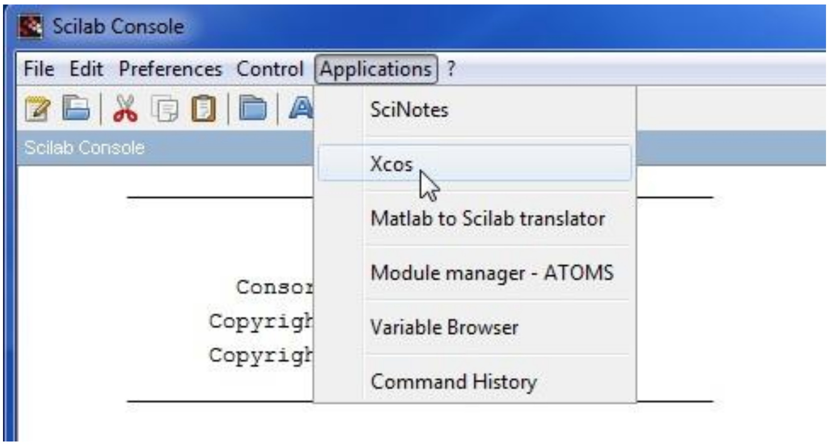
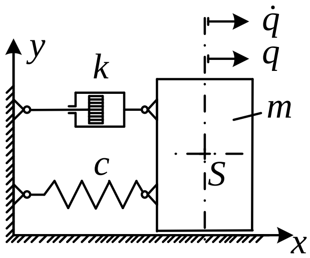
Dynamics of Machines Week 5 –1st and 2nd Exercises



5/1 Exercise - Free Vibration of a Single Degree of Freedom System (Xcos)



$$m\ddot{q} + k\dot{q} + \frac{1}{c}q = 0$$

$$\ddot{q} = \frac{1}{m}\left(-k\dot{q} - \frac{1}{c}q\right) = -\frac{k}{m}\dot{q} - \frac{1}{c\,m}q = -\frac{0.9}{5}\dot{q} - \frac{1}{0.5\cdot 5}q = 0$$

$$\ddot{q} = -\frac{0.9}{5}\dot{q} - \frac{2}{5}q \quad (\text{acceleration})$$

$k = 0.9\ \frac{Ns}{m}$ – damping coefficient

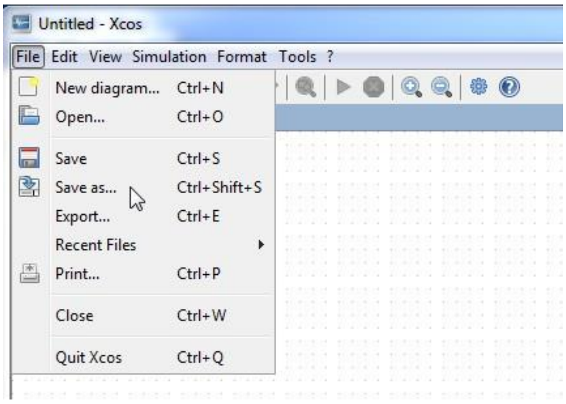
$c = 0.5\ \frac{m}{N}$ – spring constant

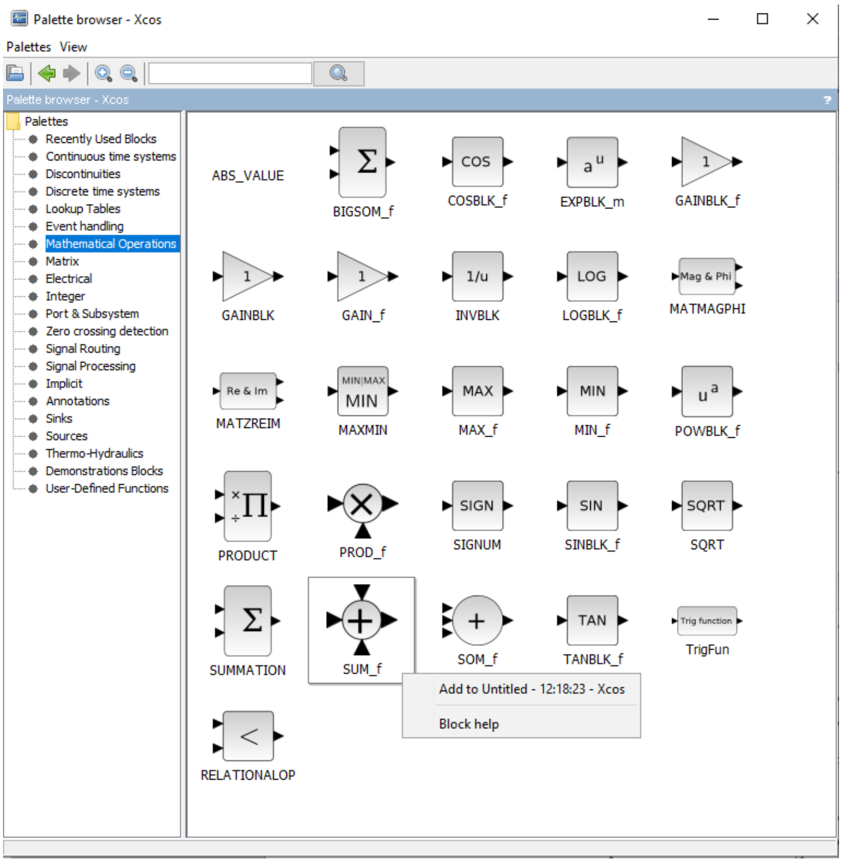
$m = 5\ kg$ – mass

Initial Conditions:

$q_0 = 1\ m$ – initial displacement

$\dot{q}_0 = 3\ m/s$ – initial velocity


Untitled - Xcos
File Edit View Simulation Format Tools ?
New diagram... Ctrl+N
Open... Ctrl+O
Save Ctrl+S
Save as... Ctrl+Shift+S
Export... Ctrl+E
Recent Files
Print... Ctrl+P
Close Ctrl+W
Quit Xcos Ctrl+Q


