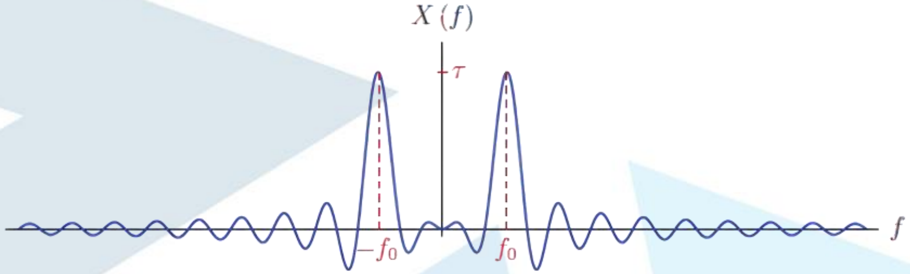
CECC507: Signals and Systems

Lecture 3: Using **Simulink** in MATLAB for Signals and Systems



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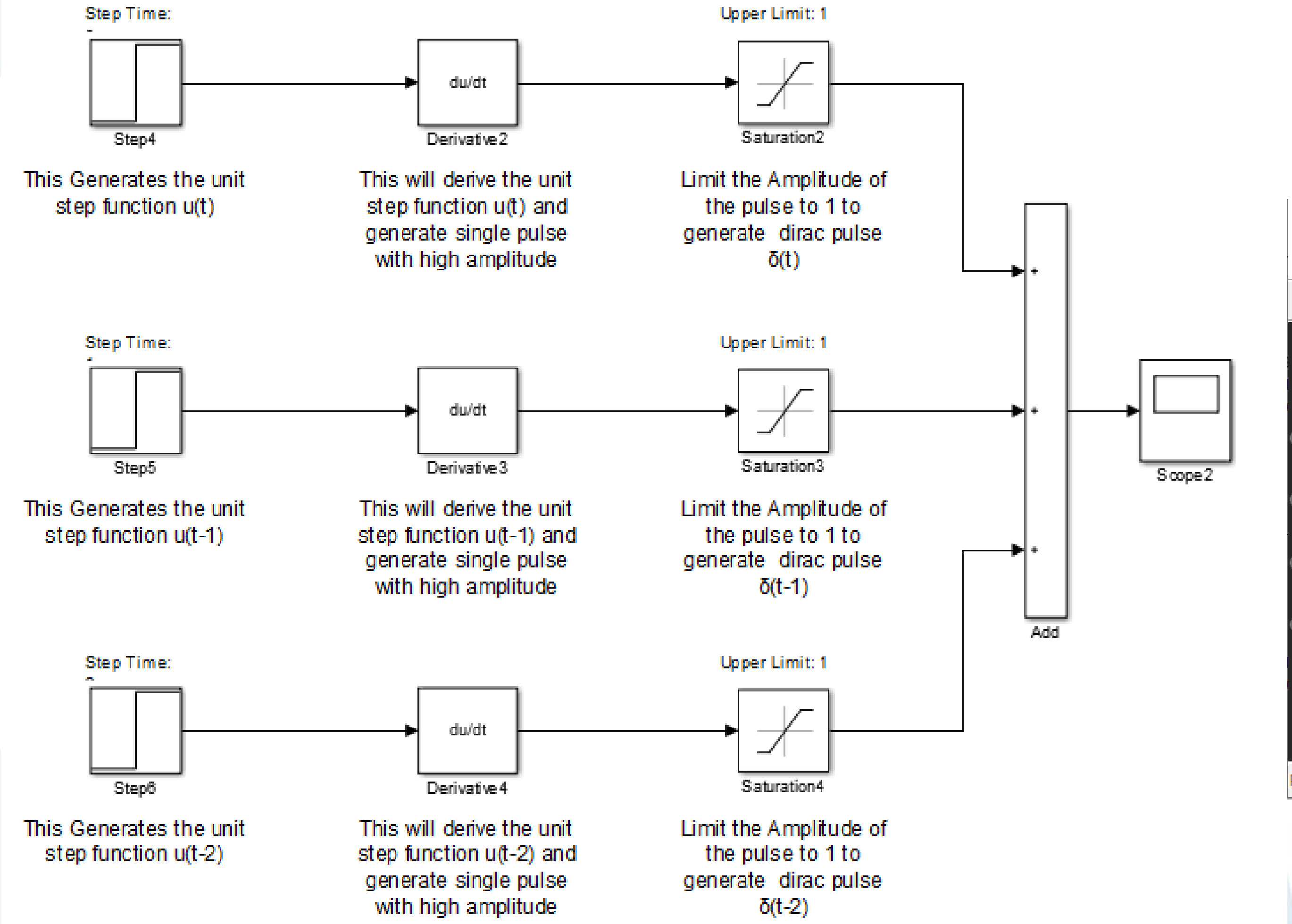
Ex 1: Sketch each of the following functions:

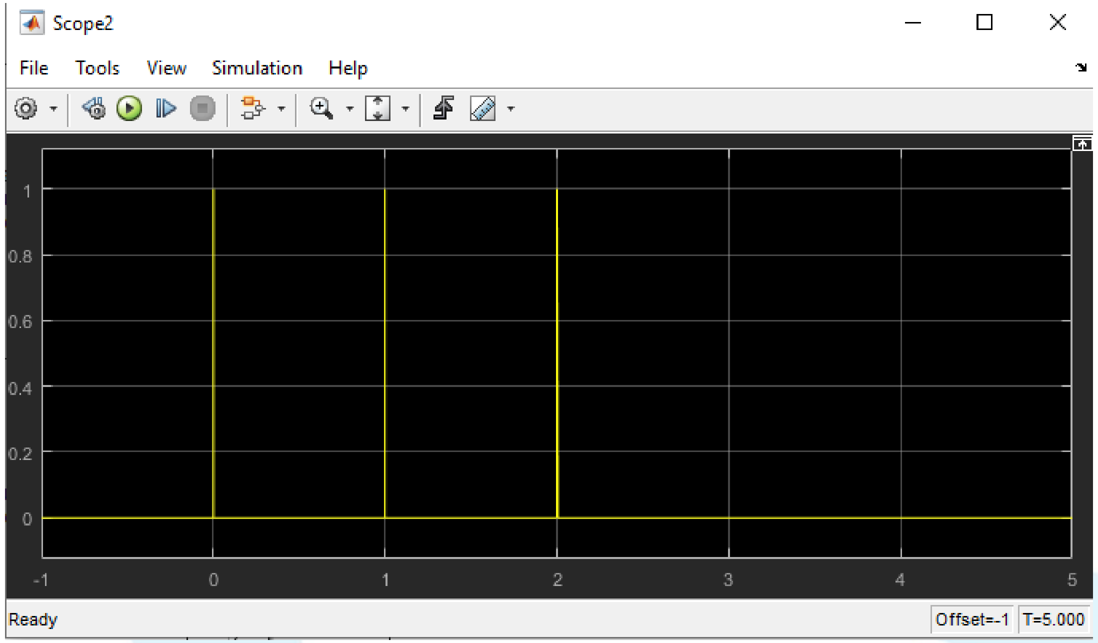
a. $\delta(t) + \delta(t - 1) + \delta(t - 2)$

