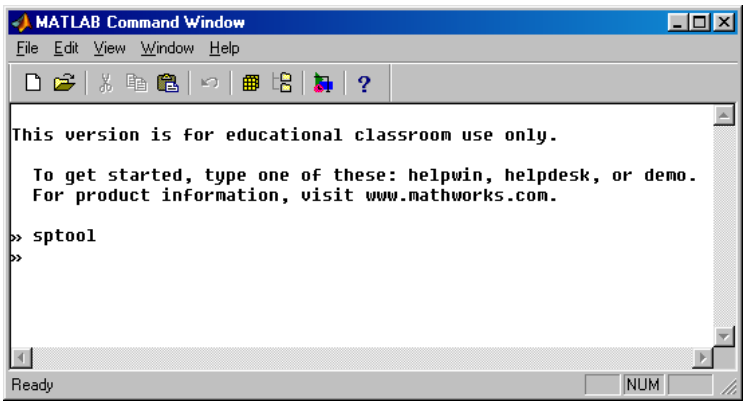
Matlab/Simulink Exercise: Digital Filter Design

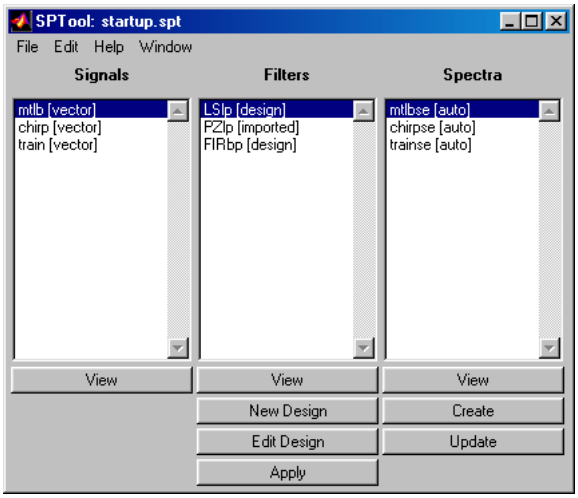
A) Design a digital FIR lowpass filter with the following specifications:

Passband cutoff frequency:	$f_p = 2$ kHz
Stopband cutoff frequency:	$f_s = 3$ kHz
Passband Ripple:	$R_p = 0.25$ dB
Stopband attenuation:	$R_s = 0.25$ dB
Sampling frequency:	$f_s = 20$ kHz

