

Home Work #1
Due on April 8th, 5 p.m.

Reading assignments do not have to be turned in.

1. **Reading assignment:** Sections 1.1 to 1.4 of the text book.

- (a) Read the sections at least once. I do not know of a better writer of mathematics. The book reads like a novel.
- (b) Read every problem at the end of each section at least once. You must either believe that you know how to solve the problem, or, even better, actually try and solve the problems. Some of them are given to be turned in as part of problem 5.

2. A MIMO LTI system has three inputs

$$x[n] = \begin{pmatrix} x_1[n] \\ x_2[n] \\ x_3[n] \end{pmatrix},$$

and two outputs

$$y[n] = \begin{pmatrix} y_1[n] \\ y_2[n] \end{pmatrix},$$

that satisfy the equation

$$Ax[n] + Bx[n-1] = y[n],$$

where A and B are two matrices that do not depend on n .

- (a) What are the dimensions of A and B ?
- (b) Find the impulse response $h[n]$ of the system explicitly in terms of A and B .

3. A causal MIMO LTI system has three inputs

$$x[n] = \begin{pmatrix} x_1[n] \\ x_2[n] \\ x_3[n] \end{pmatrix},$$

and two outputs

$$y[n] = \begin{pmatrix} y_1[n] \\ y_2[n] \end{pmatrix},$$

that satisfy the equation

$$\begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \end{pmatrix} x[n] = y[n] + \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix} y[n-1].$$

- (a) Find an explicit expression for the impulse response of the system.
- (b) Find the output when the input of the system is

$$x[n] = \begin{pmatrix} \delta[n] \\ u[n] \\ 0 \end{pmatrix},$$

where $u[n] = 0$ if $n < 0$ and $u[n] = 1$ if $n \geq 0$.

- (c) Can you find two distinct sets of three input signals that give rise to the same two output signals?

4. A square matrix L is said to be *lower triangular* if $L_{i,j} = 0$ when $i < j$. Show that the product of two lower triangular matrices is another lower triangular matrix.

5. Do problems 1.3.6, 1.4.10, 1.4.20, 1.4.22, and 1.4.24 from the textbook.