ELEC-C8201: Control Theory and Automation

Exercise 7

The problems marked with an asterisk (⋆) are not discussed during the exercise session. The solutions are given in MyCourses and these problems belong to the course material.

1. Consider the feedback control system shown in Figure 1.

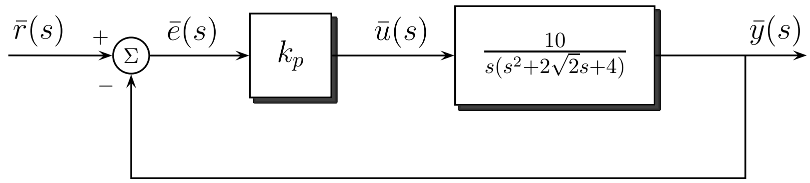

Figure 1: Feedback control system.

a) A part of the Nyquist diagram for the system is shown in Figure 2 (in the next page) for $k_p = 1$. Determine the gain and phase margins for the system. How would you expect the system to respond to changes in the desired signal $\bar{r}(s)$?

b) When $k_p = 0.5$, determine the range of frequencies for which

$$\left| \frac{1}{1 + k_p G(j\omega)} \right| \geq 1 \,,$$

where $G(s) = \frac{10}{s(s^2+2\sqrt{2}s+4)}$. Explain the implications of this for system behavior.

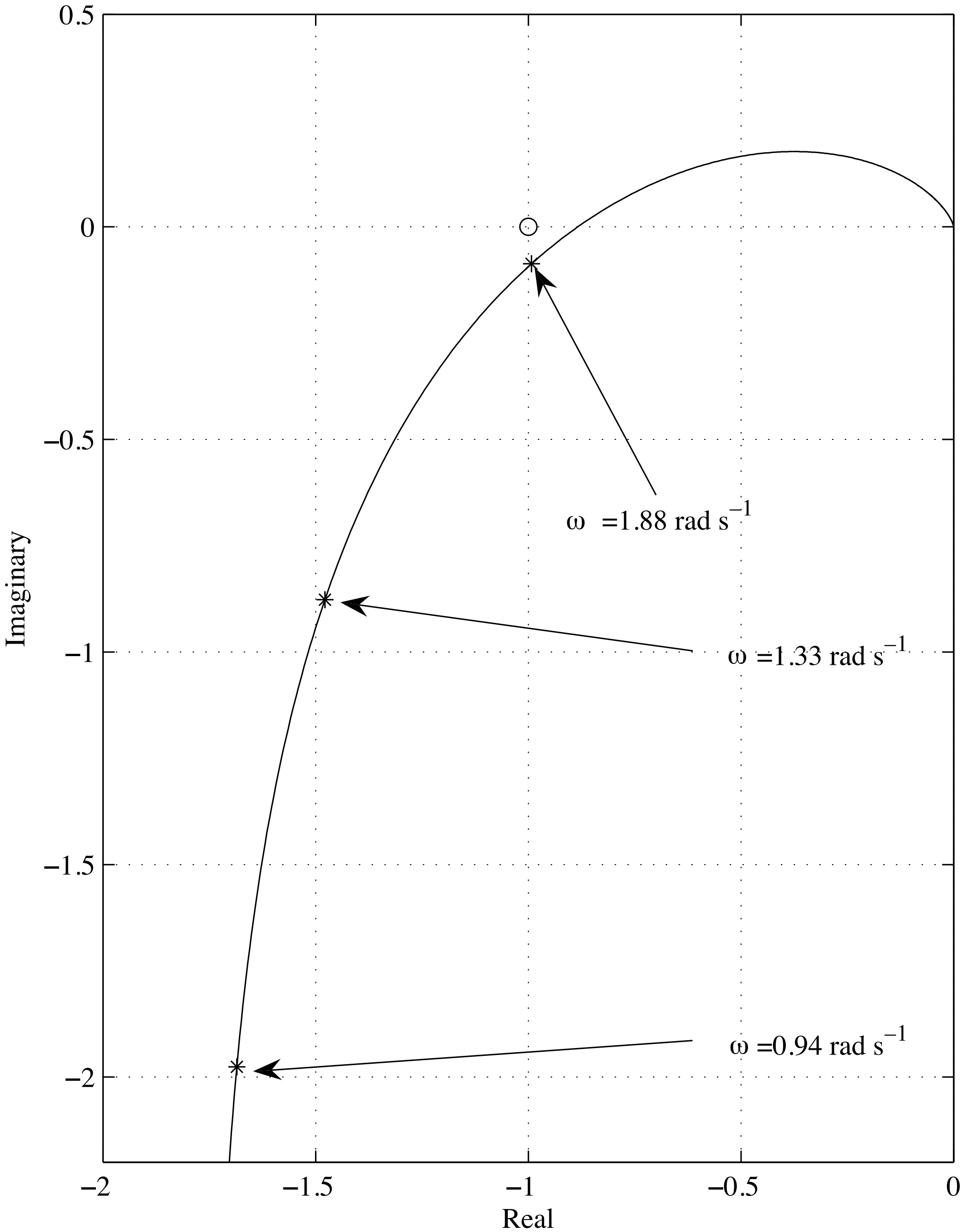

Figure 2: Incomplete Nyquist diagram.

