GATE 2022[EE]-19

EE23BTECH11066 - Yakkala Amarnath Karthik

Question:

The open loop transfer function of a unity gain negative feedback system is given by $G(s) = \frac{k}{s^2+4s-5}$. The range of k for which the system is stable,is (GATE EE 2022)

Solution:

Variable	Description	value
$G(s)$	Open loop transfer function	$\frac{k}{s^2+4s-5}$
1+G(s)	Characteristic equation	0

TABLE I
A Table with input parameters

from TableI
Characteristic equation:

$$1 + G(s) = 0 \tag{1}$$

$$\implies 1 + \frac{k}{s^2+4s-5} = 0 \tag{2}$$

$$\implies s^2 + 4s + (k-5) = 0 \tag{3}$$

By routh table analysis, for a stable system:

s^2	1	$(k-5)$
s^1	4	0
s^0	$\frac{4}{1}$	0
s^{-1}	$k-5$	
s^{-2}	$\frac{4}{1}$	
s^{-3}	$\frac{16-(k-5)}{4}$	

$$k - 5 > 0 \tag{4}$$

$$\implies k > 5 \tag{5}$$

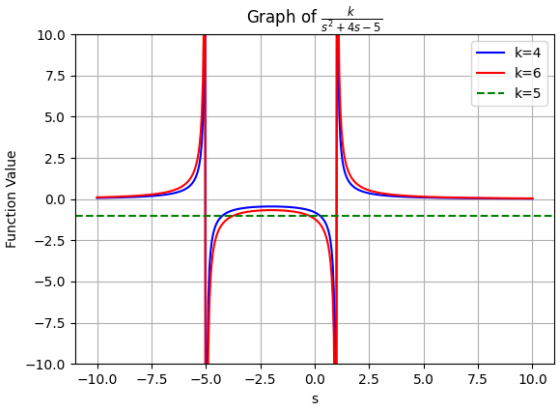

Fig. 1. Graph showing $k < 5, k = 5, k > 5$