

ECE 464/564: Digital Signal Processing - Winter 2018

Homework 2

Due: Jan 30, 2018 (Tuesday)

1. Consider a system described by a linear constant-coefficient difference equation with initial-rest conditions. The step response of the system is given by:

$$y[n] = \left(\frac{1}{3}\right)^n u[n] + \left(\frac{1}{4}\right)^n u[n] + u[n].$$

- a) Determine the difference equation
 - b) Determine the impulse response of the system
 - c) Determine whether the system is stable
2. Consider an LTI system with input $x[n]$ and output $y[n]$ for which

$$y[n-1] - \frac{5}{2}y[n] + y[n+1] = x[n]$$

The system may or may not be stable or causal. By considering the pole-zero pattern associated with this difference equation, determine three possible choices for the impulse response of the system. Show that each choice satisfies the difference equation. Indicate which choice corresponds to a stable system and which choice corresponds to a causal system.

3. The system function of an LTI system has the pole-zero plot shown below in **Fig. 1**. Specify whether each of the following statements is true/false/cannot be determined from the information given:
- a. The system is stable
 - b. The system is causal
 - c. If the system is causal, then it must be stable
 - d. If the system is stable, then it must have a two-sided impulse response

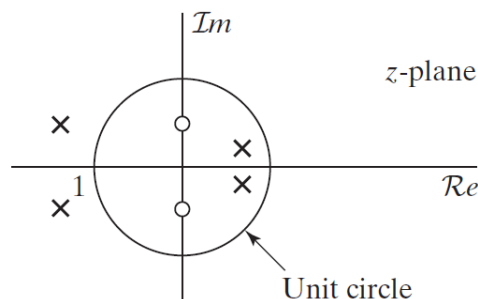


Fig. 1. Pole-Zero plot for prob. 3

4. The following figure (Fig. 2) shows the impulse response for several different LTI systems. Determine the group delay associated with each system

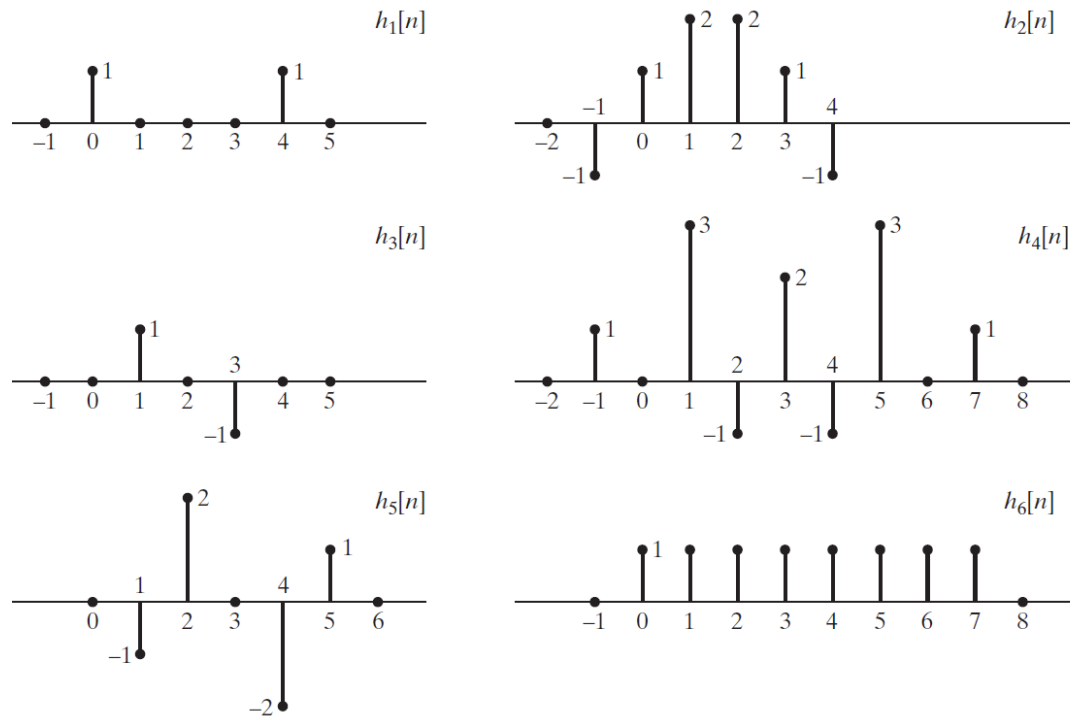


Fig. 2. Impulse response for different LTI systems (for Prob. 4)

5. A discrete-time LTI system with input $x[n]$ and output $y[n]$ has the frequency response magnitude and group delay functions shown in **Fig 3**. The signal $x[n]$, also shown in Figure 3, is the sum of three narrowband pulses. In particular, **Fig. 3** contains the following plots:
- $x[n]$
 - $|X(e^{j\omega})|$, the Fourier transform magnitude of a particular input $x[n]$
 - Frequency response magnitude plot for the system
 - Group delay plot for the system

In **Fig. 4** you are given four possible output signals, $y_i[n]$ $i=1, 2, \dots, 4$. Determine which one of the possible output signals is the output of the system when the input is $x[n]$. Provide a justification for your choice.

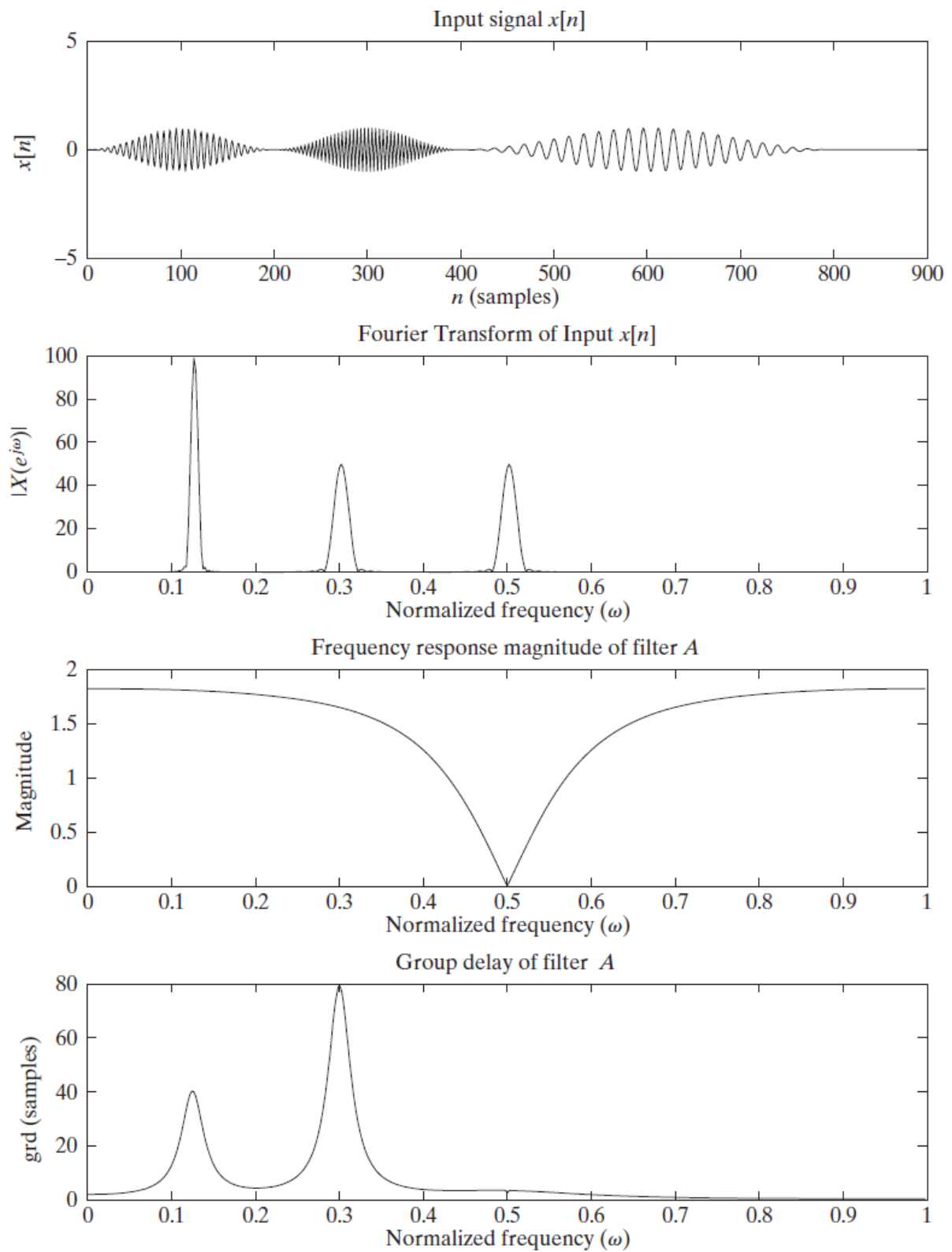


Fig. 3. The input signal and the filter frequency response

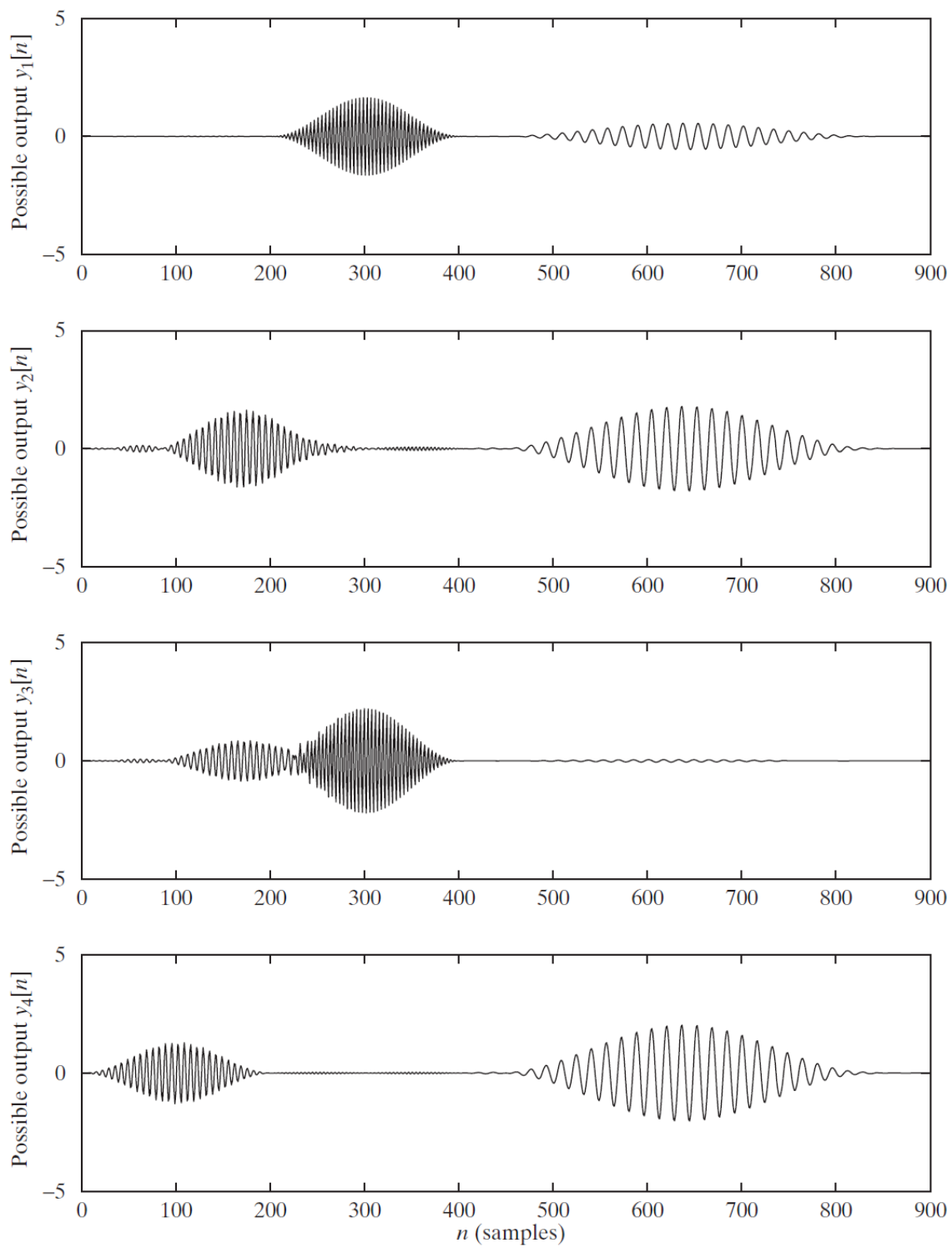


Fig. 4. Possible output signals