Matlab_Simulink

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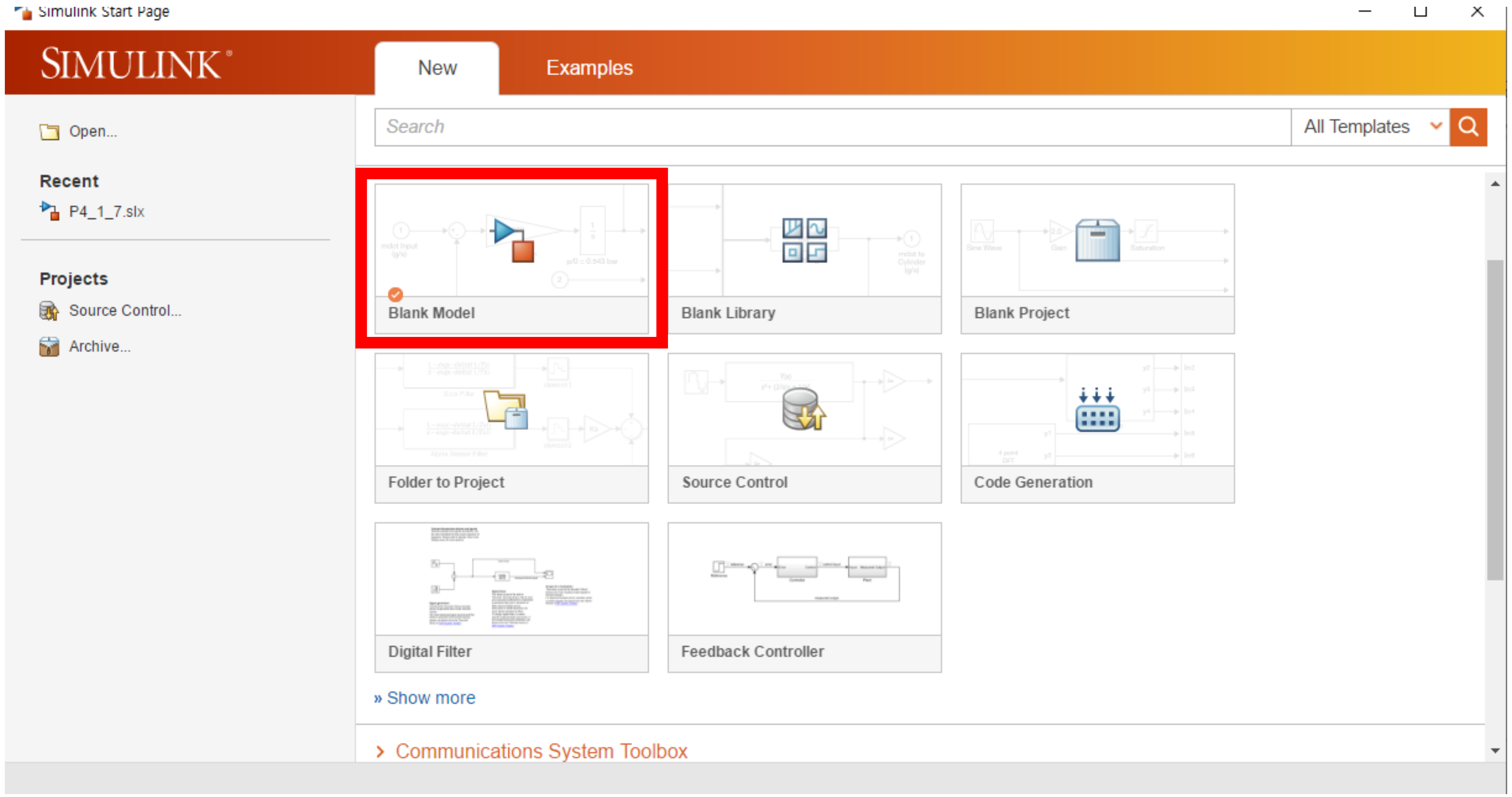
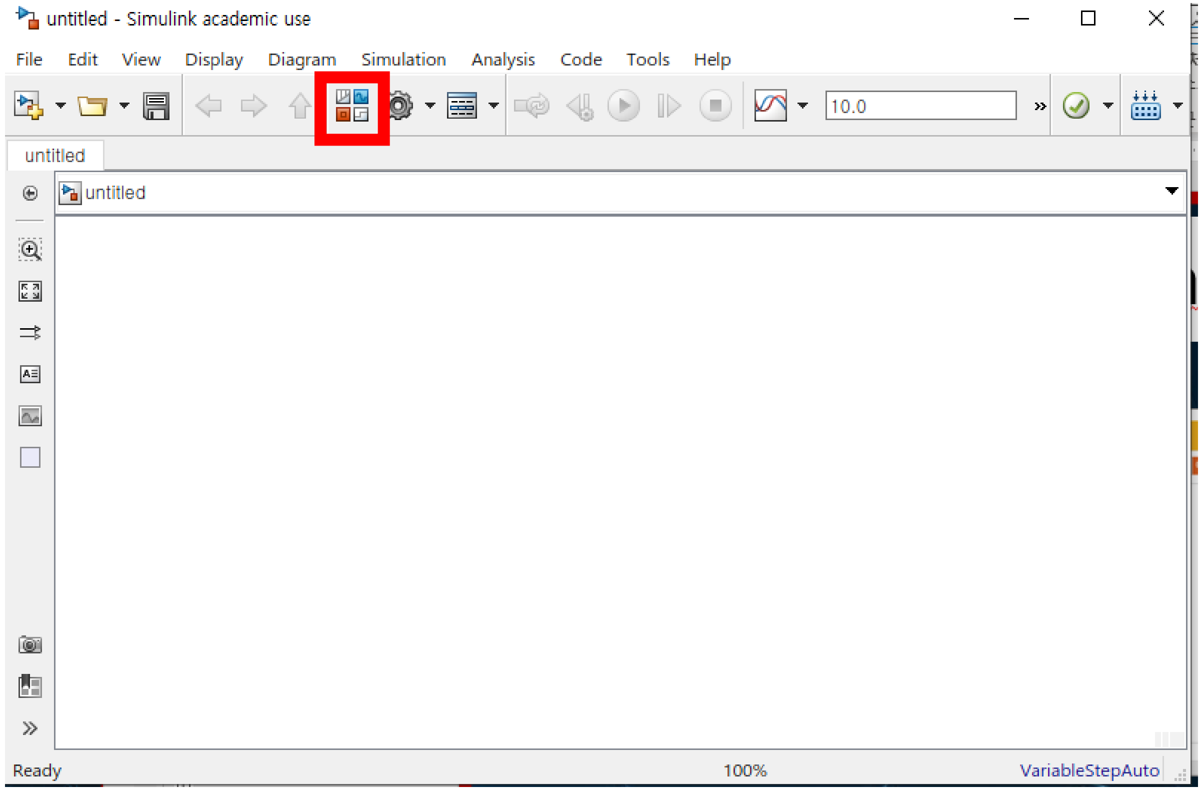
What is Simulink

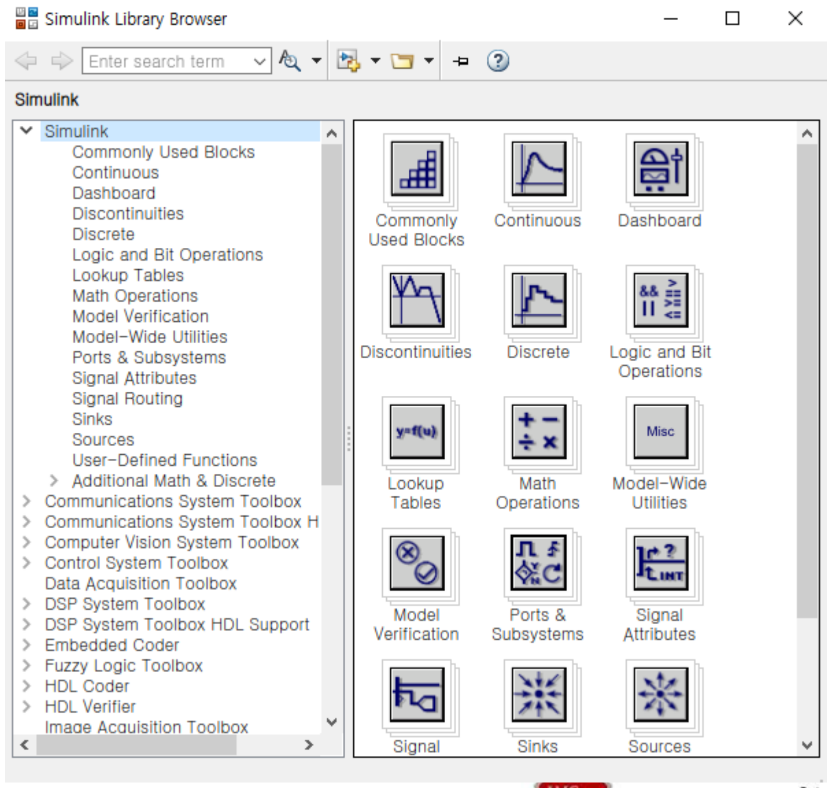
- Matlab의 확장자
- Block diagram을 그래픽화함
- 미분방정식 계산
- Block diagram을 통한 전달함수 계산
- 동적 시스템의 응답을 확인 가능
- 입/출력의 형태 지정 가능

