### 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

## 2 Routh Hurwitz Criterion

## 3 Compensators

## 4 Nyquist Plot

### *4.1 Polar plot*

4.1. Sketch the Polar Plot for

$$G(s) = \frac{1}{(1+s)(1+2s)} \tag{4.1.1}$$

**Solution:** Then the given open loop Transfer Function is

$$G(s) = \frac{1}{(1+s)(1+2s)} \tag{4.1.2}$$

Now we have to substitute s=j$\omega$

$$G(j\omega) = \frac{1}{(1+j\omega)(1+2j\omega)} \tag{4.1.3}$$

4.2. Then find the Magnitude of the Transfer Function
**Solution:**

$$|G(j\omega)| = \frac{1}{\sqrt{(1+(\omega^2))(1+(2\omega)^2}} \tag{4.2.1}$$

4.3. Next find the Phase of Transfer Function
**Solution:**

$$\angle G(j\omega) = \angle G(j\omega)_{num} - \angle G(j\omega)_{den} \tag{4.3.1}$$

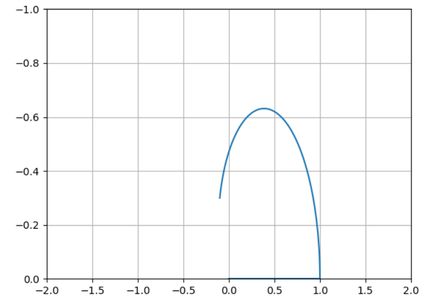


Fig. 4.4: Different systems based on $\zeta$

$$\angle G(j\omega) = -tan^{-1}(\omega) - tan^{-1}(2\omega) \tag{4.3.2}$$

4.4. Polar plot is drawn based on this magnitude and phase of transfer function
**Solution:**
For $\omega$=0

$$|G(j\omega)| = 1 \tag{4.4.1}$$
$$\angle G(j\omega) = 0 \tag{4.4.2}$$

For w= $\infty$

$$|G(j\omega)| = 0 \tag{4.4.3}$$
$$\angle G(j\omega) = -\pi \tag{4.4.4}$$

Next Polar Plot is drawn by varying $\omega$ from 0 to $\infty$.

4.5. Verify the Polar Plot by running the following Code

```
codes/ Ketan_A1(a).pyc
```