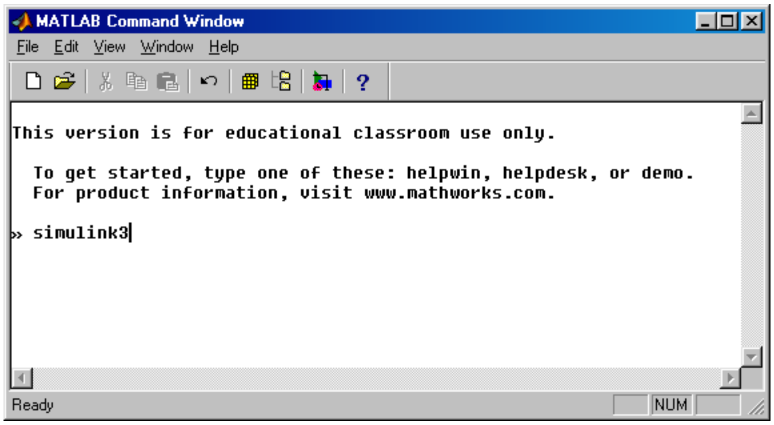
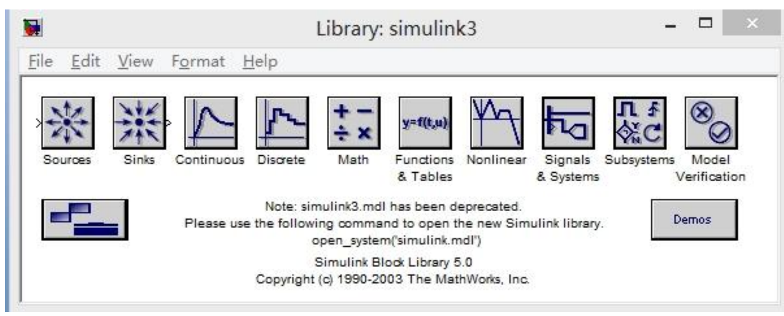
Simulink – Discrete Fourier Transform

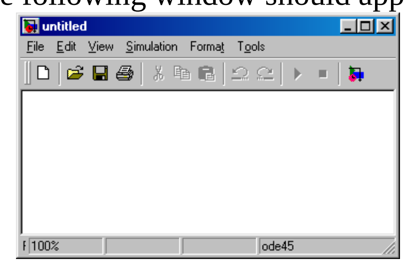
1. Start the *Matlab engine* and type <u>*simulink3*</u> at the Matlab command prompt. This will start the Simulink3 library.



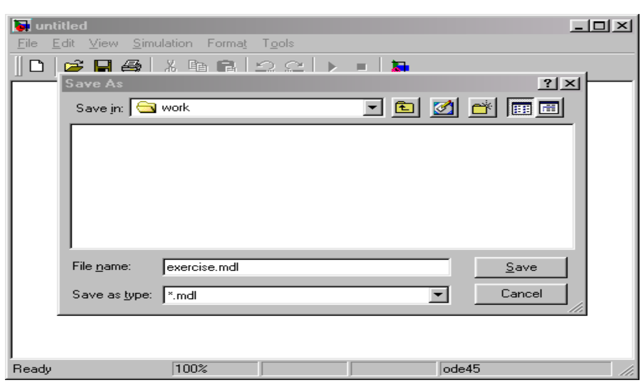
2. To open a new model select: <u>File</u> → <u>New</u> → <u>Model</u>



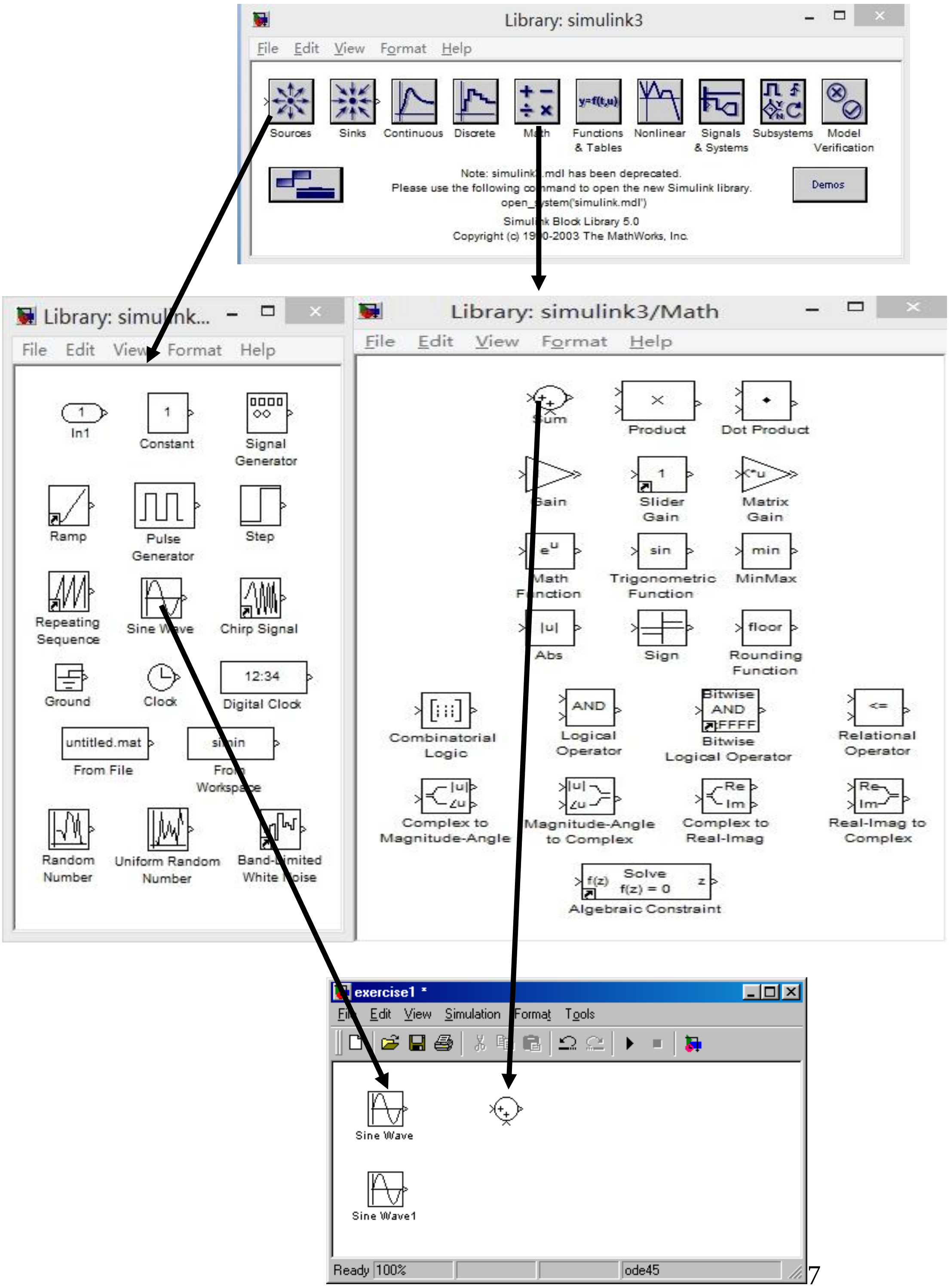
(The following window should appear.)



