ME 533 Nonlinear Dynamics Analysis
Spring 2014

Homework 3

All problems are from the textbook from the textbook "Applied Nonlinear Control" by Slotine and Li, Prentice Hall, 1991.

Problem 1

(Problem 7.7 from textbook)
Design a sliding controller for the system:

x_ddot + \alpha_1(t) |x| x_dot^2 + \alpha_2(t) x^3 cos2x = 5 u_dot + u,

where \alpha_1(t) and \alpha_2(t) are unknown time-varying functions verifying the known bounds
|\alpha_1(t)| <= 1
-1 <= |\alpha_2(t)| <= 5

[Hint: Let v = 5 u_dot + u and do the problem. Discuss the effect of chatter in v]

Problem 2

(Problem 7.10 from textbook)
Design a sliding controller for the system:

x_dddot + \alpha_1(t) x_ddot^2 + \alpha_2(t) x_dot^5 sin 4x = b(t) u,

where \alpha_i(t) are unknown time-varying functions verifying the known bounds:

|\alpha_1(t)| <= 1
|\alpha_2(t)| <= 2
1 <= |b(t)| <= 4

Assume that the state is measured and that the slowest unmodeled dynamics is the actuator dynamics with a time-constant of about 1/50. Simulate the system's performance on various trajectories (which you may want to generate using a reference model).

Problem 3

(Problem 8.3 from textbook)
Simulate the adaptive control system for the second-order plant

y = (p + b_p) / (p^2 + a_p1 p + a_p2)

with a_p1 = 0.1 and a_p2 = -4, and b_p = 2

Problem 4
(Problem 8.10 from textbook)
Discuss intuitively why parameter estimation can be easier on unstable systems than on stable systems