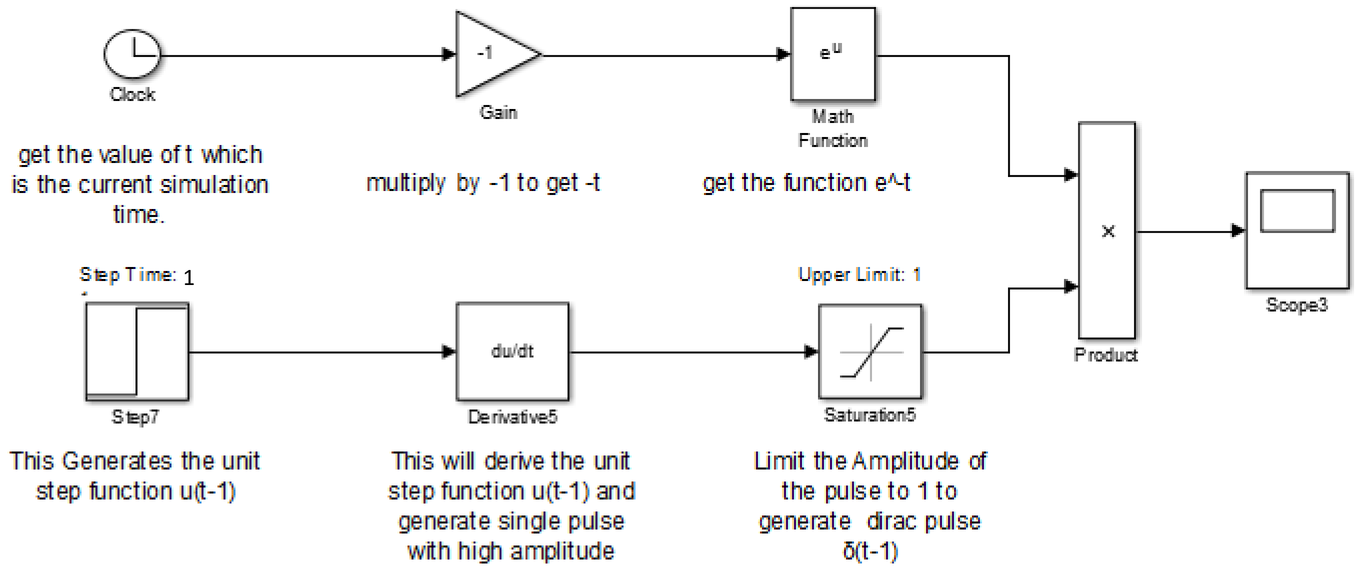
b. $e^{-t}\,\delta(t - 1)$

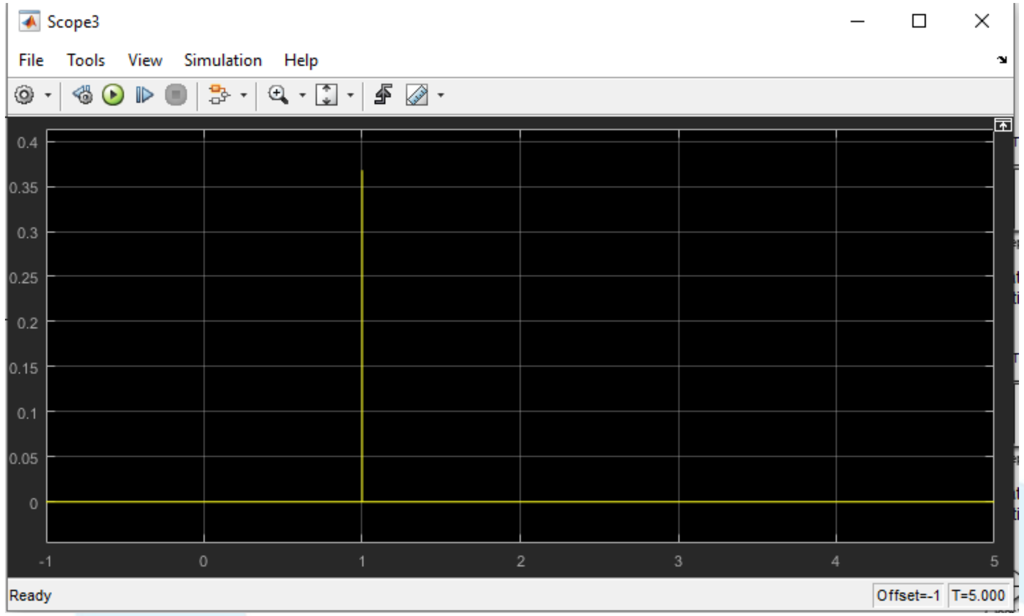
c. $e^{-t}\,[u(t - 1) - u(t - 2)]$

a. $\delta(t) + \delta(t-1) + \delta(t-2)$



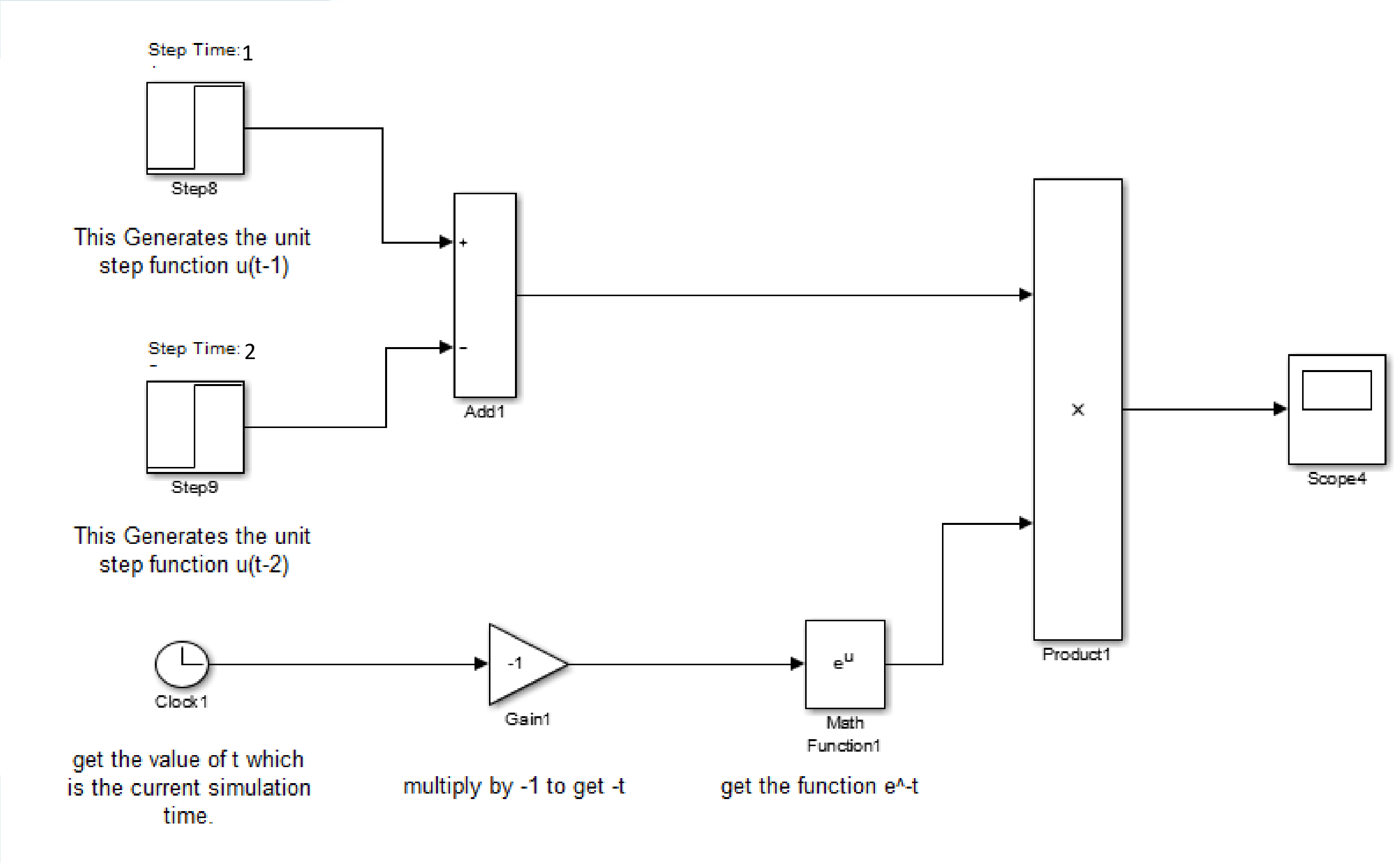


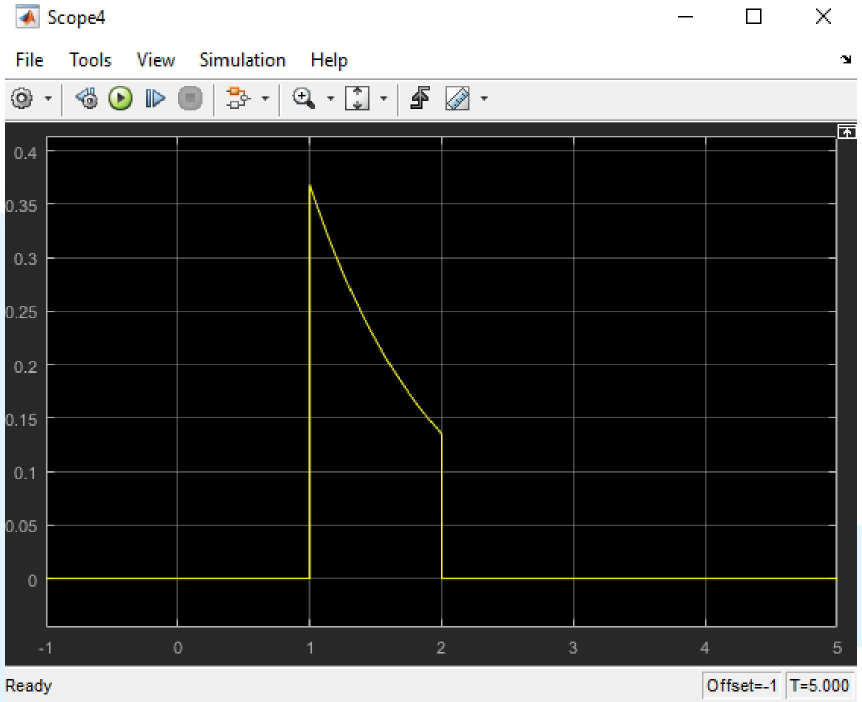

Clock
Gain
-1
e^u
Math Function
Product
Scope3
get the value of t which is the current simulation time.
multiply by -1 to get -t
get the function e^-t
Step Time: 1
Step7
du/dt
Derivative5
Upper Limit: 1
Saturation5
This Generates the unit step function u(t-1)
This will derive the unit step function u(t-1) and generate single pulse with high amplitude
Limit the Amplitude of the pulse to 1 to generate dirac pulse δ(t-1)


Scope3
File Tools View Simulation Help
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-1
0
1
2
3
4
5
Ready
Offset=-1
T=5.000

b. $e^{-t}\,\delta(t-1)$

c. $e^{-t}[u(t-1)-u(t-2)]$


Step Time: 1
Step8
This Generates the unit step function u(t-1)
Step Time: 2
Step9
This Generates the unit step function u(t-2)
Add1
Product1
Scope4
Clock1
get the value of t which is the current simulation time.
-1
Gain1
multiply by -1 to get -t
Math Function1
get the function e^-t


Scope4
File Tools View Simulation Help
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-1 0 1 2 3 4 5
Ready
Offset=-1
T=5.000

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Ex 2: Sketch each of the following functions in the time interval $-1 \le t \le 5$:

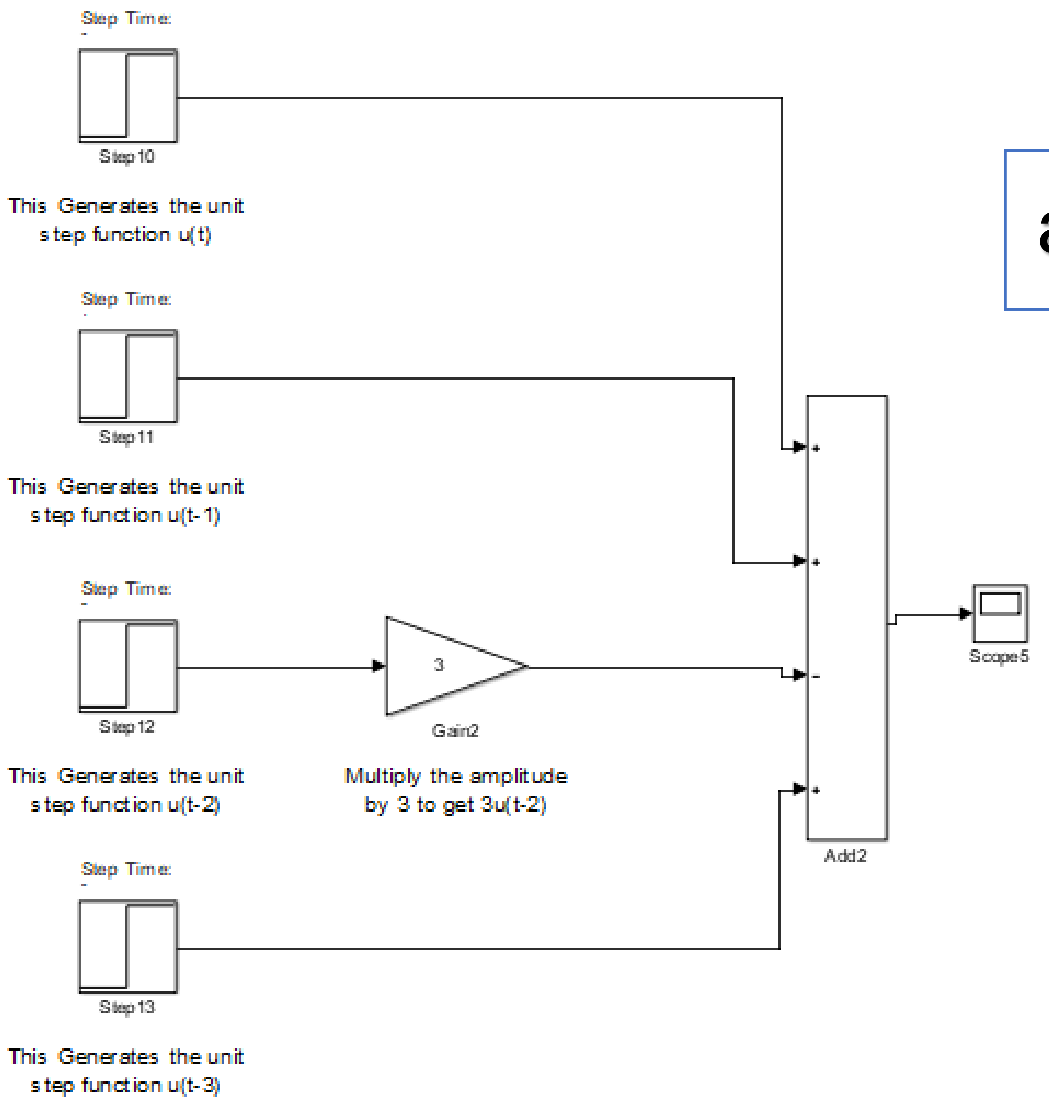
a. $u(t) + u(t-1) - 3u(t-2) + u(t-3)$

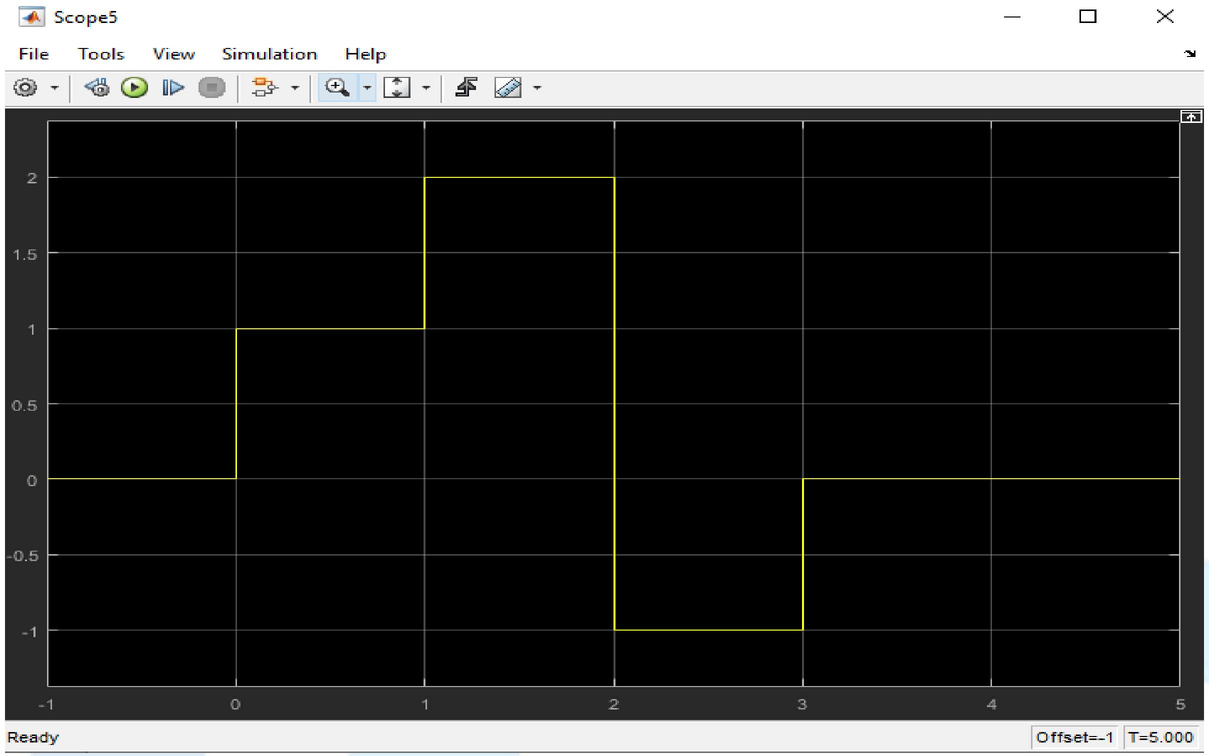
b. $r(t) - 2r(t-2) + r(t-3)$

c. $2\Pi\left(\frac{t-1}{2}\right) - \Pi\left(\frac{t-2}{1.5}\right) + 2\Pi(t-4)$

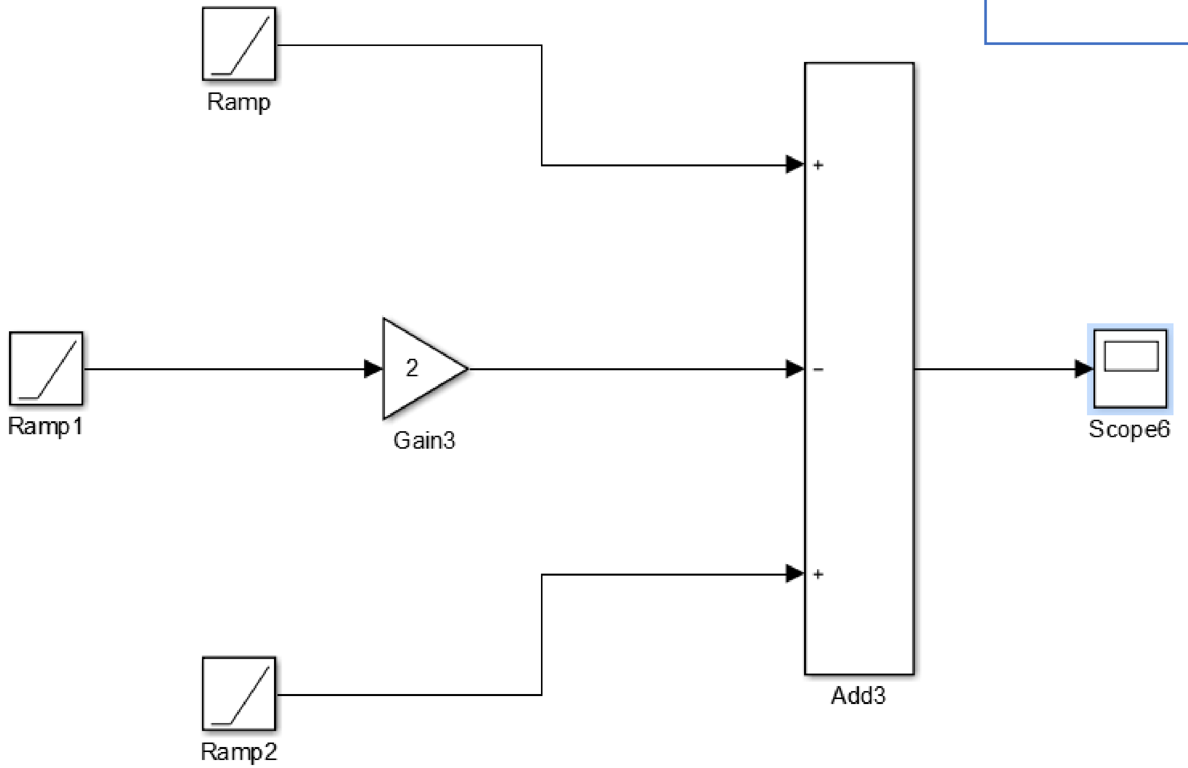
d. $\Lambda(t) + 2\Lambda(t-1) + 1.5\Lambda(t-3) - \Lambda(t-4)$

$$a.\ u(t) + u(t-1) - 3u(t-2) + u(t-3)$$

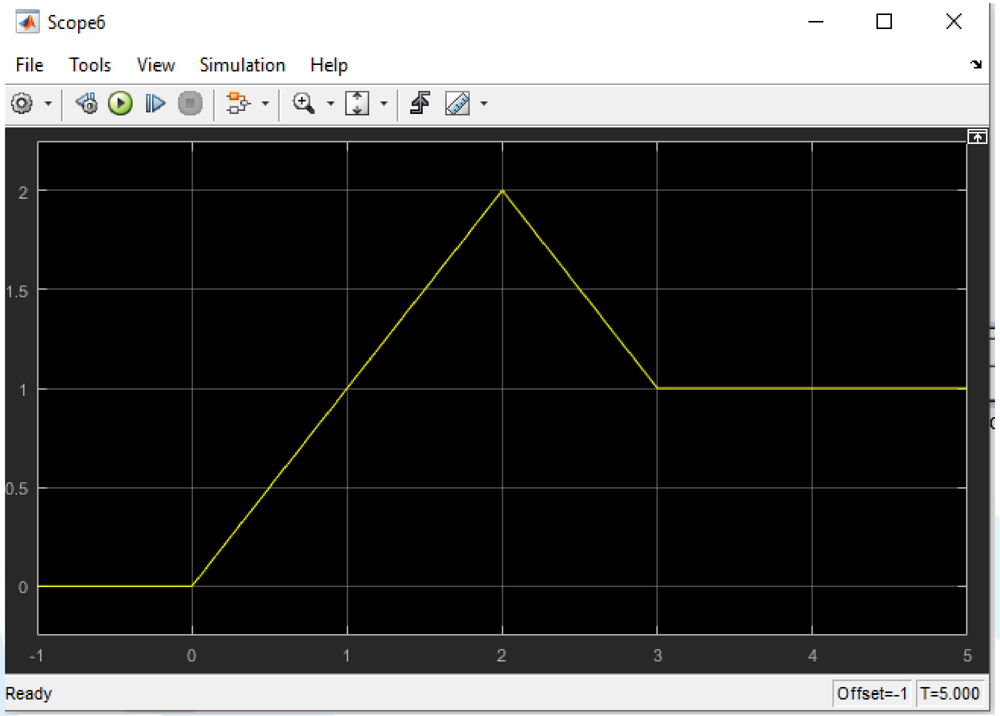




$$b.\ r(t) - 2r(t-2) + r(t-3)$$



Ramp
Ramp1
2
Gain3
Ramp2
+
-
+
Add3
Scope6

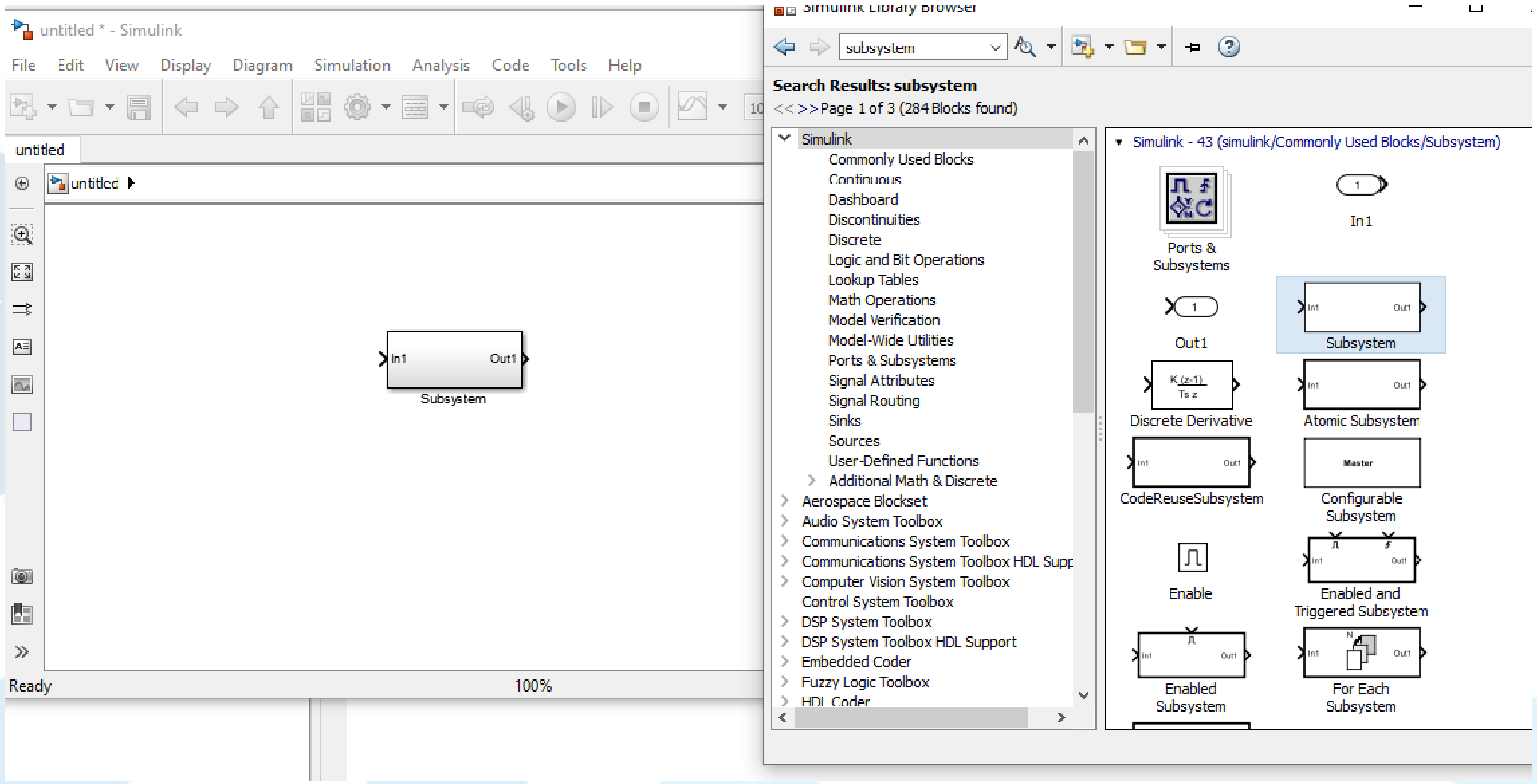


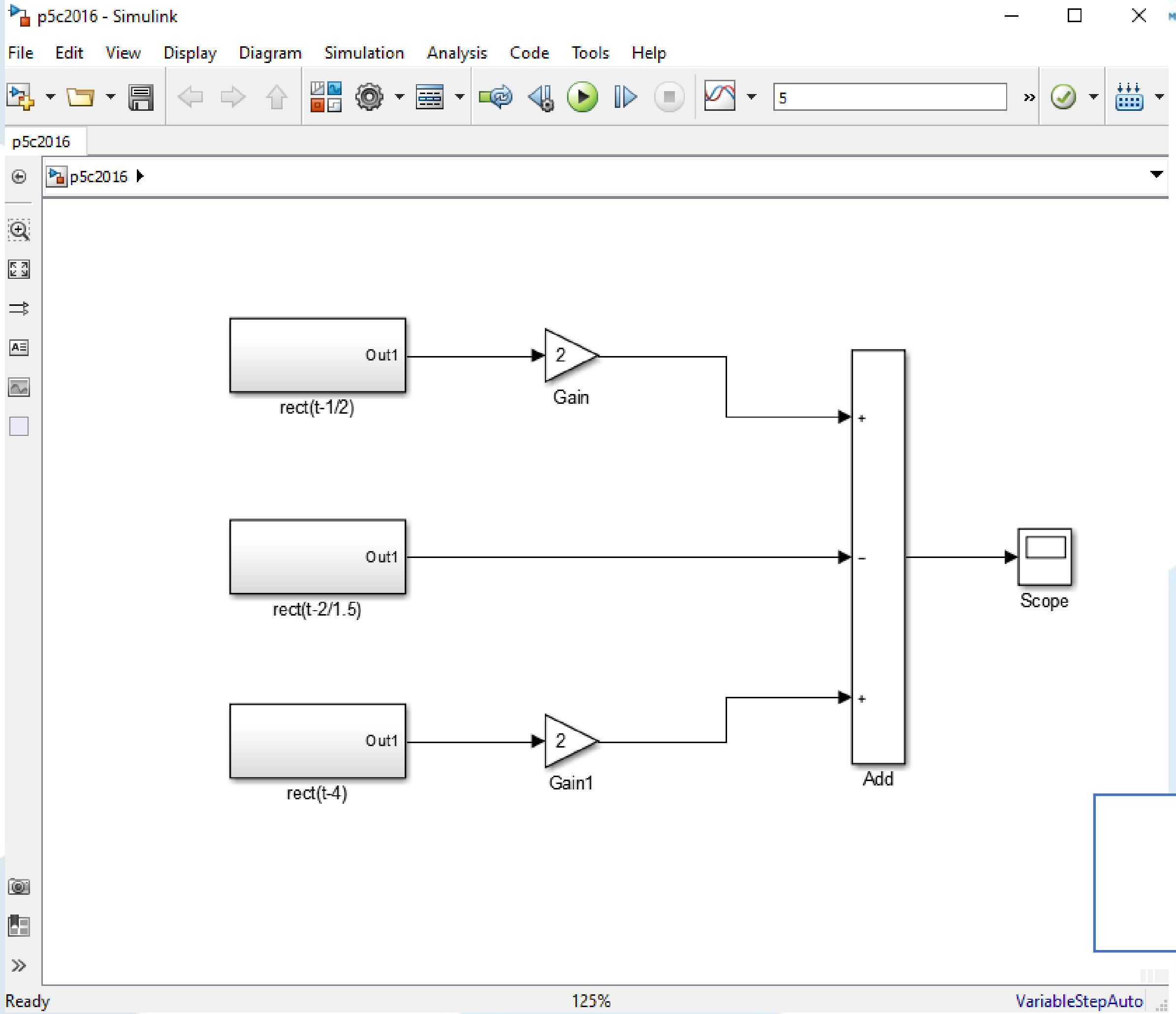
Scope6
File Tools View Simulation Help
2
1.5
1
0.5
0
-1
0
1
2
3
4
5
Ready
Offset=-1
T=5.000

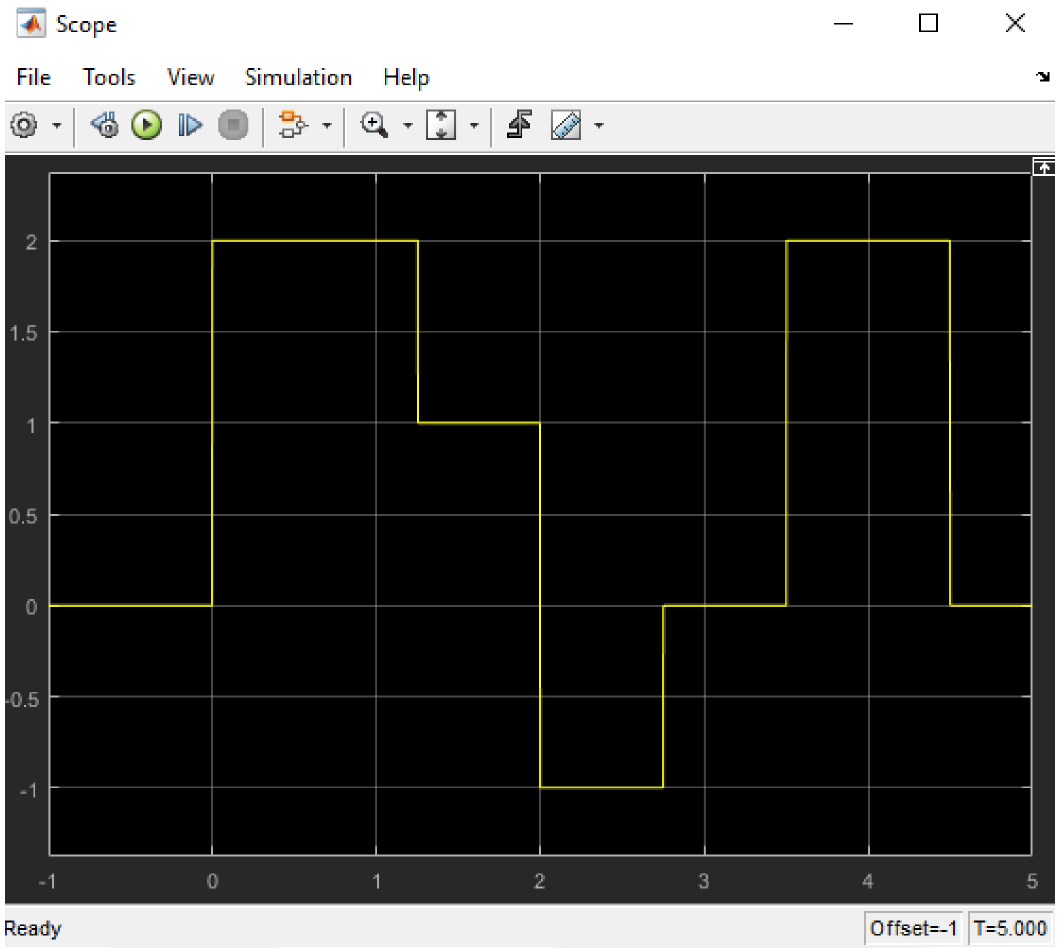
Simulink Subsystem:

Modular Design Block

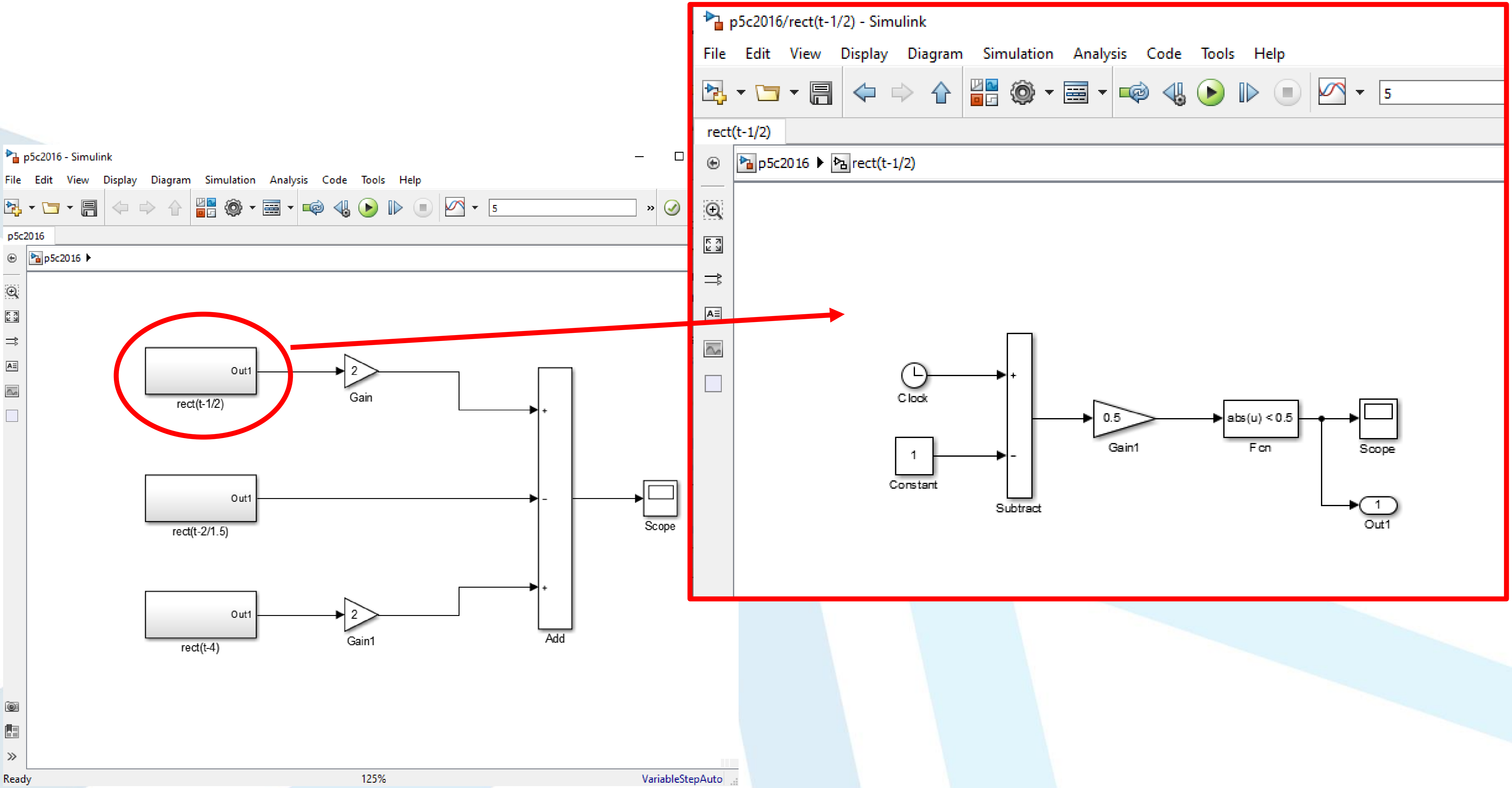
A **Subsystem** in Simulink is a container that groups multiple blocks into a single unit. It simplifies complex models by hiding internal details and improving readability.

