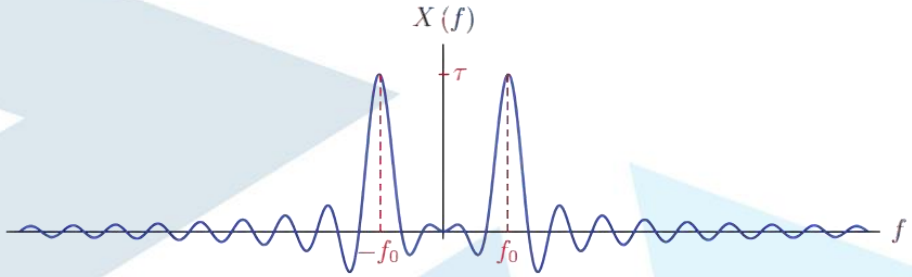
CECC507: Signals and Systems

Lecture 5: Analyzing Continuous Time Systems in the Time Domain



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Department of Mechatronics
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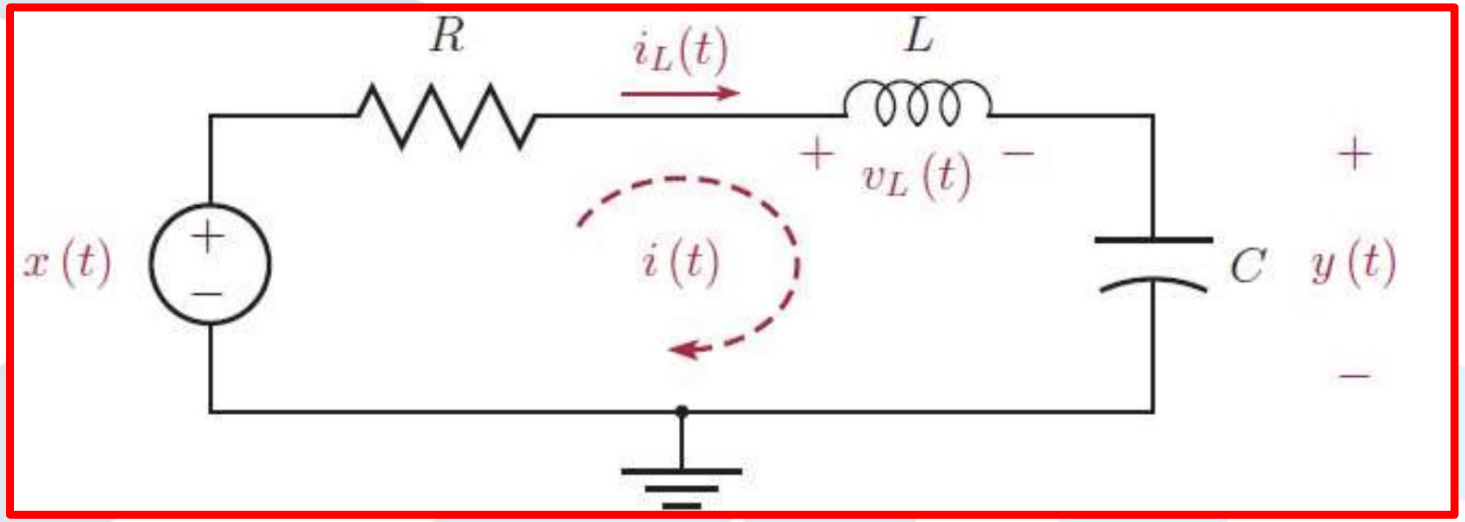
- Differential equation for RLC circuit



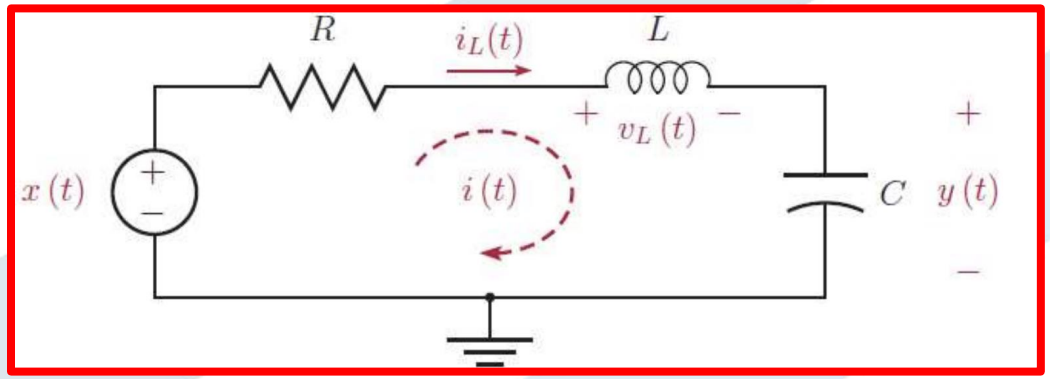
بداية لدينا معادلات كل من جهود العناصر الأساسية من مقاومة و مكثف وتيار كالتالي:

$$v_R(t) = R.i(t)$$

$$v_L(t) = L.\frac{di(t)}{dt}$$

$$i_c(t) = C.\frac{dv_c\,(t)}{dt}\,,\; V_c(t) = y(t)$$

نطبق كيرشوف حيث مجموع الجهد ضمن الدائرة يساوي الصفر



$$\sum V_{Drop} = 0$$

$$x(t) - V_R(t) - V_L(t) - V_c(t) = 0$$

$$x(t) - Ri(t) - L\frac{di(t)}{dt} - y(t) = 0$$

ولدينا أيضا:

$$i(t) = i_c(t) = c\frac{dV_c(t)}{dt} = C\frac{dy(t)}{dt}$$

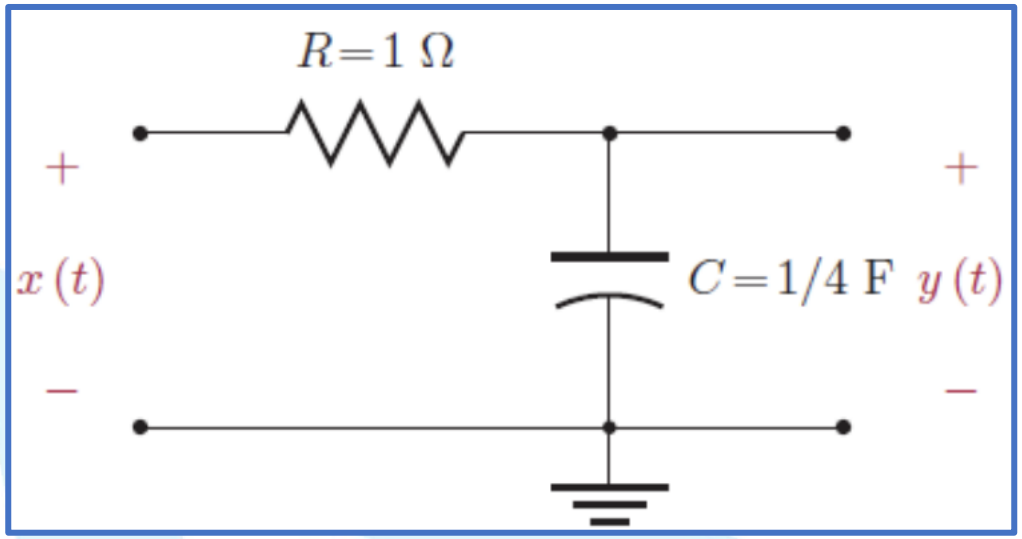
$$x(t) - RC\frac{dy(t)}{dt} - LC\frac{d^2y(t)}{dt} - y(t) = 0$$

$$x(t) = RC\frac{dy(t)}{dt} + LC\frac{d^2y(t)}{dt} + y(t)$$

$$\frac{1}{LC}x(t) = \frac{R}{L}\frac{dy(t)}{dt} + \frac{d^2y(t)}{dt} + \frac{1}{LC}y(t)$$

- Ex1: Use Simulink to draw the output of the following RC circuit :

$$\frac{dy(t)}{dt} + 4y(t) = 4x(t)$$



Let the input signal be a unit step, that is,

x(t) = u(t).

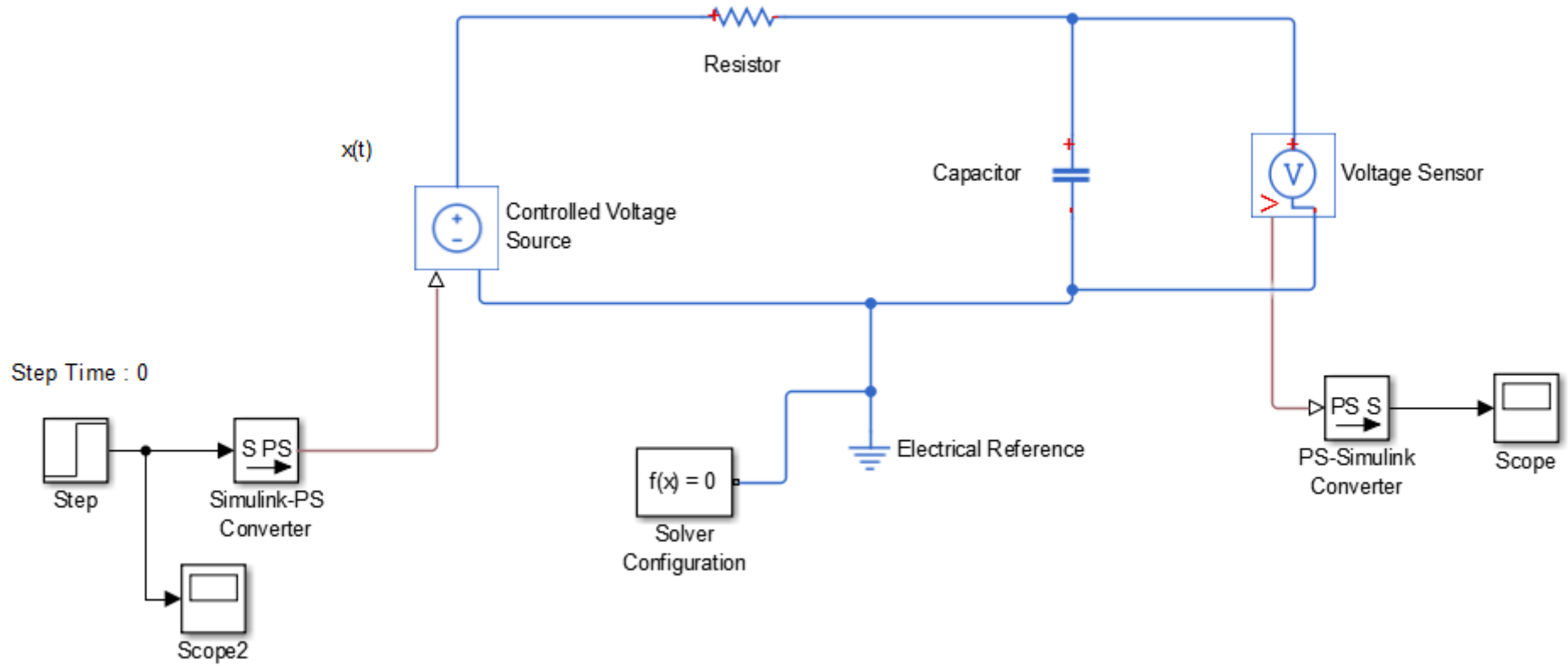
Draw the solution y(t) for t ≥ 0 subject to each initial condition specified below:

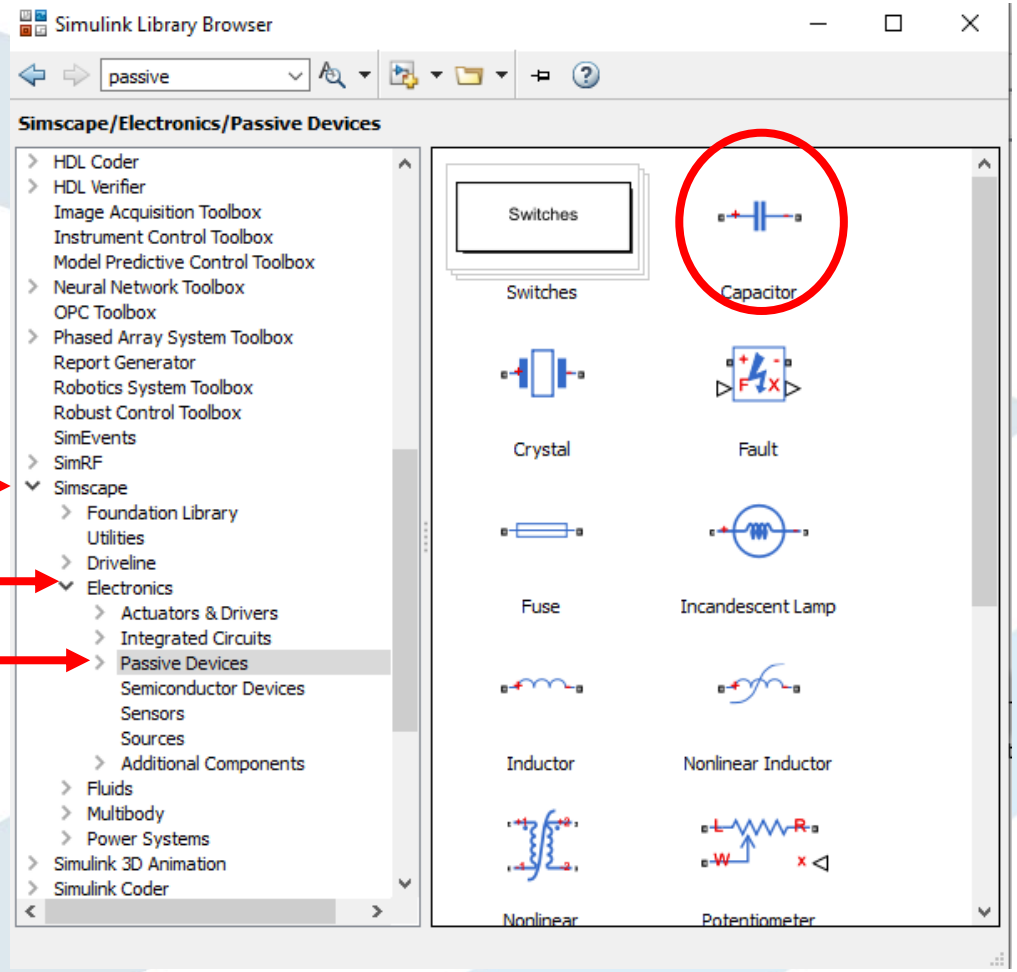
a. **y(0) = 0**

b. **y (0) = 5**

a.

$$y(0) = 0$$


Resistor
x(t)
Capacitor
Voltage Sensor
Controlled Voltage Source
Step Time : 0
S PS
Simulink-PS Converter
Step
Scope2
f(x) = 0
Solver Configuration
Electrical Reference
PS S
PS-Simulink Converter
Scope

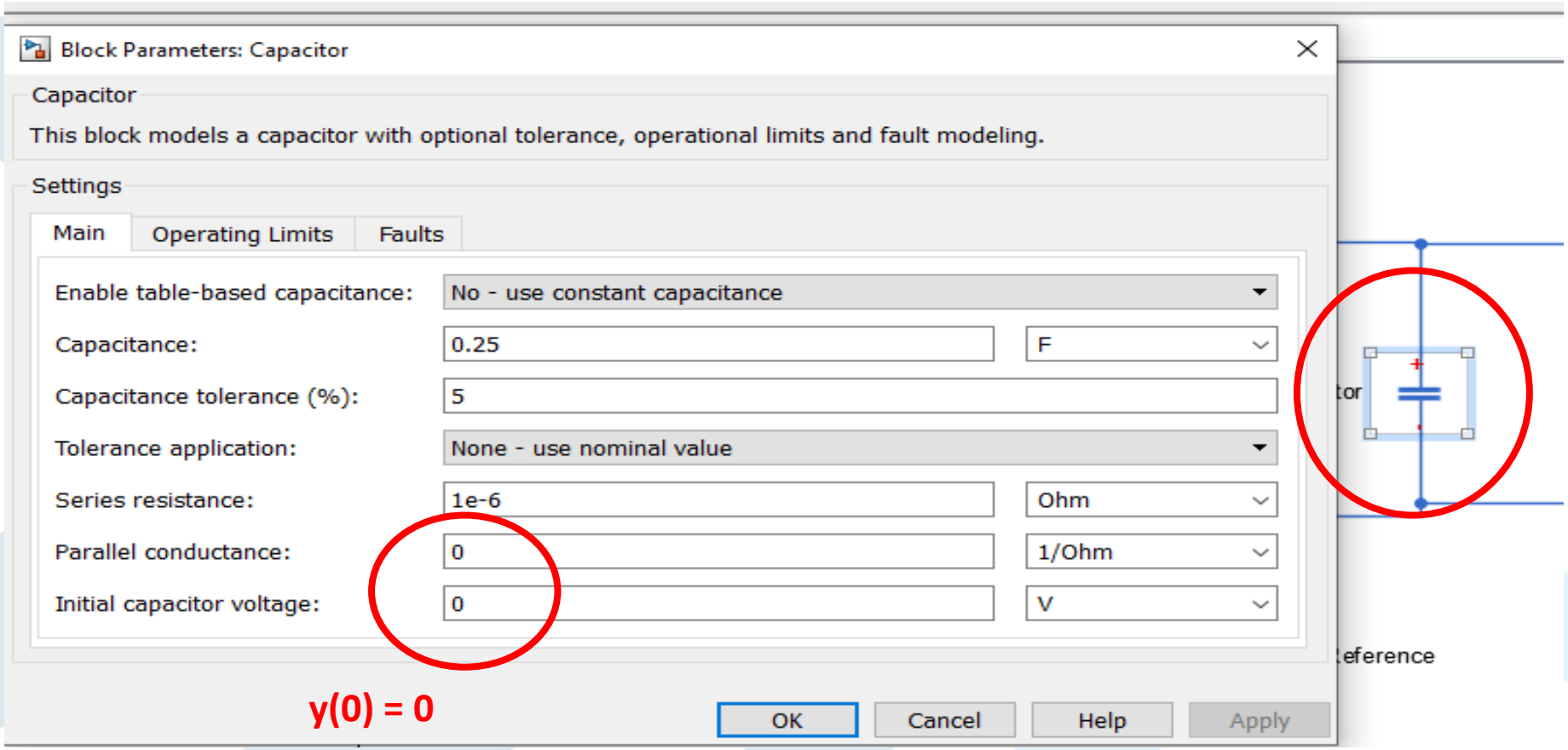


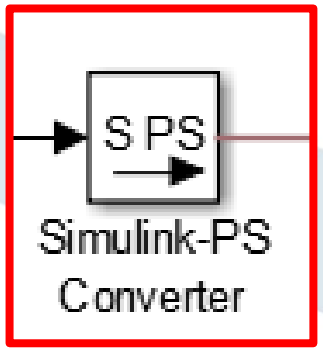
من خلال شجرة البحث الموضحة في الشكل نختار المكثف الموجود في الشجرة:

Simscape ->Electronics -> Passive Devices -> Capacitor

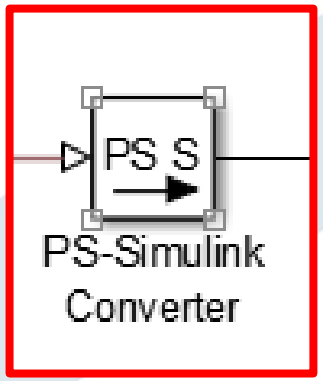
حيث يتيح لنا الخيار الحالي وضع قيمة بدائية للمكثف بناء على متطلبات الدارة وفي حالتنا هنا نعطيه قيم بدائية

y(0) = 0

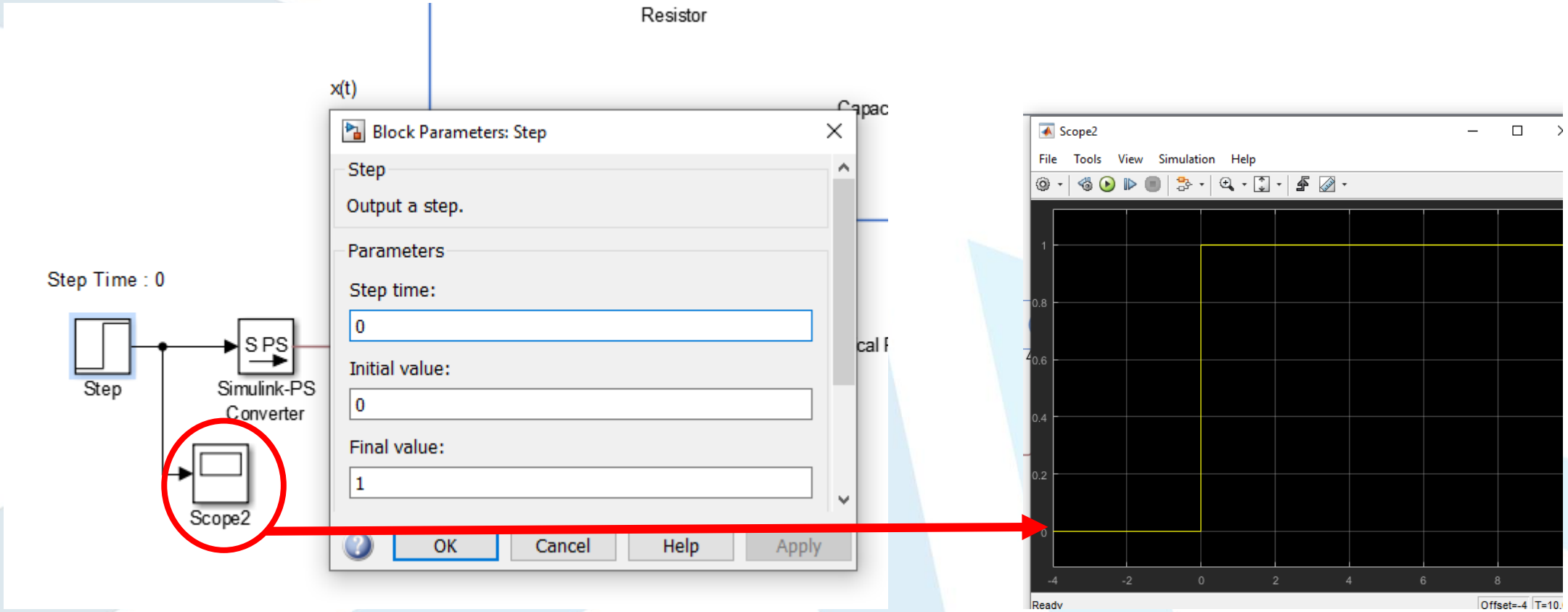

Block Parameters: Capacitor
Capacitor
This block models a capacitor with optional tolerance, operational limits and fault modeling.
Settings
Main
Operating Limits
Faults
Enable table-based capacitance:
No - use constant capacitance
Capacitance:
0.25
F
Capacitance tolerance (%):
5
Tolerance application:
None - use nominal value
Series resistance:
1e-6
Ohm
Parallel conductance:
0
1/Ohm
Initial capacitor voltage:
0
V
OK
Cancel
Help
Apply
y(0) = 0

