CALIFORNIA INSTITUTE OF TECHNOLOGY
Control and Dynamical Systems

CDS 140b
Problem Set #8

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1. Consider the system

$$\dot{x}_1 = -x_2 - \frac{3}{2}x_1^2 - x_1^3$$
$$\dot{x}_2 = u$$

We wish to stabilize the equilibrium at the origin. Note for (b) and (c) that you can use a linear feedback $\phi(x_1) = kx_1$ to stabilize the first system *without* cancelling the nonlinear terms; this will make your life easier. (What is the minimum value of k?)

(a) Design a globally stabilizing state feedback control law using feedback linearization.

(b) Design a globally stabilizing state feedback control law using backstepping.

(c) Design a globally stabilizing state feedback control law using sliding-mode control.

(d) Simulate your designs numerically, and compare both the performance and the control effort required. Start from a few "interesting" initial conditions (e.g., the four cases $x_{1,2} = \pm 1$). Note that you may need to avoid using $\mathrm{sgn}(x)$ in your sliding-mode control for numerical convergence.