

How to Use Simulink



ECE743

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Features of Matlab and Simulink

➤ Matlab (*.m):

- Only text code (Not easy to model complicated systems)
- Easy to edit figures

➤ Simulink (*.mdl):

- Schematic (Easy to model complicated systems)
- Not easy to change parameters
- Can not edit figures

➤ Matlab (*.m) + Simulink (*.mdl): Best choice

- Schematic: Simulink
- Easy to change parameters: Matlab (m file for parameter initialization)
- Edit figures: Simulink (“To Workspace”) ⇒ Matlab (m file for plot)

Available Simulink Toolbox (version. 6.5)



➤ Simulink

- Aerospace Blockset
- CDMA Reference Blockset
- Communications Blockset

➤ Control System Toolbox

- DSP Blockset

➤ Gauges Blockset

- Embedded Target for Motorola MCP555
- Embedded Target for TI C6000 DSP
- Fixed-Point Blockset

➤ Fuzzy Logic Toolbox

- MPC Blocks
- NCD Blockset

- Neural Network Blockset
- Real-Time Windows Target

➤ Real-Time Workshop

- Report Generator
- S-function demos

➤ SimMechanics

- SimPowerSystems

➤ Simulink Extras

➤ Stateflow

➤ System ID Toolbox

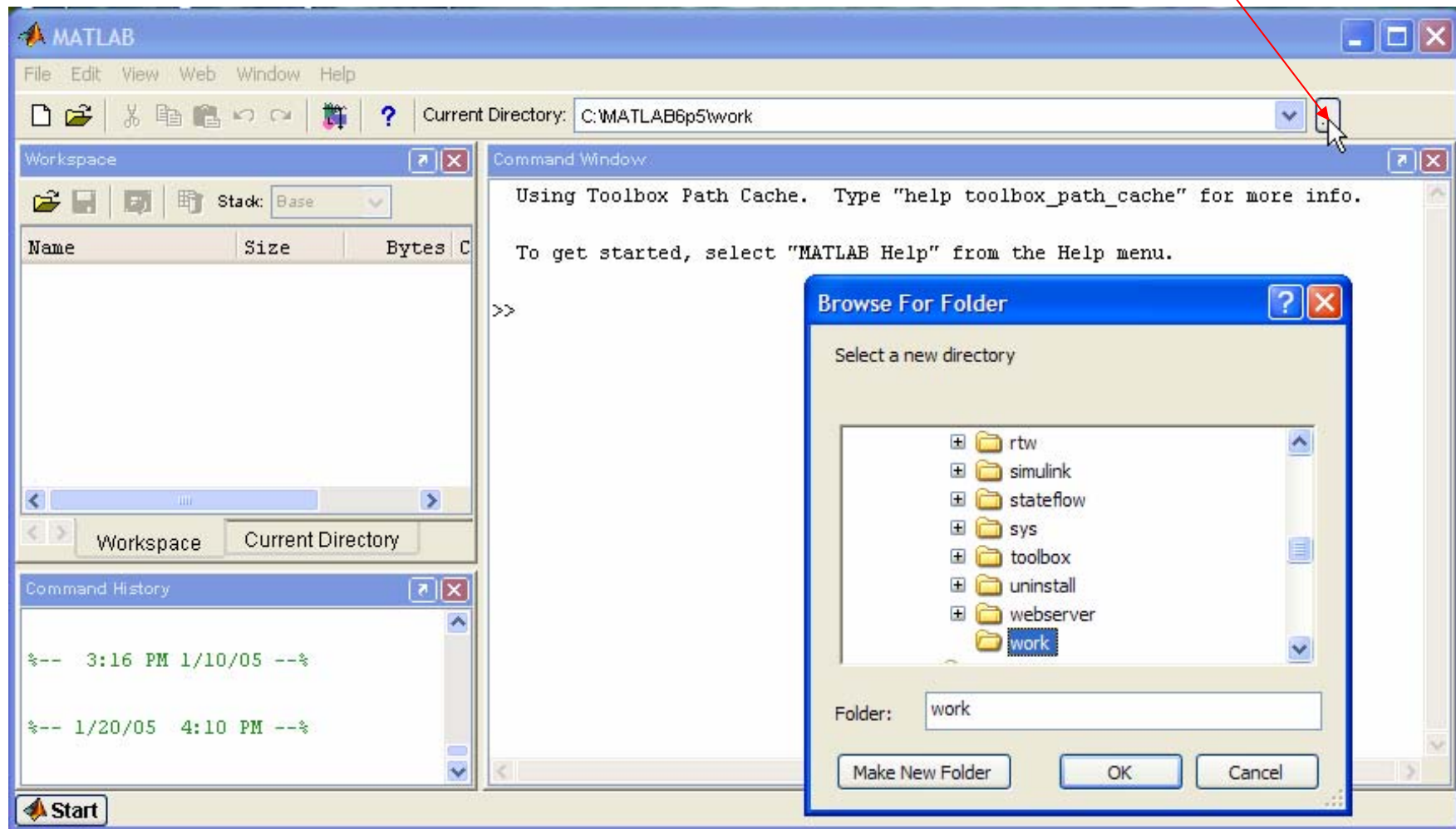
- Virtual Reality Toolbox
- xPC Target

◆ : Available toolboxes at ECE Computer Lab.

1. Current Directory

1). Change “Current directory”

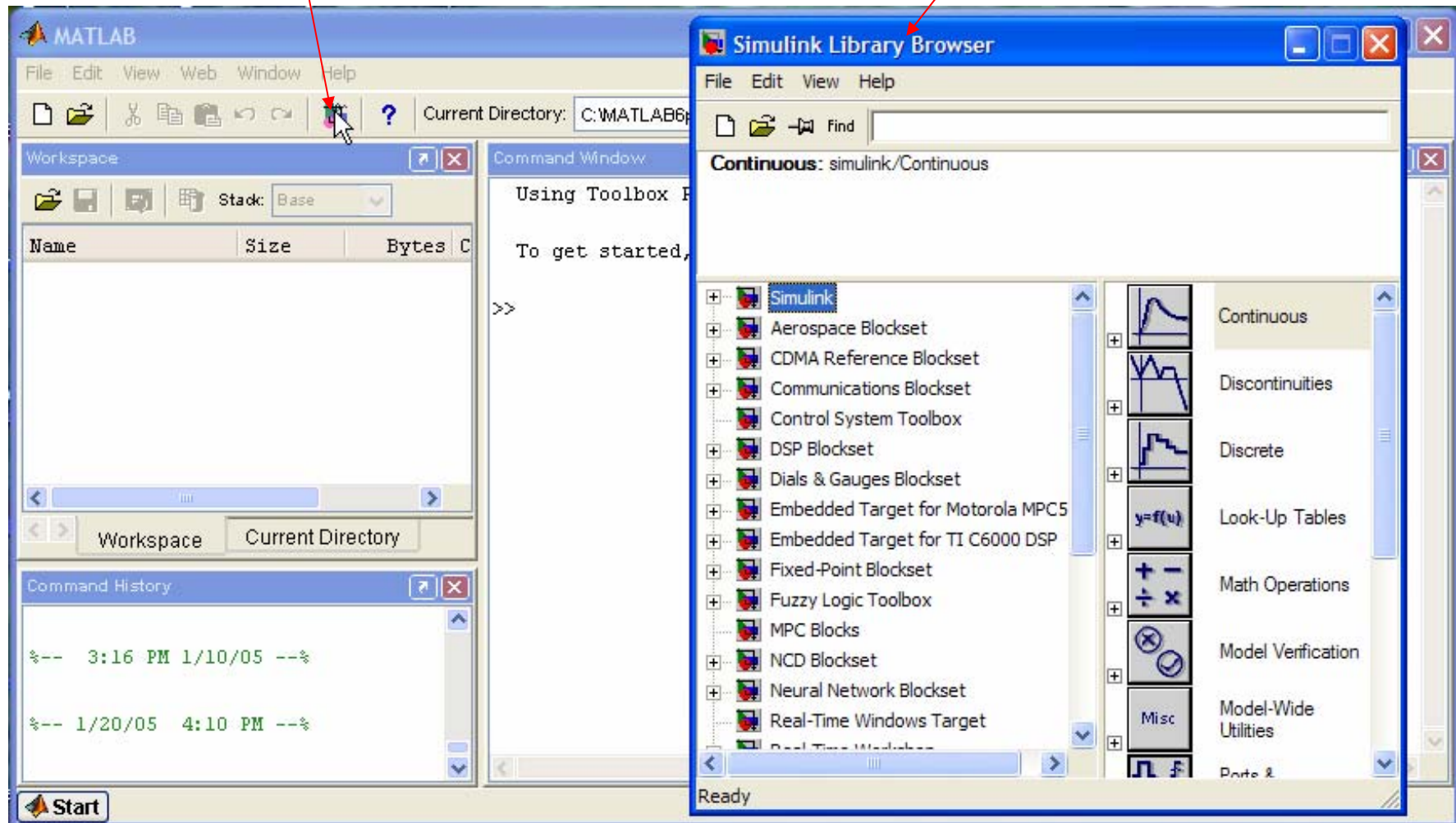
Click “Browser for folder”



2. Starting “Simulink”

1). Click “Simulink”

