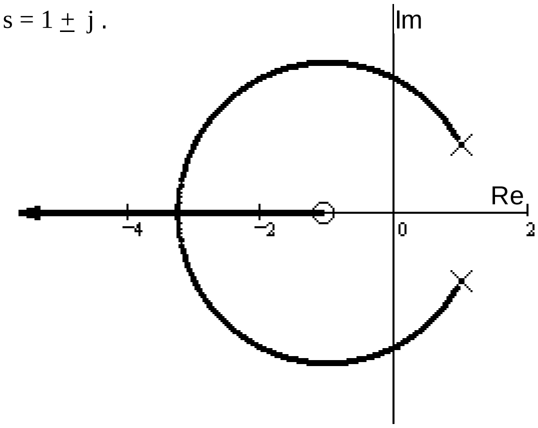
b

1. A root - locus is sketched at right.
   The open - loop transfer function has one zero at $s = -1$ and two poles at $s = 1 \pm j$.

   $\mathbf{G}(s) =$



   a) Find the departure angle from the complex pole $1 + j$.

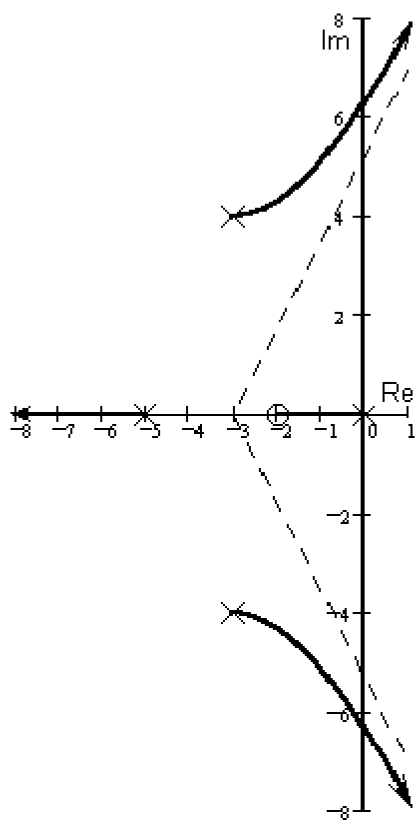
   b) It looks like the root-locus crosses the $j\omega$ axis at 2

   c) Regardless of what you found in part b, continue to assume that the root-locus crosses the $j\omega$ axis at 2.
   Give the range of gain k for which the system is closed-loop stable.

2. A root - locus is sketched at right.

   $$\mathbf{G}(s) = \frac{3\cdot(s+2)}{s\cdot(s+5)\cdot\left(s^2+6\cdot s+25\right)}$$

   a) Find the departure angle from the complex pole $-3 + 4j$.



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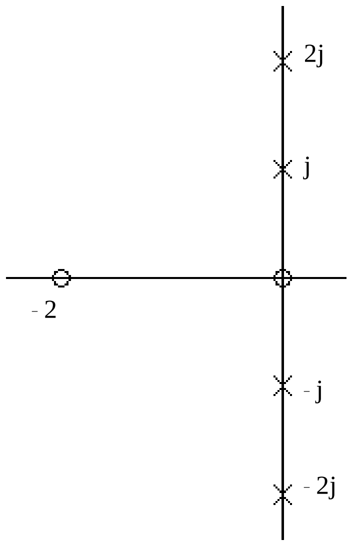
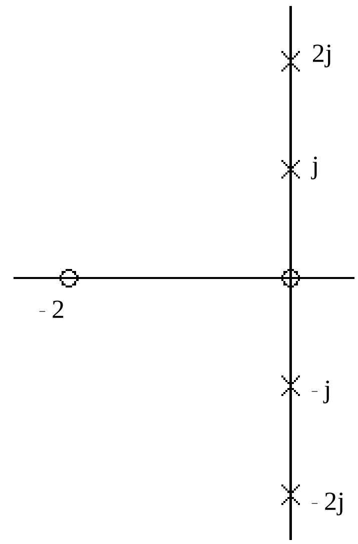
3. Problem 4.13 in the text. Sketch the root-locus for the following problem. Do not calculate the range of gain for stability, the $j\omega$ axis crossings, or the break-away points from the real axis. However, give the angles of departure from the complex poles. There is a zero at $s = 0$ and a zero at $s = -2$. There are poles at $s = \pm j$ and $s = \pm 2j$.

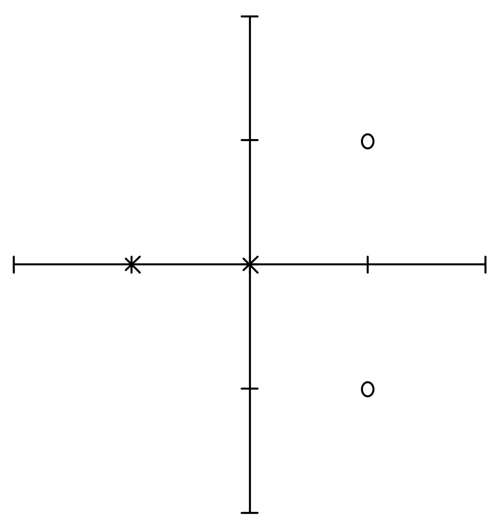
Angle of departure from pole at j



Angle of departure from pole at $2j$



4. a) Nise 3rd ed., Ch.8, problem 4.
   b) Also find the point where the root locus crosses the imaginary axis.
   c) Find the range of gain for which the system is "stable".
   d) Find the arrival angle at the top zero (departure of top pole in 4th Ed.).



Answers

1. a) $117 \cdot deg$
   b) YES
   c) $k > 2$
2. $3.73 \cdot deg$
3. $206.6 \cdot deg$
   $45 \cdot deg$

4. 3rd Ed.

$k := 0.5$

c) $k < 0.5$