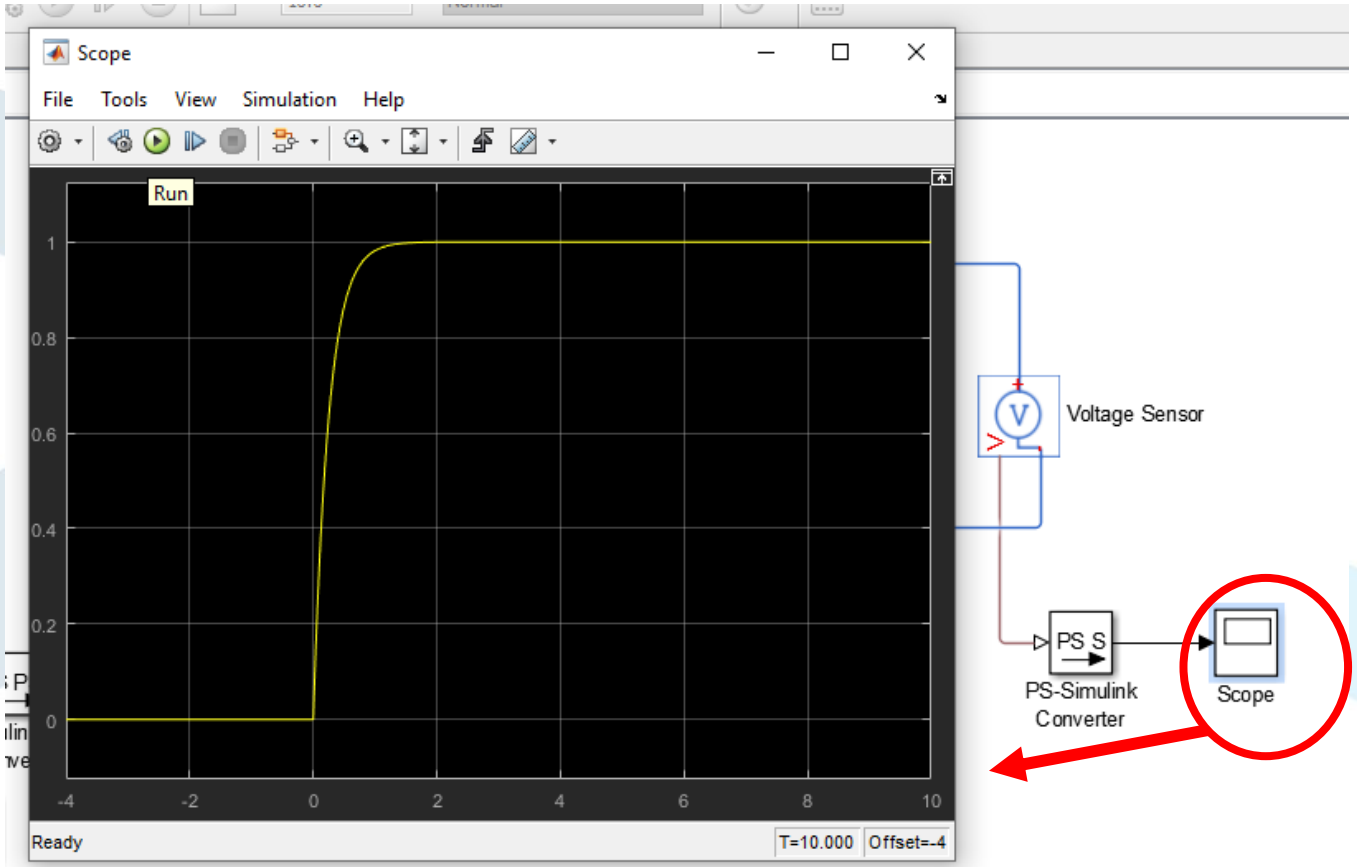


- كتلة **Simulink-PS Converter** تحول الإشارة من Simulink إلى إشارة فيزيائية.
- تُستخدم لربط مصادر Simulink مع عناصر الشبكة الفيزيائية في Simscape.
- تعمل كجسر بين الإشارات الرياضية والمحاكاة الفيزيائية.
- ضرورية لإدخال إشارات التحكم أو المدخلات الزمنية إلى النماذج الفيزيائية.



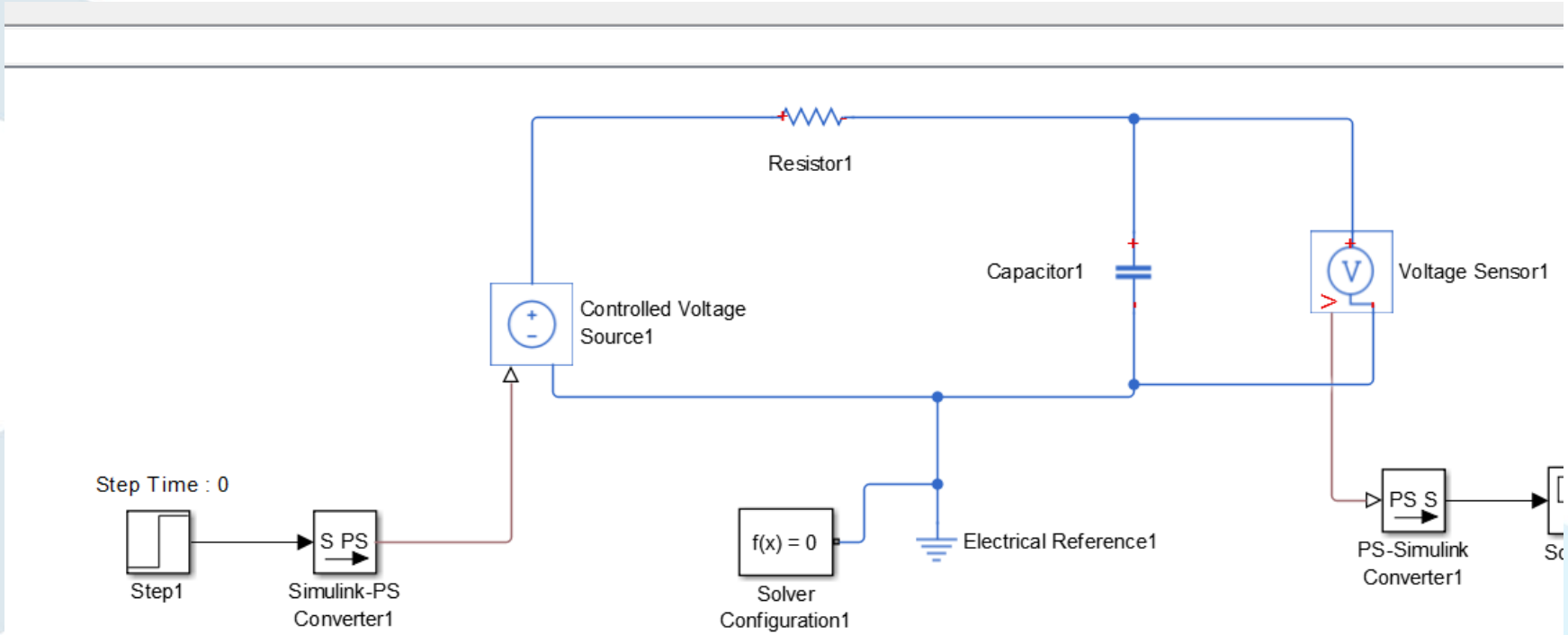
- تقوم بتحويل الإشارة الفيزيائية (Physical Signal) القادمة من شبكة Simscape إلى إشارة Simulink عادية.
- تُستخدم عندما تريد مراقبة أو معالجة نتائج النماذج الفيزيائية داخل بيئة Simulink (مثل عرضها على Scope أو استخدامها في حسابات إضافية).
- تعمل كجسر من **النمذجة الفيزيائية** إلى **الإشارات الرياضية** في Simulink.
- ضرورية لإخراج قيم من الشبكة الفيزيائية إلى أدوات التحليل أو العرض في Simulink.

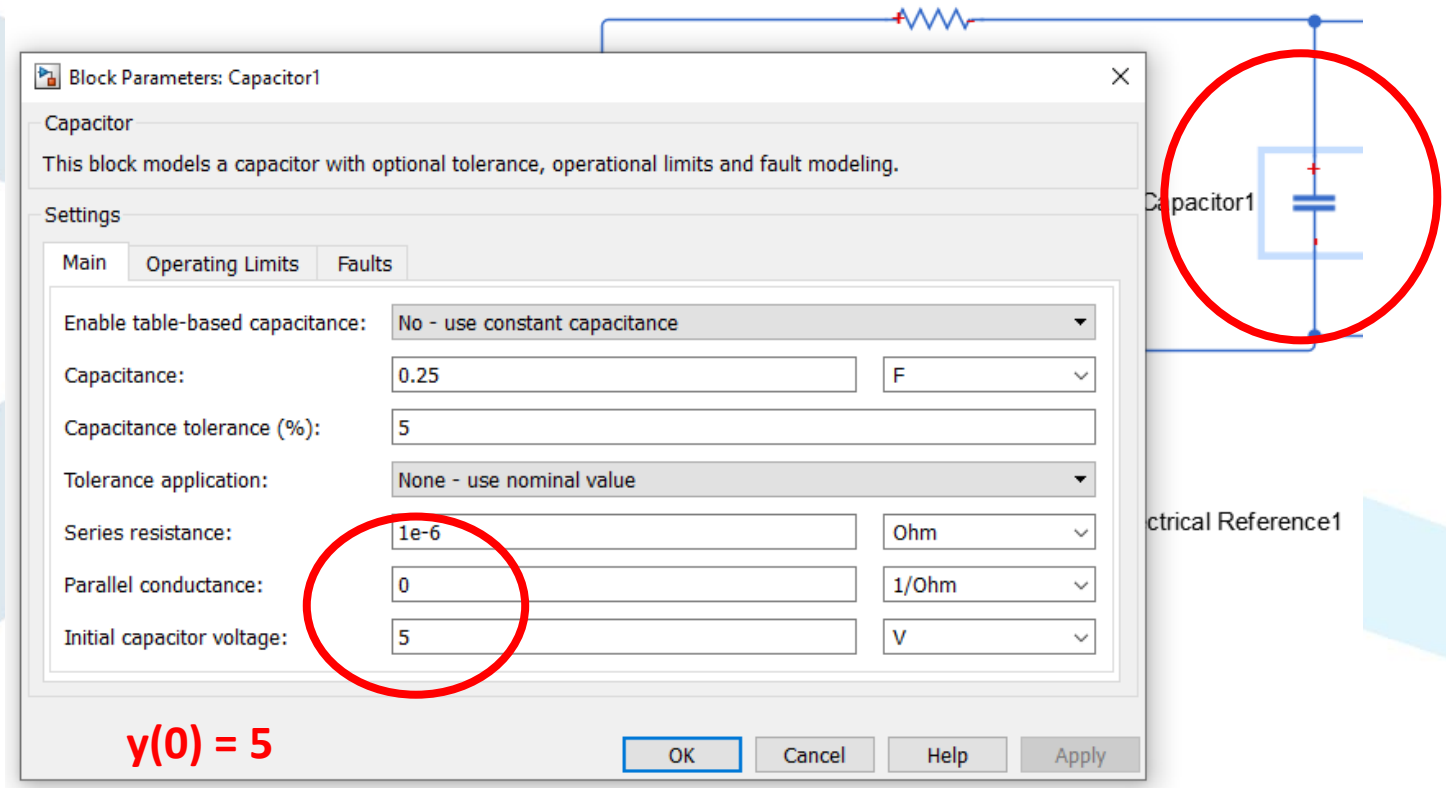

Resistor
x(t)
Capac
Block Parameters: Step
Step
Output a step.
Parameters
Step time:
0
Initial value:
0
Final value:
1
OK
Cancel
Help
Apply
Step Time : 0
Step
S PS
Simulink-PS
Converter
Scope2
Scope2
File
Tools
View
Simulation
Help
1
0.8
0.6
0.4
0.2
0
-4
-2
0
2
4
6
8
Ready
Offset=-4
T=10.

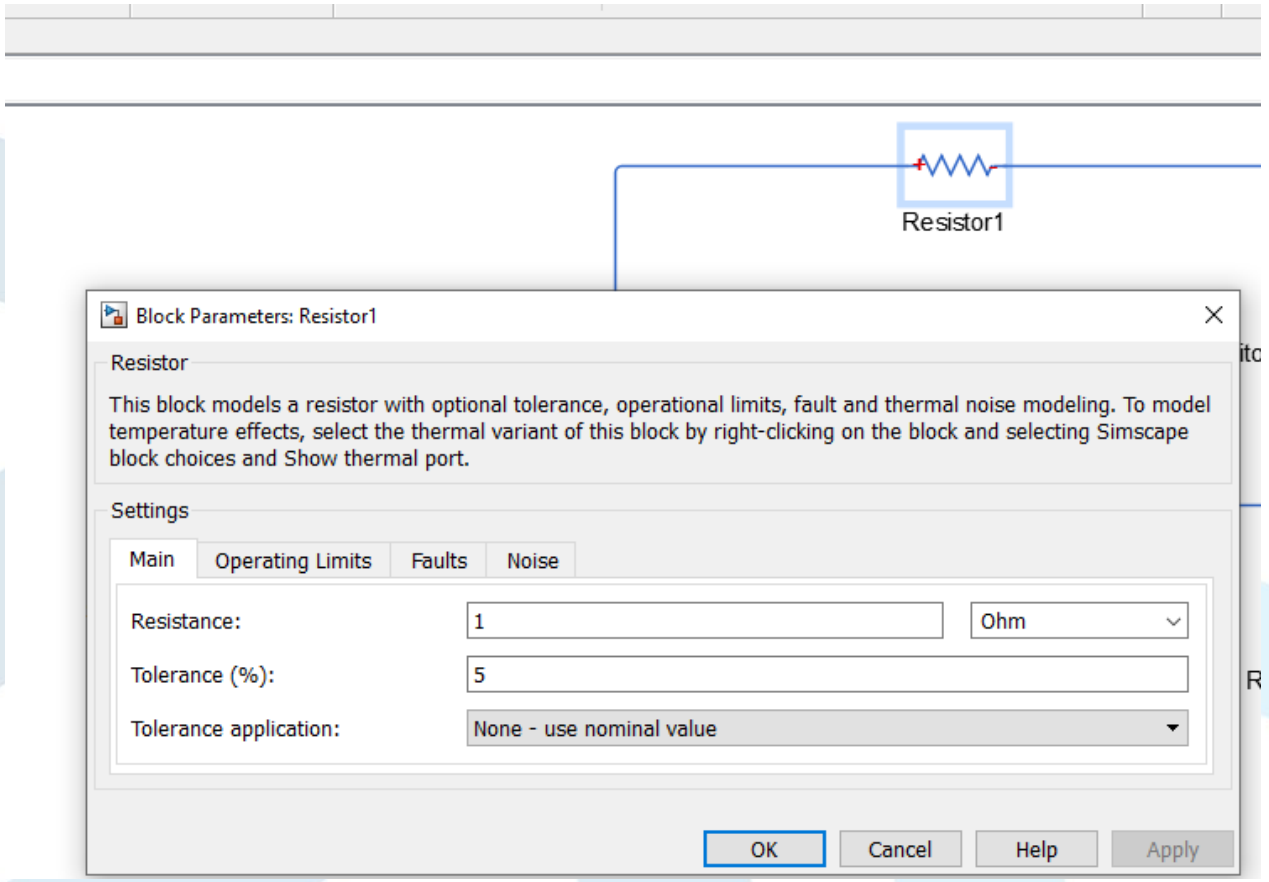

Scope
File Tools View Simulation Help
Run
1
0.8
0.6
0.4
0.2
0
-4 -2 0 2 4 6 8 10
Ready
T=10.000
Offset=-4
Voltage Sensor
PS S
PS-Simulink Converter
Scope

