Lecture 11

## Graphical Convolution

Example for graphical approach to convolution

Remember: only when number in square brackets == 0

Remember: only when number in square brackets > 0

Outcome length =

MATLAB COMMAND TO MAKE STUPID GRAPHS: “STEM”

## Matrix-Vector Product in Convolution

Using Matrix-Vector product to represent convolution between two finite duration signals

- Length

- Length

- Length

Example

|  |
| --- |
| a0 |
| a1 |
| a2 |
| a3 |
| a4 |
| a5 |
| a6 |
| a7 |

|  |  |  |  |
| --- | --- | --- | --- |
| .5 | 0 | 0 | 0 |
| 1 | .5 | 0 | 0 |
| 2 | 1 | .5 | 0 |
| 3 | 2 | 1 | .5 |
| 4 | 3 | 2 | 1 |
| 0 | 4 | 3 | 2 |
| 0 | 0 | 4 | 3 |
| 0 | 0 | 0 | 4 |

## Linear Formulas

Formulas that relate/represent relationship between input & output signal values are called “difference equations” for discrete time systems

A system is linear if it only uses linear operations of

No terms with either:

Products of y[n] with x[n]

Products of y[n] with y[n]

Products of x[n] with x[n]

No contribution to y[n] that doesn’t depend on x[n] or y[n]

x[n] & y[n] cannot be inside arguments of nonlinear operators such as exp(), powers, sinusoids, logs, absolute value, etc.

## Time-Invariant Formulas

A system is time-invariant if all coefficients for x[n] and y[n] are constants and arguments in [ ] for x[n] & y[n] cannot have ‘n’ multiplied by anything except 1

No terms in difference equation use u[ ] or

## Linear and Time-Invariant Systems

An LTI system can always be described as:

Where are constraints for given “k”, “p” values

By convention:

& put all output terms on one side & all input terms on the other side

- “Standard form” of LTI difference equation