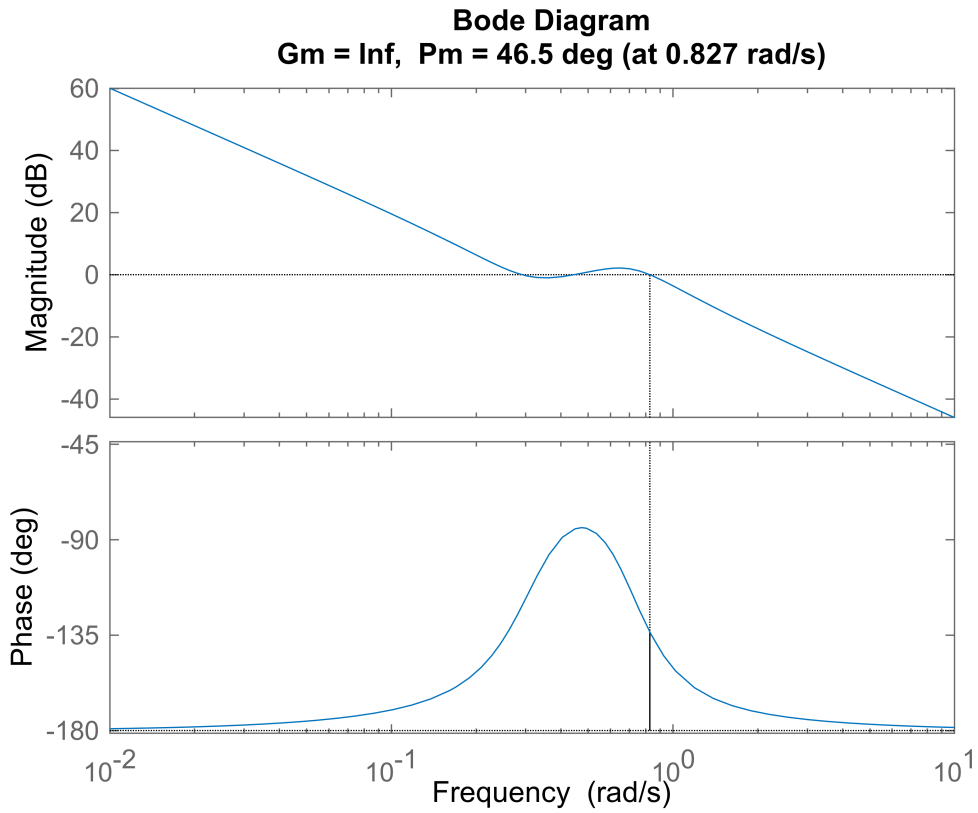

```
Zapas modułu:
7.7782
Zapas fazy:
41.6774
Transmitancja obiektu:
G =

            1
  ----------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s^2 + 1.5 s + 0.1
  -----------------
          s

Continuous-time transfer function.
```



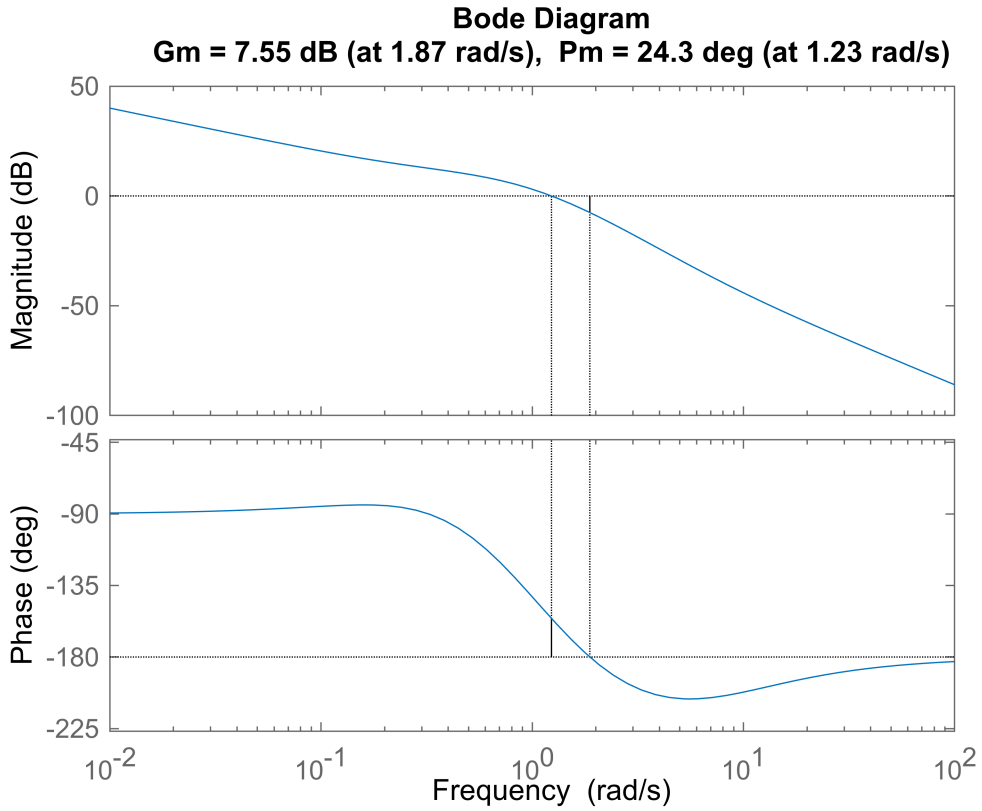

```
Zapas modułu:
Inf
Zapas fazy:
60.0626
Transmitancja obiektu:
G =

            2
  ----------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s^2 + 1.25 s + 0.1
  ------------------
          s

Continuous-time transfer function.