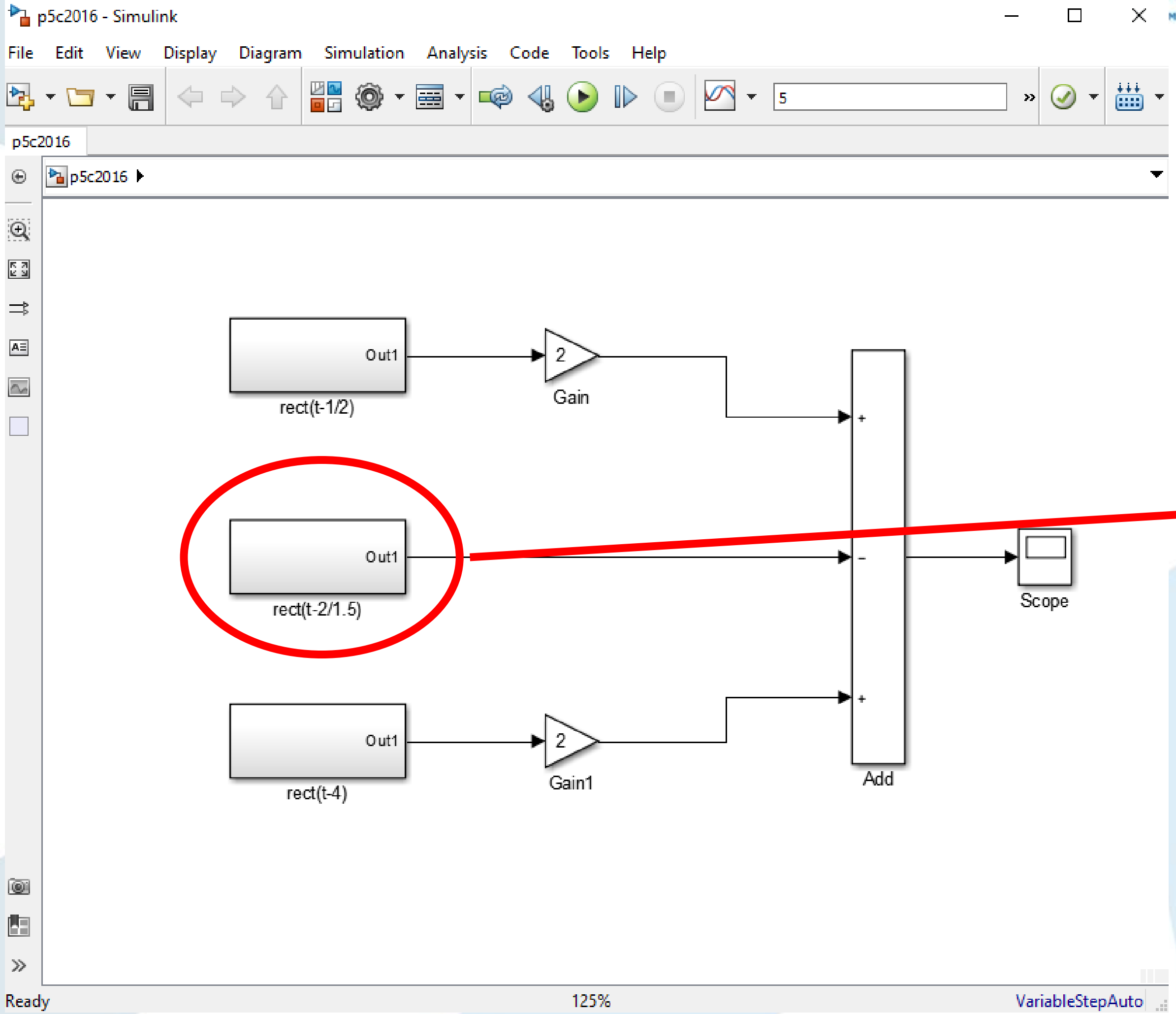


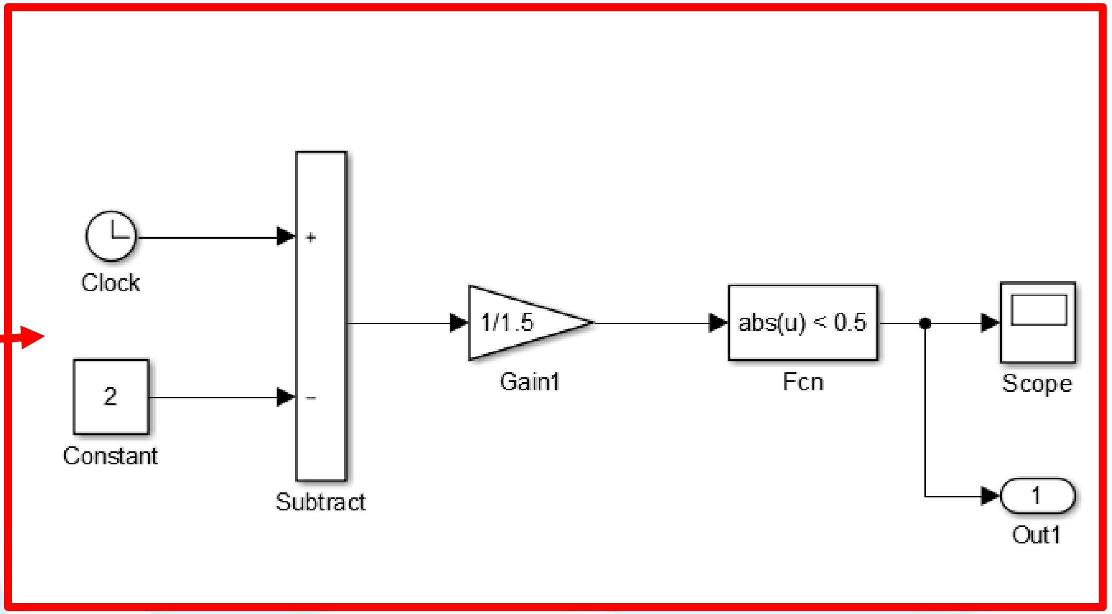


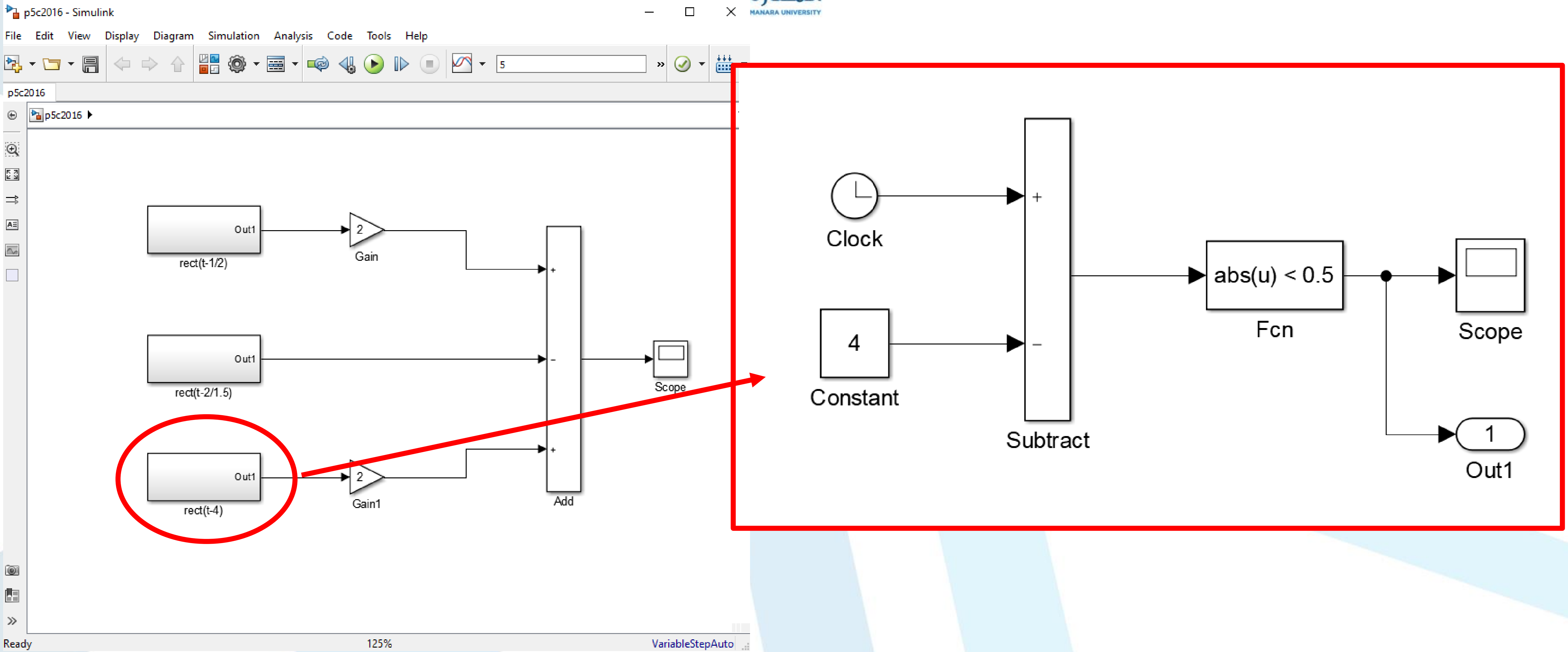


c. $2\Pi\left(\frac{t-1}{2}\right) - \Pi\left(\frac{t-2}{1.5}\right) + 2\Pi(t-4)$

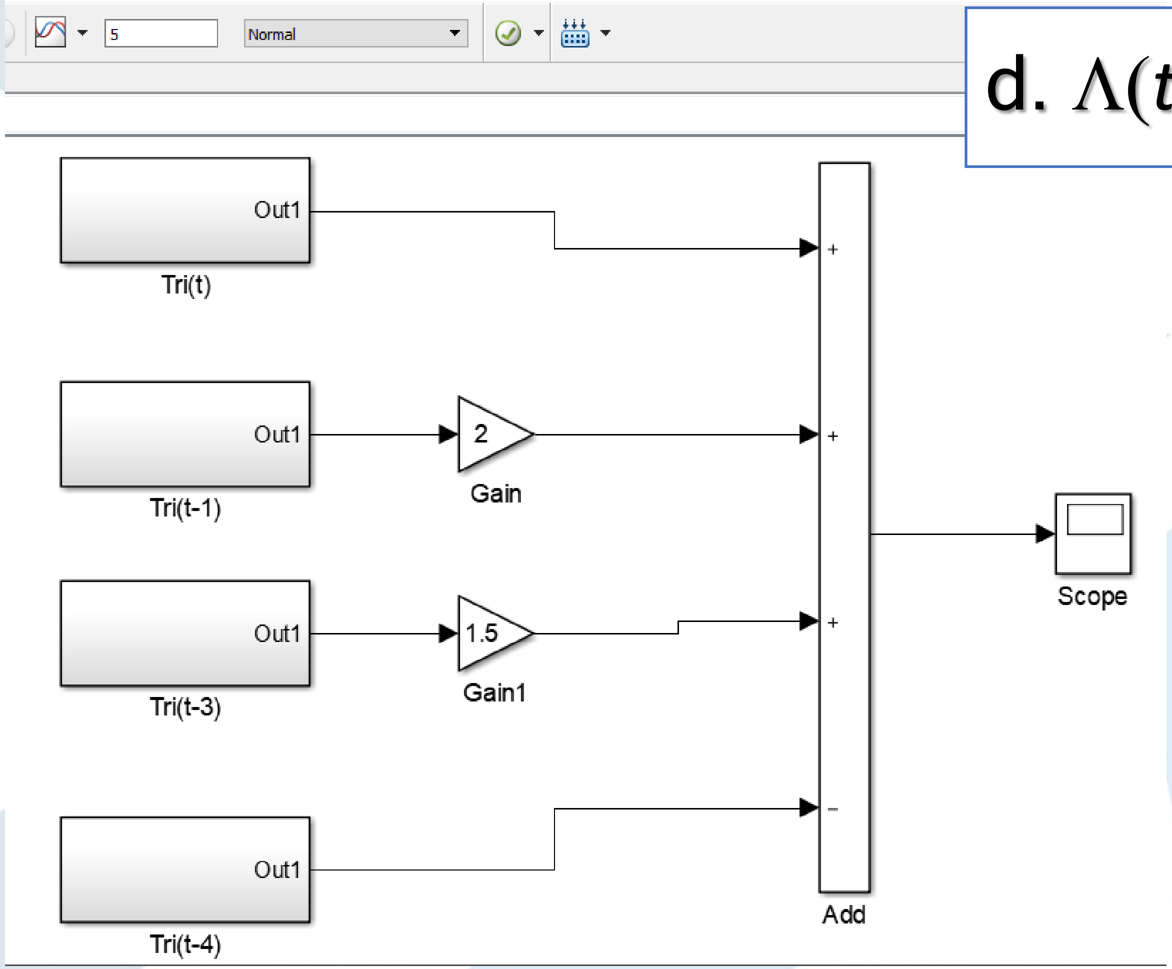

p5c2016 - Simulink
File Edit View Display Diagram Simulation Analysis Code Tools Help
p5c2016
Out1
rect(t-1/2)
Gain
2
Out1
rect(t-2/1.5)
Out1
rect(t-4)
2
Gain1
Add
Scope
Ready
125%
VariableStepAuto
p5c2016/rect(t-1/2) - Simulink
rect(t-1/2)
p5c2016
Clock
1
Constant
Subtract
0.5
Gain1
abs(u) < 0.5
Fcn
Scope
1
Out1