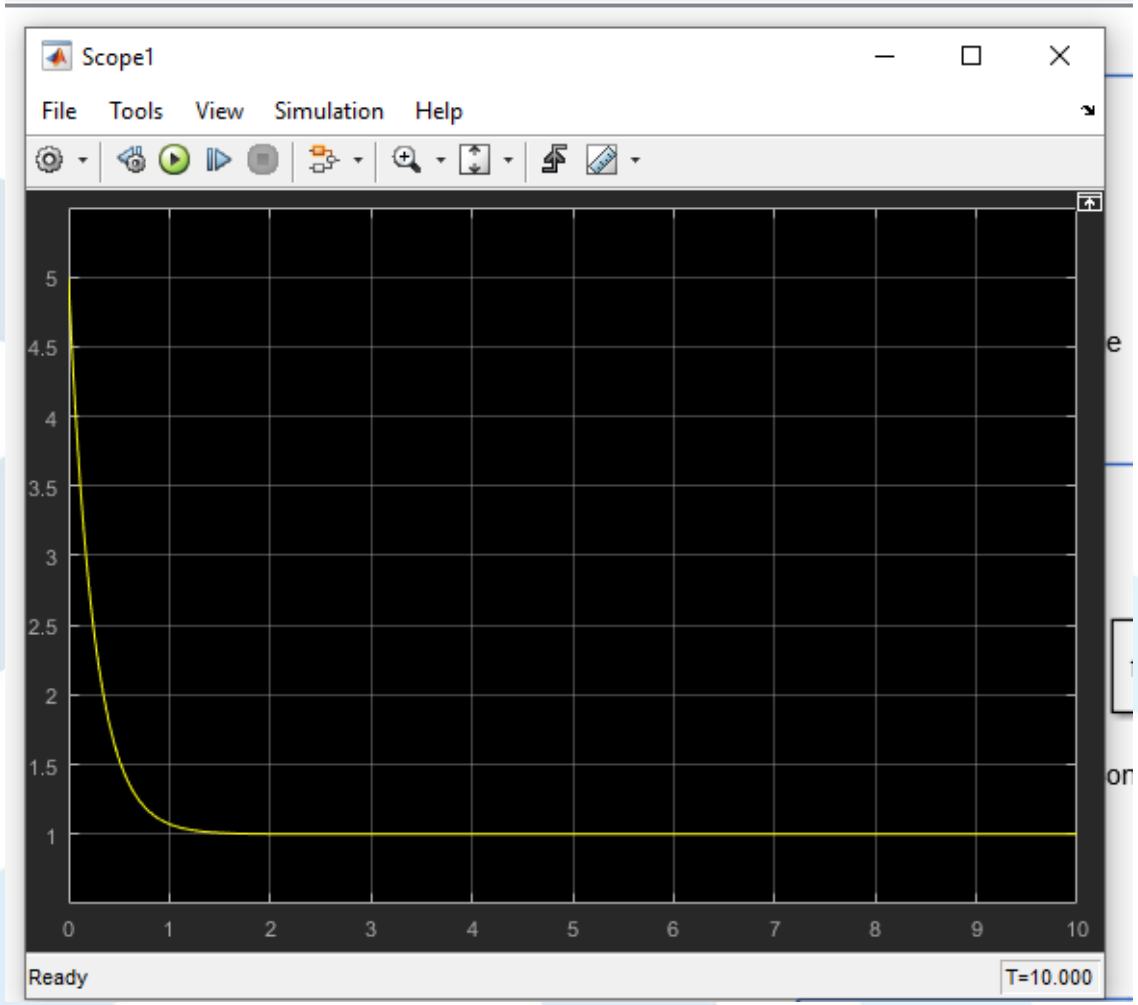
b

$y(0) = 5$


Resistor1
Capacitor1
Voltage Sensor1
Controlled Voltage Source1
Step Time : 0
Step1
S PS
Simulink-PS Converter1
f(x) = 0
Solver Configuration1
Electrical Reference1
PS S
PS-Simulink Converter1


Block Parameters: Capacitor1
Capacitor
This block models a capacitor with optional tolerance, operational limits and fault modeling.
Settings
Main
Operating Limits
Faults
Enable table-based capacitance:
No - use constant capacitance
Capacitance:
0.25
F
Capacitance tolerance (%):
5
Tolerance application:
None - use nominal value
Series resistance:
1e-6
Ohm
Parallel conductance:
0
1/Ohm
Initial capacitor voltage:
5
V
OK
Cancel
Help
Apply
y(0) = 5
pacitor1
ctrical Reference1


Resistor1
Block Parameters: Resistor1
Resistor
This block models a resistor with optional tolerance, operational limits, fault and thermal noise modeling. To model temperature effects, select the thermal variant of this block by right-clicking on the block and selecting Simscape block choices and Show thermal port.
Settings
Main
Operating Limits
Faults
Noise
Resistance:
1
Ohm
Tolerance (%):
5
Tolerance application:
None - use nominal value
OK
Cancel
Help
Apply


Scope1
File
Tools
View
Simulation
Help
5
4.5
4
3.5
3
2.5
2
1.5
1
0
1
2
3
4
5
6
7
8
9
10
Ready
T=10.000

Example 2: Natural response of a second-order system (RLC circuit)

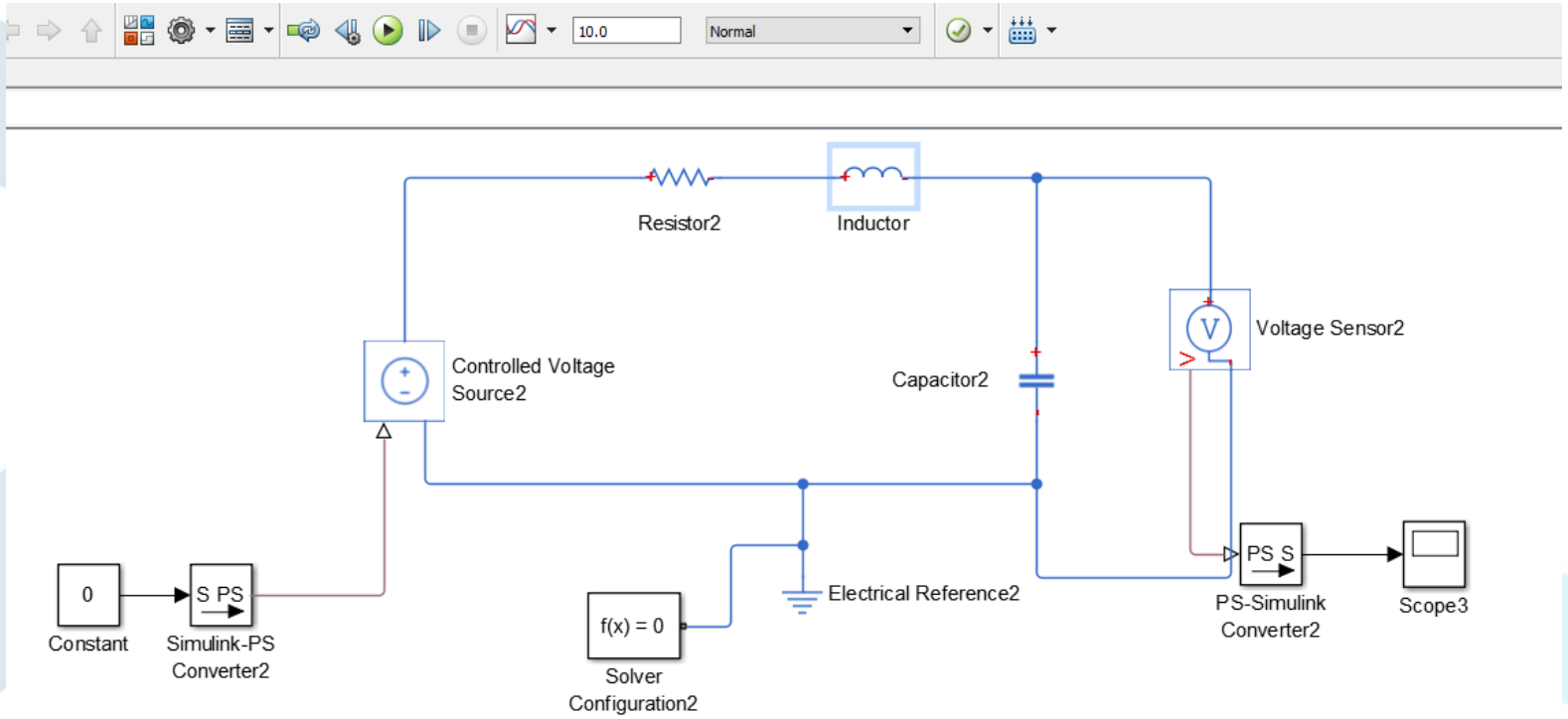
At time t=0 the initial inductor current is i(0)=0.5A and the initial capacitor voltage is y(0) =2v. **x(t)=0.**

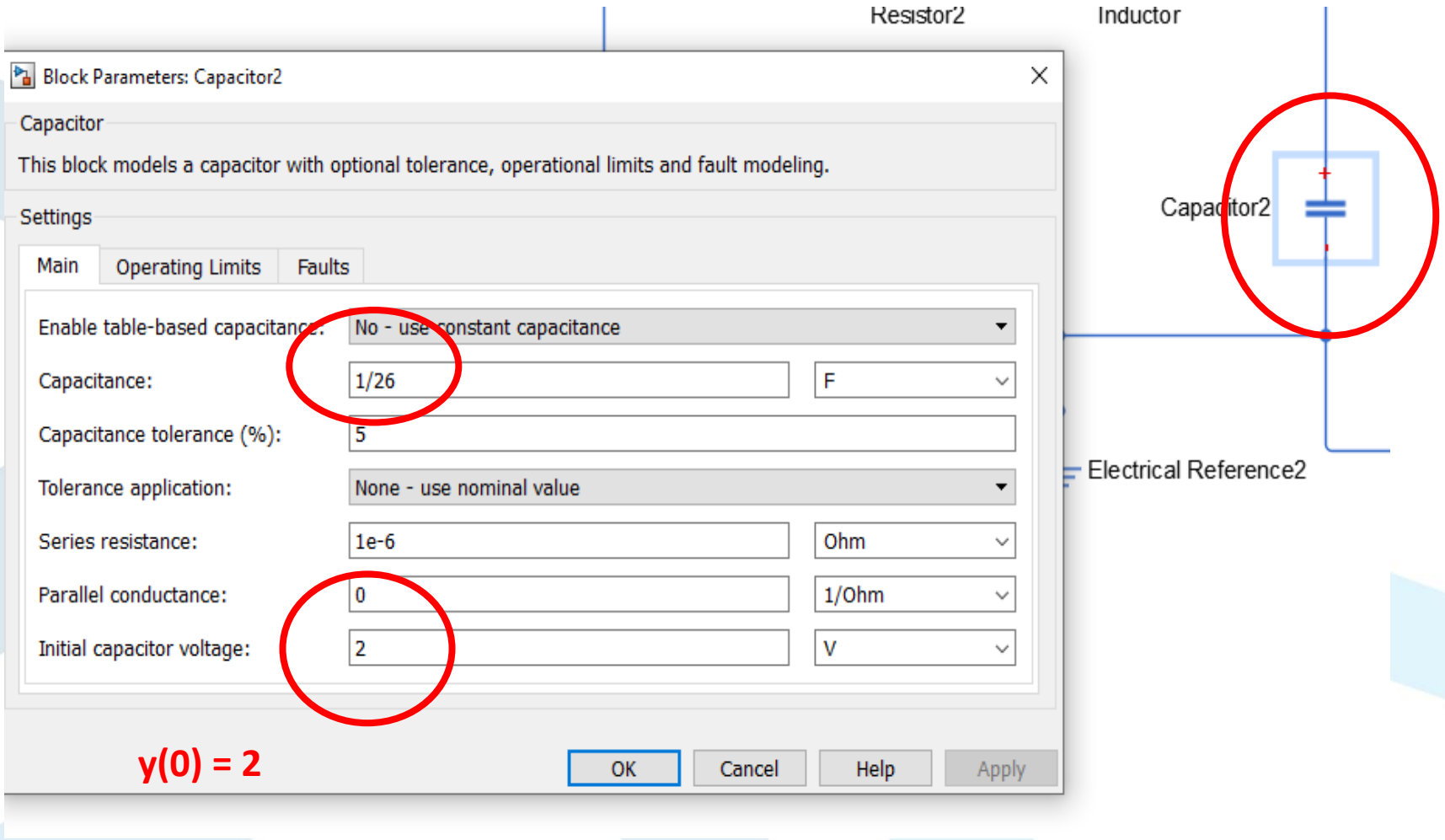
Draw the output voltage y(t) using Simulink if:

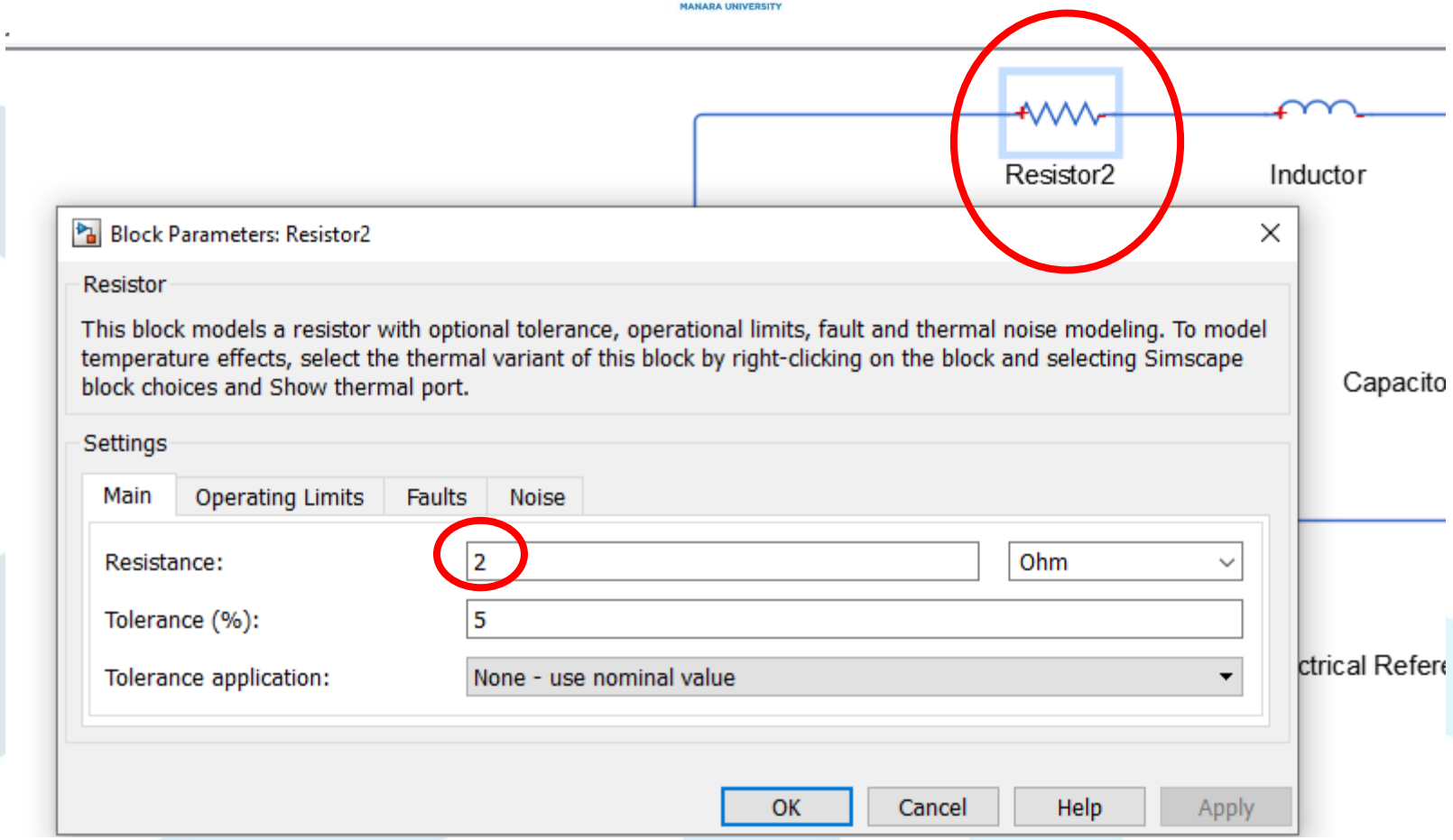
a. The element values are R=2Ω, L=1H and C=1/26 F

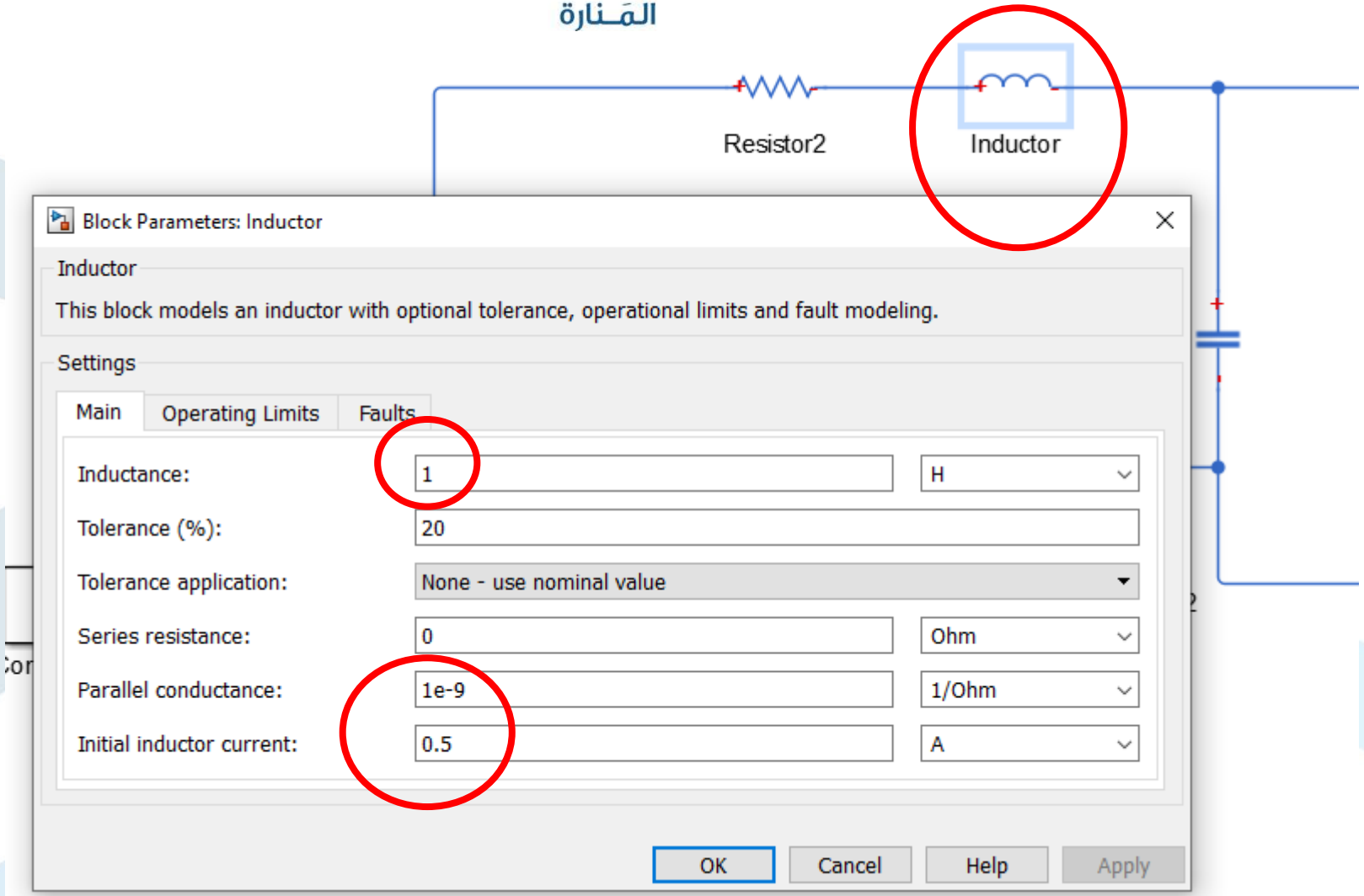
b. The element values are R=6Ω, L=1H and C=1/9 F

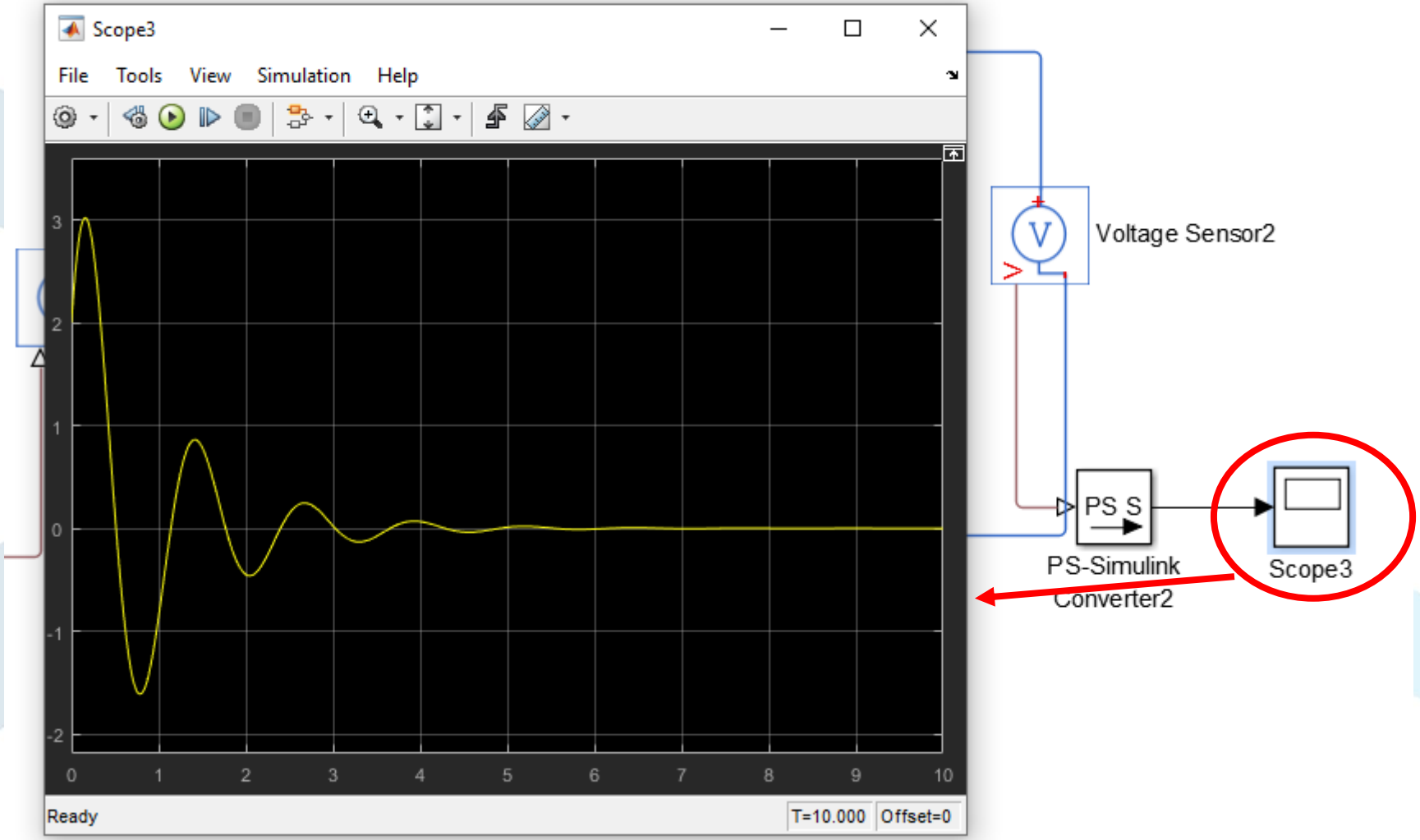
a. **The element values are R=2Ω, L=1H and C=1/26 F**