```



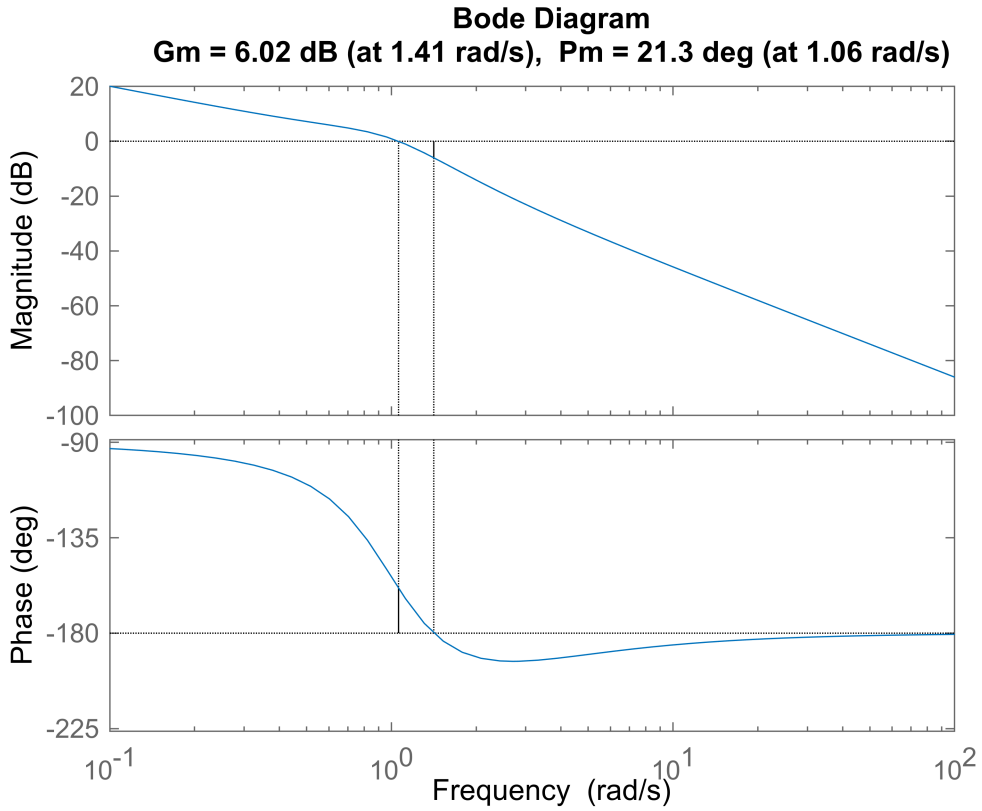

```
Zapas modułu:
Inf
Zapas fazy:
53.4605
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s^2 + 0.25 s + 0.1
  ------------------
          s

Continuous-time transfer function.