Starting Simulink

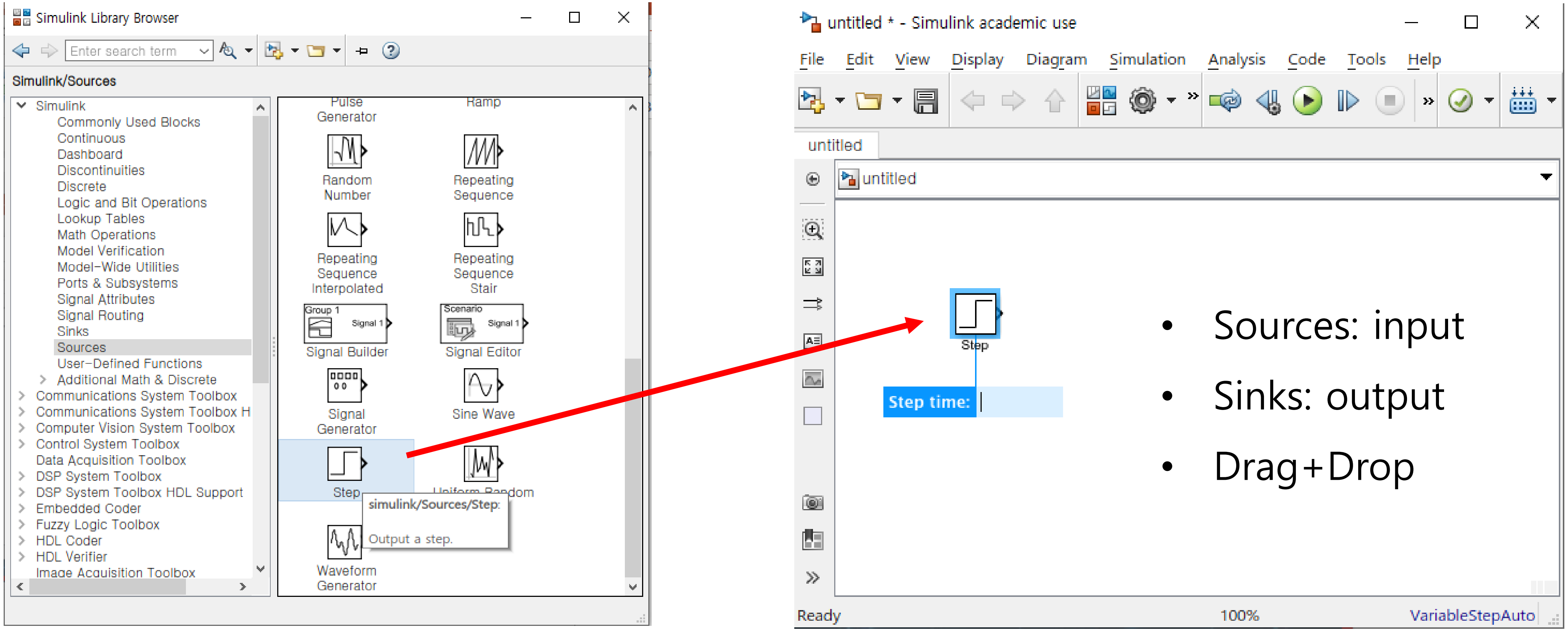


Simulink Library



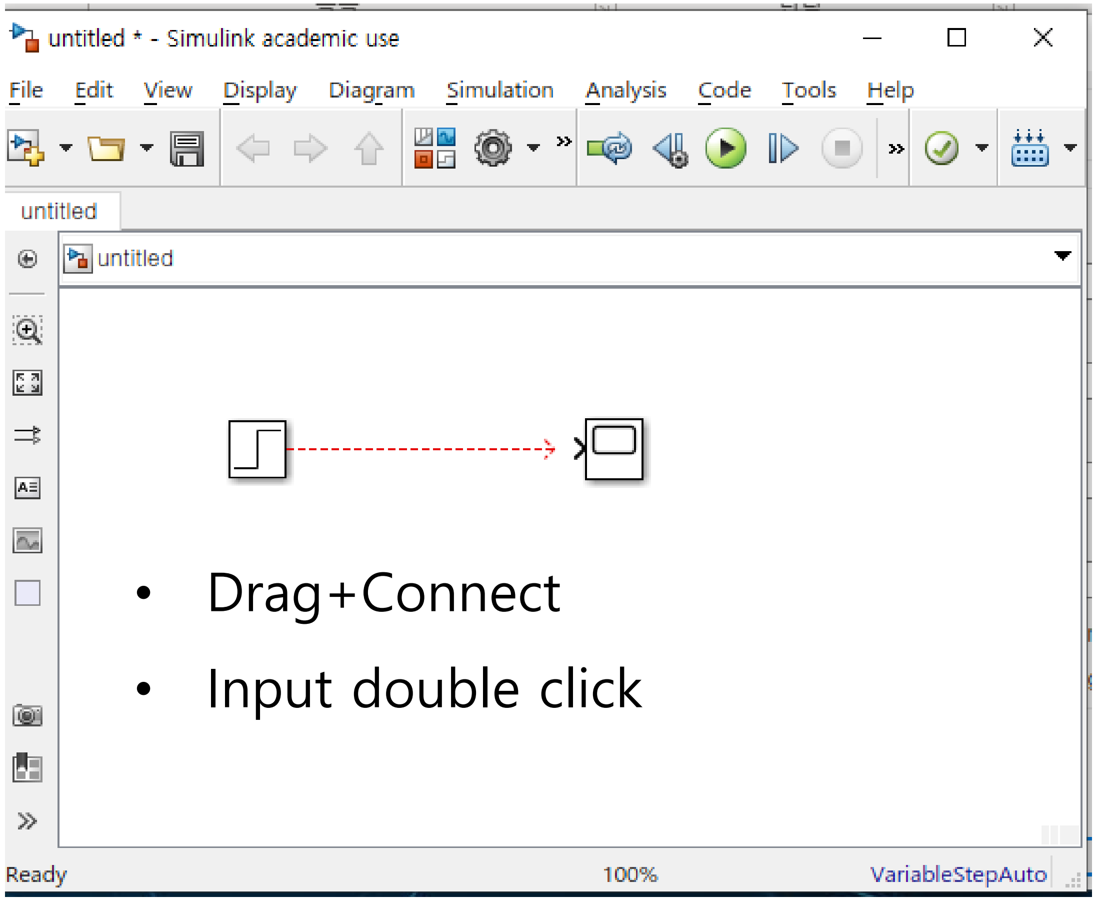


Input, Output

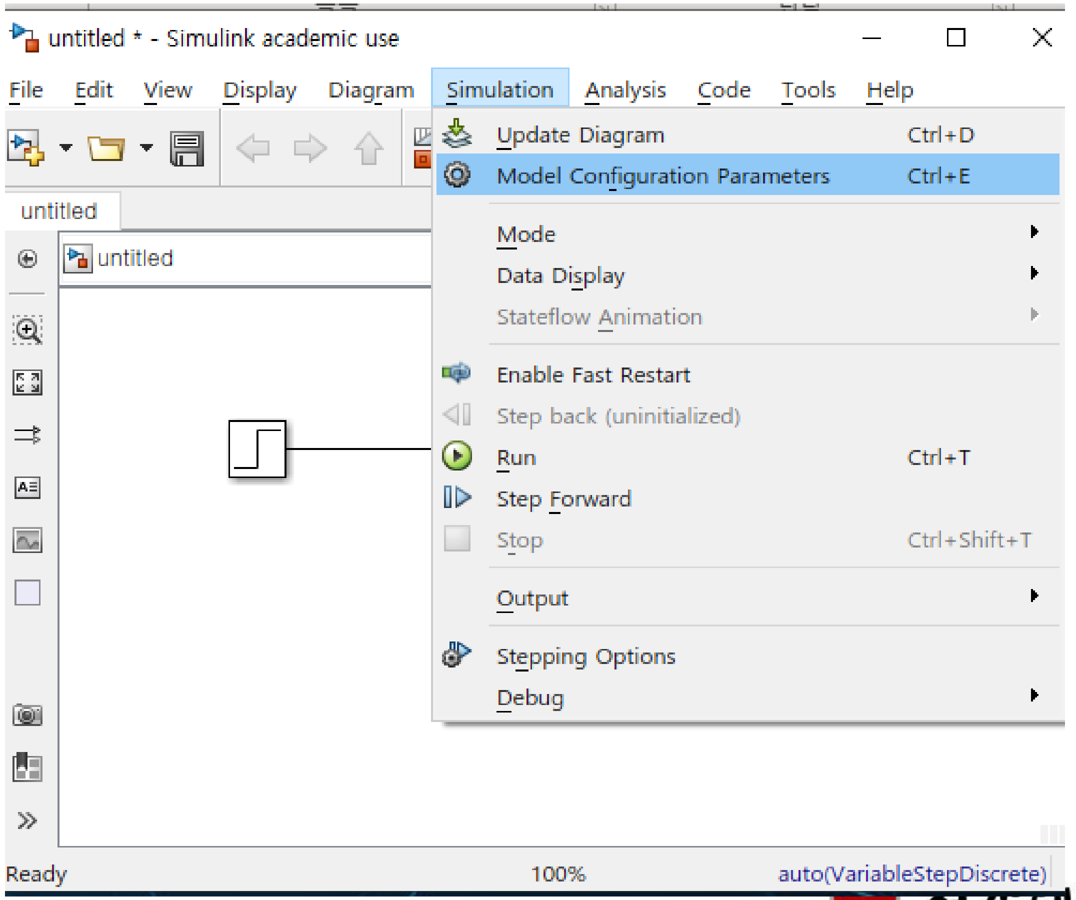


- Sources: input
- Sinks: output
- Drag+Drop

