ENSC380
Lecture 8

Objectives:

- Learn the properties of the convolution sum
- Learn how to combine systems in series and parallel
- Learn the response of LTI systems to standard excitations: unit step, complex exponential, and sinusoidal

Convolution Properties

Convolution Sum:

$$x[n] * h[n] =$$

- **Important:** $x[n] * \delta[n - n_0] = x[n - n_0]$
- Proof:

Conv. Prop. (Cont.)

- Commutative:

$$x[n] * h[n] =$$

- Distributive:

$$x[n] * (h_1[n]) + h_2[n]) =$$

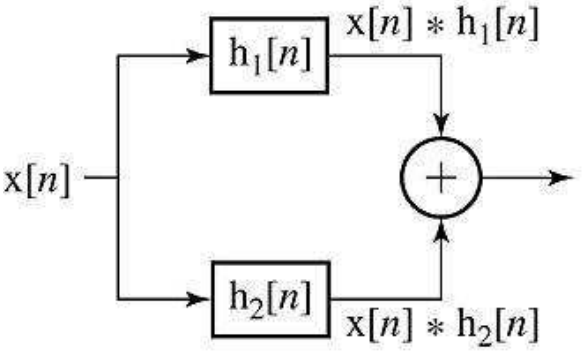
- Associative:

$$x[n] * (h_1[n] * h_2[n]) =$$

System Interconnections

- Cascade (Series) connection:

- Parallel connection:



Stability

- Recall the stability condition (BIBO)?

- How does this relate to the impulse response?

Unit Step Response

What is the System's response to $x[n] = u[n]$? (This is also called the **unit sequence response**)

Complex Exponential Response

What is the response of the system to $x[n] = z^n$, where z is a complex number?

Sinusoidal Response

What is the response of the system to $x[n] = \cos(2\pi Fn)$?

- $\cos(2\pi Fn)$ can be written in terms of complex exponentials:

- Find the response of the system to each exponential and combine:

- It can be shown that the result is:

$$y[n] = \cos(2\pi Fn) \sum_{m=-\infty}^{\infty} h[m] \cos(2\pi Fm) + \sin(2\pi Fn) \sum_{m=-\infty}^{\infty} h[m] \sin(2\pi Fm)$$

Example

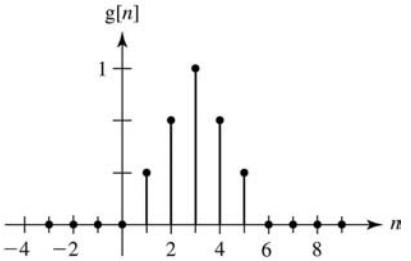
The unit sequence response to a system is given as:

$$y[n] = \left[5 - 4(\frac{4}{5})^n\right] u[n]$$

Find the impulse response of the system:

Example (Cont.)

Find the response of the system to $x[n]$ given below:



Answer using Matlab (See page 168, Text)