EE 450/550 Test # 2 - In Class - Nov 16

1. A unity feedback system has a feeforward transfer function $G(s) = K\dfrac{s+1}{s^3+3s^2+4s+5}$. Write the characteristic polynomial for the closed-loop system. Is this system stable for any value of K. If so, find the range of K for stability. (20)

Ch. poly: $s^3 + 3s^2 + (4+K)s + (5+K)$

s^3	1	$4+K$
s^2	3	$5+K$
s^1	$\frac{7+2K}{3}$	0
s^0	$5+K$	0

Stable for all positive K.

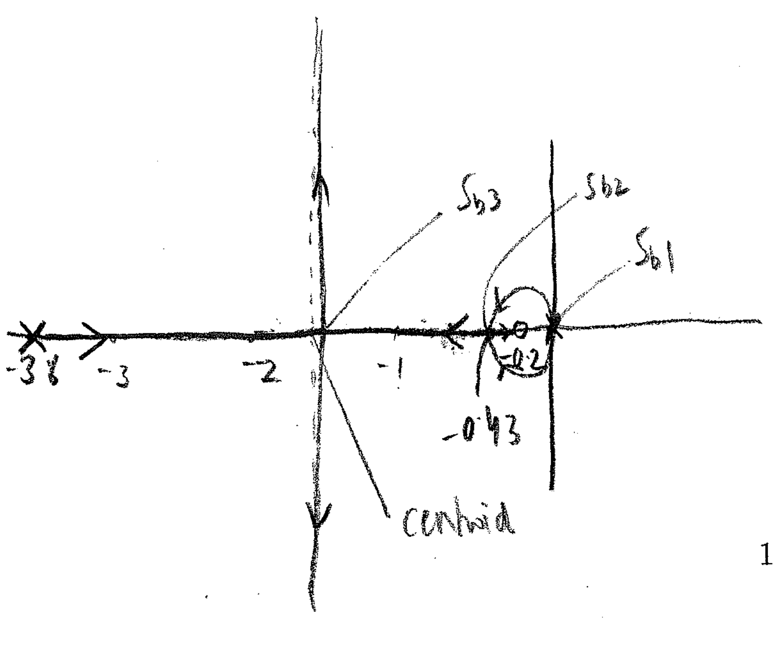
2. Draw the root locus (parameter K) for a unity feedback system whose feed-forward transfer function is given by $G(s) = \dfrac{K(s+0.2)}{s^2(s+3.6)}$. For full credit, calculate and show centroid, angle of asymptotes, breakaway/breakin points, etc. Caution: You will not be able to sketch the right locus if you don't calculate the aforementioned angles and points. (30)

Centroid $= \dfrac{\Sigma p - \Sigma z}{n-m} = \dfrac{-3.6-(-0.2)}{2} = -1.7$

$\angle$asymptotes $= \dfrac{\pm 180(2k+1)}{2} = \pm 90°$

$K = s^2(s+3.6)/(s+0.2)$

$\dfrac{dK}{ds} = 0 \Rightarrow 2s^3 + 4.2s^2 + 1.44s = 0 \Rightarrow s_{b1} = 0,\ s_{b2} = -0.43,\ s_{b3} = -1.6685$



3. In a system with n poles and m zeros with $n > m$, how many asymptotes do you expect on the root locus and why? (15)

$n - m$, because m poles end at m zeros, remaining must end at infinity.

4. Consider $s^3 + 3s^2 + 2s + K = 0$ to be the characteristic equation for a system. Find K and ω when it crosses ~~into RHP~~ the imaginary axis. (15)

Set $s = j\omega$

$$-j\omega^3 - 3\omega^2 + 2j\omega + K = 0$$

$$K - 3\omega^2 = 0 \quad \text{and} \quad \omega(\omega^2 - 2) = 0 \Rightarrow \omega = 0 \text{ and } \omega = \pm\sqrt{2}$$

$$\Rightarrow K = 0 \text{ and } K = 6$$

5. For a type 1 system, is the steady-state error to a *ramp* input (a) zero, or (b) constant other than zero, or (c) infinite? Explain. (10)

For a type 1 system, e_{ss} = constant other than zero. (b)

For Type 1, $e_{ss} = 1/K_v$ and $K_v = \lim_{s \to 0} sG(s)$ — FFTF

6. Explain what derivative control does and why it is never used alone. (10)

Derivative anticipates the actuating error and initiates corrective action. Never used alone because it acts only on derivative of error and not on error itself. (See notes)