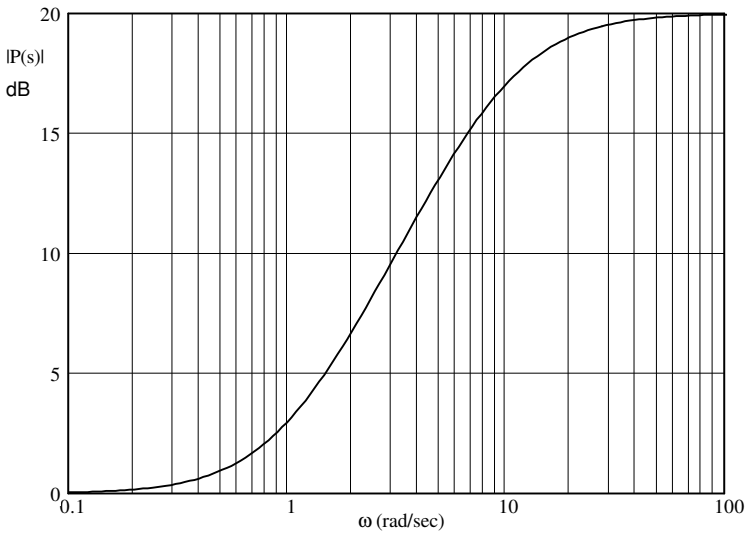
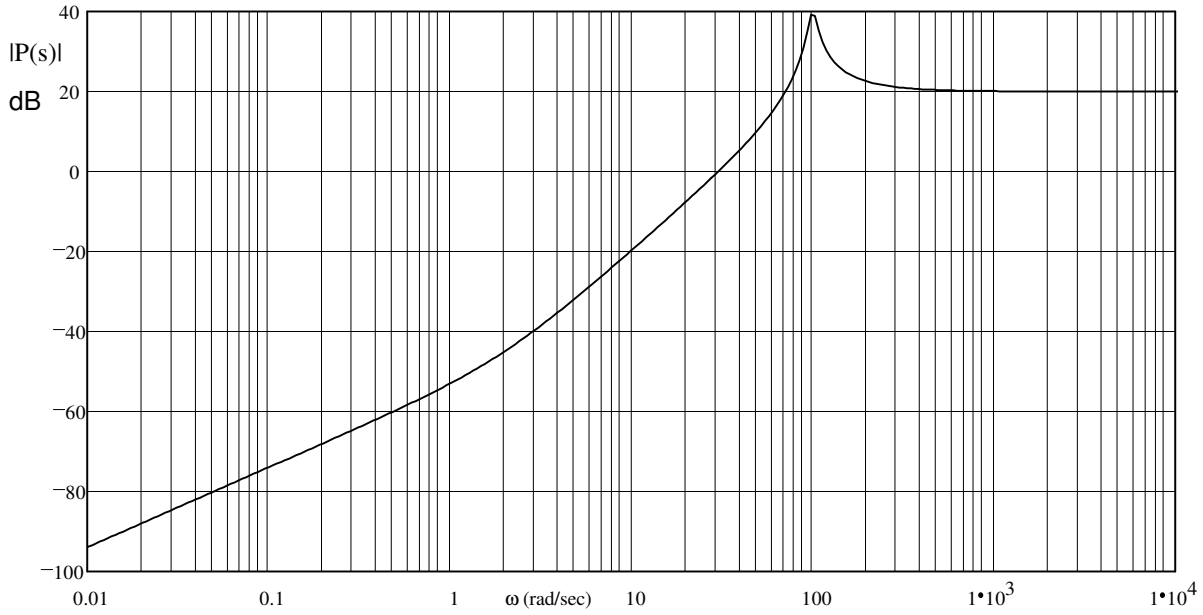
Name: _____ Homework # Bd3 a

Add your own paper if necessary.