Palette browser - Xcos
Palettes View
Palettes
Recently Used Blocks
Continuous time systems
Discontinuities
Discrete time systems
Lookup Tables
Event handling
Mathematical Operations
Matrix
Electrical
Integer
Port & Subsystem
Zero crossing detection
Signal Routing
Signal Processing
Implicit
Annotations
Sinks
Sources
Thermo-Hydraulics
Demonstrations Blocks
User-Defined Functions
ABS_VALUE
BIGSOM_f
COSBLK_f
EXPBLK_m
GAINBLK_f
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INVBLK
LOGBLK_f
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MAX_f
MIN_f
POWBLK_f
PRODUCT
PROD_f
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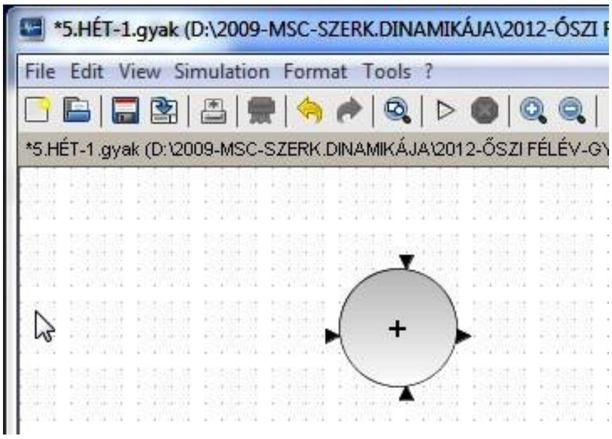
Block help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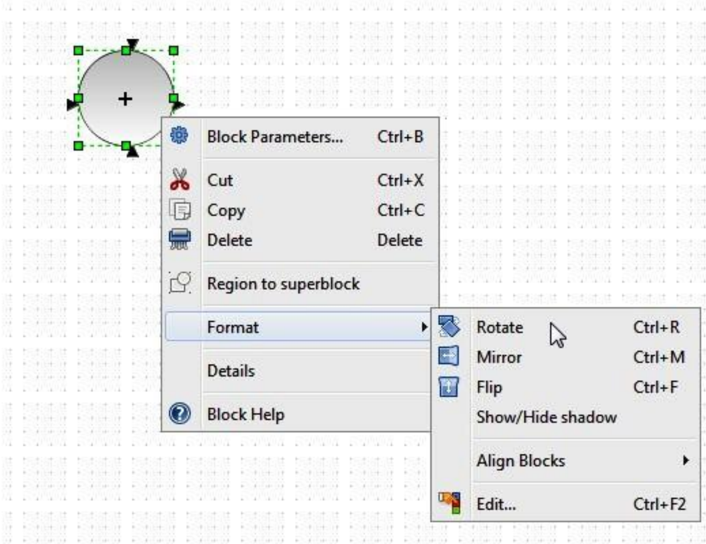
File Edit View Simulation Format Tools ?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Block Parameters... Ctrl+B
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Region to superblock
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Details
Block Help
Rotate Ctrl+R
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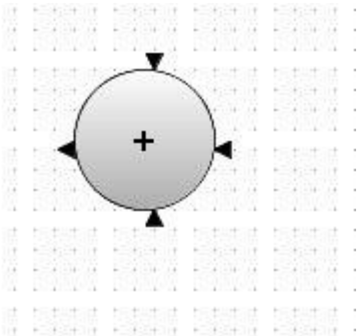
Align Blocks
Edit... Ctrl+F2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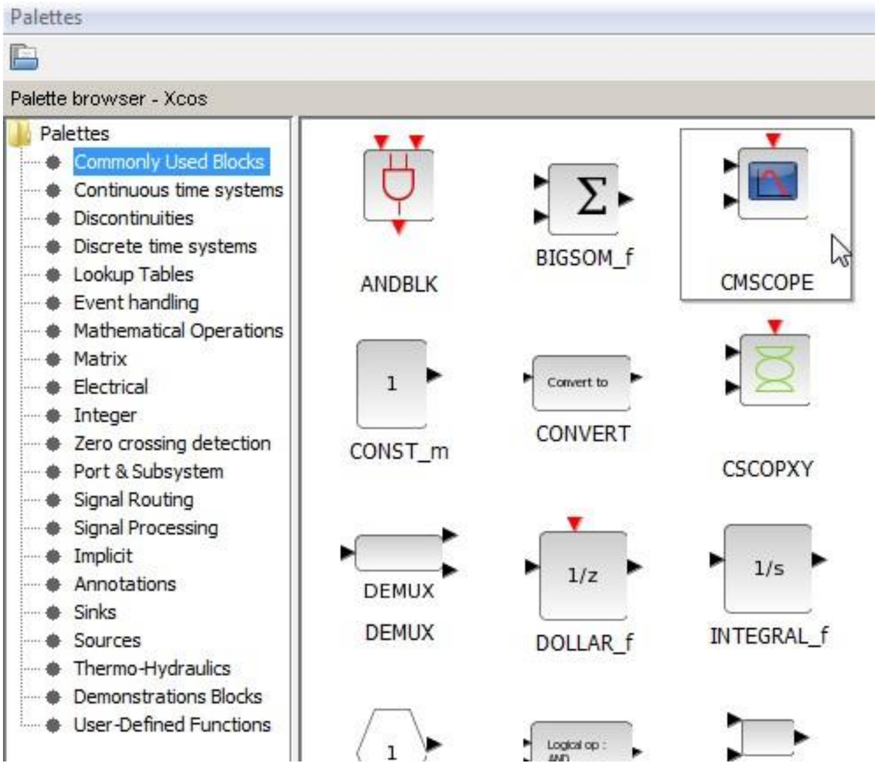
Palettes
Palette browser - Xcos
Palettes
Commonly Used Blocks
Continuous time systems
Discontinuities
Discrete time systems
Lookup Tables
Event handling
Mathematical Operations
Matrix
Electrical
Integer
Zero crossing detection
Port & Subsystem
Signal Routing
Signal Processing
Implicit
Annotations
Sinks
Sources
Thermo-Hydraulics
Demonstrations Blocks
User-Defined Functions
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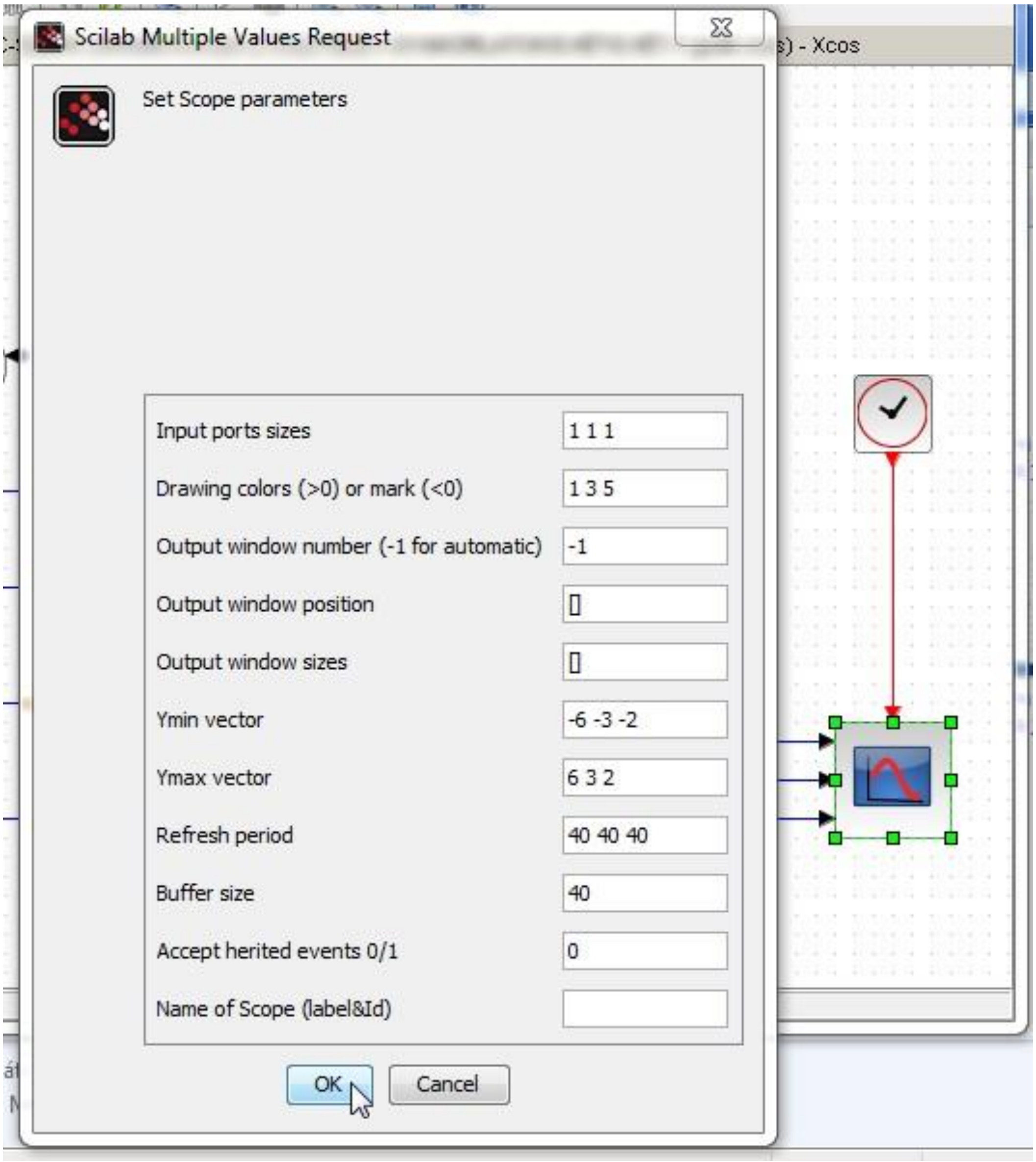
Scilab Multiple Values Request
s) - Xcos
Set Scope parameters
Input ports sizes
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Drawing colors (>0) or mark (<0)
1 3 5
Output window number (-1 for automatic)
-1
Output window position
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Output window sizes
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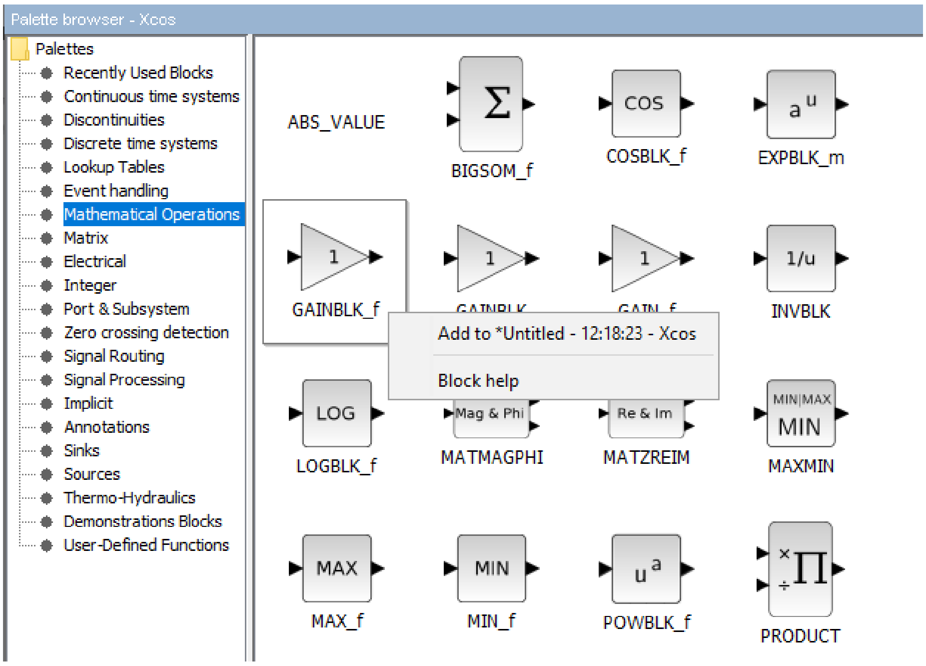
Name of Scope (label&Id)
OK
Cancel


