ECE 3510 homework # 13 Due: Thur, 3/23/06

A.Stolp
3/9/06

1. Problem 5.1 (p.136) in the text. Sketch the Bode plots for the following transfer functions. Make sure to label the graphs, and to give the slopes of the lines in the magnitude plot.

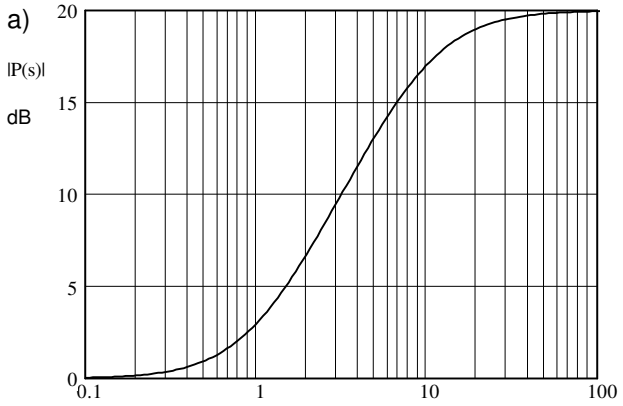
a) $P(s) = \dfrac{s-10}{(s+1)\cdot(s+100)}$ b) $P(s) = \dfrac{100\cdot(s-10)\cdot(s+10)}{(s+0.1)\cdot(s+100)^2}$ c) $P(s) = \dfrac{s+10}{s^2+0.1\cdot s+1}$

d) $P(s) = \dfrac{s-10}{s\cdot(s+1)}$ e) $P(s) = \dfrac{100}{(s-10)^2\cdot(s+1)}$ f) $P(s) = \dfrac{s^2+2\cdot s+100}{s^2}$

2. Problem 5.2 (p.137) in the text.

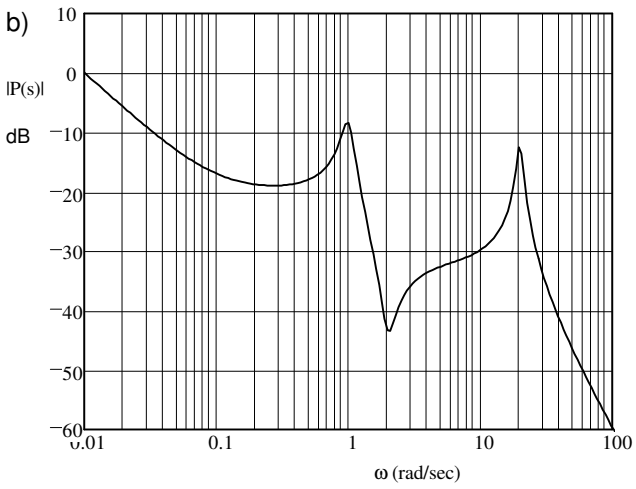
a) The magnitude Bode plot of a system is shown below. What are the possible transfer functions of stable systems having this Bode plot?

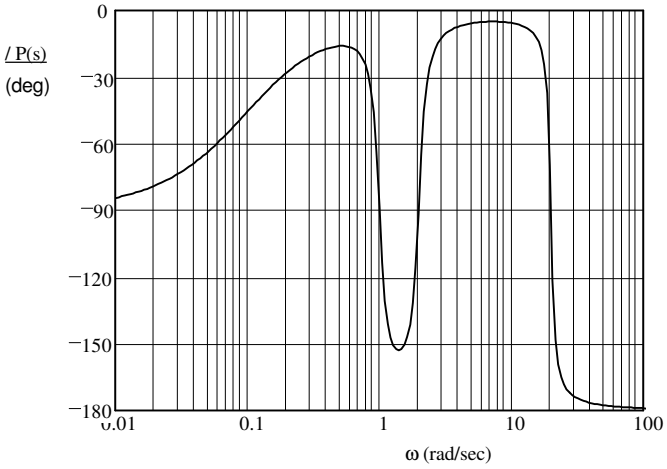
a)