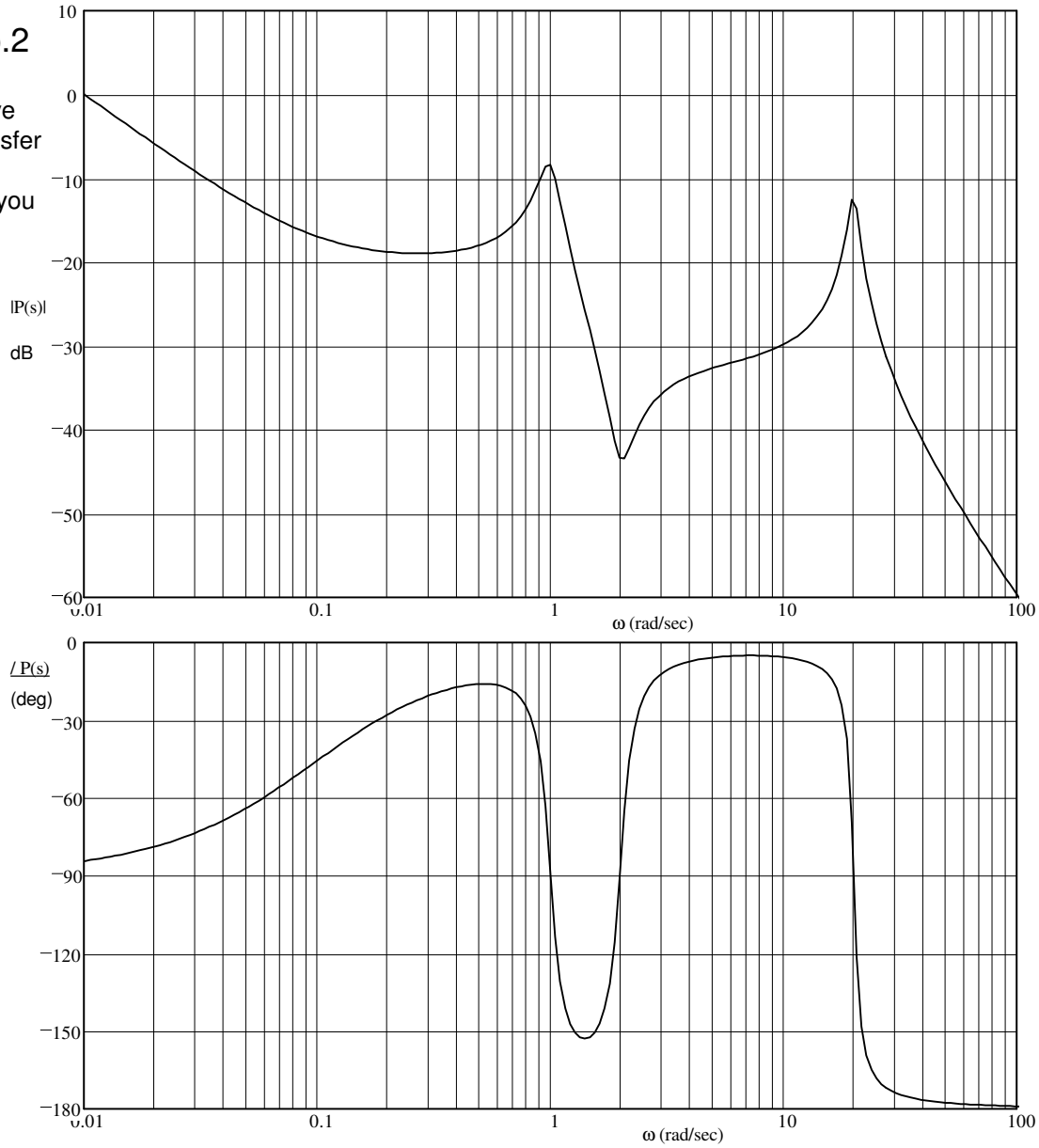
1. (a & c are from Problem 5.2 in Bodson text.)
   a) The magnitude Bode plot of a system is shown below. What are the possible transfer functions of stable systems having this Bode plot?



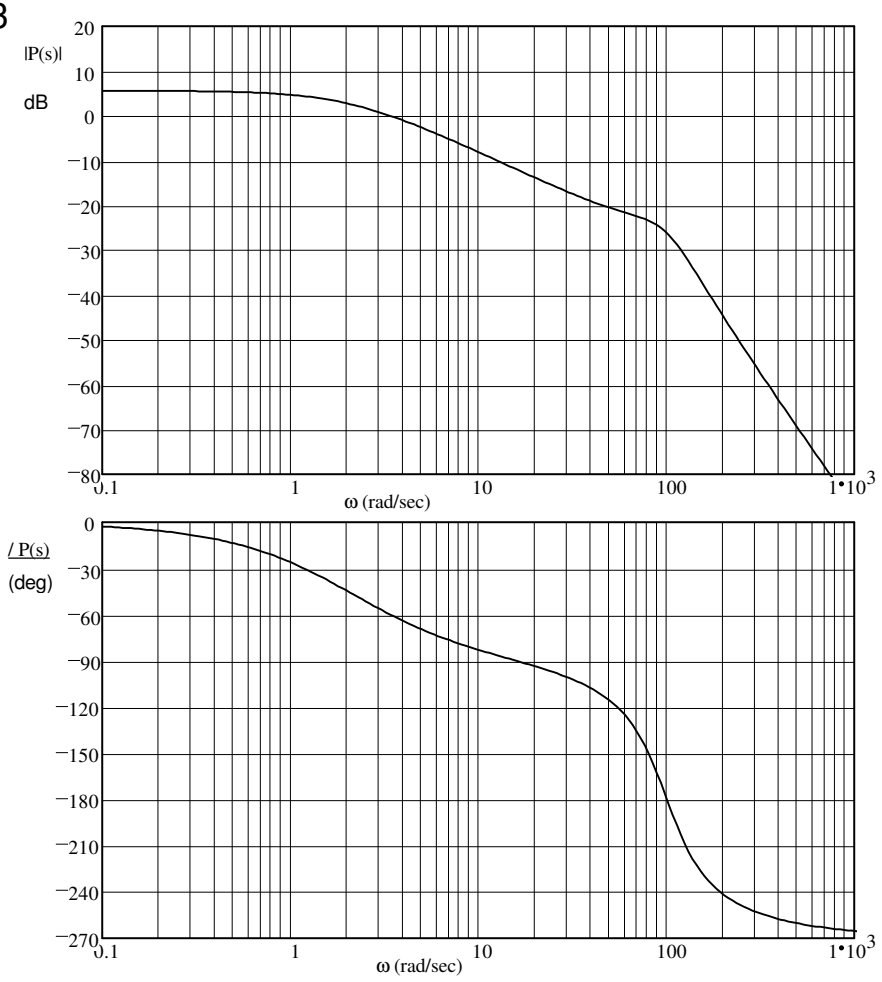
b) A Bode plot is shown below, estimate of the transfer function of the system. Assume no negative signs in the transfer function (all poles and zeros in LHP). Show your work (how you made your estimate).



