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

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

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.

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

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

Now equating the imaginary part to zero

$$(3\omega - \omega^3) = 0 \quad (4.1.4)$$

$$\Rightarrow \omega = \sqrt{3} \quad (4.1.5)$$

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
```

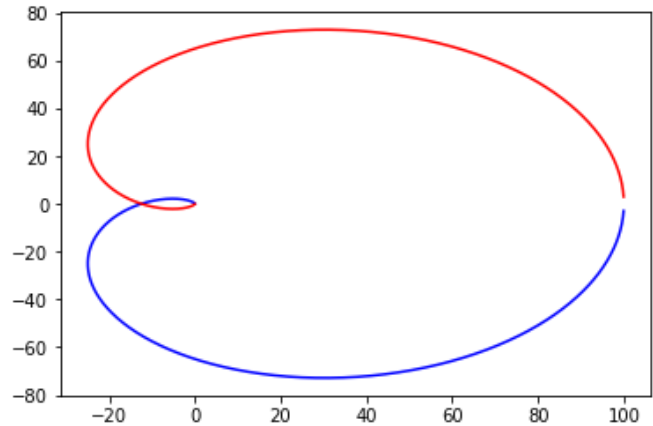


Fig. 4.2

Conclusion: Hence we saw the nyquist plot and as omega comes to be positive so system is stable.