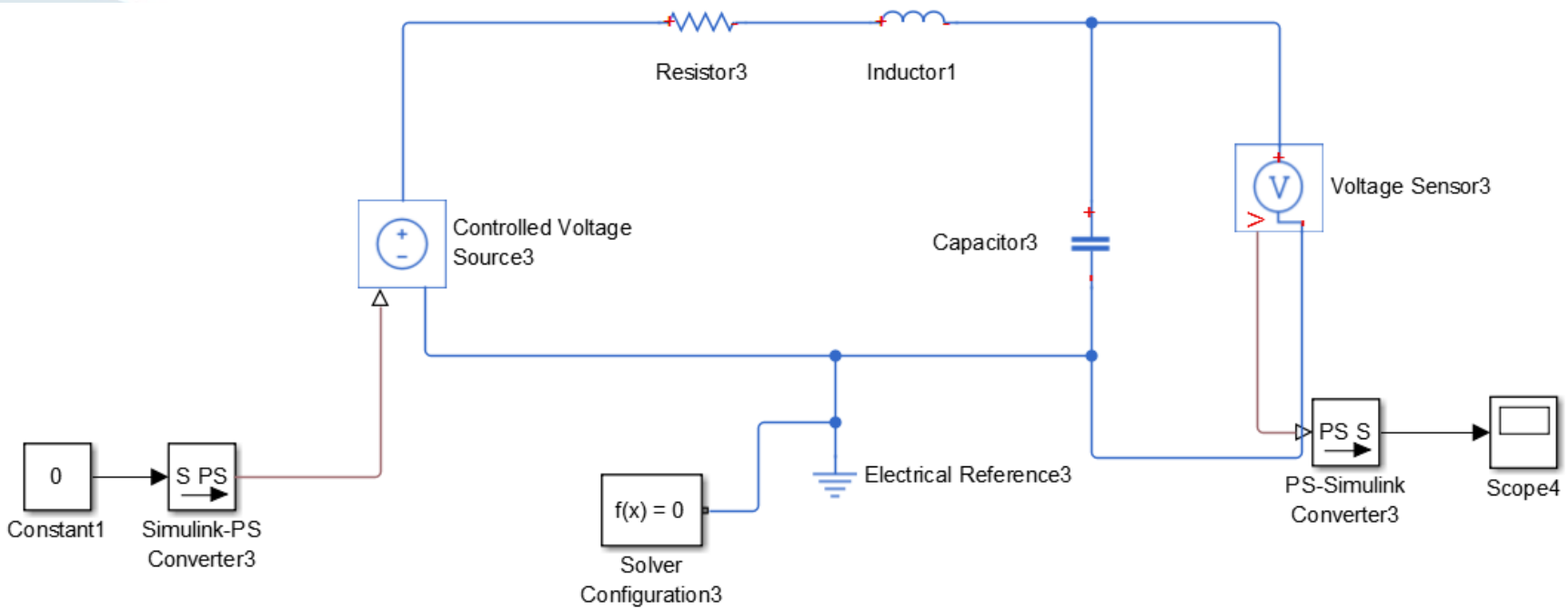

Resistor2
Inductor
Capacitor2
Electrical Reference2
Block Parameters: Capacitor2
Capacitor
This block models a capacitor with optional tolerance, operational limits and fault modeling.
Settings
Main
Operating Limits
Faults
Enable table-based capacitance:
No - use constant capacitance
Capacitance:
1/26
F
Capacitance tolerance (%):
5
Tolerance application:
None - use nominal value
Series resistance:
1e-6
Ohm
Parallel conductance:
0
1/Ohm
Initial capacitor voltage:
2
V
y(0) = 2
OK
Cancel
Help
Apply

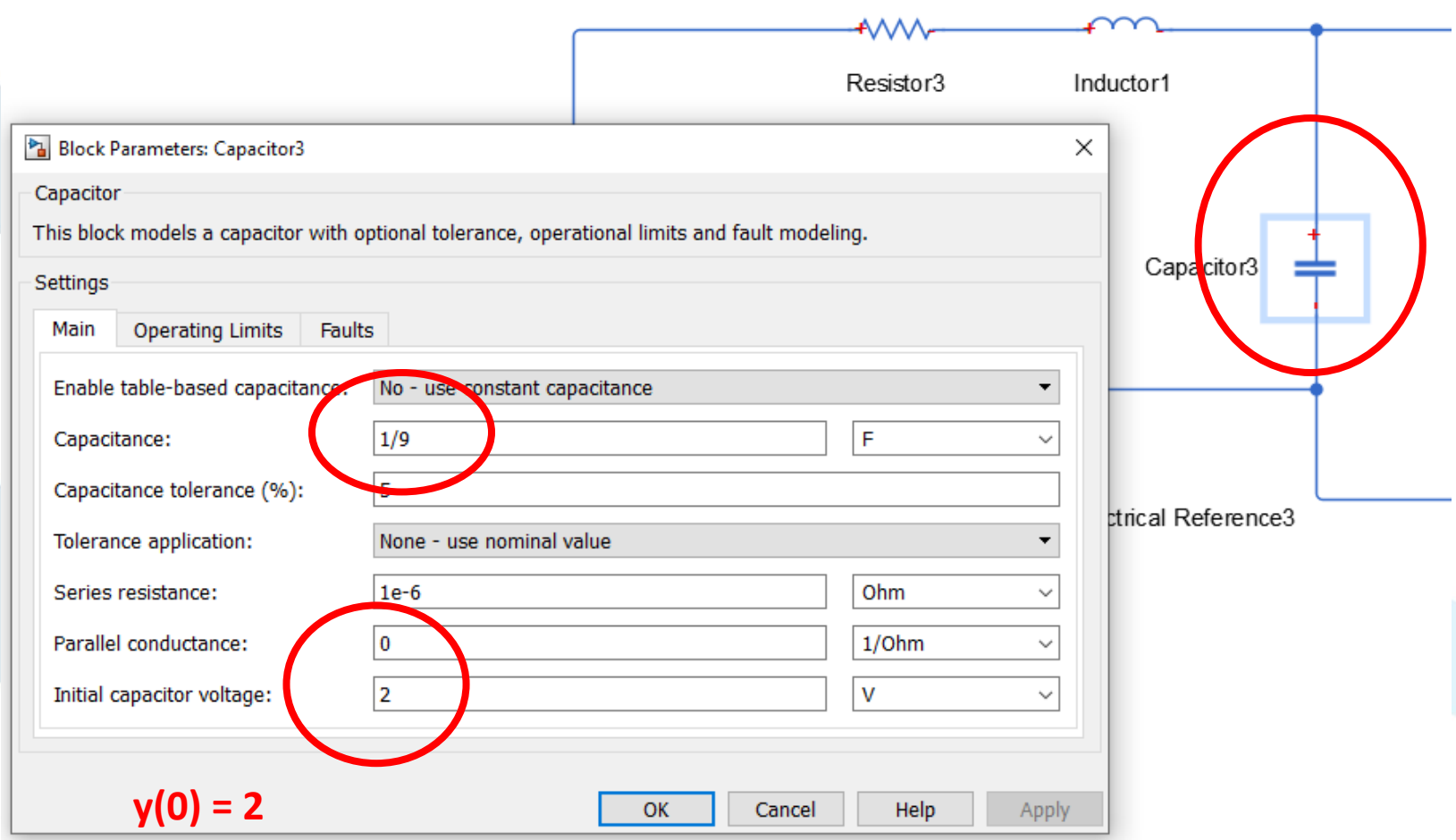

Resistor2
Inductor
Capacito
ctrical Refere
Block Parameters: Resistor2
Resistor
This block models a resistor with optional tolerance, operational limits, fault and thermal noise modeling. To model temperature effects, select the thermal variant of this block by right-clicking on the block and selecting Simscape block choices and Show thermal port.
Settings
Main
Operating Limits
Faults
Noise
Resistance:
2
Ohm
Tolerance (%):
5
Tolerance application:
None - use nominal value
OK
Cancel
Help
Apply

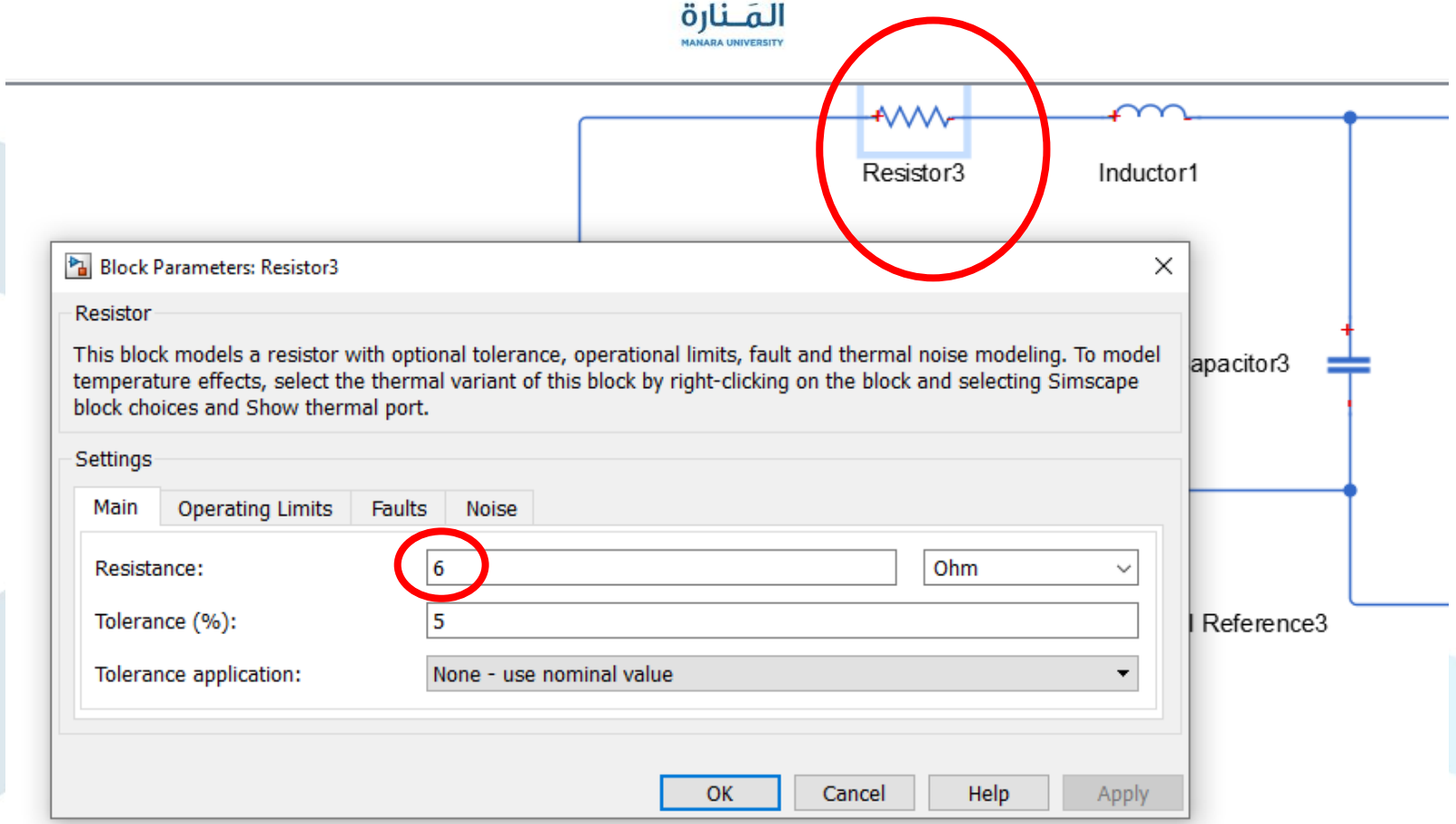

Resistor2
Inductor
Block Parameters: Inductor
Inductor
This block models an inductor with optional tolerance, operational limits and fault modeling.
Settings
Main
Operating Limits
Faults
Inductance:
1
H
Tolerance (%):
20
Tolerance application:
None - use nominal value
Series resistance:
0
Ohm
Parallel conductance:
1e-9
1/Ohm
Initial inductor current:
0.5
A
OK
Cancel
Help
Apply

