

Homework #7: ECE 461

Error Constants, Routh Criteria, Sketching a Root Locus. Due Monday, October 16th

Error Constants

1) Determine the system type, error constant, and the steady-state error a closed loop system would have for the following systems:

System $G(s)$	System Type	K_p	K_v	Steady-State Error for a Step Input
$\left(\frac{10}{(s+1)(s+5)}\right)$				
$\left(\frac{10}{(s-1)(s+5)}\right)$				
$\left(\frac{10}{s(s+1)(s+5)}\right)$				
$\left(\frac{10}{s^2(s+1)(s+5)}\right)$				

Routh Criteria

Determine the range of k for

- The following polynomials to be negative definite
- The closed-loop system $\left(\frac{Gk}{1+Gk}\right)$ to be stable (same thing)

2) $(s + 1)(s + 5)(s + 10) + 2k = 0$

$$G(s) = \left(\frac{2k}{(s+1)(s+5)(s+10)}\right)$$

3) $(s - 1)(s + 5)(s + 10)(s + 20) + 2k(s + 4) = 0$

$$G(s) = \left(\frac{2k(s+4)}{(s-1)(s+5)(s+10)(s+20)}\right)$$

4) $s^2(s + 1)(s + 5) + 2k = 0$

$$G(s) = \left(\frac{2k}{s^2(s+5)(s+10)}\right)$$

Sketching a Root Locus

Draw the root-locus plot for the following systems. Include

- The real axis loci
- The breakaway point(s)
- The $j\omega$ crossing(s)
- The departure / approach angle from complex poles / zeros

$$5) \quad G(s) = \left(\frac{2}{(s+1)(s+5)(s+10)} \right)$$

$$6) \quad G(s) = \left(\frac{2(s+4)}{(s-1)(s+5)(s+10)(s+20)} \right)$$

$$7) \quad G(s) = \left(\frac{2}{s^2(s+5)(s+10)} \right)$$

$$8) \quad G(s) = \left(\frac{(s^2+4)}{s(s+4)(s+5)(s+10)} \right)$$