HW # 4: Due Thursday, October 16, 2008 at 11:30 AM.

1. Consider the two dimensional control system

$$\dot{x} = \begin{pmatrix} -2 & 1 \\ 1 & -2 \end{pmatrix} x + \begin{pmatrix} 1 \\ 1 \end{pmatrix} u$$

1a. (10pts) Compute the controllability matrix of this system.

1b. (5pts) Is the system controllable?

1c. (10 pts) Can you drive the state $x_0 = \begin{pmatrix} 17 \\ 16.2 \end{pmatrix}$ to $x = 0$ in finite time T?

2. (30pts) Problem 6.1, p. 197 of the text

3. Consider the uncontrolled upward/downward pendula

$$\dot{x} = \begin{pmatrix} 0 & 1 \\ \pm 1 & 0 \end{pmatrix} x$$

3a. (10pts) For each matrix, compute the eigenvalues.

3b. (10pts) For each matrix compute the characteristic polynomial.

3c) (5pts) Show that the eigenvalues are the roots of the respective characteristic polynomials.

4. Consider the control system

$$\dot{x} = \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 2 & 3 & 4 \end{pmatrix} x + \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix} u$$

4a) (10pts) Using MATLAB check that the system is controllable.

4b) (10pts) Using MATLAB find a state feedback law K so that the closed-loop eigenvlaues are p =(-1,-1,-1.5,-2).