Presentation

EE2227- Control Systems

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Outline

GATE EC 2015 Question

Q.The polar plot for the transfer function $G(s) = \frac{10(s+1)}{10+s}$ for $0 \leq \omega < \infty$ will be in the

(A) first quadrant

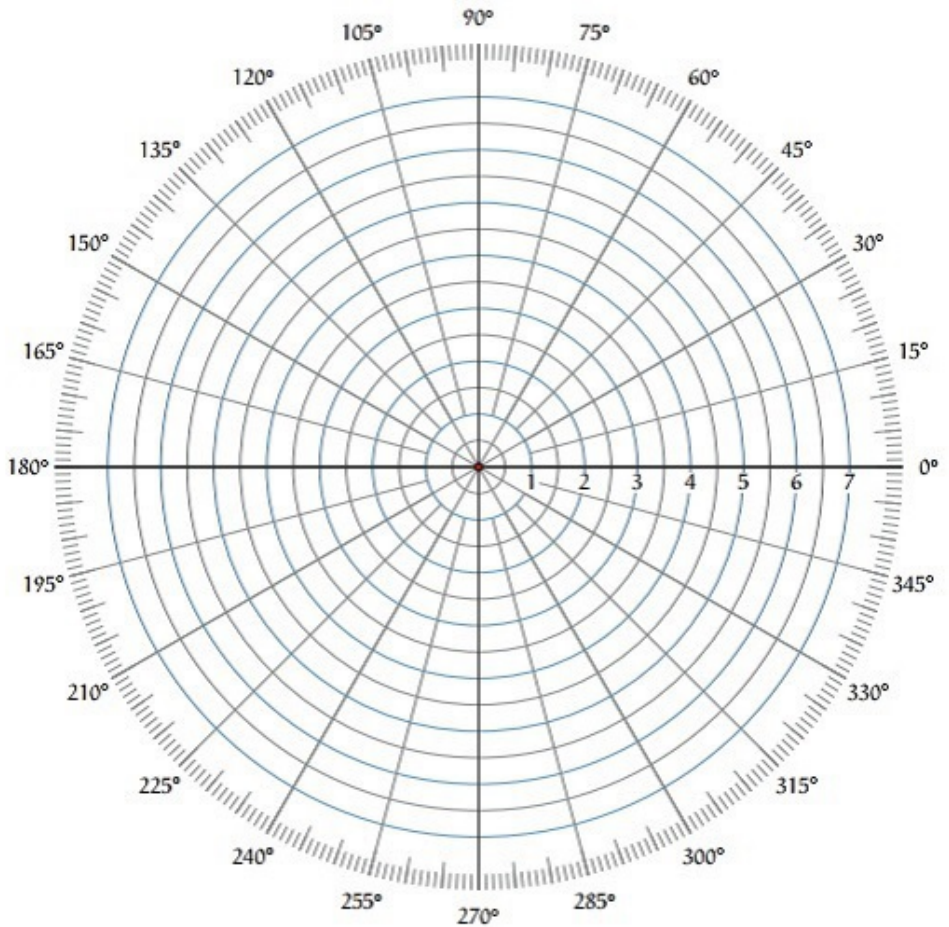
(B) second quadrant

(C) third quadrant

(D) fourth quadrant

Polar Plot

The Polar plot is a plot, which can be drawn between the magnitude and the phase angle of $G(j\omega)H(j\omega)$ by varying ω from 0 to ∞. The polar graph sheet is shown in the following figure.



Solution

Substituting s $= j\omega$ in the given transfer function gives

$G(j\omega) = \frac{10(1+j\omega)}{(10+j\omega)}$

Here, taking $1 + j\omega = \sqrt{1+\omega^2}e^{j\tan^{-1}(\omega)}$,

and $10 + j\omega = \sqrt{10^2+\omega^2}e^{j\tan^{-1}(\frac{\omega}{10})}$,

$G(j\omega) = 10\sqrt{\frac{1+\omega^2}{100+\omega^2}}e^{j(\tan^{-1}(\omega)-\tan^{-1}(\frac{\omega}{10}))}$