2. Consider the feedback control system shown in Figure 3.

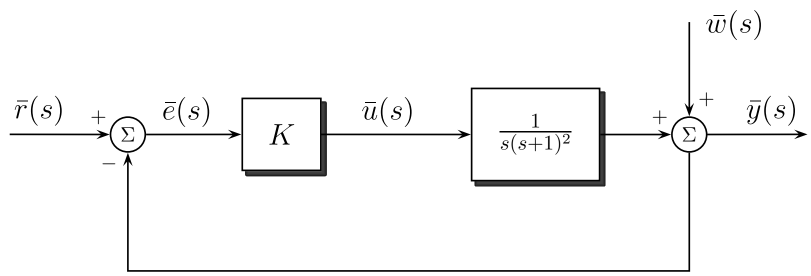

Figure 3: Feedback control system.

a) How would you determine experimentally the data necessary to plot its Nyquist diagram?

b) Determine the behavior of its Nyquist diagram as $\omega \to 0$ and $\omega \to \infty$.

c) Find the frequency where the imaginary part of $G(j\omega)$ becomes zero and hence complete the Nyquist diagram of $KG(s)$ on Figure 4 (in the next page) for $K = 1$.

d) Calculate the gain margin and estimate the phase margin of the feedback system. For what range of K is the feedback system stable?

e) For what range of frequencies (if any) will the system attenuate the effect of any disturbances $\bar{w}(s)$, if $K = 1$?

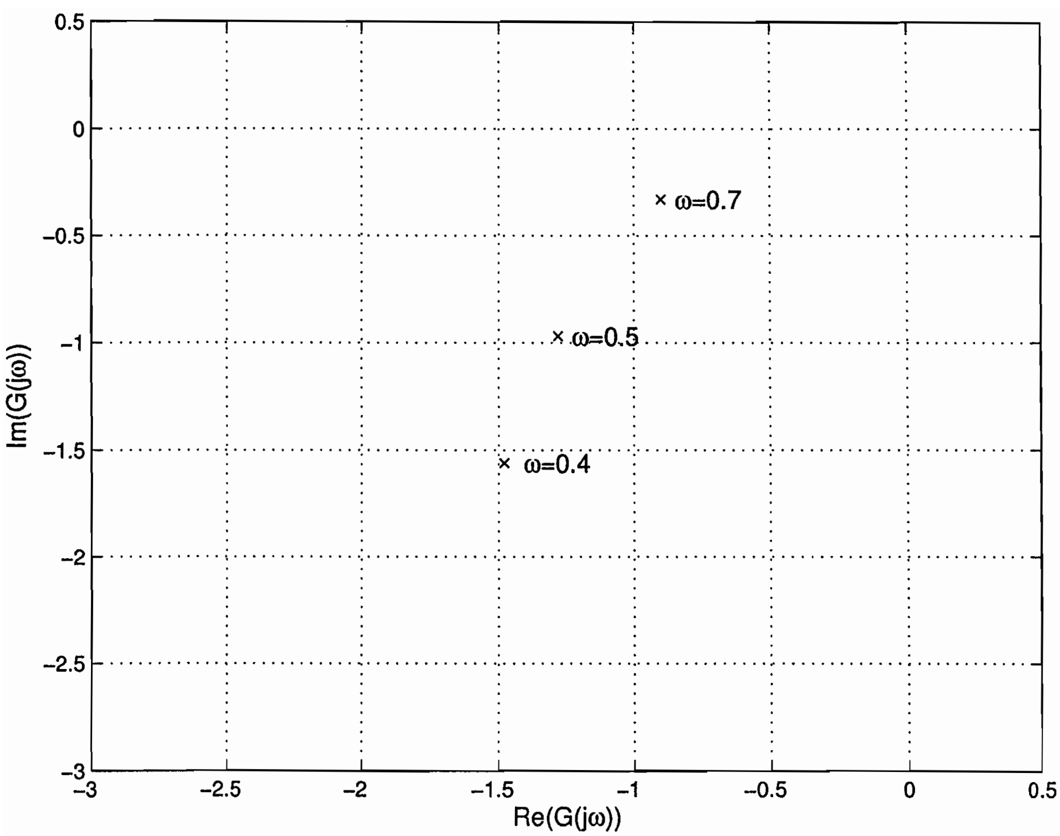

Figure 4: Incomplete Nyquist diagram.