Gate 2015 ECE

Q. 48

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Question

A plant transfer function is given as G(s) = $(K_P + \frac{K_I}{s})(\frac{1}{s(s+2)})$. When the plant operates in a unity feedback configuration, the condition for the stability of the closed loop system is

1. $K_P > \frac{K_I}{2} > 0$
2. $2K_I > K_P > 0$
3. $2K_I < K_P$
4. $2K_I > K_P$

Solution

The closed loop transfer function for unity feedback is

$$\frac{G(s)}{1+G(s)} = \frac{(K_p s+K_i)}{s^2(s+2)+(K_s s+K_i)}$$

$$= \frac{(K_p s+K_i)}{s^3+2s^2+K_p s+K_i}$$

Using Routh's tabular form:

S^3	1	K_P	
S^2	2	K_I	
S^1	$\frac{2K_p - K_i}{2}$	0	
S^0	K_p		

For system to be Stable: $K_P > 0$

and $\frac{2K_P - K_I}{2} > 0$

or

$2K_P - K_I > 0$

or

$K_P > \frac{K_I}{2} > 0$

So, 1st option is correct.