Palette browser - Xcos
Palettes
Recently Used Blocks
Continuous time systems
Discontinuities
Discrete time systems
Lookup Tables
Event handling
Mathematical Operations
Matrix
Electrical
Integer
Port & Subsystem
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Demonstrations Blocks
User-Defined Functions
ABS_VALUE
BIGSOM_f
COSBLK_f
EXPBLK_m
GAINBLK_f
INVBLK
Add to *Untitled - 12:18:23 - Xcos
Block help
LOGBLK_f
MATMAGPHI
MATZREIM
MAXMIN
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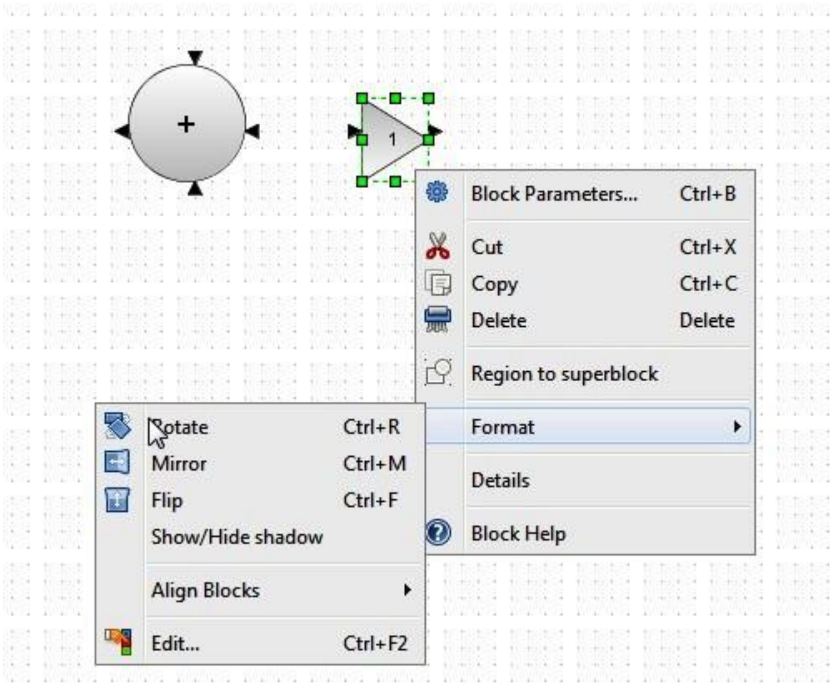
MIN_f
POWBLK_f
PRODUCT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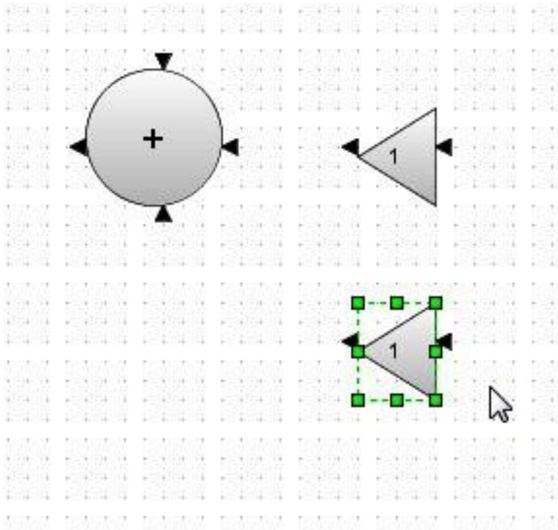
Align Blocks
Edit... Ctrl+F2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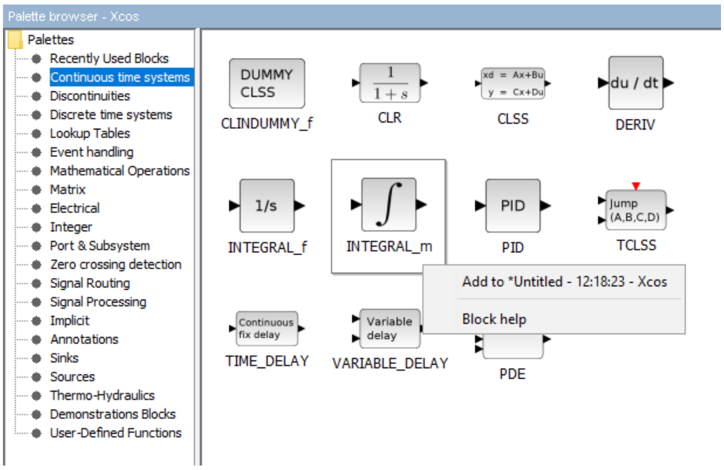
Palette browser - Xcos
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Discontinuities
Discrete time systems
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Demonstrations Blocks
User-Defined Functions
DUMMY CLSS
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CLR
CLSS
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DERIV
1/s
INTEGRAL_f
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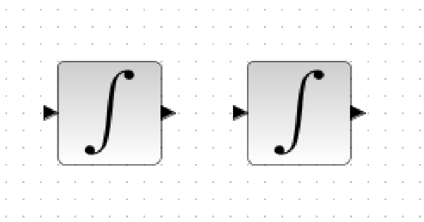

