# EE 1130 Freshman Eng. Design for Electrical and Computer Eng. Class 2

Signal Processing Module (DSP).

• Matlab and Simulink.

# Signal Processing Engineer

- We are detectives of hidden information in signals.
  - Communication signals: obtain the information.
  - Signals from CO2 sensors, heat sensors, etc.
  - Data from Hard Drives.
  - Data from Computers to computers.
- In orde to do that we study MATHEMATICS!!

# Matlab

- Matlab is a powerful tool for mathematical/engineering research and development. It is also useful to students to easily computate or solve almost all mathematical and engineering problems.
- This Signal Processing Module will use Matlab as a development and teaching tool.
- Matlab is learned in the course EE 3220 Software Applications in Electric Engineering.

# Matlab

- We will use the **Simulink** part of Matlab for two main purposes
  - We will emulate/modelate a low frequency signal corrupted with an additive noise (high frequency signal).
  - Implement a FILTER that will eliminate a high frequency component (ripple or noise) meanwhile leaving untouched a low frecuency sinewave.
- This phenomenon is common in any electrical system, where the 60Hz signal from the power lines corrupt a signal of interest as an Electro EncephaloGram (EEG), Electro CardioGram (EKG), or just a sinewave.



#### • To run Matlab, just double click on the matlab icon.



# Matlab

• The Matlab window application will appear. We can see different sub-windows:

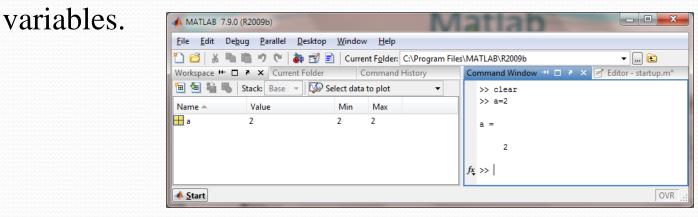
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• **Command window**: is the one where the user writes the variables and where the results are displayed

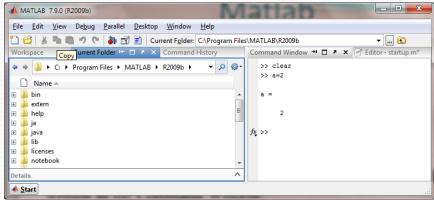
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• Workspace window: is the one where the user can see the

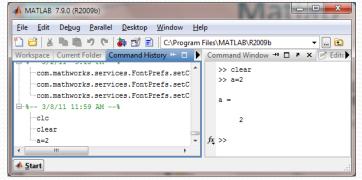


# Matlab

• **Current Folder window**: is the one where the user can see the different files stored in the current directory. The current directory is the one that Matlab uses to store and read files.

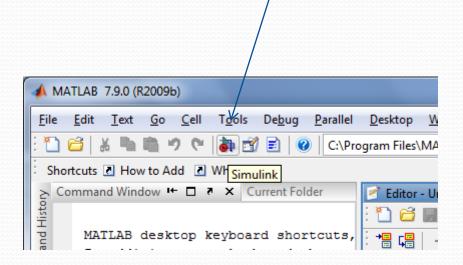


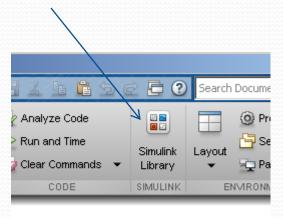
• **Command History window** that shows us all the commands written in the Command Window.



#### Simulink

- Simulink is part of Matlab. Simulink works by interconecting blocks. Each block is in fact a matlab function with input and output parameters.
- To open simulink click on the Simulink icon as shown:

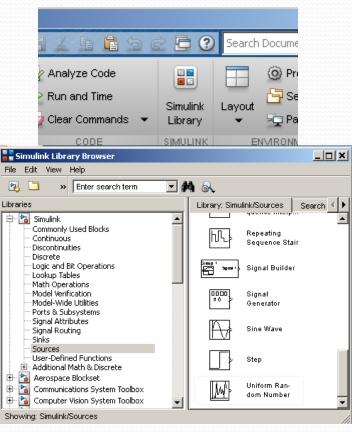




#### Simulink

 A new window appears, the library Browser: Notice Continuous, Math Operations, Source, and Sink groups that we will be using

