How to Use Simulink

ECE743

Jin-Woo Jung,

Ph. D. Student and GTA

Advisor: Prof. Ali Keyhani

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Department of Electrical and Computer Engineering

The Ohio State University

Features of Matlab and Simulink

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- **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") $\Rightarrow$ Matlab (m file for plot)

Available Simulink Toolboxes (version. 6.5)

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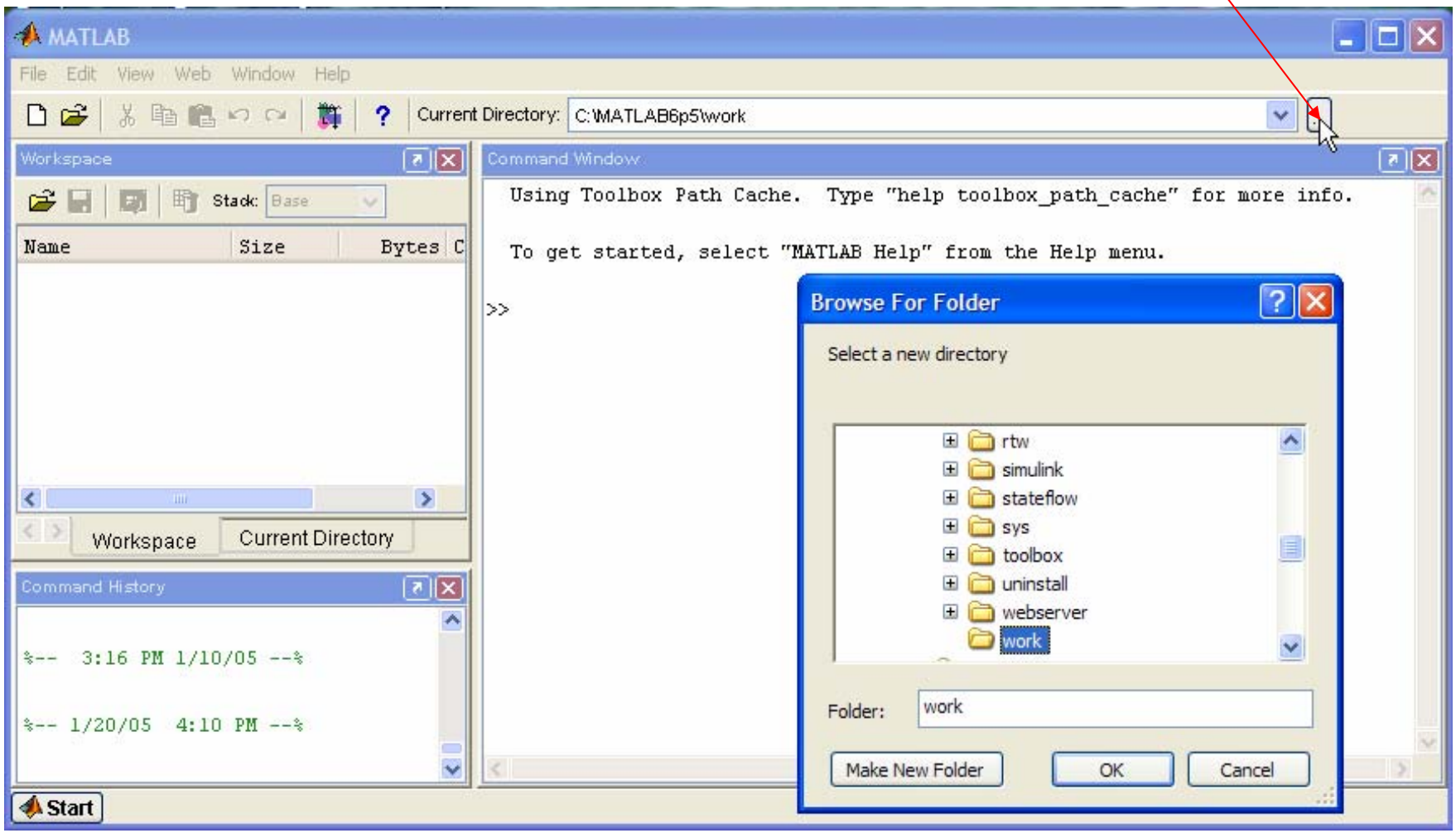
- Simulink
- Aerospace Blockset
- CDMA Reference Blockset
- Communications Blockset
- Control System Toolbox
- DSP Blockset
- Gauges Blockset
- Embedded Target for Motorola MCP555
- Embedded Target for TI C6000 DSP
- Fixed-Point Blockset
- Fuzzy Logic Toolbox
- MPC Blocks
- NCD Blockset
- Neural Network 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"

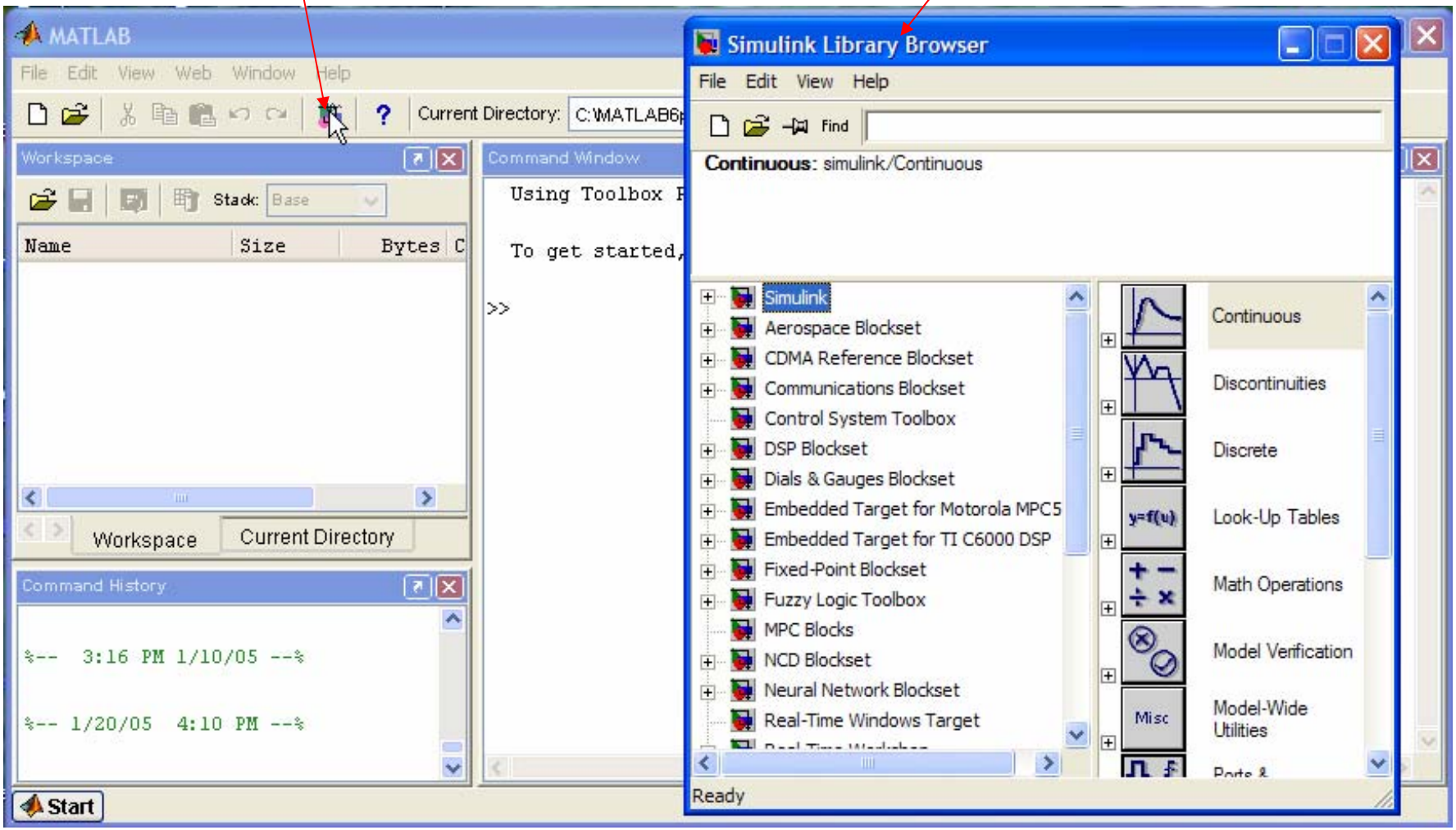
Click "Browser for folder"



2. Starting "Simulink"

1). Click "Simulink"

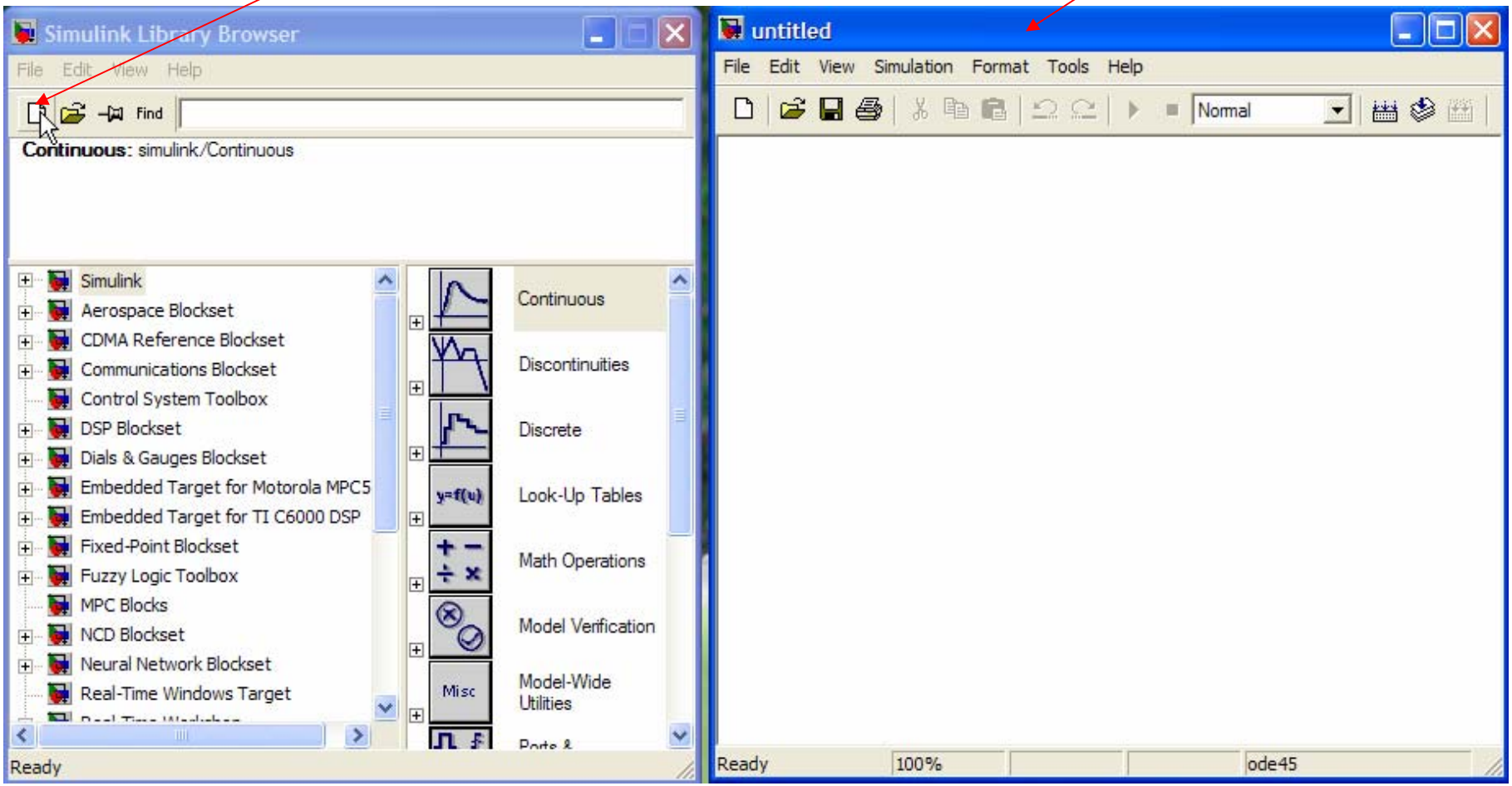
Then, Simulink Library Browser



3. Open “A new file”

1). Click “Create a new model”