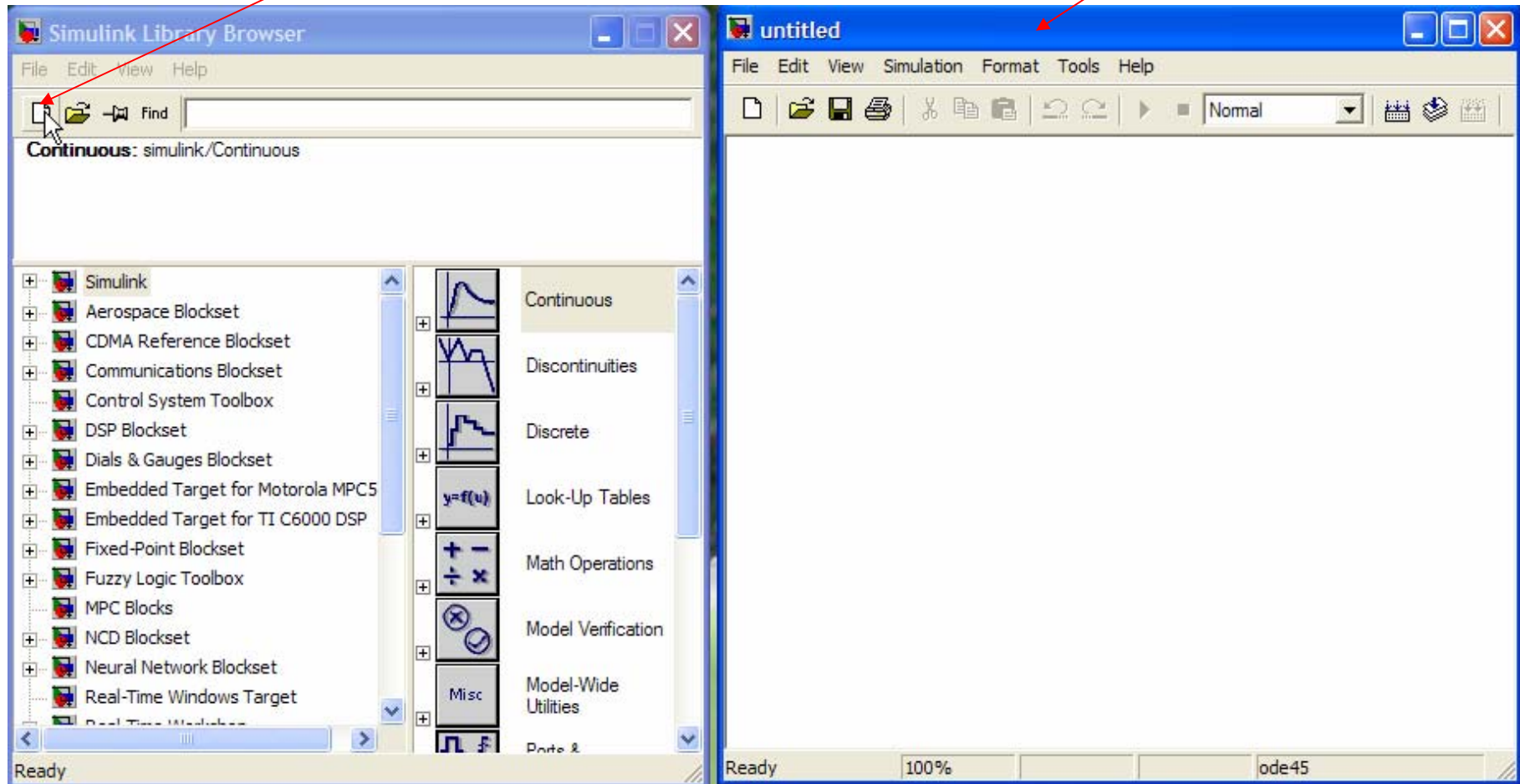
Then, Simulink Library Browser



3. Open “A new file”

1). Click “Create a new model”

Then, a new Simulink file



4. Building “System” (1)

- ❖ Find “Block“ when you know “block’s name”
- 1). Type block’s name and then drag it to a new file

“Press a right button on a mouse”
“Double click your model”

The screenshot shows the Simulink environment. On the left, the Simulink Library Browser is open with the search term 'integrator'. The 'Integrator' block is selected in the library. In the center, the 'untitled' model window shows the Integrator block being placed on the canvas. A right-click context menu is open over the block, with the 'Format' option selected, and a sub-menu showing 'Font...'. On the right, the 'Block Parameters: Integrator' dialog box is open, showing various configuration options like 'External reset', 'Initial condition source', and 'Initial condition'. A red arrow points to the 'Help' button at the bottom of this dialog box.

4. Building “System” (2)

❖ Find “Block” when you don’t know “block’s name”

1). Click “Simulink Help”

Then, type the text for model search

This is model name

The image consists of two side-by-side screenshots from the MATLAB/Simulink environment.

Left Screenshot: Simulink Library Browser
 The window title is "Simulink Library Browser". The "Help" menu is open, showing options: "Help on the selected block", "Simulink Help" (highlighted with a mouse cursor), and "Tip of the Day". Below the menu, the library tree is visible, and the "Derivative" block is selected in the main pane.

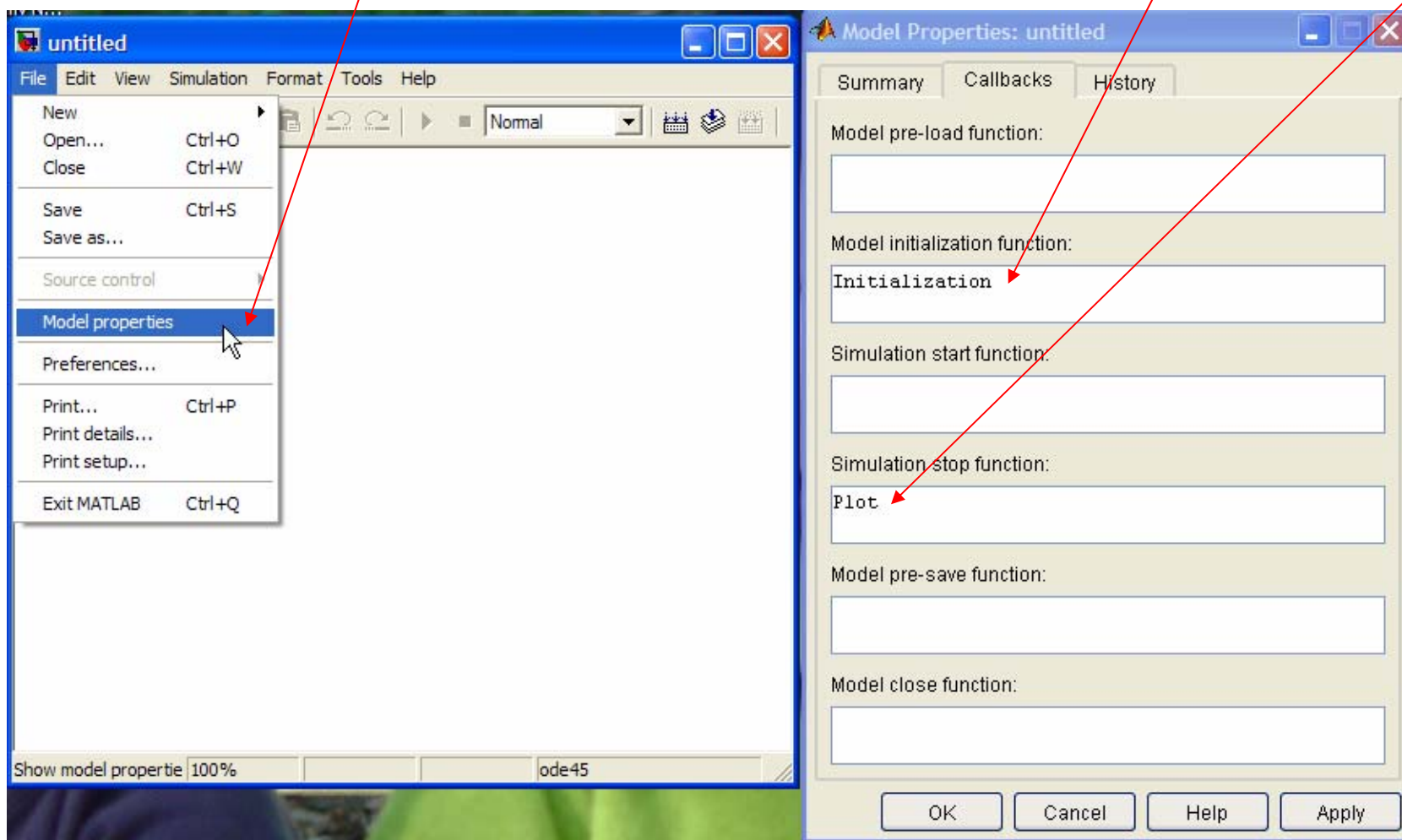
Right Screenshot: Help Window
 The window title is "Help". The "Search" tab is active. The search type is set to "Full Text" and the search term is "integrate". The search results list includes "Integrator", which is highlighted. The "Integrator" entry shows its library path and a description: "Integrate a signal". A small block diagram of the integrator is also shown.

5. Set up “Model properties”

❖ Set up m files for parameter initialization and **plot (later)**

1). Click “Model properties”

