Lecture 10: Simulink

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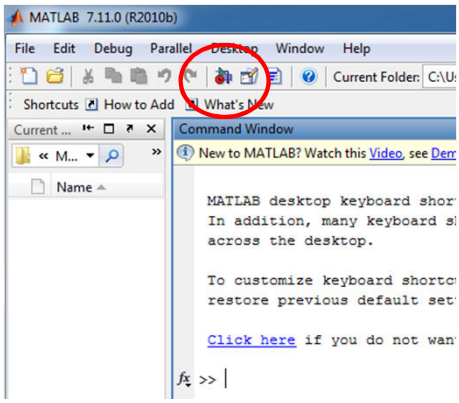
EE201: Computer Applications. See Textbook Chapter 10.

What is Simulink?

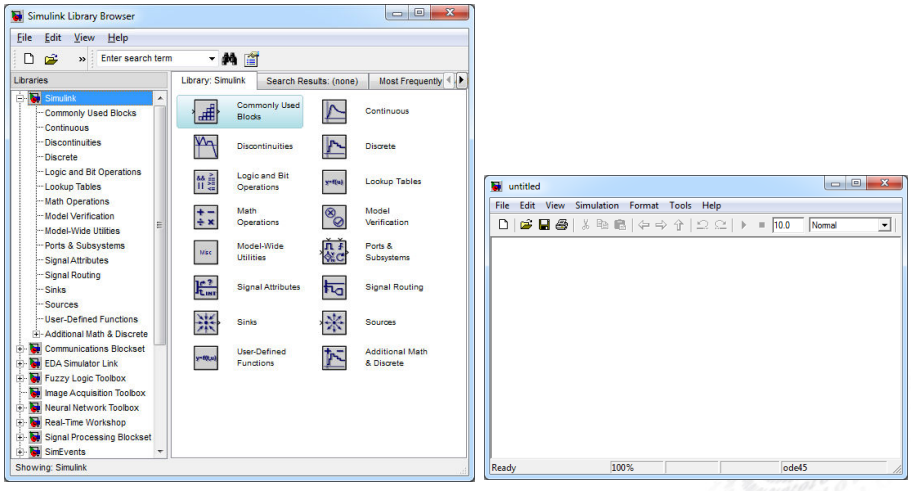
- Simulink is a tool for modeling, simulating and analyzing dynamic systems.
- Its primary interface is a graphical block diagramming tool and a customizable set of block libraries.
- It supports linear and nonlinear systems, modeled in continuous time, discrete time, or a hybrid of both.
- It easily integrates with the rest of the MATLAB environment.
- Simulink is widely used in control theory and digital signal processing for simulation and model-based design.

Starting Simulink

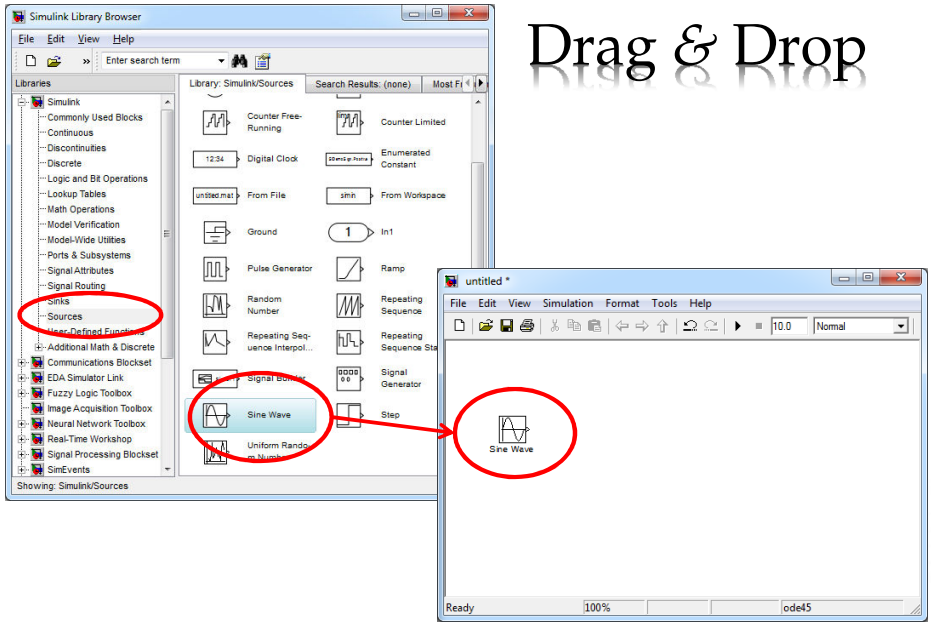
- To build a Simulink model, choose File | New | Model.
- To see the Simulink library of blocks click on the Simulink icon in MATLAB.



