Automotive Mechatronics

Introduction to Simulink

Simulink is an extension to Matlab that allows engineers to rapidly and accurately build computer models of dynamic physical systems using block diagram notation. Simulink can handle both linear as well as non-linear systems with ease.

Since, Simulink is a rapid prototyping tool, the blocks themselves are pre-programmed eliminating the need for coding.

Example: Consider a Spring-Mass-Damper system

From Newton's 2nd Law
\[ \Sigma F = ma \]

\[ f(t) - CV - Kx = ma \]

\[ ma = f(t) - CV - Kx \]

\[ a = \frac{1}{m} \left( f(t) - CV - Kx \right) \]  (Equation of motion)
New (.m) file  
Simulink Icon

Current Directory

Command Window

Matlab Workspace

Command History

**Current Directory** → Shows the current working directory & the files stored in it.

**Command Window** → Commands can be typed here for execution.

**Command History** → Previously executed commands are stored.

**Matlab Workspace** → Temporary workspace where all the data is stored.
A Simulink block diagram has to be created in a (.mdl) (model) file and while the (.m) file, which is a script file, can be used to transfer parametric values to the model file.
Building The Simulink Block Diagram:

Left click, hold, drag and drop to bring a block from the Simulink Library to the model workspace. Left Double Click anywhere on the model workspace and start typing to add annotations.

Right single click on a block, hold, and move away to duplicate it:

Left single click on the output port of a block, hold, and move to input port of another block to connect two blocks.

Right single click on a line and hold to branch off to connect to another block.

Right Single Click on any block to change its appearance and format. Left Double Click on any block to set its parameters and functions.

Tips:

→ Arrange the blocks in such a way so as to clearly represent the flow of signals through the system.
→ Give appropriate names and units to each block and the interconnecting signal.
→ You can also color-code similar blocks.
Let's Build Our System!

Recall: Equation of motion.

\[ a = \frac{1}{m} \left[ F(t) - C_v - Kx \right] \]

Initial Conditions for the integrators
The dynamic equation is now built around the integrators:

\[ a = \frac{1}{m} \left[ F(t) - C v - K x \right] \]
Specify the solver to be used for numerical integration. Fixed-Step vs Variable-Step.

Uncheck the box "Limit data points to last" so that Simulink stores all the data points.
Running the Simulation.

* It is better not to hardcode the Simulink blocks with numerical values. Use an m-file to transfer these values onto the Simulink block diagram.

* Again use another m-file to pick-up the results of the Simulation for plotting rather than capturing the plot in a `scope` window. The `To Workspace` and the `To file` blocks in Simulink help with this post processing.

Note: All data that is stored in the Workspace will be lost when exiting Matlab or if a `clear all` command is executed.
Scope Window:

Scope is an excellent resource for quick inspection of the results, but, lacks the formatting capabilities of a (.fig) file.

But use scopes generously throughout the block diagram to inspect all the internal signals that may be of importance.
Post Processing Of Results:

Unformatted Figure:

Looks very similar to the scope window!
Edited Using Figure Properties: