

E6201 Linear Systems

Homework 7 (due: Mar. 22)

1. Find  $d^n/dt^n \exp(At)$ .
2. Let  $\{A_c, b_c\}$  denote a system in controller canonical form. Show  $\mathcal{C}_c^{-1} = \mathcal{A}_-^T$ , where

$$\mathcal{C}_c = [b_c \ A_c b_c \ \cdots \ A_c^{n-1} b_c], \quad \mathcal{A}_- = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ a_1 & 1 & & 0 \\ \vdots & & \ddots & \\ a_{n-1} & a_{n-2} & & 1 \end{bmatrix},$$

and  $\det(sI - A_c) = s^n + a_1 s^{n-1} + \cdots + a_n$  ( $\mathcal{C}_c = \mathcal{C}(A_c, b_c)$  is the controllability matrix of the realization  $\{A_c, b_c\}$  and  $\mathcal{A}_-$  is a lower triangular Teoplitz matrix with first column equal to  $[1 \ a_1 \ \cdots \ a_{n-1}]^T$ ).

3. Show controllability and observability are preserved under similarity transformations.
4. Question 2.3-12 in Kailath.
5. Question 2.3-14 in Kailath.