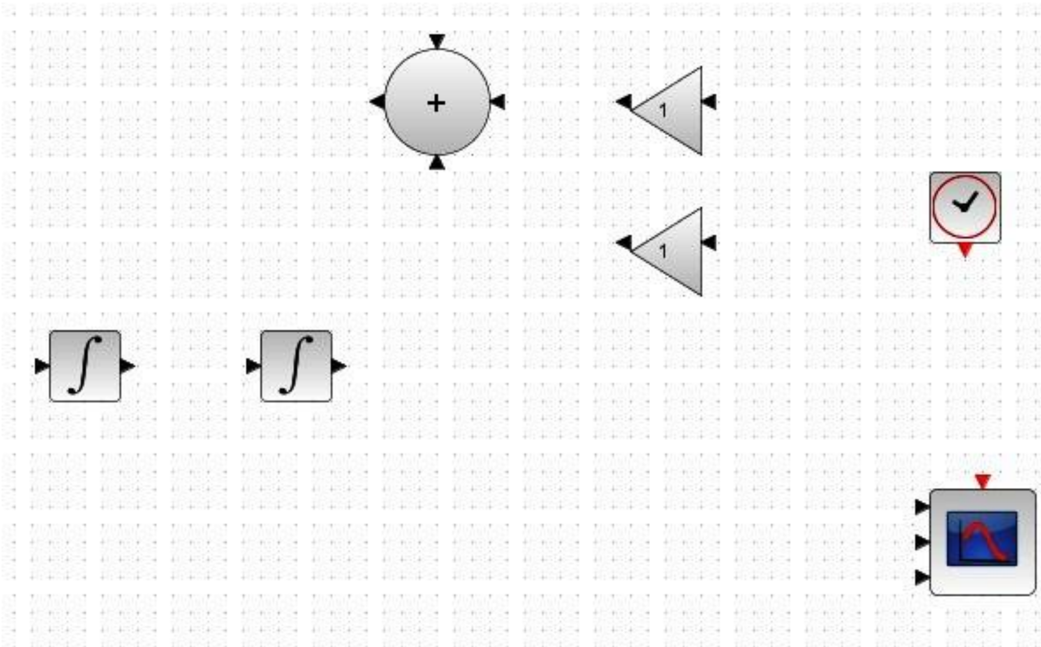
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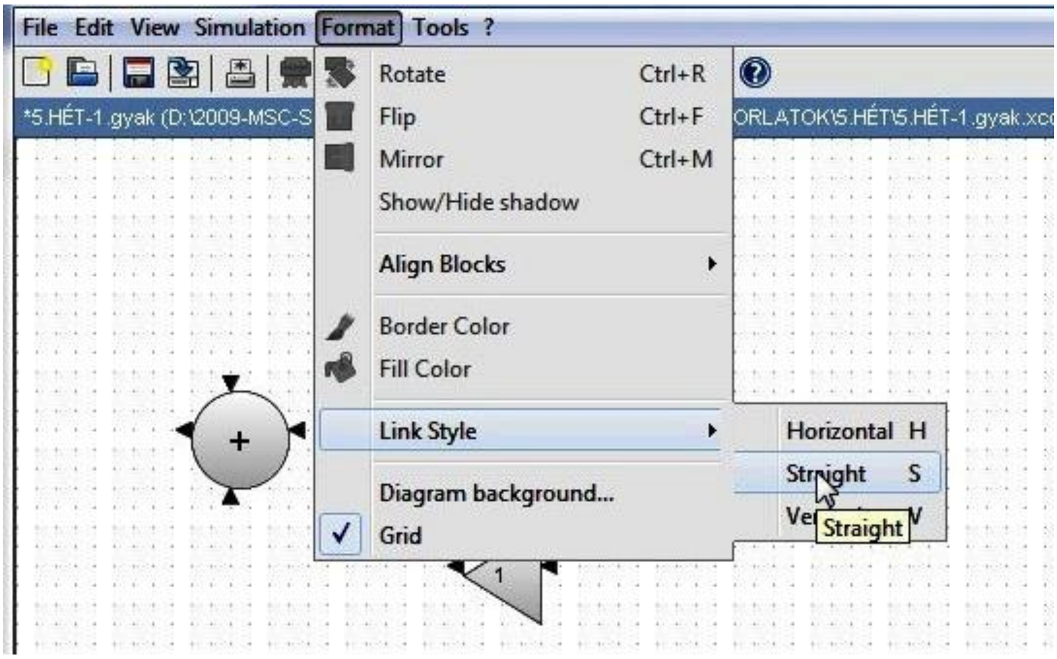
File Edit View Simulation Format Tools ?
Rotate Ctrl+R
Flip Ctrl+F
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Show/Hide shadow
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Diagram background...
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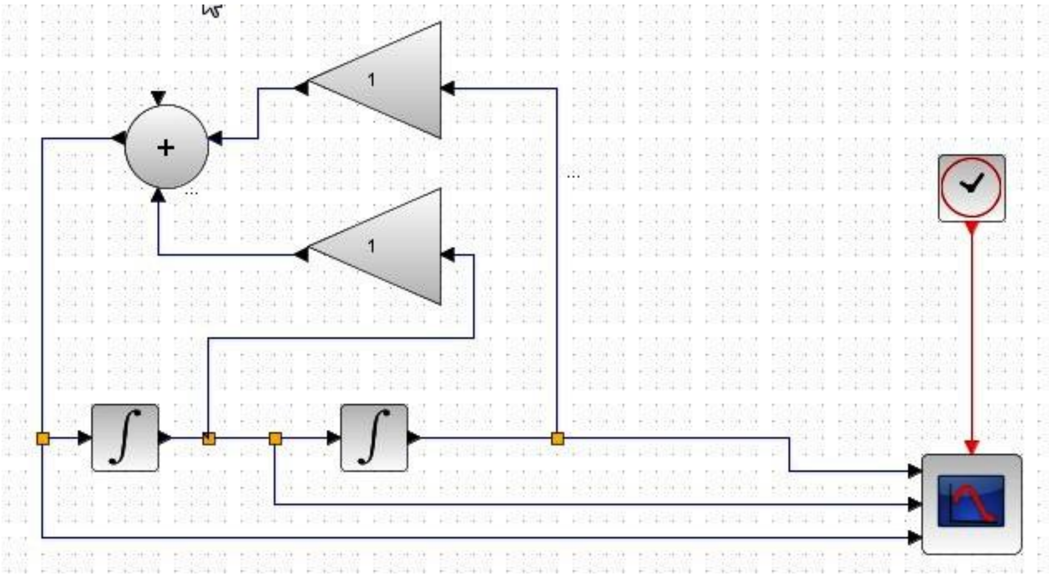
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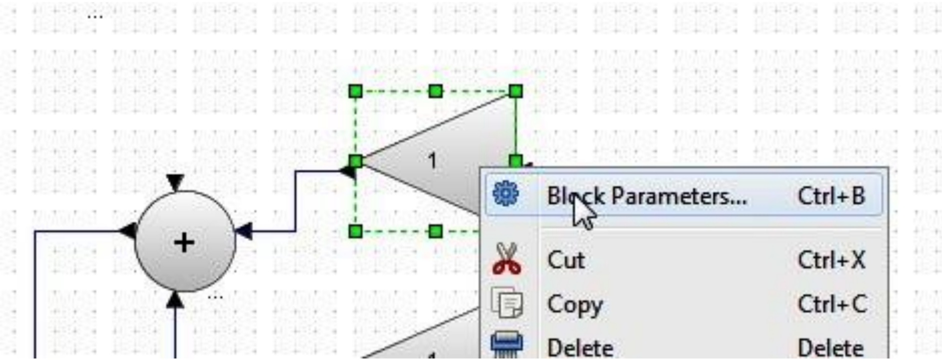
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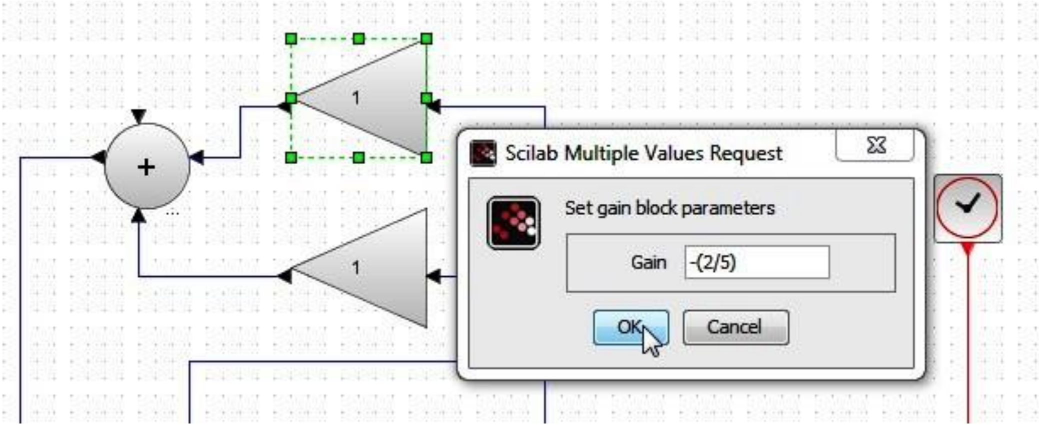