```



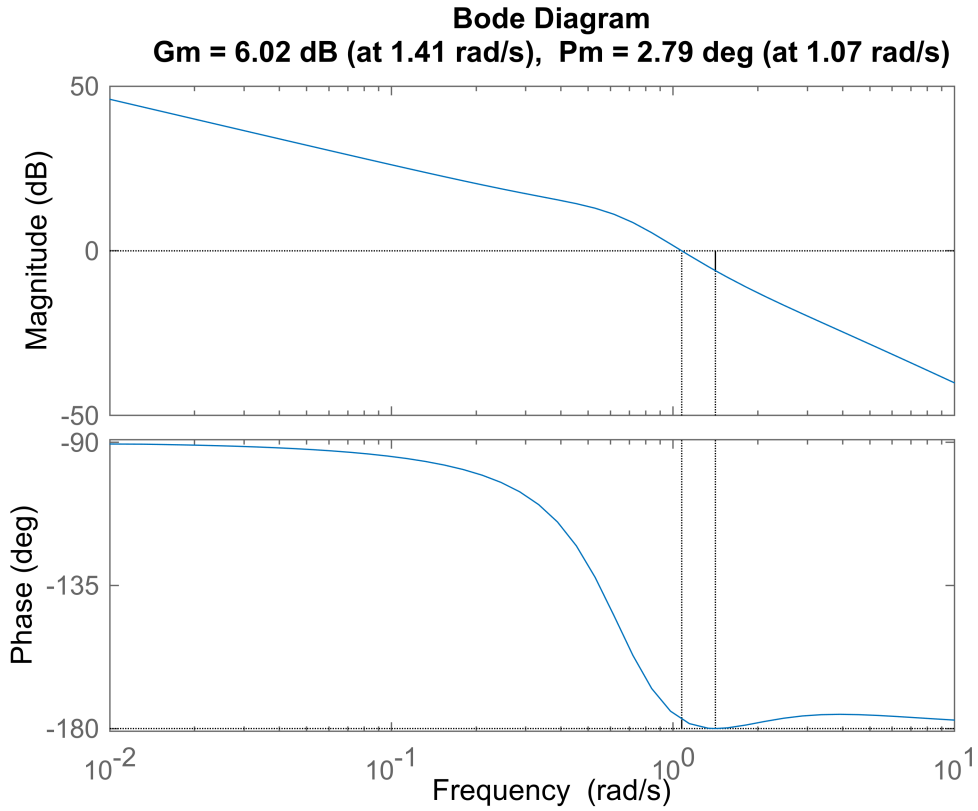

```
Zapas modułu:
0
Zapas fazy:
46.4855
Transmitancja obiektu:
G =

            1
  ---------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s^2 + 4 s + 1
  -----------------
          s

Continuous-time transfer function.
```



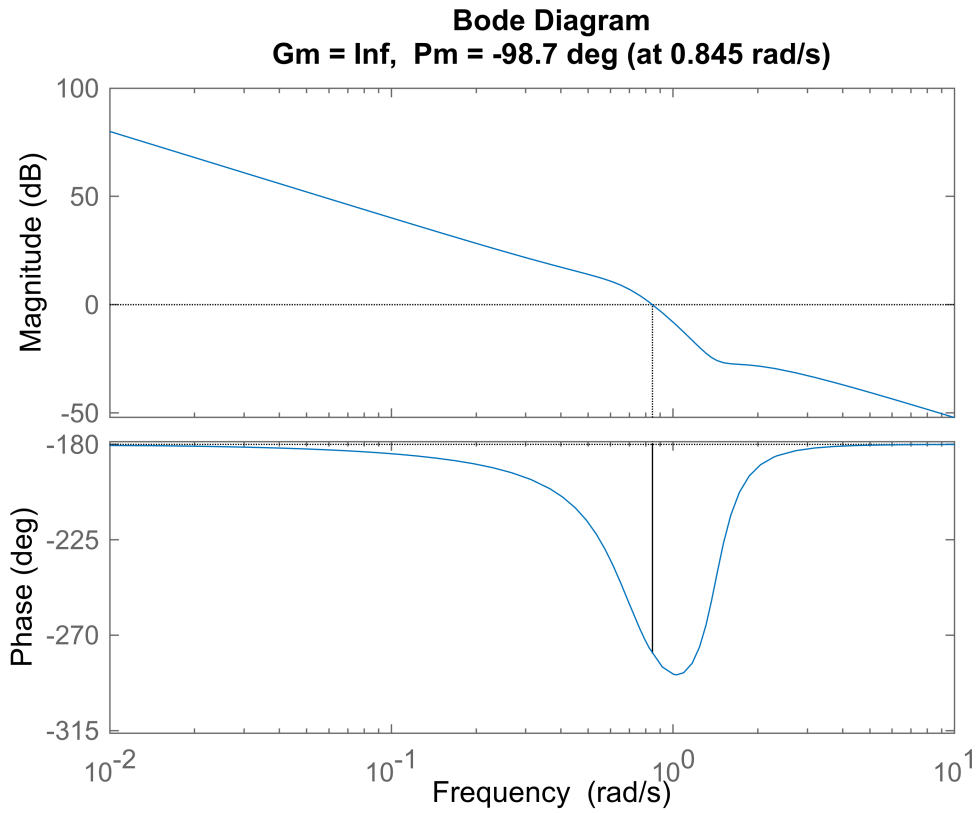

```
Zapas modułu:
2.3852
Zapas fazy:
24.3108
Transmitancja obiektu:
G =

            1
  ---------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s^2 + 1.5 s + 1
  -------------------
           s

Continuous-time transfer function.
