December 7, 2020

AAE 564 Fall 2020

TEST TWO

Wednesday, December 9, 12-2 pm, online

Problem 1 Consider the system described by

$$\begin{aligned}\dot{x}_1 &= x_2 + x_3\\ \dot{x}_2 &= x_1 + u\\ \dot{x}_3 &= x_3\\ y_1 &= x_1 + x_2\\ y_2 &= x_3\end{aligned}$$

Is this system observable?

Problem 2 Consider the system described by

$$\begin{aligned}\dot{x}_1 &= u\\ \dot{x}_2 &= x_1 + x_3 + u\\ \dot{x}_3 &= x_1 + x_2\\ y &= 3x_1 + x_2 + x_3\end{aligned}$$

(a) Is this system observable?

(b) If the system is unobservable, determine its unobservable eigenvalues.

Problem 3 Consider the system described by

$$\begin{aligned}\dot{x}_1 &= x_2 + x_3 + 3u\\ \dot{x}_2 &= x_3 + u\\ \dot{x}_3 &= x_2 + u\end{aligned}$$

(a) Is this system controllable?
(b) If the system is uncontrollable, determine its uncontrollable eigenvalues.

Problem 4 Consider the discrete-time system described by

$$\begin{aligned} x_1(k+1) &= x_2(k) + x_3(k) \\ x_2(k+1) &= x_3(k) \\ x_3(k+1) &= x_2(k) + u(k) \end{aligned}$$

Obtain a state feedback controller which always results in the state of the closed loop system going to zero in at most three time-steps.

Problem 5 Consider an LTI system described by

$$\ddot{y} - 2y = \ddot{u} - u$$

Obtain an output feedback controller which results in an asymptotically stable closed loop system.

Problem 6 Without doing any integration, compute

$$\int_0^\infty z(t)^2 \, dt$$

for the system

$$\begin{aligned} \dot{x}_1 &= -x_1 \\ \dot{x}_2 &= -2x_2 \\ z &= x_1 + x_2 \end{aligned}$$

with initial condition $x(0) = [1 \ 1]'$.