Input, Output



- Drag+Connect
- Input double click



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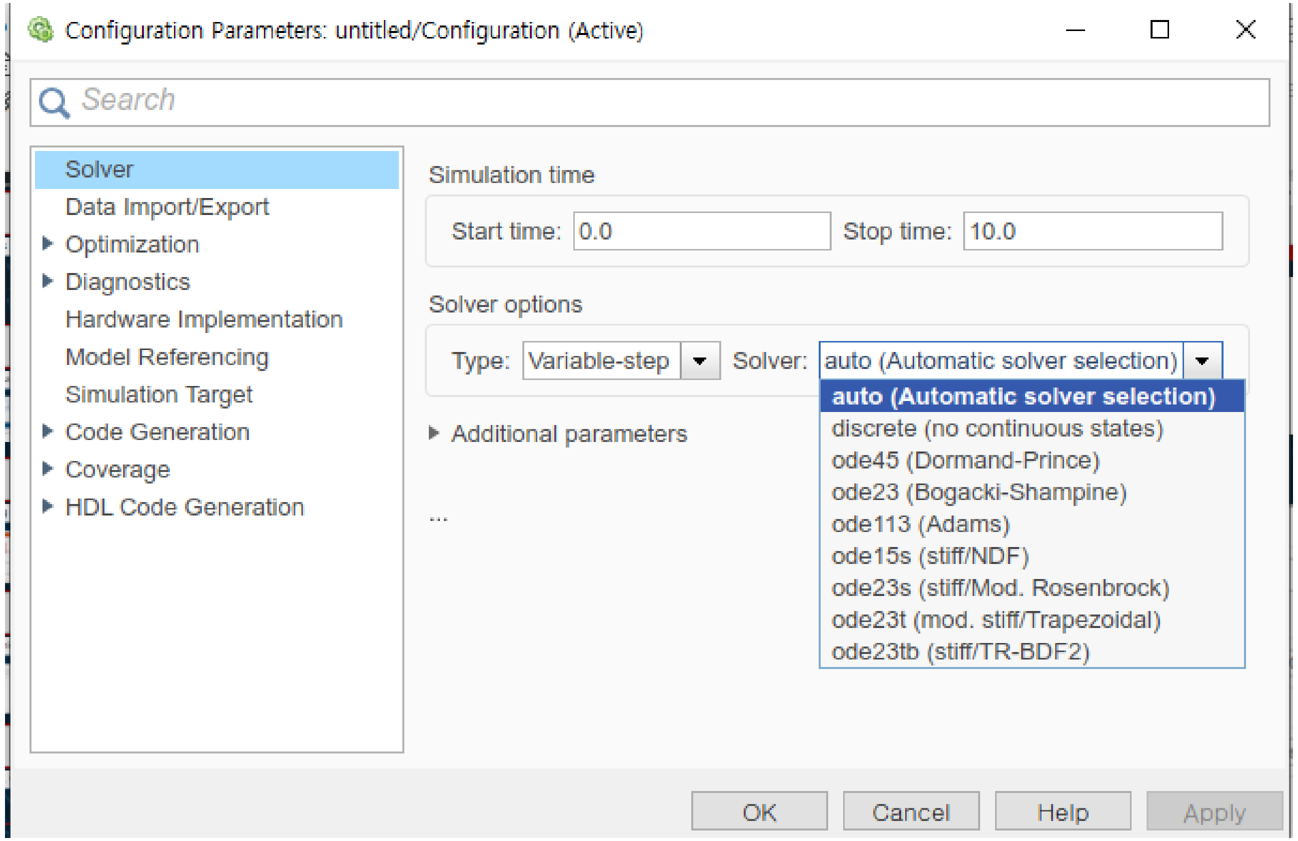
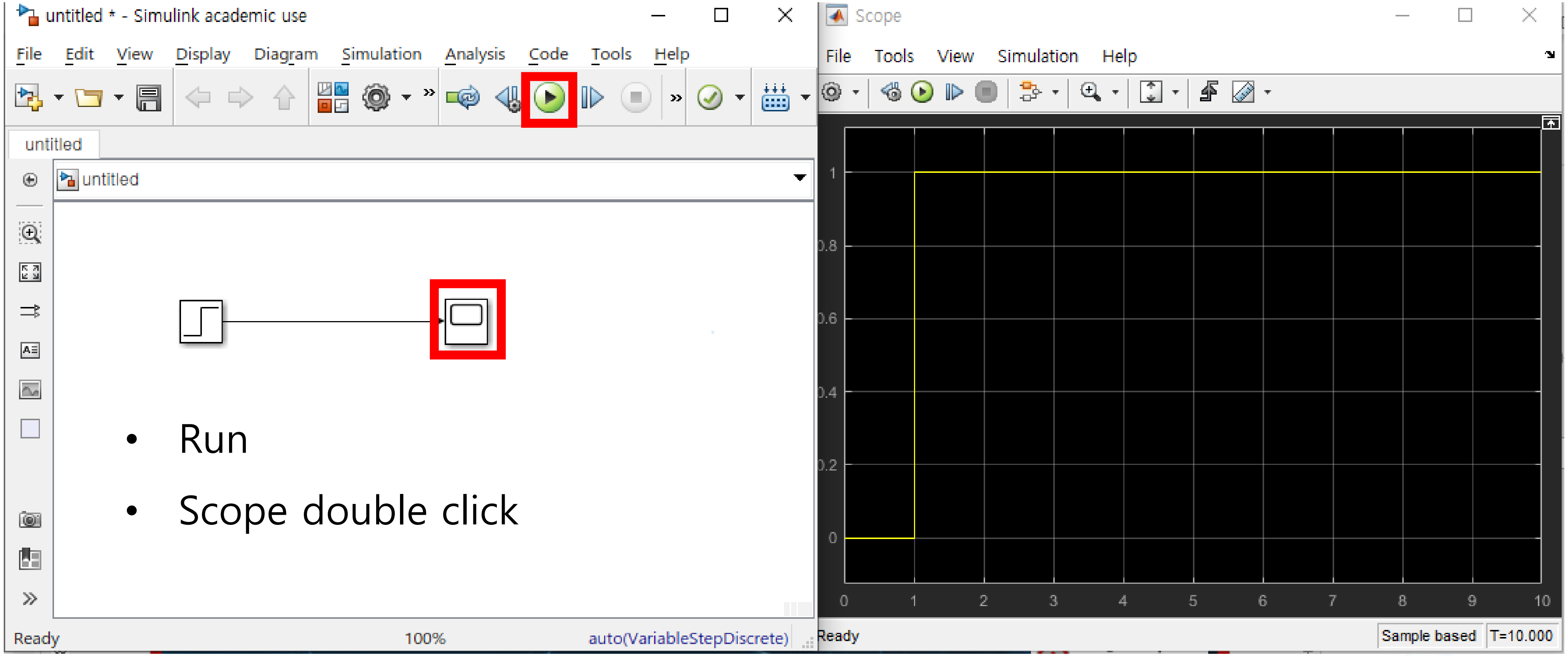
Configuration Parameters