```



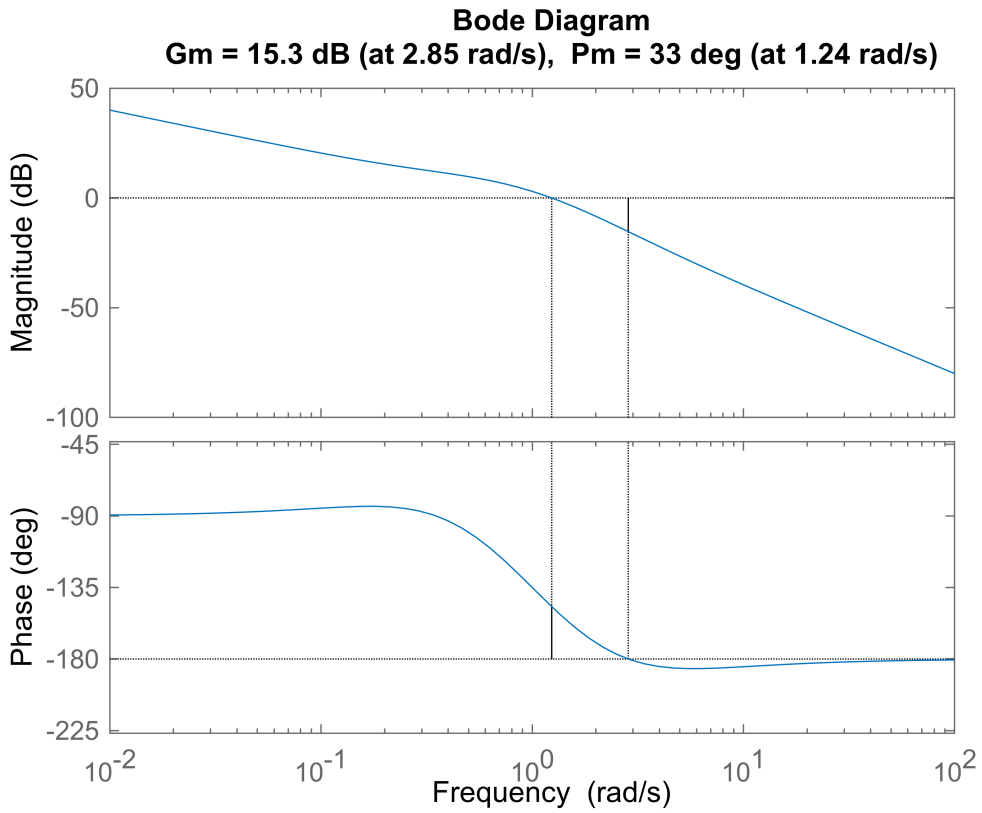

```
Zapas modułu:
2
Zapas fazy:
21.251
Transmitancja obiektu:
G =

            2
  ----------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s^2 + 1.25 s + 1
  --------------------
           s

Continuous-time transfer function.
