INTRODUCTION TO SIMULINK

EEEN 567 – SATELLITE COMMUNICATION

Friday, 03 October 2025

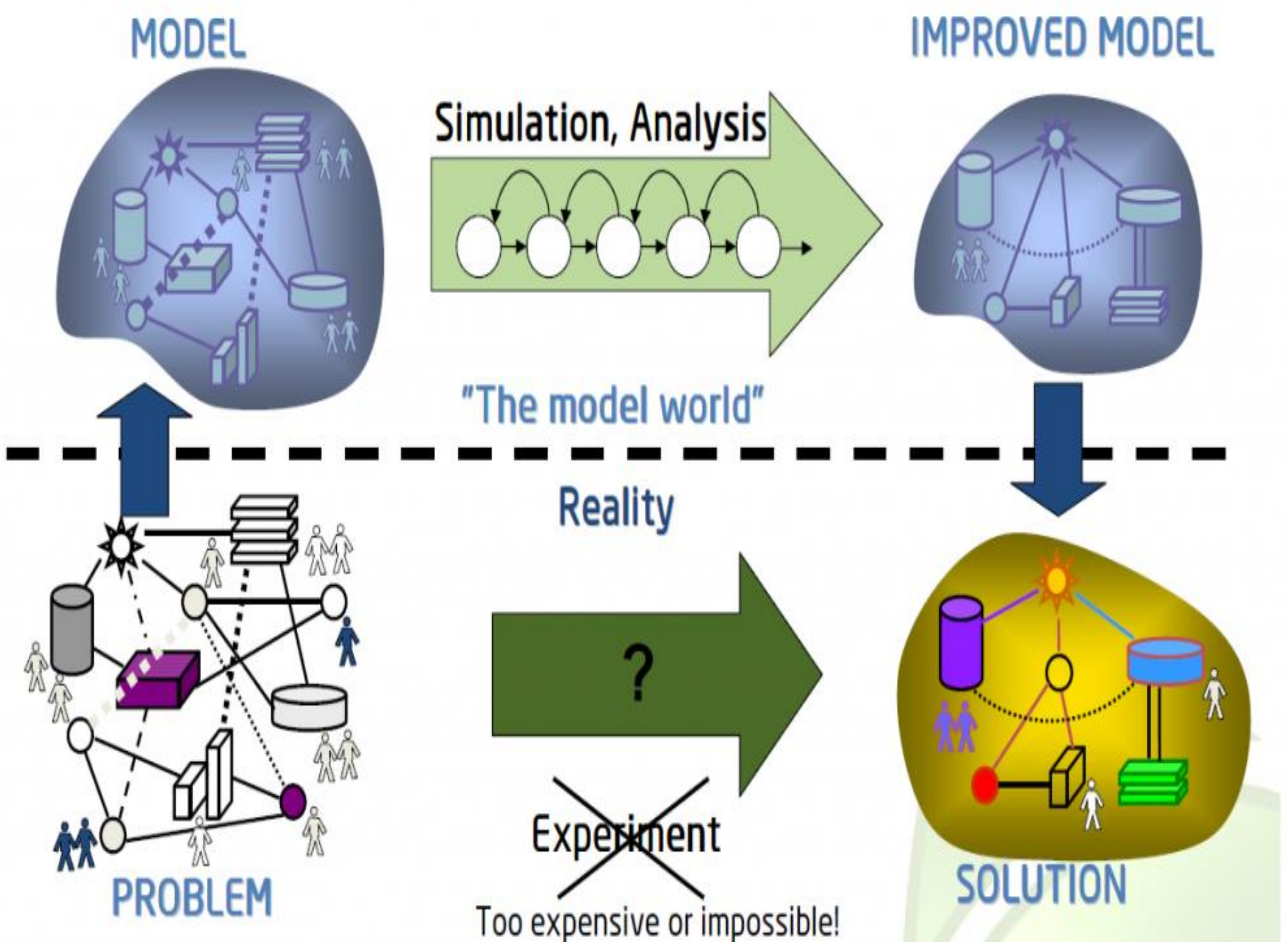
WHAT IS SIMULINK?

1. **Simulink** is a software package used during the design of dynamic systems for:
    1. modeling
    2. simulating
    3. analyzing
2. **Simulink** supports linear and nonlinear systems, modeled in continuous time, sample time, or a hybrid of the two.
3. **Systems in Simulink** can be multirate (i.e. different parts that are sampled or updated at different rates)

WHY WE NEED SIMULATION?

Main advantages of simulation include:

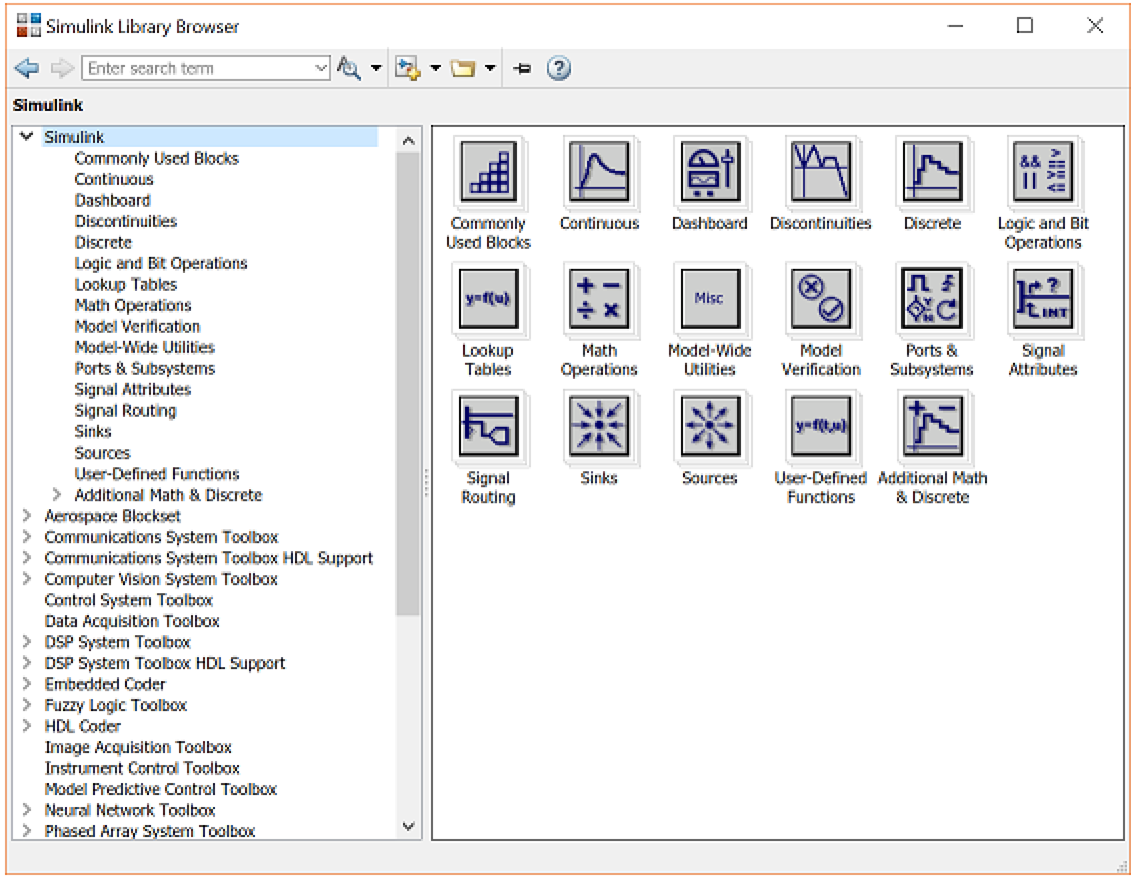
1. Study the behavior of a system without building it.
2. Results are accurate in general, compared to analytical model.
3. Help to find un-expected phenomenon, behavior of the system.
4. Easy to perform ``What-If'' analysis.



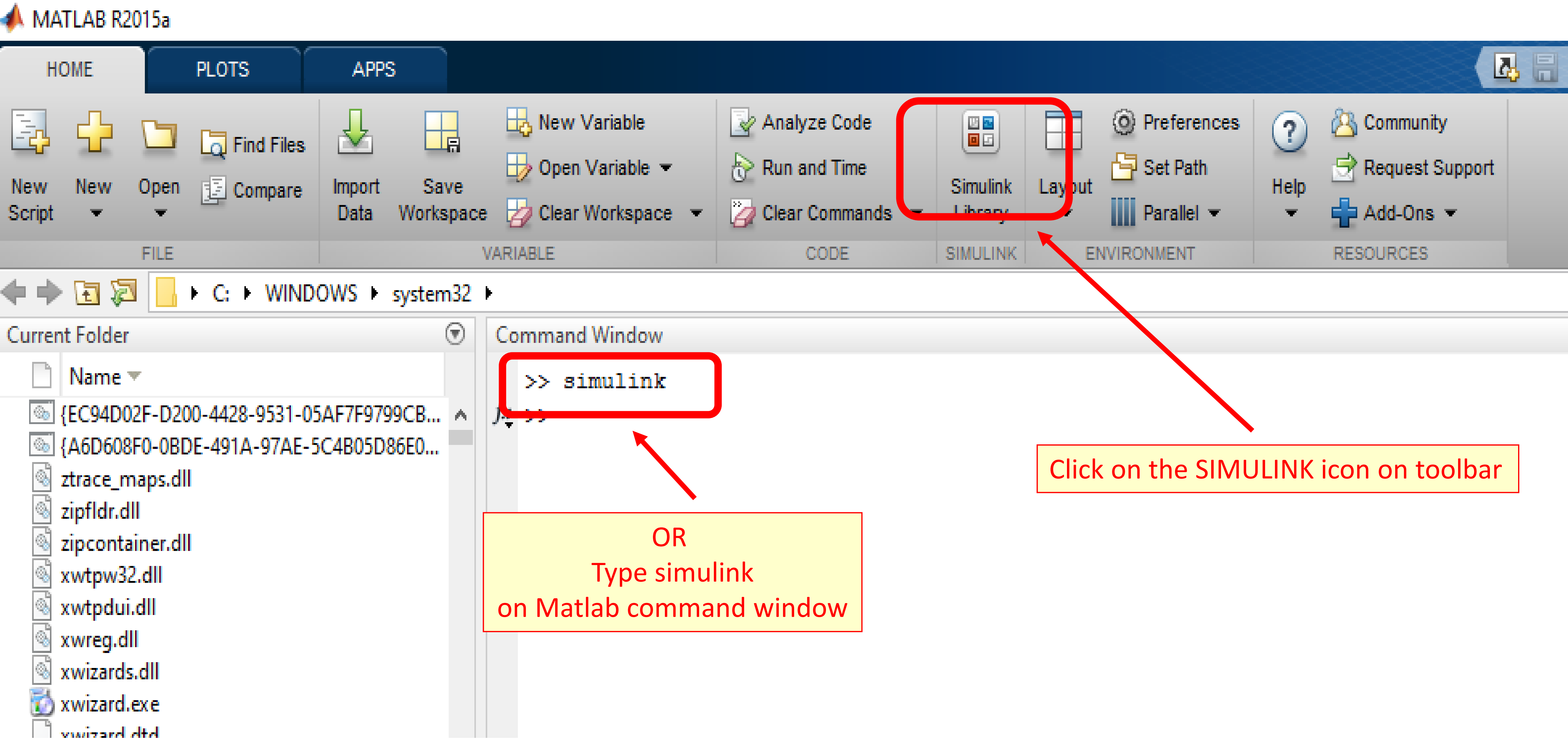
ADVANTAGES OF USING SIMULINK

Simulink provides the following advanced features:

1. **Graphical user interface** for building models as block diagrams
2. Ability to **design models in hierarchical fashion** (using both top-down and bottom-up approaches)
3. Ability to **simulate, analyze the output results**
4. Ability to **explore, revise your models.**

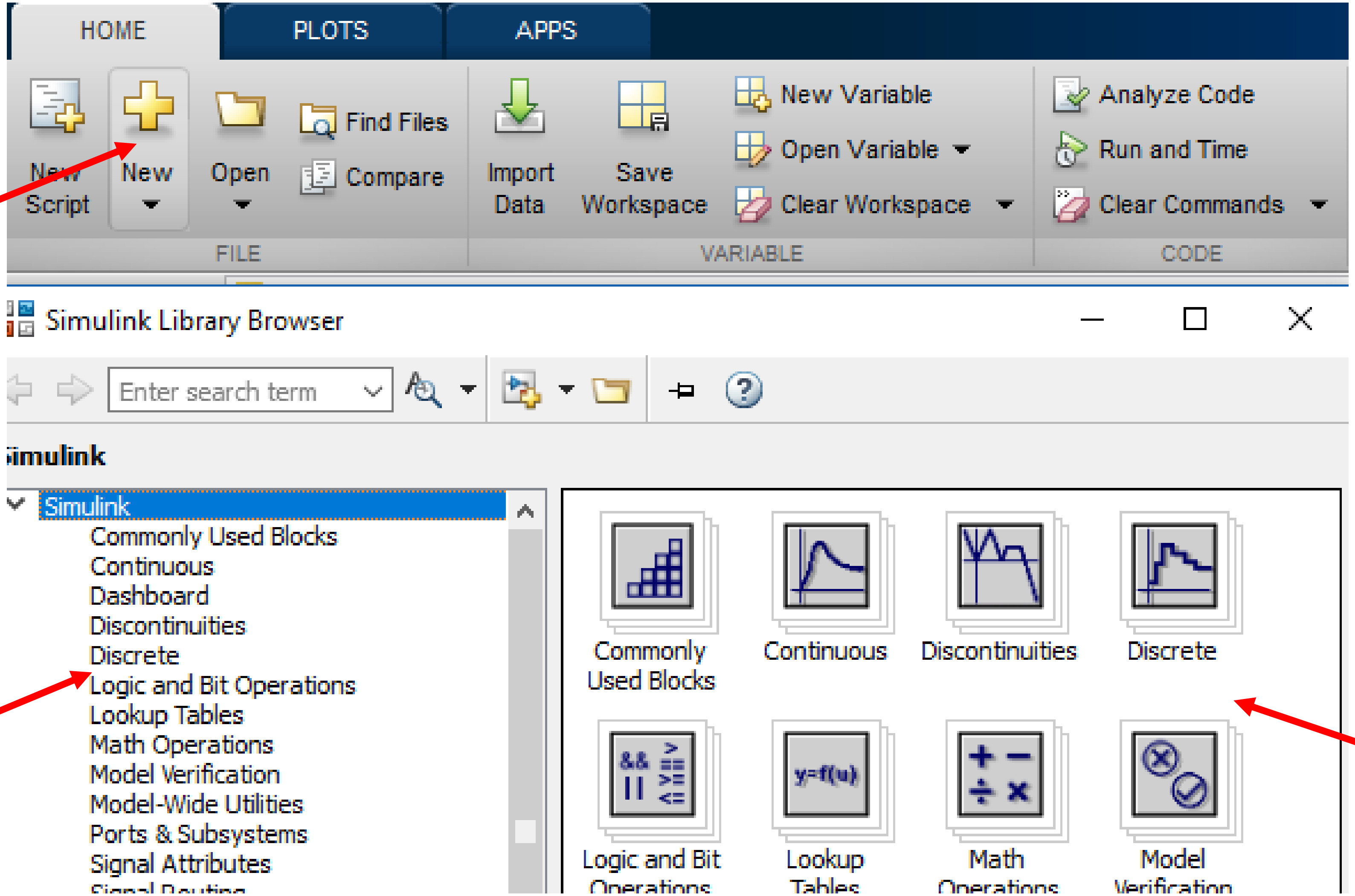


STARTING SIMULINK



SIMULINK ENVIRONMENT

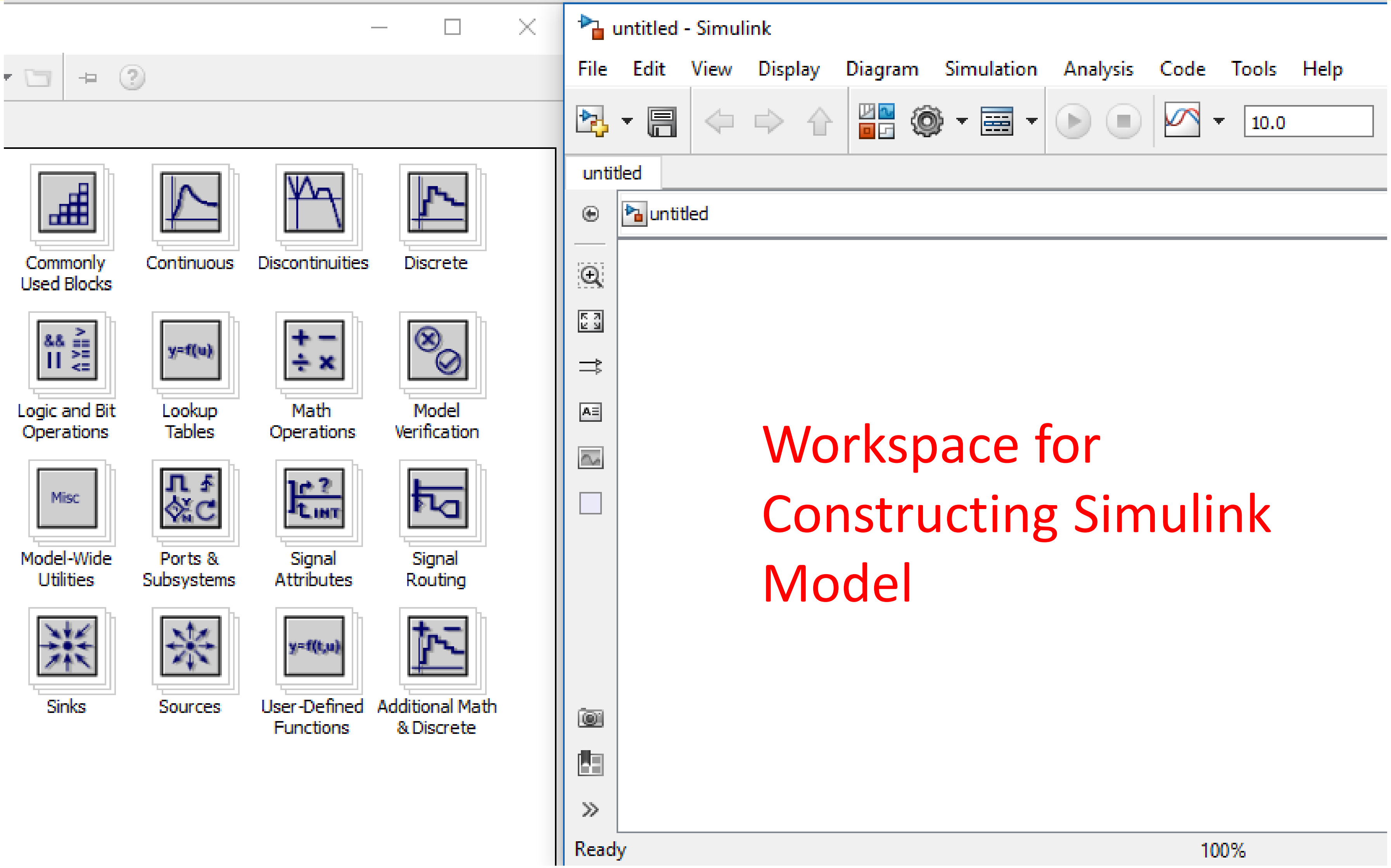
Create New Model Icon



Library

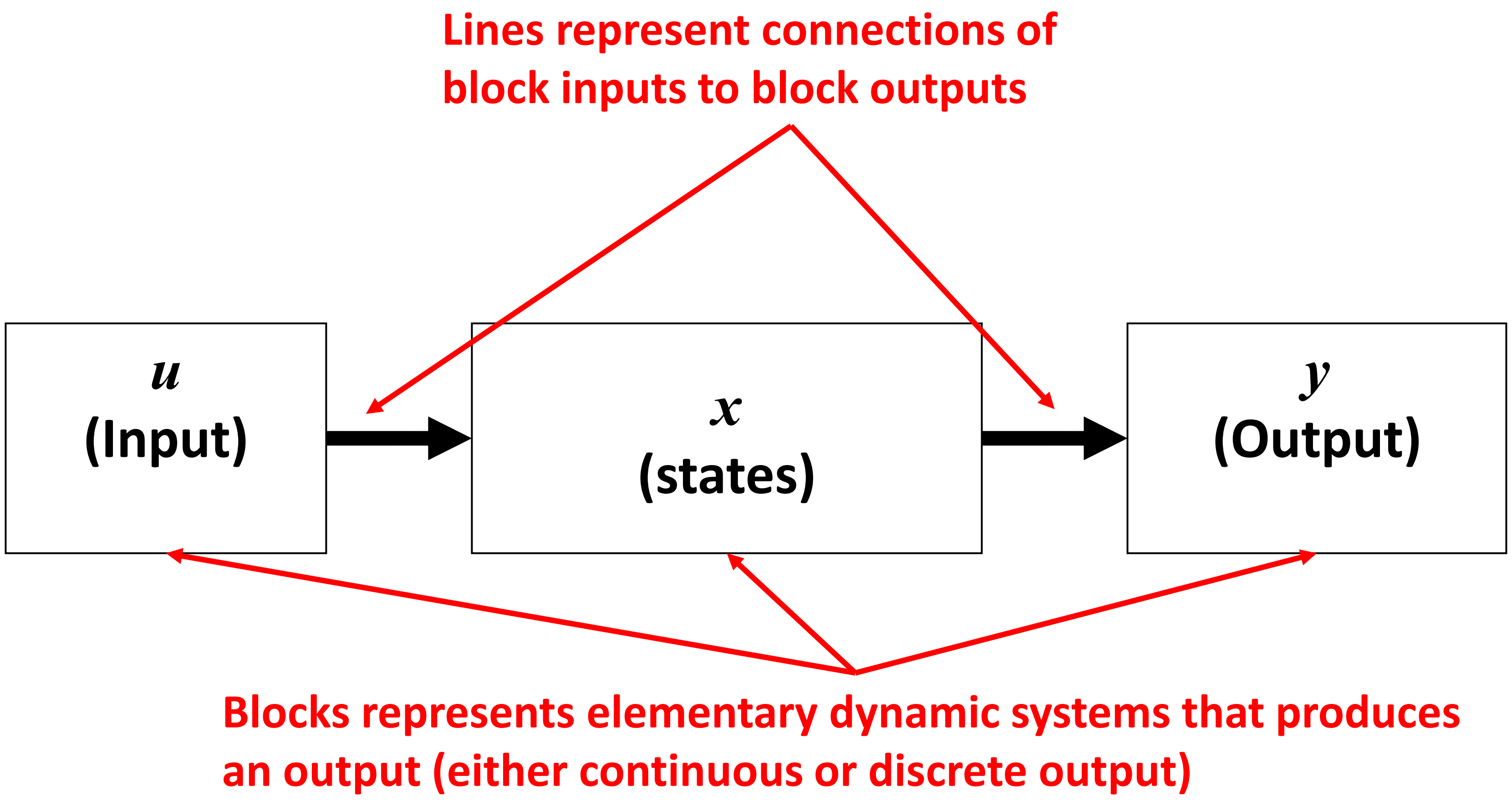
Block Set for Model Construction

CREATING A NEW SIMULINK MODEL



BUILDING A SIMULINK MODEL

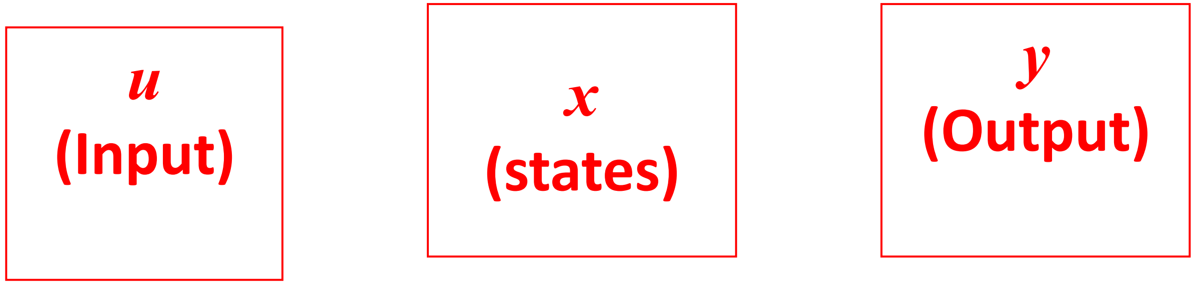
Simulink Block Diagram is a pictorial model of a dynamic system.



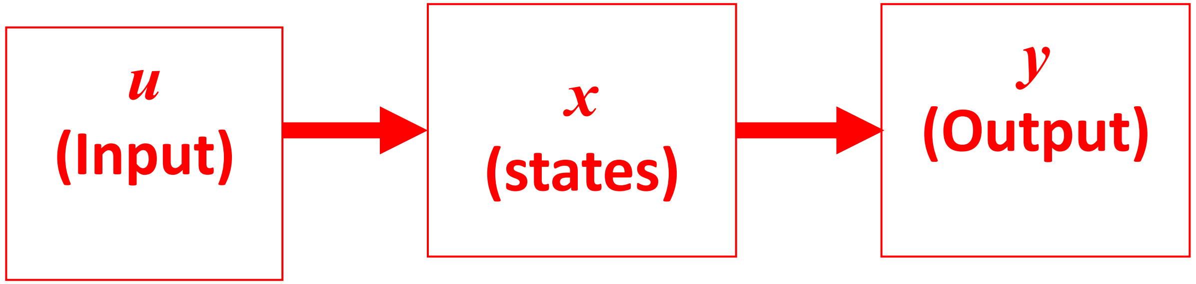
BUILDING A SIMULINK MODEL / 02

The following steps will guide you to construct a system/model:

STEP 1: Creating Blocks



STEP 2: Making connections

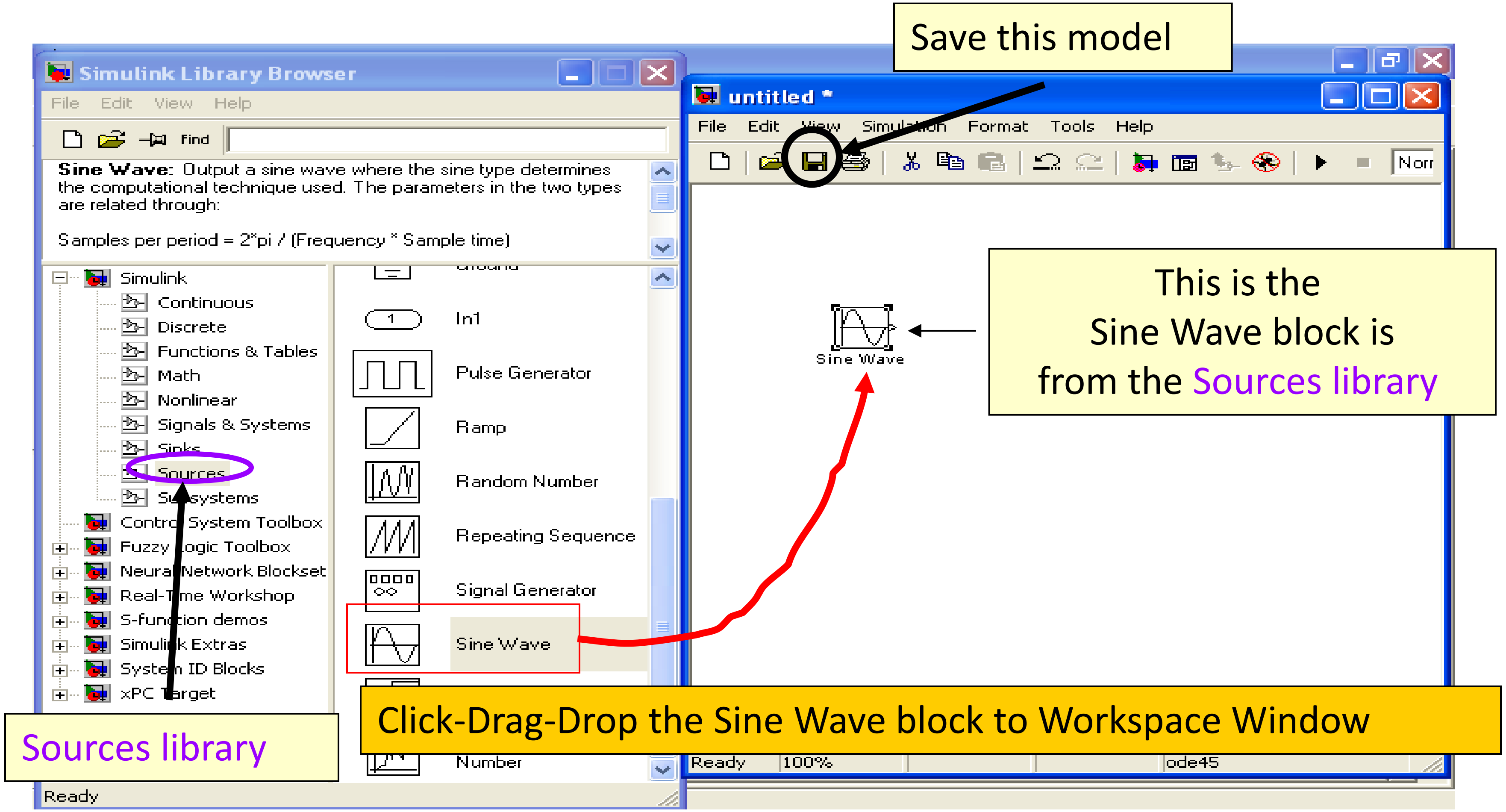


STEP 3: Set Parameters

STEP 4: Running Simulation

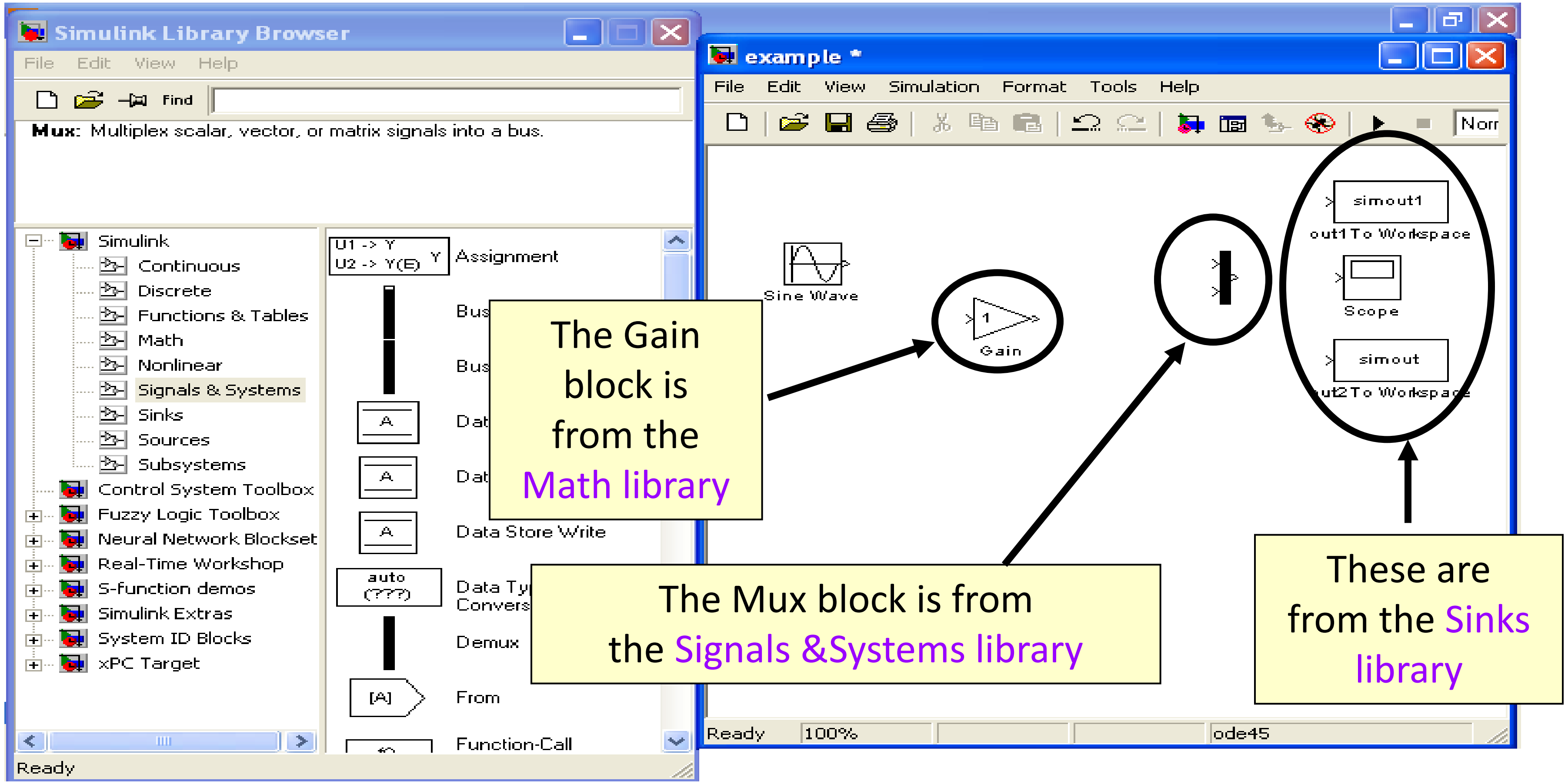
BUILDING A SIMULINK MODEL / 03

STEP 1: CREATING BLOCKS



BUILDING A SIMULINK MODEL / 04

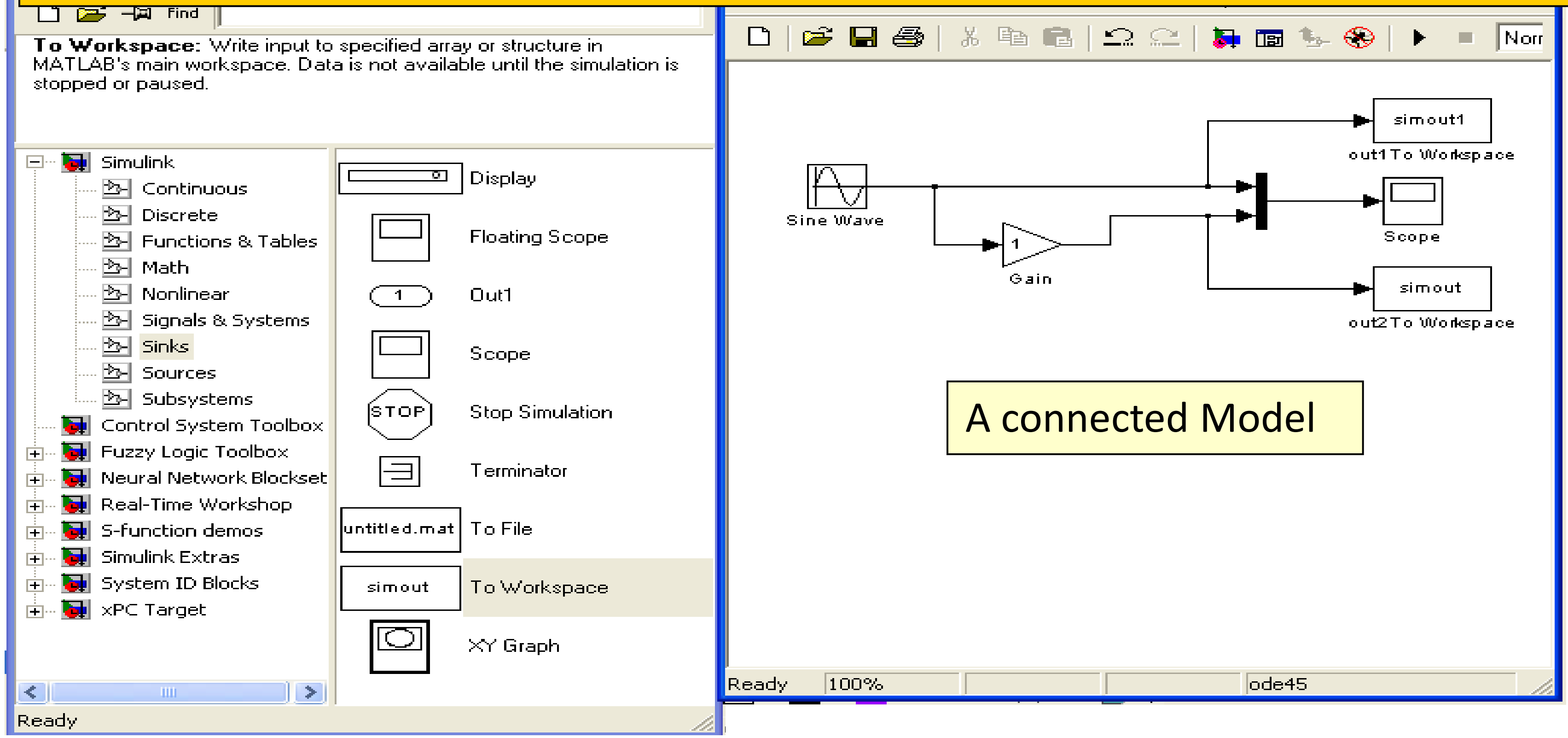
STEP 1: CREATING BLOCKS



BUILDING A SIMULINK MODEL / 04

STEP 2: MAKING CONNECTIONS

To make connection: left-click while holding down *control key* (on keyboard) and drag from source port to a destination port