Then, a new Simulink file



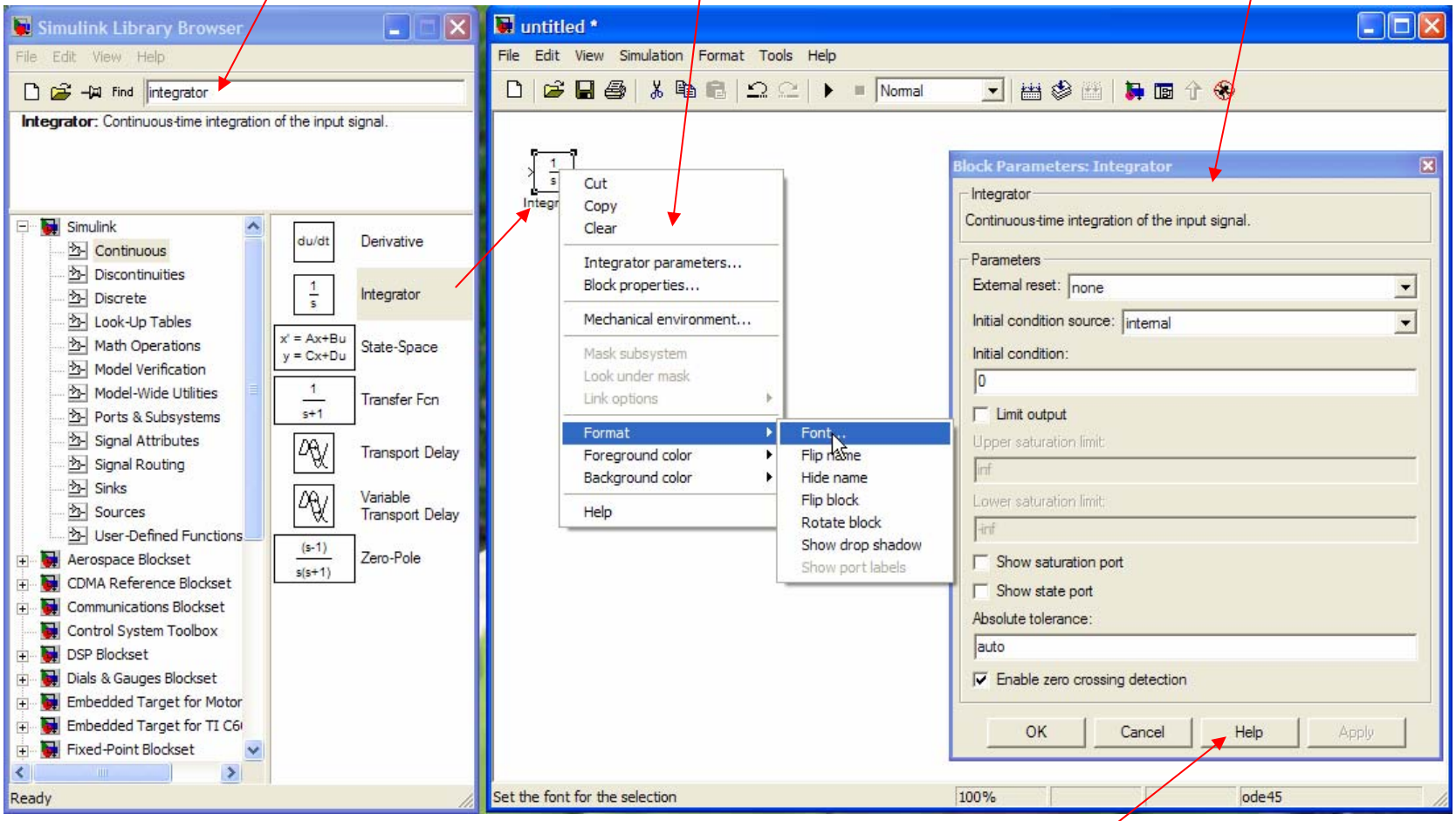
4. Building "System" (1)

❖ **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"



Click "Help" to set up parameters

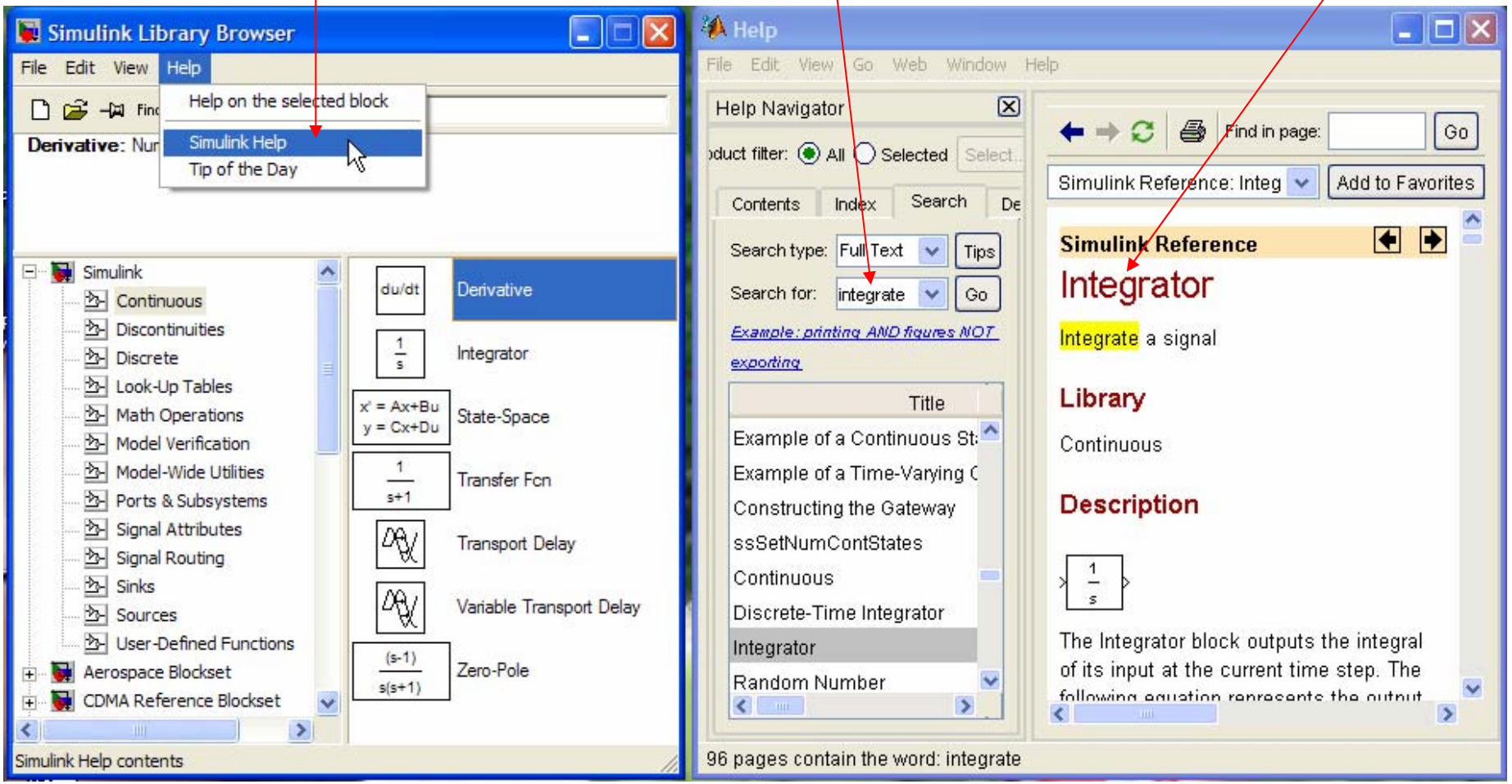
4. Building "System" (2)