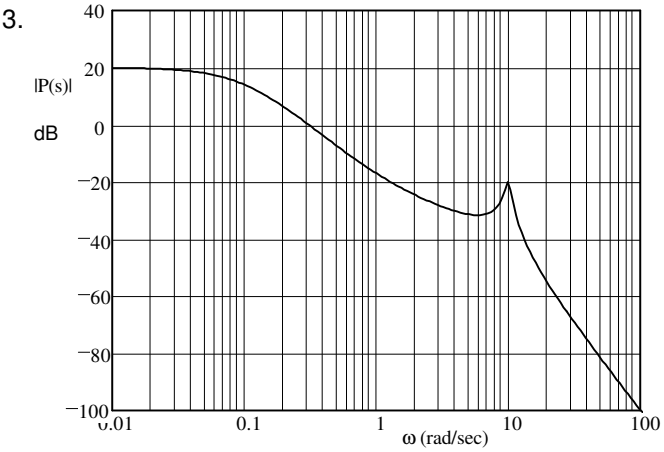
b) The Bode plots of a system are at right. Give an estimate of the transfer function of the system. Show your work (how you made your estimate).

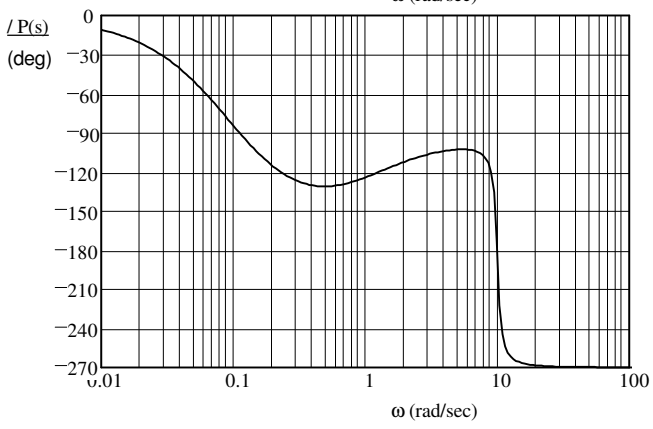
b)





3.





3. Problem 5.3 (p.138) in the text.

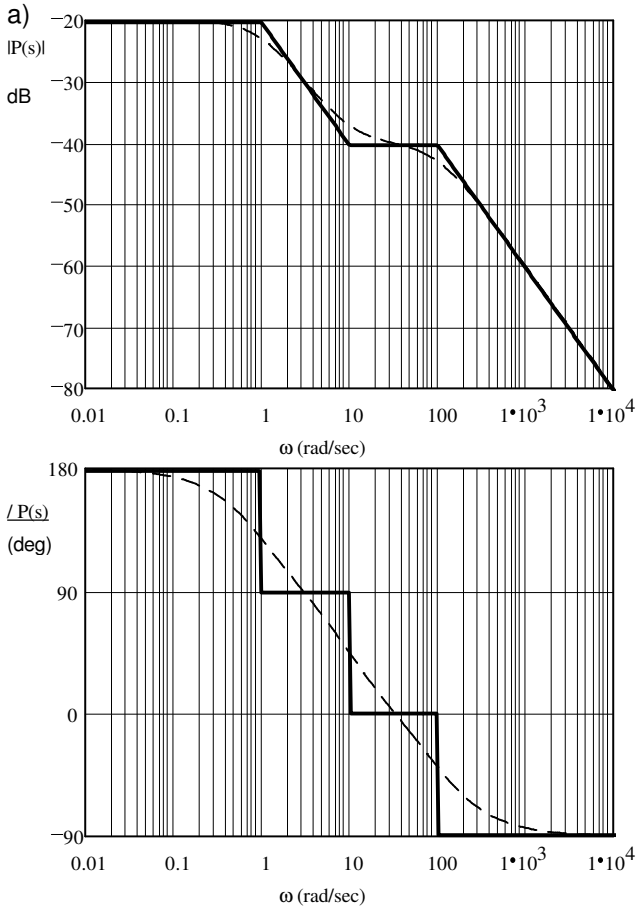
a) The system whose Bode plots are given at left is stable in closed-loop. Find its gain margin and phase margin.

b) Describe the behavior of the closed-loop system of part (a) if the open-loop gain is increased to a value close to the maximum value given by the gain margin. In particular, what can you say about the locations of the poles of the closed-loop system?