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Scilab Multiple Values Request
Set gain block parameters
Gain
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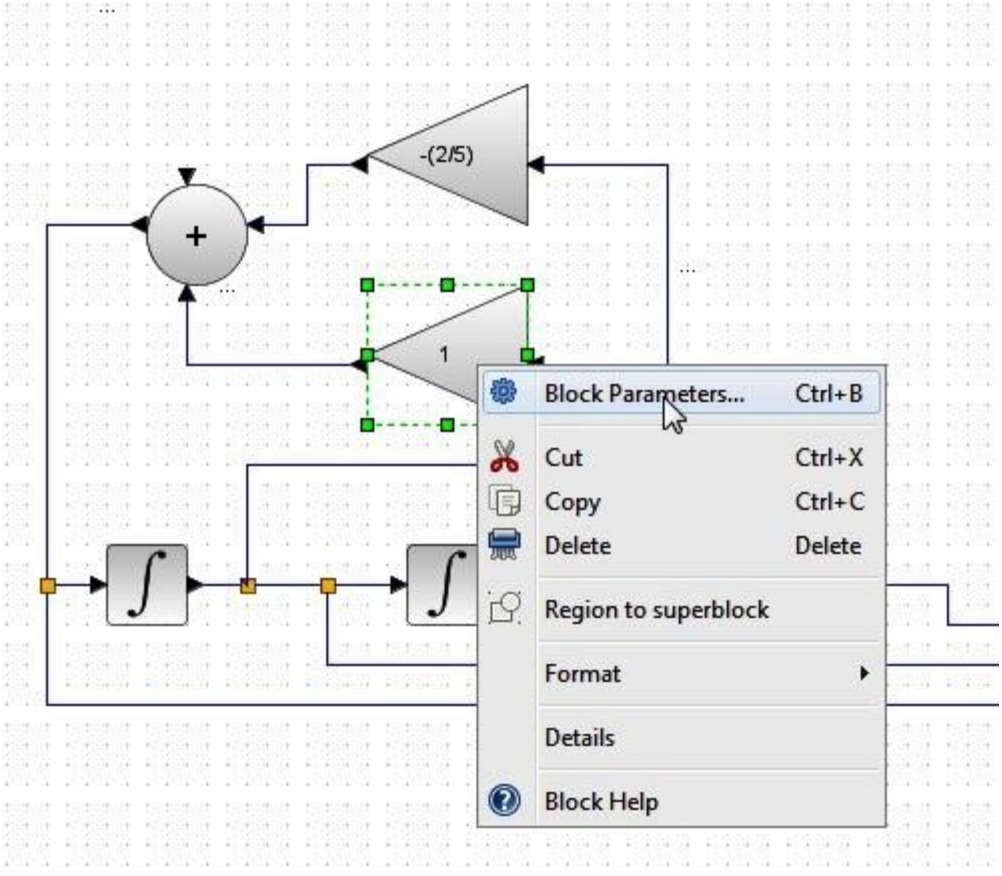
OK
Cancel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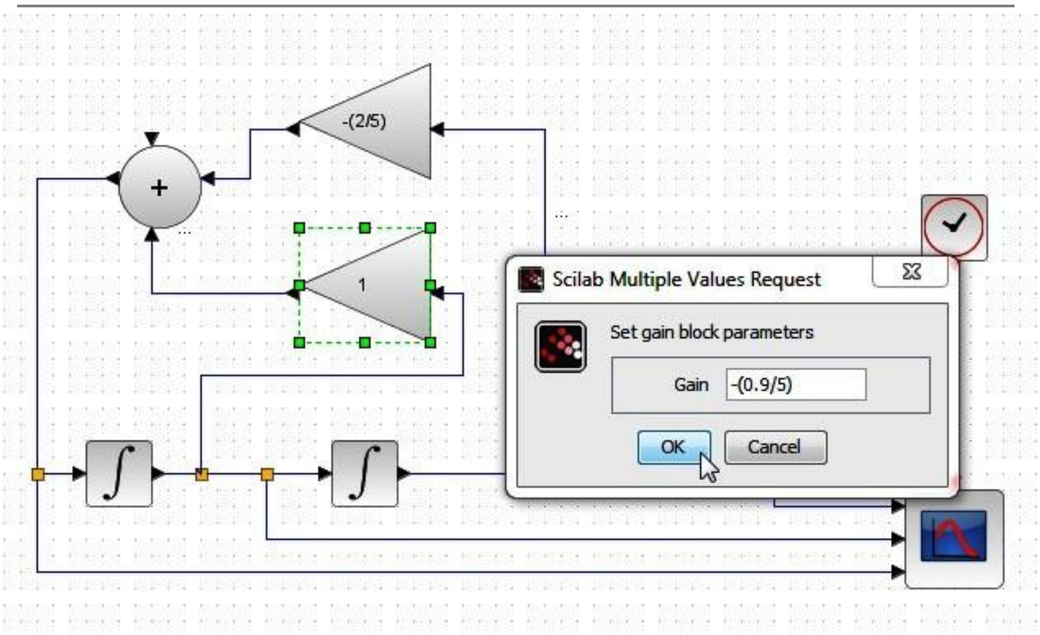
Region to superblock
Format
Details
Block Help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Scilab Multiple Values Request
Set gain block parameters
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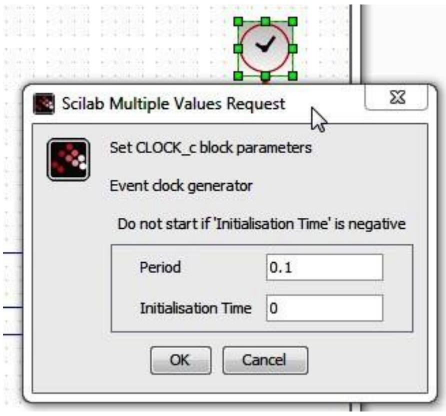
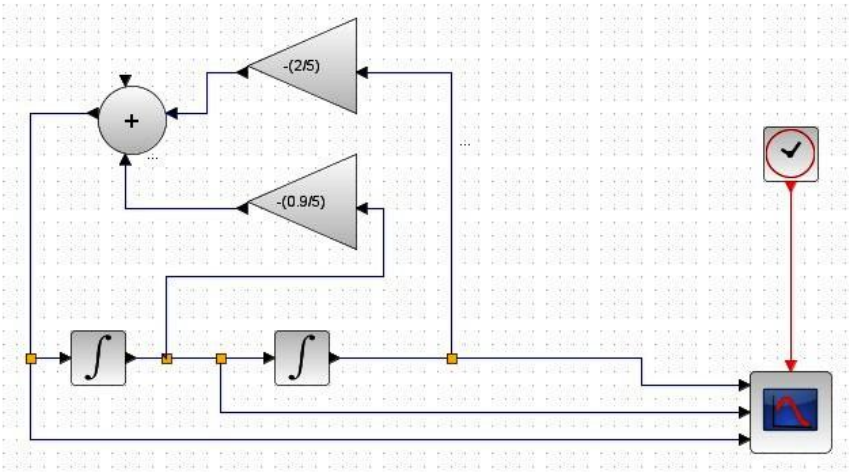
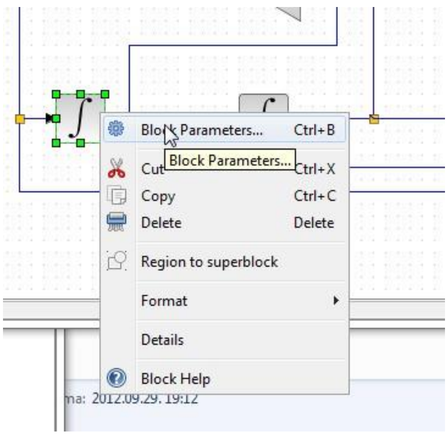
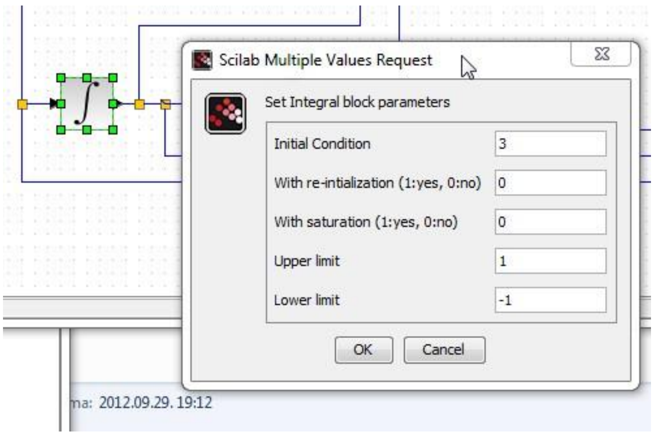


