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

Signal Processing Module (DSP).

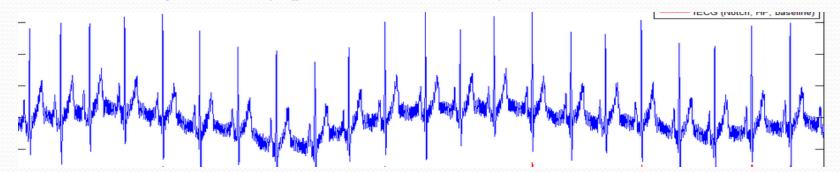
• Matlab and Simulink.

## 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 order to do that we need to master MATHEMATICS!!

#### **Problem Statement**

- Imagine you are an Electrical Engineer Signal Processing proficient. A medical doctor running a Hospital building hires you to solve the following problem:
  - Doc: "Our EKG readings show a garbled signal and I can not diagnose my patients correctly".

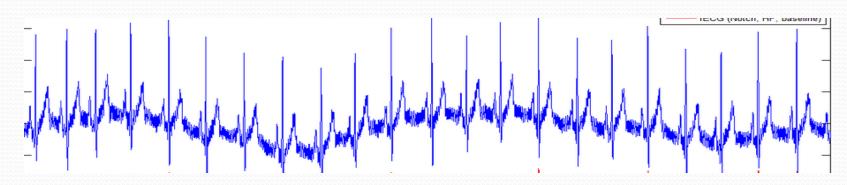


• He is expecting this kind of signal:



## **Problem Statement**

• What is the difference?.



- The above signal has and ondulation (low frequency envelope)
- Besides that, it is noisy (has a lot of ripples or high frequency component)



## Matlab

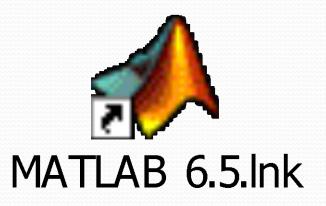
- Matlab is a powerful tool for mathematical/engineering research and development. It is also useful to students to easily computate or solve almost all mathematical and engineering problems.
- This Signal Processing Module will use Matlab as a development and teaching tool.
- Matlab is learned in the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

## Matlab

- We will use the **Simulink** part of Matlab for two main purposes inside this DSP Module:
  - We will emulate/modelate a low frequency signal corrupted with an additive noise (high frequency signal).
  - Design and implement a FILTER that will eliminate a high frequency component (ripple or noise) meanwhile leaving untouched a low frequency sine wave.
- 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:

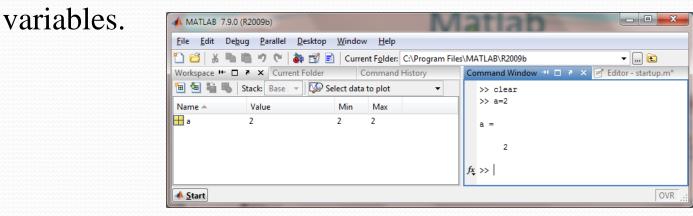
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• **Command window**: is the one where the user writes the variables and where the results are displayed

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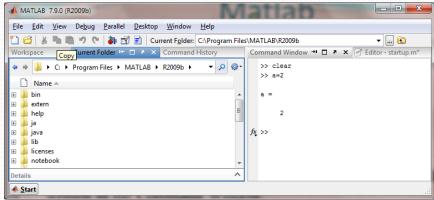
• Workspace window: is the one where the user can see the



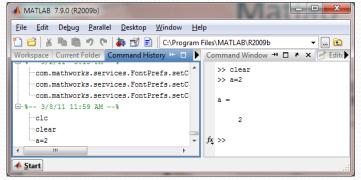


## Matlab

• **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.

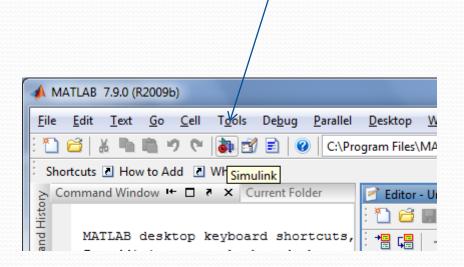


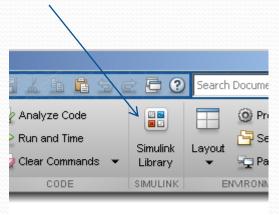
• **Command History window** that shows us all the commands written in the Command Window.



