EE3004: Control Engineering - Section ESB350 July - Nov 2018

Tutorial & Homework #7 Due: 4 October 2018

Note: Try to consistently use the eight rules for constructing the root locus plots. Summary is provided below:

1. Number of branches
2. Symmetry
3. Real axis segments of root locus
4. Starting and ending points
5. Behavior at infinity
6. Breakaway or break in points
7. jw-axis crossings
8. Departure and arrival angles

Important: In the following problems provide all the information, at least wherever possible, related to a root locus plot, i.e., open loop poles and zeros, starting and ending points, asymptotes (angles and centroid), breakaway and breakin points, jw-axis crossings (if any), departure and arrival angles.

1. Sketch the general shape of the root locus for each of the open loop pole zero plots shown in figure 1.

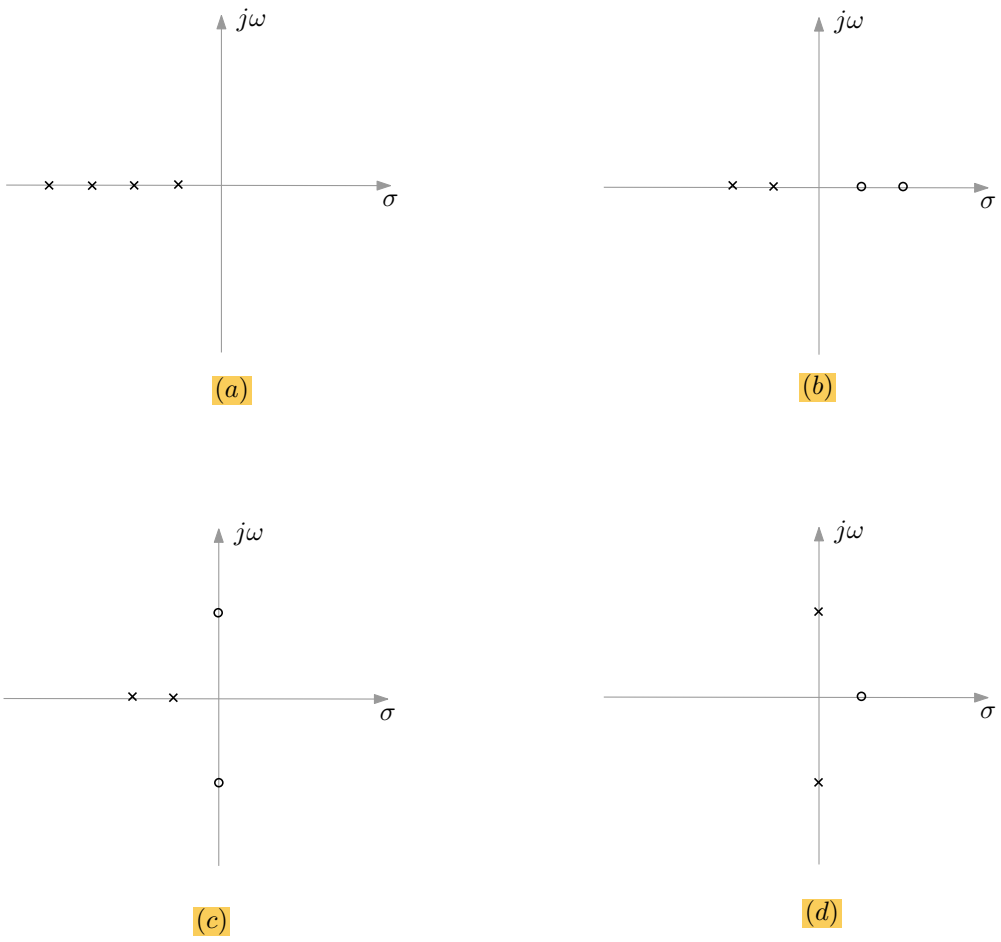

Figure 1

2. Sketch the root locus for the following. Take help of matlab or other software while finding breakaway/breakin points if hand calculations appear tedious.

   a) $G(s) = \frac{(s+2)(s+6)}{s^2+8s+25}$, $H(s) = 1$

   b) $G(s) = \frac{(s^2+4)}{(s^2+1)}$, $H(s) = 1$

   c) $G(s) = \frac{(s^2+1)}{s^2}$, $H(s) = 1$

   d) $G(s) = \frac{1}{(s+1)^3(s+4)}$, $H(s) = 1$

   e) $G(s) = \frac{s^2(s+6)}{(s+\frac{2}{3})}$, $H(s) = 1$

   f) $G(s) = \frac{(s+30)(s^2-20s+200)}{(s+10)(s+20)}$, $H(s) = 1$

   g) $G(s) = \frac{(s^2-2s+2)}{(s+2)(s+4)(s+5)(s+6)}$, $H(s) = 1$

   h) $G(s) = \frac{1}{s(s+2)(s^2+2s+10)}$, $H(s) = 1$

   i) $G(s) = \frac{1}{(s+2)(s+4)}$, $H(s) = \frac{s^2+6s+18}{s^2+4s+8}$

3. Show that the root loci for a control system with $KG(s)H(s) = \frac{K(s^2+6s+10)}{(s^2+2s+10)}$ are arcs of the circle centered at the origin with a radius equal to $\sqrt{10}$.

4. The loop transfer function of a feedback control system is given by $KG(s)H(s) = \frac{K(s+1)}{s^2(s+b)}$ sketch the root locus for

   a) $b = 20$

   b) $b = 9$

   c) $b = 2$

   d) $b = 0.1$

   What are the observations one can make due to movement of pole as in (a), (b), (c), (d)?