EEC-371 Digital Signal Processing

Lab1 Report (Block Filtering)

ECE LEVEL 3

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In this lab, you try to understand the theory behind the Overlap-Add and Overlap-Save algorithms which are methods used to preform linear convolution in an easy way.

Overlap Add VS Overlap Save:

Overlap-add:

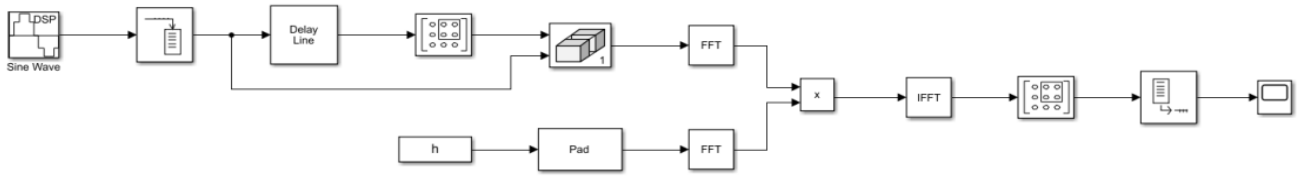
The overlap-add algorithm filters the input signal in the frequency domain. The input is divided into non-overlapping blocks which are linearly convolved with the FIR filter coefficients. The linear convolution of each block is computed by multiplying the discrete Fourier transforms (DFTs) of the block and the filter coefficients, and computing the inverse DFT of the product. For filter length M and FFT size N, the last M-1 samples of the linear convolution are added to the first M-1 samples of the next input sequence. The first N-M+1 samples of each summation result are output in sequence.

Overlap-save:

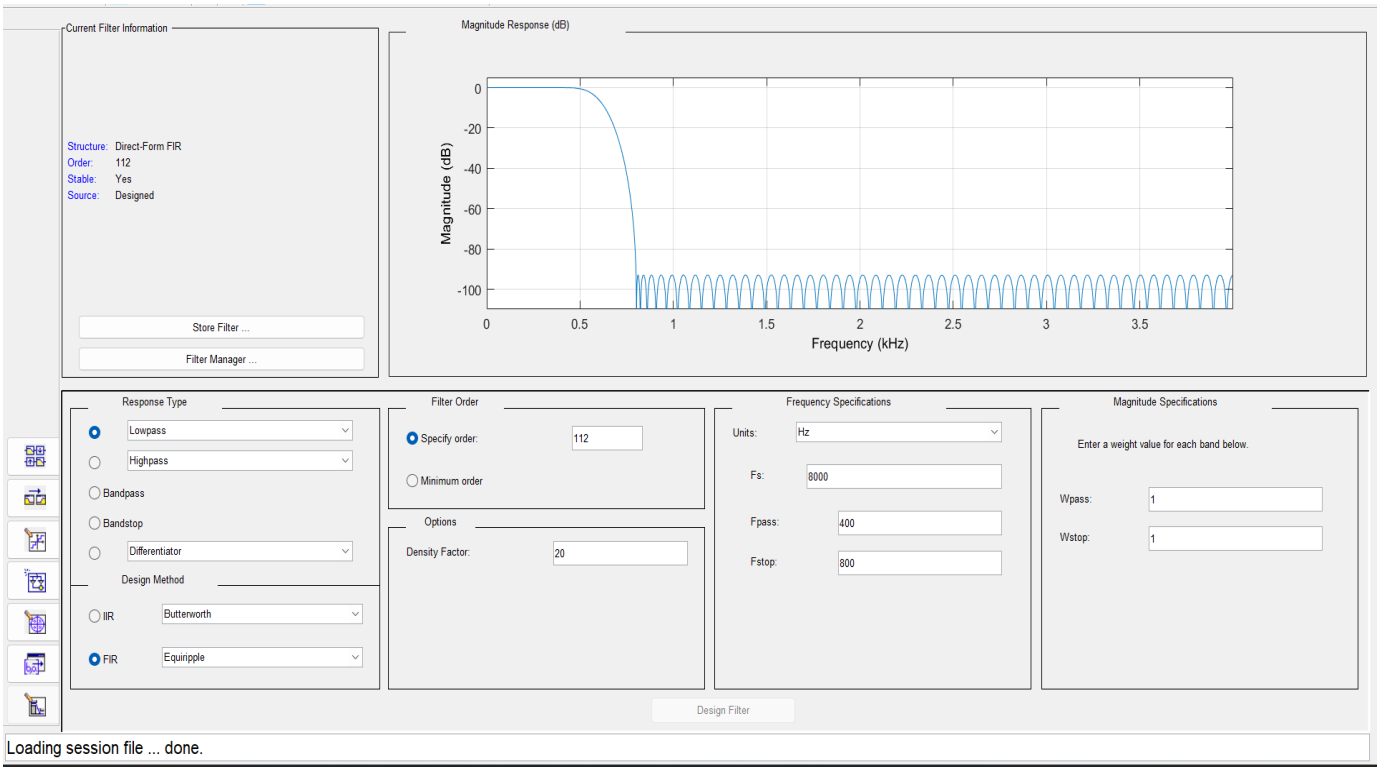
The overlap-save algorithm also filters the input signal in the frequency domain. The input is divided into overlapping blocks which are circularly convolved with the FIR filter coefficients. The circular convolution of each block is computed by multiplying the DFTs of the block and the filter coefficients, and computing the inverse DFT of the product. For filter length M and FFT size N, the first M-1 points of the circular convolution are invalid and discarded. The output consists of the remaining N-M+1 points, which are equivalent to the true convolution.

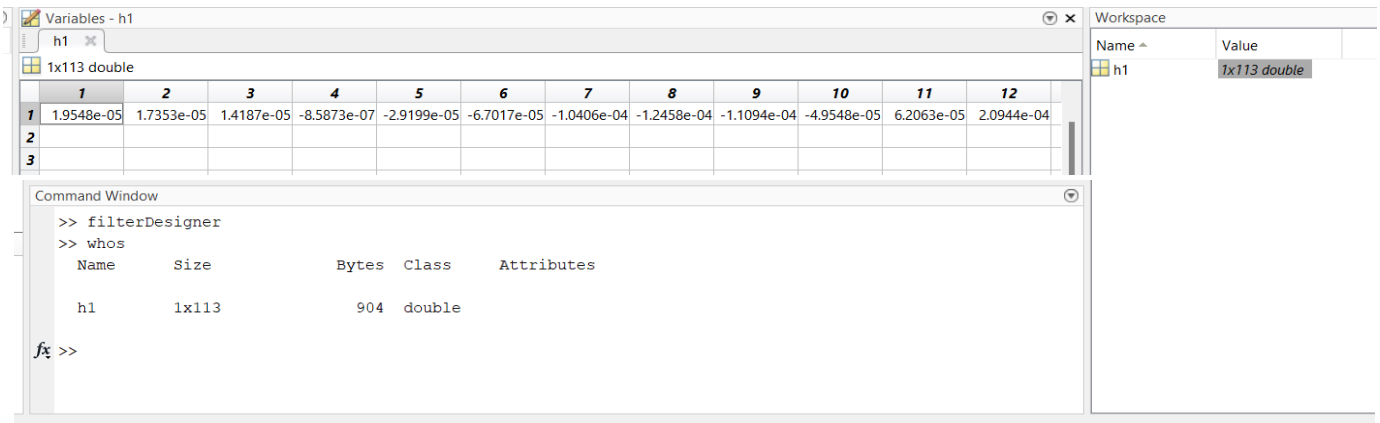
1- Overlap-save:

Block Diagram

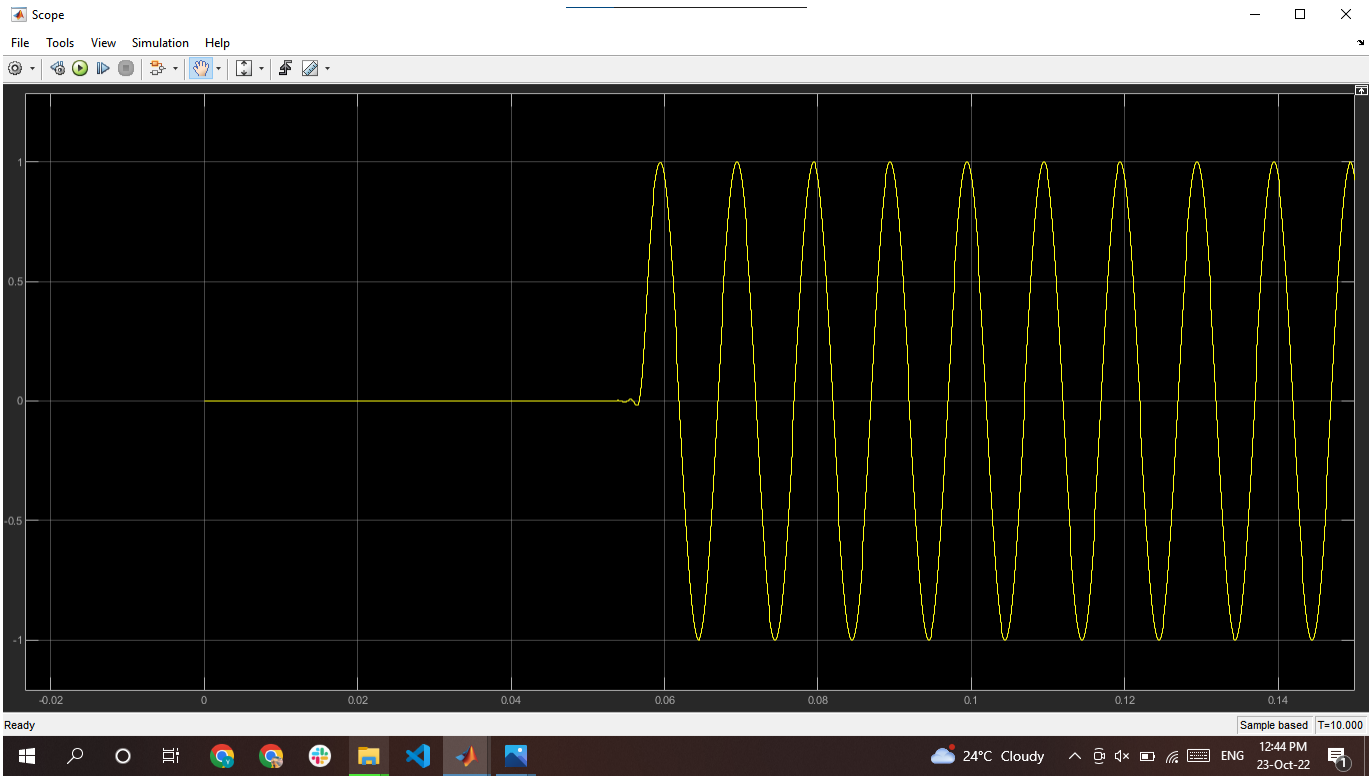


Filter



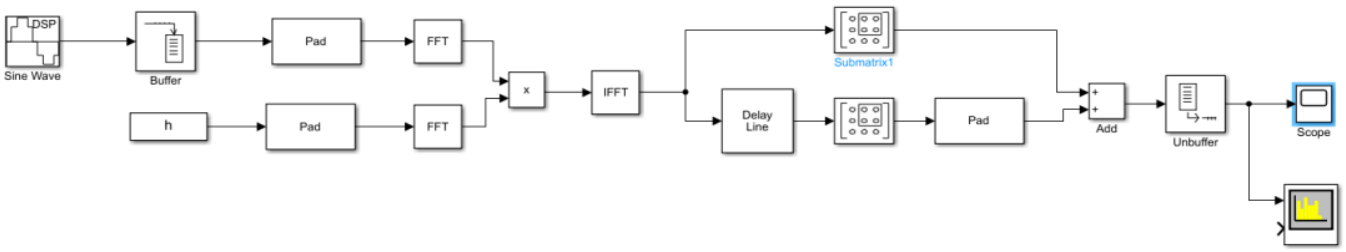


Scope


Scope
File Tools View Simulation Help
1
0.5
0
-0.5
-1
-0.02
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
Ready
Sample based
T=10.000
24°C Cloudy
ENG
12:44 PM
23-Oct-22

2- Overlap-add:

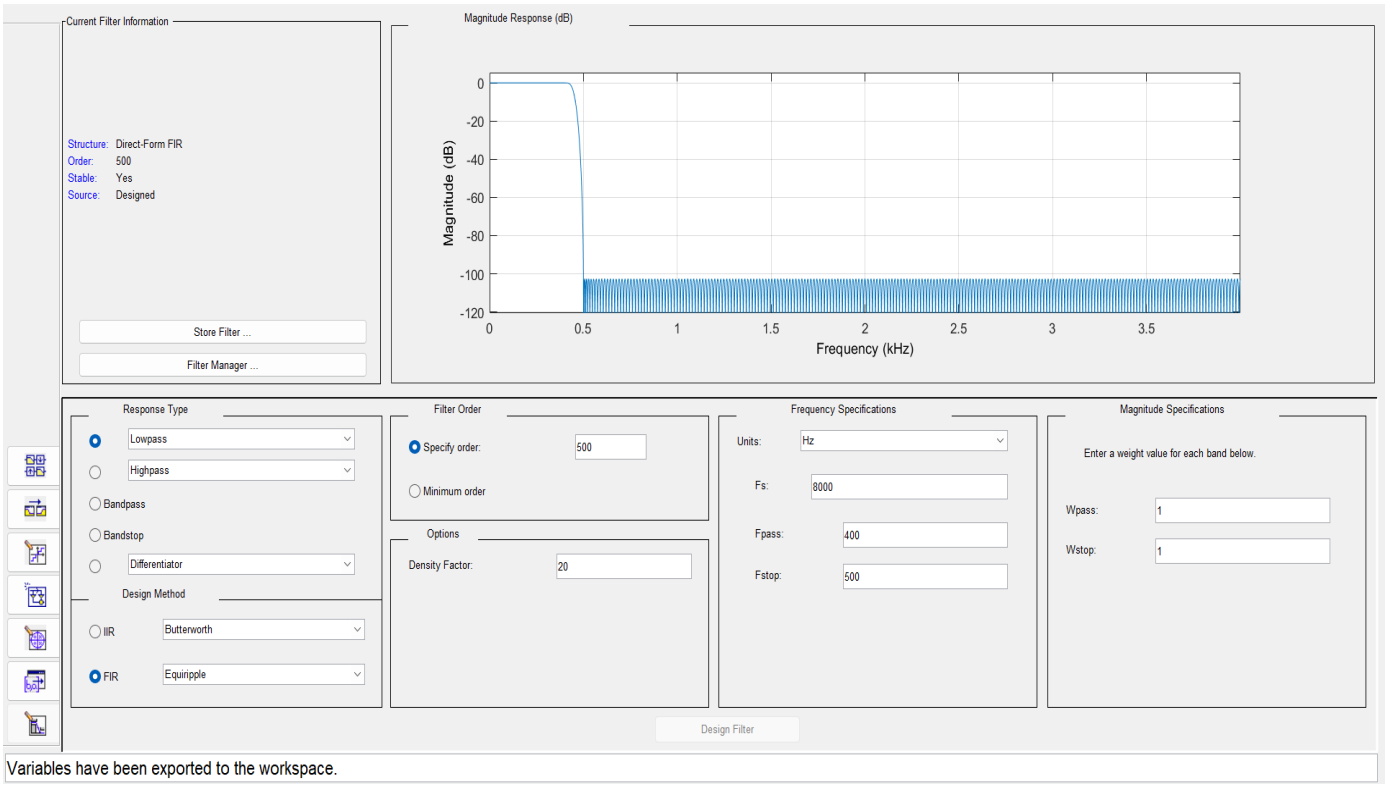
Block Diagram