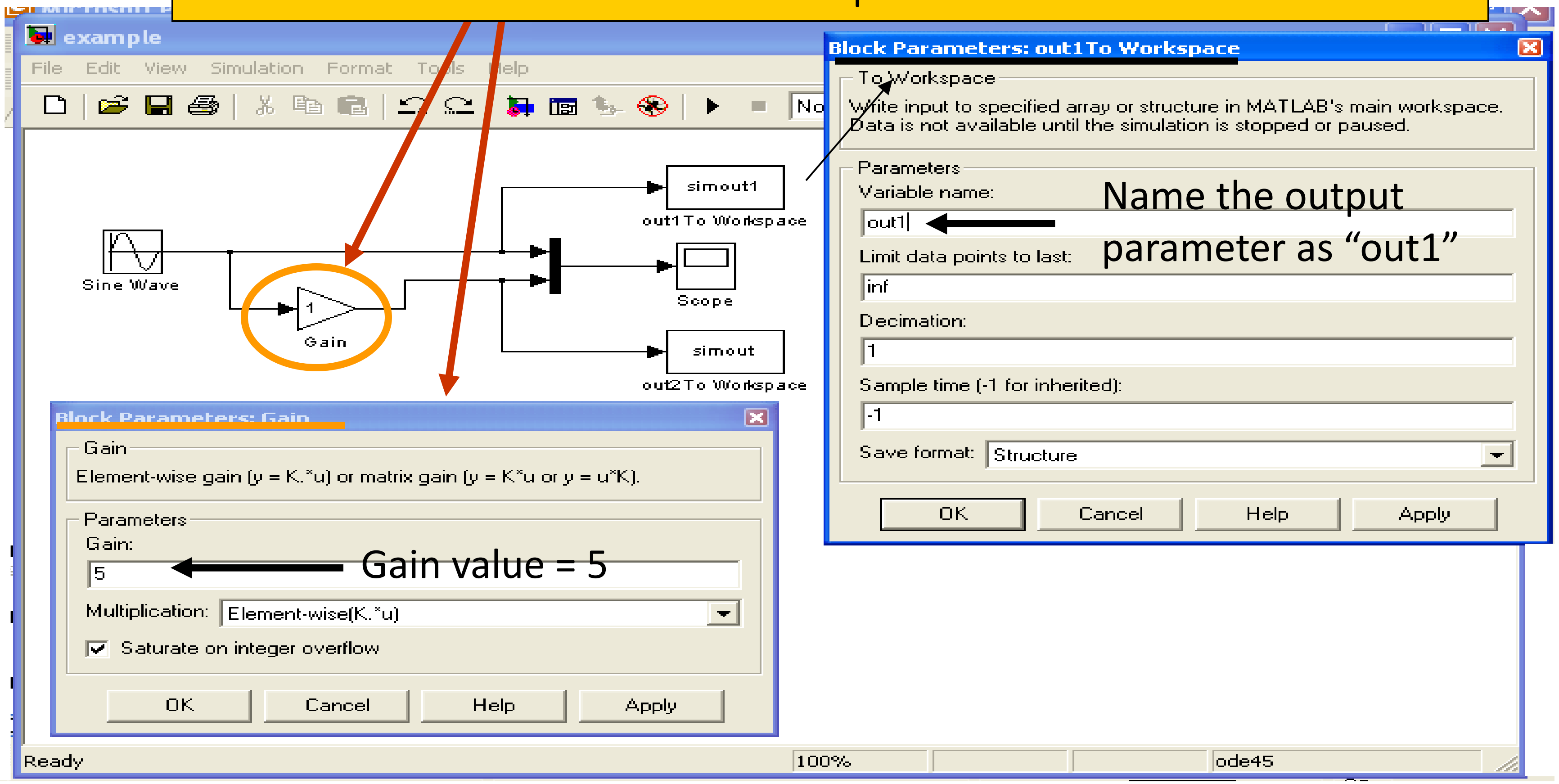


A connected Model

BUILDING A SIMULINK MODEL / 05

STEP 3: SET PARAMETERS

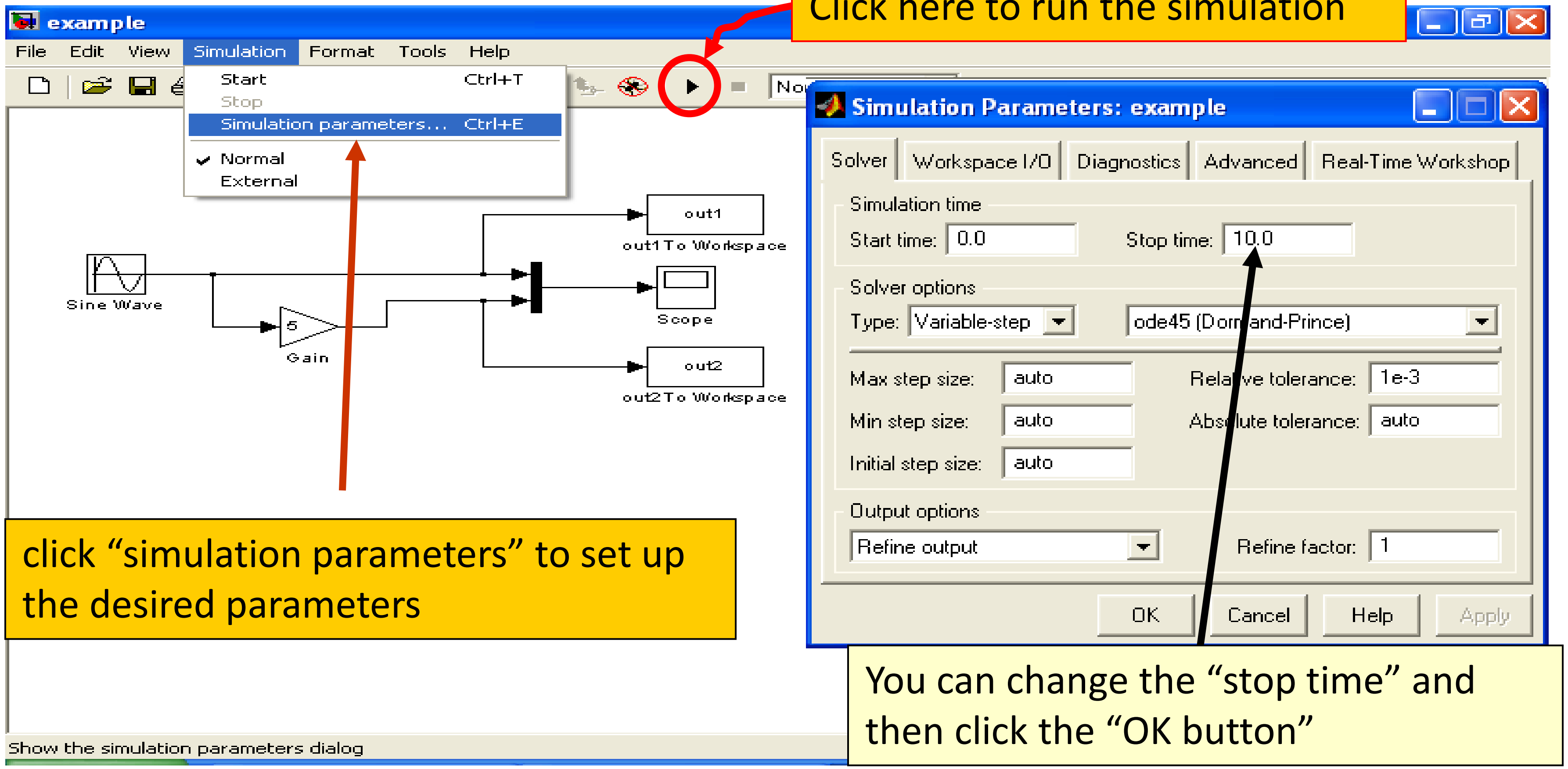
Double click the Gain block to set the parameter for the Gain block



BUILDING A SIMULINK MODEL / 06

STEP 4: RUNNING SIMULATION

Click here to run the simulation

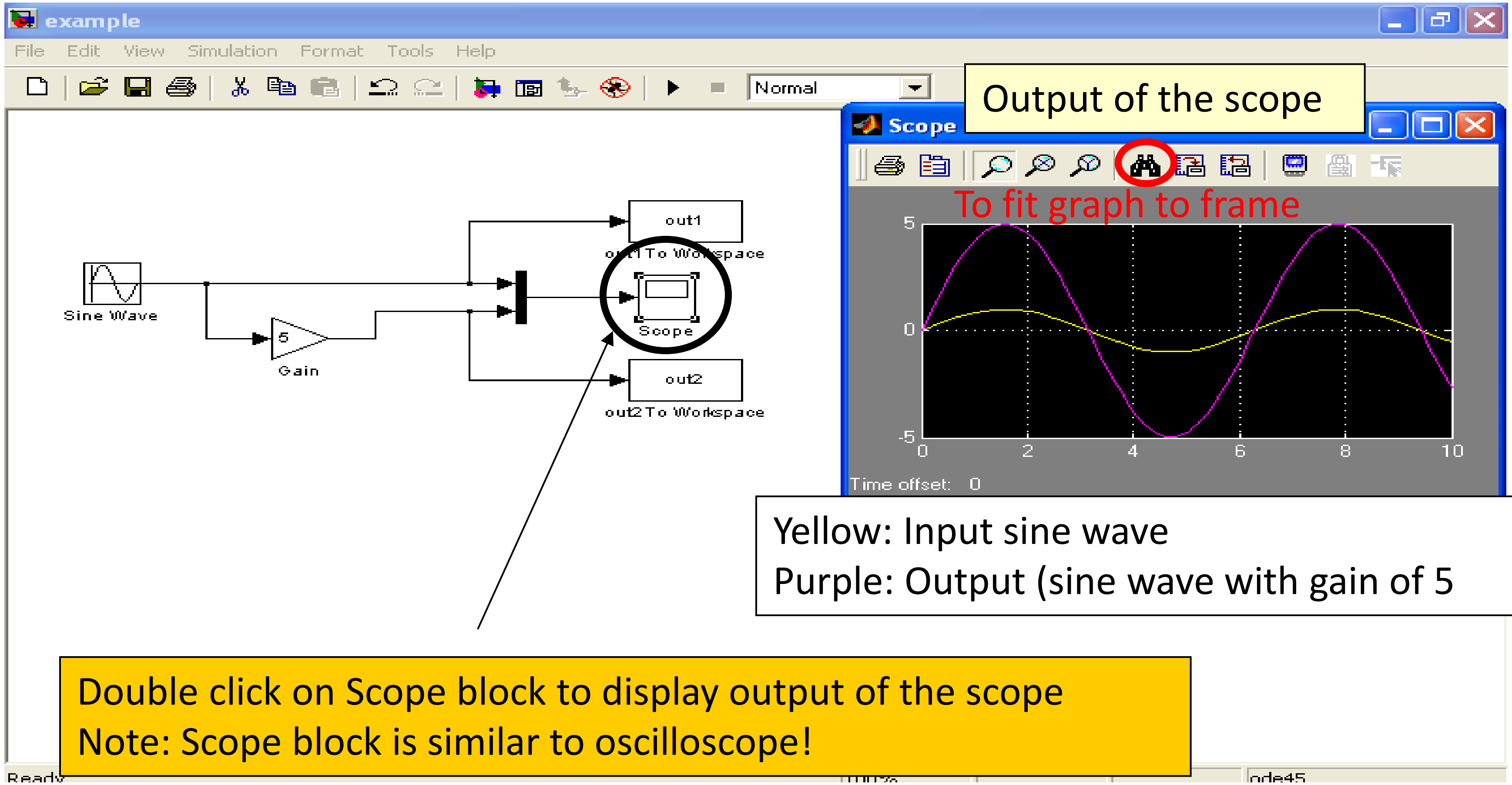


click “simulation parameters” to set up the desired parameters

You can change the “stop time” and then click the “OK button”

