Department of Engineering Cybernetics

TTK4215 Adaptive Control

Assignment 9

Problem 1
Consider the second-order plant

$$y_p = \frac{b_1 s + b_0}{s^2 + a_1 s + a_0} u_p, \tag{1}$$

where a_0, a_1, b_0 and b_1 are constants with $b_0, b_1 > 0$. The reference model is given by

$$y_m = \frac{4}{s+5} r. \tag{2}$$

a) Assume that a_0, a_1, b_0 and b_1 are known. Design an MRC law that guarantees closed-loop stability and meets the control objective $y_p \to y_m$ as $t \to \infty$ for any bounded reference signal r.
b) Assume that a_0, a_1, b_0 and b_1 are unknown and that $b_0, b_1 > 0$. Design an MRAC law with the same objectives as above.
c) Assume now that a_0, a_1, and b_1 are known (only b0>0 is unkown), and that their values are $a_0 = -1$, $a_1 = 0$, and $b_1 = 1$. Simplify the control law from b) using this information.

Problem 2
Consider a mass-spring-dashpot system with dynamics

$$M\ddot{x} = u - kx - f\dot{x}, \tag{3}$$

where the constants M, f, and k are unkown, and the reference model

$$y_m = \frac{1}{s^2 + \sqrt{2}s + 1} r. \tag{4}$$

a) Design a direct MRAC law with unnormalized adaptive law so that all signals in the closed-loop system are bounded and the displacement of the mass, x, converges to y_m as $t \to \infty$ for any bounded reference signal r.
b) Simulate a) for $M = 10kg$, $f = 1Ns/m$, $k = 9N/m$ using $r = 10$ and $r = 2\sin(3t) + 5\sin(t)$.