#### 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:

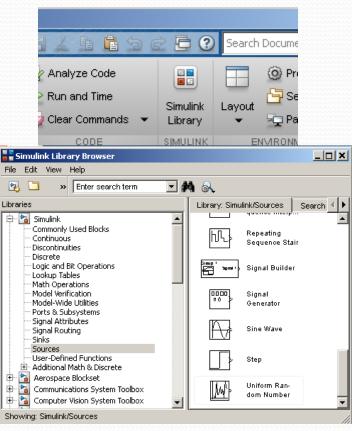




#### Simulink

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

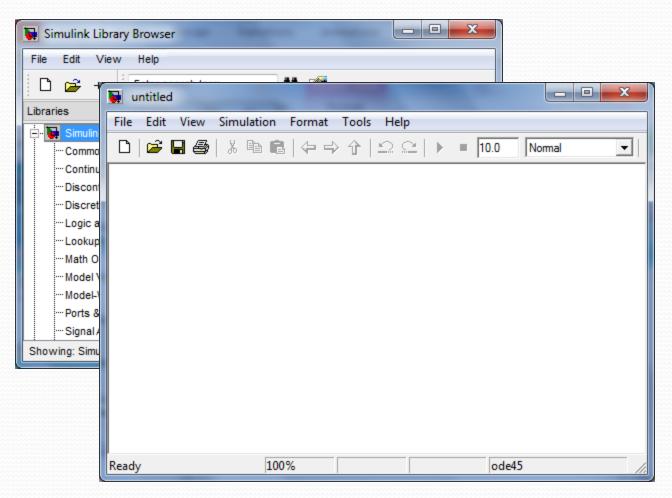
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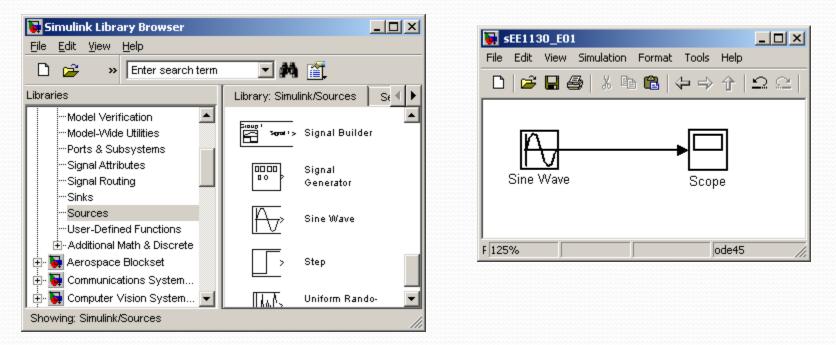
#### Simulink

• 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



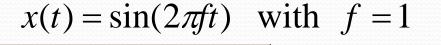
• We inserted a sinewave from the sources, and a scope from the sink library groups respectively.

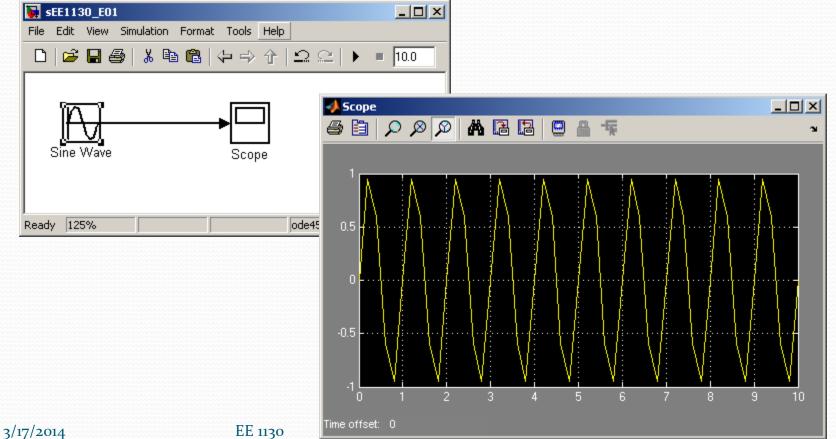
• By double clicking on the Sine Wave box we open its properties box and set the angular frequecy to 2\*pi\*1:

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

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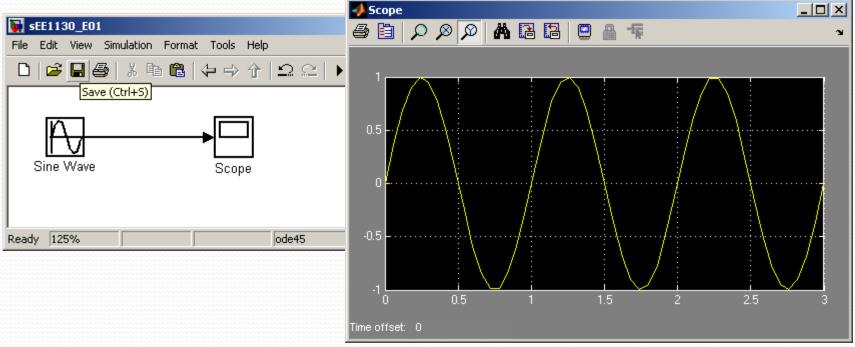
- To open the scope we double click on the Scope box.
- We hit the play icon to run the simulation.





