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 = jω

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

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

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

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

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

As the Magnitude is taken positive in Nyquist Plot.
Now substitute $\omega = 0$

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

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

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

$\angle$G(jω) $= \angle Num(G(j\omega)) - \angle Den(G(j\omega))$

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

and so from this at $\omega =\infty$ $\angle$G(jω) $=$-π

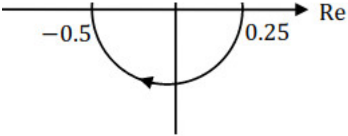
$$| (G(j\omega)) | = \frac{\sqrt{1+\omega^2}}{\sqrt{16+4\omega^2}}$$

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

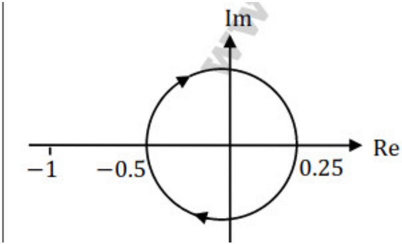
when $\omega = \infty$ $| (G(j\omega)) | = \frac{1}{2}$

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 ω=0 to ∞

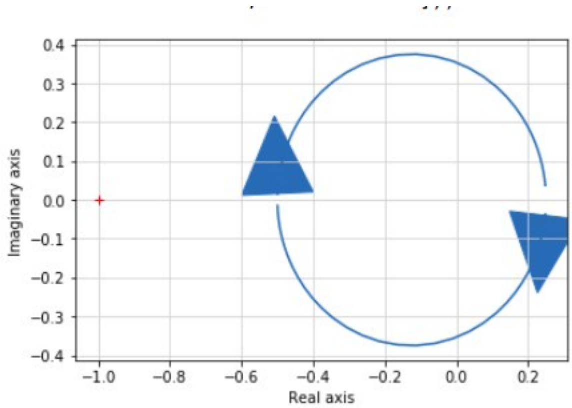


- Draw the Mirror image of the Polar Plot 1.



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

Nyquist plotting



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

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

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.