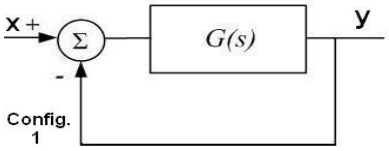
Eskişehir Osmangazi University - Electrical Engineering Department
Fundamentals of Control Systems; Final Examination - Spring 2012

For each question, put the answer just next to or below it. Correct answers are sufficient for full credits.

1. For Configuration 1, $G(s) = \frac{K(s^2+2s+5)}{(s^2+5s+6)(s-1)}$ is given.



a) [10 pts.] Show the poles and zeros of $G(s)$on the complex plane.
b) [20 pts.] Sketch the root locus for the system in Config. 1. If exist(s), show values of the asymptotes' real axis crossing points; imaginary axis crossing points, and break away points.
c) [10 pts.] For which K values is the closed loop system stable?

2. Let $F(s) = s^5 + 11s^4 + 46s^3 + 90s^2 + 81s + 27$ be given. It maps the closed contour Γ to the closed contour δ shown in Figure 2.
a) [15 pts.] Write a formula relating the number of poles (P) and number of zeros (Z) of $F(s)$ in the contour Γ to the clockwise encirclement N of the origin by δ.
b) [15 pts.] Write the values of Z, P, and N. Use the formula in part a) to evaluate number of zeros of $F(s)$ in the contour Γ.

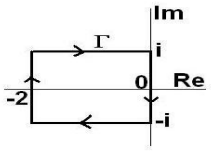
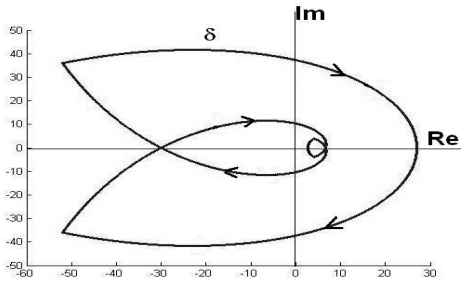


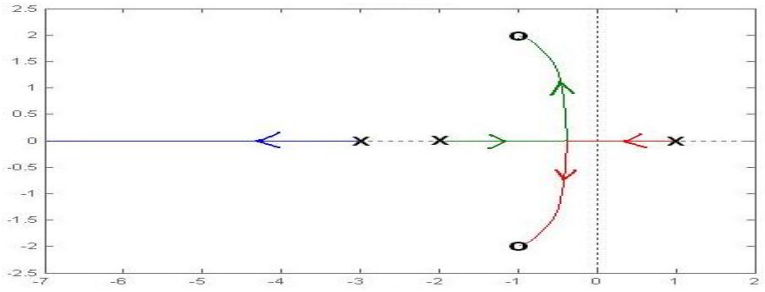
Figure 2



3. Let $P(s) = s^5 + 6s^4 + 5s^3 + s^2 + 8s + 1$ be given.
a) [15 pts.] Obtain and write the Routh table for $P(s)$.
b) [15 pts.] How many roots of $P(s)$ are in the open left half complex plane.
Good Luck,
A. Karamancıoğlu

Solutions

1. The unstable closed loop system pole enters the LHP through $s = 0$. At



this point the gain condition implies $|G(s)|_{s=0} =\rightarrow K = 1.2$ Thus, the system is stable for $K > 1.2$ The breakaway point is at $s = -0.39$.

2.

a)$N = Z - P$

b) $P = 0, N = 2 \rightarrow Z = 2$

3.

a)

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[        1,    5, 8]
[        6,    1, 1]
[     29/6, 47/6, 0]
[  -253/29,    1, 0]
[ 2122/253,    0, 0]
[        1,    0, 0]
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b) 3