❖ **Find ''Block'' when you don't know "block's name"**

1). **Click "Simulink Help"**

Then, type the text for model search

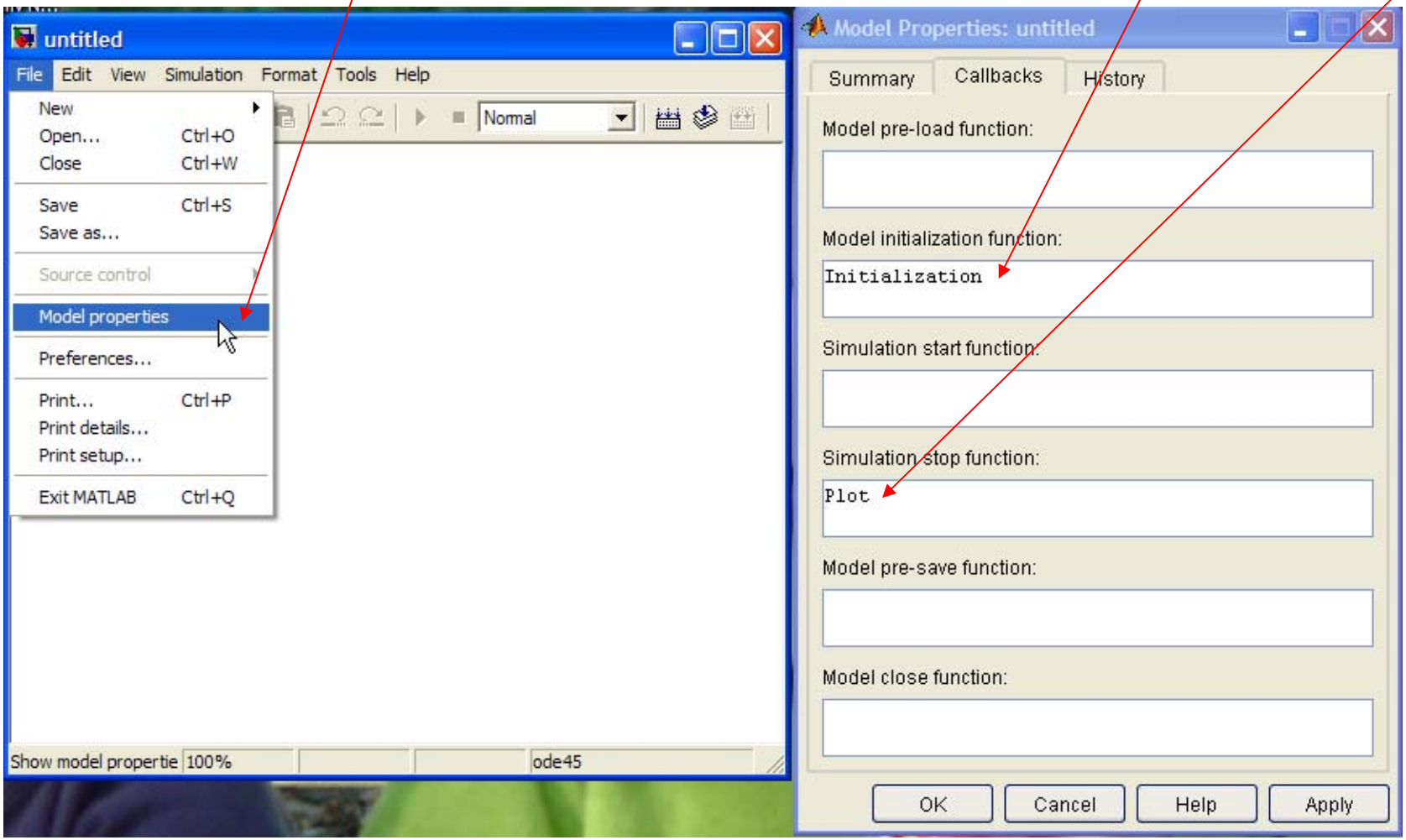
This is model name



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**

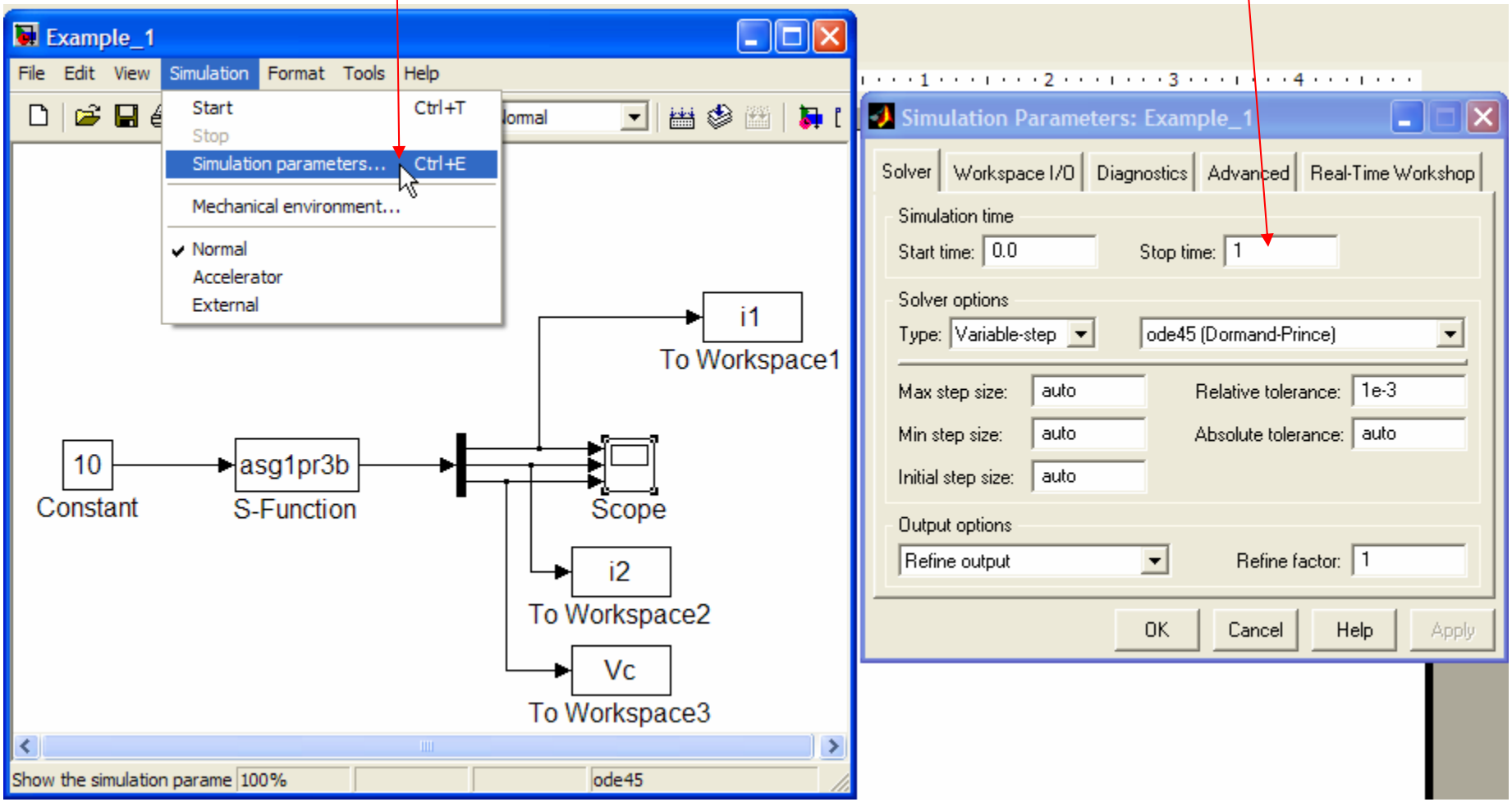


6. Start "Simulation" (1)

❖ **Set up "Simulation parameters"**

1). Click "Simulation parameters"

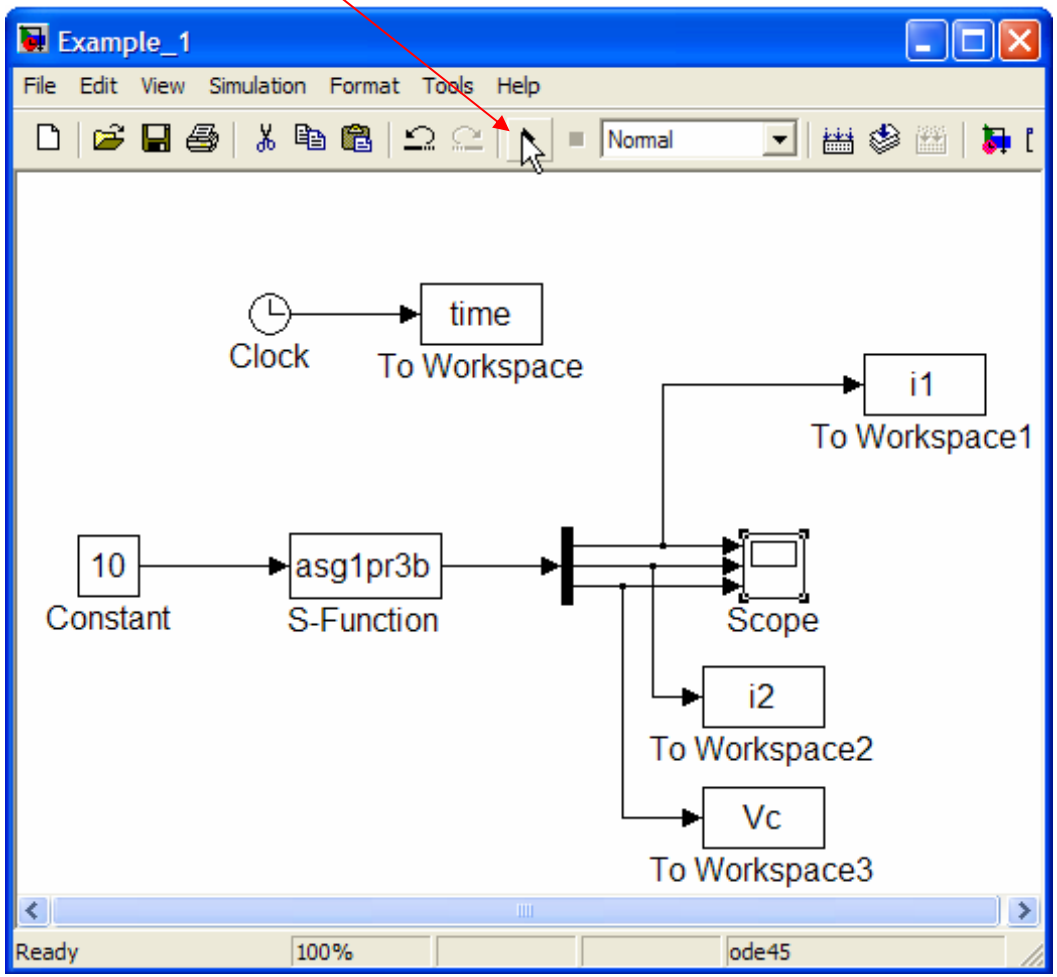
Then, change "Stop time"



6. Start "Simulation" (2)

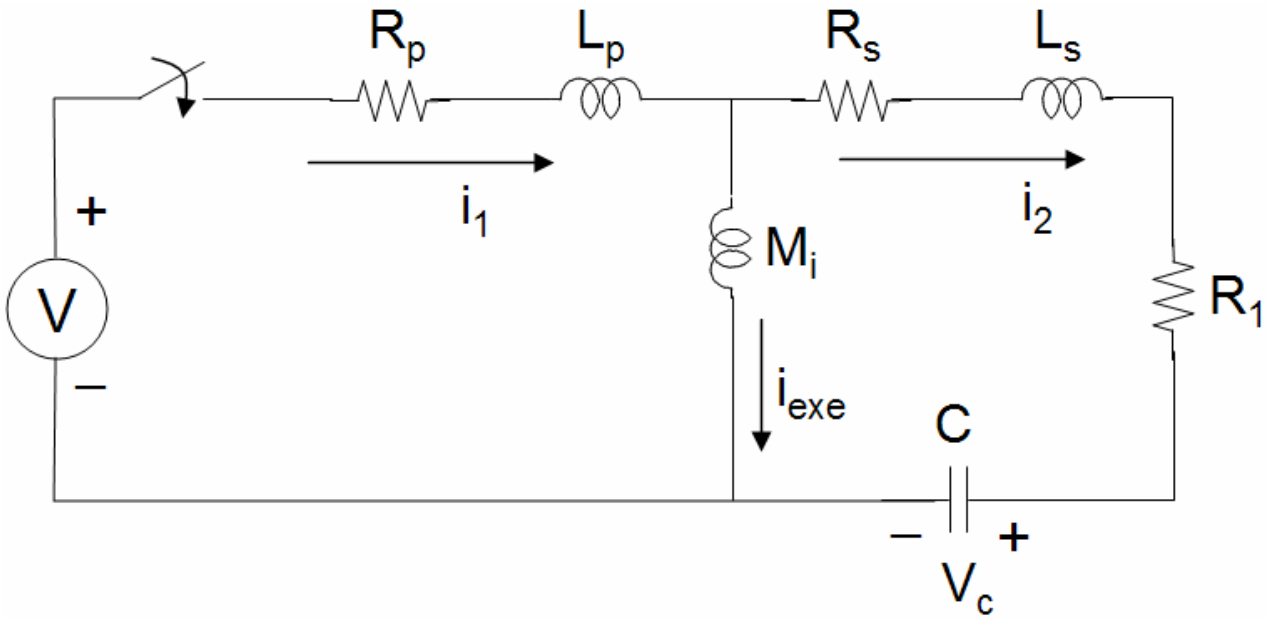
❖ **Start Simulation**

1). Click "Start simulation"



