Modelling and control summaries

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Margins 8: Effects of gain changes tutorial

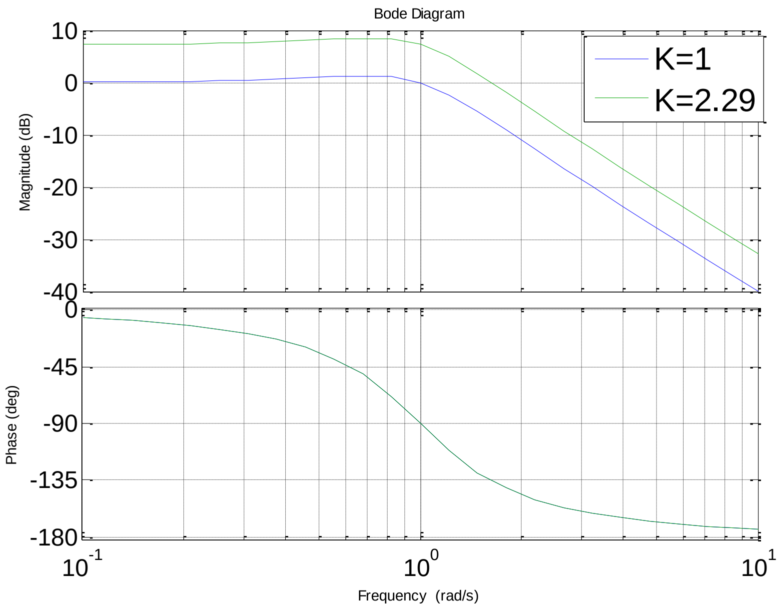
PHASE MARGIN:	**GAIN MARGIN**
1. Find a frequency w_g such that $\lvert G(jw_g)\rvert=1$. 2. Clockwise rotation $e^{-j\phi}$ such that $G(jw_g)\,e^{-j\phi}=-1$. 3. Phase margin $=\phi = 180+\arg(G(jw_g))$.	1. Find w_p such that $\arg(G(jw_p))=-180$. 2. Find a real number K such that $G(jw_p)K=-1$. 3. Gain margin = $K = 1/\lvert G(jw_p)\rvert$

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

Find K to give a 45° phase margin.
Use analysis and Bode diagrams and compare results.

Check your answers with MATLAB, e.g.

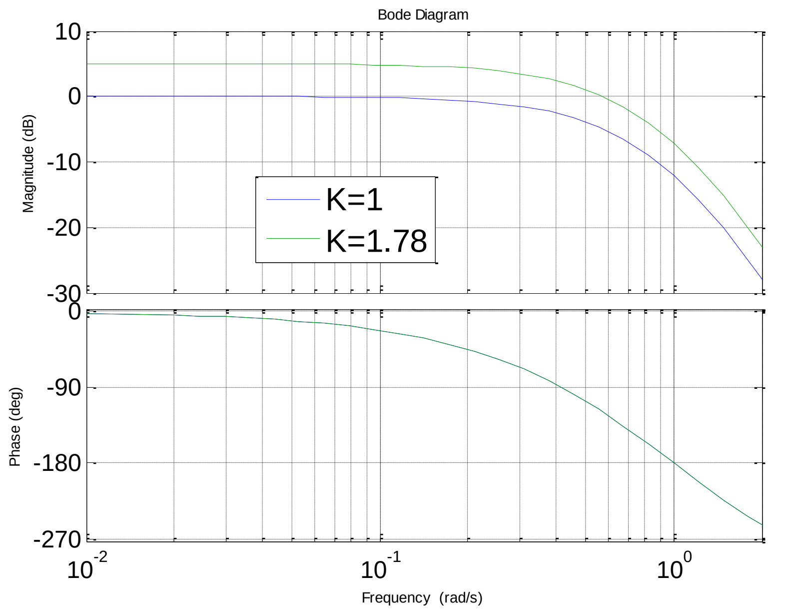
```
>>G=tf(1,[1 1 1]);
>>K=1;
>>[g,p]=margin(G*K)
```



$$G(s)=\frac{K}{(s+1)^4}$$

Find K to give a 60° phase margin. Use analysis and Bode diagrams and compare results.

Check your answers with MATLAB.



Consider a unity negative feedback system with forward path transfer function G where K is a proportional control system gain.

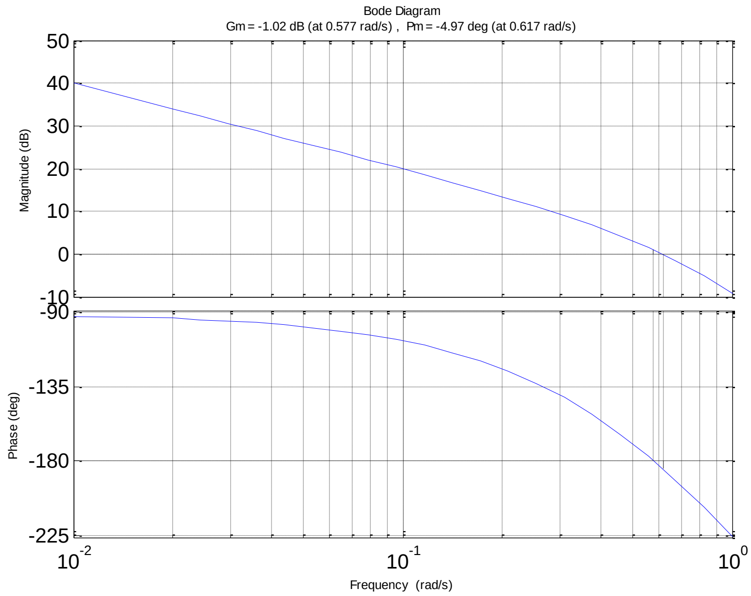
$$G(s) = \frac{K(1-s)}{(s+1)^2}$$

1. Sketch the Bode and Nyquist diagrams of G(s) with K=1.
2. Use the Bode diagrams to estimate the gain K such that the closed loop system phase margin is 45°. Estimate the corresponding gain margin in dB.
3. Use the Nyquist stability criterion to confirm that the closed-loop system is stable with this PM.

Calculate the maximum positive gain K for closed loop stability.
Use the Bode diagram to estimate the K which will give a PM of 60 degrees?

$$G(s) = K \Big/ s(s+1)^3$$

Check your results with MATLAB.



Use MATLAB sisotool to find K to give a 60 degree phase margin.

$$G(s) = \frac{0.4}{(s+2)(s+1)};$$

$$M(s) = K\frac{s+5}{s};$$

```
>> G=tf(0.4,[1 3 2]);
>> M=tf([1 5],[1 0]);
>> sisotool(G,M)
```

$$G(s) = \frac{0.2}{(s+3)(s-1)};$$

$$M(s) = K\frac{s+0.1}{s};$$