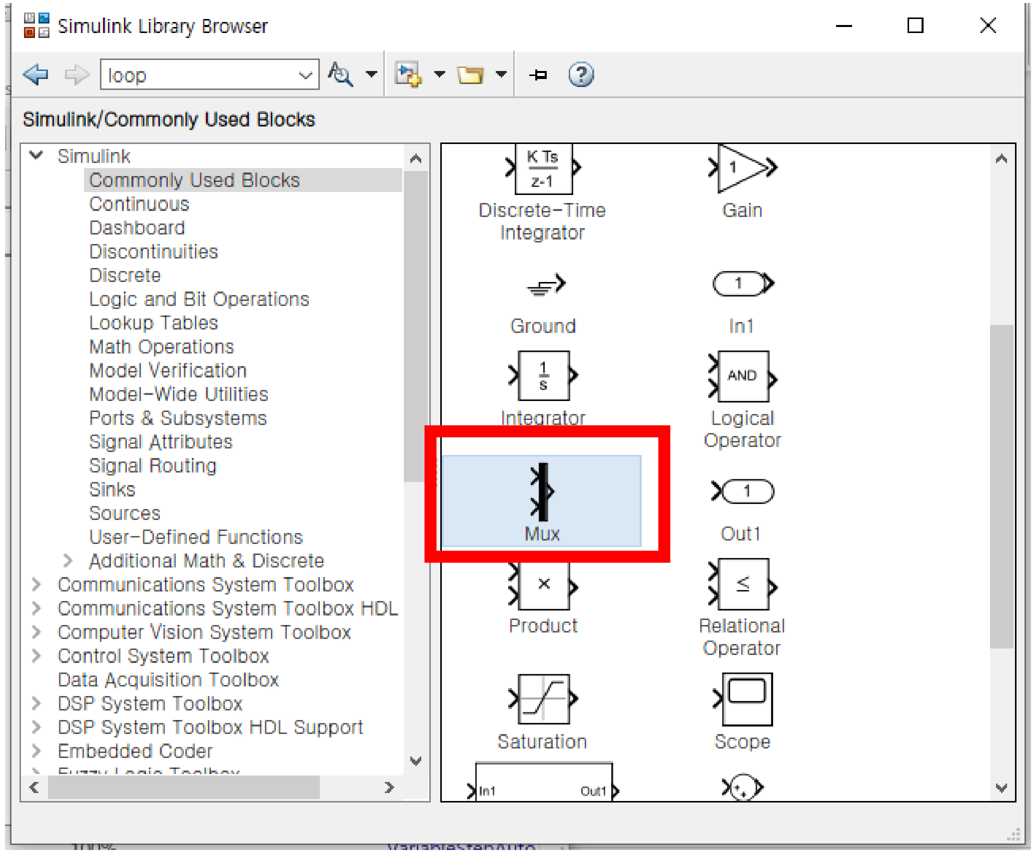


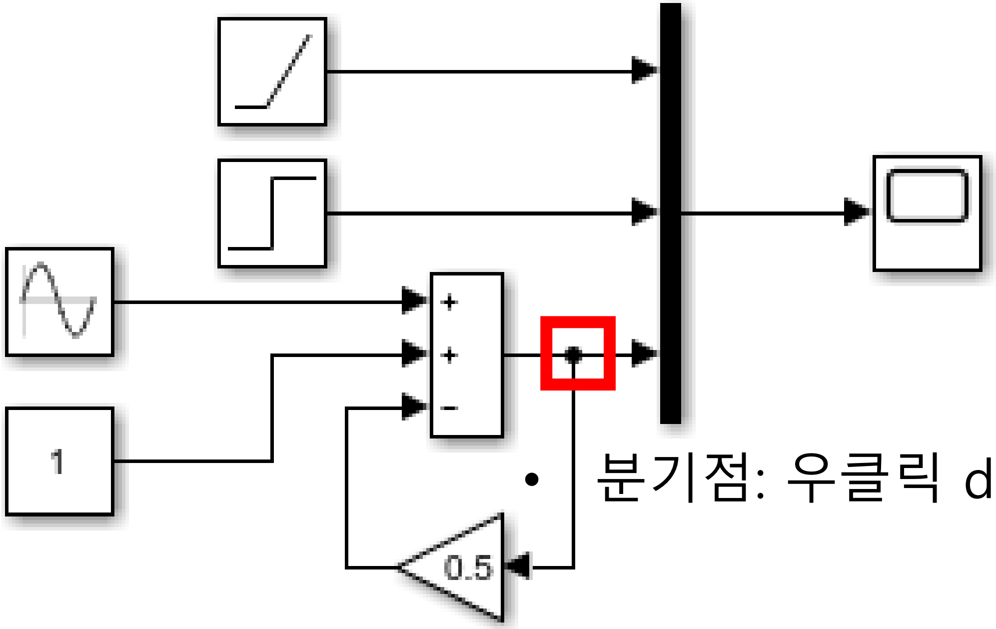
Step Function



- Run
- Scope double click

Multi Plot



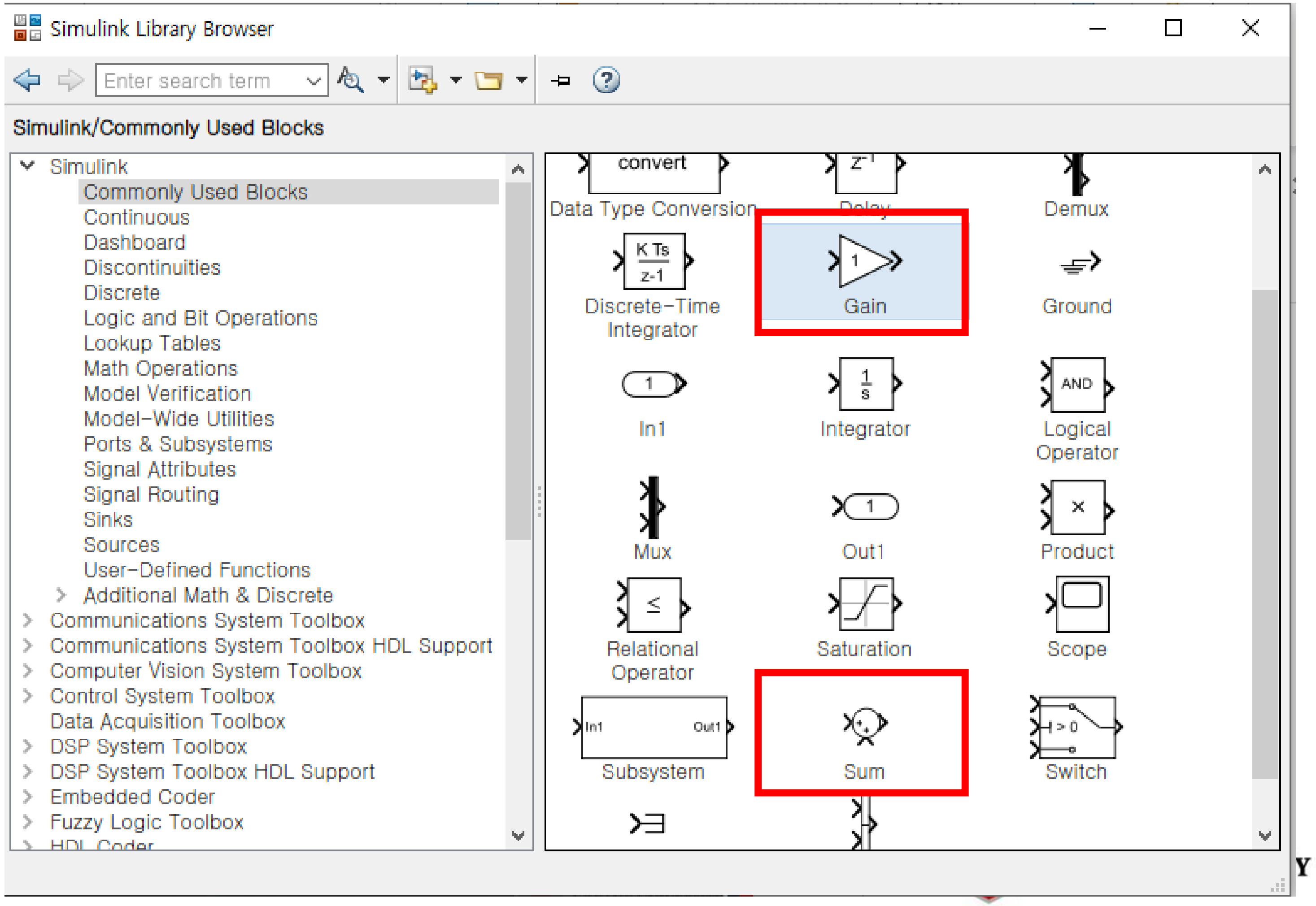


- 분기점: 우클릭 drag

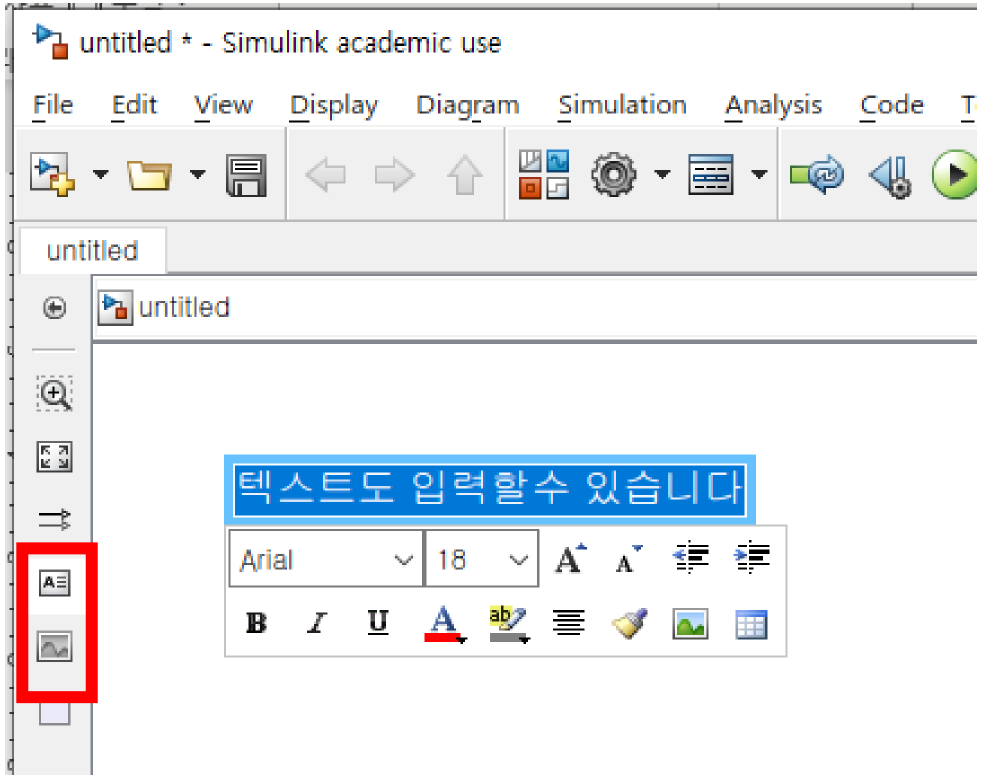
- 각 구성요소 double click 하면 편집 가능!