7. Example for Matlab/Simulink

❖ **Example 1:**



where: Lp = 0.1 H, Ls = 0.2 H, Rp = 1 Ω, Rs = 2 Ω, R1 = 1 Ω, Mi = 0.1 H, C = 1 μF, and V = 10 V (Step Input)

- **Simulate the dynamic response of i1, i2, and Vc 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)**

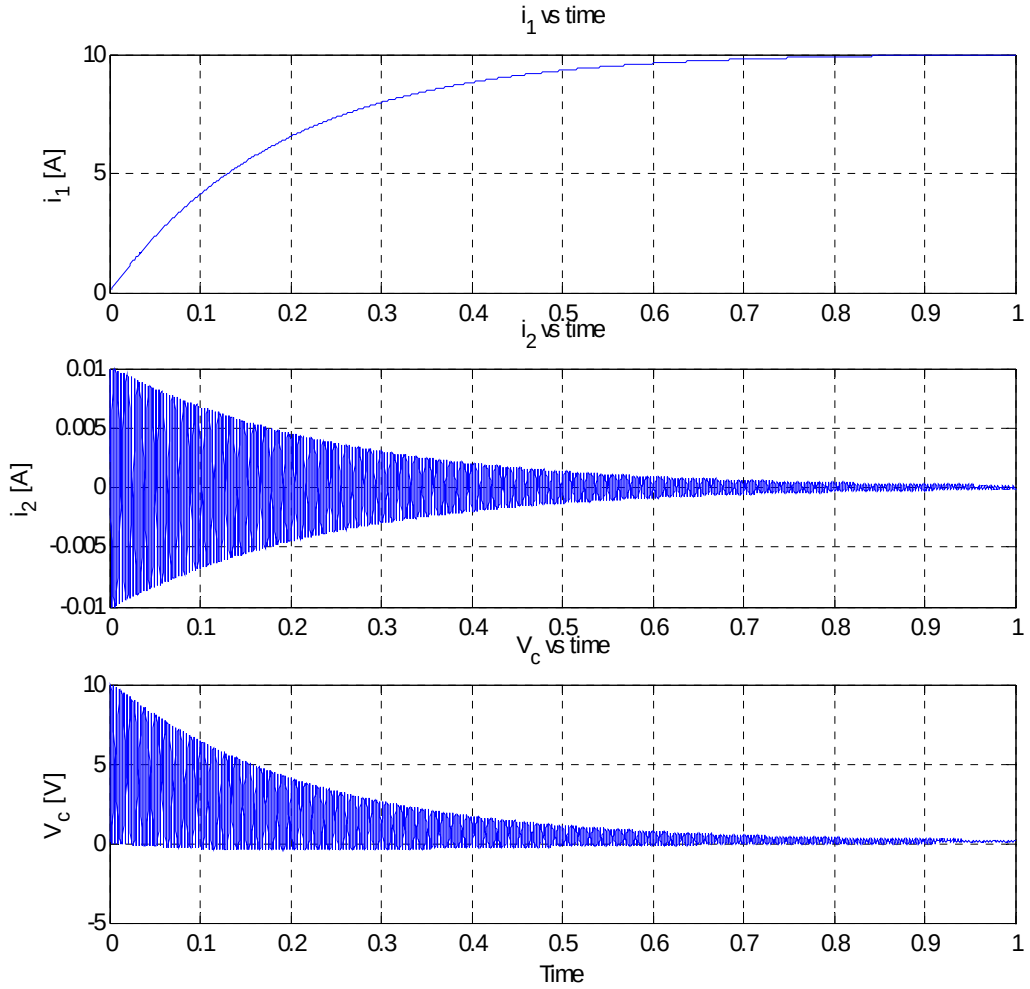
```
figure (1)
subplot(3,1,1)
plot(n1*T,i1)
grid
ylabel('i_1 [A]')
title('i_1 vs time')

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)

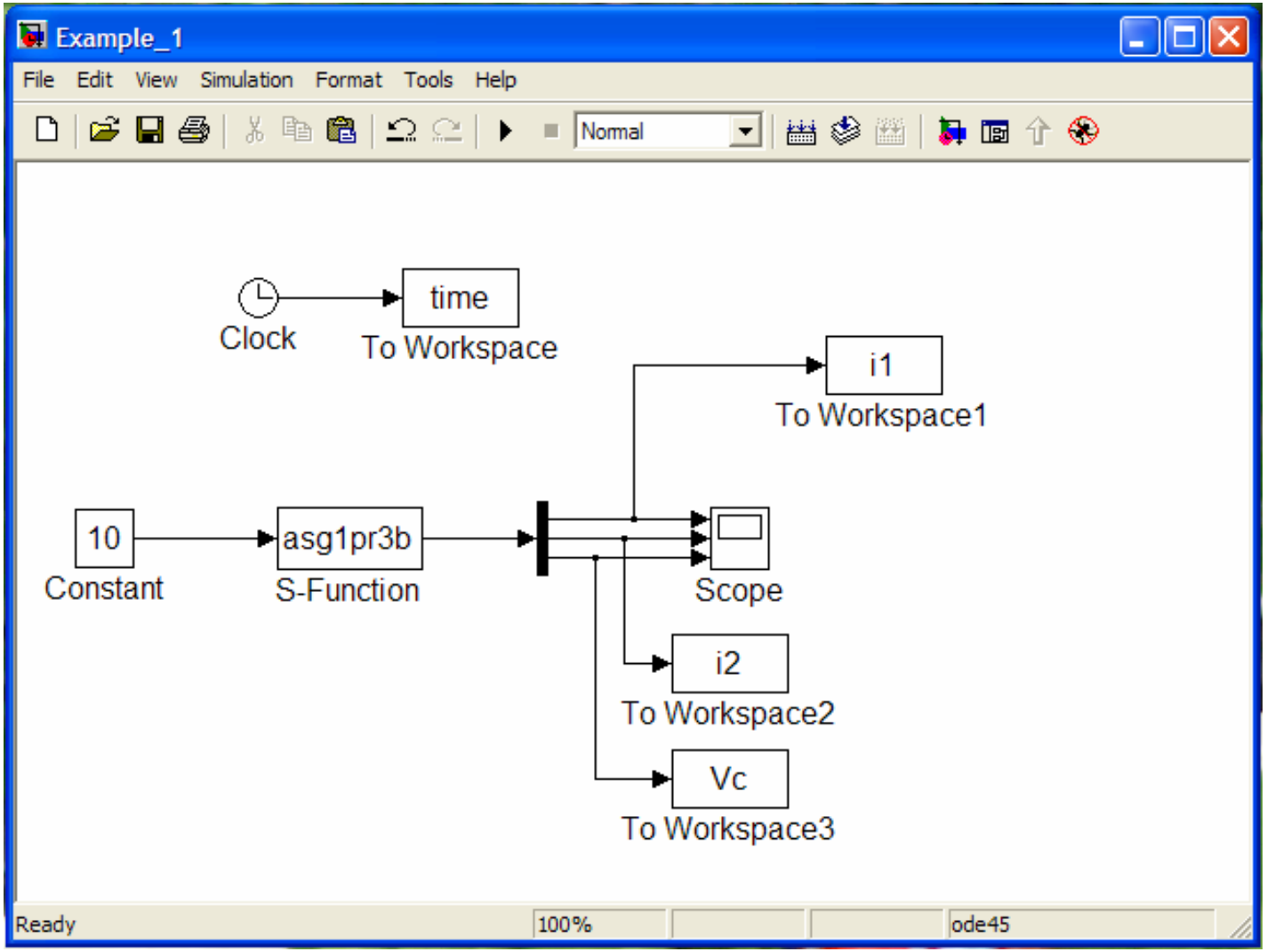
```
if abs(flag)==1
    sys(1:3)=A*x(1:3)+B*u;
elseif abs(flag)==3
    sys(1:3)= x(1:3);

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)

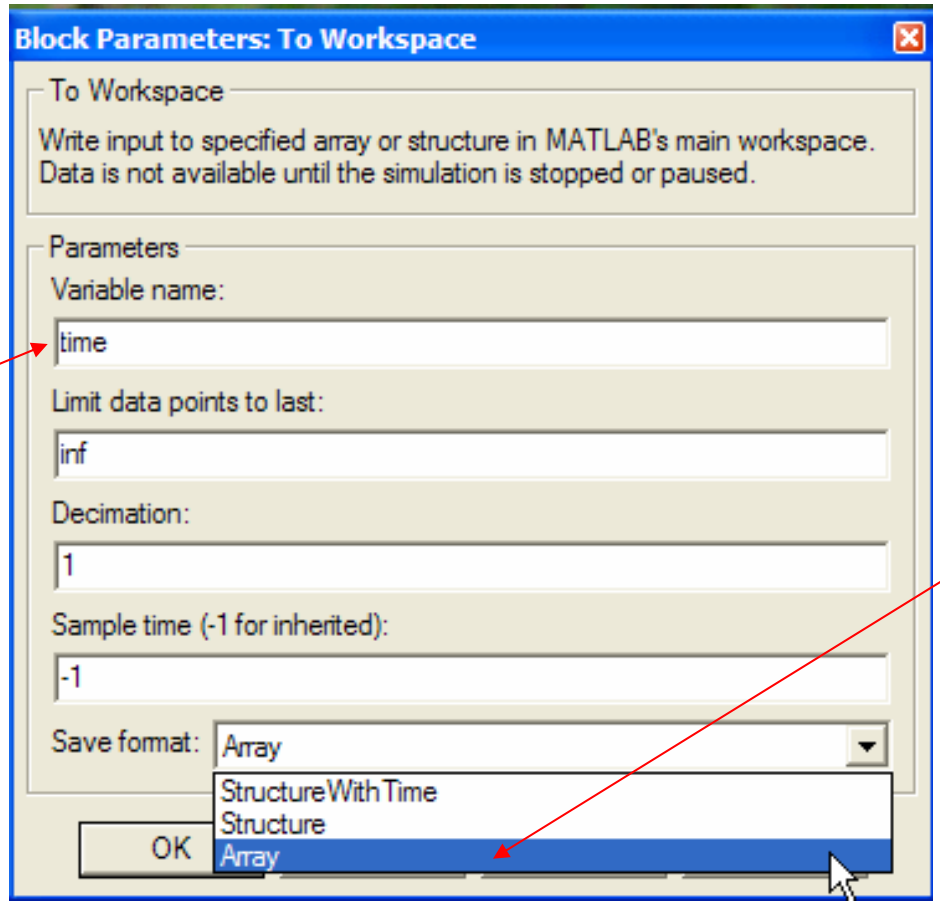
❖ **Simulink code:** "Example_1.mdl" --- (1)



