

# **INTRODUCTION TO MATLAB**

MATLAB commands used

- rlocus
- rltool

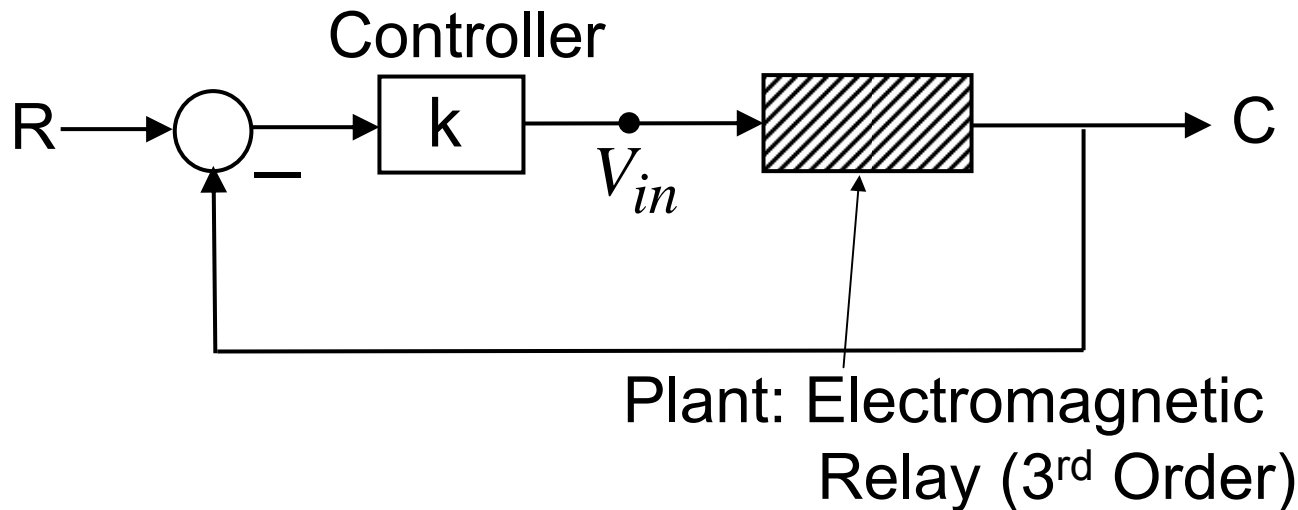
Use MATLAB help for further information.

# EXAMPLE

## ELECTROMAGNETIC RELAY CONTROL

(Refer Handout for figure)

$$\text{OLTF: } G(s) = \frac{1}{s^3 + 16s^2 + 44s - 160} = \frac{\Theta(s)}{V_{in}(s)}$$



$$\text{CE: } s^3 + 16s^2 + 44s - 160 + k = 0$$

Stable or not? and why?

$$\text{RH: } k - 160 > 0$$

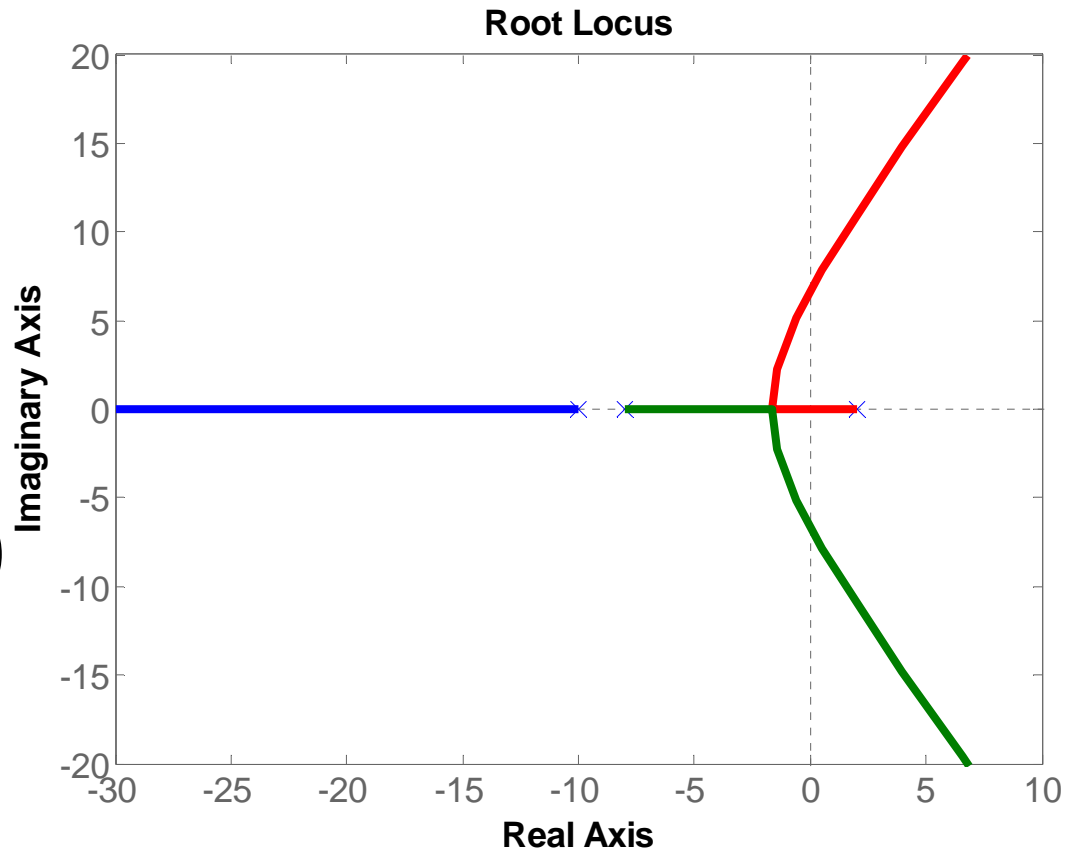
$$n = 3$$

$$m = 0$$

$$n_a = 3$$

$$\theta_a = \pm 60(2q + 1)$$

$$\sigma_a = -5.33$$



At intersection with Im – Axis  $s = j\omega$

$$\text{CE} : (j\omega)^3 + 16(j\omega)^2 + 44(j\omega) - 160 + k = 0$$

$$-j\omega^3 - 16\omega^2 + 44j\omega - 160 + k = 0$$

$$\left(-16\omega^2 - 160 + k\right) + \left(-\omega^3 + 44\omega\right)j = 0$$

$$\omega\left(-\omega^2 + 44\right) = 0 \Rightarrow \omega = 0 \text{ or } \omega = \sqrt{44}$$

$$-16\omega^2 - 160 + k = 0$$

$$\Rightarrow -16(44) - 160 + k = 0$$

$$k = 864$$

RH: Let  $\alpha = k - 160$

$$s^3 + 16s^2 + 44s + \alpha = 0$$

$s^3$	1    44	$b_1 = -\frac{1}{16} \left  \begin{array}{cc} 1 & 44 \\ 16 & \alpha \end{array} \right  = -\frac{1}{16}(\alpha - 704)$
$s^2$	1 $\alpha$	$b_1 > 0 \Rightarrow \alpha < 704 \Rightarrow k - 160 < 704$
$s^1$	$b_1$	$k < 864$
$s^0$	$c_1$	$c_1 = \alpha = k - 160 > 0 \Rightarrow k > 160$

$$160 < k < 864$$