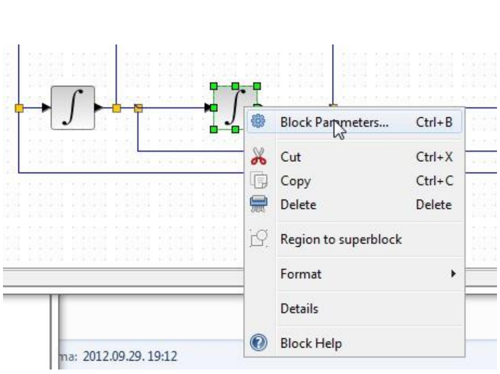


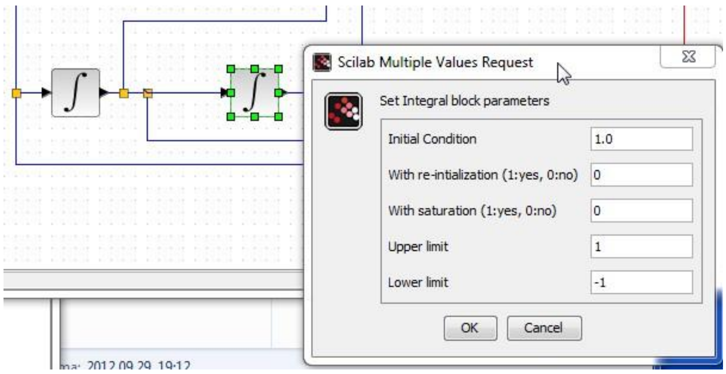
Initial velocity: 3 (m/s)



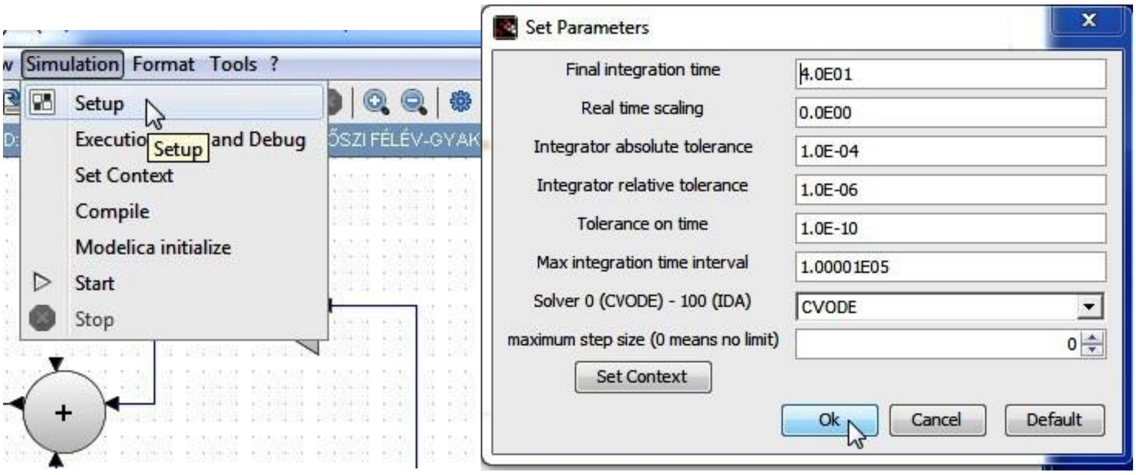


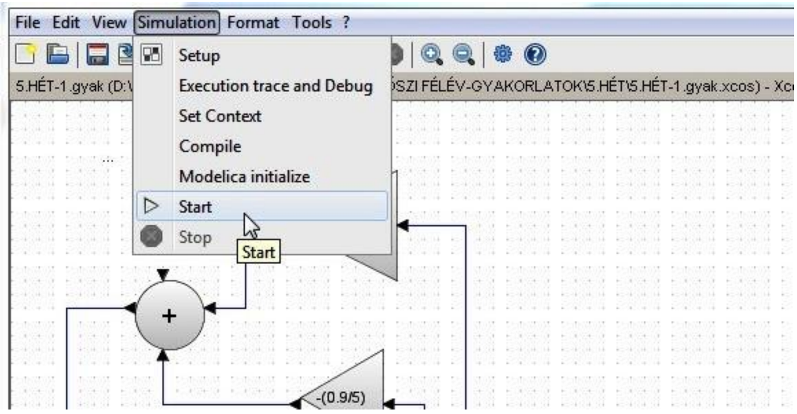
Initial displacement: 1 (m)

