# Control Systems

## Gate Question Presentation

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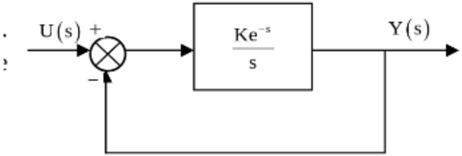
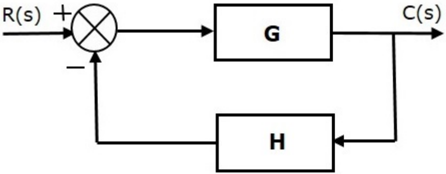
## Question




Q. Consider the unity feedback control system shown. The value of K the results in the phase margin of system to be 30°is

Ans: 1.047




Phase margin is the difference between phase of G(s)H(s) and -180°evaluated at gain crossover frequency ($\omega_{gc}$).
Where $\omega_{gc}$ is defined as the frequency at which magnitude of G(s)H(s) is unity.

PM = $\phi$ - (-180°) = $\phi$ + 180°

## Calculation

In our case H(s) = 1, G(s) = $Ke^{-s}/s$ .

Put s = j$\omega$ for frequency domain analysis, and equate $|$G(j$\omega_{gc}$)$|$to 1. We have,

$|\frac{Ke^{-j\omega_{gc}}}{j\omega_{gc}}| = 1 \implies \omega_{gc}$ = K (assuming positive K)

then, $\angle G(j\omega_{gc})$ H(j$\omega_{gc}$) $= \angle\frac{Ke^{-j\omega_{gc}}}{j\omega_{gc}} = \angle\frac{Ke^{-jK}}{jK}$

$\implies -90^\circ - K * 180/\pi \qquad [= \phi]$

## Calculation

PM = $30^\circ = \phi + 180^\circ$

On solving, we get K = $\frac{\pi}{3} = 1.047$

## Verification