p5c2016 - Simulink
File Edit View Display Diagram Simulation Analysis Code Tools Help
p5c2016
Out1
rect(t-1/2)
2
Gain
Out1
rect(t-2/1.5)
Out1
rect(t-4)
2
Gain1
Add
Scope
Ready
125%
VariableStepAuto

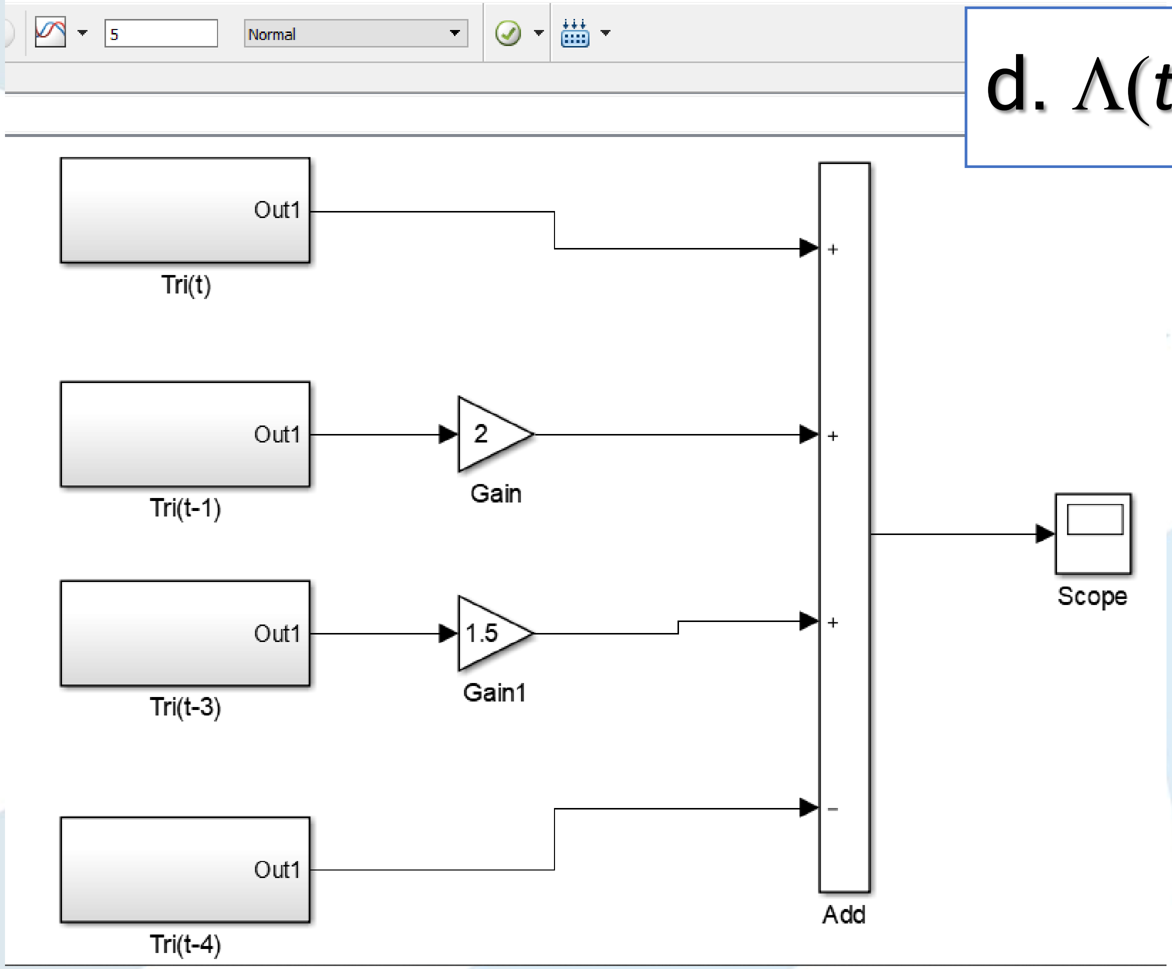

Clock
2
Constant
Subtract
1/1.5
Gain1
abs(u) < 0.5
Fcn
Scope
1
Out1

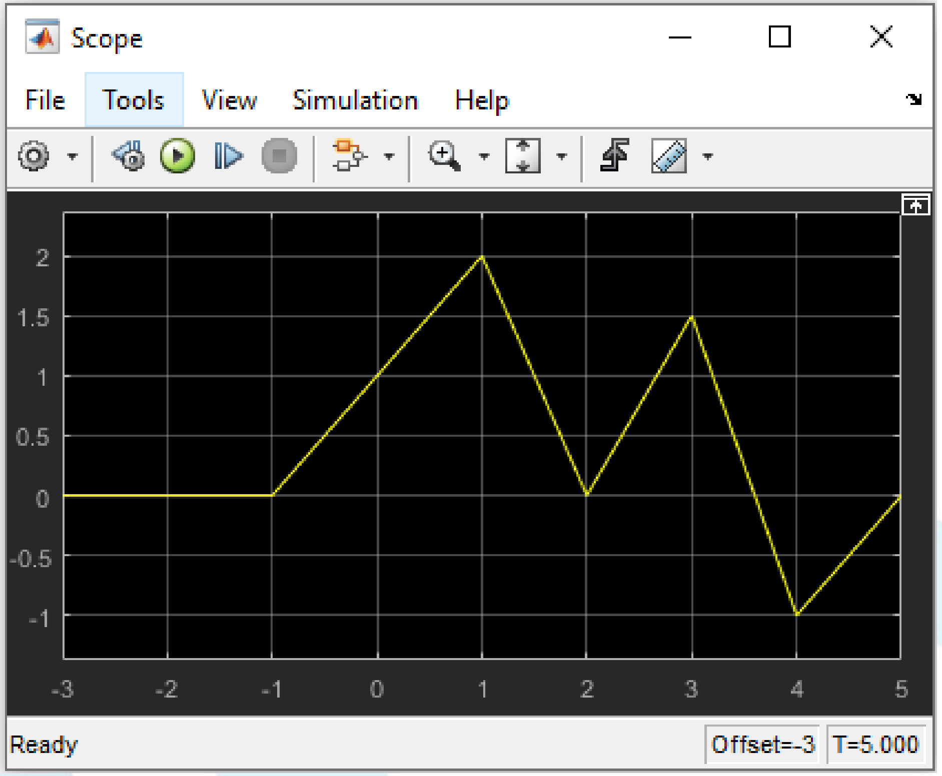

p5c2016 - Simulink
File Edit View Display Diagram Simulation Analysis Code Tools Help
5
p5c2016
Out1
rect(t-1/2)
2
Gain
Out1
rect(t-2/1.5)
Out1
rect(t-4)
2
Gain1
Add
Scope
Ready
125%
VariableStepAuto
Clock
4
Constant
Subtract
abs(u) < 0.5
Fcn
Scope
1
Out1

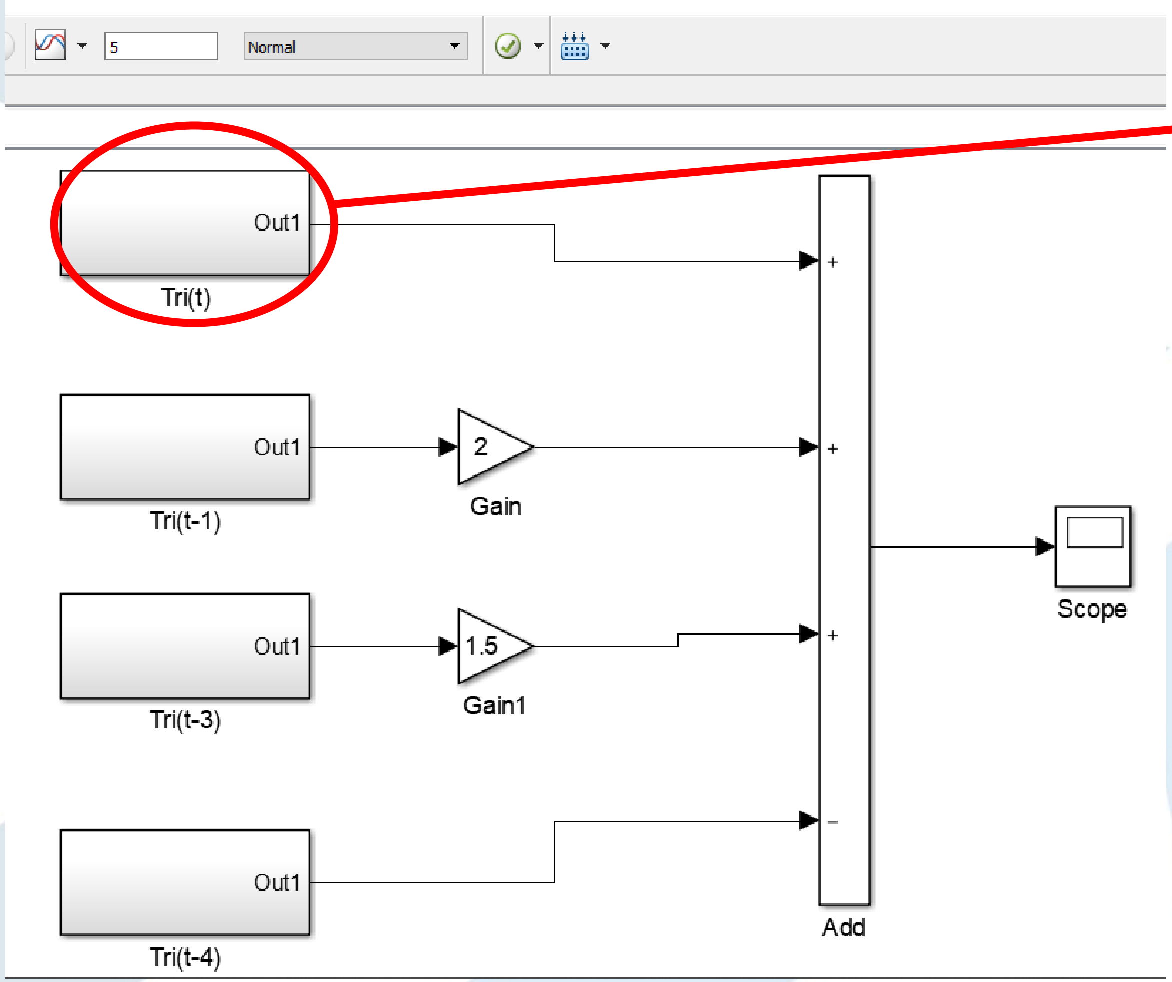
$$d.\ \Lambda(t) + 2\Lambda(t-1) + 1.5\Lambda(t-3) - \Lambda(t-4)$$