```



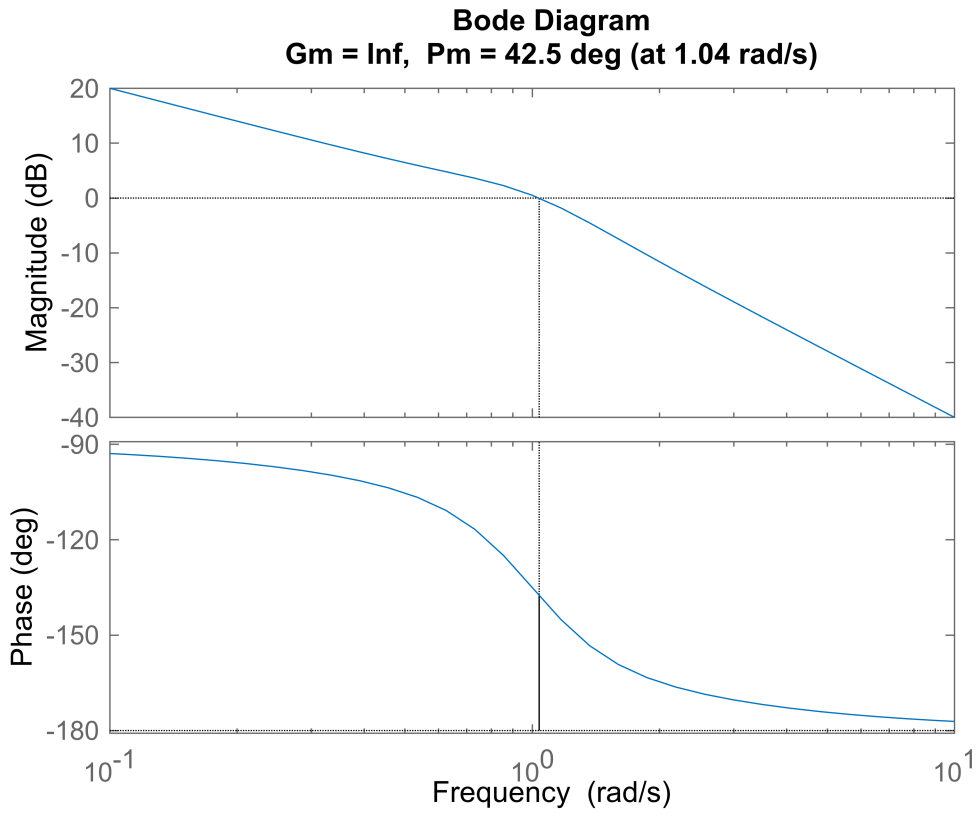

```
Zapas modułu:
2
Zapas fazy:
2.787
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  0.5 s^2 + 0.25 s + 1
  --------------------
           s

Continuous-time transfer function.
```



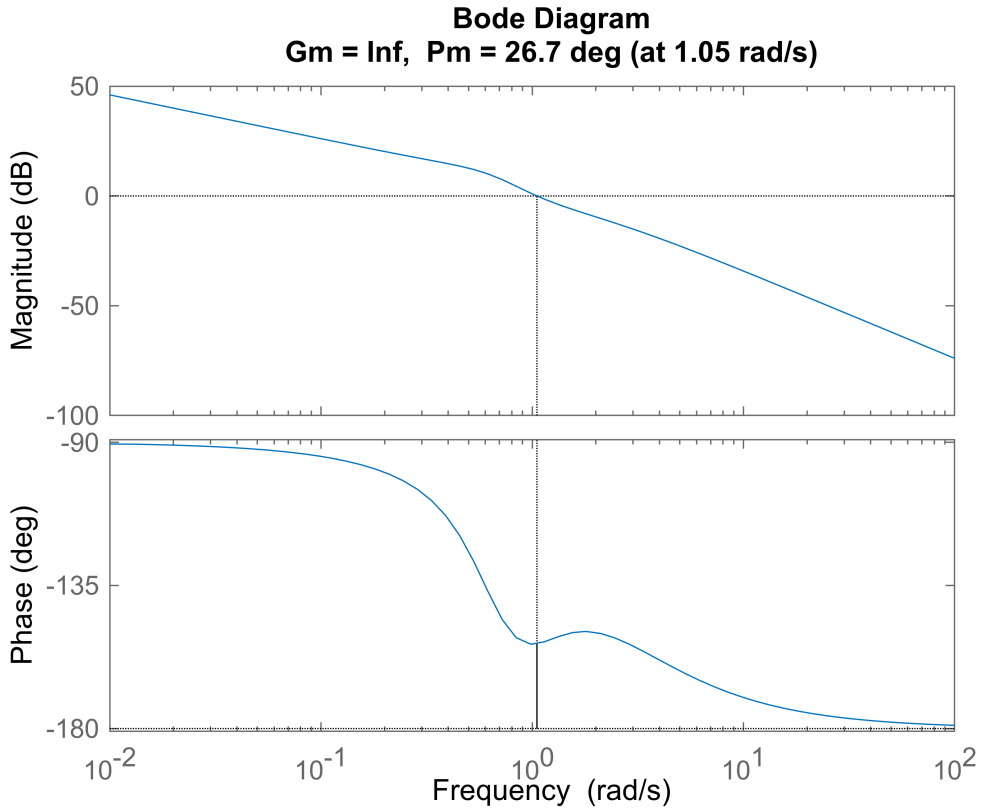

```
Warning: The closed-loop system is unstable.
