EE 650 Homework #1 due Wednesday, 9/10/08

QUESTIONS

1. Determine the unit impulse response of the unit delay system $y(t) = u(t-1)$, $t \in (-\infty, +\infty)$.
2. Textbook Problem 2.3.
3. Textbook Problem 2.5.
4. Textbook Problem 2.6.
5. For a satellite of mass m in earth orbit, kinematics equations in polar coordinates (r, θ, ϕ) can be shown to be

$$
\begin{aligned}
\ddot{r} &= r\dot{\theta}^2 \cos^2 \phi + r\phi^2 - k/r^2 + u_r/m \\
\ddot{\theta} &= -2\dot{r}\dot{\theta}/r + 2\dot{\theta}\dot{\phi} \sin\phi / \cos\phi + u_\theta/(mr\cos\phi) \\
\ddot{\phi} &= -\dot{\theta}^2 \cos\phi \sin\phi - 2\dot{r}\dot{\phi}/r + u_\phi/(mr)
\end{aligned}
$$

where u_r, u_θ and u_ϕ are the input thrusts on the satellite in the r, θ and ϕ directions, respectively, applied by using small rocket engine, and k is a constant.

ii) By choosing $(r, \dot{r}, \theta, \dot{\theta}, \phi, \dot{\phi})$ as state variables and (r, θ, ϕ) as the output variables, obtain a *non-linear* state-space realization for this system.

ii) A free (undriven) solution of these equations correspond to the satellite being in a circular orbit,

$$\bar{x}(t) = [r_0, 0, w_0 t, w_0, 0, 0]', \ \bar{u}_r = \bar{u}_\theta = \bar{u}_\phi = 0,$$

where the radius r_0 and the angular velocity w_0 are such that $r_0^3 w_0^2 = k$. Obtain linearized state-space equations of the satellite around these nominal state and control trajectories.

6. Textbook Problem 2.17.
7. Textbook Problem 2.20.