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

2 Routh Hurwitz Criterion

3 Compensators

4 Nyquist Plot

4.1. Find the cross-over frequency of the given transfer function :

$$G(s) = \frac{100}{(s+1)^3} \tag{4.1.1}$$

Solution: The phase crossover is a frequency at which phase angle first reaches -180 degree or at which frequency the imaginary part of denominator of transfer function is equal to zero.The corresponding frequency is the phase crossover frequency.

$$G(j\omega) = \frac{100}{(j\omega+1)^3} \tag{4.1.2}$$

$$= \frac{100}{(1-3\omega^2)+j(3\omega-\omega^3)} \tag{4.1.3}$$

Now equating the imaginary part to zero

$$(3\omega - \omega^3) = 0 \tag{4.1.4}$$

$$\implies \omega = \sqrt{3} \tag{4.1.5}$$

As phase should be greater than zero for stability.

4.2. The Nyquist plot.

Solution: Use the following python code to generate the Nyquist plot in Fig. 4.2

```
codes/es17btech11019_1.py
```

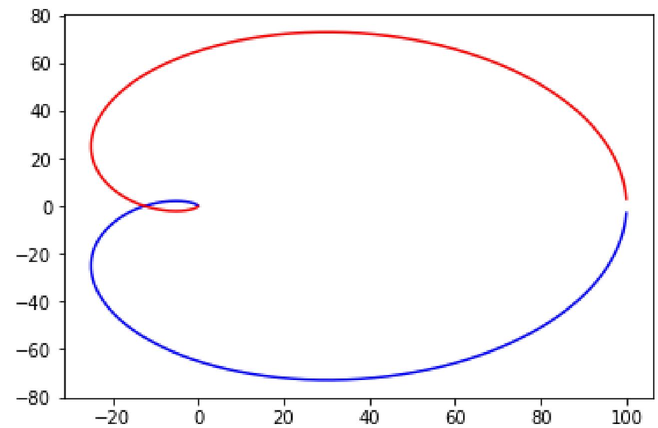

Fig. 4.2

4.3. For Stability:

For system to be stable, The value of

$$\log \quad \mathrm{mod}\; G(\omega) \tag{4.3.1}$$

at phase crossover frequency , should be less than 0 for system to be stable.

$$\log \quad \mathrm{mod}\; G(\omega = 1.73) = 1.09 \tag{4.3.2}$$

Which is greater than zero. Hence , The system is unstable