Contents

***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:

$$G(s) = \frac{\pi e^{-0.25s}}{s} \tag{1.1.1}$$

Nyquist plot cuts the negative real Axis at ω = phase cross over frequency,at phase cross over frequency the phase of nyquist plot becomes -π radians.

substitute

$$s = j\omega. \tag{1.1.2}$$

$$G(j\omega) = \frac{\pi}{\omega}(-\sin 0.25\omega - j\cos 0.25\omega) \tag{1.1.3}$$

$$\angle G(j\omega) = -\pi/2 - 0.25\omega. \tag{1.1.4}$$

$$\angle G(j\omega)|_{\omega=\omega_{pc}} = -\pi \tag{1.1.5}$$

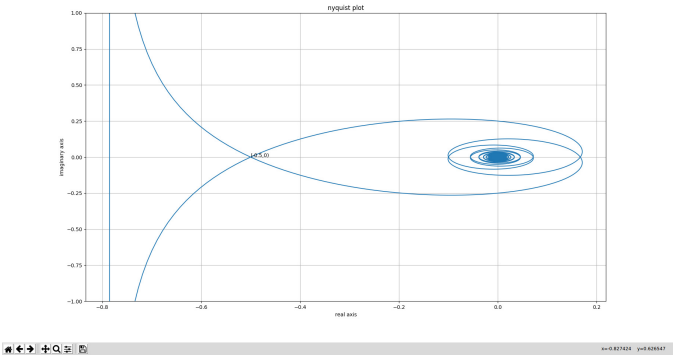

Fig. 1.1: Nyquist plot

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

$$X = |G(j\omega)| = \frac{\pi}{\omega}. \tag{1.1.6}$$

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

so it intersects at (-0.5,0j) so answer is A.
we can verify with the following plot that it intersects at (-0.5,0j)

2 Routh Hurwitz Criterion

3 Compensators

4 Nyquist Plot