Then, type file names: Initialization.m and Plot.m

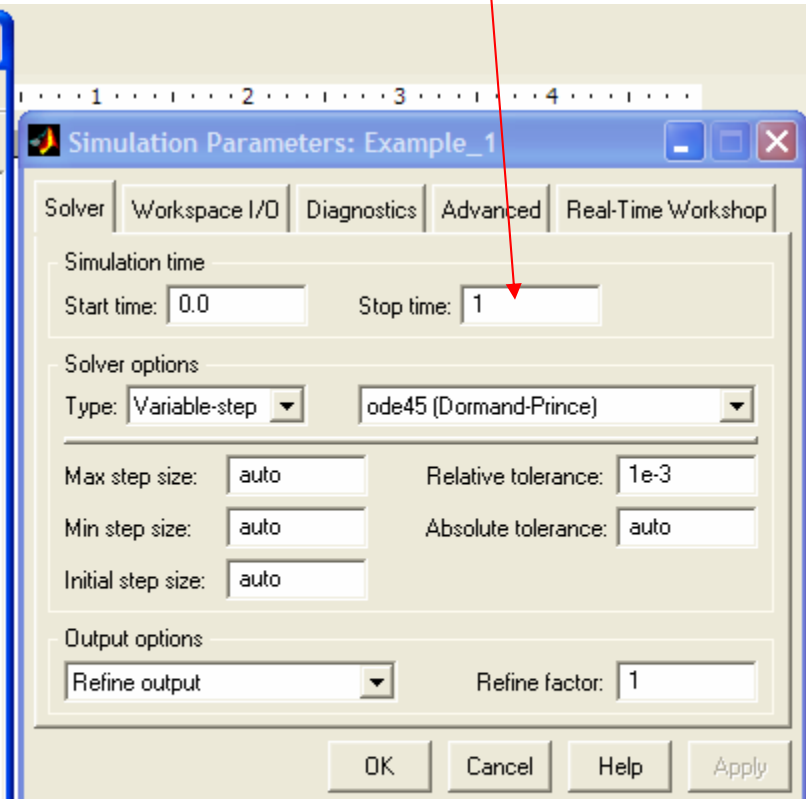
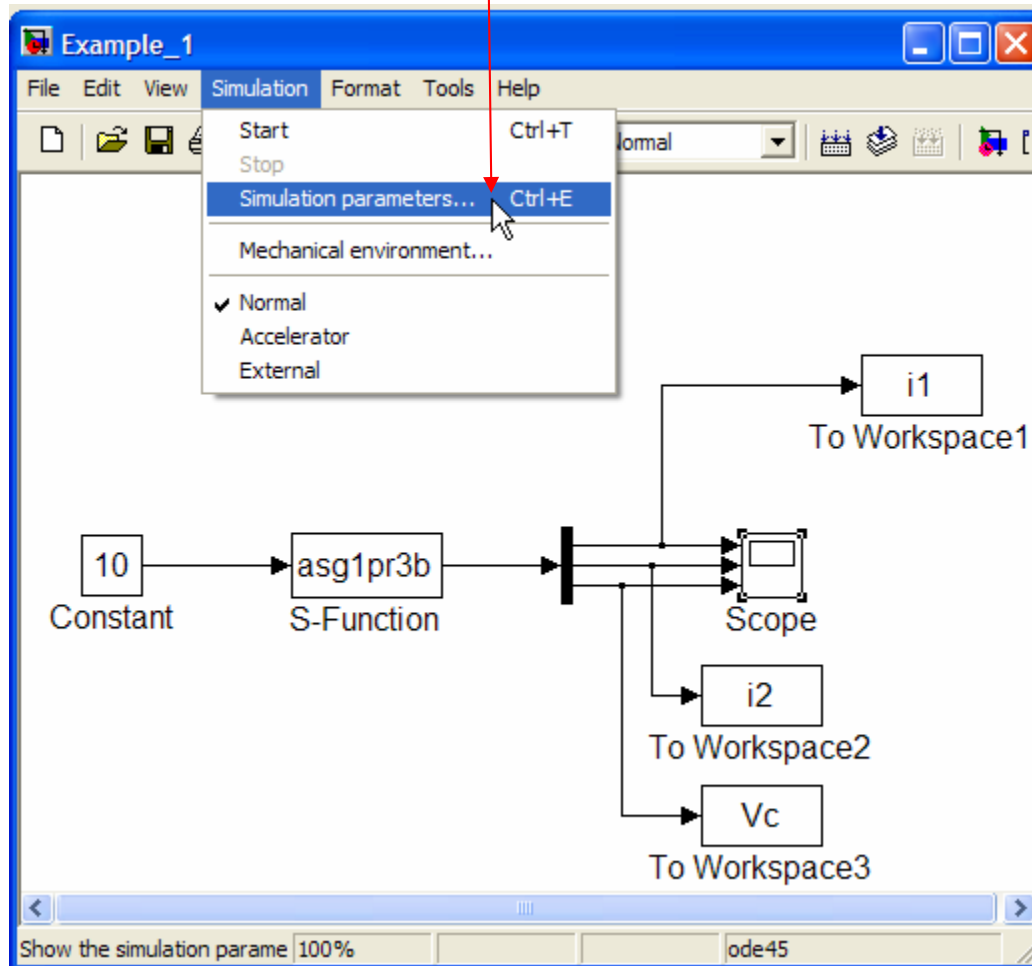


6. Start “Simulation” (1)

❖ Set up “Simulation parameters”

1). Click “Simulation parameters”

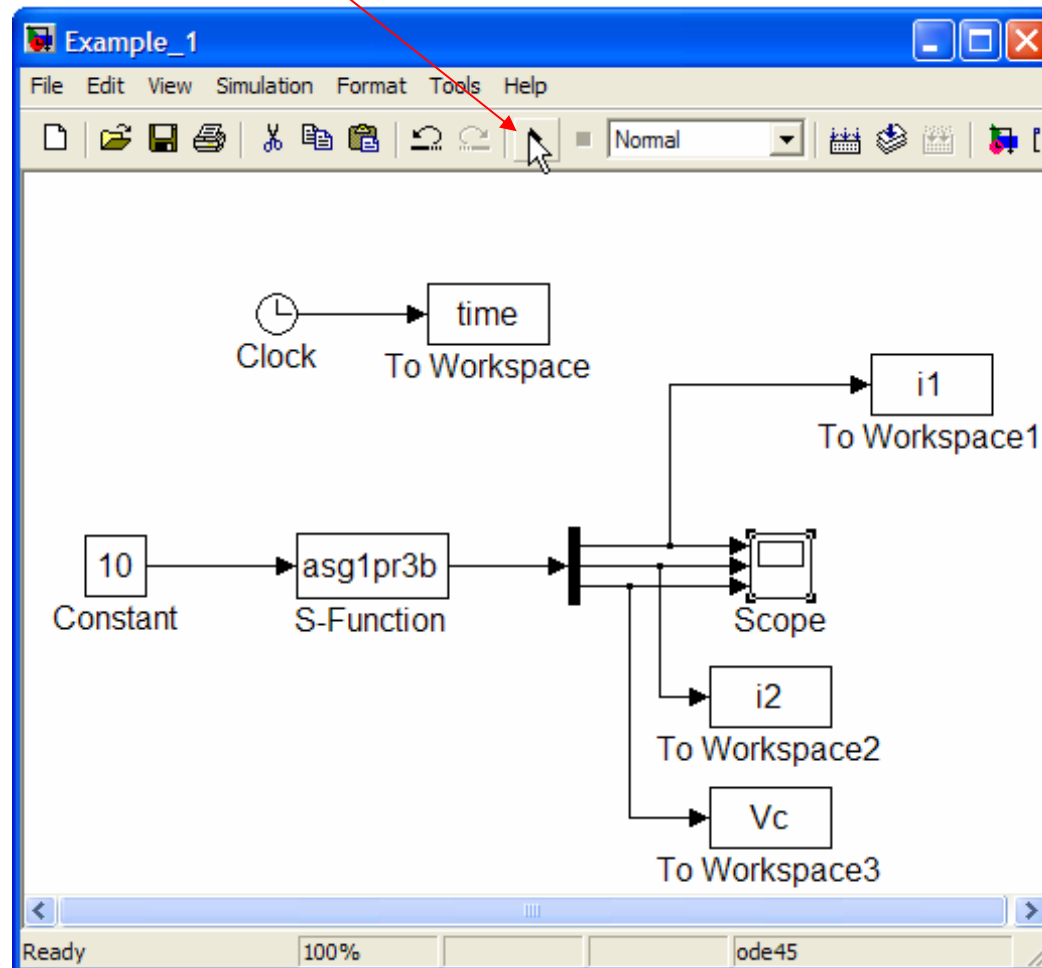
Then, change “Stop time”



6. Start “Simulation” (2)

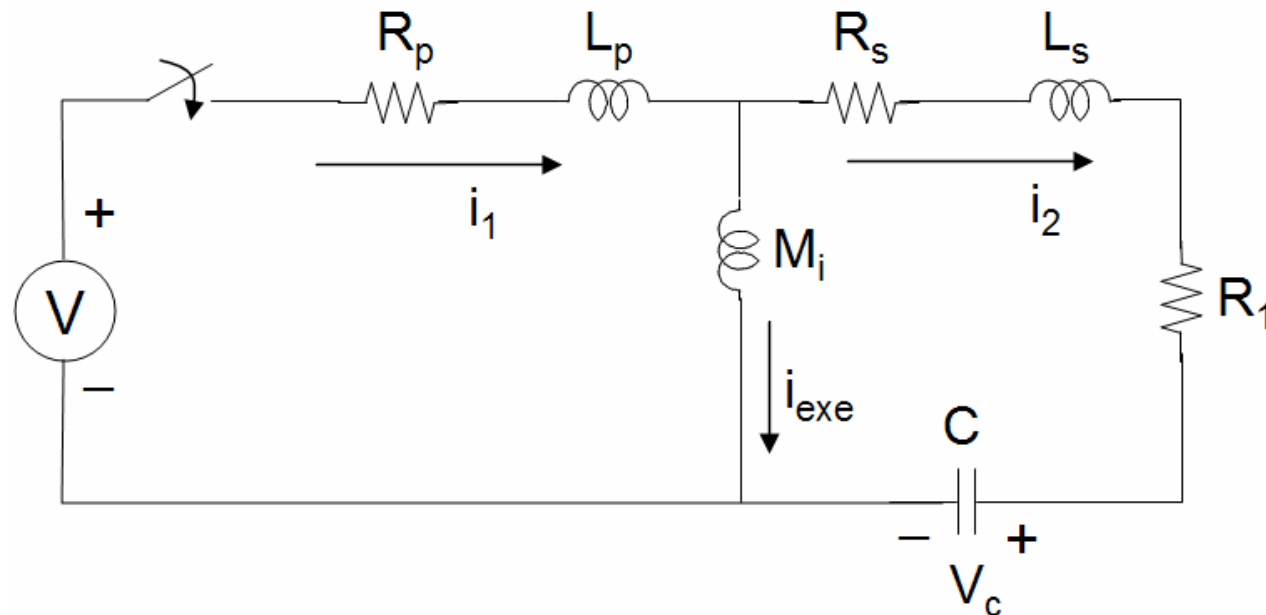
❖ Start Simulation

1). Click “Start simulation”



7. Example for Matlab/Simulink

❖ Example 1:



where: $L_p = 0.1$ H, $L_s = 0.2$ H, $R_p = 1$ Ω , $R_s = 2$ Ω , $R_1 = 1$ Ω , $M_i = 0.1$ H,
 $C = 1$ μ F, and $V = 10$ V (Step Input)

- Simulate the dynamic response of i_1 , i_2 , and V_c and plot the results on the same page.

7. Example 1

❖ Four different Methods

- **Case 1: Only Matlab**
 - **Case 2: Matlab + Simulink: S-Function**
 1. S-function: "asglpr3b.m"
 2. Simulink: "Example_1.mdl"
 3. Plot: Plot_1.m
 - **Case 3: Matlab + Simulink: Not S-Function**
 1. Parameter initialization: "Initialization.m"
 2. Simulink: "Case_3.mdl"
 3. Plot: Plot_1.m
 - **Case 4: Matlab + Simulink: "SimPowerSystems"**
 1. Parameter initialization: "Para_Initial.m"
 2. Simulink: "Case_4.mdl"
 3. Plot: Plot_1.m
- ◆ **"Note that all files should be under current directory"**

7. Example 1 – Case 1 – (1)

▪ Case 1: Only Matlab – (1)

% Only Matlab code - Example 1 - Case 1

```
clear all
Lp = 0.1;
Ls = 0.2;
Mi = 0.1;
Rp = 1;
Rs = 2;
R1 = 1;
C = 1e-6;
V = 10;
alpha = 0.1;

R = [-Rp 0 0; 0 -(Rs+R1) -1; 0 1 0]
D = [1;0;0]
L = [(Lp+Mi) -Mi 0; -Mi (Ls+Mi) 0; 0 0 C]
Linv = inv(L);

A = Linv*R;
B = Linv*D;

X = [0;0;0];
U = V;
```

7. Example 1 – Case 1 – (2)

- **Case 1: Only Matlab – Matlab code continued - (2)**

```

T = 0.0001; % time step

for n = 1:10000
% Trapezoidal Integration
    n1(n) = n;
    Xest = X + T*(A*X + B*U);
    Xdotest = A*Xest + B*U;
    alpha1 = 1 + alpha;
    alpha2 = 1 - alpha;
    term1 = alpha1*Xdotest;
    termint = A*X + B*U;
    term2 = alpha2 + termint;

    X = X + (T/2)*(term1 + term2);

    i1(n) = X(1);
    i2(n) = X(2);
    Vc(n) = X(3);

end

```

7. Example 1 – Case 1 – (3)

- **Case 1: Only Matlab – Matlab code continued - (3)**

```

figure (1)
subplot(3,1,1)
plot(n1*T,i1)
grid
ylabel('i_1 [A]')
title('i_1 vs time')

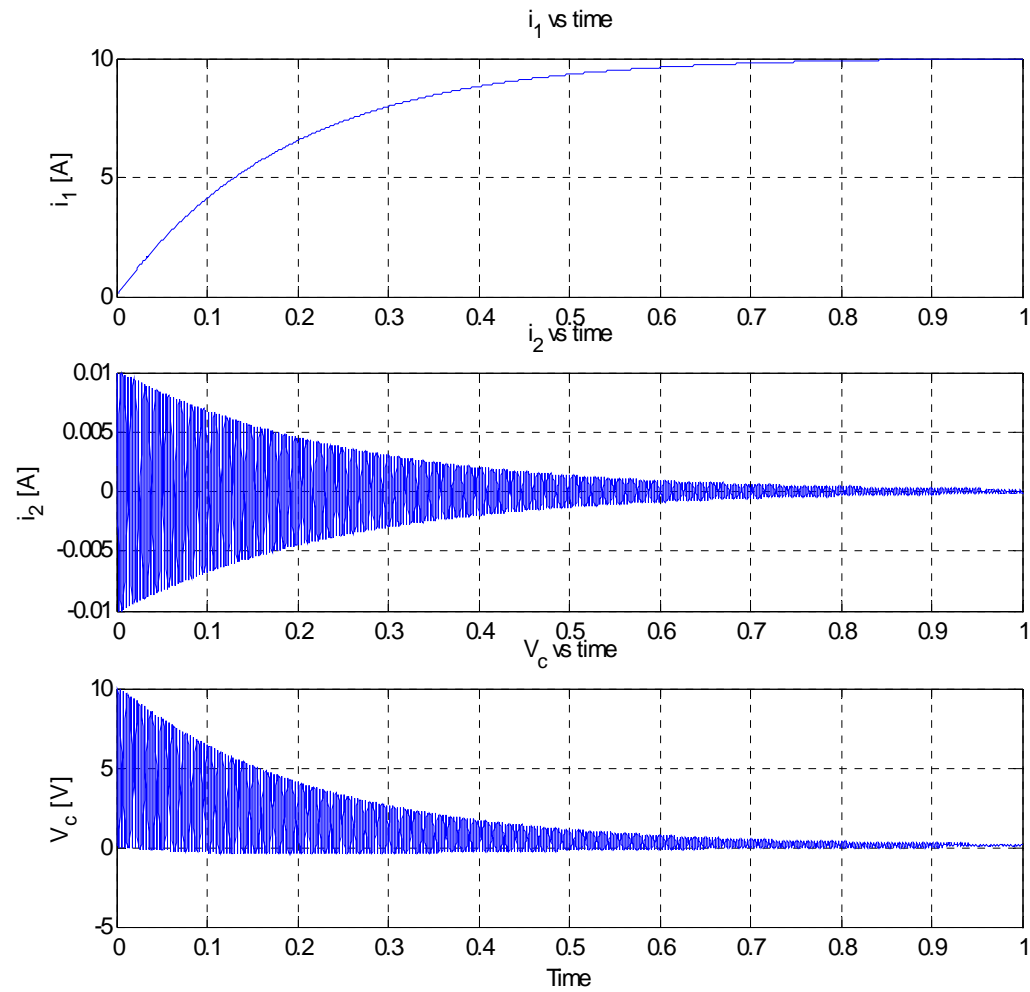
subplot(3,1,2)
plot(n1*T,i2)
grid
axis([0 1 -0.01 0.01])
ylabel('i_2 [A]')
title('i_2 vs time')

subplot(3,1,3)
plot(n1*T,Vc)
grid
axis([0 1 -5 10])
xlabel('Time')
ylabel('V_c [V]')
title('V_c vs time')

```


7. Example 1 – Case 1 – (4)

❖ Results



7. Example 1 – Case 2 – (1)

❖ Case 2: Matlab + Simulink: S-function

- S-function code: “asglpr3b.m” --- (1)

```
function [sys, x0]=prob1(t,x,u,flag)

Lp = 0.1;
Ls = 0.2;
Mi = 0.1;
Rp = 1;
Rs = 2;
Rl = 1;
C = 1e-6;
V = 10;
alpha = 0.1;
R = [-Rp 0 0; 0 -(Rs+Rl) -1; 0 1 0]
D = [1;0;0]
L = [(Lp+Mi) -Mi 0; -Mi (Ls+Mi) 0; 0 0 C]
Linv = inv(L);
A = Linv*R;
B = Linv*D;
```

7. Example 1 – Case 2 – (2)

❖ **S-function code:** “asglpr3b.m” --- Matlab code continued - (2)

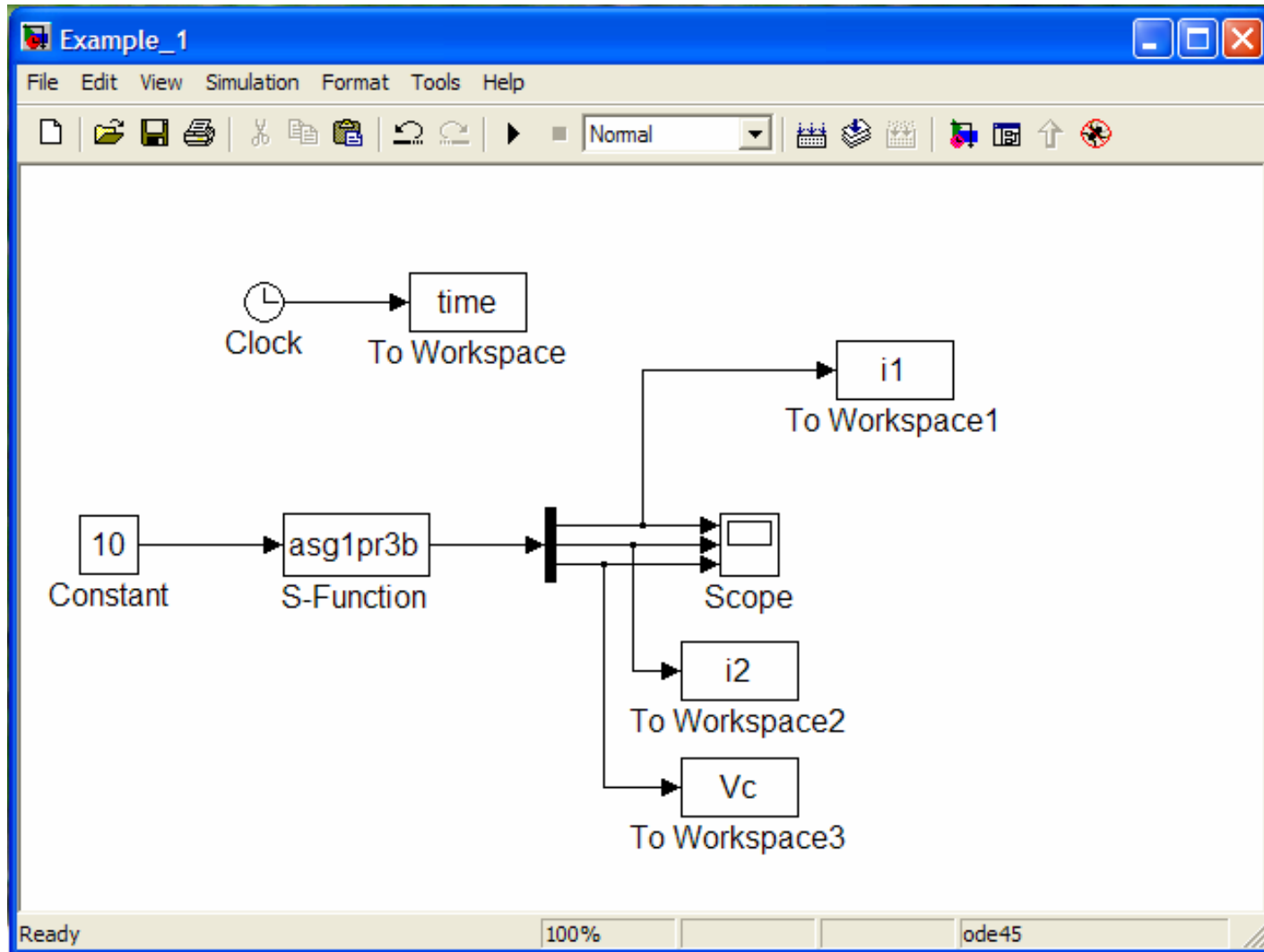
```
if abs(flag)==1
    sys(1:3)=A*x(1:3)+B*u;
elseif abs(flag)==3
    sys(1:3)= x(1:3);

elseif flag==0
    sys(1)=3;
    sys(2)=0;
    sys(3)=3;
    sys(4)=1;
    sys(5)=0;
    sys(6)=0;

    x0= [0; 0; 0];
else
    sys=[];
end;
```

7. Example 1 – Case 2 – (3)

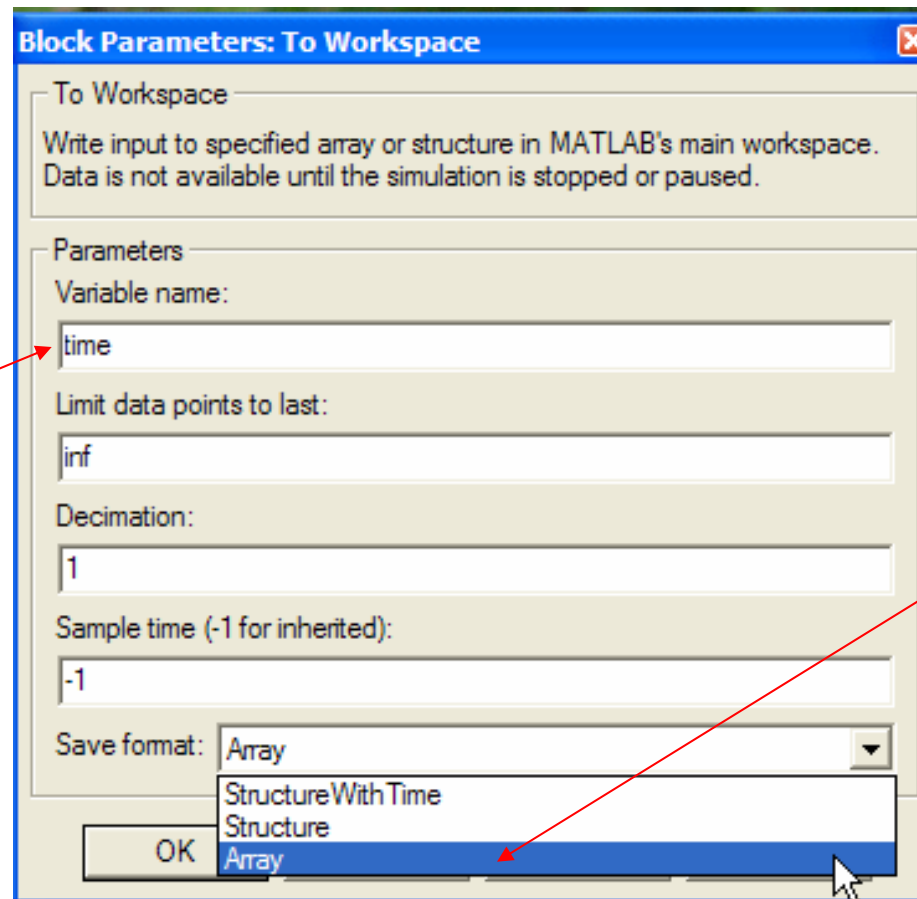
❖ Simulink code: “Example_1.mdl” --- (1)



7. Example 1 – Case 2 – (4)

❖ **Simulink code:** “Example_1.mdl” --- (2)

1. “To Workspace”



“Type a variable name”

Click “Array”

7. Example 1 – Case 2 – (5)

❖ **Simulink code:** “Example_1.mdl” --- (3)

2. “S-Function”

“Type S-function name”

“Blank”

Block Parameters: S-Function

S-Function

User-definable block. Blocks may be written in M, C, Fortran or Ada and must conform to S-function standards. t,x,u and flag are automatically passed to the S-function by Simulink. "Extra" parameters may be specified in the "S-function parameters" field.

Parameters

S-function name:

asg1pr3b

S-function parameters:

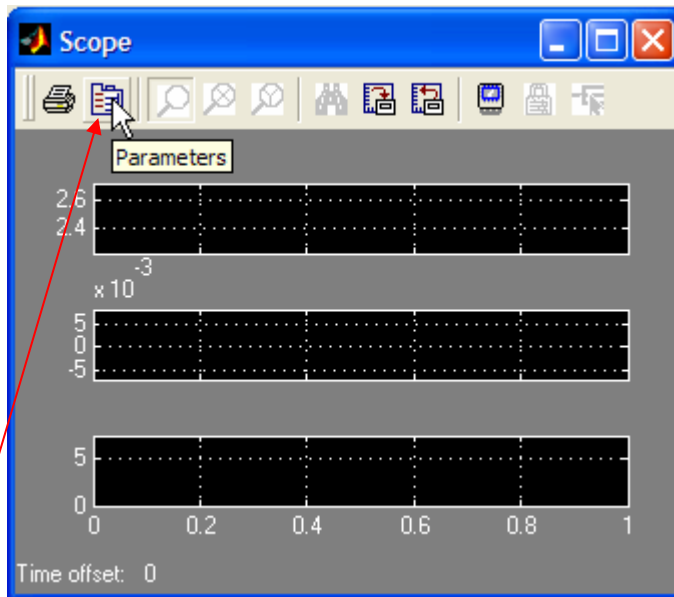
OK Cancel Help Apply

7. Example 1 – Case 2 – (6)

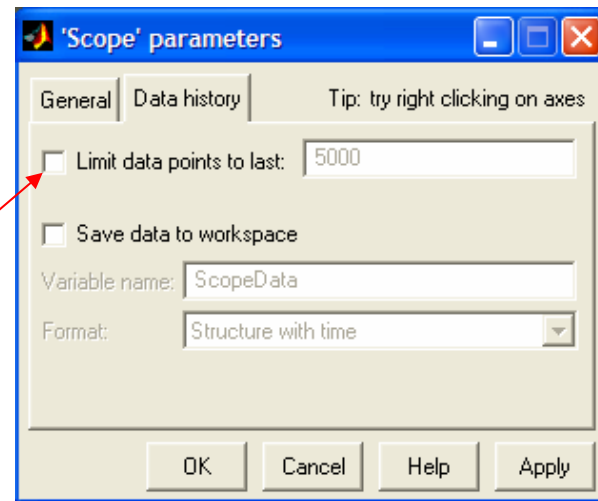
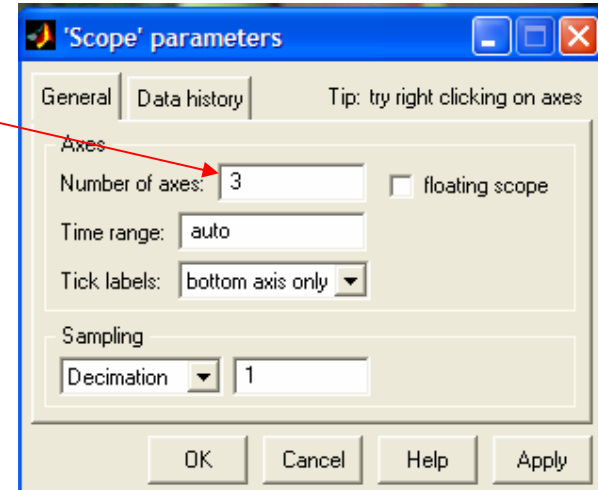
❖ Simulink code: “Example_1.mdl” --- (4)

3. “Scope”

“Type the number of axes”



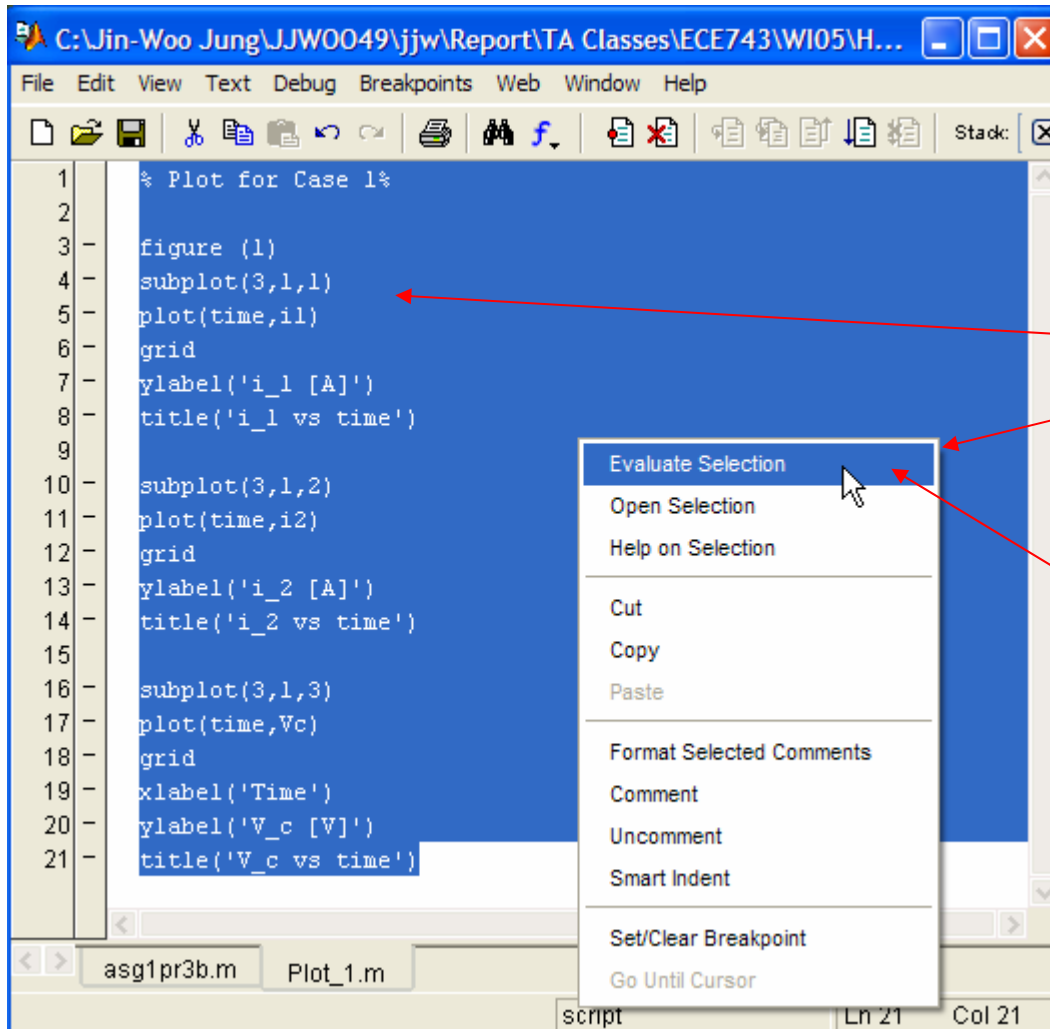
“Click Parameters”



Release “Limit data points to last”

7. Example 1 – Case 2 – (7)

❖ **Plot Matlab code:** “Plot_1.m” --- (Method1 for plot)



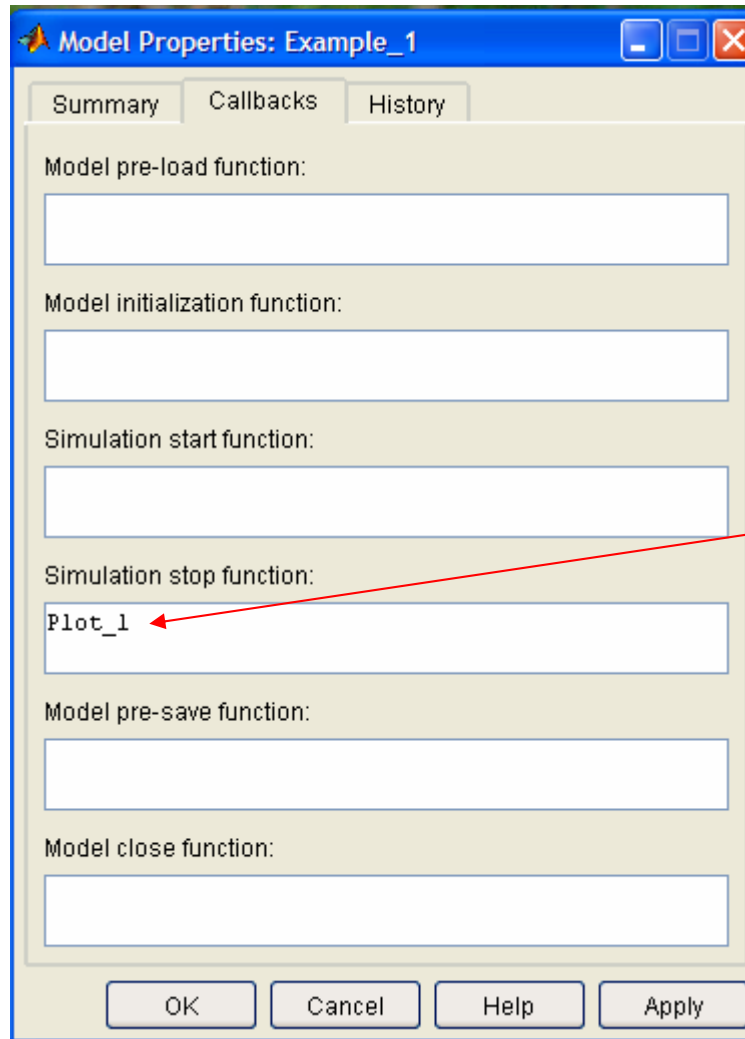
```
1 % Plot for Case 1%
2
3 figure (1)
4 subplot(3,1,1)
5 plot(time,i1)
6 grid
7 ylabel('i_1 [A]')
8 title('i_1 vs time')
9
10 subplot(3,1,2)
11 plot(time,i2)
12 grid
13 ylabel('i_2 [A]')
14 title('i_2 vs time')
15
16 subplot(3,1,3)
17 plot(time,Vc)
18 grid
19 xlabel('Time')
20 ylabel('V_c [V]')
21 title('V_c vs time')
```

**“Select the texts” and then
“Press a right button on a mouse”**

Click “Evaluate Selection”

7. Example 1 – Case 2 – (8)

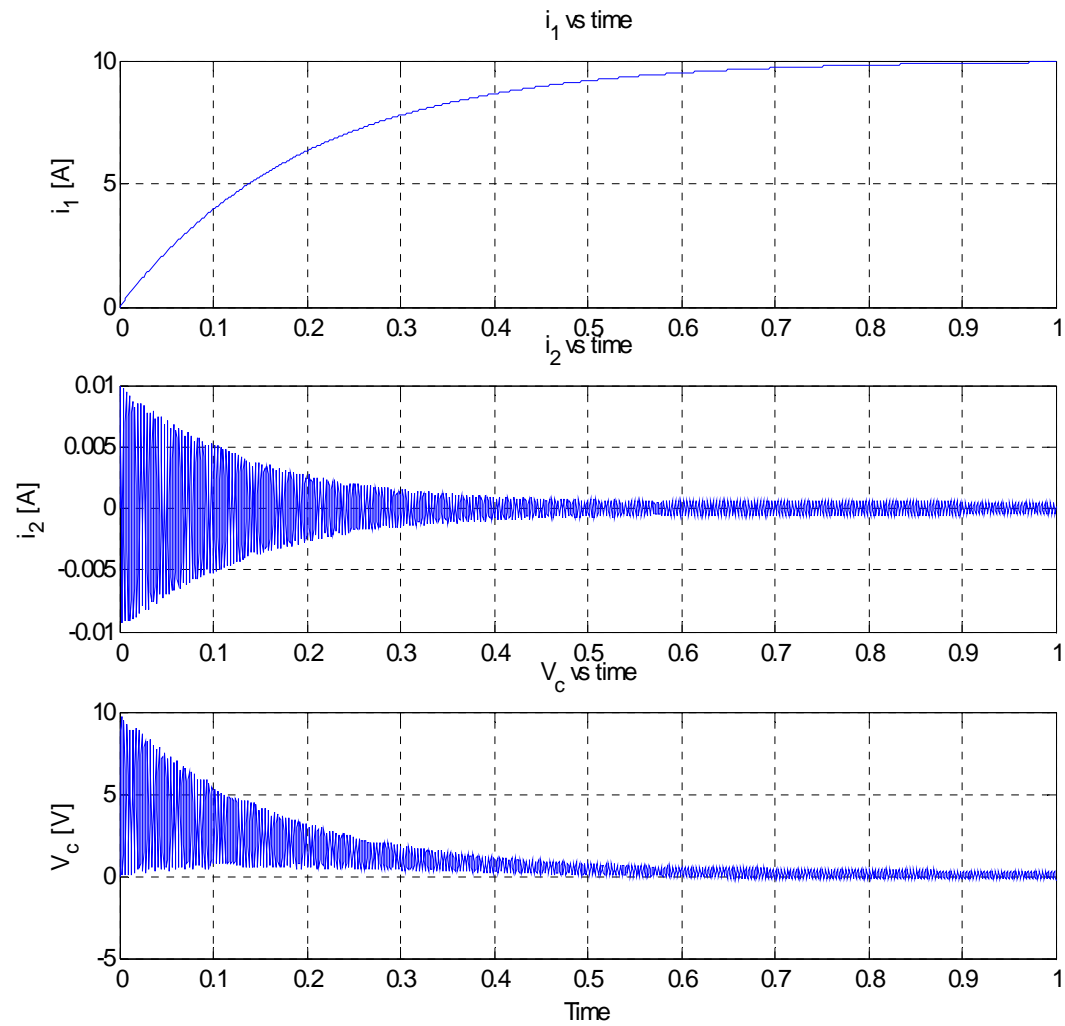
❖ **Plot Matlab code:** “Plot_1.m” --- (Method 2 for plot)



Type "a file name for plot"

7. Example 1 – Case 2 – (9)

❖ Results



7. Example 1 – Case 3 – (1)

❖ Case 3: Matlab + Simulink: Not S-Function

▪ Parameter Initialization: “Initialization.m” - (1)

```
% Parameters Initialization - Example 1 - Case 3
```

```
clear all
```

```
Lp = 0.1;
```

```
Ls = 0.2;
```

```
Mi = 0.1;
```

```
Rp = 1;
```

```
Rs = 2;
```

```
R1 = 1;
```

```
C = 1e-6;
```

```
V = 10;
```

```
alpha = 0.1;
```

```
R = [-Rp 0 0; 0 -(Rs+R1) -1; 0 1 0]
```

```
D = [1;0;0]
```

```
L = [(Lp+Mi) -Mi 0; -Mi (Ls+Mi) 0; 0 0 C]
```

```
Linv = inv(L);
```

```
A = Linv*R;
```

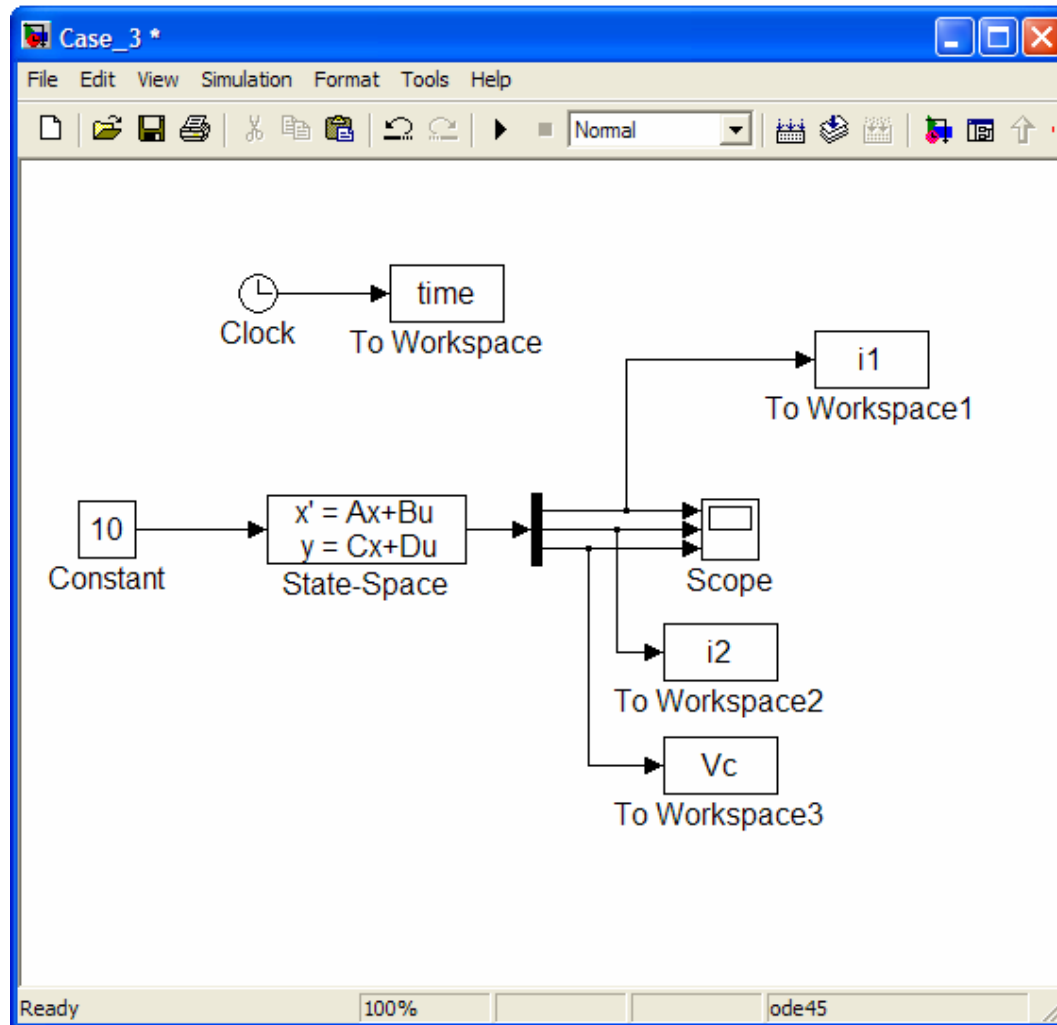
```
B = Linv*D;
```

```
C = eye(3);
```

```
D = zeros(3,1);
```

7. Example 1 – Case 3 – (2)

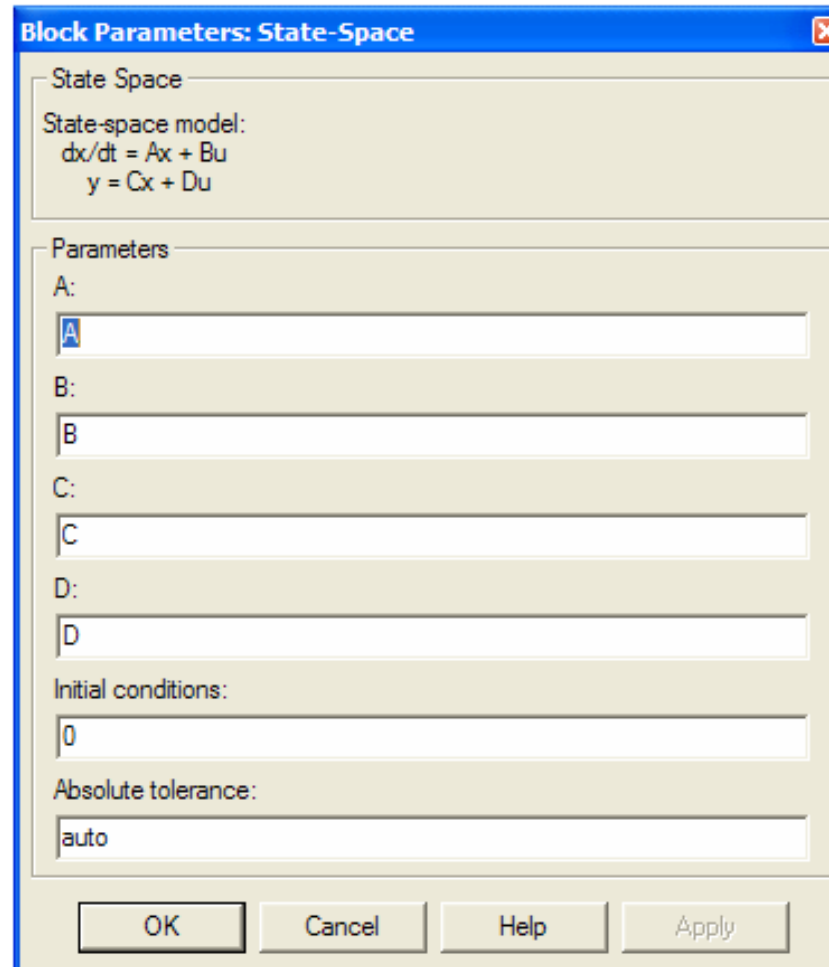
❖ Simulink code: “Case_3.mdl” --- (1)



7. Example 1 – Case 3 – (3)

❖ **Simulink code:** “Case_3.mdl” --- (2)

1. “State-space”



7. Example 1 – Case 3 – (4)

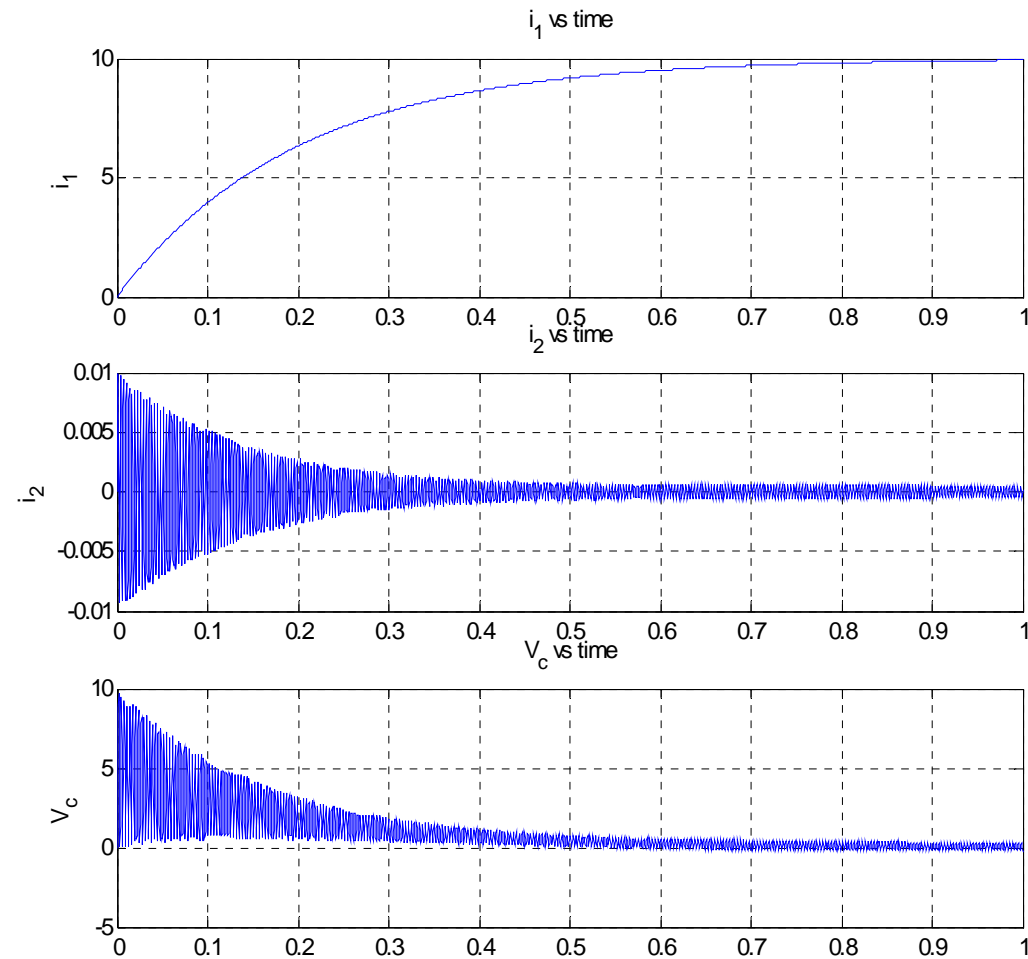
❖ Set up m files for parameter initialization and plot

1). Click “Model properties” Then, type file names: Initialization.m and Plot_1.m

The image shows two windows from the MATLAB software. The left window, titled 'Case_3', displays the 'File' menu with 'Model properties' highlighted. The main workspace shows a Simulink model with blocks for 'time', 'Scope', and three 'To Workspace' blocks labeled 'i1', 'i2', and 'Vc'. The right window, titled 'Model Properties: Case_3', has the 'Summary' tab selected. The 'Model initialization function' field contains the text 'Initialization', and the 'Simulation stop function' field contains 'Plot_1'. Red arrows originate from the text 'Initialization' and 'Plot_1' in the text above and point to these respective fields in the dialog box.

7. Example 1 – Case 3 – (5)

❖ Results



7. Example 1 – Case 4 – (1)

❖ Case 4: Matlab + Simulink (SimPower Systems)

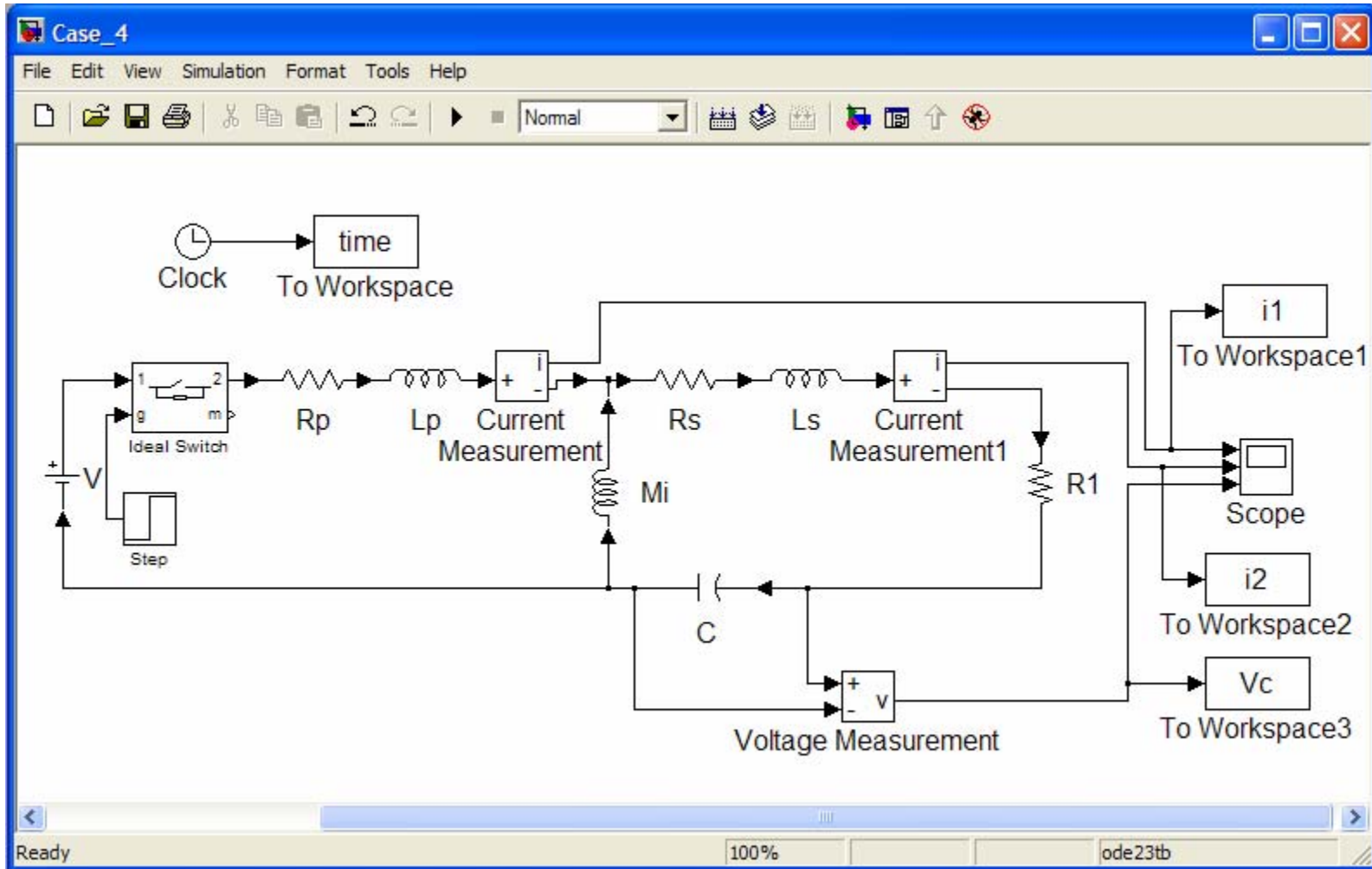
▪ Parameter Initialization: “Para_Initial.m”

```
% Parameters Initialization - Example 1 - Case 4
```

```
clear all  
V = 10;  
Lp = 0.1;  
Ls = 0.2;  
Mi = 0.1;  
Rp = 1;  
Rs = 2;  
R1 = 1;  
C = 1e-6;
```


7. Example 1 – Case 4 – (2)

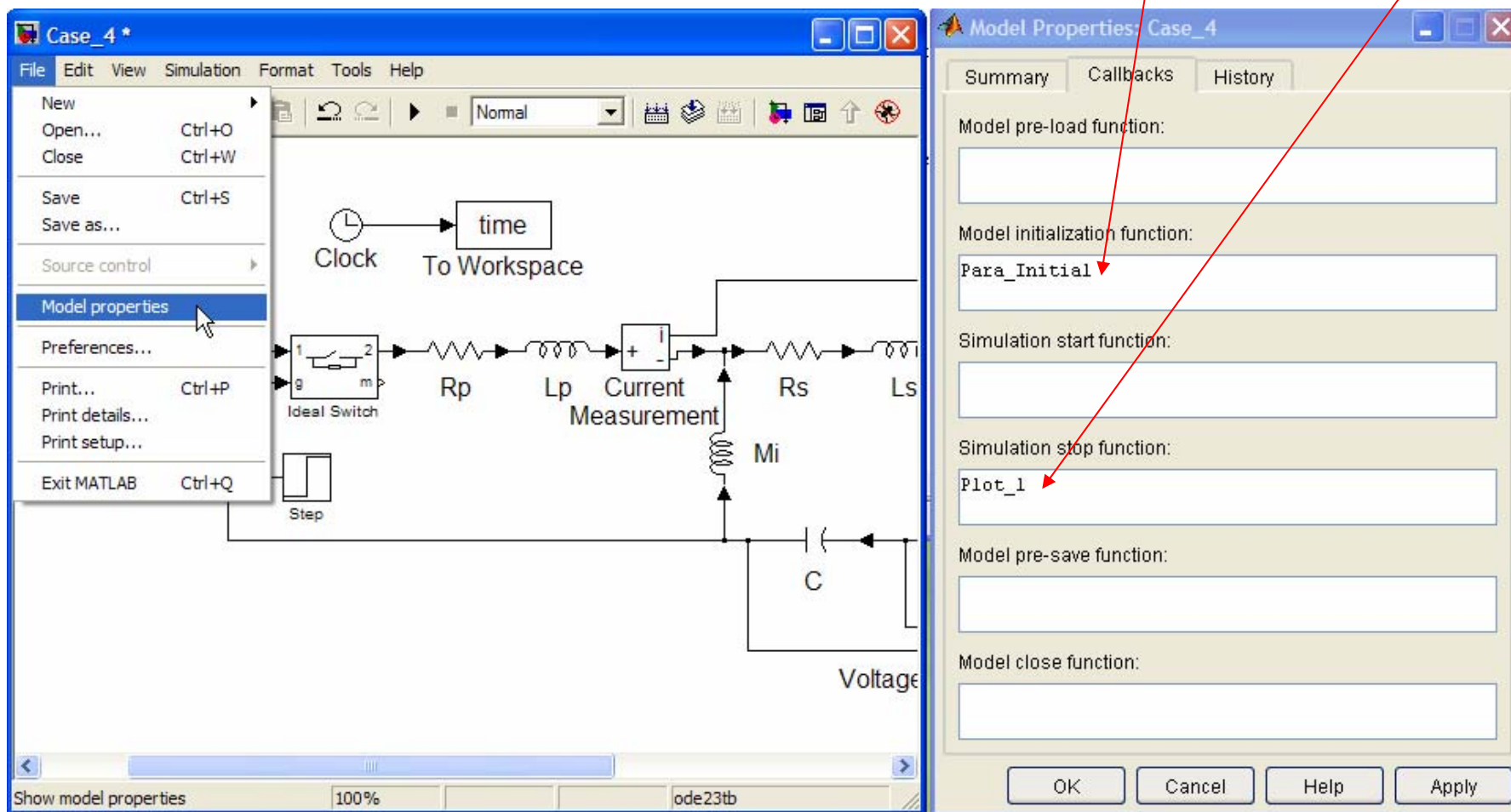
❖ Simulink code: “Case_4.mdl”



7. Example 1 – Case 4 – (3)

❖ Set up m files for parameter initialization and plot

1). Click “Model properties” Then, type file names: Para_Initial.m and Plot_1.m

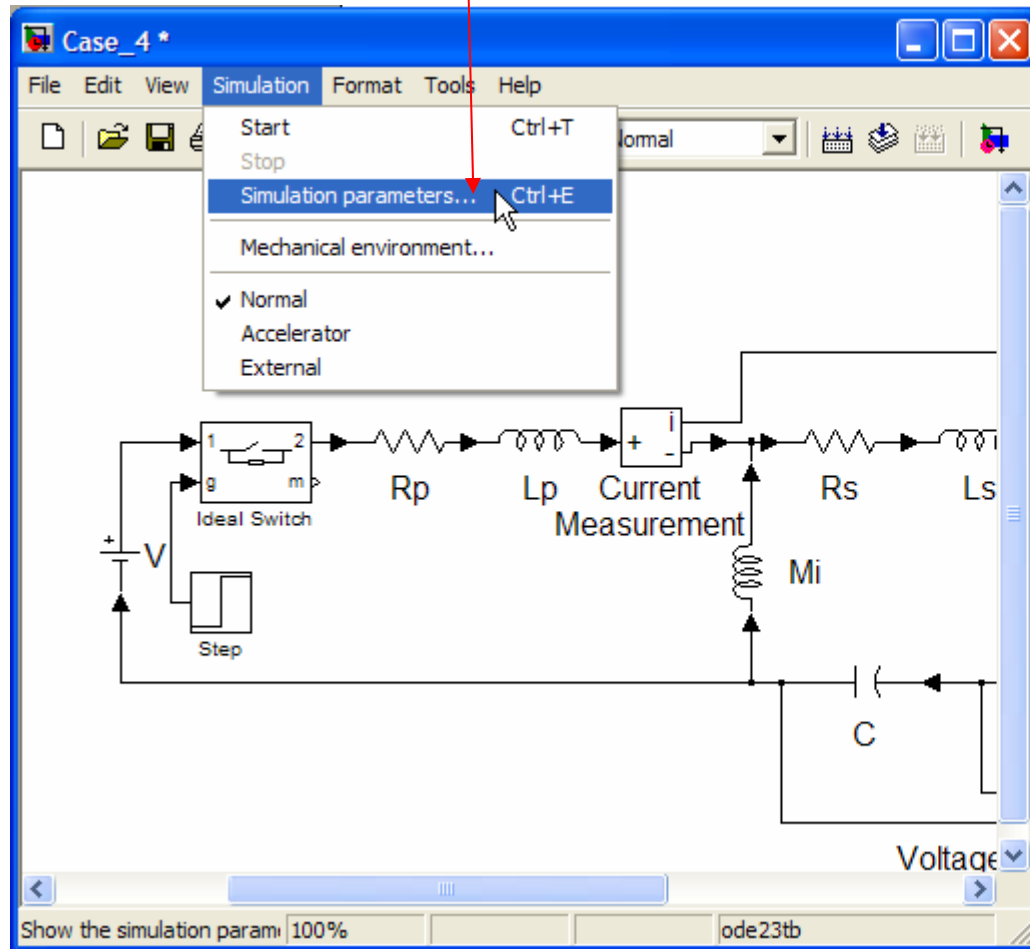


7. Example 1 – Case 4 – (4)

❖ Set up “Simulation parameters”

1). Click “Simulation parameters”

Then, change “Stop time” and “Solver options”



The 'Simulation Parameters: Case_4' dialog box is shown. The 'Advanced' tab is active. The 'Simulation time' section has 'Start time' set to 0.0 and 'Stop time' set to 1. The 'Solver options' section has 'Type' set to 'Variable-step' and 'ode23tb (stiff/TR-BDF2)' selected. The 'Max step size' is set to 1e-5. Other parameters include 'Relative tolerance' (1e-3), 'Absolute tolerance' (auto), and 'Initial step size' (auto). The 'Output options' section has 'Refine output' selected and 'Refine factor' set to 1.

Then, reduce “Max step size”

7. Example 1 – Case 4 – (5)

❖ Results