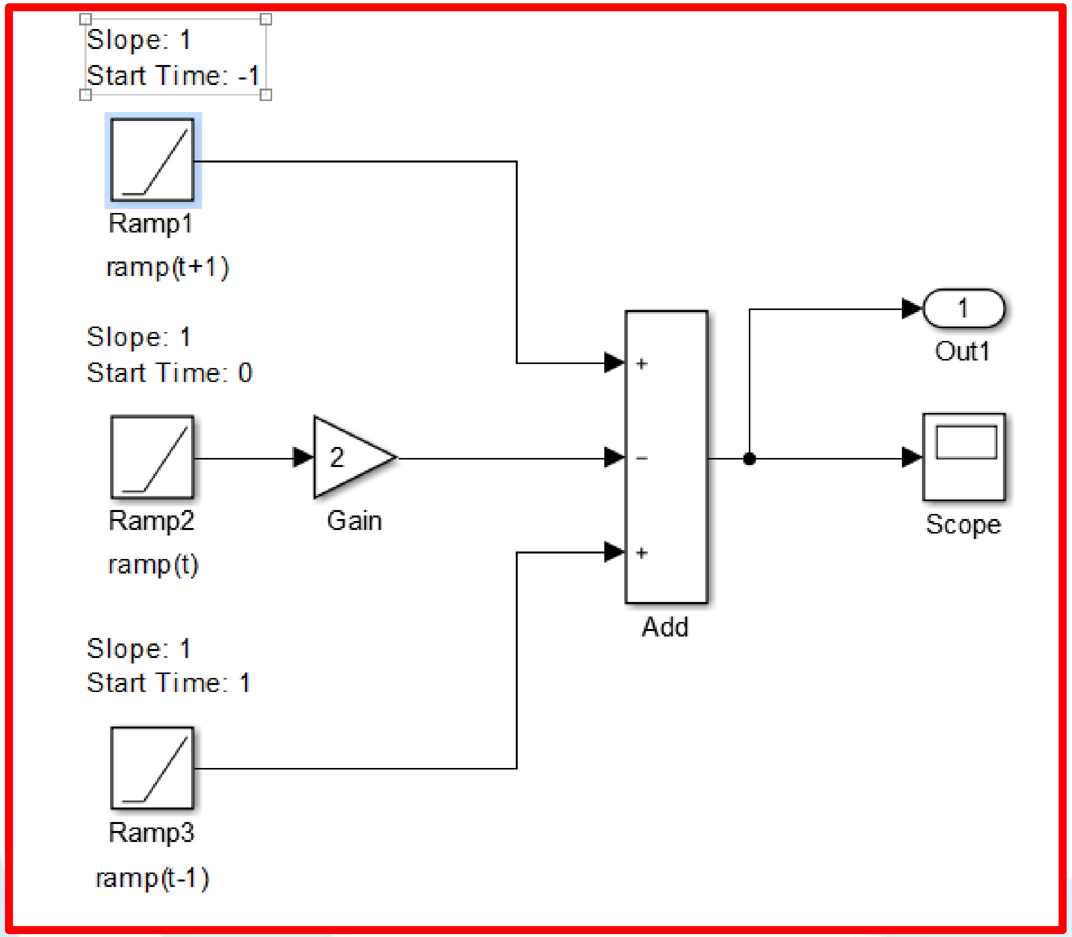
$$d.\ \Lambda(t) + 2\Lambda(t-1) + 1.5\Lambda(t-3) - \Lambda(t-4)$$