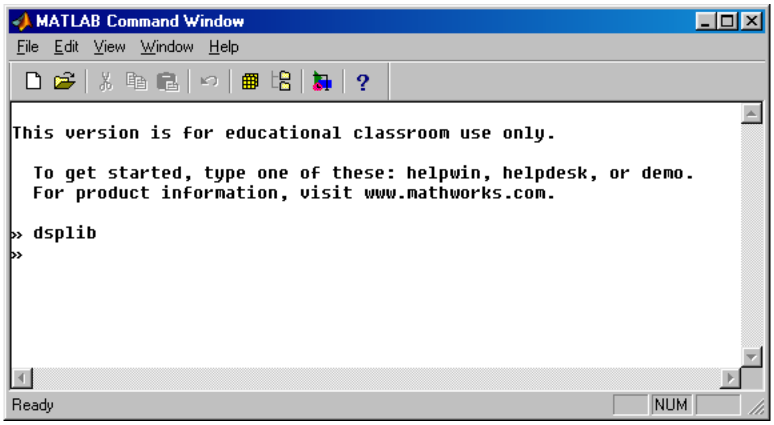
3. To save the new simulink model select: <u>File</u> → <u>Save As</u>



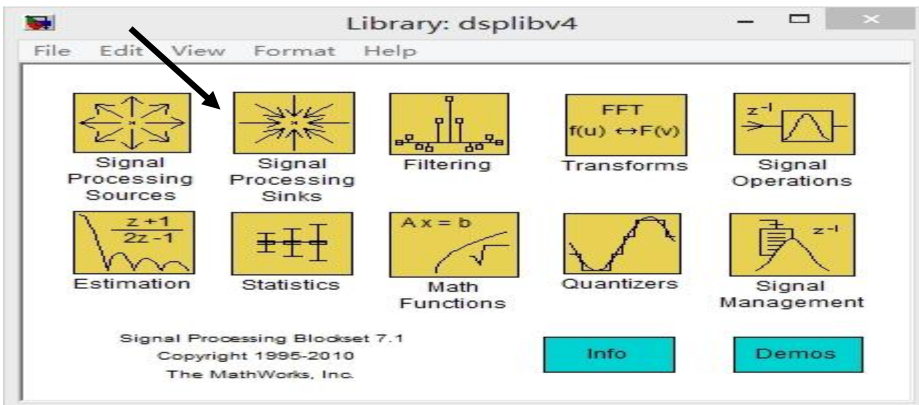
4. **Double click *Sources*, Drag & drop two *sine-wave* blocks and a *summation* block from *Math* icon of the *simulink3* libraries as illustrated below.**