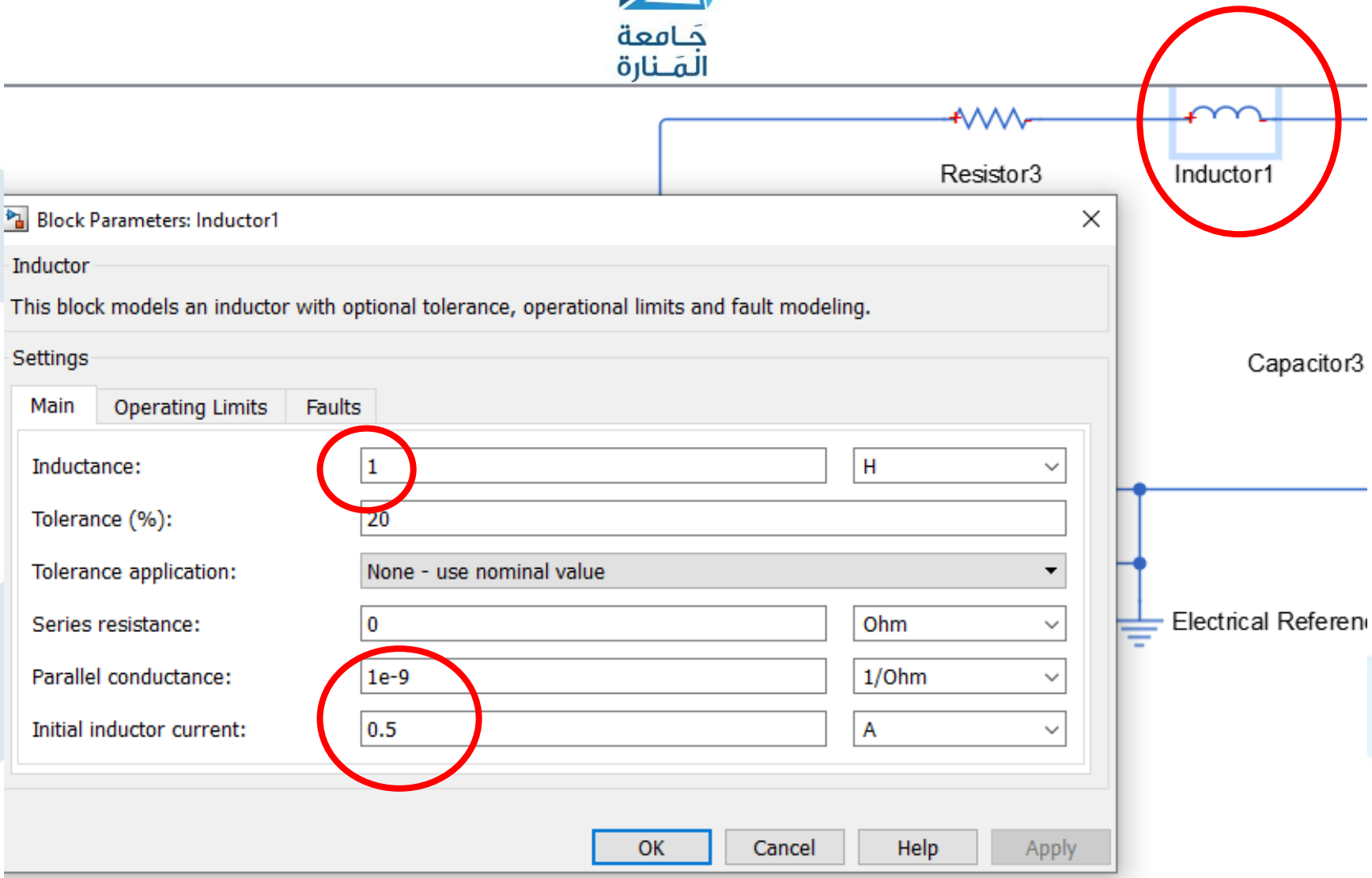

Scope3
File
Tools
View
Simulation
Help
3
2
1
0
-1
-2
0
1
2
3
4
5
6
7
8
9
10
Ready
T=10.000
Offset=0
Voltage Sensor2
PS S
PS-Simulink
Converter2
Scope3

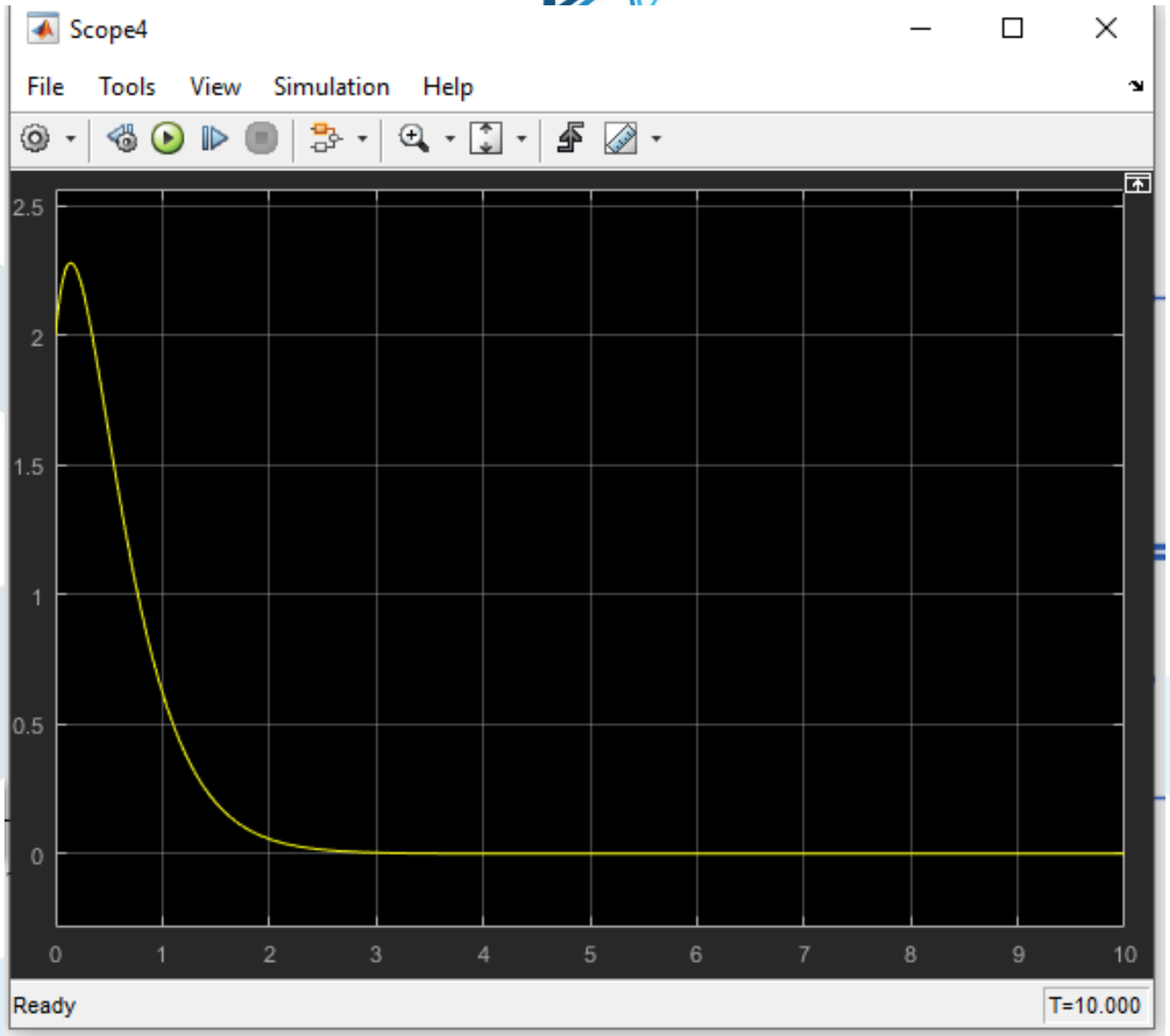
b. The element values are R=6Ω, L=1H and C=1/9 F




Resistor3
Inductor1
Capacitor3
ctrical Reference3
Block Parameters: Capacitor3
Capacitor
This block models a capacitor with optional tolerance, operational limits and fault modeling.
Settings
Main
Operating Limits
Faults
Enable table-based capacitance:
No - use constant capacitance
Capacitance:
1/9
F
Capacitance tolerance (%):
5
Tolerance application:
None - use nominal value
Series resistance:
1e-6
Ohm
Parallel conductance:
0
1/Ohm
Initial capacitor voltage:
2
V
y(0) = 2
OK
Cancel
Help
Apply

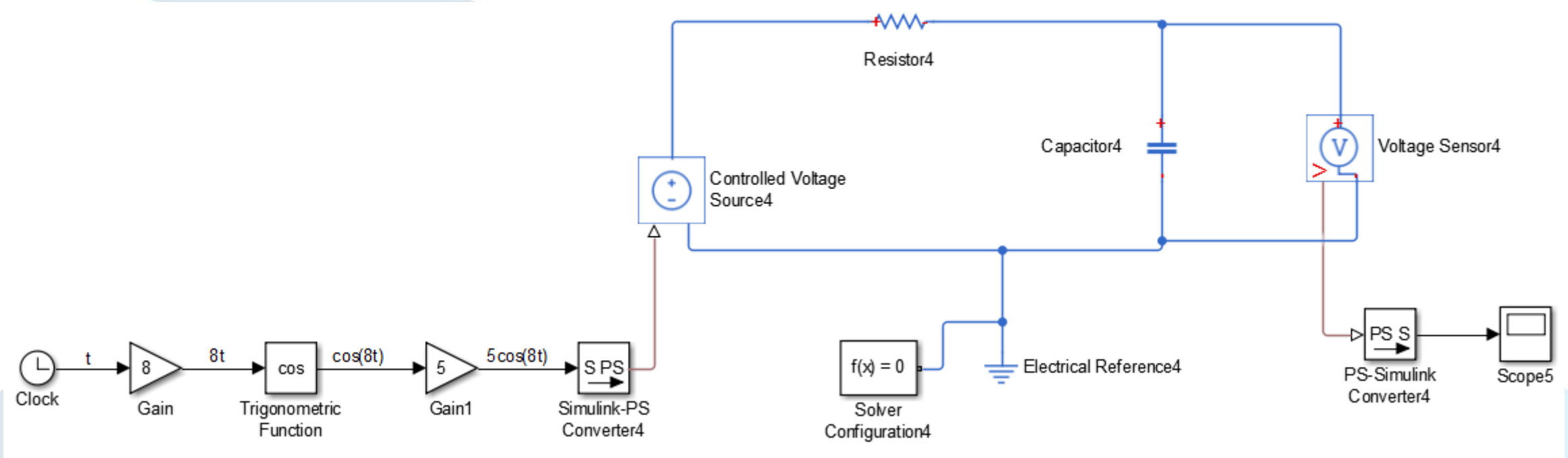

Resistor3
Inductor1
apacitor3
l Reference3
Block Parameters: Resistor3
Resistor
This block models a resistor with optional tolerance, operational limits, fault and thermal noise modeling. To model temperature effects, select the thermal variant of this block by right-clicking on the block and selecting Simscape block choices and Show thermal port.
Settings
Main
Operating Limits
Faults
Noise
Resistance:
6
Ohm
Tolerance (%):
5
Tolerance application:
None - use nominal value
OK
Cancel
Help
Apply

