Minimum Phase Root Locus

Generate **straight line** root locus of following **plant** and determine the **approximate** value of '**K**' for which the **closed loop** system has all **poles** to the left of **-0.5.**

$$G(s) = \frac{K}{(s+1)^4}$$

Poles: $-1, -1, -1, -1; \quad n = 4; \quad m = 0; \quad n - m = 4$

Real axis: No root on real axis as $(n+m) = 0$ on both sides.

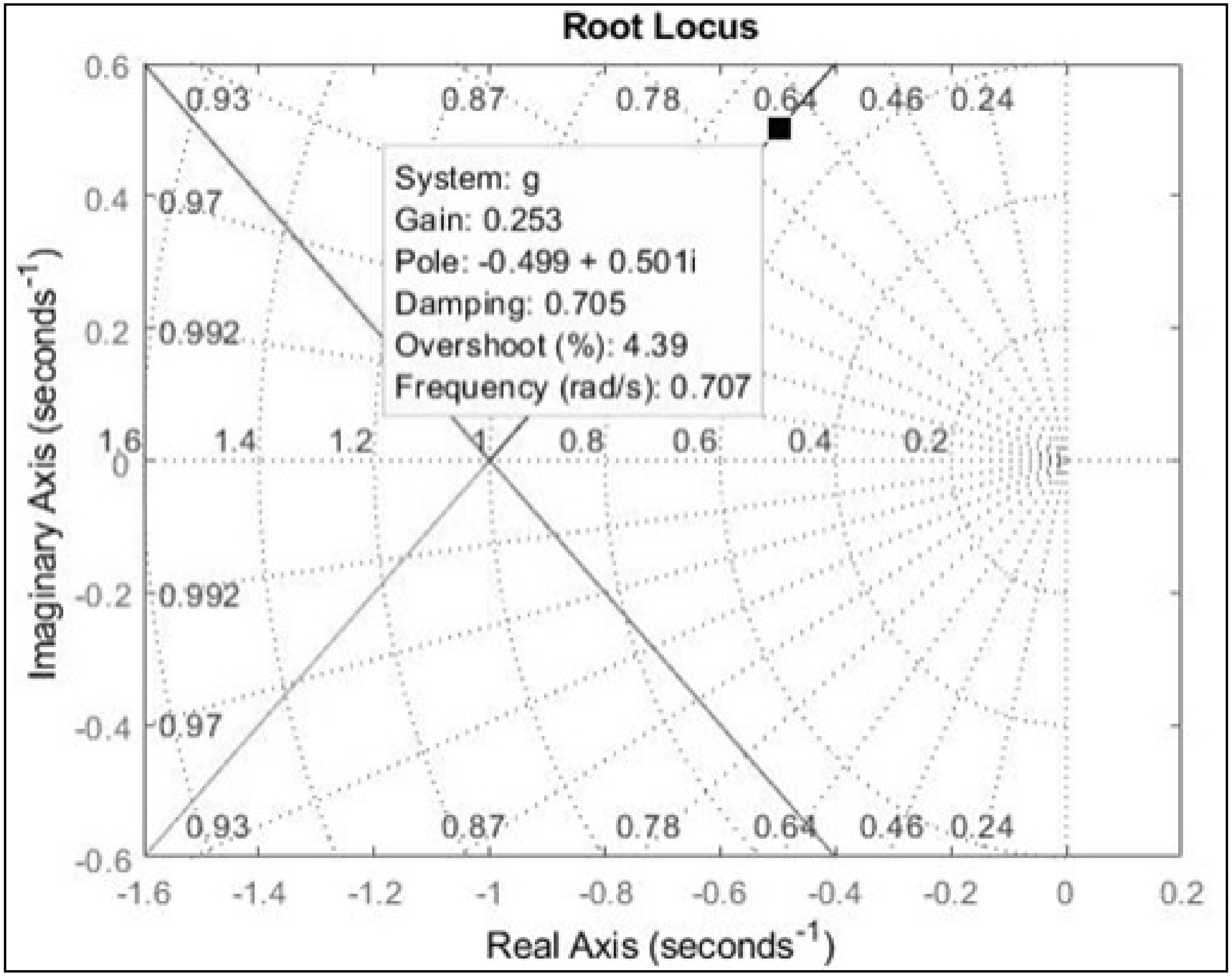
Asymptotes: $\phi = \dfrac{\pm(2k+1)180}{n-m} = \pm 45; \quad \pm 135; \quad \sigma = -1$

Break-away: $K(s) = -(s+1)^4 \rightarrow \dfrac{dK}{ds} = -4(s+1)^3 = 0 \rightarrow s = -1$

Imaginary axis: $s^4 + 4s^3 + 6s^2 + 4s + (K+1) = 0 \rightarrow K = 4; \quad s = \pm j1$

Dominant Poles: $s = -0.5 \pm j0.5; \quad K = -(0.5 + j0.5)^4 = 0.25$

Verification with MATLAB



Non-minimum Phase Root Locus

Generate and **sketch** the asymptotic root locus **plo**t for the following **system** and compare it with the case when there is **no time delay**. (Use 1st order Pade' approximation).

$$G(s) = \frac{4e^{-2s}}{(s+1)^3}$$

$G(s) = \dfrac{4(1-s)}{(s+1)^4}$; Poles: $-1, -1, -1, -1$; Zero: 1; $n - m = 3$

Real axis: RL between $+1$ & ∞; Asymptotes: $\phi = \pm 120, +360$

$\sigma = -2/3$; BA: $s = -1; +5/3$; Imag axis: $K = 0.475$; $\omega = 0.73$

$G(s) = \dfrac{4}{(s+1)^3}$; Poles: $-1, -1, -1$; $n - m = 3$

Real axis: No RL; Asymptotes: $\phi = \pm 60, 180$; $\sigma = -1$

BA: $s = -1$; Imag axis: $K = 2$; $s = -\sqrt{3}$

Verification with MATLAB