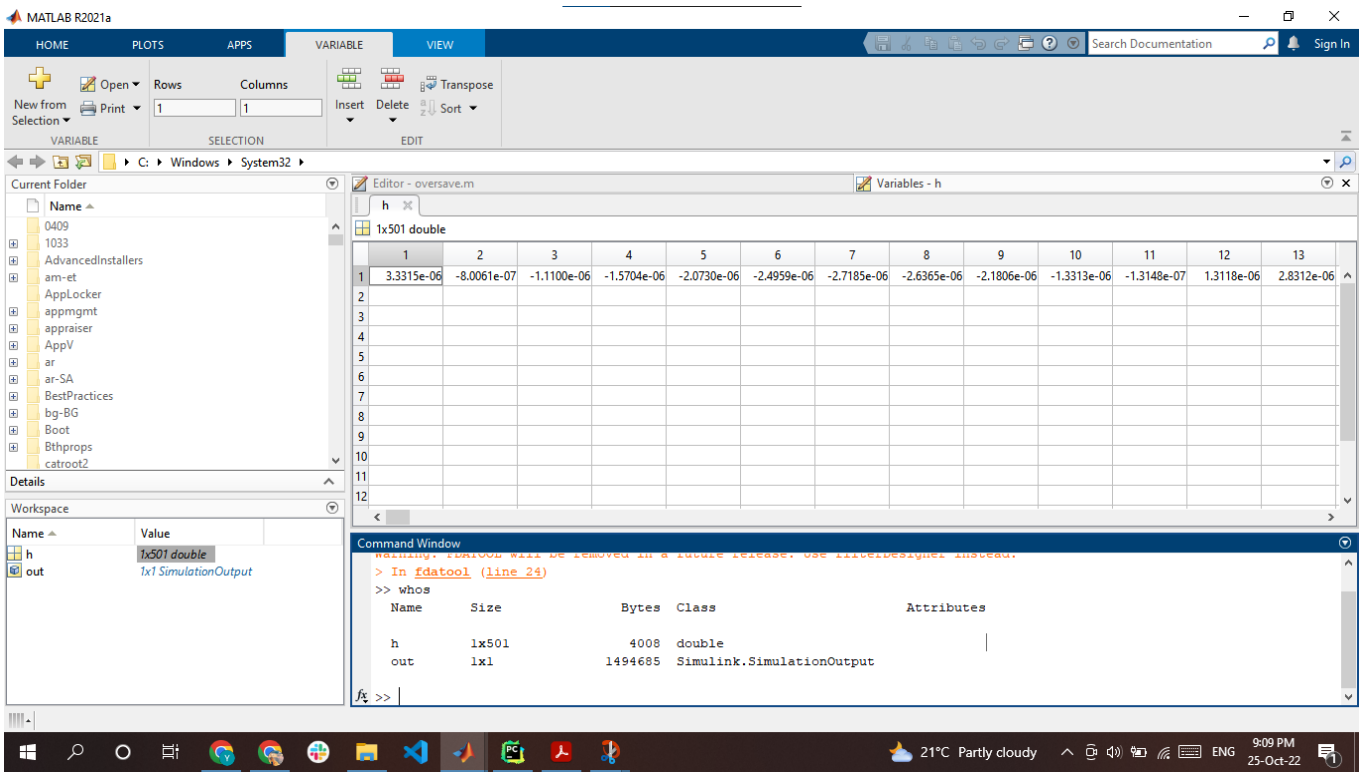


Algorithm:

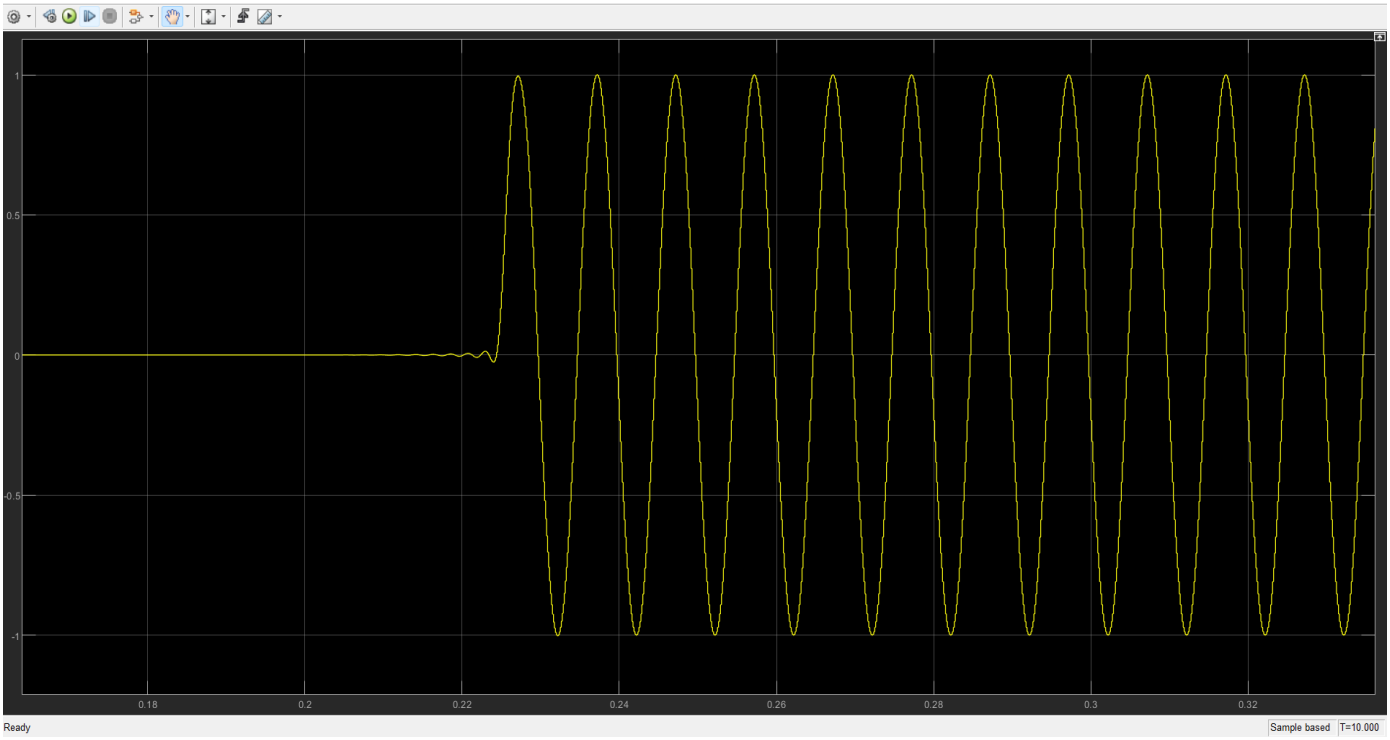
1. In Simulink, Get a Sine wave with Amplitude 1 ,Frequency 100 Hz ,Sample time (1/8000)
2. Connect Buffer block with output size = 1548
3. Add Pad block , to pad with zeros , Column size = 2048
4. Get the FFT of the input sine wave and Filter coefficients h
5. Multiply both FFT outputs using product block X
6. Get the IFFT of the product result
7. Store the result of IFFT in Submatrix to discard all of the points that have been aliasing , with starting row index at:1548
8. This submatrix is added to the result of IFFT after delay , delay line with the same size as input L so set its size to 1549 ,Store it in Submatrix ,Pad the Submatrix results with zeros
9. After Addition , Add unbuffer block with size = 1548
10. View results on Scope.

Filter


Current Filter Information
Structure: Direct-Form FIR
Order: 500
Stable: Yes
Source: Designed
Store Filter ...
Filter Manager ...
Magnitude Response (dB)
Magnitude (dB)
Frequency (kHz)
Response Type
Lowpass
Highpass
Bandpass
Bandstop
Differentiator
Design Method
IIR
Butterworth
FIR
Equiripple
Filter Order
Specify order:
500
Minimum order
Options
Density Factor:
20
Frequency Specifications
Units:
Hz
Fs:
8000
Fpass:
400
Fstop:
500
Magnitude Specifications
Enter a weight value for each band below.
Wpass:
1
Wstop:
1
Design Filter
Variables have been exported to the workspace.