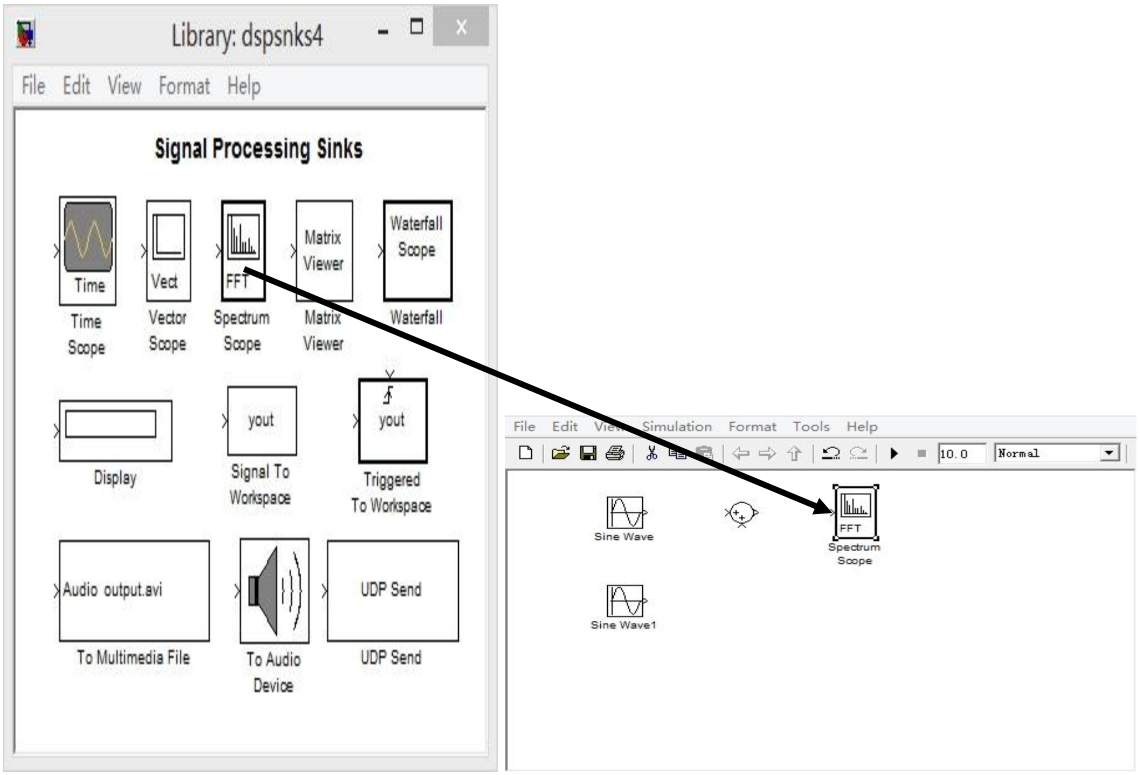
5. Open the DSP Library by typing *<u>`dsplib`</u>* at the command prompt.



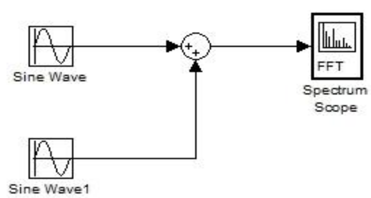
6. Open the DSP Sinks library by double-clicking the *<u>Signal Processing Sinks</u>* icon.



7. Drag & drop the *<u>FFT Spectrum Scope</u>* block.



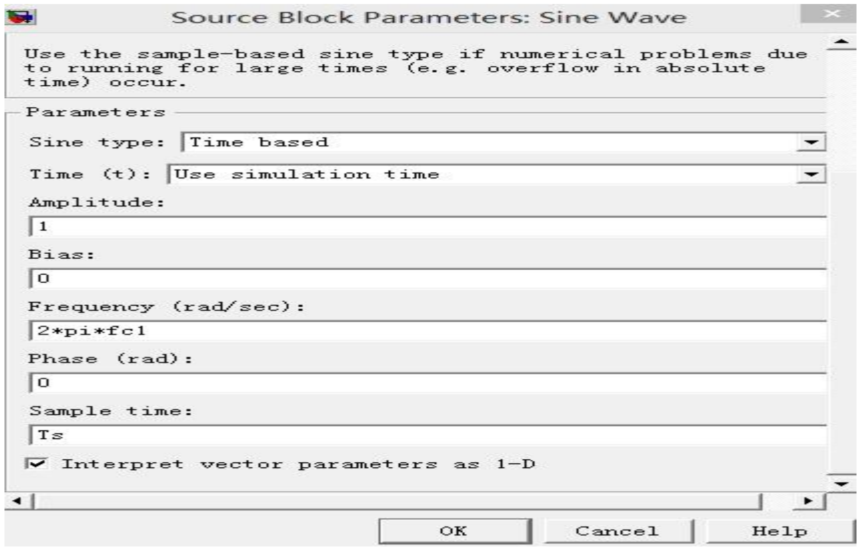
8. Connect the *simulink* blocks.



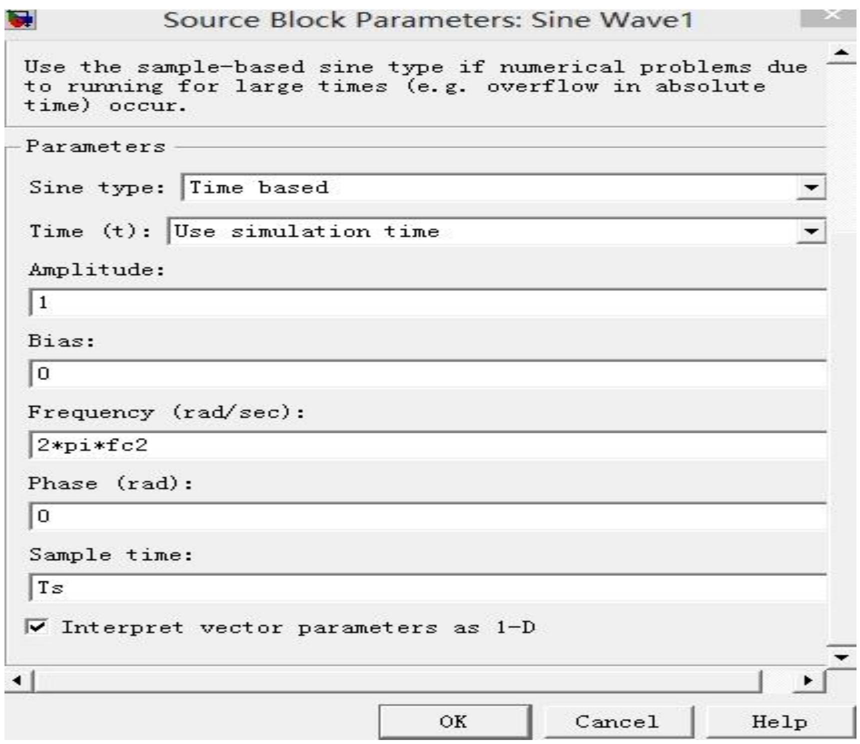
9. To enter the *sine-wave* block parameters double-click the corresponding icon.