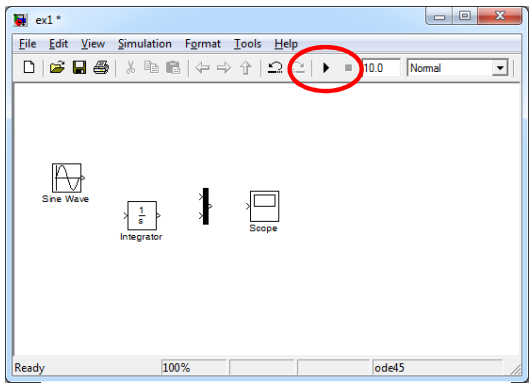
Library Browser & Model Window

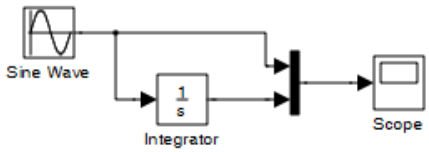


Drag & Drop



- Sources | *Sine Wave*
- Continuous | *Integrator*
- Signal Routing | *Mux*
- Sinks | *Scope*
- To connect blocks, move the cursor to the output port represented by ">" sign. Once placed at a port, the cursor will turn into a cross "+" enabling you to make the connection between blocks.
- Run the simulation of the simple system shown by clicking on the play icon.

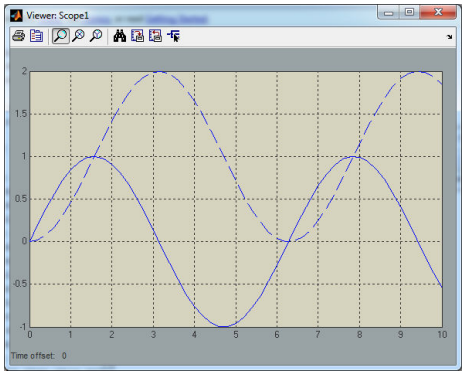




$$\mathcal{L}\left\{\int_0^t f(v)dv\right\} = \frac{1}{s}F(s)$$

Scope Results

- Double click on the scope block to see the results of the simulation.
- To view/edit the parameters of a block, double click on the block to see the *Block Parameters* window.
- Try changing the initial condition of the Integrator from 0 to -1.



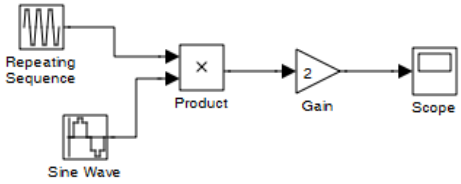
Blocks & Model File

- MATLAB uses the default values of the block parameters, except where you explicitly change them.
- You can always click on Help within the Block Parameters window to obtain more information.
- You can edit the label of a block by clicking on the text and making the changes.
- You can search for Blocks in the Simulink search window.
- You can save the Simulink model as **.mdl** file by selecting File | Save menu item in Simulink.

Exercise: Modulation

Blocks:

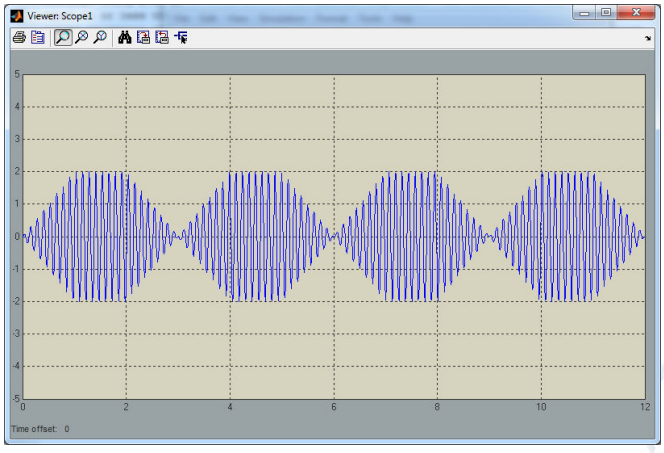
- Sources: Repeating Sequence
- Sources: Since Wave
- Math Operation: Produc
- Math Operation: Gain
- Sinks: Scope



Edit the following properties:

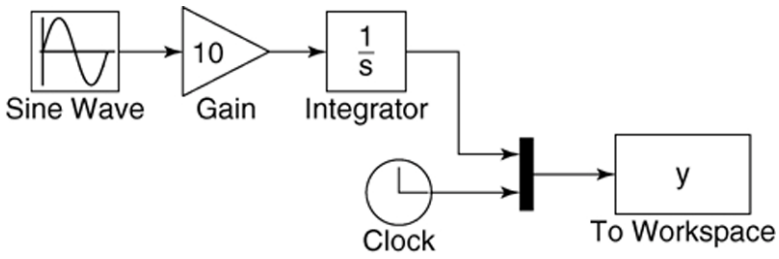
- Repeating Sequence:
  - Time Values: [0 1 2 3 4 5 6]
  - Output Values: [0 1 1 0 -1 -1 0]
- Sine Wave:
  - Frequency: 50 rad/s
  - Sample time: 0.01
- Gain: 2
- Simulation Stop Time:
  - 12 seconds

Results



Exercise: Sending data to Workspace.