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

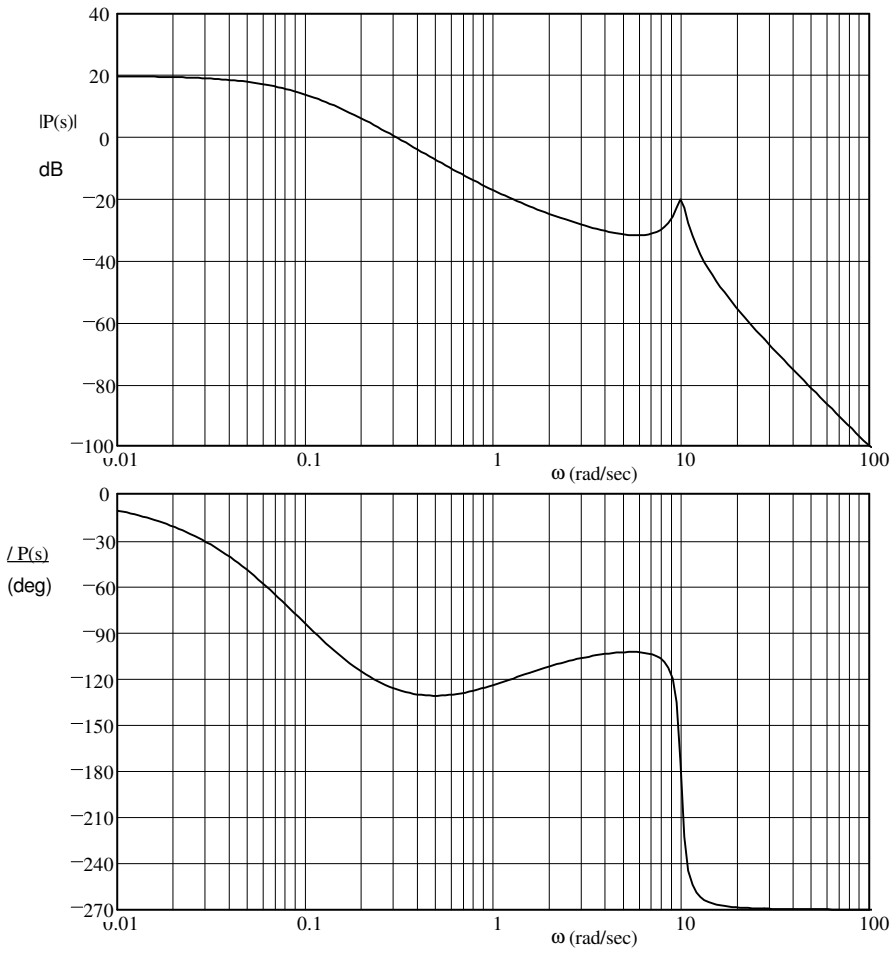


2. The system whose Bode plots are given at right is stable in closed-loop. Find its gain margin, phase margin, and delay margin. Show your work on the drawings.



3. Problem 5.3 in the text.

a) The system whose Bode plots are given at left is stable in closed-loop. Find its gain, phase, and delay margins. Show your work on the drawings.



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, including the gain factor k, is less than 1 for all ω ($|kG(s)| < 1$). Can you determine whether the closed-loop system is stable with only that information? If yes, shown how.

Answers

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

The rest are NOT stable

$10\cdot\frac{s+1}{s-10}$ $-10\cdot\frac{s-1}{s-10}$ $-10\cdot\frac{s-1}{s-10}$ $-10\cdot\frac{s+1}{s-10}$

b) $P(s) = \frac{10\cdot s\cdot(s+2)}{\left(s^2+10\cdot s+10000\right)}$

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

2. GM ≃ 25·dB PM ≃ 120·deg DM := 600·ms

3. a) GM ≃ 21·dB PM ≃ 50·deg DM := 2.6·sec

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

c) Yes, it must be stable. Prove by closed-loop transfer function, Bode gain margin or Nyquist: N=0, P=0, Z=0