Recall: Amplitude * sin (2 * pi * *Frequency* * t + *Phase*)

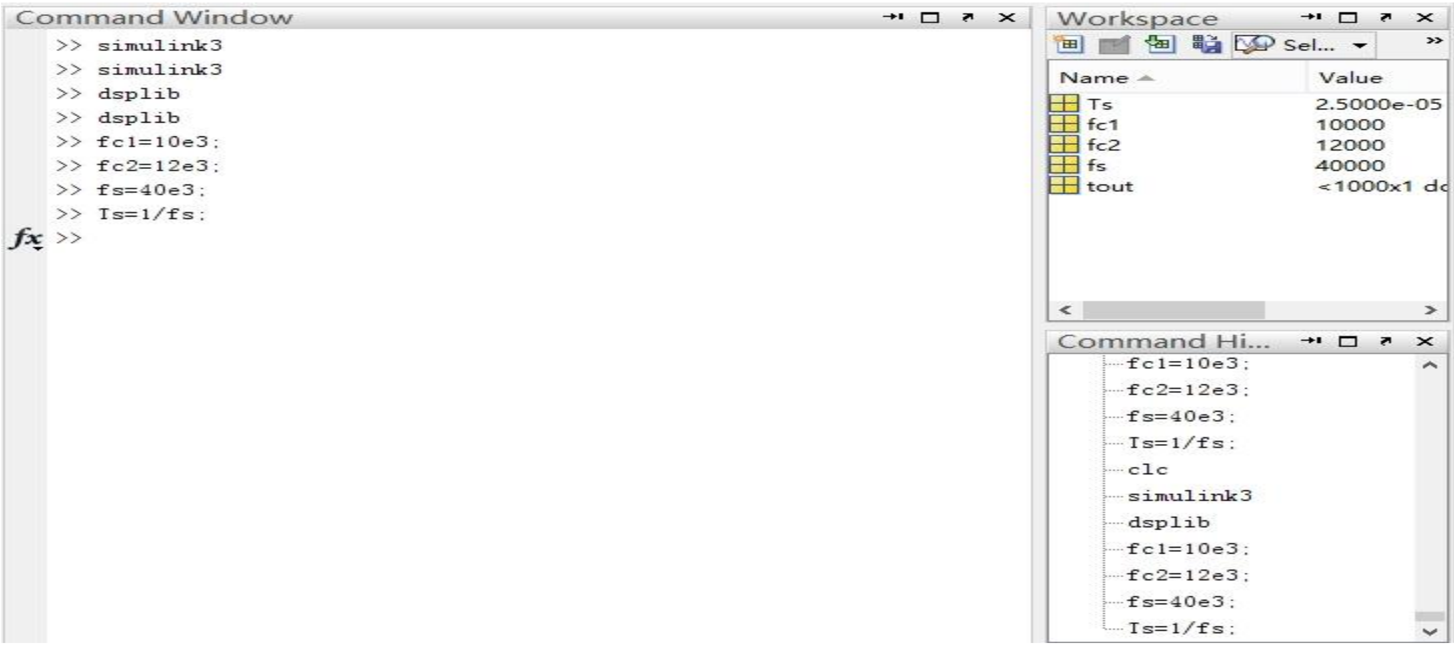
where t = 0, Ts, 2*Ts, 3*Ts,…



10. Repeat above for the block <u>*sine-wave1*</u> *(*careful of *fc2*)

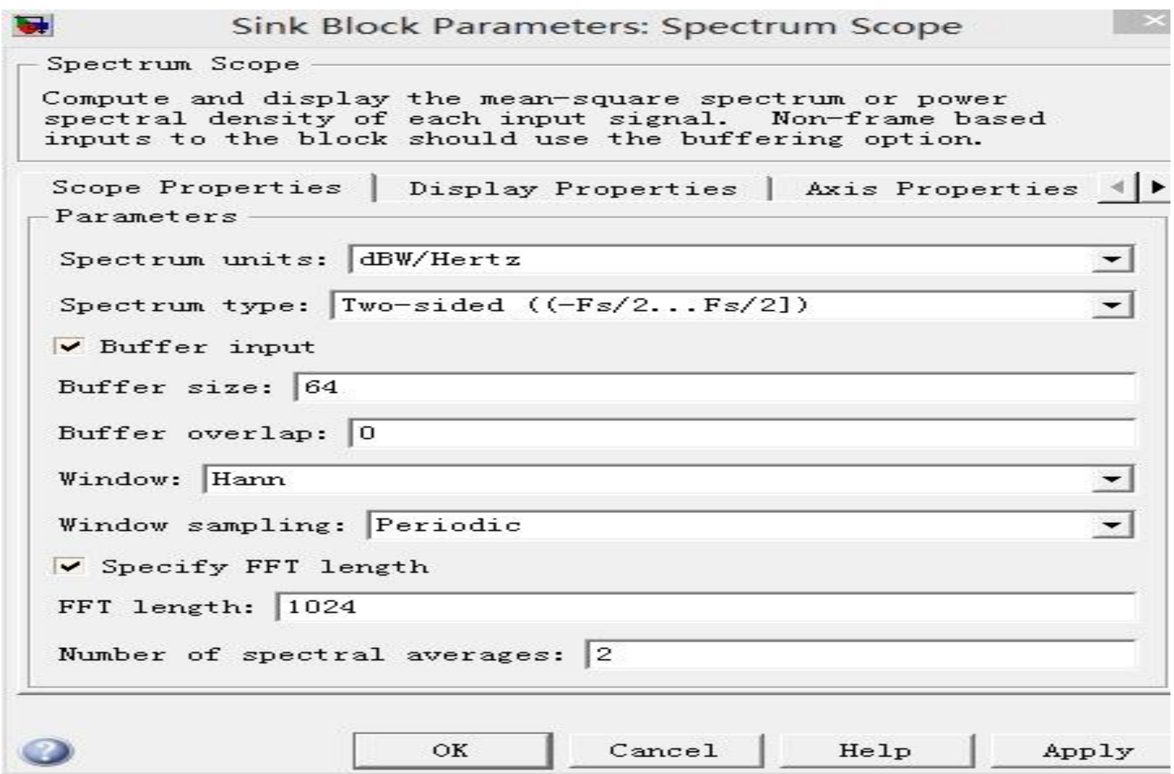


