Midterm #1 Eng. 0138: Advanced Control II

February 28th, 2001.
1:30 PM to 2:30 PM
Closed Book exam.
Programmable calculators are not allowed.

Q-1 (5/20)
Consider the following matrices

$$A_1 = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}, \quad A_2 = \begin{bmatrix} 2 & 1 & 0 & 0 & 0 \\ 0 & 2 & 1 & 0 & 0 \\ 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 3 & 0 \\ 0 & 0 & 0 & 0 & 4 \end{bmatrix}$$

Compute $e^{A_1 t}$ and $e^{A_2 t}$.

Q-2 (15/20)

Consider the system defined by:

$$\dot{x} = Ax + Bu$$
$$y = Cx$$

where

$$A = \begin{bmatrix} 0 & 1 \\ 2 & 3 \end{bmatrix}, \qquad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \qquad C = [1 \quad 0]$$

a) Check the state controllability and observability of the system.
b) Using the state feedback control $u = -Kx + lr$, determine K and l such that the closed loop system will have:
   i) Zero-steady-state error for a step input ($r(t) = 2$ *for* $t \geq 0$)
   ii) 5% overshoot and 2 seconds settling time.

c) Design an observer for the system having the poles at $s = -4 \pm j4$
d) Give the block diagram of the observer-based state feedback controller.

Percent overshoot: $\%\,OS = 100 \exp\left(\frac{-\xi\pi}{\sqrt{1-\xi^2}}\right)$

Settling time at 2%: $T_s \approx \frac{4}{\xi\omega_n}$