EE 212 Homework 2.

1. Show that the time-varying system described by the state-space equations on lecture01-13 (refer to lecture01, slide 13) is indeed linear.

2. Verify that if u and y satisfy the state equations given in lecture03-21 (when applied to a third-order system), then they also satisfy the ODE on lecture03-08.

3. Express $\theta^{(3)} + \theta = \tau$ as a state equation with input $u = \tau$, output $y = \theta$, and state $x = [\theta \ \dot{\theta} \ \ddot{\theta}]^T$. ($\theta^{(3)}$ denotes the third deriative w.r.t t). What is the transfer function of this system?

4. Consider the transfer function

$$G(s) = \frac{1}{(s+1)(s+2)(s+3)}.$$

   Find realizations of G in the following forms: controller, observer, controllability, observability, and diagonal.

5. Verify the solution to the state equations for the example system on lecture03-32.

6. The matrix A given by

$$A = \begin{bmatrix} -a_1 & -a_2 & \dots & -a_{n-1} & -a_n \\ 1 & 0 & \dots & 0 & 0 \\ 0 & 1 & \dots & 0 & 0 \\ & & \vdots & & \\ 0 & 0 & \dots & 1 & 0 \end{bmatrix}$$

   is called a top companion matrix (recall the dynamics matrix of the controller canonical form). Show that the characteristic polynomial of A, i.e. $det(sI - A)$, equals

$$s^n + a_1 s^{n-1} + \dots + a_{n-1}s + a_n.$$