

Princess Sumaya University for Technology	 جامعة سميرة سميعة Princess Sumaya University for Technology التكنولوجيا	جامعة الأميرة سمية للتكنولوجيا
Automatic Control	Student Name:	
Quiz 4 Summer 2025 2026	Student ID No.: 20281159	
Date: Summer 20/07/2026	Grade:	

Be neat and clear, and show all the details.

For the system shown in Fig. 1, let

$$G_F(s) = \frac{K}{(s-1)(s+3)(s+4)} = \frac{K}{s^3 + 6s^2 + 5s - 12} : (10 \text{ points})$$

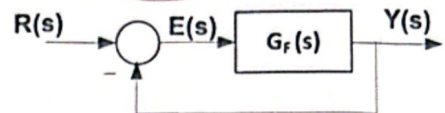


Fig. 1

Given the roots of dk/ds as $s = -3.5275$, $s = -0.4725$:

- Investigate the stability of the system using the Routh-Hurwitz stability criterion to find the range of k for stability (4 points)
- Sketch the Root Locus for the system (show details) (4 points)
- Find the range of K for an overdamped type of response (2 points)

i) $\Delta(s) = 1 + G(s) = s^3 + 6s^2 + 5s + (k-12)$ using Routh for stability

s^3	1	5
s^2	6	$k-12$
s	x	
s^0	$k-12$	

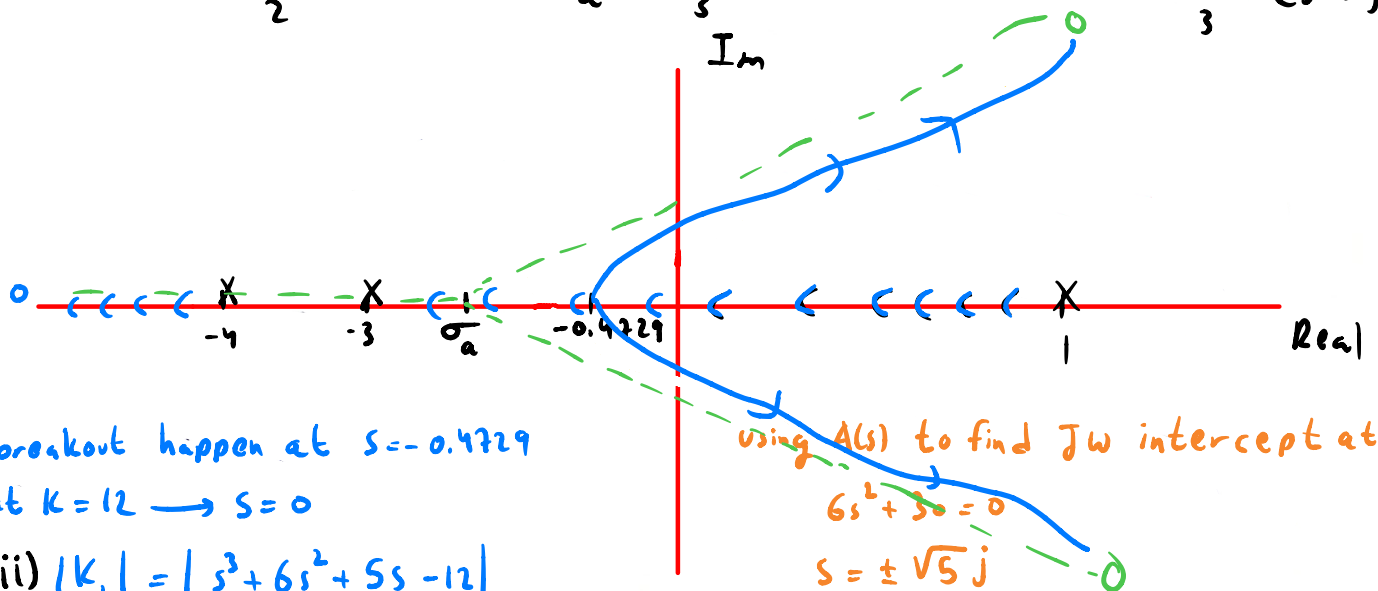
① $k > 12$

② $x > 0$, $x = \frac{30 - (k-12)}{6}$

$30 - k + 12 > 0 \Rightarrow k < 42$

$12 < k < 42$

ii) $\sigma_a = \frac{1-3-4}{2} = -3$, $\theta_a = \frac{\pi}{3} (60^\circ)$, $\pi (180^\circ)$, $\frac{5\pi}{3} (300^\circ)$



breakout happen at $s = -0.4729$

at $k = 12 \rightarrow s = 0$

iii) $|K_1| = |s^3 + 6s^2 + 5s - 12|$

$s = -0.4725$

$K_1 = 13.12$ so for OD response

$12 < k < 13.12$