BUILDING A SIMULINK MODEL / 07

STEP 5: VIEW OUTPUT VIA SCOPE BLOCK



Output of the scope

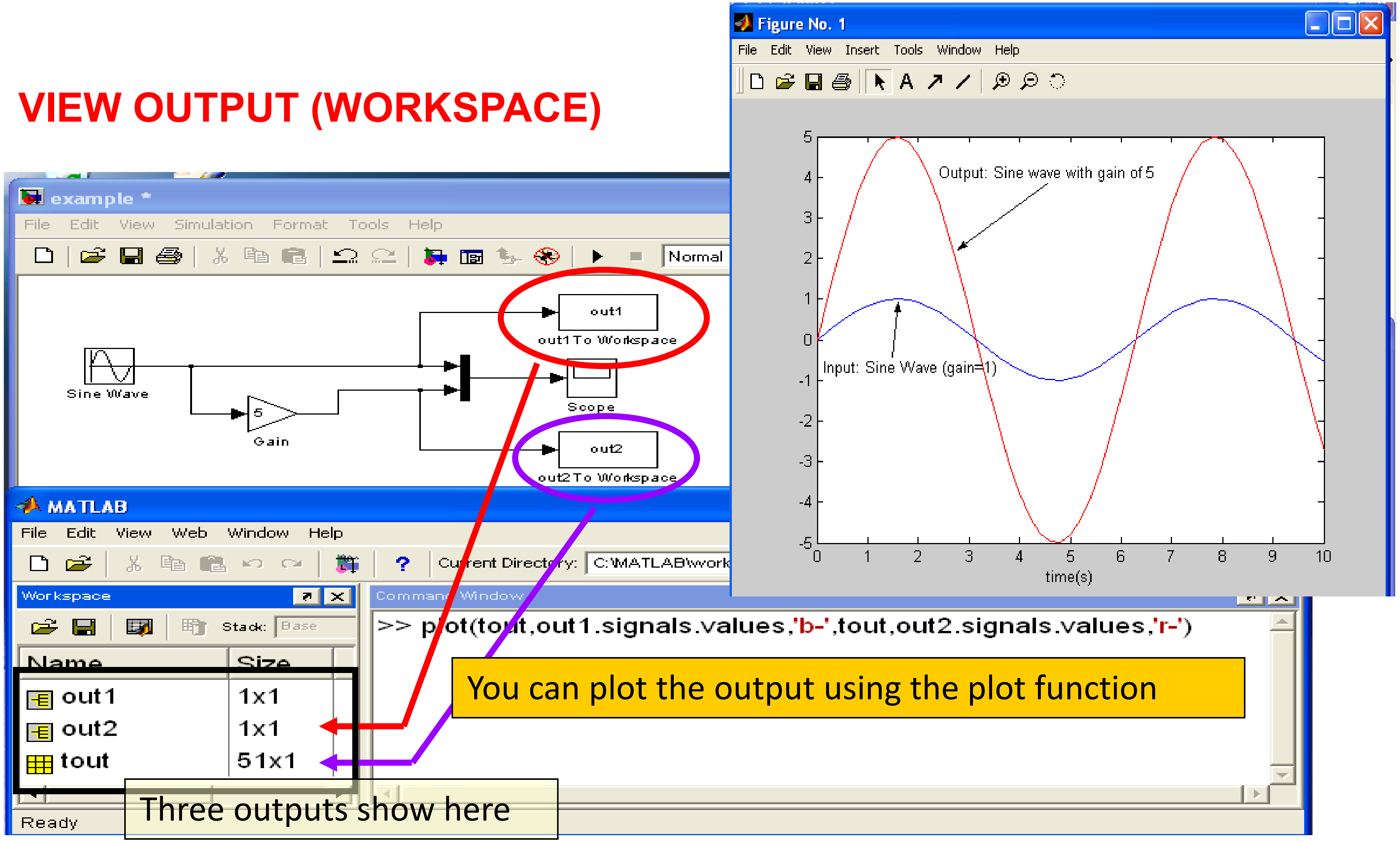
To fit graph to frame

Yellow: Input sine wave
Purple: Output (sine wave with gain of 5

Double click on Scope block to display output of the scope
Note: Scope block is similar to oscilloscope!

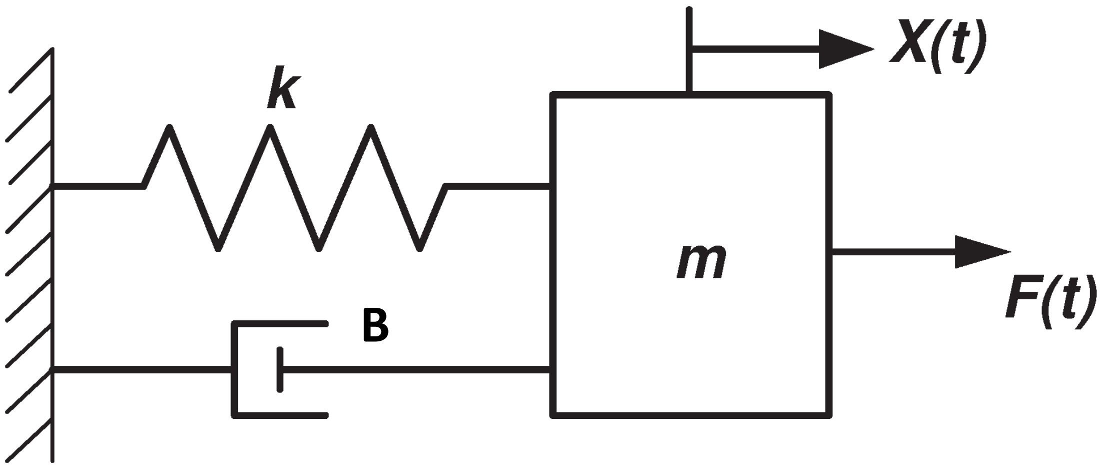
BUILDING A SIMULINK MODEL / 08

VIEW OUTPUT (WORKSPACE)



EXAMPLE 1:DIFFERENTIAL EQUATIONS (1)

Example of a dynamic system: A mass-spring-damper system



The Mathematical model of the system is described by the equation:

$$\ddot{x} = \frac{1}{M}\left(-B\dot{x} - Kx + f\left(t\right)\right)$$

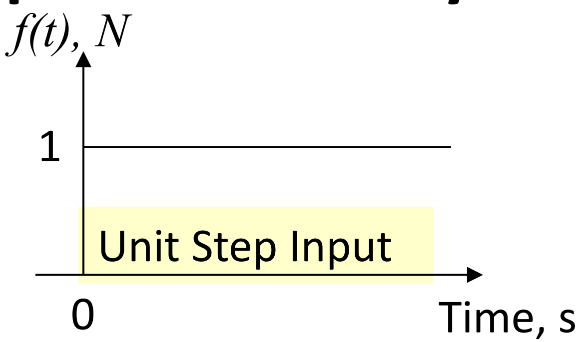
If *M*=2kg, *B* = 2 Ns/m, *K*=2 N/m, then

$$\ddot{x} = \frac{1}{2}\left(-2\dot{x} - 2x + f\left(t\right)\right)$$

EXAMPLE 1: DIFFERENTIAL EQUATIONS (2)

- **Use Simulink to simulate the step response of the system, i.e.**

$$\ddot{x} = \frac{1}{2}\left(-2\dot{x} - 2x + f\left(t\right)\right)$$

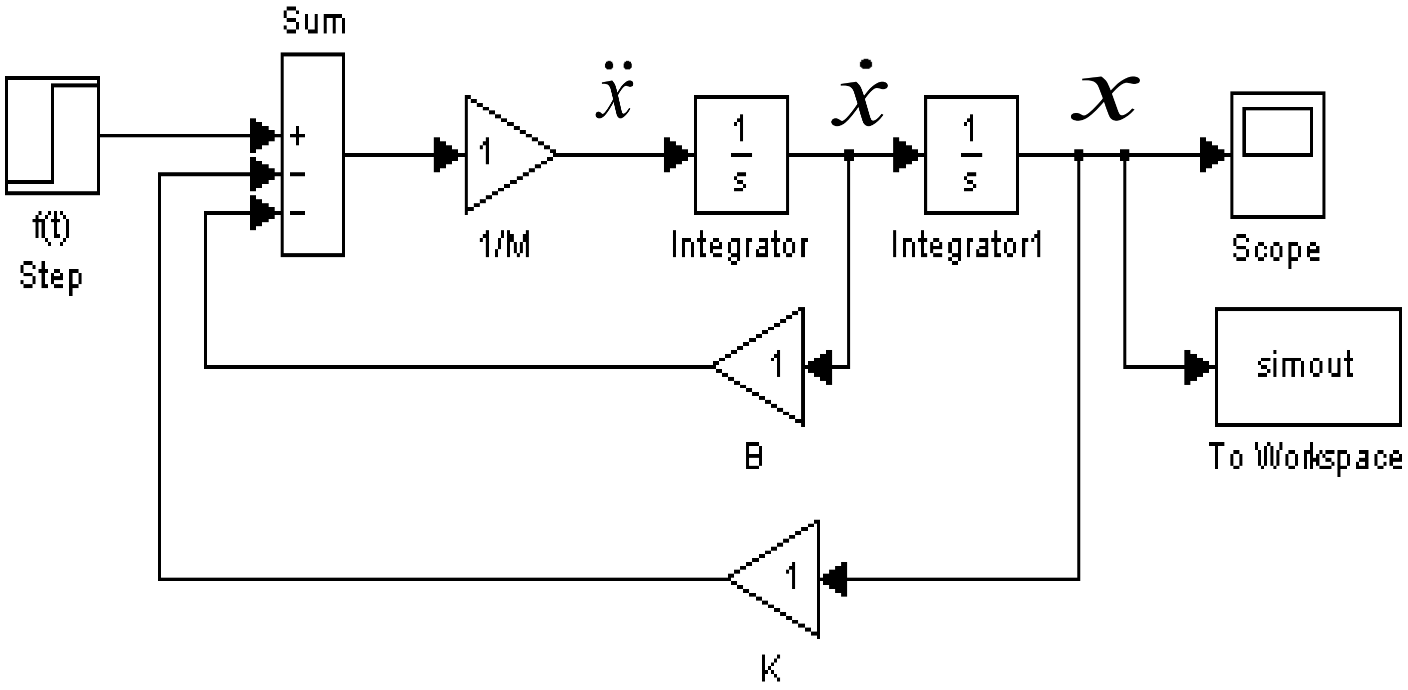


STEP 1: Creating Blocks

Select BLOCK set	Location in Simulink Library
Step	Sources
Sum	Math Operation
Gain	Math Operation
Integrator	Continuous
Scope & To Workspace	Sinks

EXAMPLE 1:DIFFERENTIAL EQUATIONS (2)

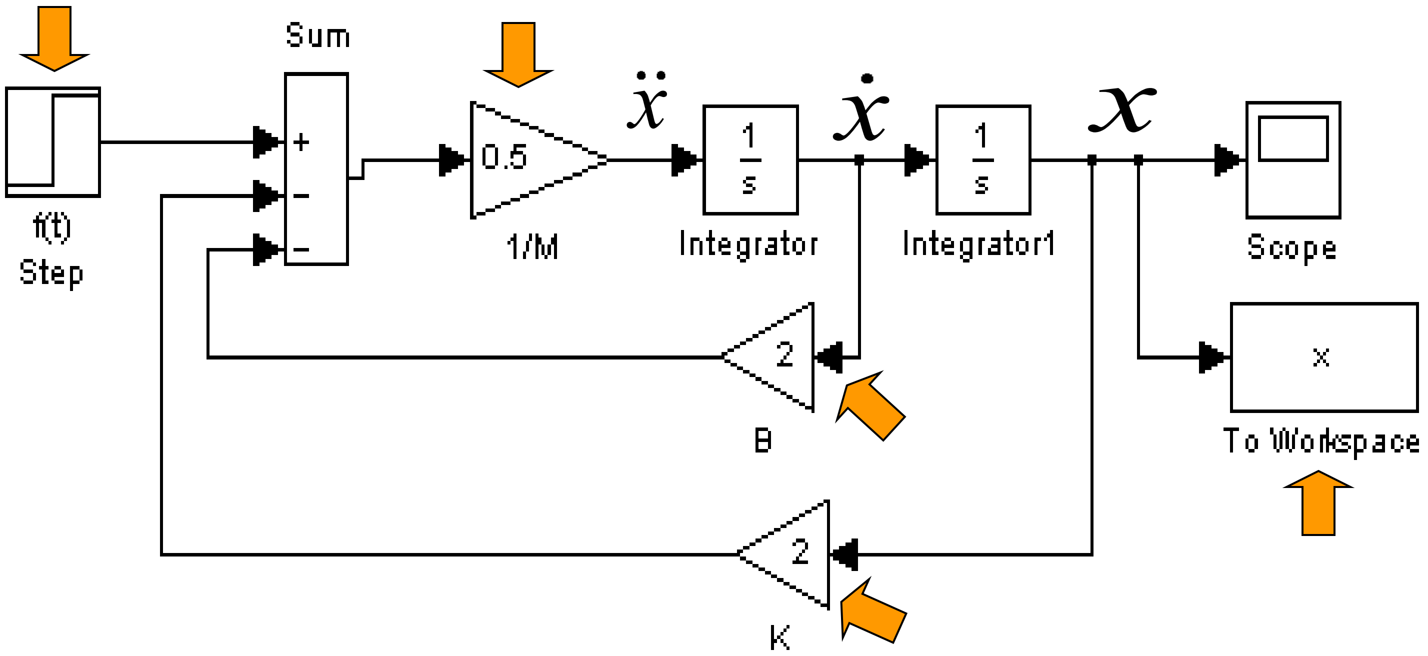
STEP 2: Making connections



EXAMPLE 1:DIFFERENTIAL EQUATIONS (3)

