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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4.3 Stability

A closed loop system has the characteristic equation given by

$$s^3 + Ks^2 + (K+2)s + 3 = 0 \tag{4.3.0.1}$$

Determine the condition for K for which the system is stable.

Solution: Computing the Routh array for the given characteristic equation, we get-

$$\begin{vmatrix} s^3 \\ s^2 \\ s \\ s^0 \end{vmatrix}\begin{vmatrix} 1 & K+2 & 0 \\ K & 3 & 0 \\ \frac{K^2+2K-3}{K} & 0 & 0 \\ 3 & 0 & 0 \end{vmatrix} \tag{4.3.0.2}$$

According to the Routh-Hurwitz stability criterion, for the system to be stable there should be no sign changes in the first column of the Routh array. That means-

$$K > 0 \text{ and } \frac{K^2 + 2K - 3}{K} > 0 \tag{4.3.0.3}$$

$$\Rightarrow K > 0 \text{ and } (K-1)(K+3) > 0 \tag{4.3.0.4}$$

which gives us

$$K > 0 \text{ and } (K > 1 \text{ or } K < -3). \tag{4.3.0.5}$$

Note that K cannot be negative.

$$\Rightarrow K > 1 \tag{4.3.0.6}$$

The program to compute the routh-array and stabilty for different values of K.

```
codes/ee18btech11039/routh_array.py
```

The program for plotting the poles of the system for different values of K.

```
codes/ee18btech11039/pole_plot.py
```

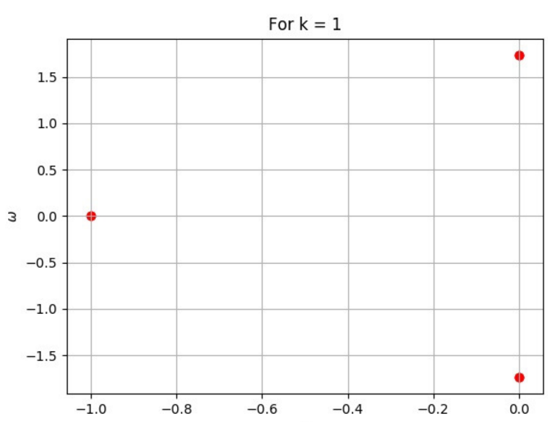
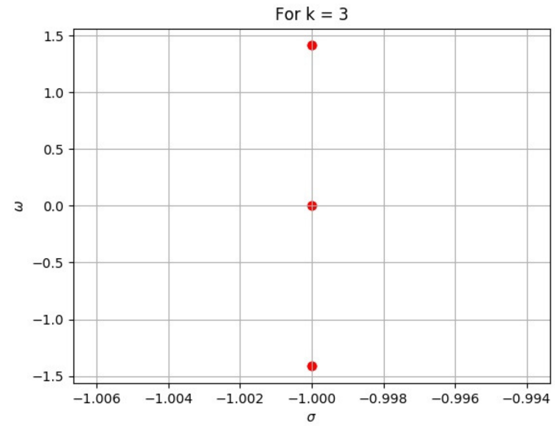
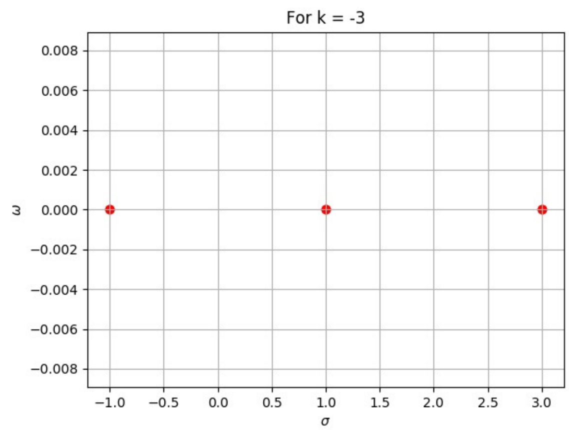


Fig. 4.3.0: Pole plots for different values of K





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