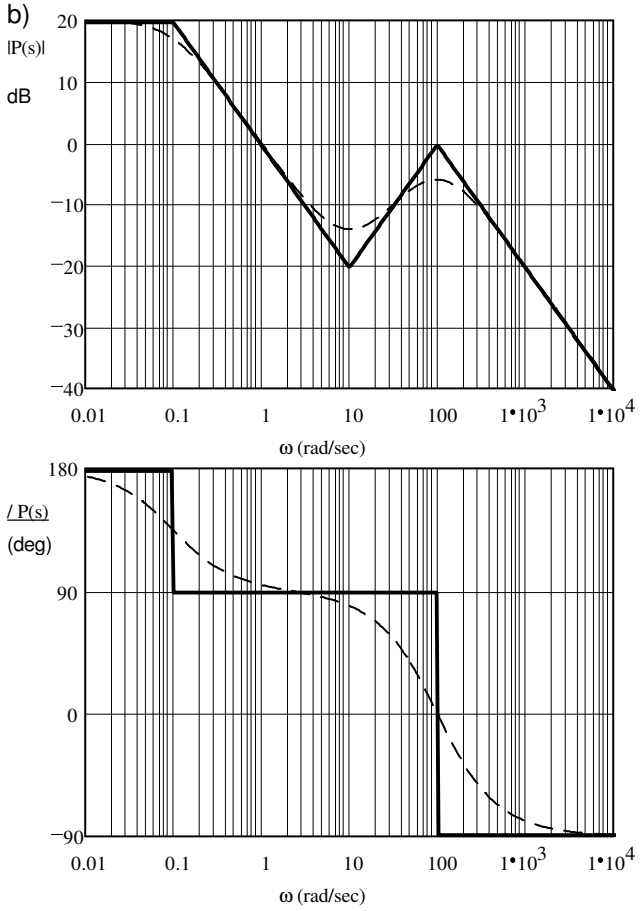
c) Consider an open-loop stable system which is such that the magnitude of its frequency response is less than 1 for all ω ($|kG(\omega)| < 1$). Can it be determined whether the closed-loop system is stable with only that information?

Answers

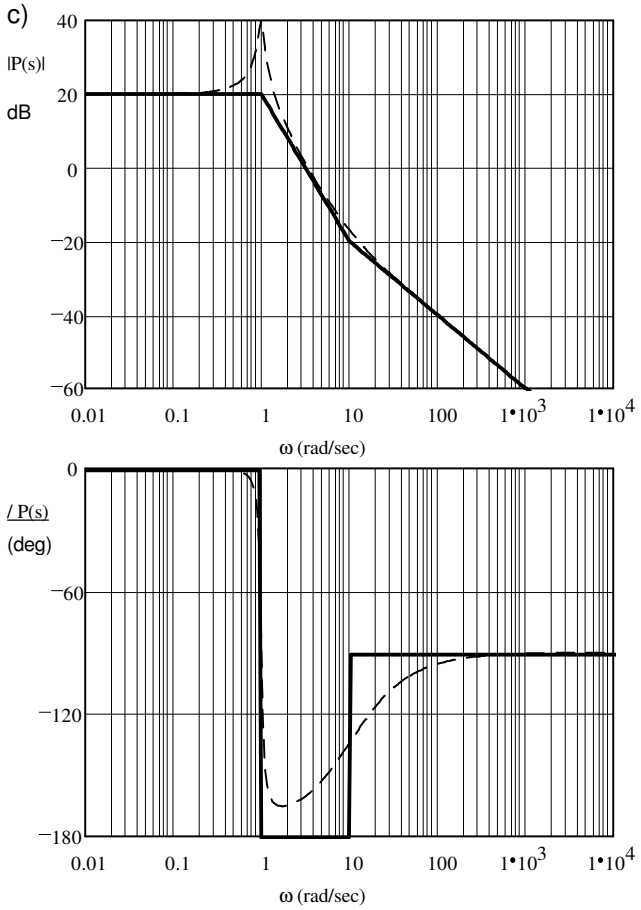
1. a)



