Control Systems

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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
```

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8.1. Plot the Bode magnitude and phase plots for the following system

$$G(s) = \frac{75(1+0.2s)}{s(s^2+16s+100)} \tag{8.1.1}$$

Also compute gain margin and phase margin .
Solution: From (8.1.1), we have

$$G(j\omega) = \frac{75(1+0.2j\omega)}{j\omega\left((j\omega)^2+16j\omega+100\right)} \tag{8.1.2}$$

poles = 0 , -8-6j , -8+6j
zeros = -5
Gain and phase plots are shown in 8.1:a and 8.1:b The following code plots Fig 8.1:a and 8.1:b

```
codes/ee18btech11049.py
```

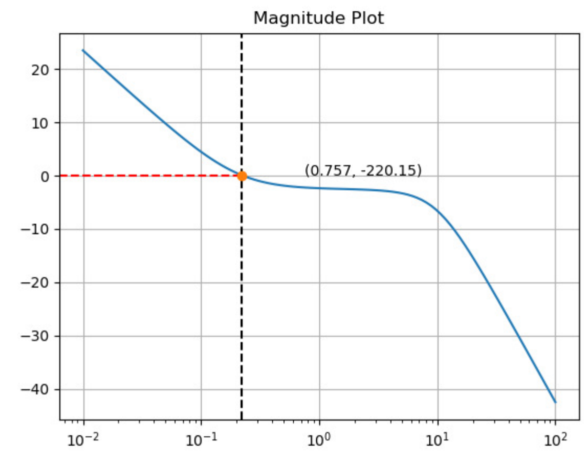

Fig. 8.1: a

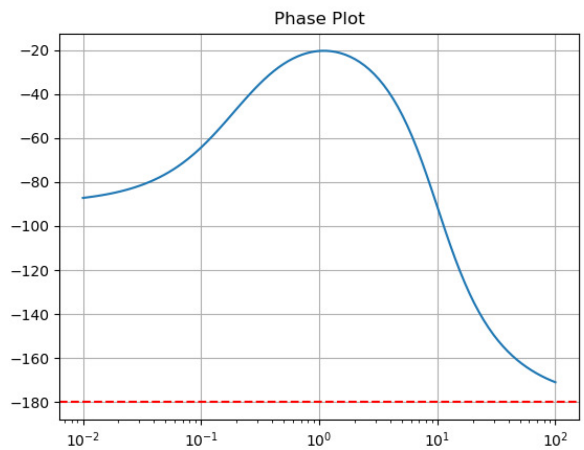

Fig. 8.1: b

8.2. Find $\angle G(\jmath\omega) + 180°$, where ω is frequency when gain = 1 . This is known as *phase margin* (PM)
Solution:

$$\frac{75\sqrt{\omega^2+25}}{\omega\sqrt{(\omega+6)^2+64}\sqrt{(\omega-6)^2+64}} = 1 \tag{8.2.1}$$

Solving (8.2.1) (*or*)
from Fig 8.1:a frequency at which gain = 1 ,is gain crossover frequency ω_{gc} .

$$\implies \omega_{gc} = 0.757 \tag{8.2.2}$$

$$\angle G\left(\jmath\omega_{gc}\right) = -88.3 \tag{8.2.3}$$

$$\implies PM = 91.7 \tag{8.2.4}$$

8.3. Find $-G(\jmath\omega)$ db , where ω is frequency when phase = $-180°$. This is known as *gain margin* (GM)
Solution: From Fig 8.1:b ,we can say that phase never crosses $-180°$. So , the gain margin is *infinite*. Which means we can add any gain , and the equivalent closed loop system never goes unstable.

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9.1 Intoduction

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