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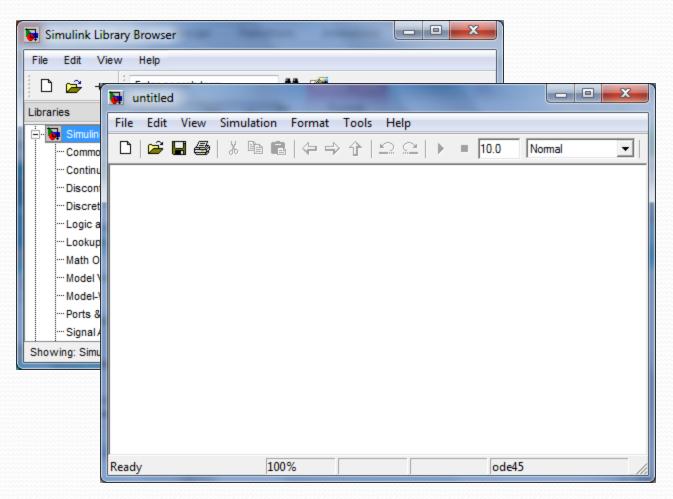


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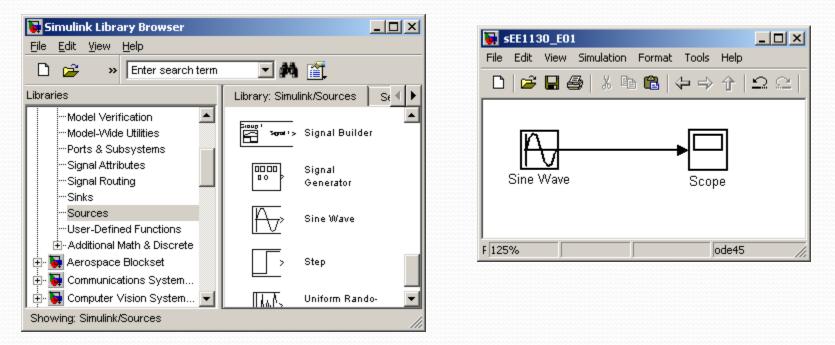
#### Simulink

• Click on the new document to open:



• Lets build an easy example of a sinewave and scope it:

 $x(t) = \sin(2\pi f t)$  with f = 1



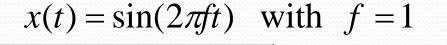
• We inserted a sinewave from the sources, and a scope from the sink library groups respectively.

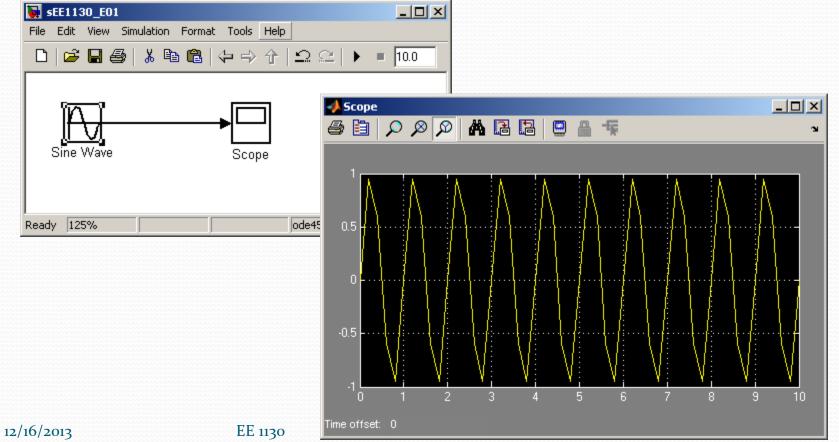
• By double clicking on the Sine Wave box we open its properties box and set the angular frequecy to 2\*pi\*1:

 $x(t) = \sin(2\pi f t)$  with f = 1

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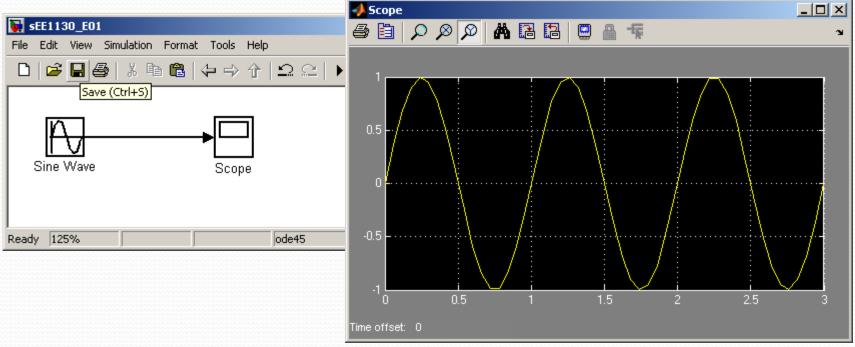
- To open the scope we double click on the Scope box.
- We hit the play icon to run the simulation.