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

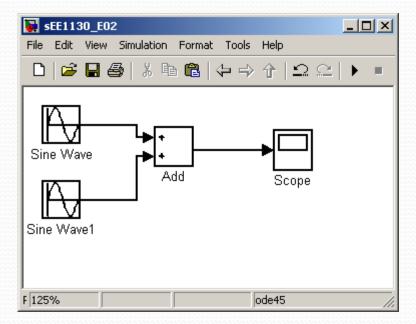
 $x(t) = \sin(2\pi f t)$  with f = 1



• 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:

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



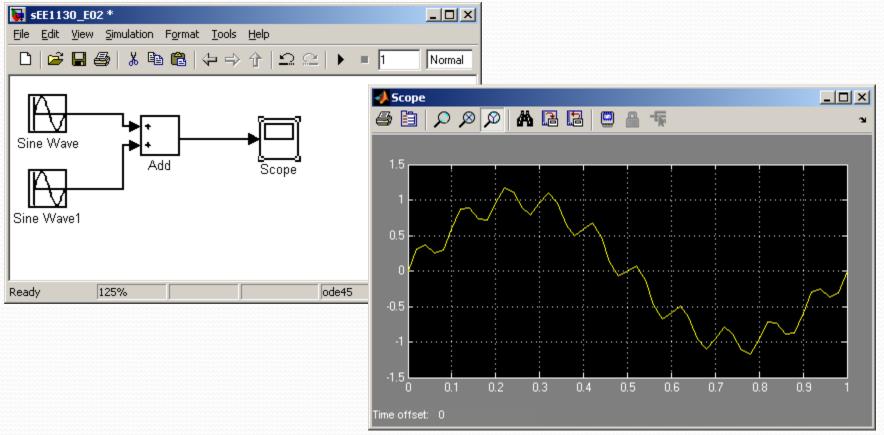
• We need to click on each sinewave box to set up the amplitude and frequencies:  $x(t) = \sin(2\pi 1t) + 0.2\sin(2\pi 60t)$ 

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Bias:	2*pi*60
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Frequency (rad/sec):	
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#### 3/17/2014

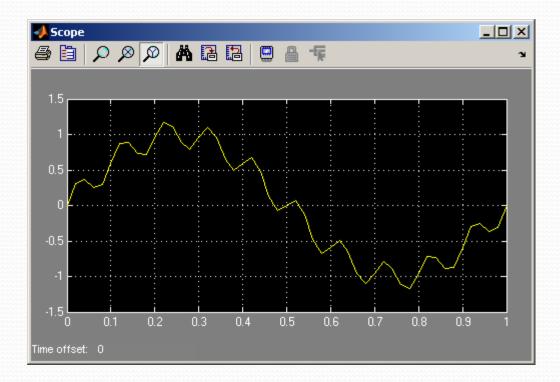
• Set the running time to 1 second, double click on the Scope box to open it up and hit play:

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



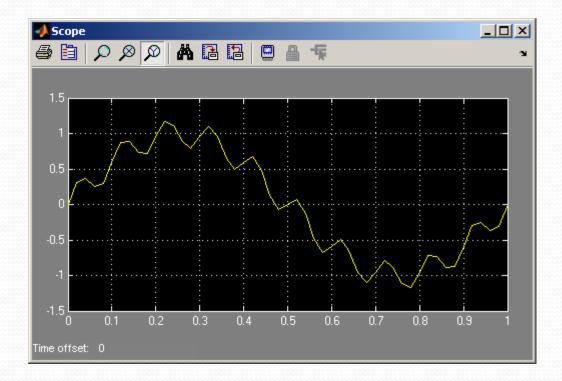
EE 1130

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



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

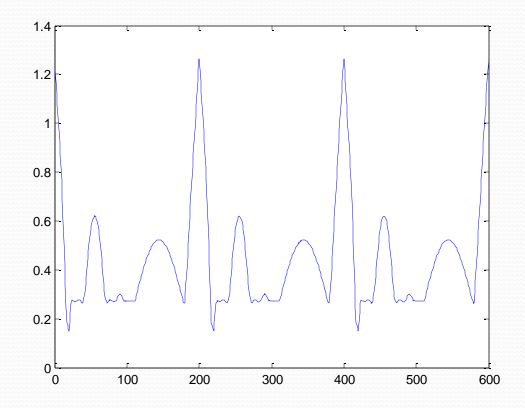
• The objective of next class is to get rid of the ripple and keep the 1Hz sinewave clean of noise!!! This is Signal Processing!!



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

#### Emulation of an EKG signal

• There is a code that I copied emulaing a EKG signal!!

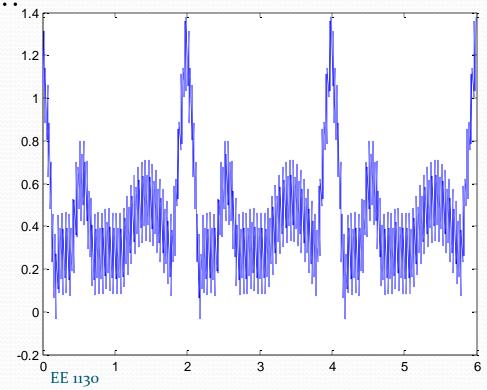


## **Emulation of an EKG signal**

• The location is!!



• I modified the code to create a noisy signal. This is the power of Matlab!!



**End of Class**