7. Example 1 – Case 2 – (4)

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

1. "To Workspace"



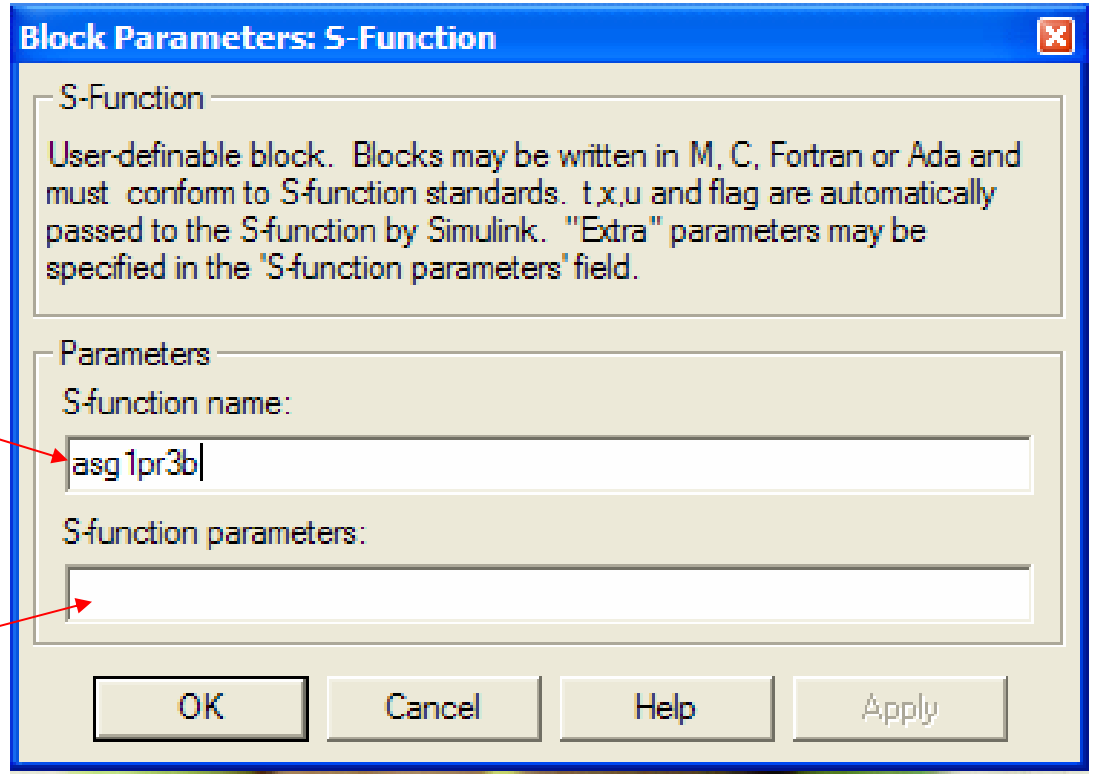
"Type a variable name"

Click "Array"

7. Example 1 – Case 2 – (5)

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

2. “S-Function”



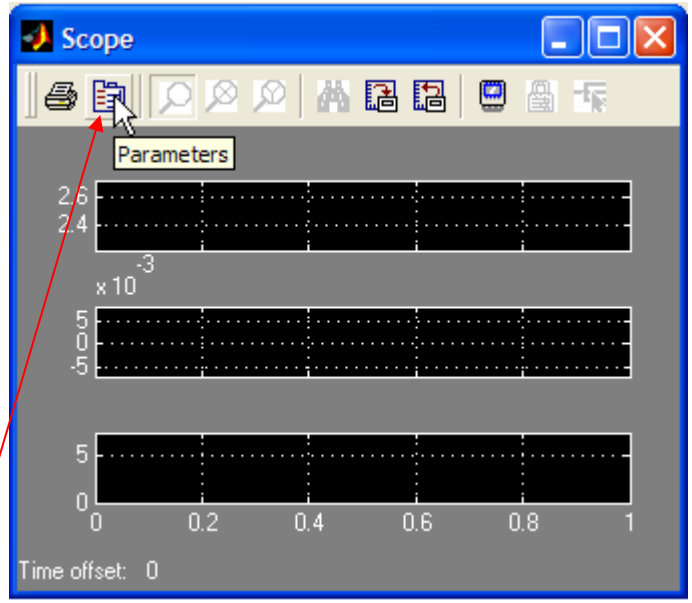
“Type S-function name”

“Blank”

7. Example 1 – Case 2 – (6)

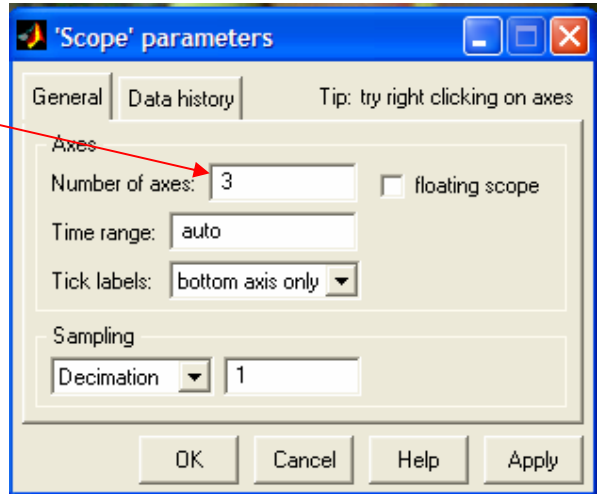
❖ **Simulink code:** "Example_1.mdl" --- (4)

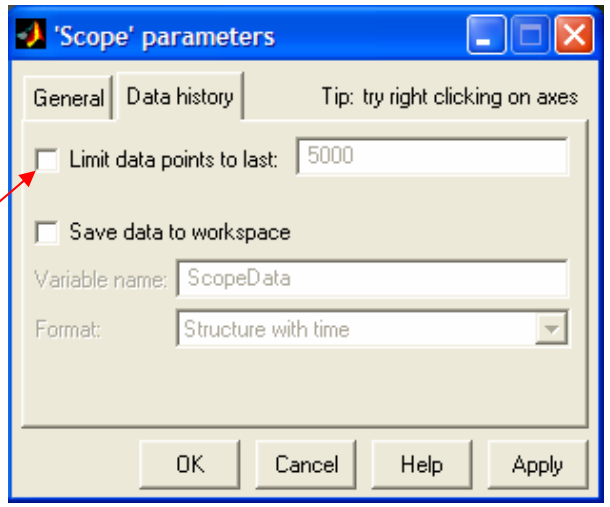
3. "Scope"



"Click Parameters"

"Type the number of axes"

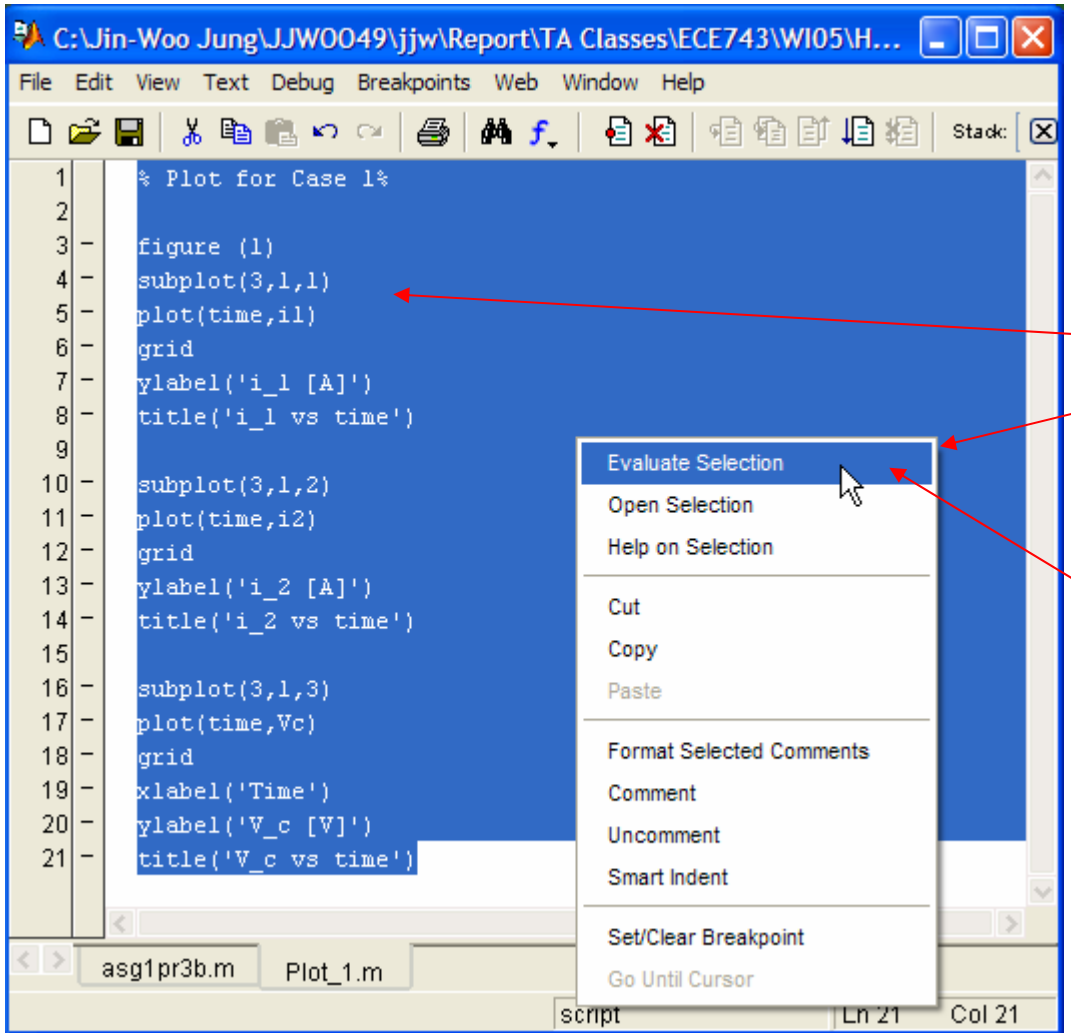




Release "Limit data points to last"