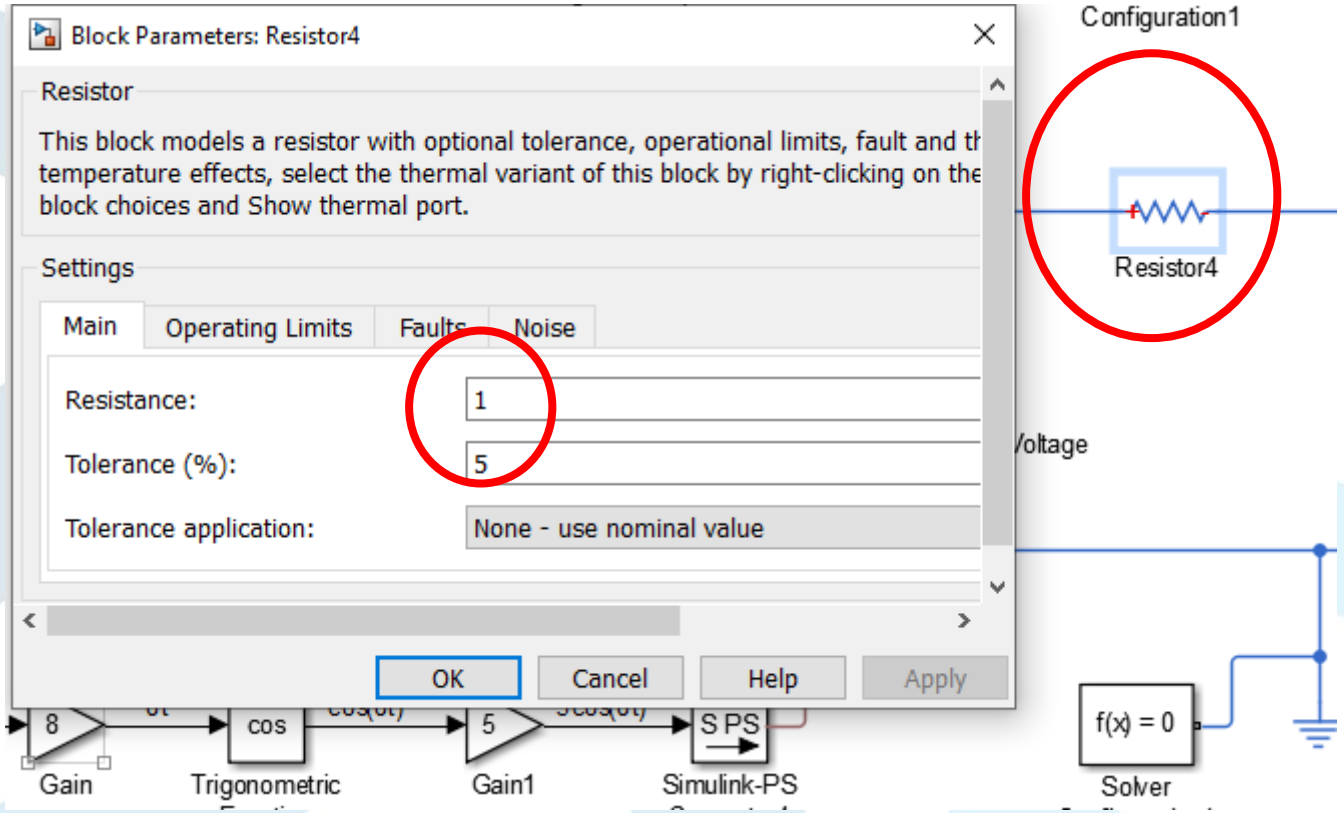

Resistor3
Inductor1
Capacitor3
Electrical Referen
Block Parameters: Inductor1
Inductor
This block models an inductor with optional tolerance, operational limits and fault modeling.
Settings
Main
Operating Limits
Faults
Inductance:
1
H
Tolerance (%):
20
Tolerance application:
None - use nominal value
Series resistance:
0
Ohm
Parallel conductance:
1e-9
1/Ohm
Initial inductor current:
0.5
A
OK
Cancel
Help
Apply

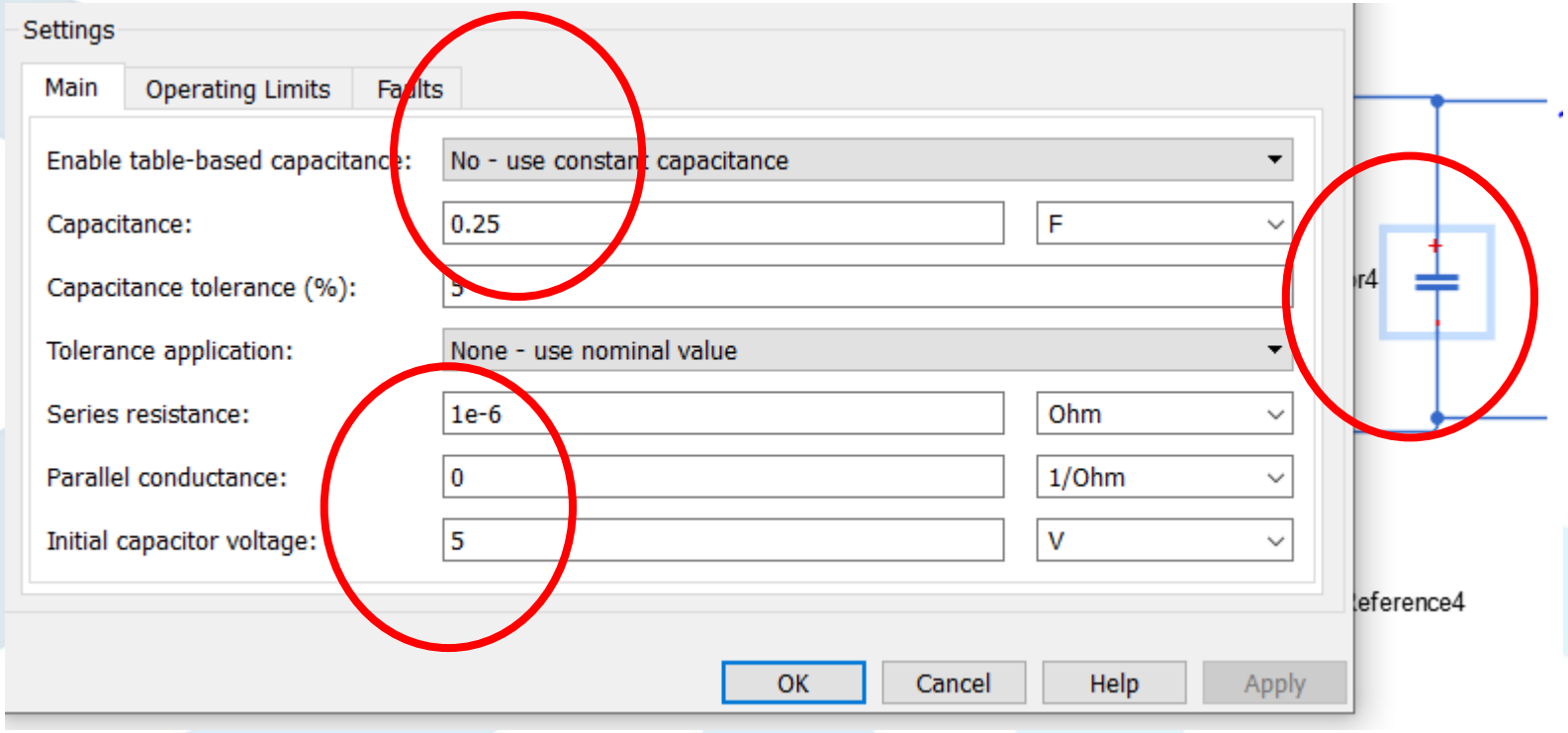

Scope4
File
Tools
View
Simulation
Help
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5
6
7
8
9
10
Ready
T=10.000

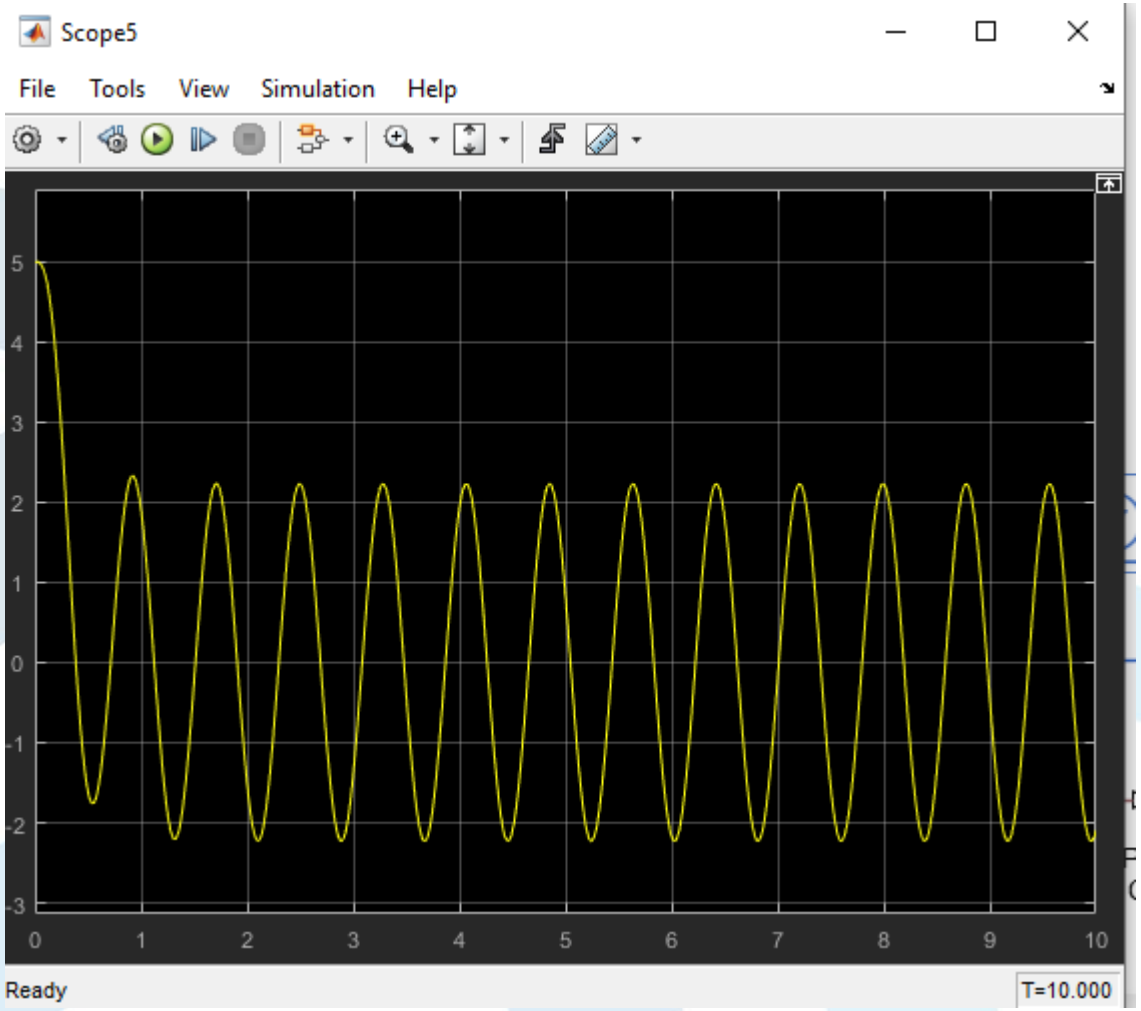
Example 3: Forced response of the first-order system for sinusoidal input The initial value of the output signal is y(0) =5v.

Draw the output voltage y(t) using Simulink in response to a sinusoidal input signal in the form $x(t) = 5\cos(8t)$**.**


Resistor4
Capacitor4
Voltage Sensor4
Controlled Voltage
Source4
Clock
t
8
Gain
8t
cos
Trigonometric
Function
cos(8t)
5
Gain1
5cos(8t)
S PS
Simulink-PS
Converter4
f(x) = 0
Solver
Configuration4
Electrical Reference4
PS S
PS-Simulink
Converter4
Scope5


Block Parameters: Resistor4
Resistor
This block models a resistor with optional tolerance, operational limits, fault and th
temperature effects, select the thermal variant of this block by right-clicking on the
block choices and Show thermal port.
Settings
Main
Operating Limits
Faults
Noise
Resistance:
1
Tolerance (%):
5
Tolerance application:
None - use nominal value
OK
Cancel
Help
Apply
Configuration1
Resistor4
oltage
8
Gain
cos
Trigonometric
5
Gain1
S PS
Simulink-PS
f(x) = 0
Solver


Settings
Main
Operating Limits
Faults
Enable table-based capacitance:
No - use constant capacitance
Capacitance:
0.25
F
Capacitance tolerance (%):
5
Tolerance application:
None - use nominal value
Series resistance:
1e-6
Ohm
Parallel conductance:
0
1/Ohm
Initial capacitor voltage:
5
V
OK
Cancel
Help
Apply
r4
eference4


Scope5
File
Tools
View
Simulation
Help
5
4
3
2
1
0
-1
-2
-3
0
1
2
3
4
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6
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8
9
10
Ready
T=10.000

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Thanks for Listening