11. Specify *fc1*, *fc2*, *fs*, and *Ts* at the command prompt.

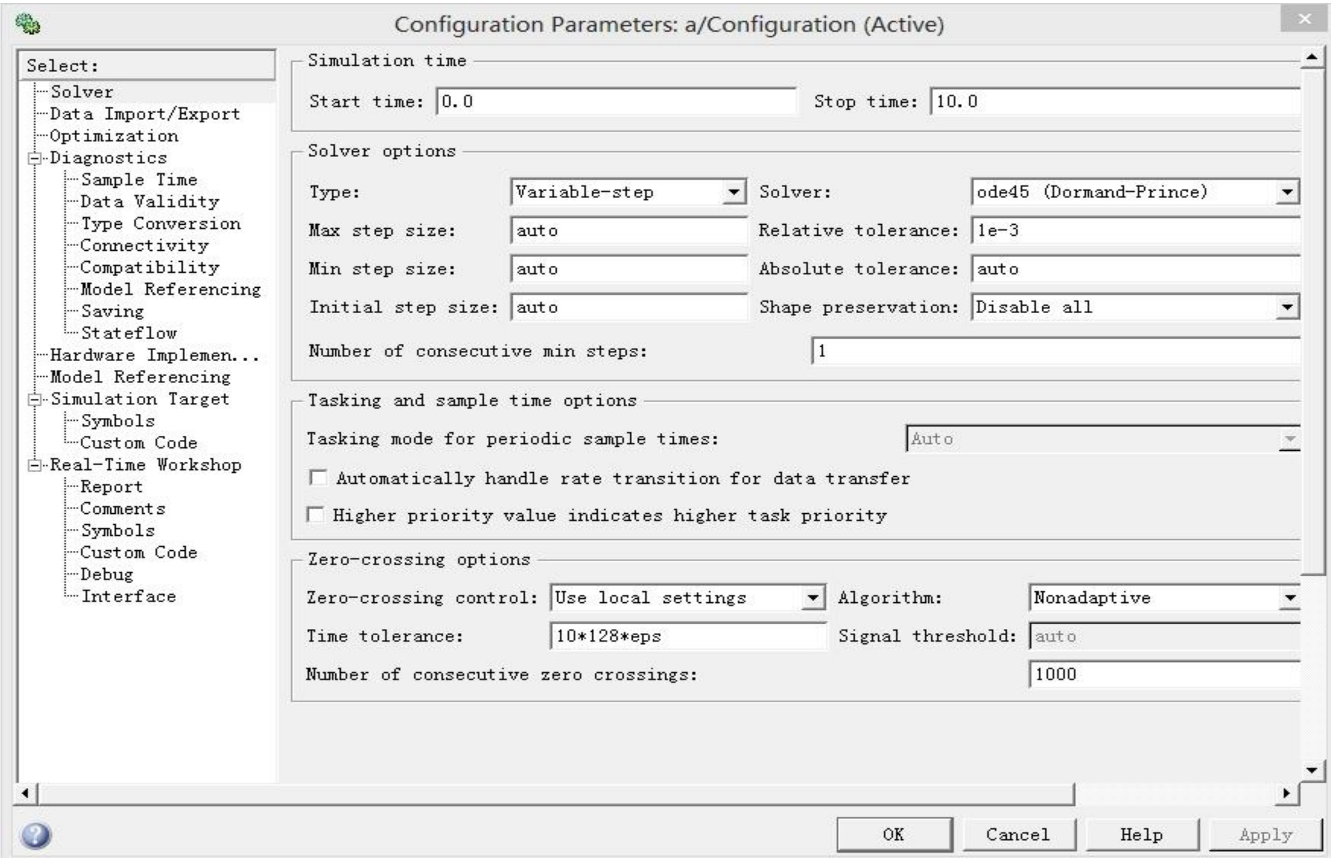


where *fc1* and *fc2* are the carrier frequencies, *fs* is the sampling frequency, and *Ts* is the sampling time.