7. Example 1 – Case 2 – (7)

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

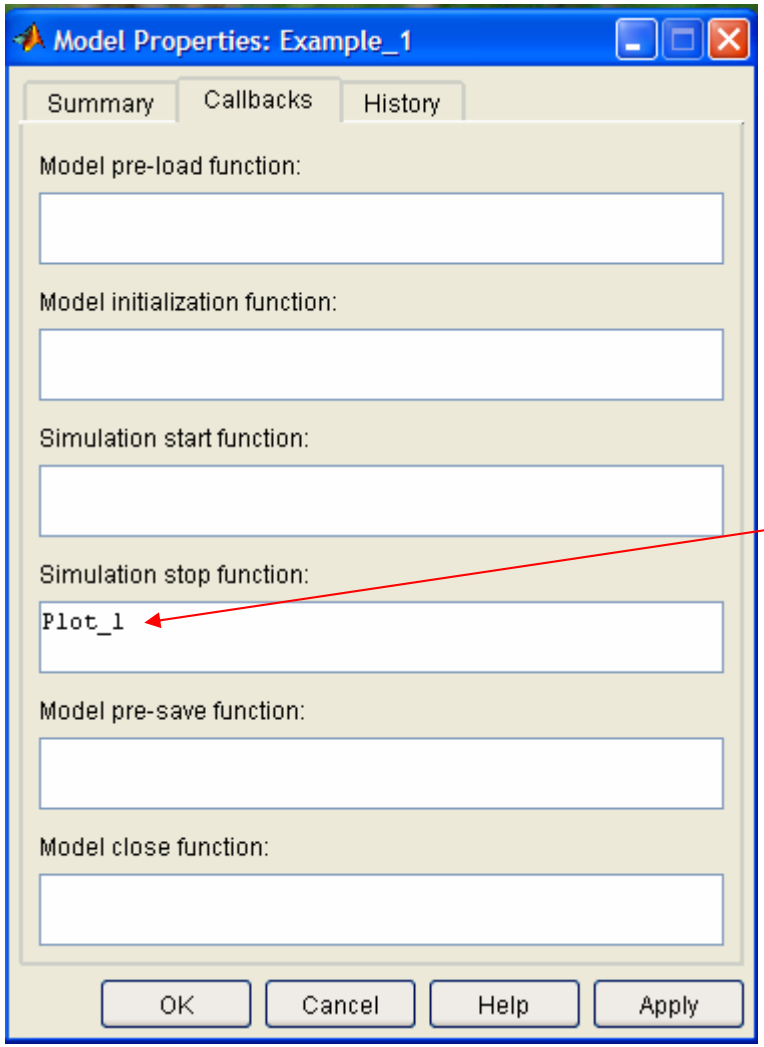


"Select the texts" and then "Press a right button on a mouse"

Click "Evaluate Selection"

7. Example 1 – Case 2 – (8)

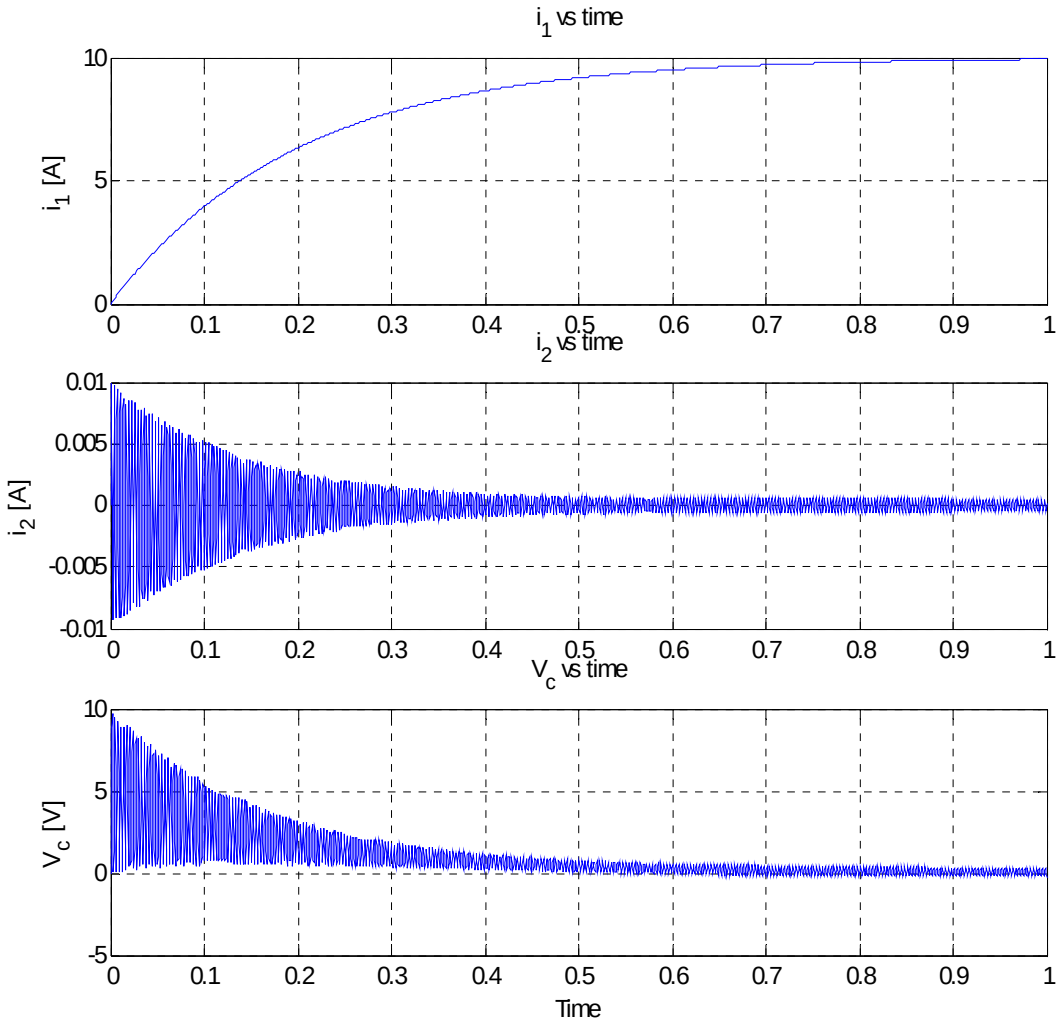
❖ **Plot Matlab code:** "Plot_1.m" --- (Method 2 for plot)



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)

