Department of Engineering Cybernetics

TTK4215 Adaptive Control

Assignment 10

Problem 1

Consider the system

$$y = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2} u, \tag{1}$$

where the parameter ω_n (the natural frequency) is known, but the damping ratio ξ is unknown. The control objective is to choose u such that the closed-loop is stable and $y(t)$ tracks the reference signal $y_m(t) = c$, where c is a finite constant. The performance specifications for the closed-loop system are given in terms of the unit step response as follows: (i) the peak overshoot is less than 5% and (ii) the settling time is less than 2 seconds (recall example 4.9 in Reguleringsteknikk by Balchen, Andresen and Foss, and in particular equation (4.120). The settling time can be defined as $t_s \cong \frac{3.2}{\xi\omega_n}$).
a) Design an estimation scheme to estimate ξ when ω_n is known.
b) Design an APPC to meet the control objective.

Problem 7.5 from I&S

7.5 Consider the plant

$$y = \frac{s + b}{s(s + a)} u$$

(a) Design an adaptive law to generate $\hat{a}$ and $\hat{b}$, the estimate of a and b, respectively, on-line.

(b) Design an APPC scheme to stabilize the plant and regulate y to zero.

(c) Discuss the stabilizability condition $\hat{a}$ and $\hat{b}$ have to satisfy at each time t.

(d) What additional assumptions you need to impose on the parameters a and b so that the adaptive algorithm can be modified to guarantee the stabilizability condition? Use these assumptions to propose a modified APPC scheme.