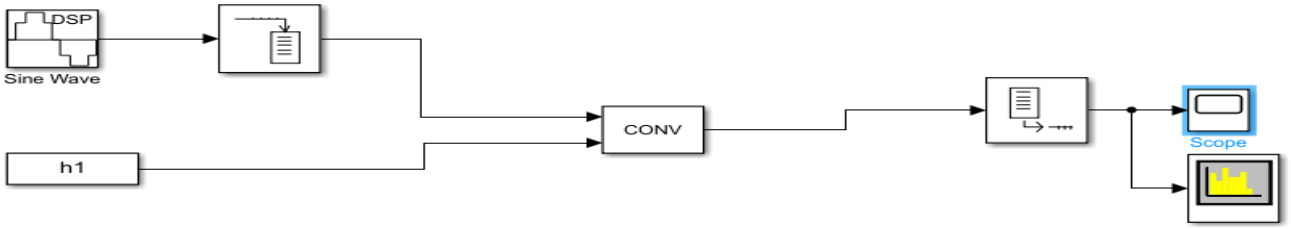

MATLAB R2021a
HOME
PLOTS
APPS
VARIABLE
VIEW
Search Documentation
Sign In
New from Selection
Open
Print
Rows
Columns
Insert
Delete
Transpose
Sort
VARIABLE
SELECTION
EDIT
C: ▸ Windows ▸ System32 ▸
Current Folder
Name
0409
1033
AdvancedInstallers
am-et
AppLocker
appmgmt
appraiser
AppV
ar
ar-SA
BestPractices
bg-BG
Boot
Bthprops
catroot2
Details
Workspace
Name
Value
h
1x501 double
out
1x1 SimulationOutput
Editor - oversave.m
Variables - h
h
1x501 double
1 2 3 4 5 6 7 8 9 10 11 12 13
1 3.3315e-06 -8.0061e-07 -1.1100e-06 -1.5704e-06 -2.0730e-06 -2.4959e-06 -2.7185e-06 -2.6365e-06 -2.1806e-06 -1.3313e-06 -1.3148e-07 1.3118e-06 2.8312e-06
Command Window
> In fdatool (line 24)
>> whos
Name Size Bytes Class Attributes
h 1x501 4008 double
out 1x1 1494685 Simulink.SimulationOutput
>>
21°C Partly cloudy
ENG
9:09 PM
25-Oct-22

Scope

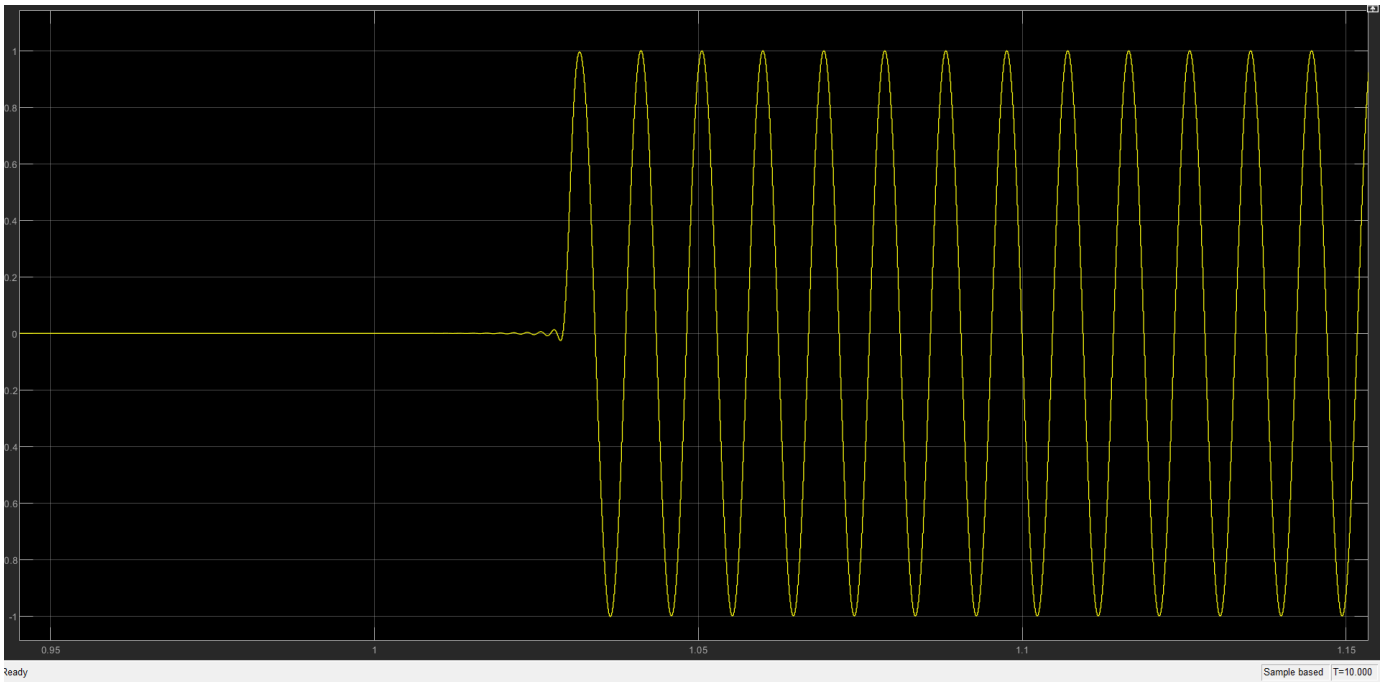

1
0.5
0
-0.5
-1
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
Ready
Sample based
T=10.000

Linear Convolution:

Block Diagram



Scope



Comment:

The overlap-save and overlap-add are methods to solve the linear convolution so scopes are similar.