Zapas modułu:
0
Zapas fazy:
-98.6901
Transmitancja obiektu:
G =

            1
  ---------------------
  s^3 + 3 s^2 + 3 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s^2 + 4 s + 1
  -------------
        s

Continuous-time transfer function.
```



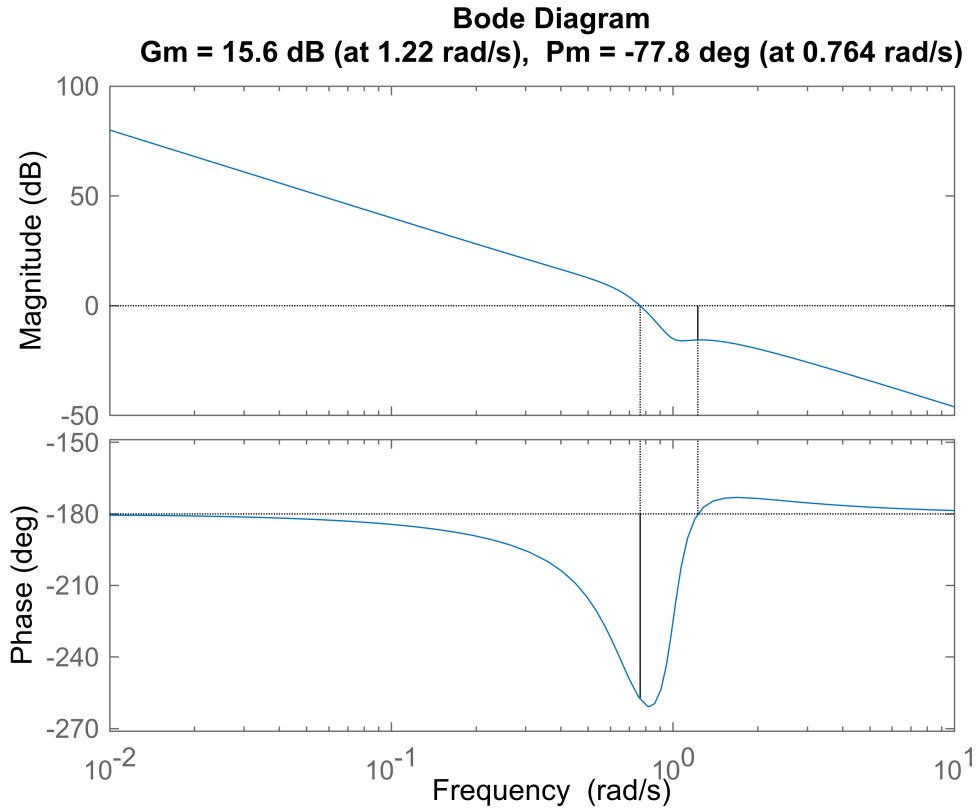

```
Zapas modułu:
5.8402
Zapas fazy:
32.9828
Transmitancja obiektu:
G =

            1
  ----------------------
  s^3 + 2 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s^2 + 1.5 s + 1
  ---------------
         s

Continuous-time transfer function.
```




```
Zapas modułu:
Inf
Zapas fazy:
42.4687
Transmitancja obiektu:
G =

            2
  ----------------------
  s^3 + 3 s^2 + 2 s + 1

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s^2 + 1.25 s + 1
  ----------------
         s

Continuous-time transfer function.
```




```
Zapas modułu:
Inf
Zapas fazy:
26.6936
Transmitancja obiektu:
G =

         1
  ---------------
  2 s^3 + s^2 + s

Continuous-time transfer function.
Transmitancja regulatora:
Gr =

  s^2 + 0.25 s + 1
  ----------------
         s

Continuous-time transfer function.
```




```
Warning: The closed-loop system is unstable.
Zapas modułu:
6
Zapas fazy:
-77.754
```

Wnioski

Regulatrory P oraz PI zmiejszają zapas stabilności. Regulatory PD oraz PID zwiększają zapas stabilności.