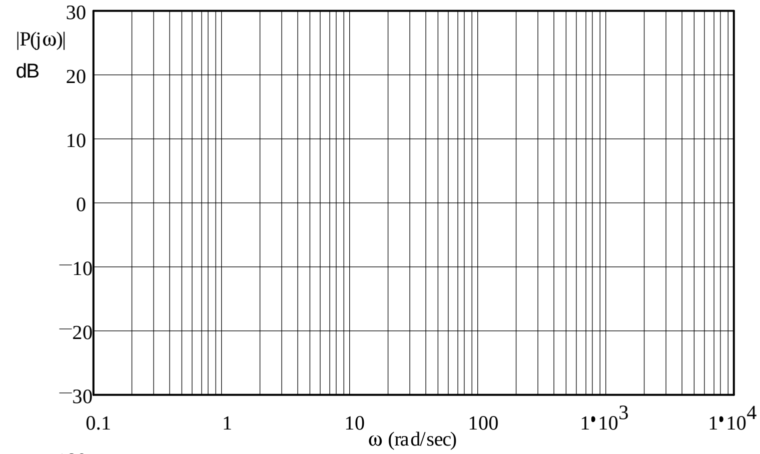
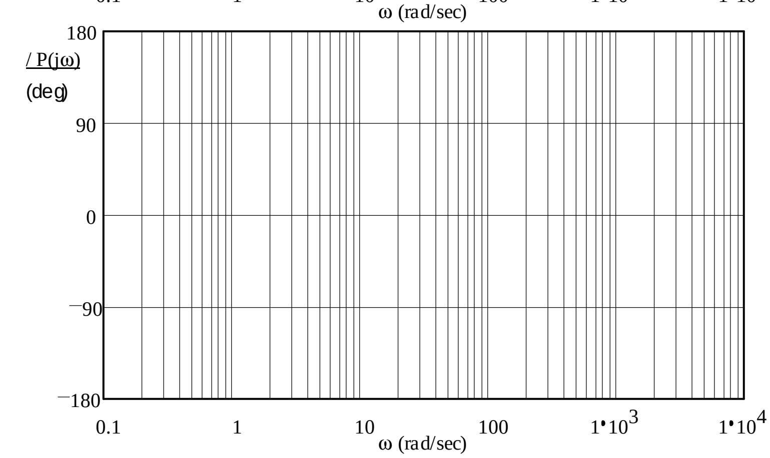
ECE 3510 Exam 3 given: Spring 08

Complex-pole Bode plot information was shown on the last page of the exam

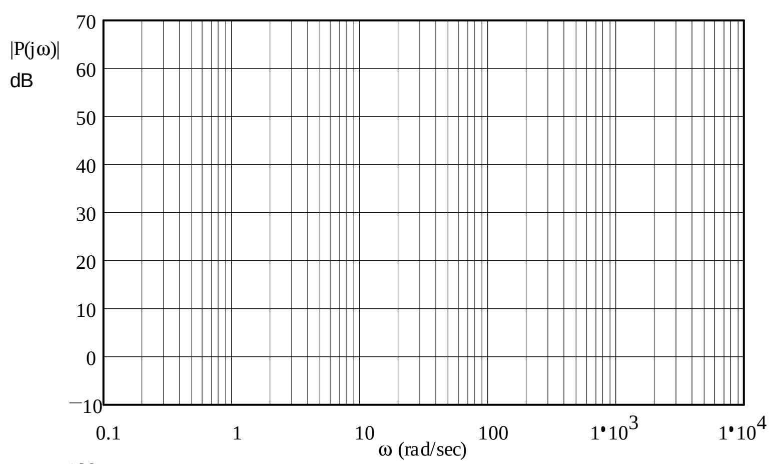
1. (20 pts) Sketch the Bode plots for the following transfer functions. Make sure to label the graphs as necessary to show the magnitudes and slopes. Also draw the "smooth" lines.

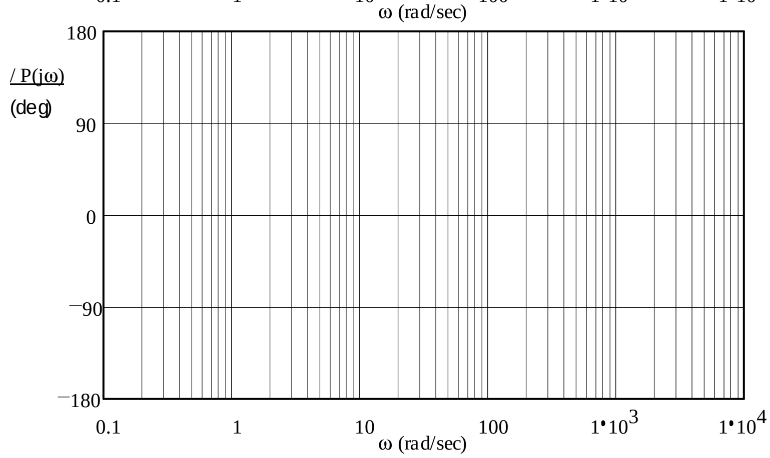
a) $P_a(s) = \dfrac{(s+4)\cdot(s+200)}{s\cdot(s+1000)}$





b) $P_{b.}(s) = \dfrac{10\cdot\left(s^2+80\cdot s+40000\right)}{(s+20)^2}$



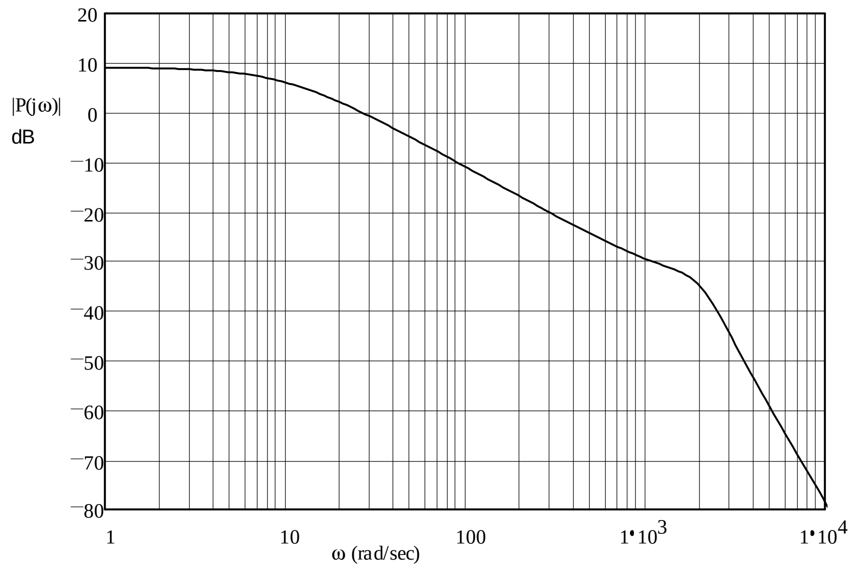


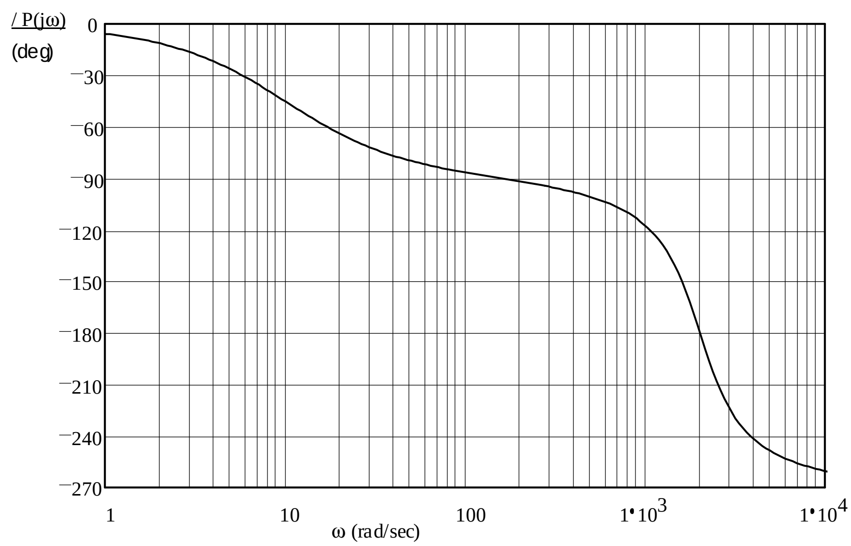
2. (20 pts) The open-loop Bode plots of a system are given at right.

   a) Find the gain margin and phase margin of the closed-loop system. Show your work on the drawings.

   b) For the system of part (a), give the steady-state response of the open-loop system an input $x(t) = 7\cos(10t)$.