Commonly Used Blocks

- Gain: multiplying const
- Sum



etc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File
Edit
View
Display
Diagram
Simulation
Analysis
Code
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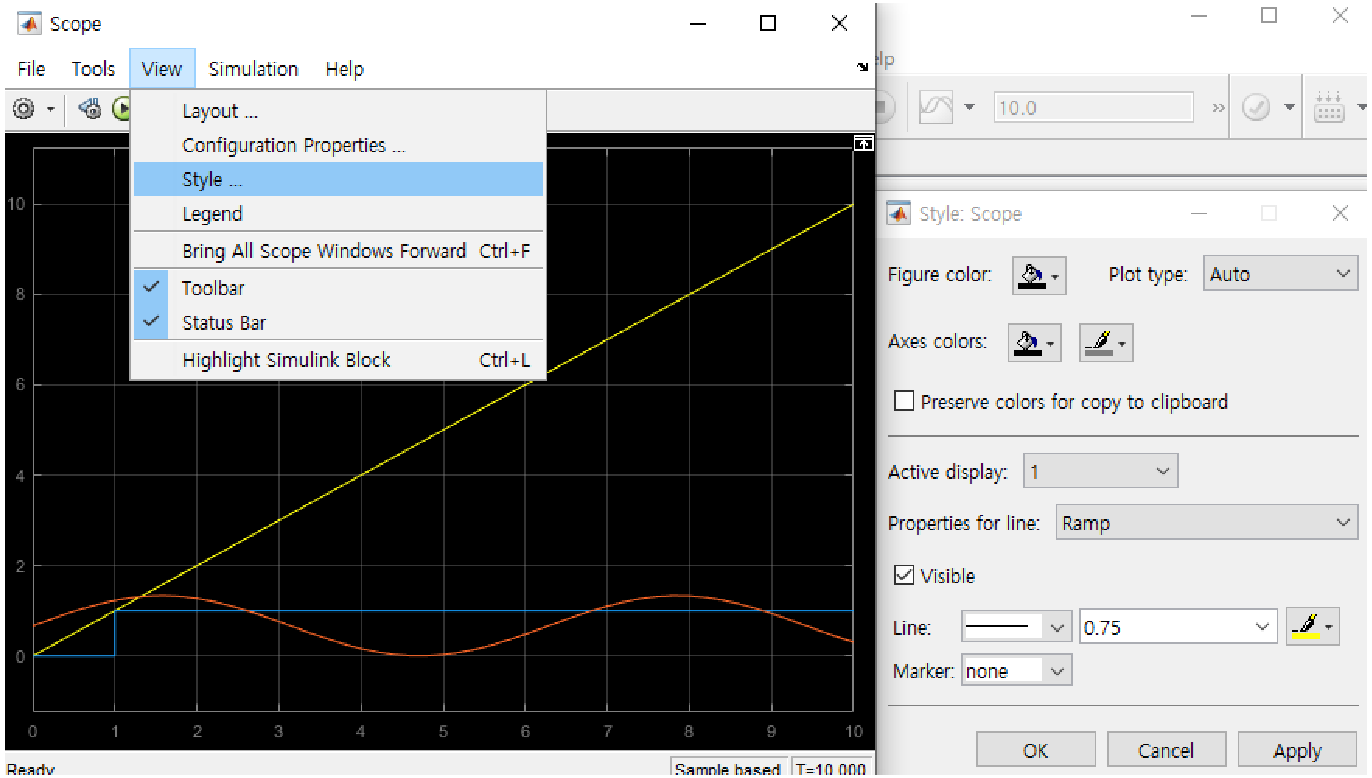
텍스트도 입력할수 있습니다
Arial
18


Scope
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Tools
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Simulation
Help
Layout ...
Configuration Properties ...
Style ...
Legend
Bring All Scope Windows Forward Ctrl+F
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Status Bar
Highlight Simulink Block Ctrl+L
Ready
Sample based
T=10.000
Style: Scope
Figure color:
Plot type:
Auto
Axes colors:
Preserve colors for copy to clipboard
Active display:
1
Properties for line:
Ramp
Visible
Line:
0.75
Marker:
none
OK
Cancel
Apply

Simple 1^{st} order ODE

$$y' = 0.2y$$

$$\frac{dy}{dx} = 0.2y, \quad \frac{dy}{y} = 0.2dx$$

$$\int \frac{1}{y} dy = \int 0.2dx$$

$$\ln|y| = 0.2x + C$$

$$y = C^* e^{0.2x}$$

- In Matlab

```
% solve 1st order ODE y'= 0.2y with y(0)=10
% exponential growth
[x,y]=ode45(@(x,y) 0.2*y, [0,10], 10)
% solver_name(ODE_function,tspan or xspan, initial condition y0)
plot(x,y)
```

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Simple 1st order ODE

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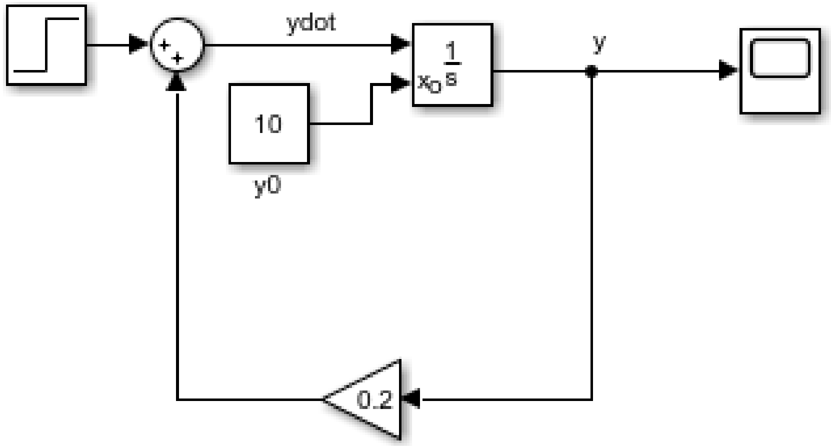
- In Simulink



- Tip : y'와 y에 초점을 둔다!

Matlab using ode45

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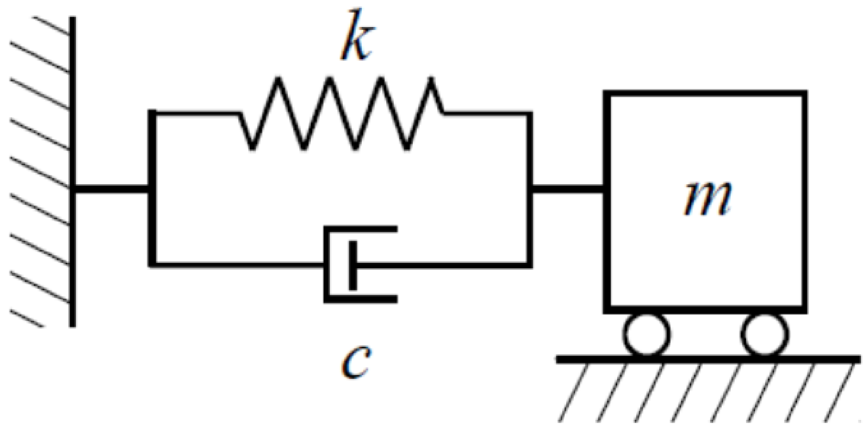
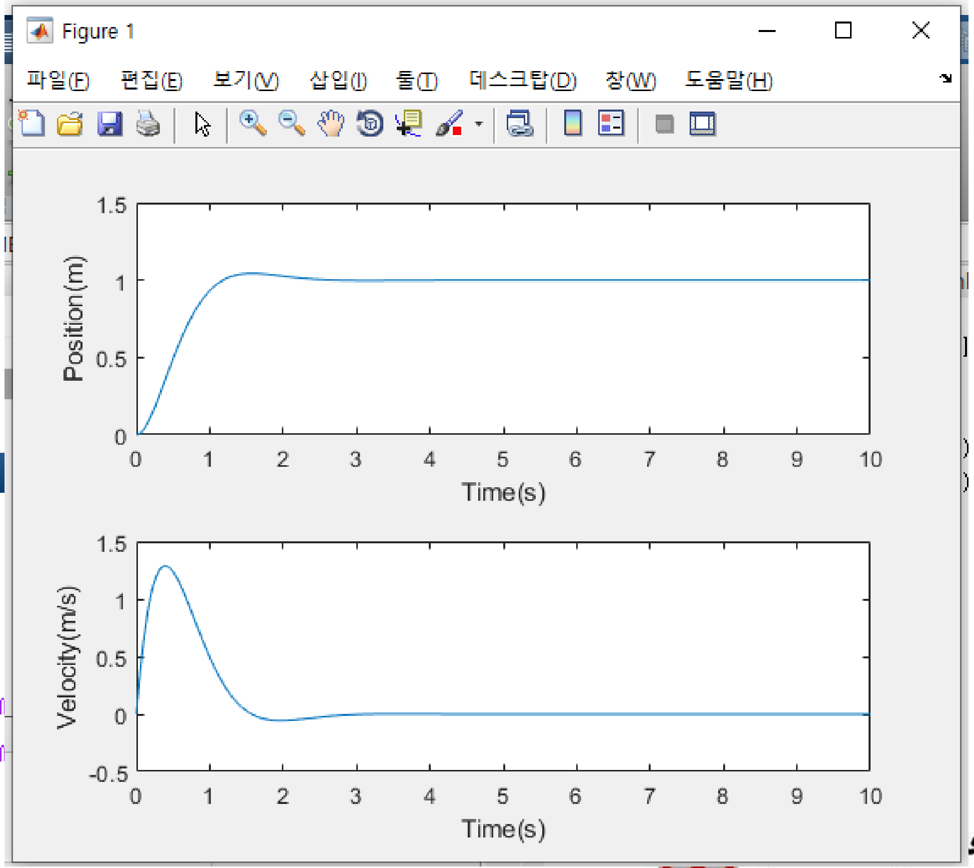


ocuments₩2021₩MECHA₩Seminar₩matlab_simulink01.m*

```
clear all; close all; clc;
[t,x]=ode45(@mck_ss,[0,10],[0,0]);
position=x(:,1);
velocity=x(:,2);
subplot(2,1,1); plot(t,position); xlabel('Time(s)'); ylabel('Position(m
subplot(2,1,2); plot(t,velocity); xlabel('Time(s)'); ylabel('Velocity(m
```