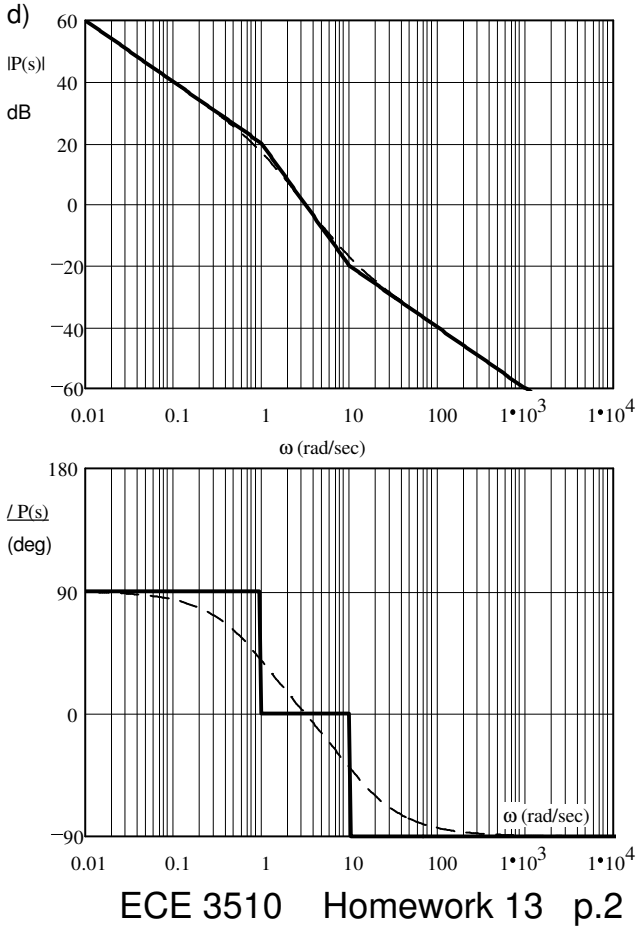
b)



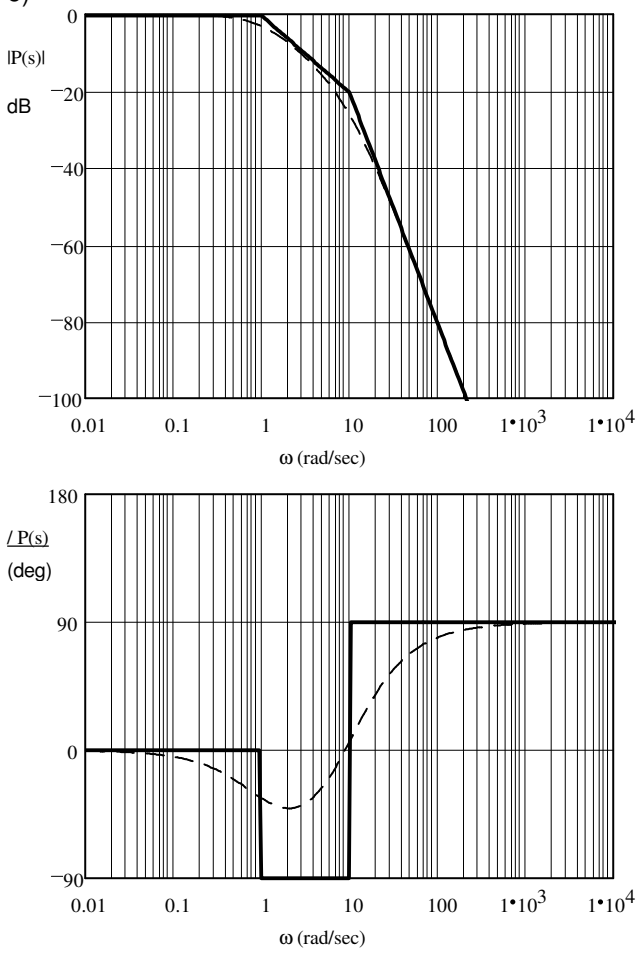
c)