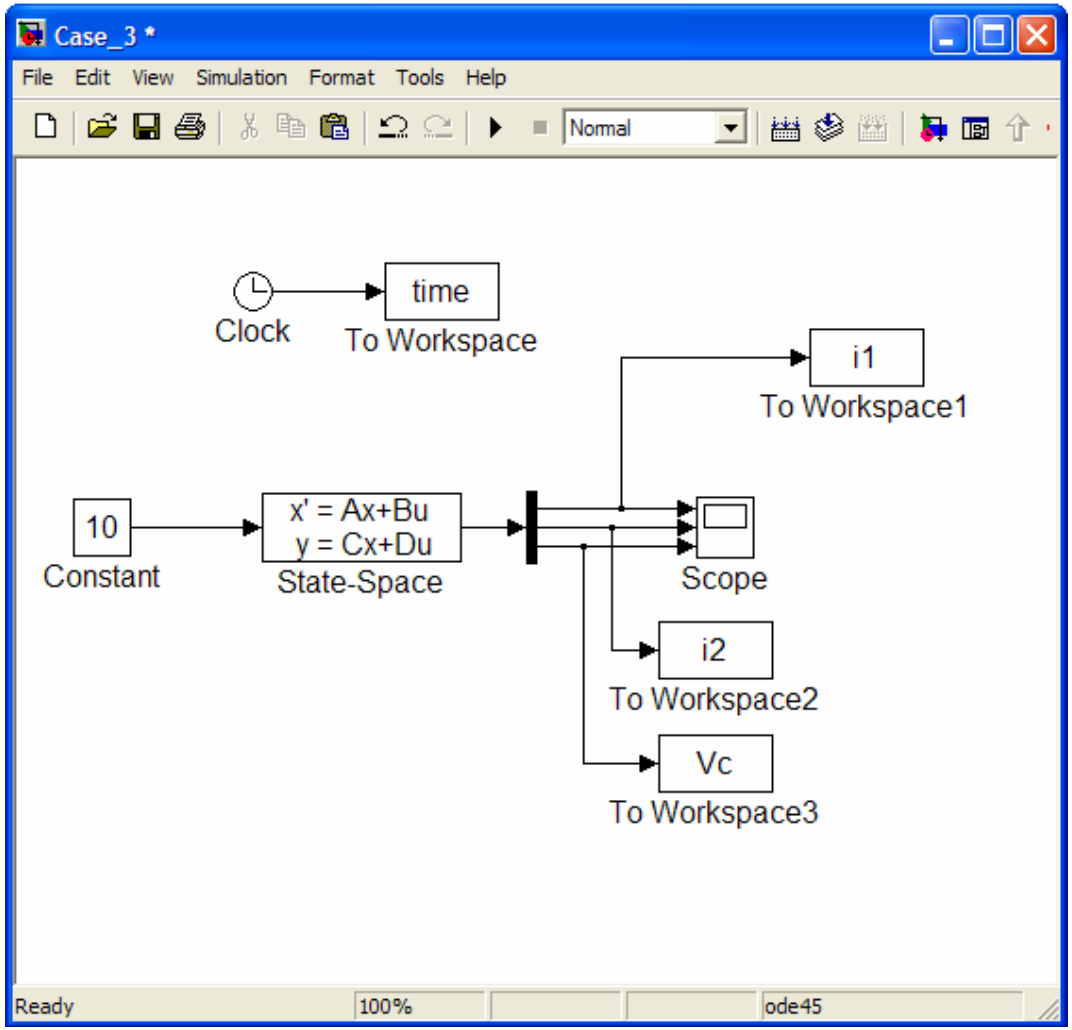
```
% Parameters Initialization - Example 1 - Case 3
clear all
Lp = 0.1;
Ls = 0.2;
Mi = 0.1;
Rp = 1;
Rs = 2;
R1 = 1;
C = 1e-6;
V = 10;
alpha = 0.1;

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)

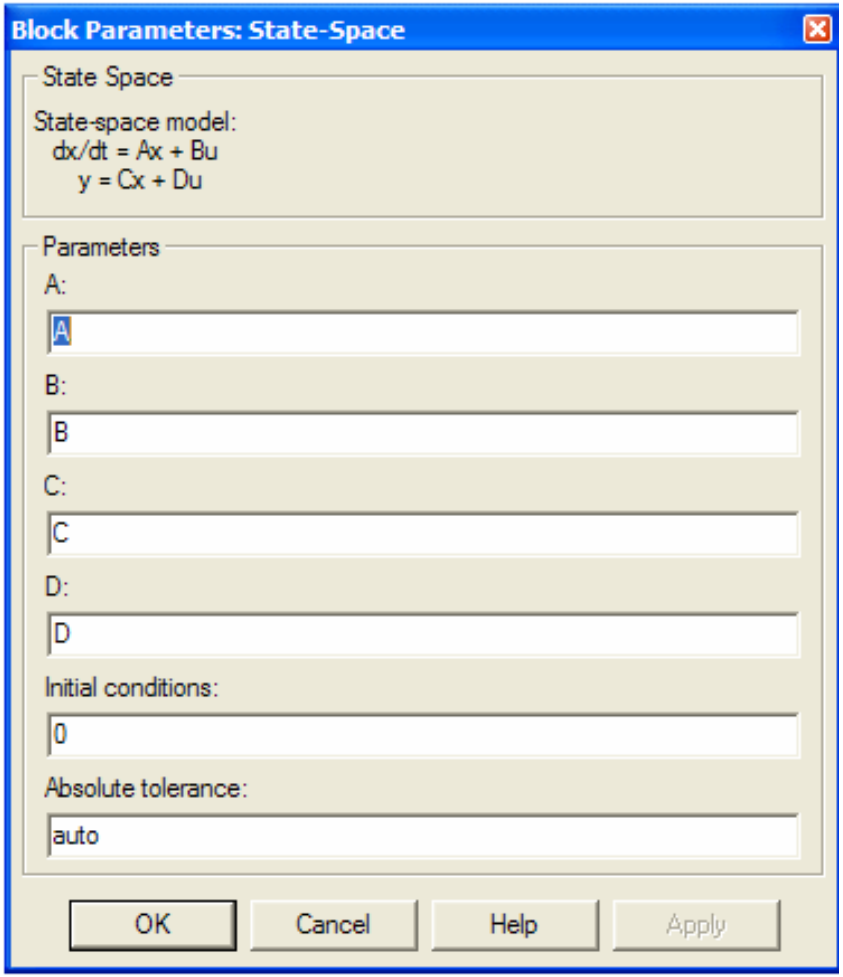
❖ **Simulink code:** "Case_3.mdl" --- (1)



7. Example 1 – Case 3 – (3)

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

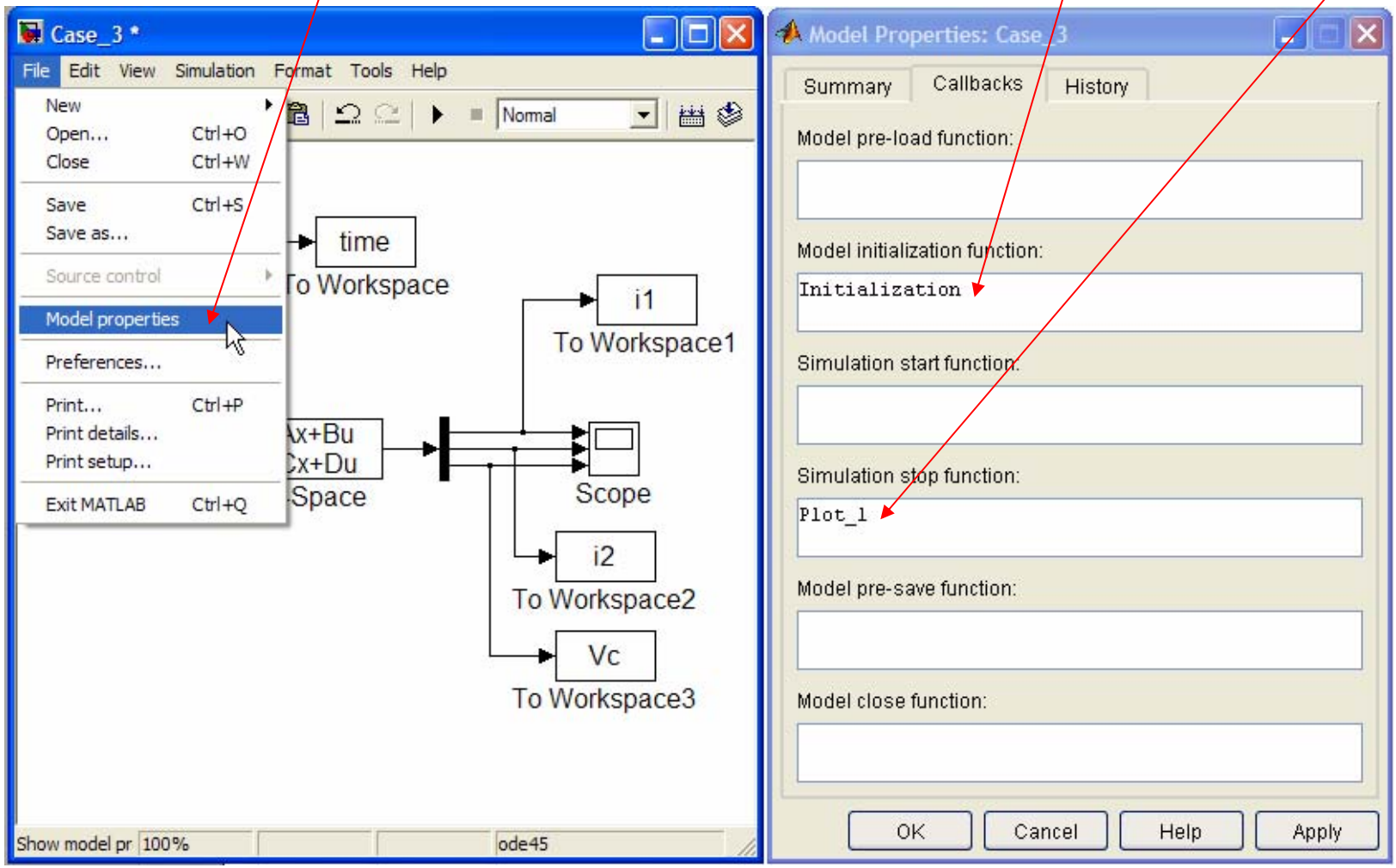
1. "State-space"



7. Example 1 – Case 3 – (4)

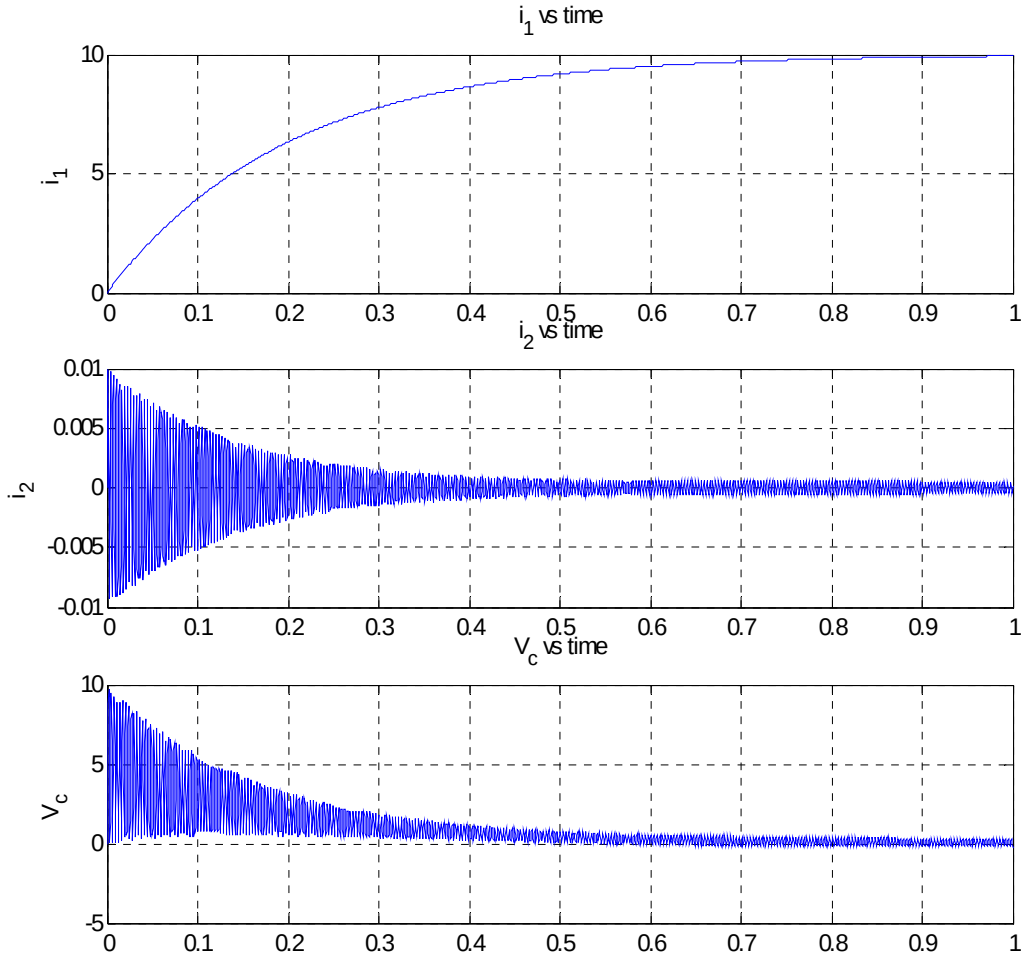
❖ **Set up m files for parameter initialization and plot**

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



7. Example 1 – Case 3 – (5)

❖ **Results**



7. Example 1 – Case 4 – (1)

❖ Case 4: Matlab + Simulink (SimPower Systems)

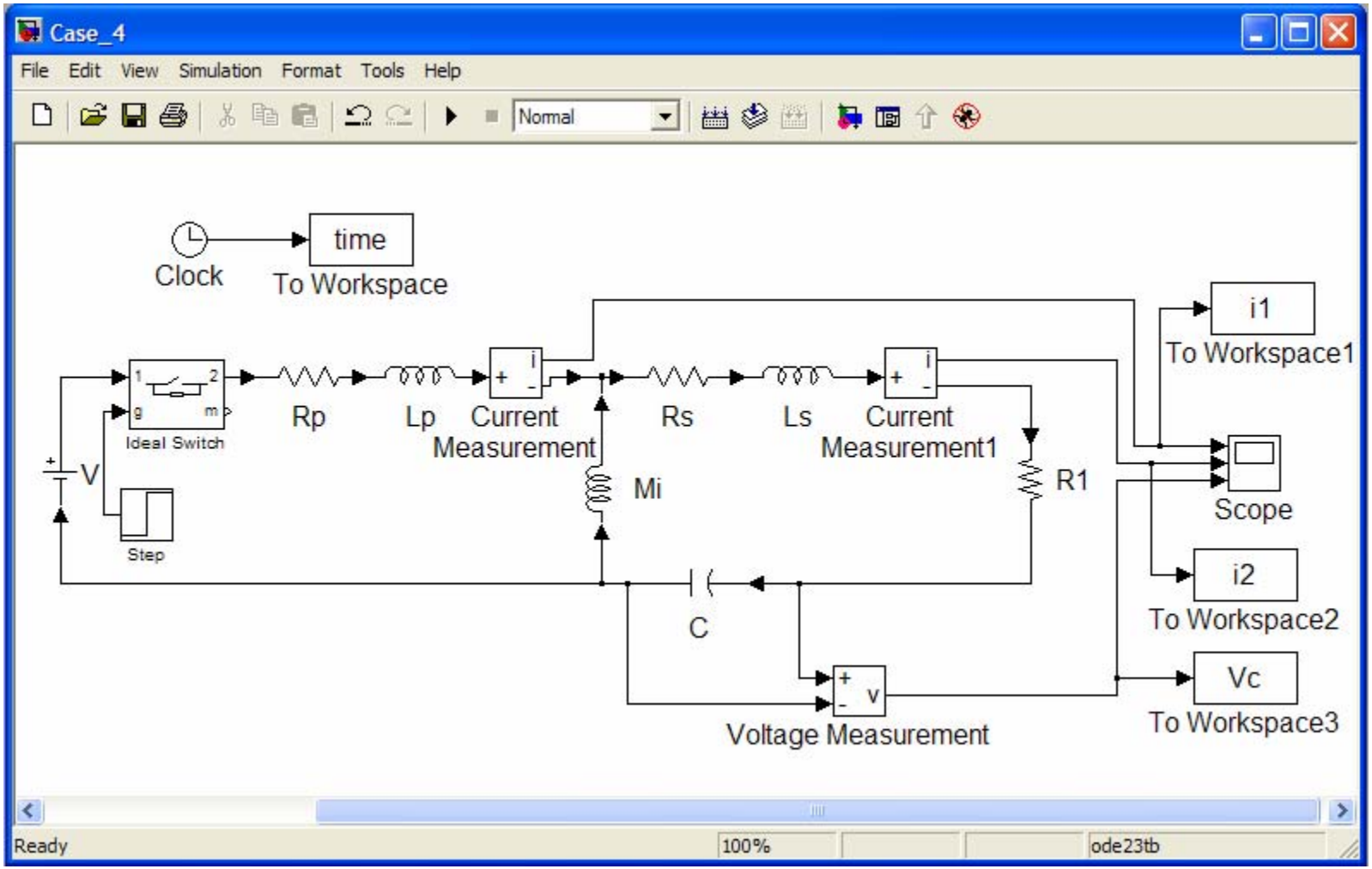
- **Parameter Initialization:** "Para_Initial.m"

