ChE 436 – Process Control
Stability Analysis Worksheet

Example 11.13 (modified)

Consider a feedback control system that has the open-loop transfer function,

$$G_{OL}(s) = \frac{4K_c}{(s+1)(s+2)(s+3)} \qquad (11\text{-}108)$$

Determine the values of K_c that keep the closed loop system response stable.

Part a) Derive the characteristic equation (denominator of the closed loop response).

Part b) Using Routh Array analysis, determine the critical gain (K_{cu}).

$$a_n s^n + a_{n-1}s^{n-1} + \cdots + a_1 s + a_0 = 0 \qquad (11\text{-}93)$$

$$a_n > 0$$

Row				
1	a_n	a_{n-2}	a_{n-4}	$\cdots$
2	a_{n-1}	a_{n-3}	a_{n-5}	$\cdots$
3	b_1	b_2	b_3	$\cdots$
4	c_1	c_2	$\cdots$	
$\vdots$	$\vdots$			
$n+1$	z_1			

$$b_1 = \frac{a_{n-1}a_{n-2} - a_n a_{n-3}}{a_{n-1}} \qquad (11\text{-}94)$$

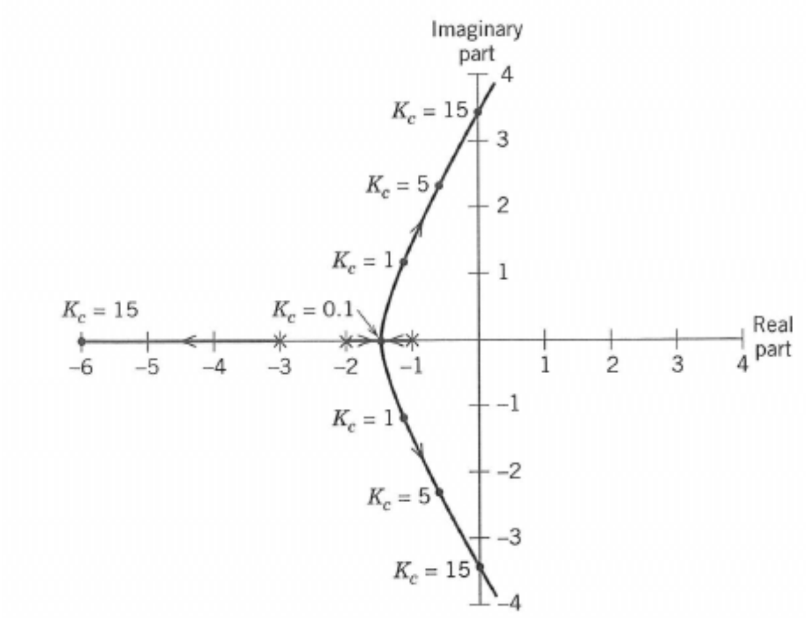
$$b_2 = \frac{a_{n-1}a_{n-4} - a_n a_{n-5}}{a_{n-1}} \qquad (11\text{-}95)$$

$$\vdots$$

$$c_1 = \frac{b_1 a_{n-3} - a_{n-1}b_2}{b_1} \qquad (11\text{-}96)$$

$$c_2 = \frac{b_1 a_{n-5} - a_{n-1}b_3}{b_1} \qquad (11\text{-}97)$$

Part c) Using the Root Locus Plot, determine the critical gain (K_{cu}).



Part d) Using the Bode Plot, determine the critical gain (K_{cu}).