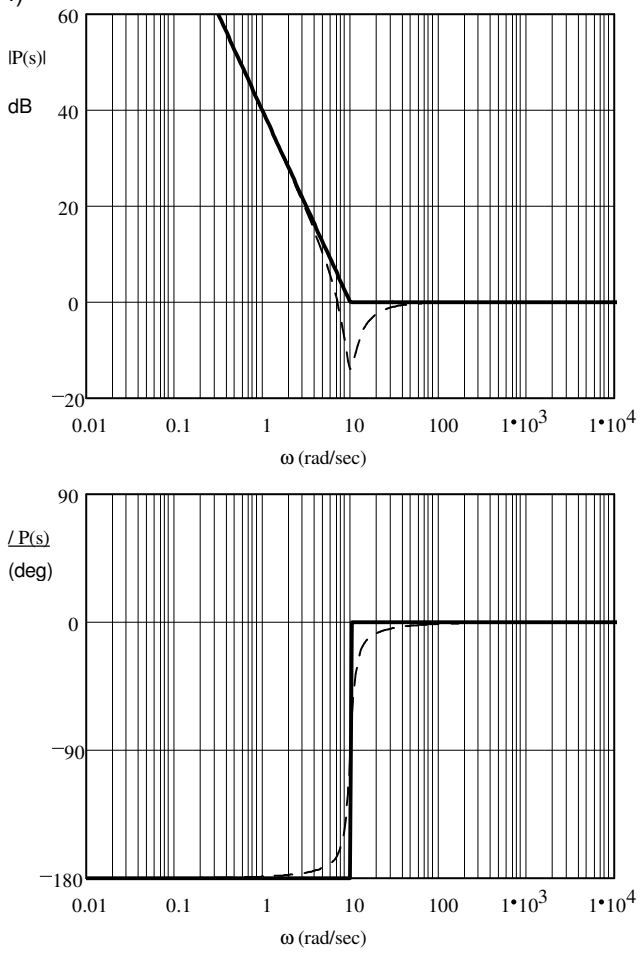
d)



e)



f)



2.a) $P(s) = 10\cdot\frac{s+1}{s+10} \quad 10\cdot\frac{s-1}{s+10} \quad 10\cdot\frac{s+1}{s-10} \quad -10\cdot\frac{s-1}{s-10} \quad -10\cdot\frac{s+1}{s+10} \quad -10\cdot\frac{s-1}{s+10} \quad -10\cdot\frac{s-1}{s-10} \quad -10\cdot\frac{s+1}{s-10}$

b) $P(s) = \frac{10\cdot(s+0.1)\cdot\left(s^2+0.4\cdot s+4\right)}{s\cdot\left(s^2+0.2\cdot s+1\right)\cdot\left(s^2+2\cdot s+400\right)}$

3. a) $GM \simeq 21\cdot dB \qquad PM \simeq 50\cdot deg$

b) The system will have a transient ring at about 10 rad/sec.
Two poles of the closed loop system will be close to $\pm 10j$.

c) Yes, it must be stable. N=0, P=0, Z=0