```
% 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)

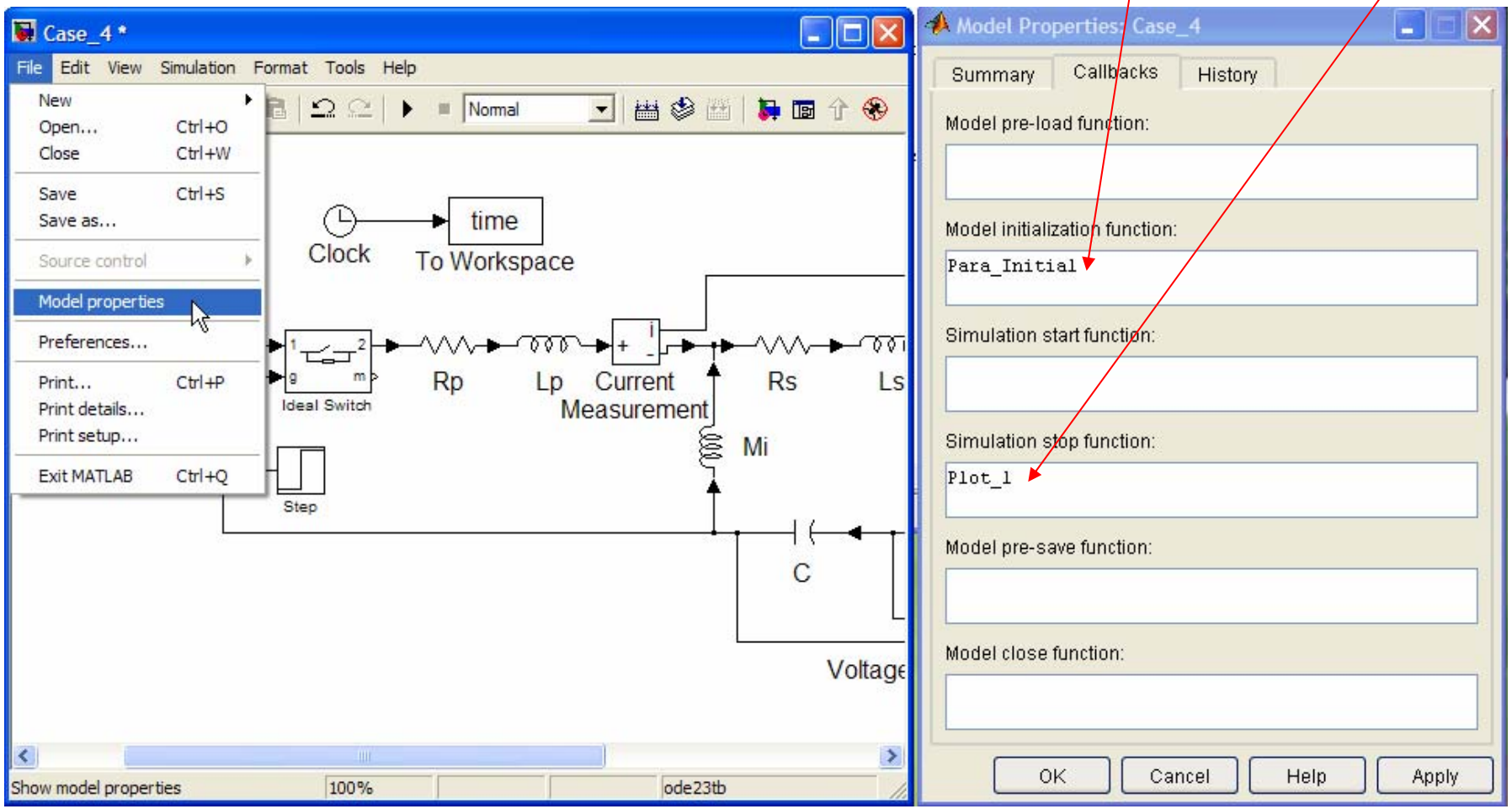
❖ **Simulink code:** "Case_4.mdl"



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

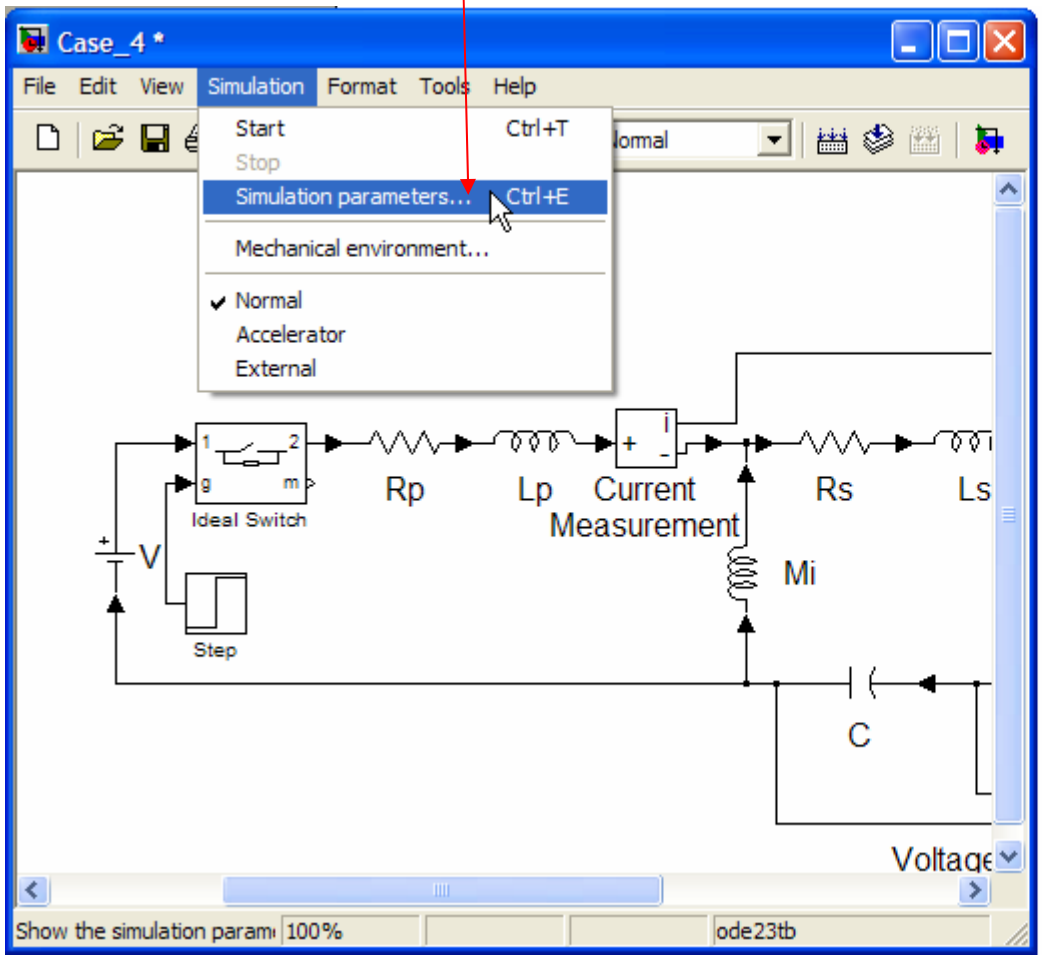


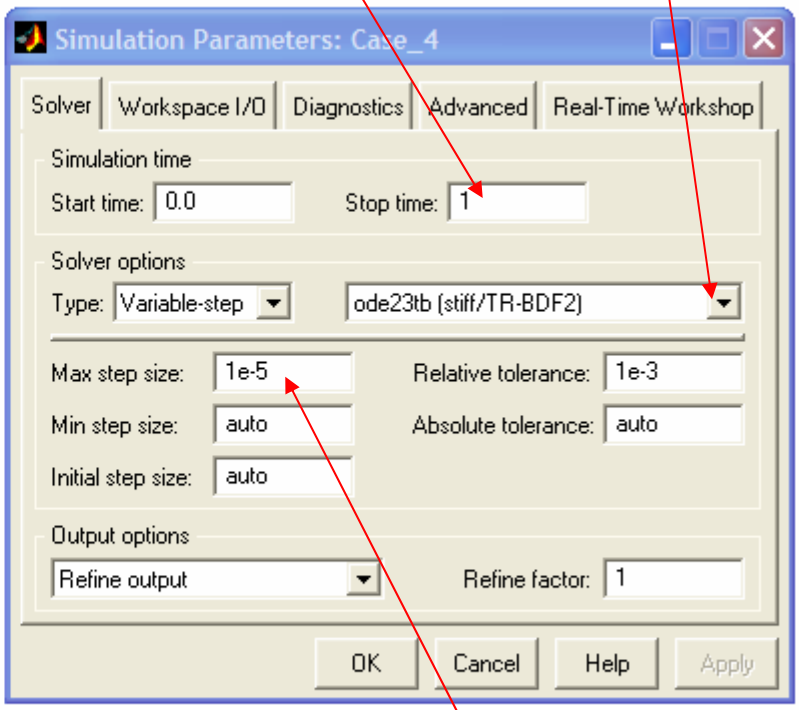
7. Example 1 – Case 4 – (4)

❖ **Set up "Simulation parameters"**

1). Click "Simulation parameters"

Then, change "Stop time" and "Solver options"





Then, reduce "Max step size"

7. Example 1 – Case 4 – (5)

❖ **Results**