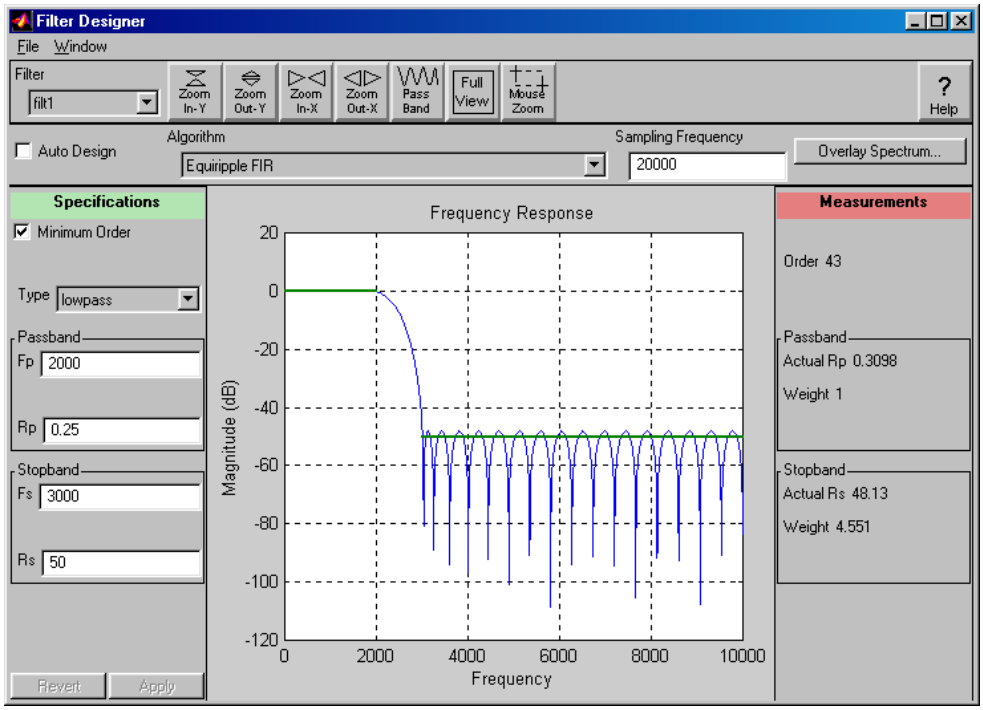
Solution

1) Start `sptool` and select `New Design.`

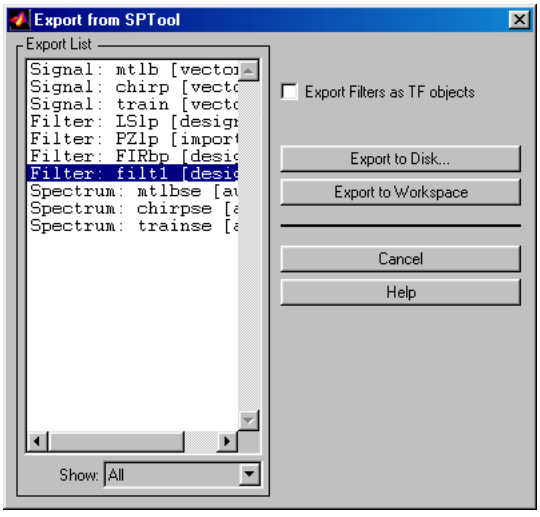




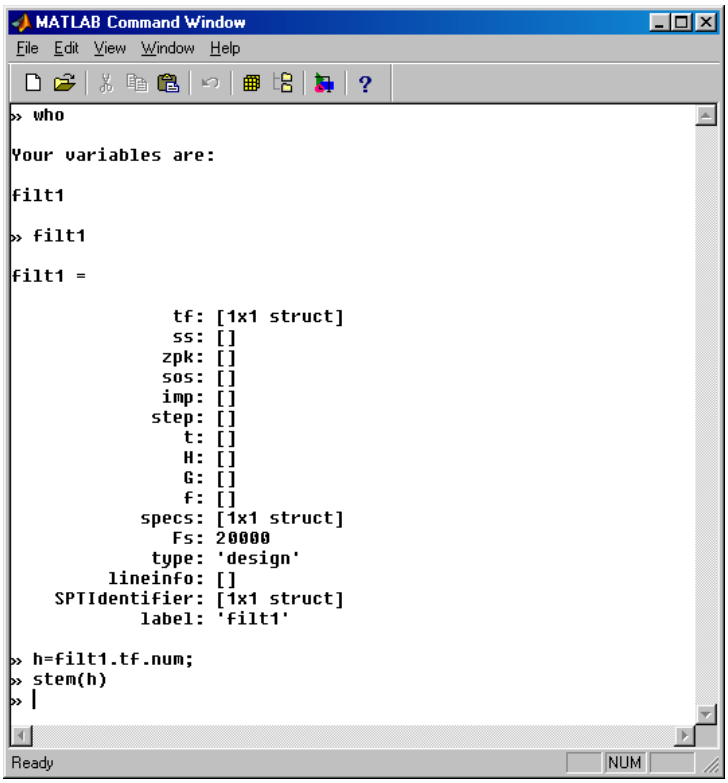
3) Insert the filter specifications and complete the filter design by pressing `Apply`.



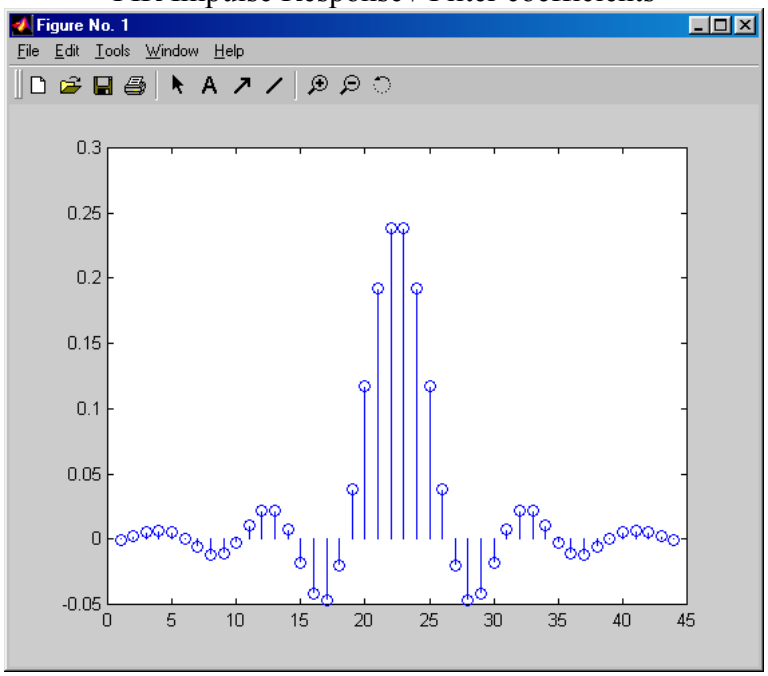
4) To access the filter coefficients of the designed filter go to the `SPTool` window and select `Export` from the `File` Menu. Next highlight the designed filter and use the `Export to Workspace` button to make the filter parameters accessible on the workspace.



