Homework #1
ME EN 5210/6210 & CH EN 5203/6203 & ECE 5652/6652
Linear Systems & State-Space Control

Use this page as the cover page on your assignment, submitted as a single pdf.

Problem 1

For each of the following input-output differential equations, first find the transfer function, and then find a valid set of state-space equations expressed in the standard form.

(a) $\dot{y} + ay = bu$

(b) $\ddot{y} + a\dot{y} = bu$

(c) $\ddot{y} + a\dot{y} + y = \dot{u} + bu$

Problem 2

For each of the following SISO systems in state-space form, find the transfer function. Make sure your answers are expressed as rational transfer functions, and are fully simplified. Note how the subtle differences in these equations relate to the resulting transfer functions. See page 65 in the textbook for a review of how to invert a 2 x 2 matrix.

(a) $\dot{\vec{x}} = \begin{bmatrix} -a & 0 \\ 0 & -b \end{bmatrix} \vec{x} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$
$y = [1 \quad 0]\vec{x} + [0]u$

(b) $\dot{\vec{x}} = \begin{bmatrix} -a & 1 \\ 0 & -b \end{bmatrix} \vec{x} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$
$y = [1 \quad 0]\vec{x} + [0]u$

(c) $\dot{\vec{x}} = \begin{bmatrix} -a & 0 \\ 0 & -b \end{bmatrix} \vec{x} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$
$y = [1 \quad 0]\vec{x} + [2]u$

Problem 3

For the following MIMO system in state-space form, find the transfer function matrix. Make sure your answers are expressed as rational transfer functions, and are fully simplified.

$$\dot{\vec{x}} = \begin{bmatrix} -a & c \\ 0 & -b \end{bmatrix} \vec{x} + \begin{bmatrix} 1 & 1 \\ 0 & 10 \end{bmatrix} \vec{u}$$
$$\vec{y} = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix} \vec{x} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \vec{u}$$

Problem 4

Do Problem 2.5 from the textbook.