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Matlab using ode45

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- Method 1. System of 1st order ODE

```
function dx=mck(t,x)
m=1/8; c=1/2; k=1; u=1;
dx=zeros(2,1);
dx(1)=x(2);
dx(2)=-c/m*x(2)-k/m*x(1)+1/m*u;
```

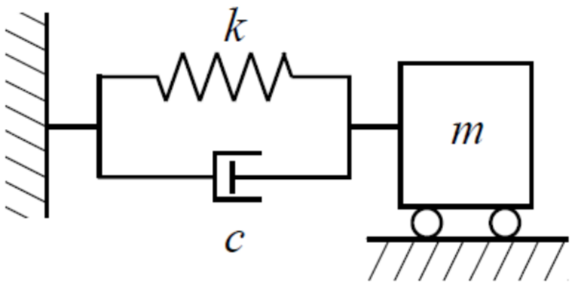
$$m\ddot{x}+c\dot{x}+kx=u$$

$$x_1=x$$

$$x_2=\dot{x}=\dot{x}_1$$

$$\dot{x}_2=\ddot{x}=\frac{-c\dot{x}-kx+u}{m}$$

$$\boxed{\begin{aligned}\dot{x}_1&=x_2\\ \dot{x}_2&=-\frac{k}{m}x_1-\frac{c}{m}x_2+\frac{1}{m}u\end{aligned}}$$



- Method 2. State Space

ocuments₩2021₩MECHA₩seminar₩mck_ss.m

```
function dx=mck_ss(t,x)
m=1/8; c=1/2; k=1; u=1;
A=[0 1; -k/m -c/m];
B=[0;1/m];
dx=A*x+B*u;
```

$$\dot{x}_1=x_2$$

$$\dot{x}_2=-\frac{k}{m}x_1-\frac{c}{m}x_2+\frac{1}{m}u$$

$$\begin{pmatrix}\dot{x}_1\\ \dot{x}_2\end{pmatrix}=\begin{bmatrix}0 & 1\\ -k/m & -c/m\end{bmatrix}\begin{pmatrix}x_1\\ x_2\end{pmatrix}+\begin{bmatrix}0\\ 1/m\end{bmatrix}u$$

$$\dot{X}=AX+BU$$

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Continuous System

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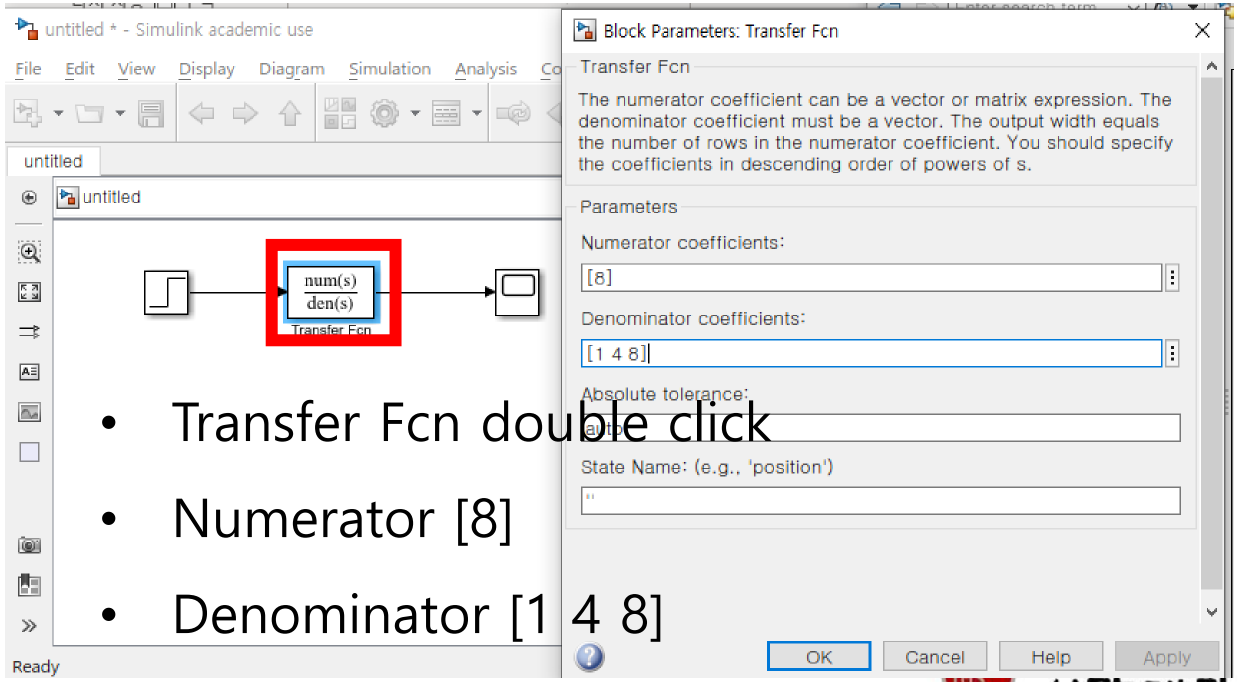
- mck 진동시스템
- Transfer Function method

$$m\ddot{x}+c\dot{x}+kx=F \qquad x(0)=0,\ \dot{x}(0)=0$$

$$ms^2X(s)+csX(s)+kX(s)=F(s)$$

$$G(s)=\frac{F(s)}{X(s)}=\frac{\frac{1}{m}}{s^2+\frac{c}{m}s+\frac{k}{m}}$$

- Laplace Transformation을 통해 얻어진 G(s)를 transfer function(전달함수) 라 한다.



- Transfer Fcn double click
- Numerator [8]
- Denominator [1 4 8]