The filter parameters are stored under the variable name filt1 in an object-oriented manner. You can access the filter coefficients as illustrated below.

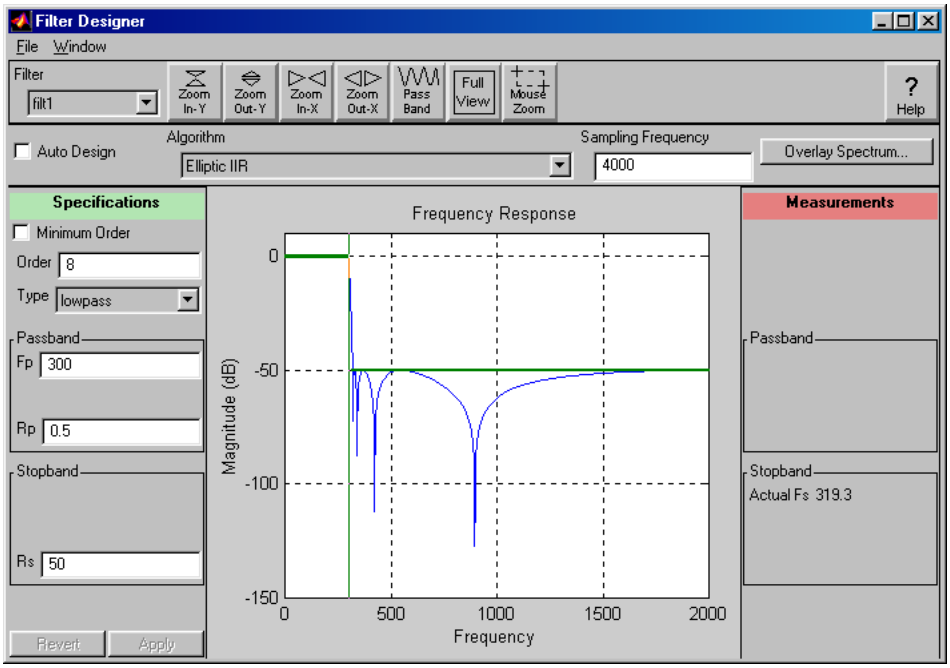


FIR Impulse Response / Filter coefficients

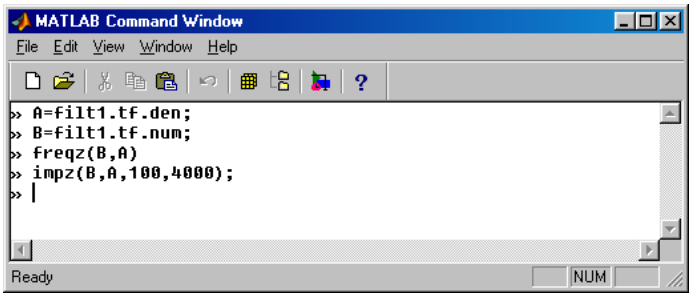


B)Design a digital IIR lowpass filter with the following specifications:

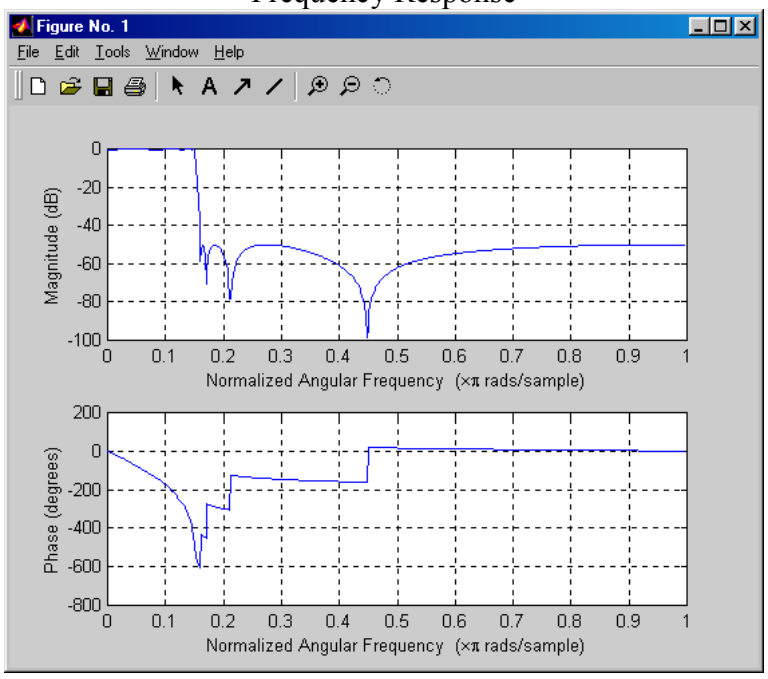
Filter Order:	8^{th}
Filter type:	elliptic IIR
Passband cutoff frequency:	$f_p = 300$ Hz
Passband Ripple:	$R_p = 0.5$ dB
Stopband attenuation:	$R_s = 50$ dB
Sampling frequency:	$f_s = 4$ kHz



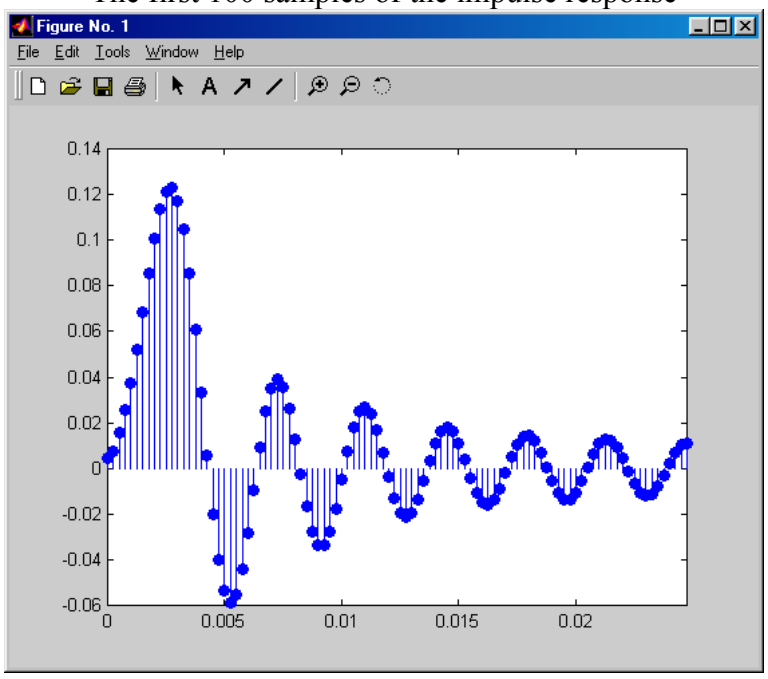
2) Export the filter parameters in the workspace as in the previous example. For IIR filters both the numerator and the denominator are required to compute the frequency and impulse response of the IIR filter.



Frequency Response



The first 100 samples of the impulse response



Repeat the Design for the following digital Filters:

C) Design a digital FIR bandpass filter with the following specifications:

Passband:	8-12 kHz
Stopband Ripple:	$R_s = 0.001$
Passband Ripple:	$R_p = 0.001$
Transition width:	3kHz
Sampling frequency:	$f_s = 44.1$ kHz

Obtain the filter coefficients and frequency response for the above FIR using the Blackman window method.

D) Design a digital IIR bandpass filter with Butterworth characteristics meeting the following specifications:

Passband:	8-10 kHz
Sampling frequency:	$f_s = 44.1$ kHz
Filter Order:	4
Filter Characteristics:	Butterworth

Obtain the filter coefficients and frequency response for the above FIR using the Blackman window method.