Solution

As $0 \leq \omega < \infty$,

$10\sqrt{\frac{1+\omega^2}{100+\omega^2}} > 0$ and $0 \leq \tan^{-1}(\omega), \tan^{-1}(\frac{\omega}{10}) < \frac{\pi}{2}$

and as $\tan^{-1}$ is a monotonically increasing function,

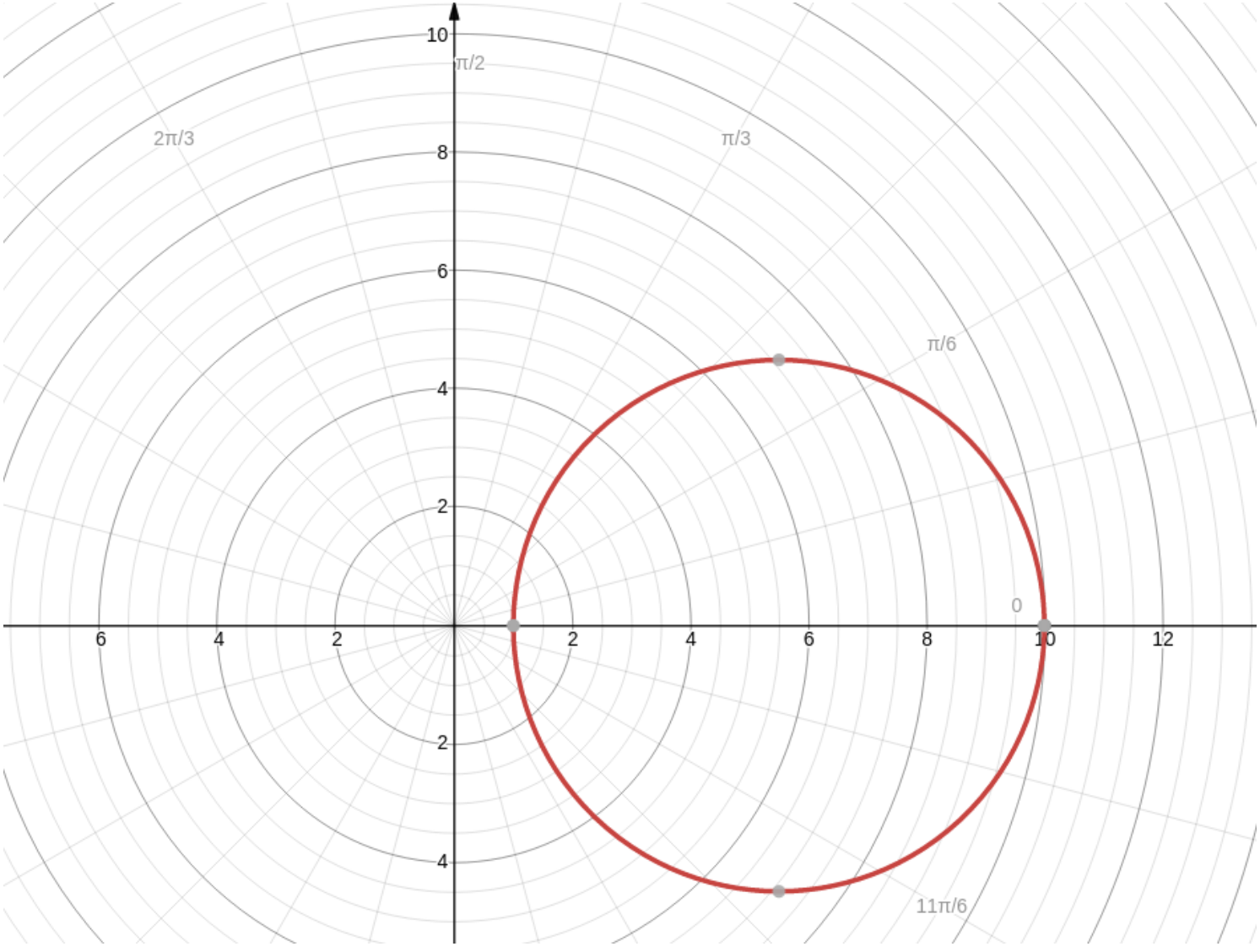
$\tan^{-1}(\omega) \geq \tan^{-1}(\frac{\omega}{10})$, with equality as $\omega \to \infty$

So, $|G(j\omega)| > 0$ and $0 \leq \angle G(j\omega) < \frac{\pi}{2}$

Therefore, the polar plot of G(s) lies in the first quadrant.

The plot of G(s) is:

Plot of G(s)



Final Slide

THANK YOU