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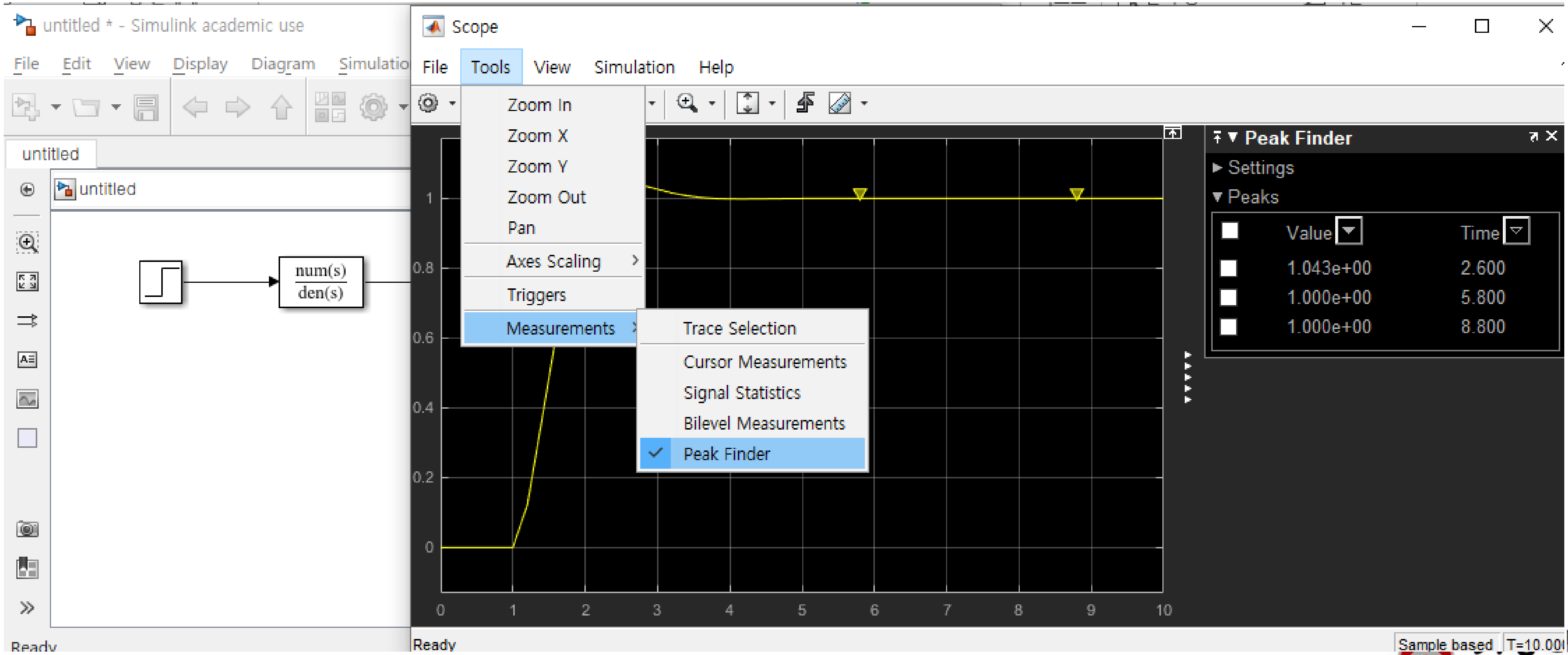
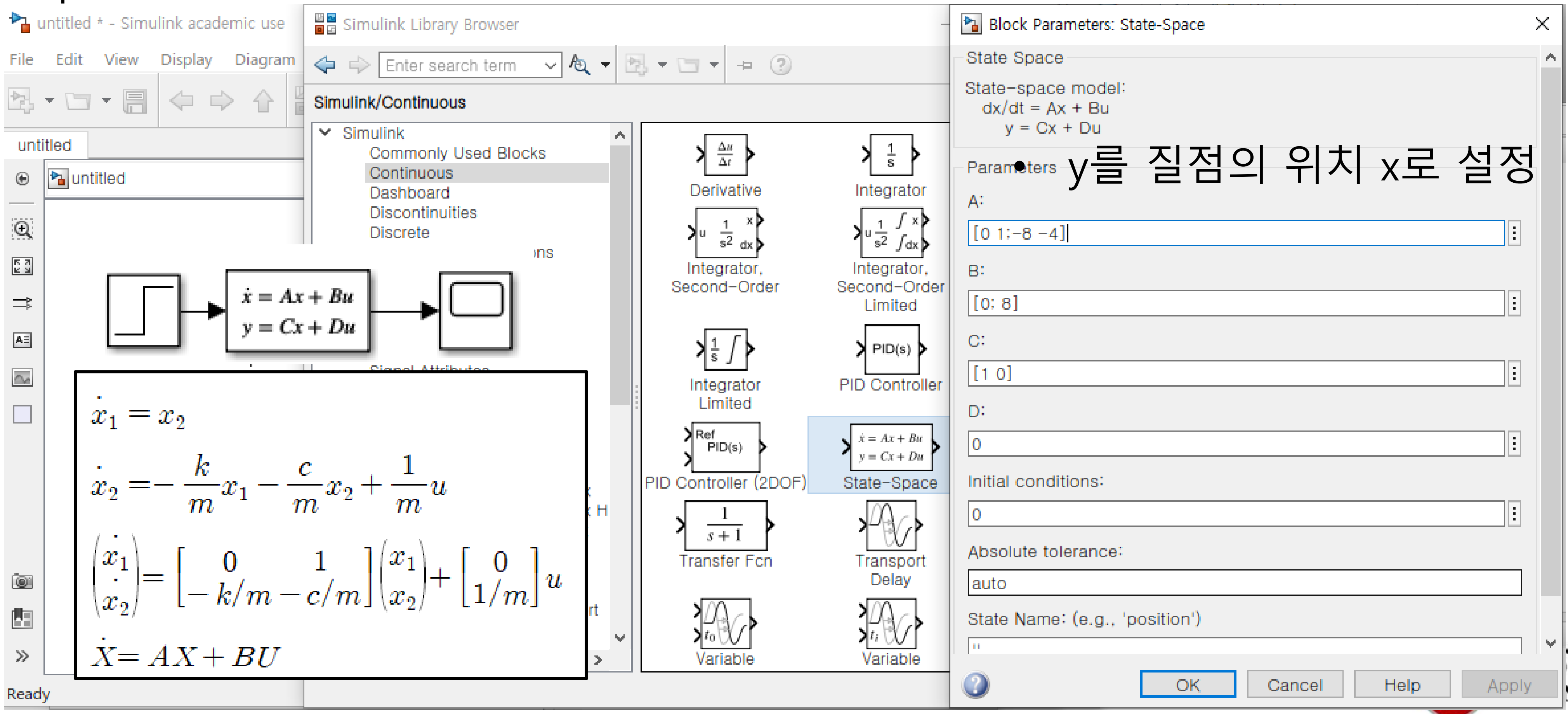
Continuous System