STEP 3: Set Parameters

Set Step time =0



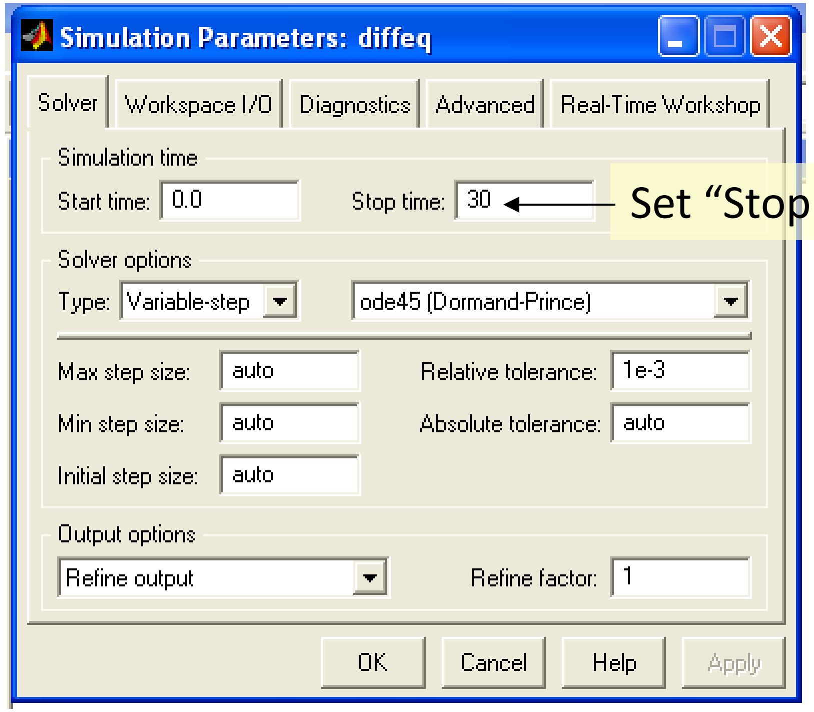
Note: Assume all initial conditions = 0

EXAMPLE 1:DIFFERENTIAL EQUATIONS (4)

STEP 4: Running Simulation

1

Open “simulation parameters” window



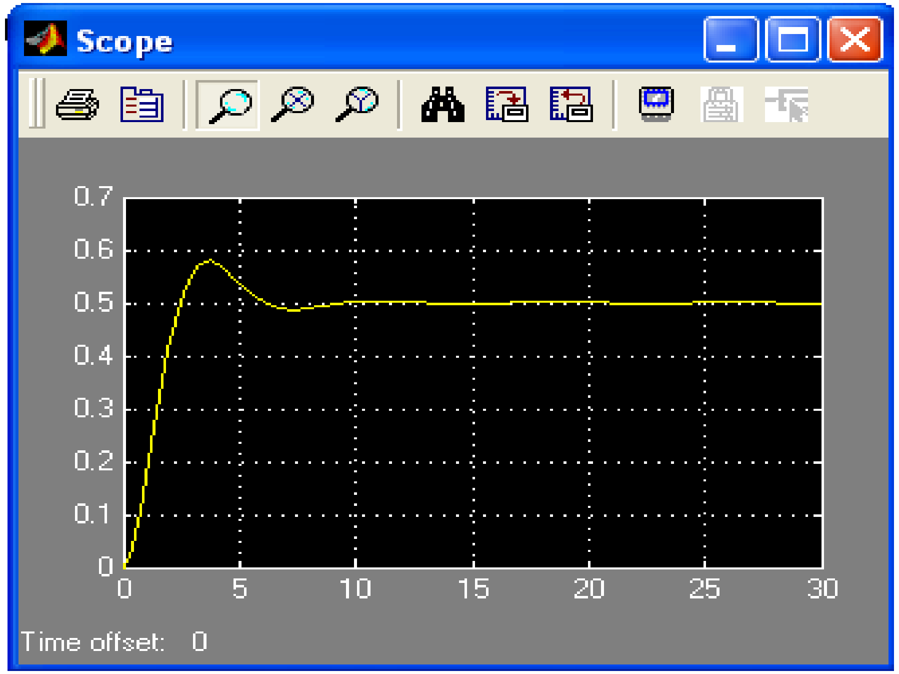
Set “Stop time” = 30

2

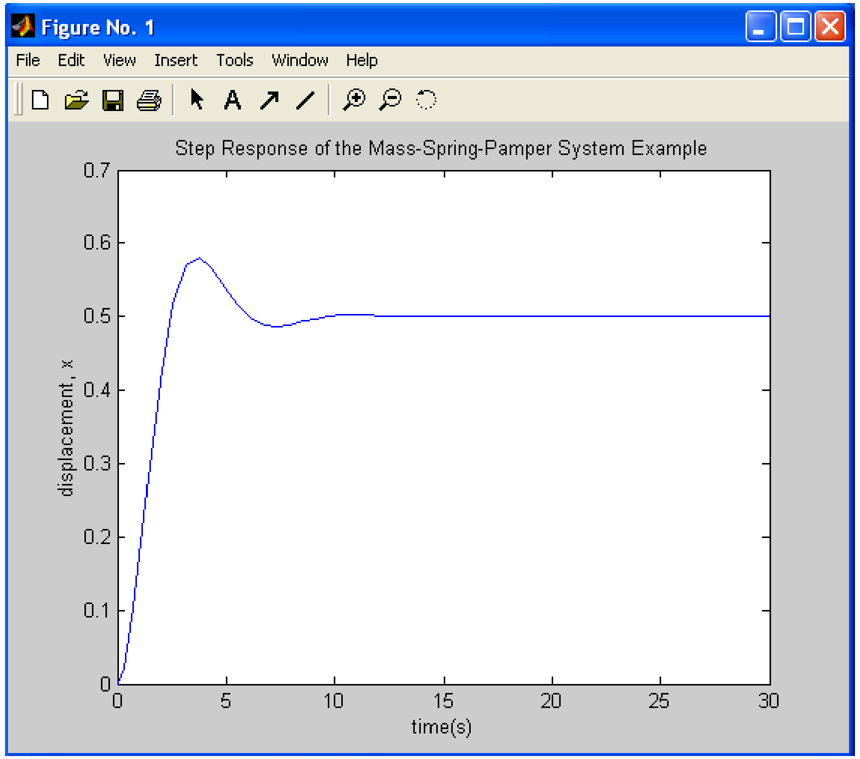
RUN Simulation

EXAMPLE 1:DIFFERENTIAL EQUATIONS (5)

Step Response for the mass-spring-damper system example



Output from Scope block



Plot system response

EXAMPLE 2: TRANSFER FUNCTION (1)

- **Use the same mass-spring-damper system example and simulate the response using transfer function approach**

$$\ddot{x} = \frac{1}{2}\left(-2\dot{x} - 2x + f(t)\right)$$

The transfer function of the equation (assume all initial conditions =0)

$$\frac{X(s)}{F(s)} = \frac{1}{2s^2 + 2s + 2}$$

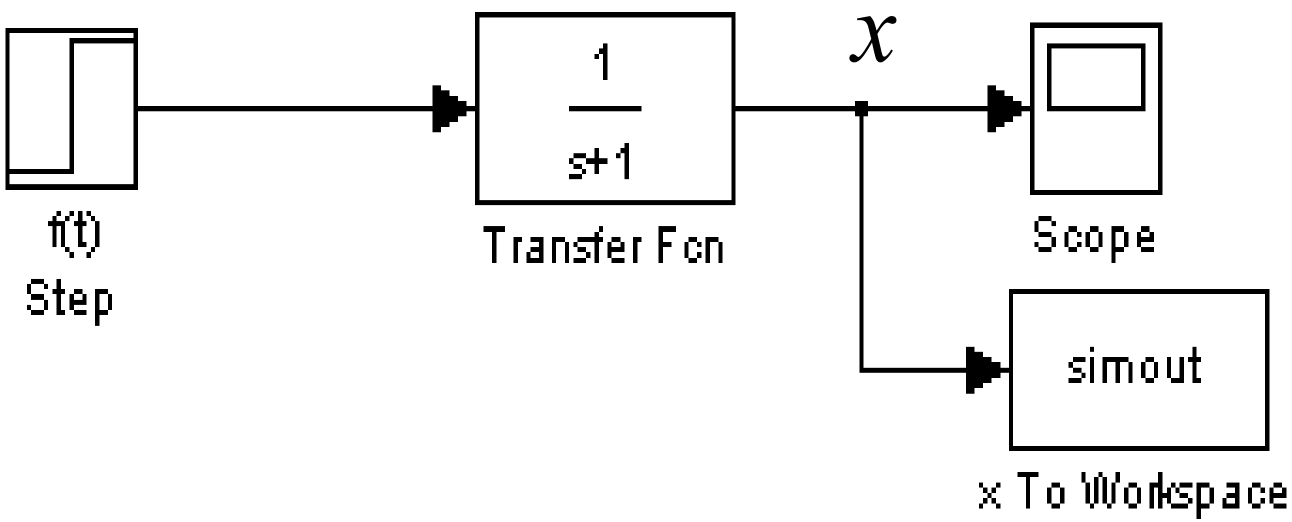
EXAMPLE 2: TRANSFER FUNCTION (2)