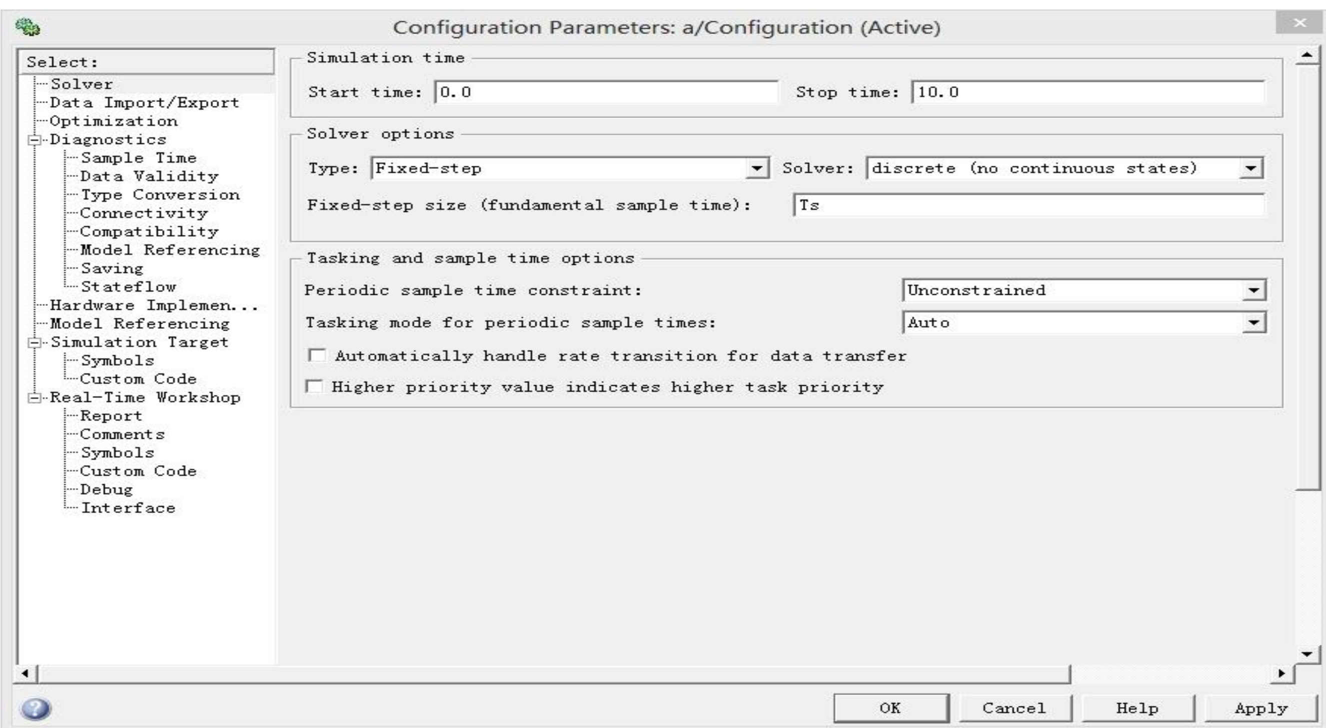
11. Enter the following *FFT scope* parameters.



12.Finally, to enter the ***Simulation Parameters*** choose: **Simulation** → **Configurations Parameters**.

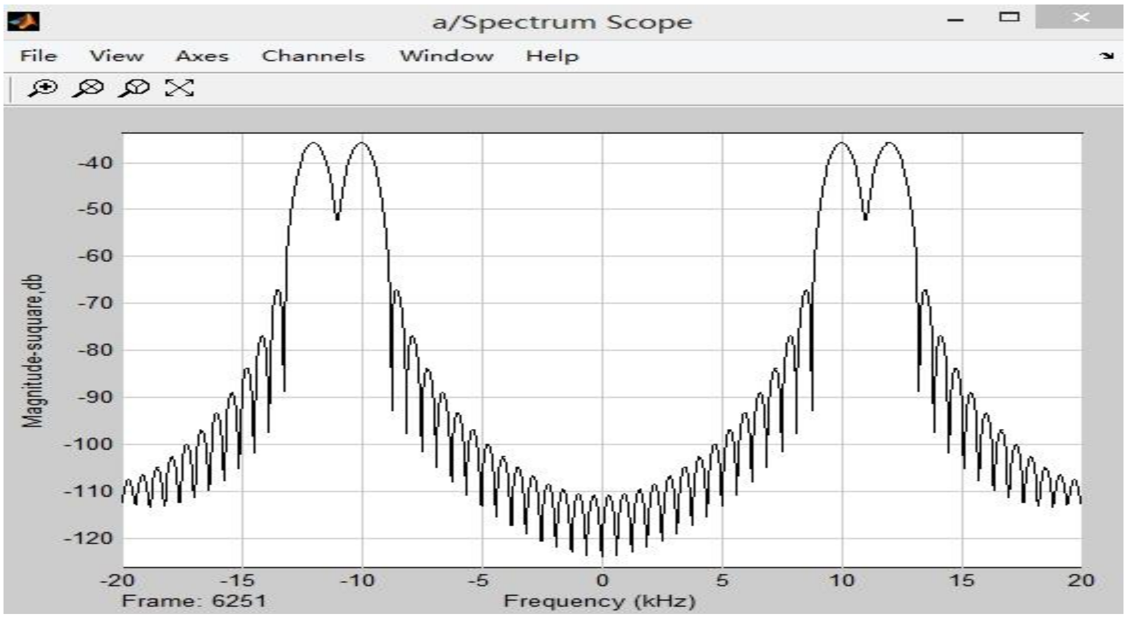


From ***Type***: choose **Fixed-step** and follow the below setting up and press ***Apply*** and click ***OK***



