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Abstract—This manual is an introduction to control systems based on GATE problems. Links to sample Python codes are available in the text.

Download python codes using

```
svn co https://github.com/gadepall/school/trunk/
control/codes
```

1 STABILITY

1.1 Second order System

2 ROUTH HURWITZ CRITERION

3 COMPENSATORS

4 NYQUIST PLOT

4.1. Question—The open loop transfer function of a unity feedback system is given by

$$G(s) = \frac{\pi e^{-0.25s}}{s}$$

in $G(s)$ plane, the Nyquist plot of $G(s)$ passes through the negative real axis at the point (A) $(-0.5, j0)$ (B) $(-0.75, j0)$ (C) $(-1.25, j0)$ (D) $(-1.5, j0)$

Solution:

$$G(s) = \frac{\pi e^{-0.25s}}{s} \quad (4.1.1)$$

Nyquist plot cuts the negative real Axis at $\omega =$ phase cross over frequency, at phase cross over frequency the phase of nyquist plot becomes $-\pi$ radians.

substitute

$$s = j\omega. \quad (4.1.2)$$

$$G(j\omega) = \frac{\pi}{\omega}(-\sin 0.25\omega - j \cos 0.25\omega) \quad (4.1.3)$$

$$\angle G(j\omega) = -\pi/2 - 0.25\omega. \quad (4.1.4)$$

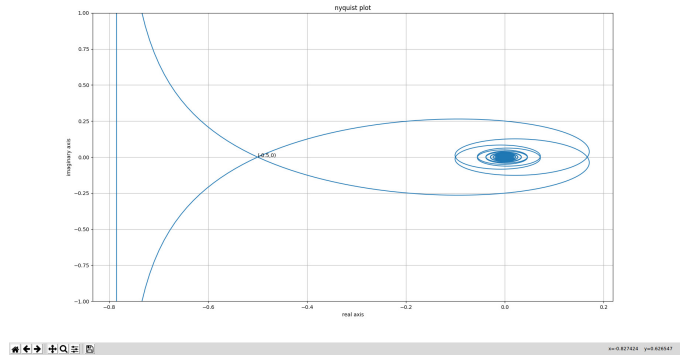


Fig. 4.1: Nyquist plot

$$\angle G(j\omega)|_{\omega=\omega_{pc}} = -\pi \quad (4.1.5)$$

by solving for ω we get $\omega_{pc} = 2\pi$.
magnitude at any point is

$$X = |G(j\omega)| = \frac{\pi}{\omega}. \quad (4.1.6)$$

substituting $\omega = 2\pi$ in magnitude equation we get $X=0.5$.

so it intersects at $(-0.5, j0)$ so answer is A.

we can verify with the following plot that it intersects at $(-0.5, j0)$

Nyquist Stability Criterion - for the stability of a closed loop transfer function $G(s)/(1+G(s)*H(s))$, the number of poles of $G(s)*H(s)$ on right half of s-plane must equal the number of encirclement of $G(s)*H(s)$ about the critical point $-1+j0$

we must find

$$Z = P - N \quad (4.1.7)$$

Z =number of poles of closed loop transfer function in right half of s-plane.

P =number of poles of open loop transfer function in right half of s-plane

N =number of encirclement of $G(s)*H(s)$ about the critical point $-1+j0$, here $H(s)=1$.

from plot we get $N=0, P=0$

$$Z = 0 - 0 = 0 \quad (4.1.8)$$

$Z=0$ implies the system is stable because we don't have any poles on right half of the s-plane