STEP 1: Creating Blocks

Select BLOCK set	Location in Simulink Library
Step	Sources
Transfer Function	Continuous
Scope & To Workspace	Sinks

EXAMPLE 2: TRANSFER FUNCTION (3)

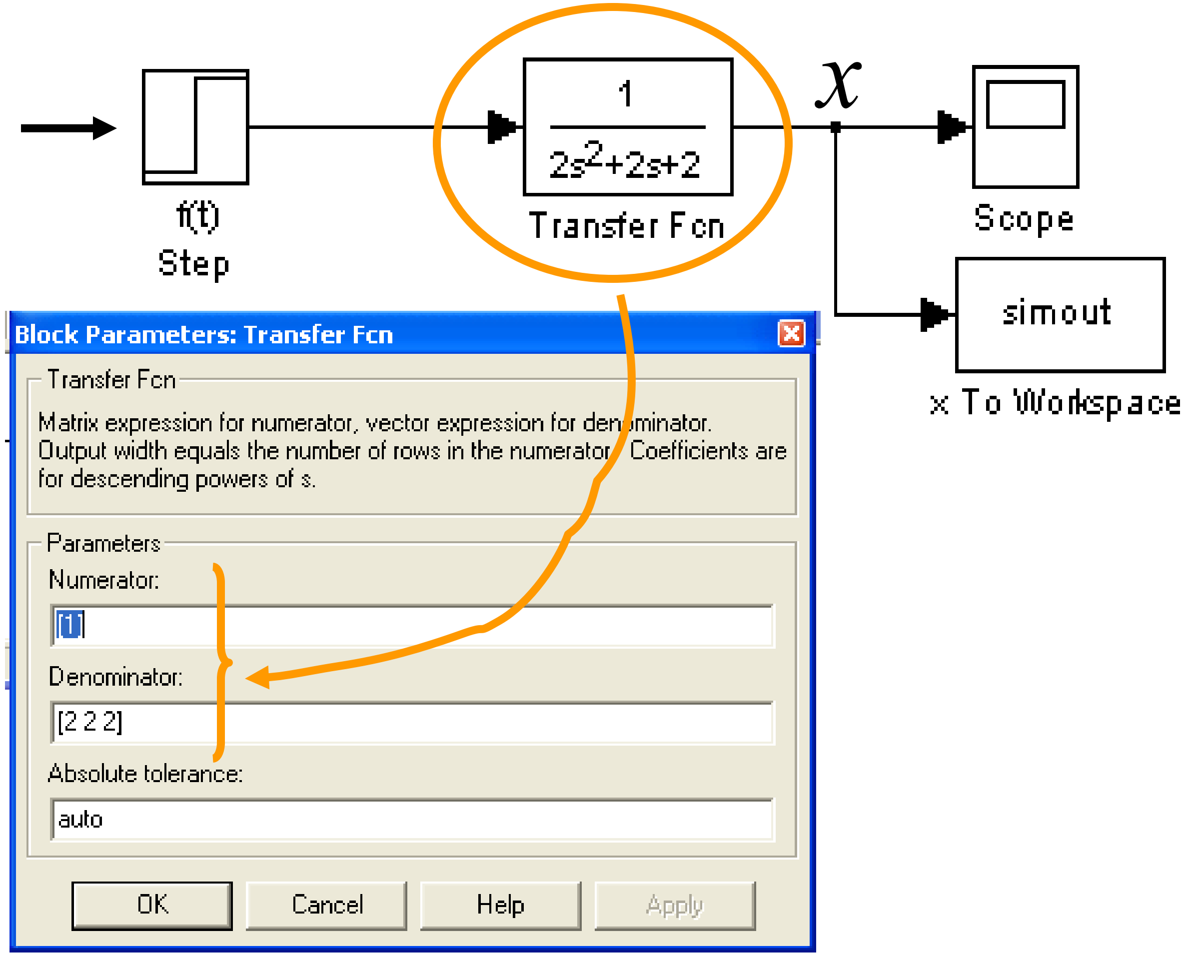
STEP 2: Making connections



EXAMPLE 2: TRANSFER FUNCTION (4)

STEP 3: SET PARAMETERS

Set Step time =0

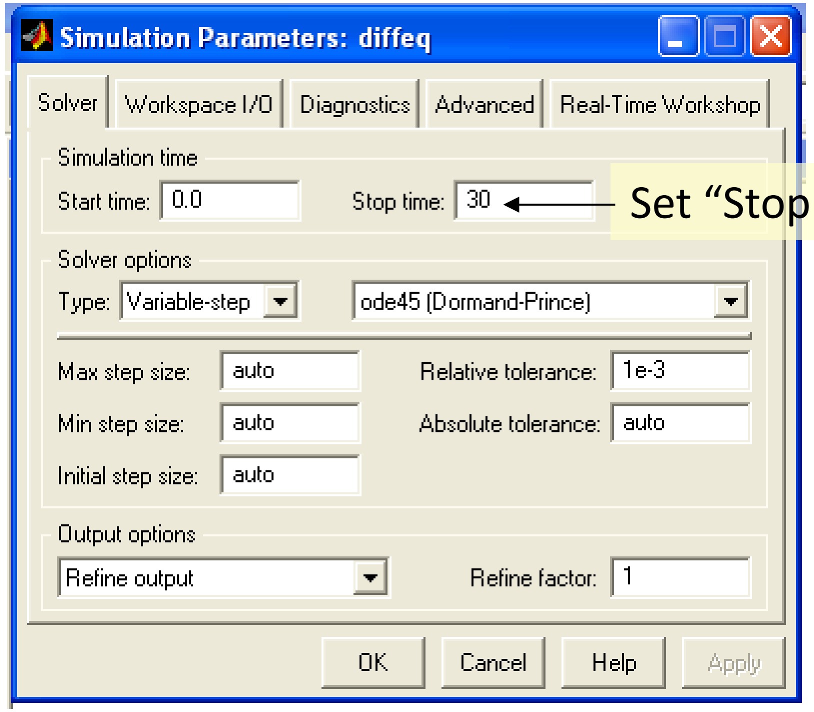


EXAMPLE 2: TRANSFER FUNCTION (5)

STEP 4: Running Simulation

1

Open "simulation parameters" window



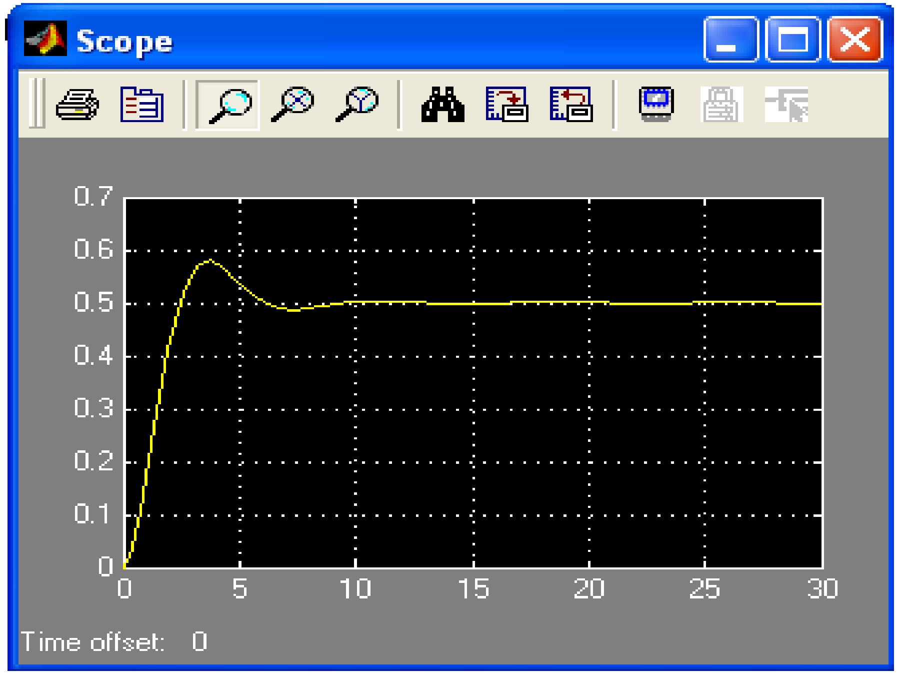
Set "Stop time" = 30

2

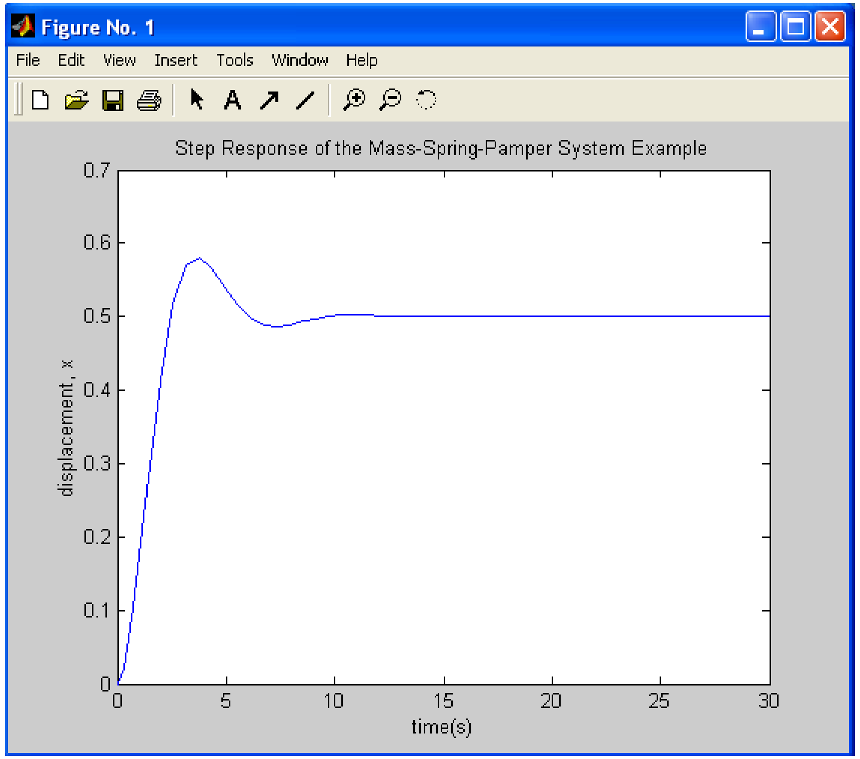
RUN Simulation

EXAMPLE 2: TRANSFER FUNCTION (6)

VIEW OUTPUT (SCOPE & WORKSPACE)



Output from Scope block



Plot system response