13. Choose <u>*simulation*</u> and click <u>start</u> or point & click at the <u>play</u> button on the toolbar.

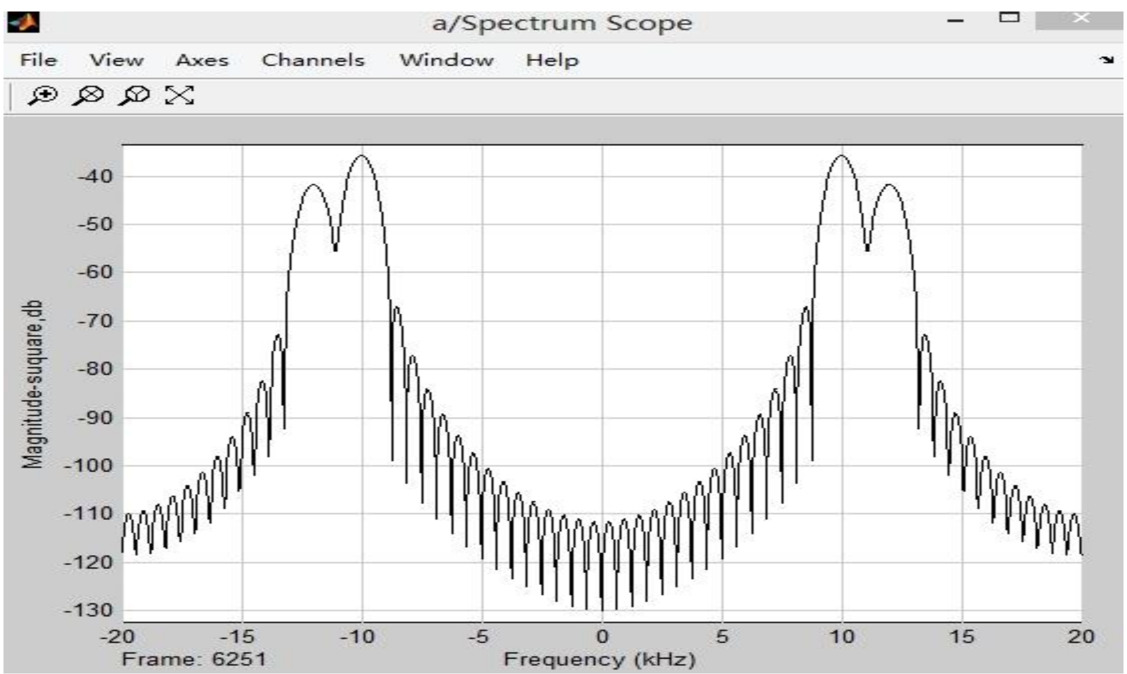
14. Once the simulation is running <u>*right click*</u> on the scope window and choose <u>*autoscale*</u>. The following plot should appear.



Explain the resulting spectral components by considering the following Fourier transform pair:

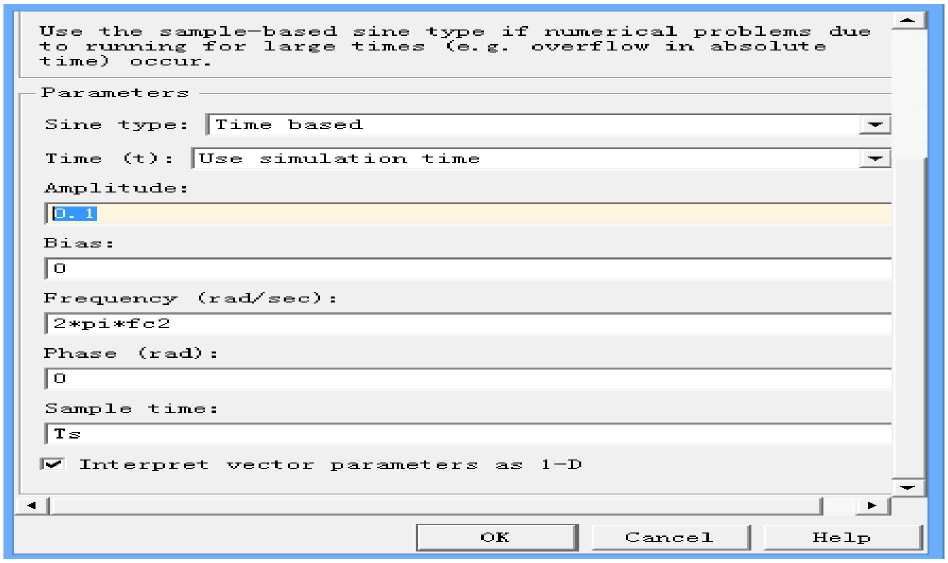
$$\sin(2\pi f_c t) \overset{FT}{\leftrightarrow} \frac{1}{2j}\delta(f - f_c) - \frac{1}{2j}\delta(f + f_c)$$