Notice the "Clock" and "To Workspace" blocks.
Set simulation time to 13 seconds.



Double-click on the To Workspace block. You can specify any variable name you want as the output; the default is `simout`. Change its name to `y`.

The output variable `y` will have as many rows as there are simulation time steps, and as many columns as there are inputs to the block.

The second column in our simulation will be time, because of the way we have connected the Clock to the second input port of the Mux.

Specify the **Save format** as **Array**. Use the default values for the other parameters (these should be `inf`, `1`, and `-1` for Maximum number of rows, Decimation, and Sample time, respectively). Click on **OK.**

Simulink can be configured to put the time variable `tout` into the MATLAB workspace automatically when you are using the To Workspace block.

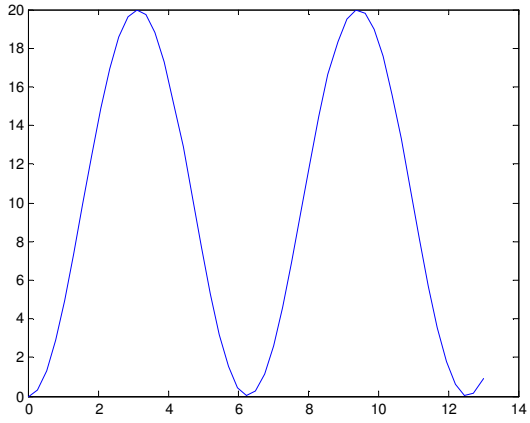
This is done with the Data I/O tab under **Configuration Parameters** on the Simulation menu.

The alternative is to use the Clock block to put `tout` into the workspace.

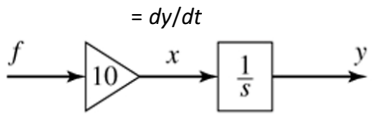
The Clock block has one parameter, **Decimation**. Set this parameter to **1**, which means the Clock block will output the time every time step; if set to 10 for example, the block will output every 10 time steps, and so on.

In MATLAB, try: **plot(y(:,2), y(:,1))**

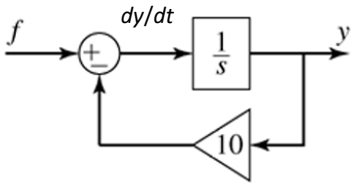
Result



Simulation diagrams for $x = dy/dt = 10\,f(t)$

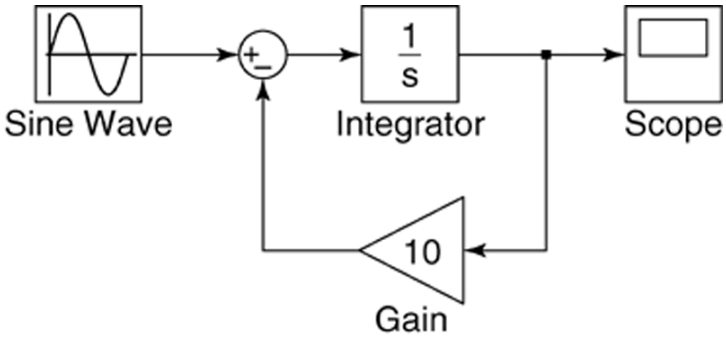


Simulation diagram for $dy/dt = f(t) - 10y$



Exercise: Simulink model to solve the first-order ODE

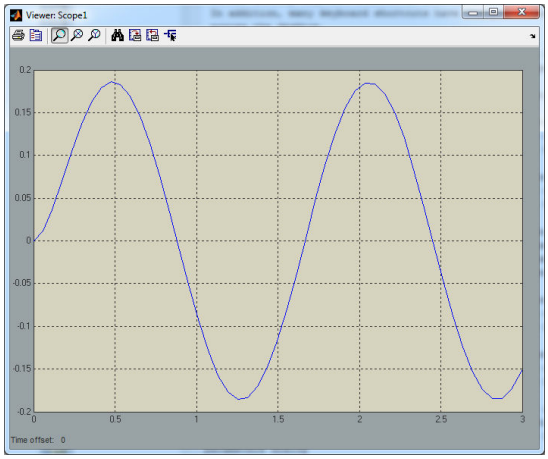
$$dy/dt = -10y + 2\sin(4t) \quad 0 \le t \le 3$$



Homework: Use Simulink to solve the second-order ODE

$$d^2x/dt^2 = 5\cos(2t) - 3\,dx/dt - 4x \qquad 1 \le t \le 3$$

Result



Homework

- Solve as many problems from Chapter 10 as you can
- Suggested problems:
- Solve: 10.1, 10.3, 10.4.

