

MENG366 SYSTEM DYNAMICS AND CONTROL LABORATORY

LABORATORY 1: INTRODUCTION TO COMPUTER SIMULATION

Objective:

1. To understand MATLAB SIMULINK and implement system's transfer function using it.
2. To solve the system equations and obtain the response of the system for different inputs.

Getting started with MATLAB SIMULINK

2.1 SIMULINK Tutorial

SIMULINK is the Graphical User Interface (GUI) for MATLAB. This section presents a brief tutorial on how to use SIMULINK to create an open-loop block diagram.

1. Start MATLAB and at the prompt type "SIMULINK" (all lower case) or you can click on the icon located on toolbar.



Figure 1.1

2. If installed, the SIMULINK Library Browser will soon pop up.
3. Click on the new icon, identical to a MS Word new file icon. That is your space to work in. After creating a model it can be saved (using the save icon).

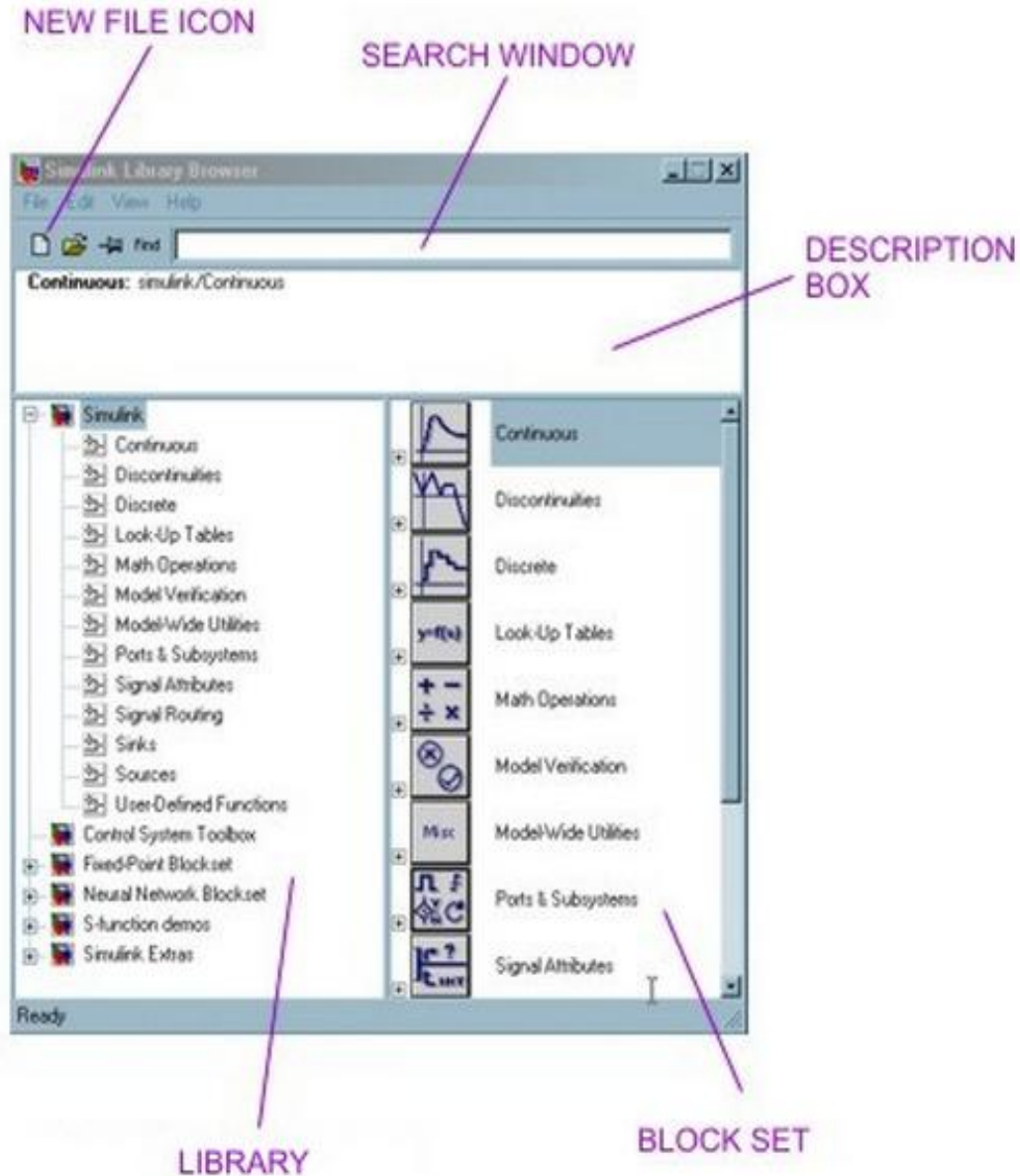


Figure 1.2

4. To build simulation models, you will be creating block diagrams .In general all blocks are double-clickable to change the values within. You can connect the ports on each block via arrows easily by clicking and dragging with the mouse. You can also double-click any arrow (these are the controls variables) to label what it is. Same with all block labels (SIMULINK will give a default name that you can change).

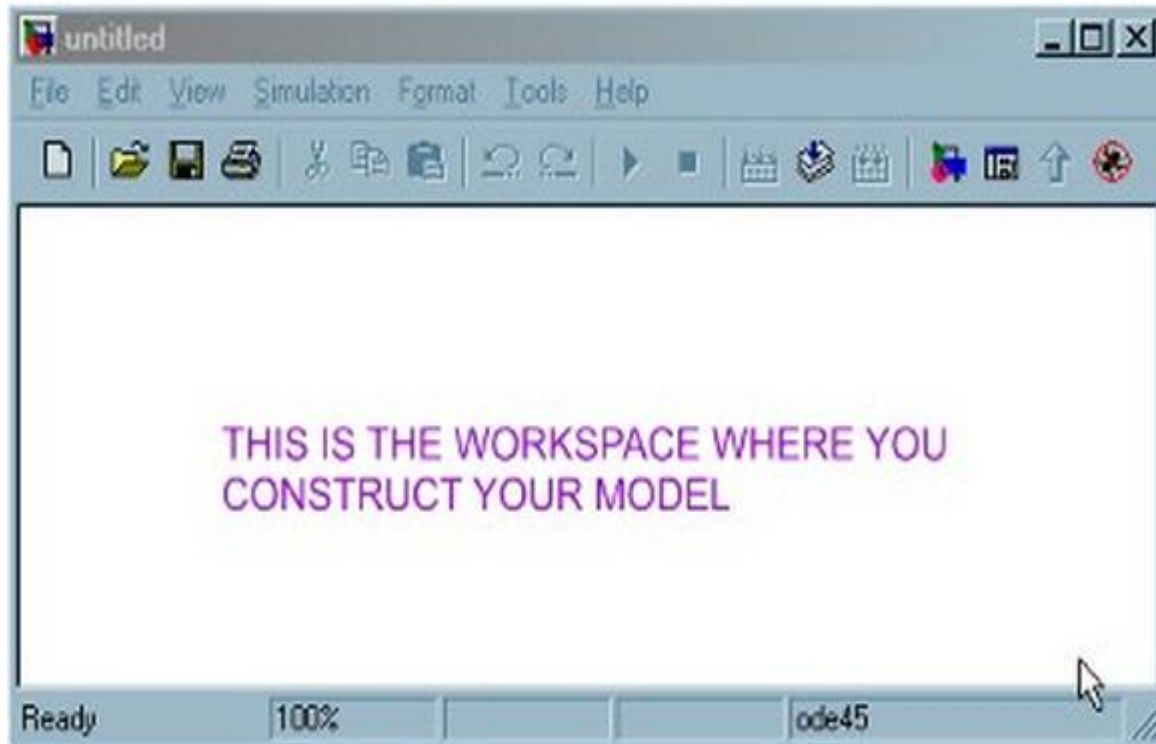


Figure 2.3

5. SIMULINK uses EE lingo. Sources are inputs and sinks are outputs. If you click around in the SIMULINK Library Browser, you will see the possible sources, blocks, and sinks you have at your disposal.

Example:

Now let us create a simple one-block transfer function and simulate it subject to a unit step input.

The given open-loop transfer function is $(s) = \frac{1}{s^2+2s+8}$

- a. Click the new icon in the SIMULINK Library Browser to get a window to work in (untitled with the SIMULINK logo).
- b. Double-click the “Continuous” button in the SIMULINK Library Browser to see what blocks are provided for continuous control systems. Grab and slide the “Transfer Fcn” block to your workspace.

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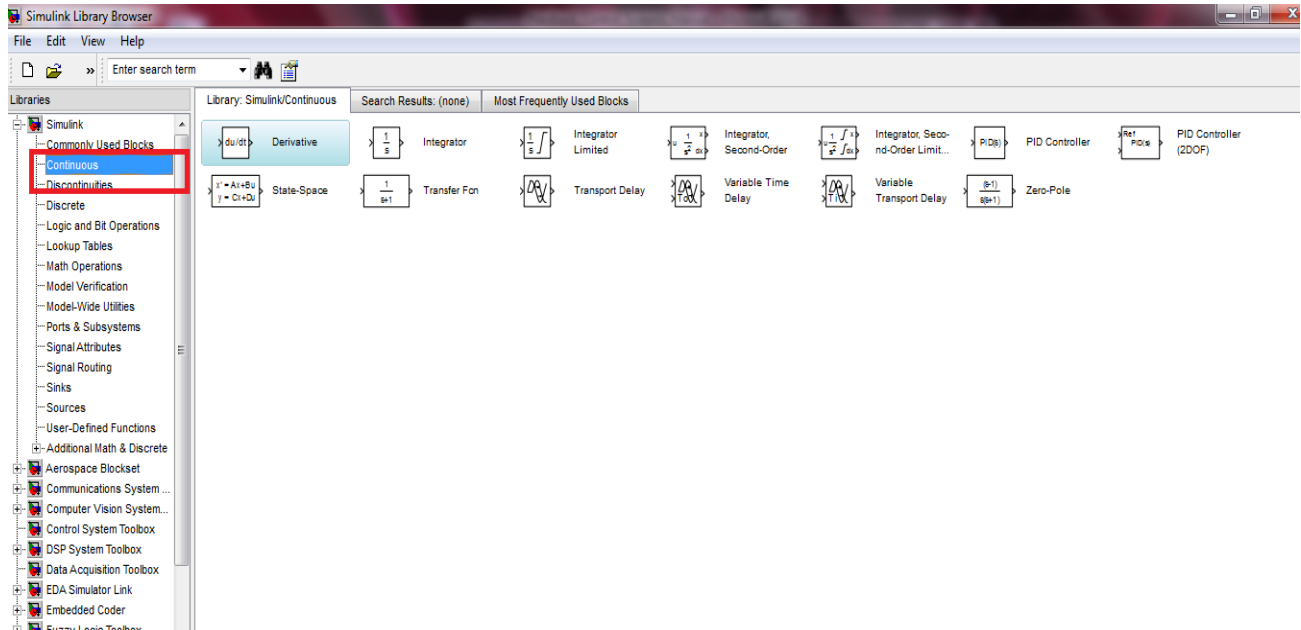


Figure 1.4

c. Double-click the block in your workspace and enter 1 in Numerator coefficients and 1 2 8 in Denominator coefficients and close by clicking OK. SIMULINK will update the transfer function in the block, both mathematically and visually.

d. Go ahead and save your model as name.mdl (whatever name you want, as long as it is not a reserved MATLAB word).

e. Click the Sources tab in the SIMULINK Library Browser to see what source blocks are provided. You will find a Step, Ramp, Sine Wave, etc. Grab and slide the Step block to your workspace.

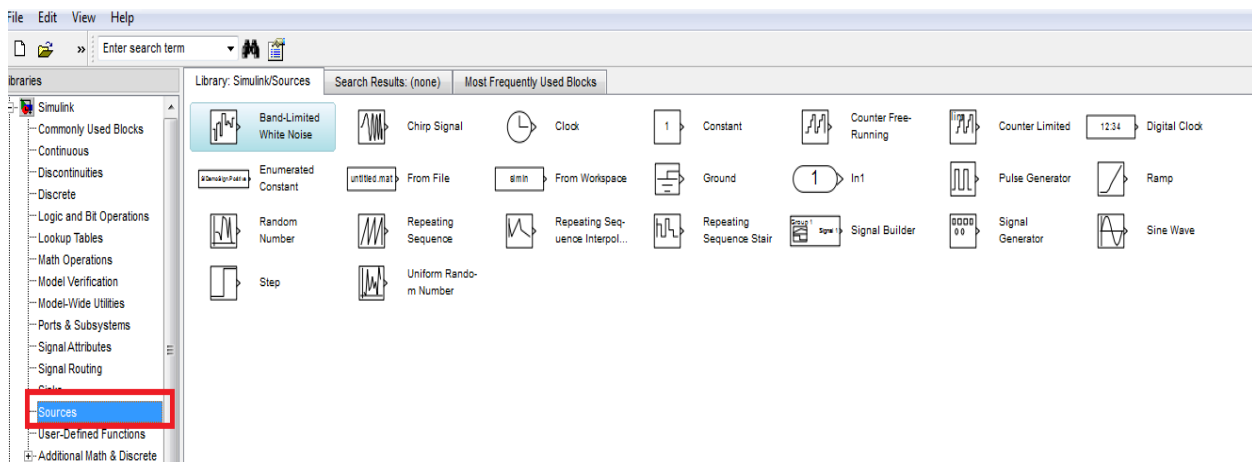


Figure 1.5

Double-click the Step block in your workspace and ensure 1 is entered as the final value (for a unit step) and that 0 is the initial value. Close by clicking OK.

f. Draw arrows

g. Click the Sinks tab in the SIMULINK Library Browser to see what sink blocks are provided. Grab and slide the Scope block to your workspace.

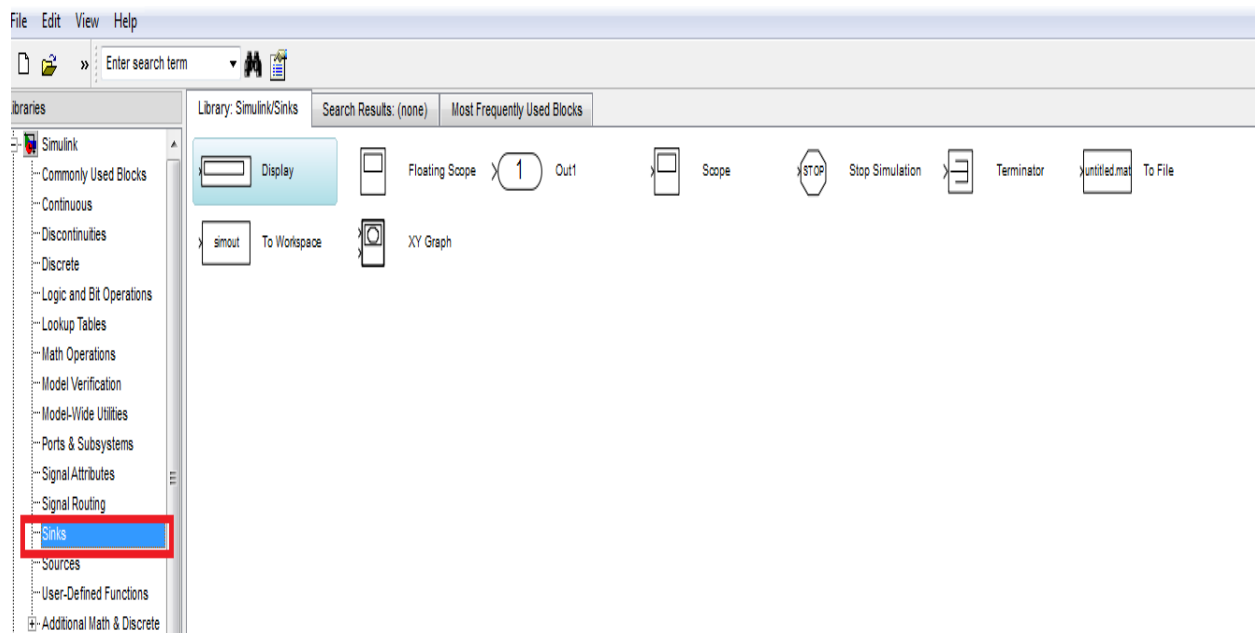


Figure 1.6

h. Draw an arrow from the “Transfer Fcn” block to the Scope block by using the mouse, the same method as before.

i. To run the model (solve the associated differential equation numerically and plot the output results vs. time automatically), simply push play (the solid black triangle button in your workspace window).

j. After it runs, double-click on your Scope to display the results. Your final model will look like this:

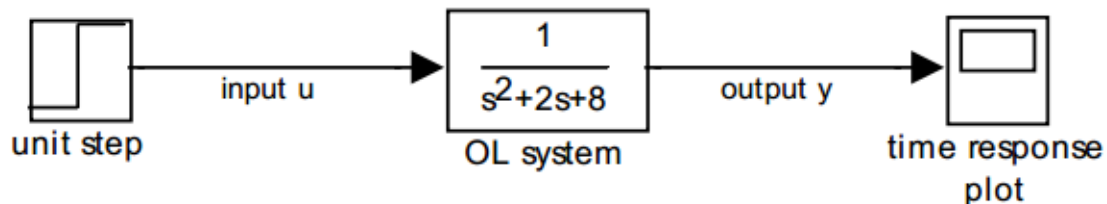


Figure 1.7

Exercise1:

Generate the following MATLAB SIMULINK model and simulate its step response.

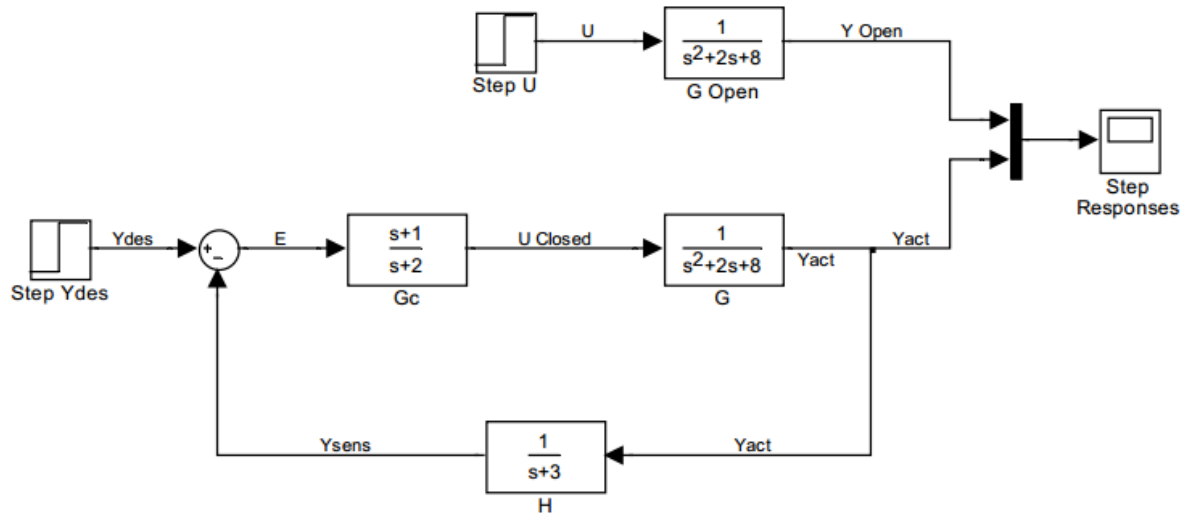


Figure 1.8

Exercise2:

a. Obtain the unit impulse response of the following system using SIMULINK.

$$\frac{(s)}{A(s)} = \frac{1}{s^2 + 0.2s + 1}$$

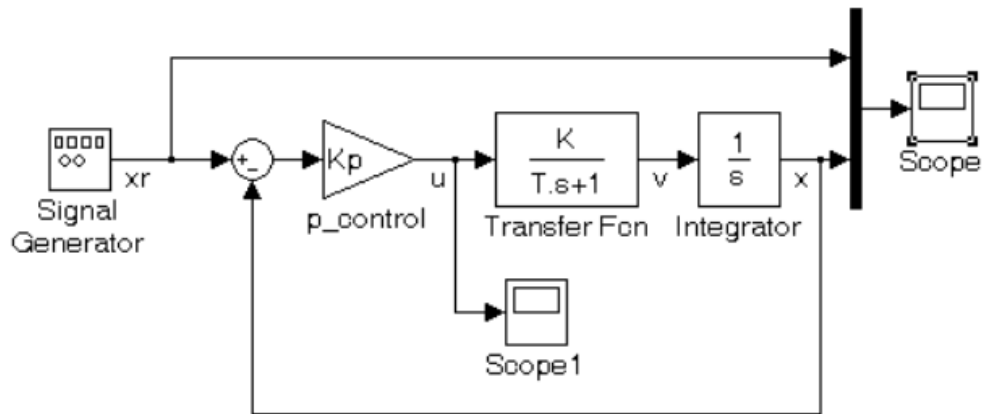
b. Obtain the unit step response of the following system using SIMULINK.

$$\frac{(s)}{A(s)} = \frac{s}{s^2 + 0.2s + 1}$$

Explain why the results in a and b are same.

POST LAB

Create a SIMULINK model with a first order system, with gain, $K = 1$, and time constant, $T = 0.1$ sec. Simulate a square wave input with unit amplitude and frequency of 0.3 Hz. The sample time is 0.001 sec. View the reference position, $x_r(t)$, input, $u(t)$, and actual position, $x(t)$, through a scope, as in Figure below. Experiment with different values of K_p and observe how the system response changes. Plot the results.

**Figure 2.9**