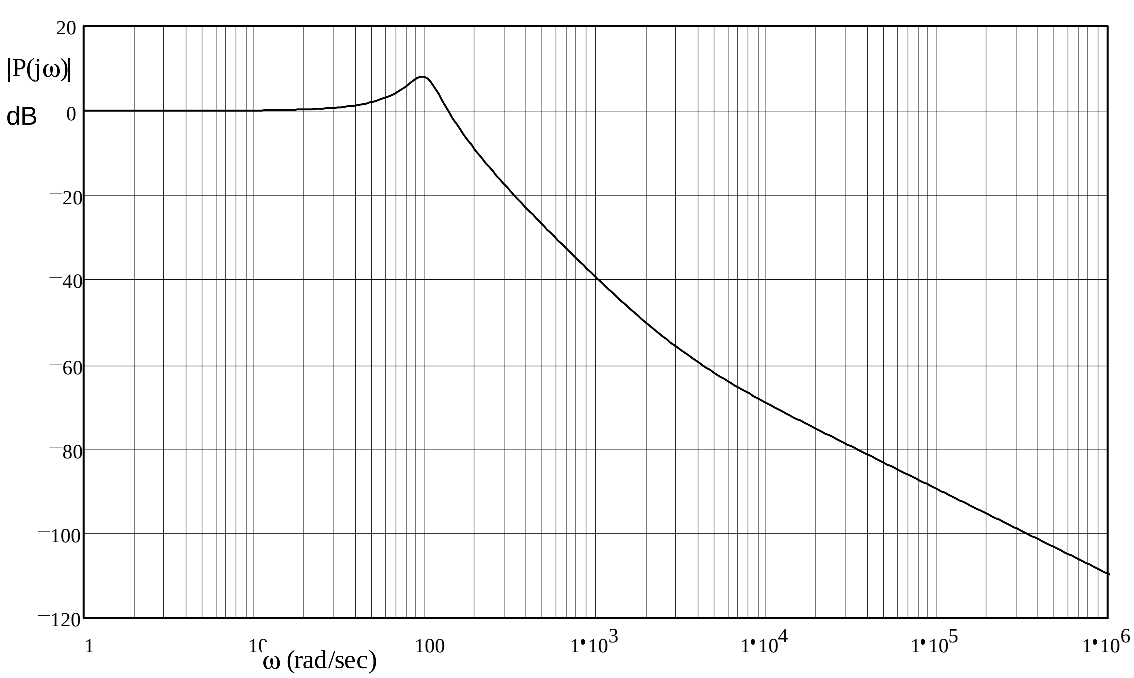
   c) Give the steady-state response of the closed-loop system for the same input. You may give mathematical expressions of the magnitude and phase if it's too hard to solve without a calculator.





3. (15 pts) Given the magnitude Bode plot of a system, estimate the transfer function of the system. Assume there are no negative signs in the transfer function (all poles and zeros are in the left-half plane).

   Show your work (how you made your estimate).



4. (17 pts) Refer to the Nyquist plot (only the portion for $\omega > 0$ is plotted).

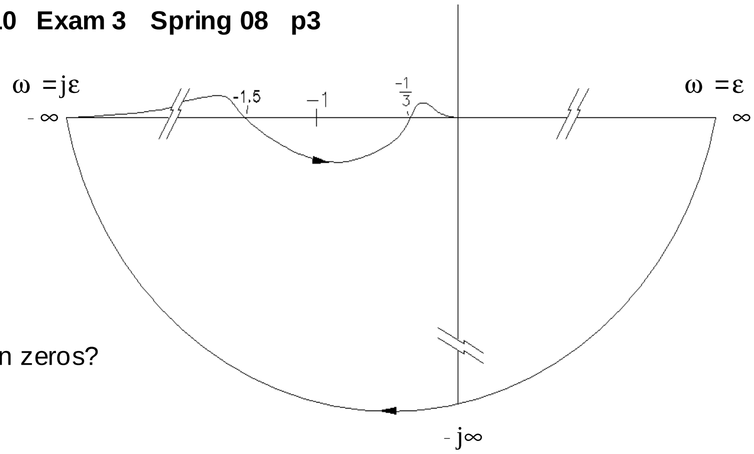
   a) Can the closed-loop system be stable? Show why

   b) If the answer to (a) is yes, what condition must the open-loop system satisfy?

