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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

- 1.1. 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**

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

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  $s=j\omega$ .

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

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

$$\angle G(j\omega) \big|_{\omega=\omega_{pc}} = -\pi \text{ radians}$$

by solving for  $\omega$  we get  $\omega_{pc} = 2\pi$ .

magnitude at any point is  $X = |G(j\omega)| = \frac{\pi}{\omega}$ .

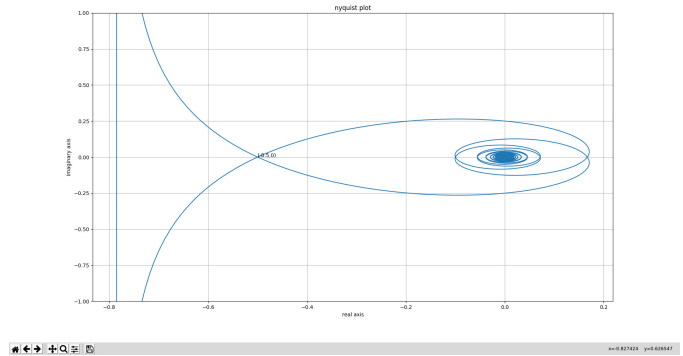


Fig. 1.1: Nyquist plot

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

hence it intersects at  $(-0.5, 0j)$  so answer is A.

**plot verification**

we can verify with the following plot that it intersects at  $(-0.5, 0j)$

## 2 ROUTH HURWITZ CRITERION

### 3 COMPENSATORS

### 4 NYQUIST PLOT