

EE2227 CONTROL SYSTEMS PRESENTATION

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The number of directions and encirclements around the point $-1+j0$ in the complex plane by the Nyquist plot of

$$G(s) = \frac{1-s}{4+2s}$$

- Zero
- One, Anti-Clock wise
- One, Clock wise
- Two, Clock wise

Solution

First, we need to draw the polar plot of given $G(S)$. In the polar plot, substitute $s = j\omega$

$$G(j\omega) = \frac{1 - j\omega}{4 + 2j\omega}$$

$$\lim_{\omega \rightarrow \infty} G(j\omega) = \frac{1 - j\omega}{4 + 2j\omega}$$

$$\lim_{\omega \rightarrow \infty} G(j\omega) = \frac{j\omega(\frac{1}{j\omega} - 1)}{j\omega(\frac{4}{j\omega} + 2)}$$

$$\lim_{\omega \rightarrow \infty} G(j\omega) = \frac{-1}{2} \angle 0$$

which is equal to $\frac{1}{2} \angle -180$

As the Magnitude is taken positive in Nyquist Plot.

Now substitute $\omega = 0$

$$\lim_{\omega \rightarrow 0} G(j\omega) = \frac{1 - j\omega}{4 + 2j\omega} = \frac{1}{4} \angle 0$$

$$\angle \text{Num}(G(j\omega)) = \tan^{-1} \frac{-\omega}{1} = -\tan^{-1} \frac{\omega}{1}$$

$$\angle \text{Den}(G(j\omega)) = \tan^{-1} \frac{\omega}{2} = \tan^{-1} \frac{\omega}{2}$$

$$\angle G(j\omega) = \angle \text{Num}(G(j\omega)) - \angle \text{Den}(G(j\omega))$$

so from this at $\omega = 0$ $\angle G(j\omega) = 0$

and so from this at $\omega = \infty$ $\angle G(j\omega) = -\pi$

$$| (G(j\omega)) | = \frac{\sqrt{1 + \omega^2}}{\sqrt{16 + 4\omega^2}}$$

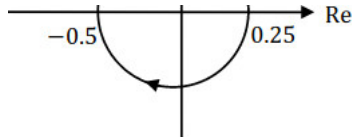
when $\omega = 0$ $| (G(j\omega)) | = \frac{1}{4}$

when $\omega = \infty$ $| (G(j\omega)) | = \frac{1}{2}$

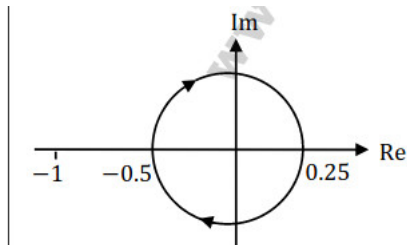
Hence, magnitude should be every time positive.

So, we have to plot first 0.25 then we have to turn -180 degrees to that point i.e 180 degrees clockwise (in this case)

- Now Plot the Polar Plot 1 from $\omega=0$ to ∞

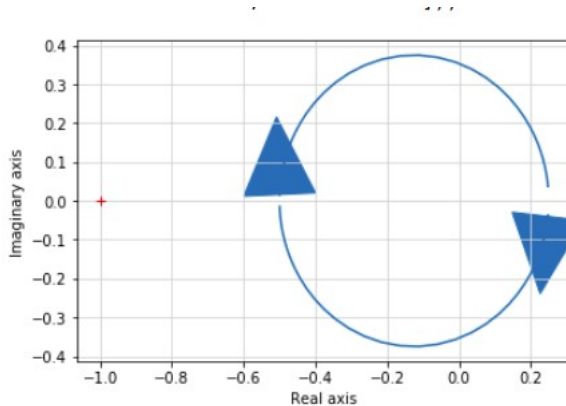


- Draw the Mirror image of the Polar Plot 1.



- Find the points where $G(j\omega)$ intersects the real and imaginary axes(if needed) and then locate the given co-ordinate

Nyquist plotting



Put $s = Re^{j\theta}$

$$\lim_{R \rightarrow \infty} G(Re^{j\theta}) = \frac{1 - Re^{j\theta}}{4 + 2Re^{j\theta}} = \frac{-1}{2}$$

As there are no $e^{j\theta}$ terms,

There there will be no enclosed Nyquist path here.

So, for this Transfer function $G(s)$, the Nyquist plot is same as the Polar plot.

As from the observed plot the co-ordinate $-1 + j0$ is outside the contour

Hence, the number of encirclements around the the given co-ordinate is zero.