15. Change the amplitude of the <u>*sine-wave1*</u> to <u>*0.5*</u>, save the changes, and re-run the simulation.

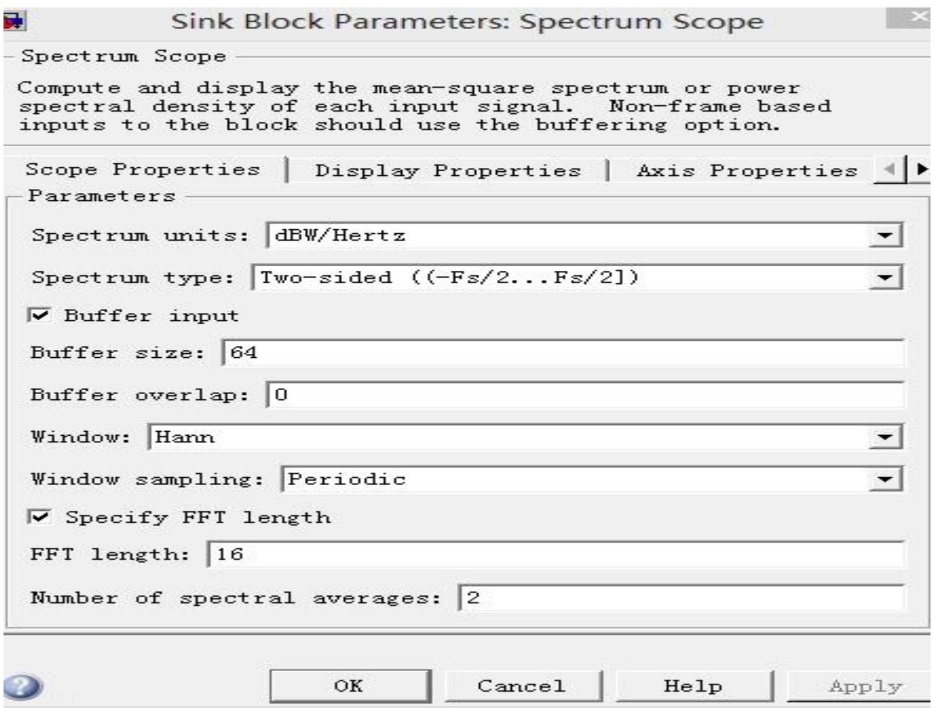


Explain the resulting spectrum.

- **Change of the *sine-wave1* to *0.1* and number of FFT to *N=16* which is expressed as follow, explain the results**

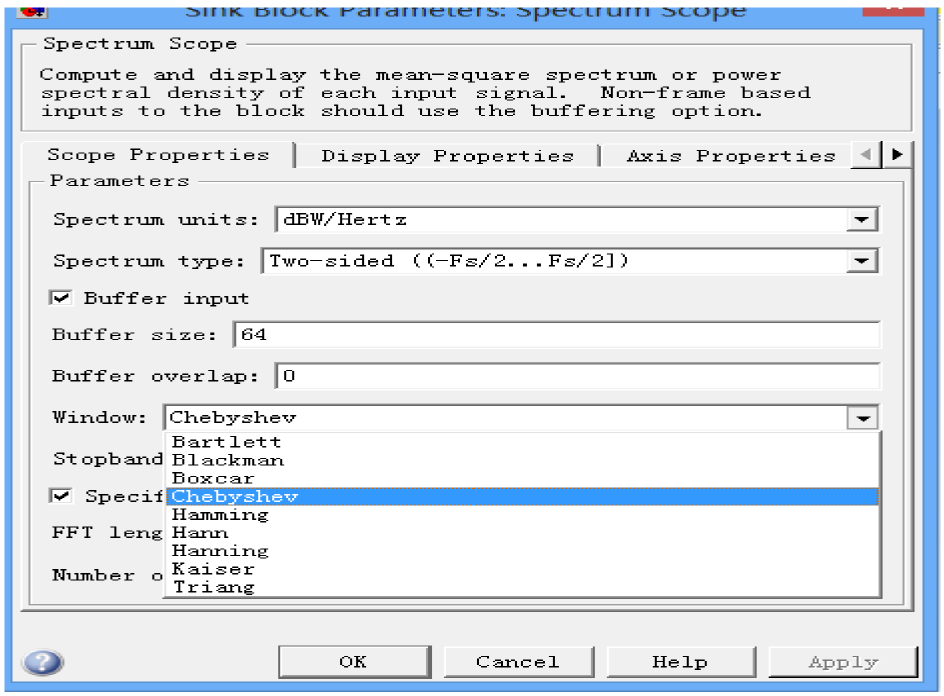


and



- **Change number of FFT back to *N=1024*, re-run the simulation, explain the results.**

- **Change *fc2=10500*, amplitude of *sine-wave1* is set to *1* and choose different window function, re-run the simulation, explain the results.**


Sink Block Parameters: Spectrum Scope
Spectrum Scope
Compute and display the mean-square spectrum or power spectral density of each input signal. Non-frame based inputs to the block should use the buffering option.
Scope Properties
Display Properties
Axis Properties
Parameters
Spectrum units:
dBW/Hertz
Spectrum type:
Two-sided ((-Fs/2...Fs/2])
Buffer input
Buffer size:
64
Buffer overlap:
0
Window:
Chebyshev
Stopband
Specif
FFT leng
Number o
Bartlett
Blackman
Boxcar
Chebyshev
Hamming
Hann
Hanning
Kaiser
Triang
OK
Cancel
Help
Apply