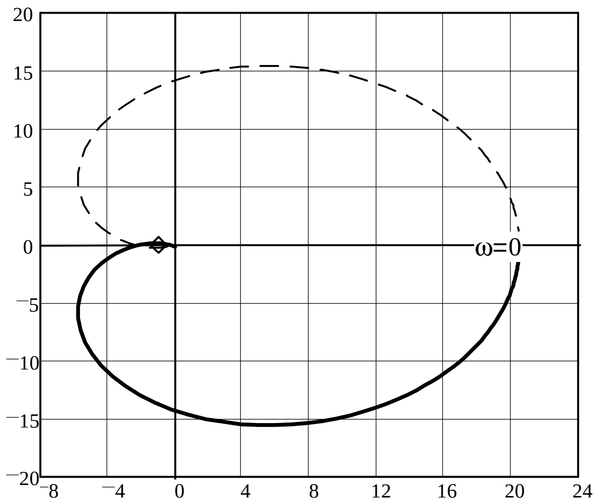
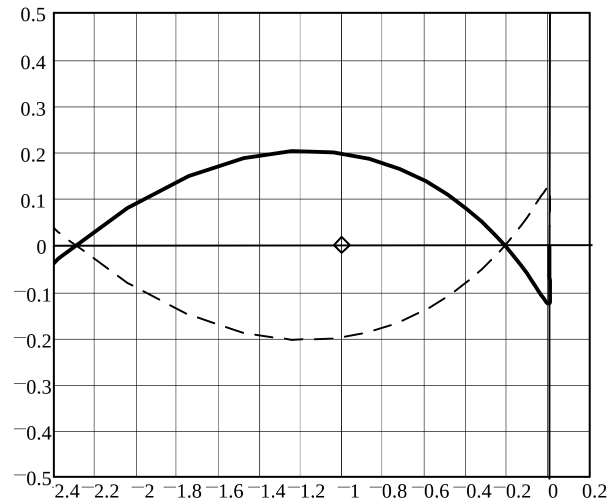
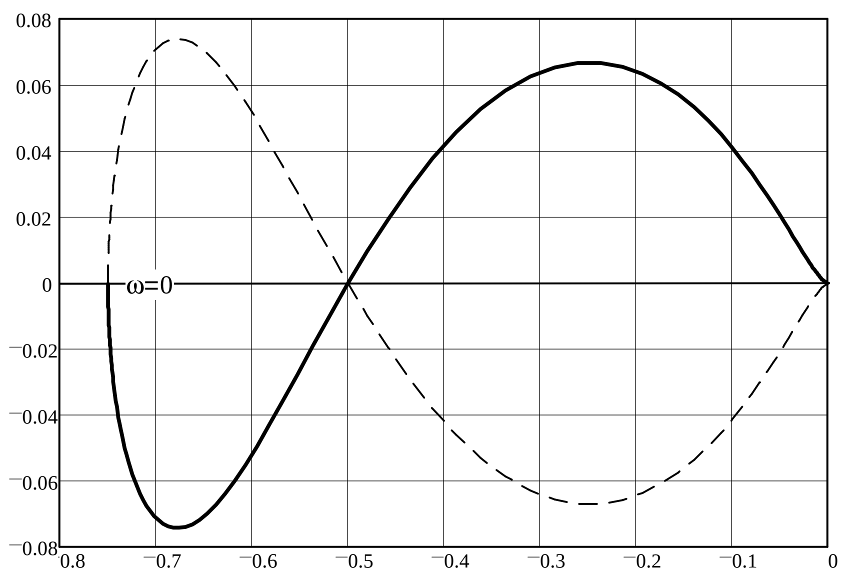
1. Similar to problem 5.4 (p.144) in Bodson text.

   a) The Nyquist diagram of a stable system is shown below (or in text), with the overall diagram shown on the left and the detail around the (-1,0) point shown on the right. The solid line corresponds to $\omega > 0$, with the arrow giving the direction of increasing ω. The dashed line is the symmetric curve obtained for $\omega < 0$. Assuming that the transfer function of the system is multiplied by a gain $k > 0$, what is the set of values of k for which the system is stable in closed-loop?





   b) Repeat part (a) for the system whose Nyquist curve is shown at below (or in text), given that the system has one unstable pole.



3. For problem 2a (5.5 in Bodson text):

   a) Find the DC gain ($s = 0 = \omega$) from the transfer function and compare it to the $\omega = 0$ point on the Nyquist diagram.

   b) Find the final value ($\omega = \infty$) from the transfer function and compare it to the $\omega = \infty$ point on the Nyquist diagram.

   c) Find the approach angle to the final value ($\omega = \infty$) from the transfer function and compare to the Nyquist diagram.

   d) Reproduce the Nyquist diagram (left drawing). If you do this by hand, find and plot at least 5 more points (besides a & b, above) which will show the shape of the curve. You may also plot this diagram using a computer program of your choice.