• To obtain a better view of the sinewave, we reduce the running time to 3 seconds as shown in next figure:

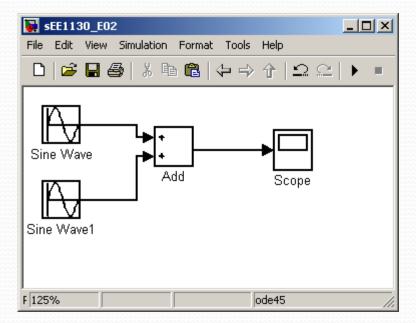
 $x(t) = \sin(2\pi f t)$  with f = 1



• Click on the binoculars to zoom the signal so it fills the Scope.

• Lets perform a summation of two sinewaves. One of 1Hz of frequency and 1 volt of amplitude and another of 60Hz frequency and 0.2 volts of amplitude:

$$x(t) = \sin(2\pi 1t) + 0.2\sin(2\pi 60t)$$



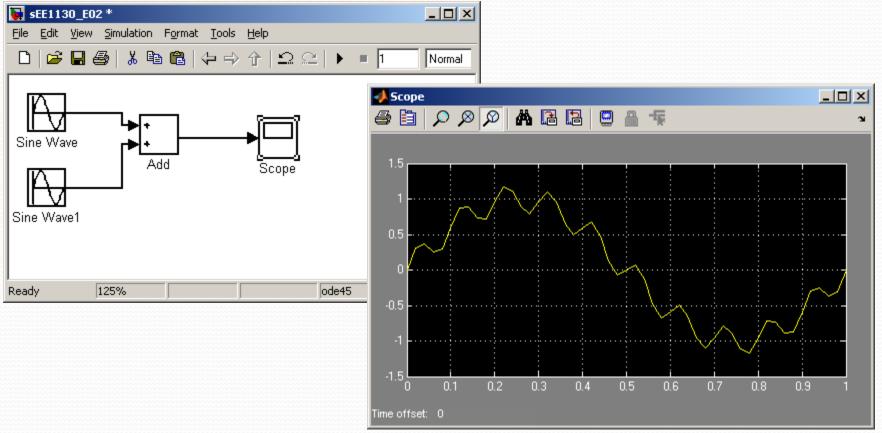
• We need to click on each sinewave box to set up the amplitude and frequencies:  $x(t) = \sin(2\pi 1t) + 0.2\sin(2\pi 60t)$ 

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Time (t): Use simulation time	Bias:
Amplitude:	0
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Bias:	2*pi*60
0	Phase (rad):
Frequency (rad/sec):	0
2*pi*1	Sample time:
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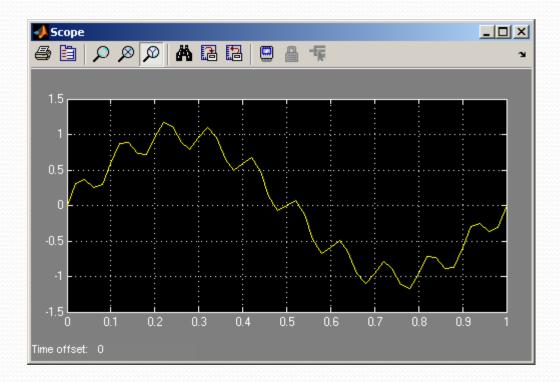
• Set the running time to 1 second, double click on the Scope box to open it up and hit play:

 $x(t) = \sin(2\pi 1t) + 0.2\sin(2\pi 60t)$ 



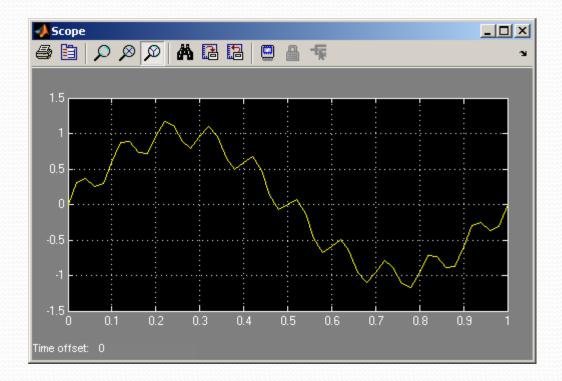
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• We see the 60Hz wave riding on the 1Hz wave. This is called 60Hz noise or ripple.



 $x(t) = \sin(2\pi 1t) + 0.2\sin(2\pi 60t)$ 

• The objective of next class is to get rid of the ripple and keep the 1Hz sinewave clean of noise!!! This is Signal Processing!!



 $x(t) = \sin(2\pi 1t) + 0.2\sin(2\pi 60t)$ 

**End of Class**