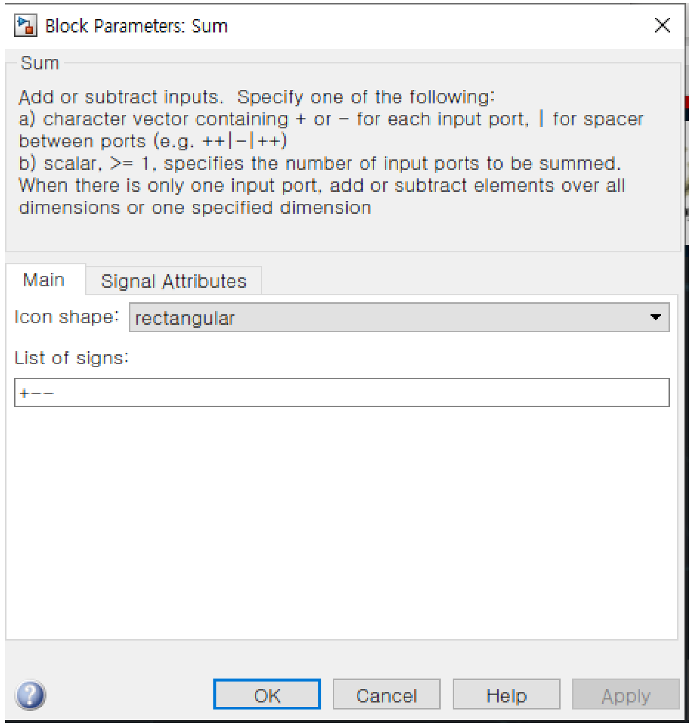
Continuous System

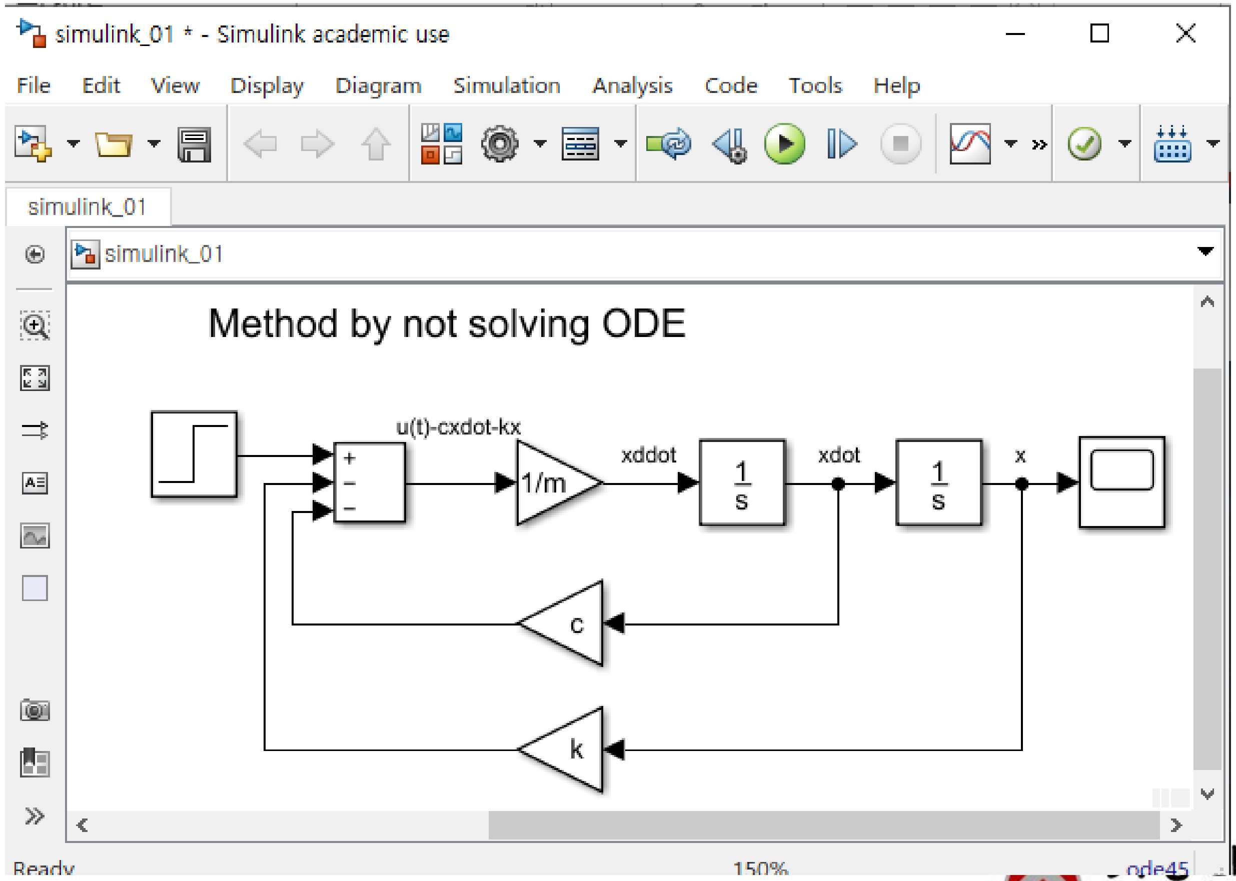
- State Space method



Not Solving ODE

$$\ddot{x} = \frac{1}{m}\left[u(t) - c\dot{x} - kx\right]$$





2-DOF MCK System

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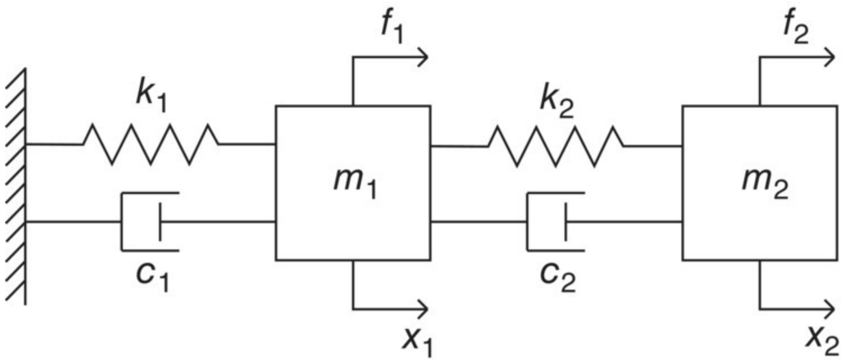
- Engineering Vibration 4th ed Daniel. J Inman
- Chap. 4 Multi-Degree-of-Freedom Systems
- Example 4.10.3



$$\ddot{x}_1 = \frac{1}{m_1}\left(f_1 - (c_1 + c_2)\dot{x}_1 + c_2\dot{x}_2 - (k_1 + k_2)x_1 + k_2 x_2\right)$$

$$\ddot{x}_2 = \frac{1}{m_2}\left(f_2 + c_2\dot{x}_1 - c_2\dot{x}_2 + k_2 x_1 - k_2 x_2\right)$$

Consider the following system excited by a pulse of duration 0.1s(units in newtons)

$$\begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{bmatrix} + \begin{bmatrix} 0.3 & -0.05 \\ -0.05 & 0.05 \end{bmatrix}\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} + \begin{bmatrix} 3 & -1 \\ -1 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}[\Phi(t-1) - \Phi(t-1.1)]$$

and subject to the initial conditions

$$x_0 = \begin{bmatrix} 0 \\ -0.1 \end{bmatrix} m,\ v_0 = \begin{bmatrix} 0 \\ 0 \end{bmatrix} m/s$$

Compute and plot the response of the system. Here indicates the Heaviside step function introduced in Section 3.2.

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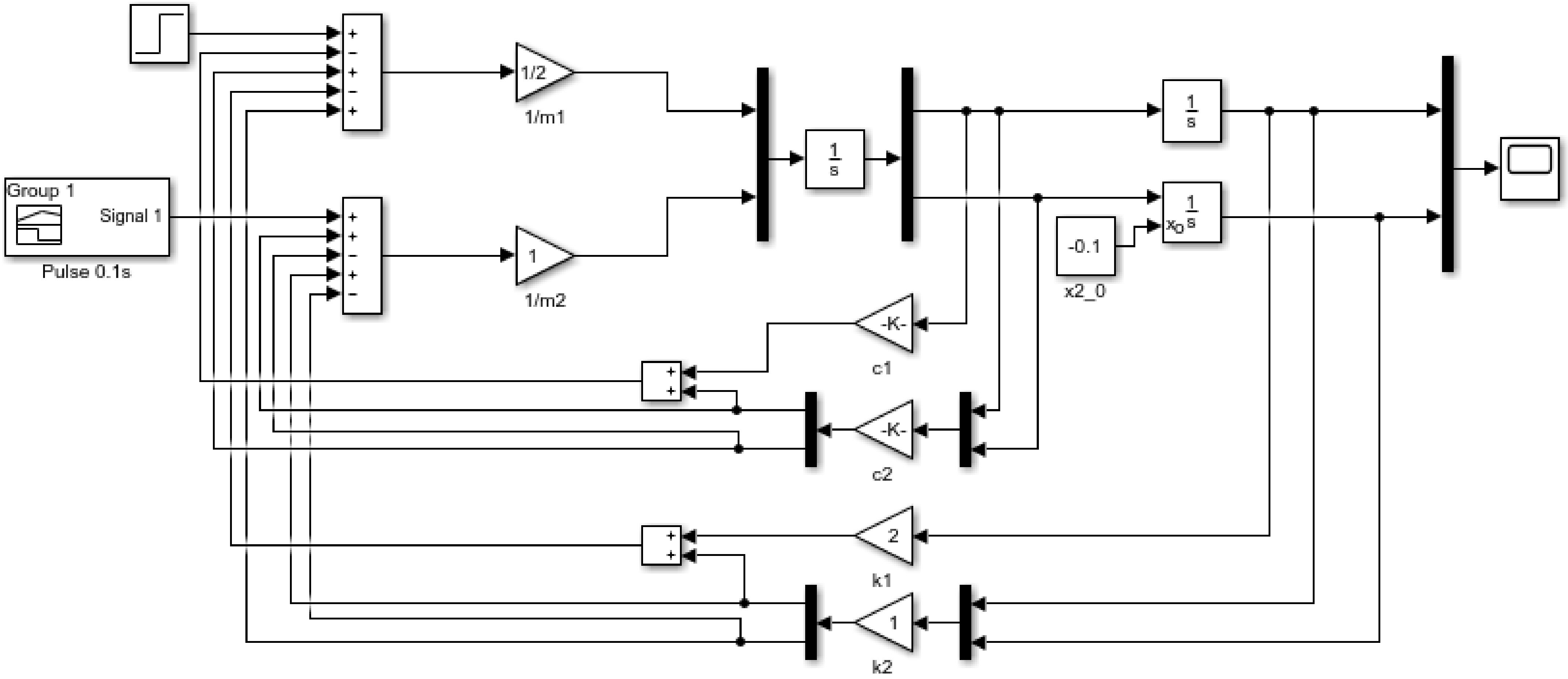
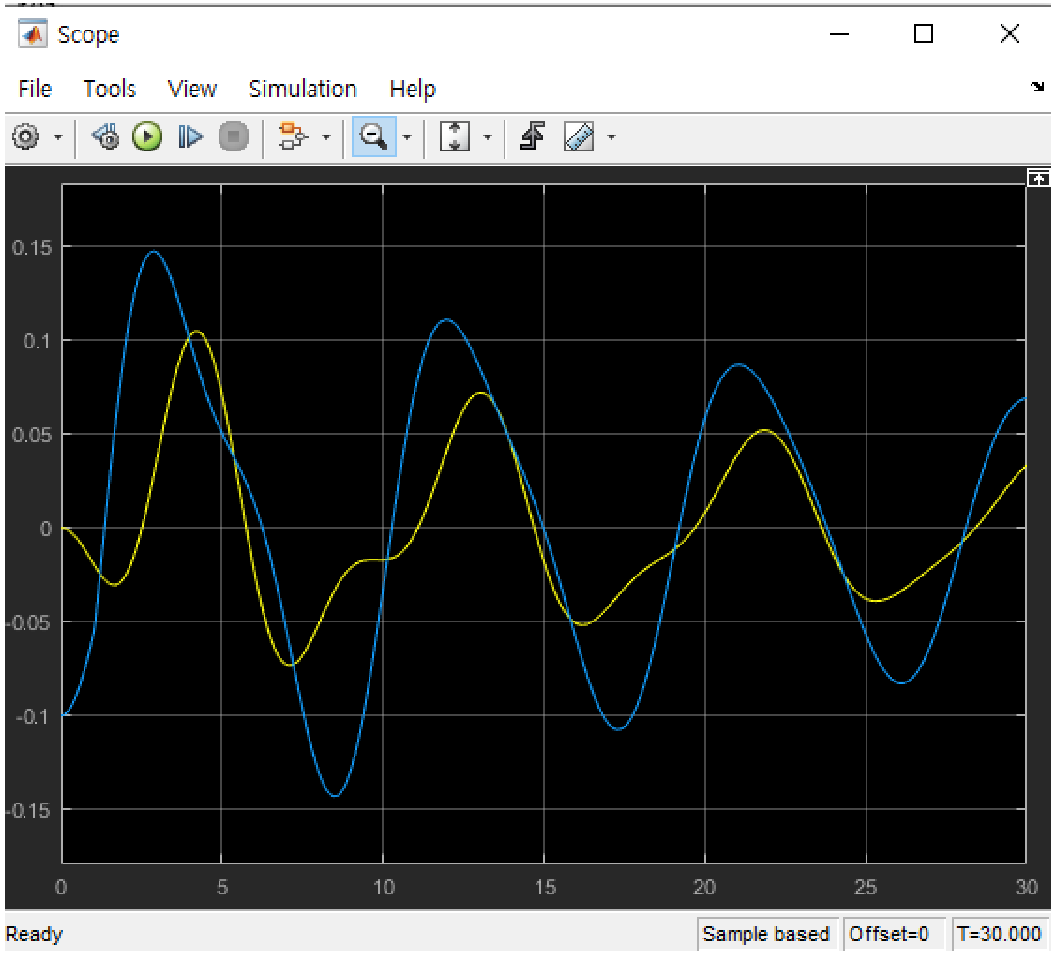
2-DOF MCK System



2-DOF MCK System



- m1: yellow
- m2: blue

Q&A