4. Repeat problem 4 for $G(s) := \dfrac{(s+40)}{(s-0.5)\cdot\left(s^2+4\cdot s+4\right)\cdot(s+4)}$

<u>Answers</u>

1. a) $k < 0.435$ or $k > 5$ b) $\frac{4}{3} < k < 2$

2. problem on next page

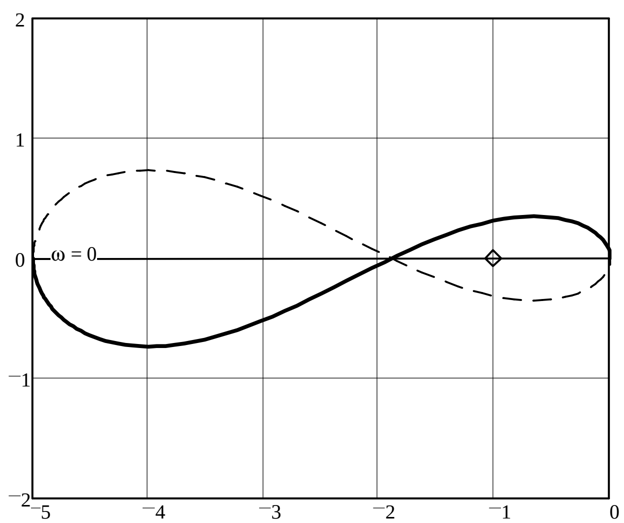
   a) $GM = \infty$ $PM = 30\cdot deg$ GM confirmed by both root-locus and Routh-Hurwitz

   a) $GM = 2$ $PM = 12.2\cdot deg$ GM confirmed by both root-locus and Routh-Hurwitz

3. a) $P(0) = 10$ b) $P(\infty) = 0$ c) $-180\cdot deg$ d) See problem 2a

4. a) $G(0) = -5$ b) $G(\infty) = 0$ c) $-270\cdot deg = 90\cdot deg$

   d)

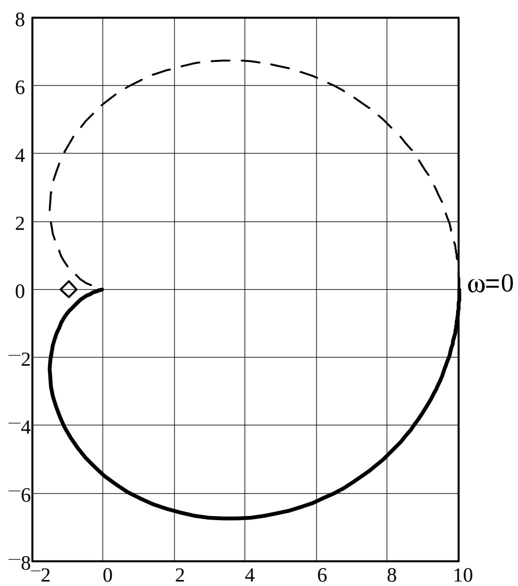


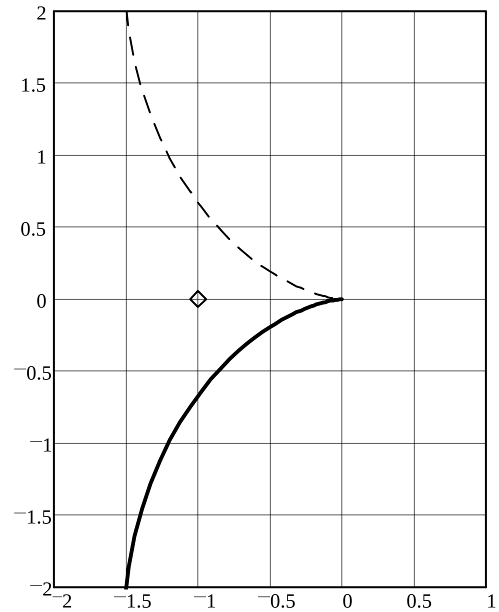
Name: ________________________________ **Pages 2 & 3 are intentionally out of order**

Hand in this page showing drawing modifications needed to find phase margins.

2. Problem 5.5 (p.145) in Bodson text.

   a) The Nyquist diagram for $P(s)=5(s+2)/(s+1)^3$ is shown below (or in text), with the overall diagram shown on the left and the detail around the (-1,0) point shown on the right. Indicate what the gain margin and the phase margins are (for the phase margin, show work on the drawing below). Compare the gain margin results with those predicted by a root-locus plot and the use of the Routh-Hurwitz criterion.





   b) Repeat part (a) for $P(s)=2(s+5)/(s+1)^3$ and the diagrams shown below.