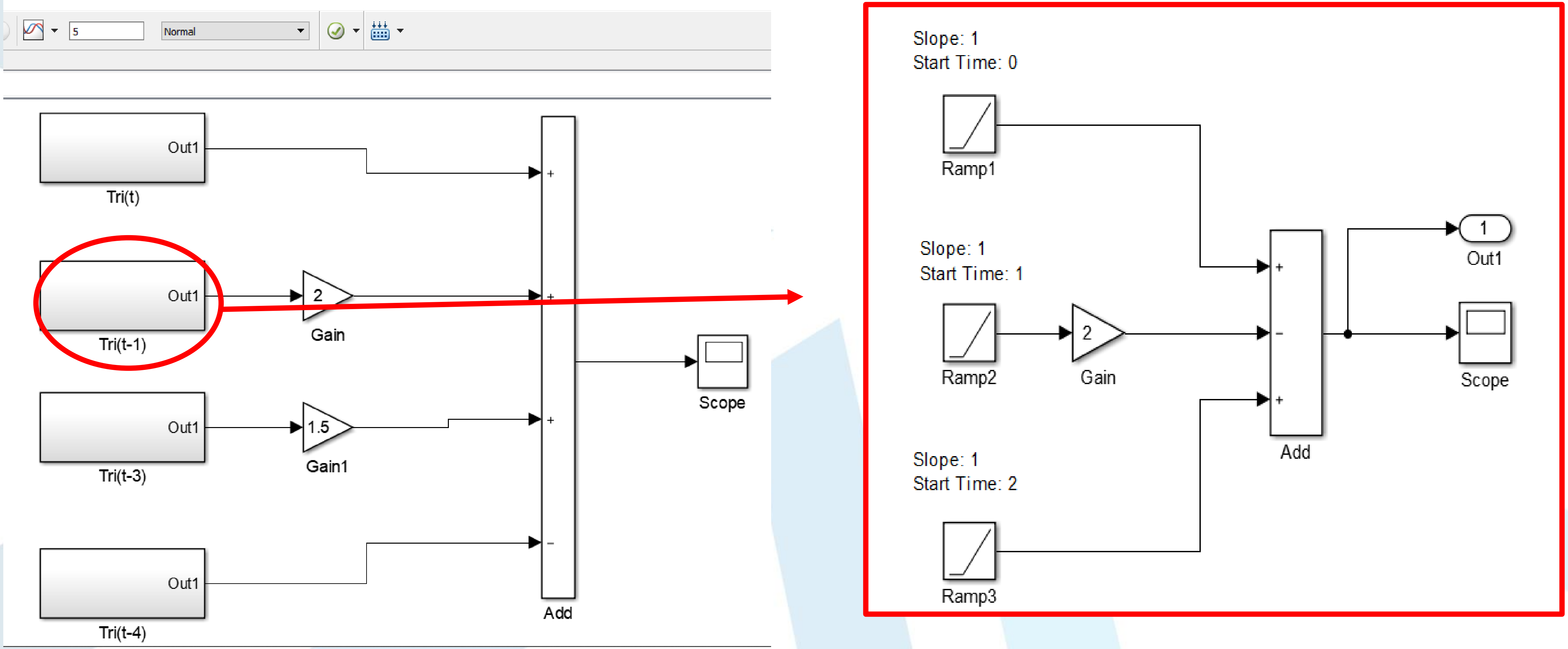


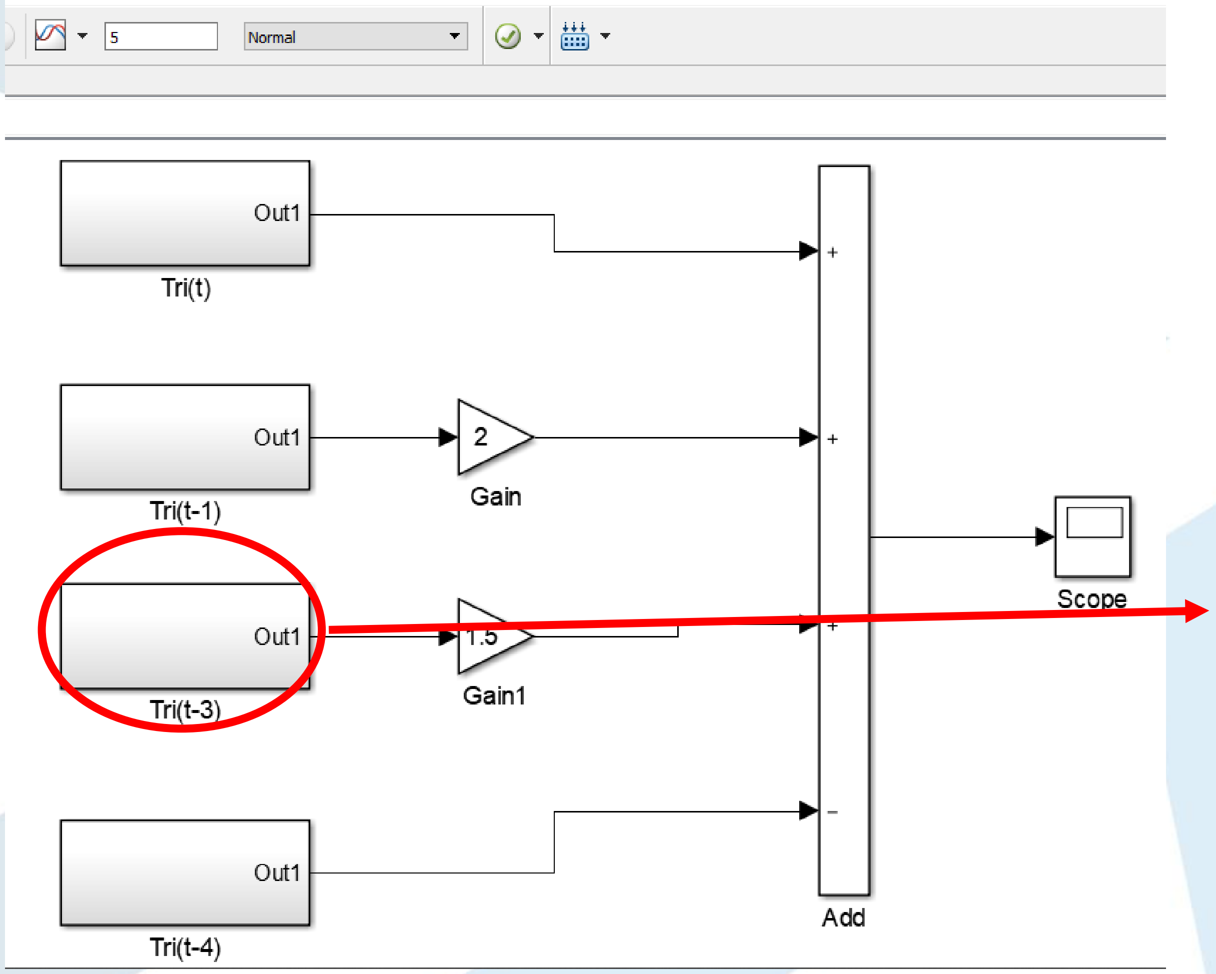


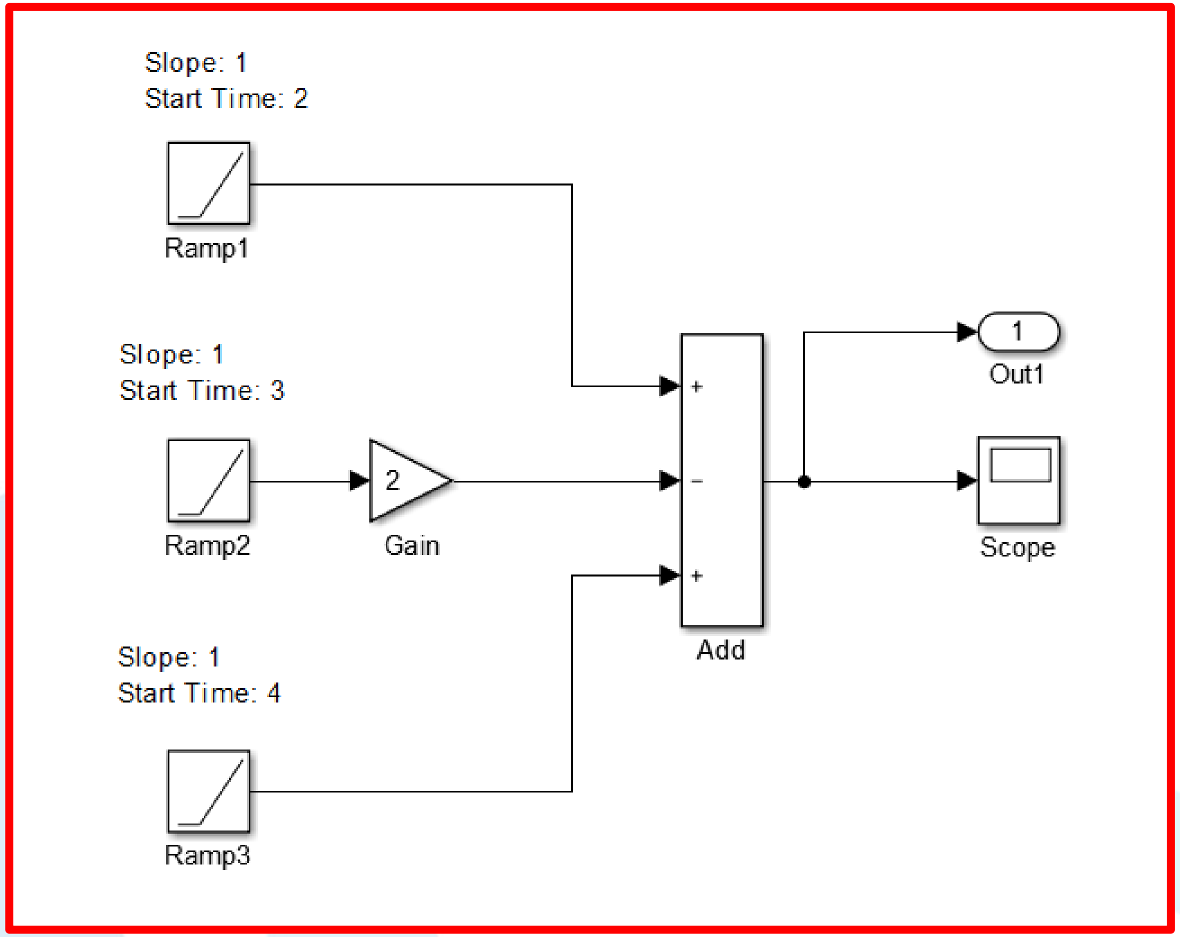
5
Normal
Out1
Tri(t)
Out1
Tri(t-1)
2
Gain
Out1
Tri(t-3)
1.5
Gain1
Out1
Tri(t-4)
Add
Scope

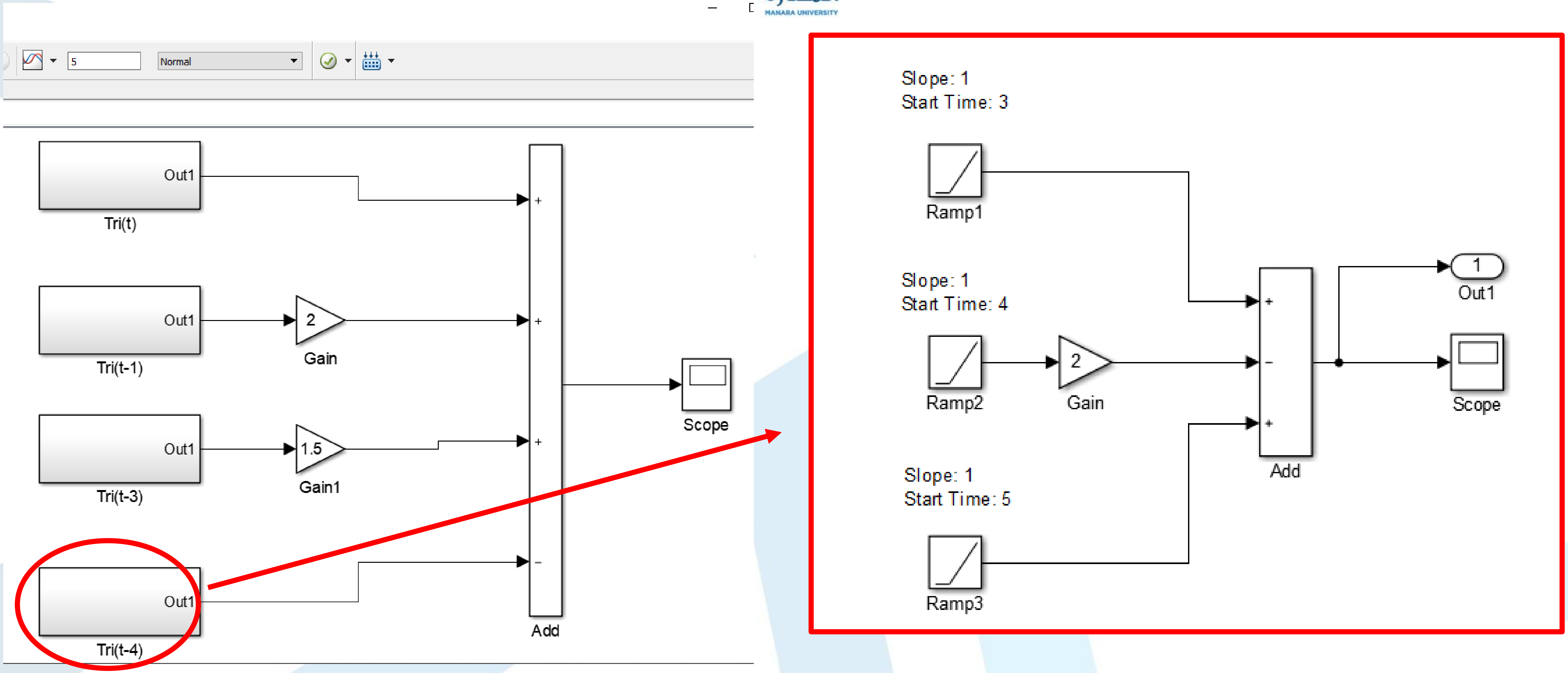


Slope: 1
Start Time: -1
Ramp1
ramp(t+1)
Slope: 1
Start Time: 0
Ramp2
ramp(t)
2
Gain
Slope: 1
Start Time: 1
Ramp3
ramp(t-1)
Add
1
Out1
Scope


5
Normal
Out1
Tri(t)
Out1
Tri(t-1)
2
Gain
Out1
Tri(t-3)
1.5
Gain1
Out1
Tri(t-4)
Add
Scope
Slope: 1
Start Time: 0
Ramp1
Slope: 1
Start Time: 1
Ramp2
2
Gain
Slope: 1
Start Time: 2
Ramp3
Add
1
Out1
Scope


5
Normal
Out1
Tri(t)
Out1
Tri(t-1)
2
Gain
Out1
Tri(t-3)
1.5
Gain1
Out1
Tri(t-4)
Add
Scope


Slope: 1
Start Time: 2
Ramp1
Slope: 1
Start Time: 3
Ramp2
2
Gain
Slope: 1
Start Time: 4
Ramp3
Add
1
Out1
Scope


5
Normal
Out1
Tri(t)
Out1
Tri(t-1)
2
Gain
Out1
Tri(t-3)
1.5
Gain1
Out1
Tri(t-4)
Add
Scope
Slope: 1
Start Time: 3
Ramp1
Slope: 1
Start Time: 4
Ramp2
2
Gain
Slope: 1
Start Time: 5
Ramp3
Add
1
Out1
Scope

- Determine the energy of each of the signals

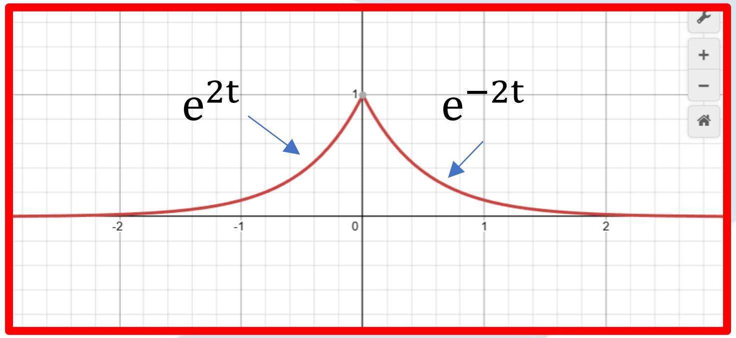
a. $x(t) = e^{-2|t|}$

b. $x(t) = e^{-2t}.u(t)$

- Determine the energy of each of the signals

a. $x(t) = e^{-2|t|}$

تحليل شكل الإشارة :



$$|t| = \begin{cases} -t, & t < 0 \\ t, & t \geq 0 \end{cases} t;$$

ومنه

$$x(t) = \begin{cases} e^{-2(-t)}, & t < 0 \\ e^{-2t}, & t \geq 0 \end{cases}$$

وبالتالي

$$x(t) = \begin{cases} e^{2t}, & t < 0 \\ e^{-2t}, & t \geq 0 \end{cases}$$

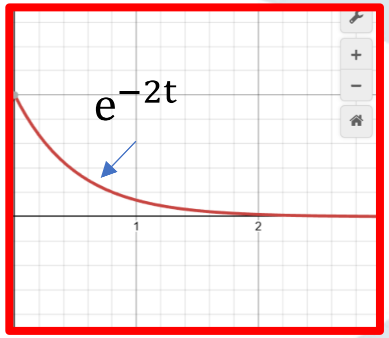
$$E_x = \int_{-\infty}^{\infty} |x(t)|^2 dt = \int_{-\infty}^{\infty} e^{-4|t|} dt = \int_{-\infty}^{0} e^{4t} dt + \int_{0}^{\infty} e^{-4t} dt = \frac{1}{4} e^{4t}\Big|_{-\infty}^{0} - \frac{1}{4} e^{-4t}\Big|_{0}^{\infty} = \frac{1}{4}(e^0 - e^{-\infty}) - \frac{1}{4}(e^{-\infty} - e^0)$$

وبالتالي

$$E_x = \frac{1}{4}(1-0) - \frac{1}{4}(0-1) = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$

- Determine the energy of each of the signals

b. $x(t) = e^{-2t}u(t)$



$$E_x = \int_{-\infty}^{\infty} |x(t)|^2 dt = \int_{-\infty}^{\infty} (e^{-2t}u(t))2dt$$

التابع $u(t)$ يقوم بقص التابع e^{-2t} من 0 إلى ∞ أي أن

$$x(t) = \begin{cases} 0, & t < 0 \\ e^{-2t}, & t \geq 0 \end{cases}$$

$$E_x = \int_{-\infty}^{0} 0\, dt + \int_{0}^{\infty} (e^{-2t})^2 dt = -\frac{1}{4} e^{-4t}\Big|_0^{\infty} = -\frac{1}{4}(e^{-\infty} - e^{0})$$

وبالتالي

$$E_x = -\frac{1}{4}(0-1) = \frac{1}{4}$$

Thanks for Listening