TD Automatique continue n°3

H. Garnier
F. Collin

Stability of LTI systems

Exercise 3.1 - Stability from the system impulse response
Determine and plot the impulse response of the LTI systems described by the transfer functions below. Conclude about their stability:

$$G_1(s) = \frac{2}{s+2}; \qquad G_2(s) = \frac{2}{s^2+3s+2}; \qquad G_3(s) = \frac{1}{s^2+2s+2}$$
$$G_4(s) = \frac{2}{s^2+4}; \qquad G_5(s) = \frac{2}{s(s+2)}; \qquad G_6(s) = \frac{2}{s^2(s+2)}$$

Exercise 3.2 - Stability from the system poles
Plot the diagram of poles and zeros of the LTI systems described by the transfer functions below. Conclude about their stability:

$$G_1(s) = \frac{2}{s+2}; \qquad G_2(s) = \frac{2}{s^2+3s+2}; \qquad G_3(s) = \frac{1}{s^2+2s+2}$$
$$G_4(s) = \frac{2}{s^2+4}; \qquad G_5(s) = \frac{2}{s(s+2)}; \qquad G_6(s) = \frac{2}{s^2(s+2)}$$
$$G_7(s) = \frac{2(s^2-2s+2)}{(s+2)(s^2+2s+2)}; \qquad G_8(s) = \frac{200}{(s+2)(s^2-2s+2)}$$

Exercise 3.3 - Stability analysis by using the Routh-Hurwitz criterion
Study the stability of the LTI systems having the characteristic equations below. Specify, in case of instability, the number of unstable poles:

a) $s^3 - 25s^2 + 10s + 450 = 0$

b) $s^3 + 25s^2 + 450 = 0$

c) $s^3 + 25s^2 + 10s + 450 = 0$

d) $s^3 + 25s^2 + 10s + 50 = 0$

e) $s^3 + 25s^2 + 250s + 10 = 0$

f) $2s^4 + 10s^3 + 5.5s^2 + 5.5s + 10 = 0$

Exercise 3.4 - Stability range by using the Routh-Hurwitz criterion
Consider the proportional feedback control displayed in Figure 3.1:

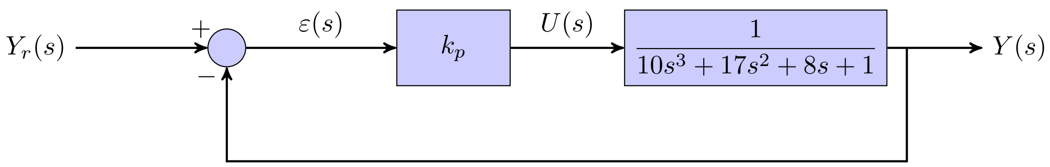

Figure 3.1: Closed-loop block-diagram

Determine the range of values for k_p which ensures the stability of the feedback control system.