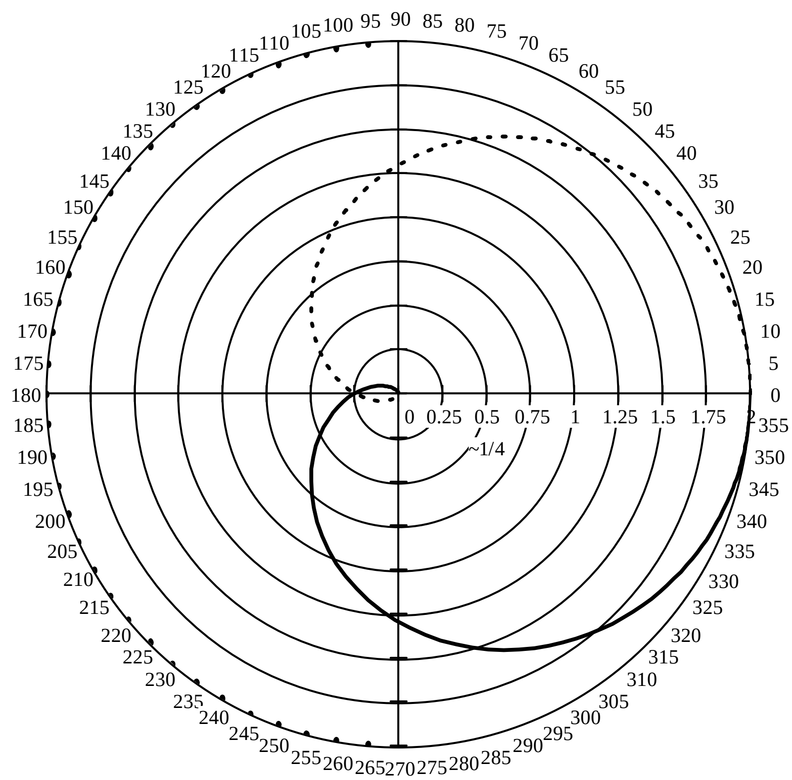
   c) If closed-loop stability is possible, what is (are) the gain margin(s)?

   d) Does the open-loop system have more poles than zeros? If yes, how many?

   e) The large arc is actually at "∞". Does this tell you something about one or more of the open-loop system poles? If yes, where is/are those pole(s) and how many are there?



5. (7 pts) For the given Nyquist plot, find the gain margin and phase margin of the closed-loop system. Show your work on the drawing.



6. (14 pts) An open-loop system has:

   2 unstable poles

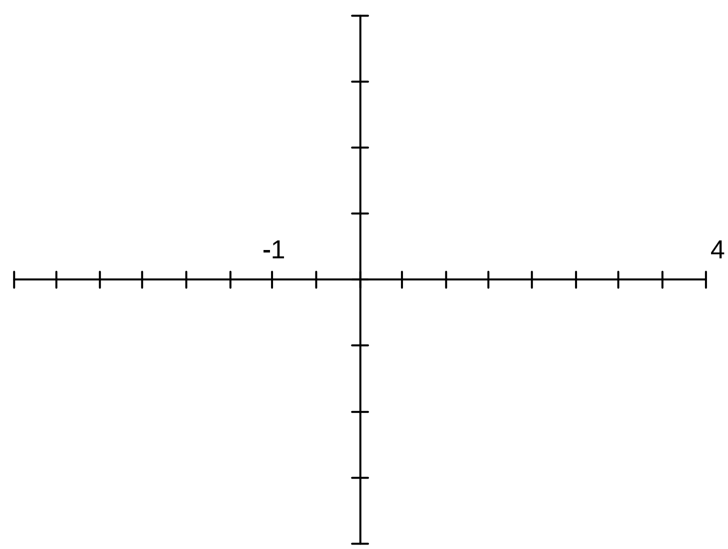
   A DC gain of 3

   3 more poles than zeros

The closed-loop gain margin is

$$GM = \left[\ \frac{1}{2.5}\ ,\ 2\ \right]$$

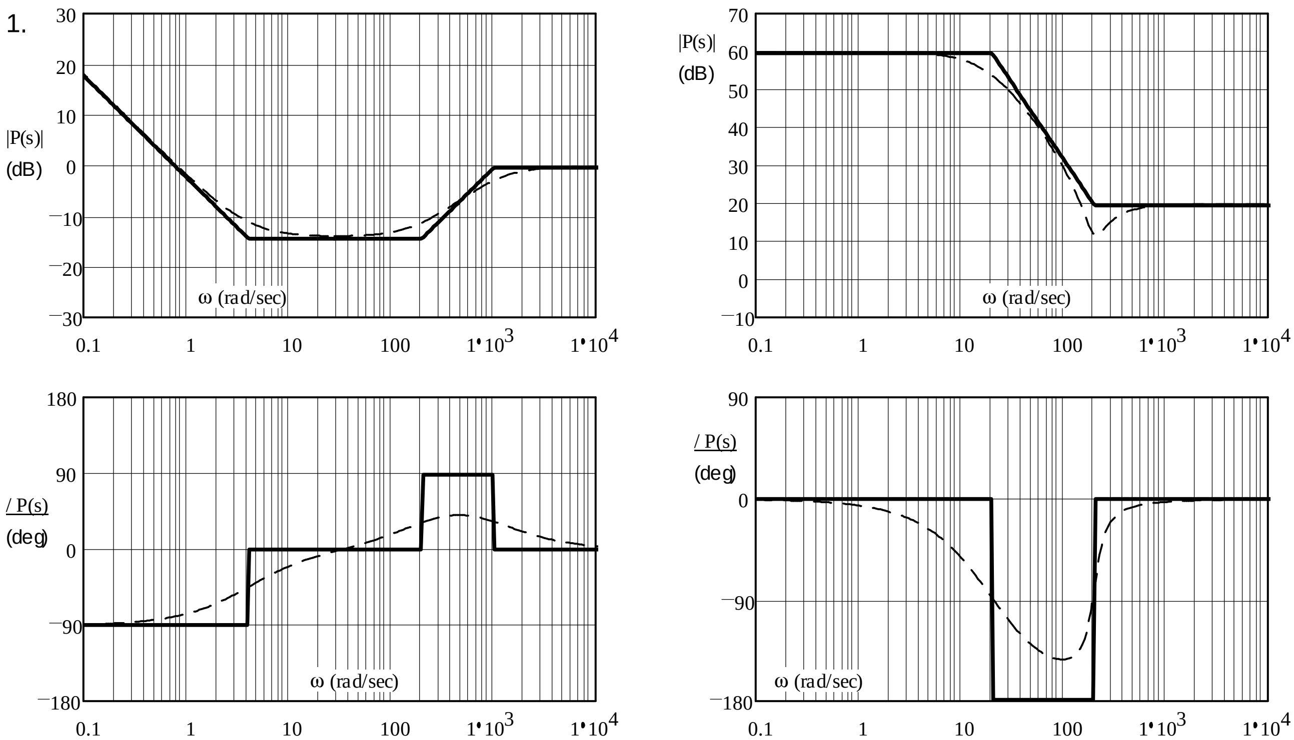
Draw a possible Nyquist plot for this system so that $Z = 0$.



7. (7 pts) Think back to labs 6 and 7, the Phase-Locked-Loop (PLL) labs.
   a) At the end of lab 6 the PLL was performing a specific function, but not all that well. What was it doing?
   b) The purpose of lab 7 was to improve the function mentioned above. What part of the feedback loop did you improve with your circuit?
   c) What, if anything, improved in the function mentioned above?

<u>Answers</u>

1.



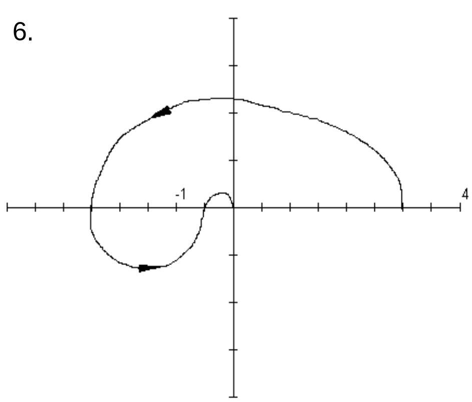
2. a) $GM := 35 \cdot dB$ $\quad PM := 115 \cdot deg$
   b) $y_{ss}(t) = 14 \cdot \cos(10 \cdot t - 45 \cdot deg)$
   c) $y_{ss}(t) = 5 \cdot \cos(10 \cdot t - 15 \cdot deg)$

3. $$P(s) = \frac{\frac{10}{3} \cdot (s + 3000)}{\left(s^2 + 40 \cdot s + 10000\right)}$$

4. a) Yes, $N = 0$ so if $P = 0$ then $Z = 0$ b) $P = 0$
   c) $2/3 <$ gain < 3 d) 2 e) 2 poles at the origin

5. $GM := 4 \quad (12 \cdot dB)$
   $PM := 67 \cdot deg$

6.



ECE 3510 Exam 3 Arn Stolp

Name ________________________________
Scores:
Pages 1&2 _________ of a possible 38 pts
Pages 3&4 _________ of a possible 36 pts
Page 5&6 _________ of a possible 26 pts
Total _________ of a possible 100 pts

7. a) FM demodulation
   b) The low-pass filter between the phase detector and the VCO
   c) Ripple was less Transient response was better