HW 2
DUE MARCH 13TH

Problems from book: Chapter 2, Problems: 3, 5, 6, 8

Typed Problem 1: Adaptive PI Controller with Disturbance
The liner system

\[ \dot{x} = \frac{1}{J}(-Bx + \tau) \]

shall be controlled by a PI Controller. As the parameters of the system \( J \) and \( B \) are unknown and are expected to slowly vary with time, an adaptive PI Controller is to be developed. A further requirement of the controller is that a constant disturbance \( d \), entering the system in the same way as \( \tau \), does not lead to a constant tracking error in the case of a constant reference value. The plant input \( \tau = u + d \), where \( u \) is the controller output.

a) For better tracking accuracy, introduce a mixed feedforward-feedback control architecture like in the lecture and sketch it.

b) Find an appropriate reparametrization of the standard transfer function of a PI-controller

\[ \frac{U(s)}{E(s)} = G_c(s) = K\frac{s + \lambda}{s}, \]

such that designing an adaptive controller is simplified.

c) Develop the adaptive law via a Lyapunov approach.

d) Show that the tracking error \( e \) approaches zero asymptotically.

e) Discuss the cancellation of the disturbance.

Typed Problem 2:
(a) Consider the dynamical system

\[ \ddot{x} = \lambda u; \]

\( \lambda \) is unknown. Find an adaptive controller that computes \( u \) so that \( x \) follows \( x_m \), \( x_m \) given by

\[ \ddot{x}_m + 2\zeta \omega \dot{x}_m + \omega^2 x_m = \omega^2 r. \]

(b) Suppose a constant disturbance \( d \) is present in the plant,

\[ \ddot{x} = \lambda u + d \]

Find a \( u \) so that (i) \( x - x_m \) is bounded; (ii) \( x - x_m \) goes to zero