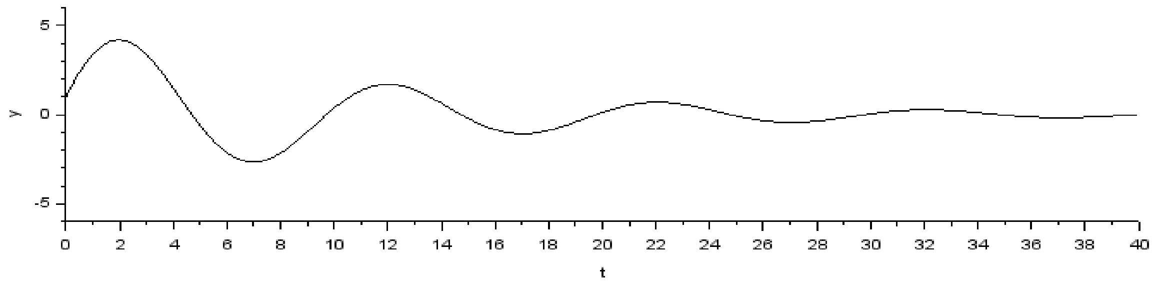


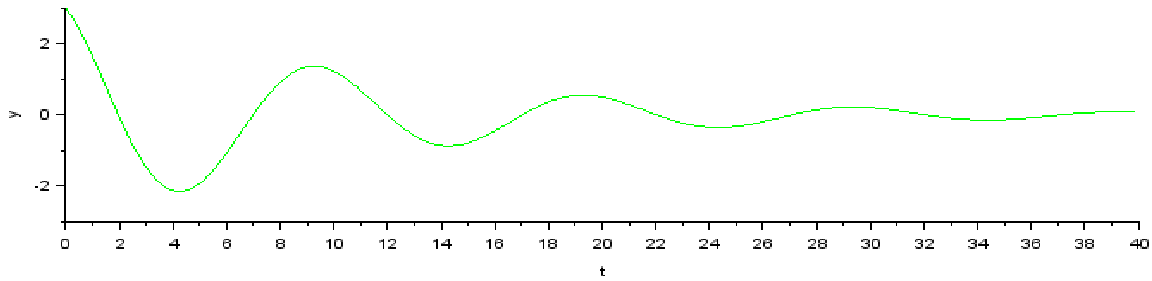


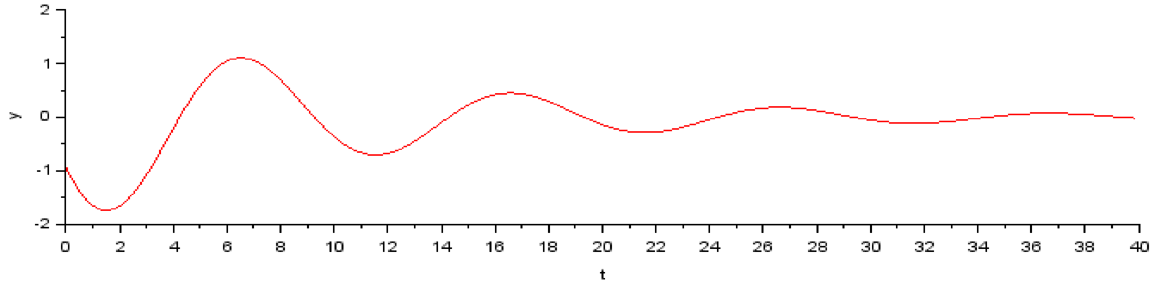
Final integration time: 40 (s)



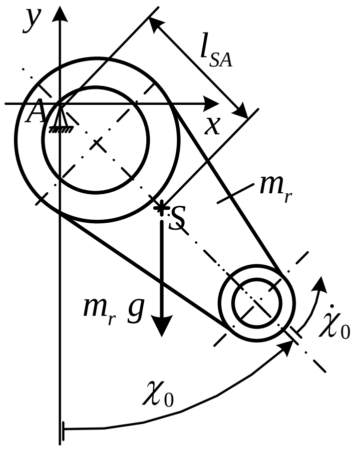








5/2 Exercise – Physical Pendulum (Xcos)



$$J_{AZ}\,\ddot{\chi} = -l_{SA}\, m_r\, g\, sin\chi$$

$$\ddot{\chi} = -\frac{l_{SA}\, m_r\, g}{J_{AZ}} sin\chi \quad (rad/s^2) \quad \text{angular acceleration}$$

$$l_{SA} = 0{,}15\ m \qquad J_{AZ} = 0{,}05\ kgm^2$$

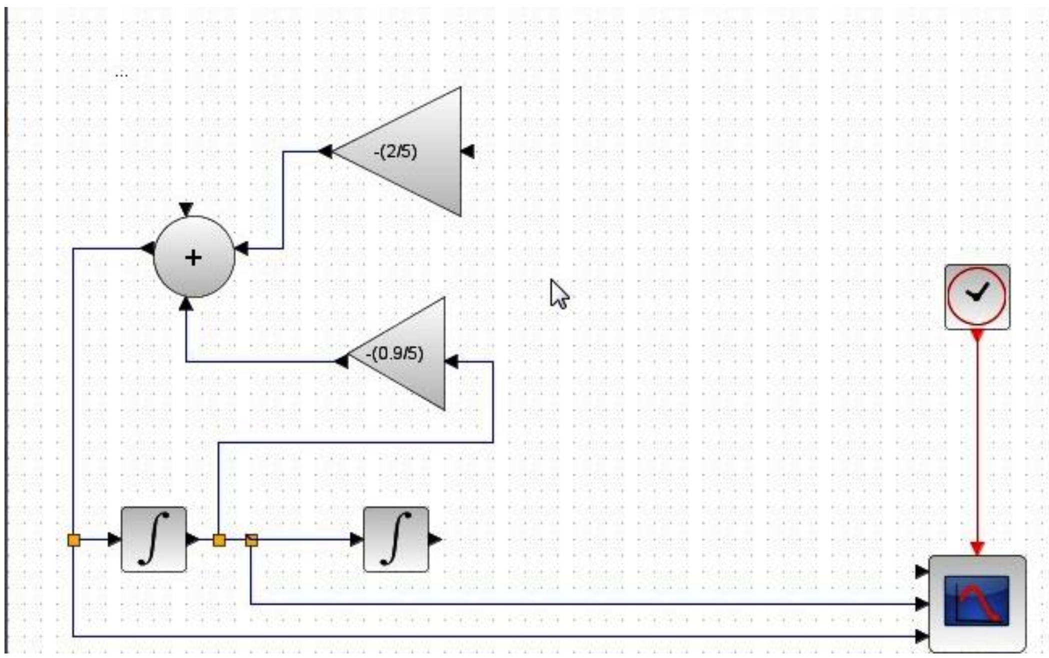
$$m_r = 0{,}45\ kg \qquad g = 10\ \frac{m}{s^2}$$

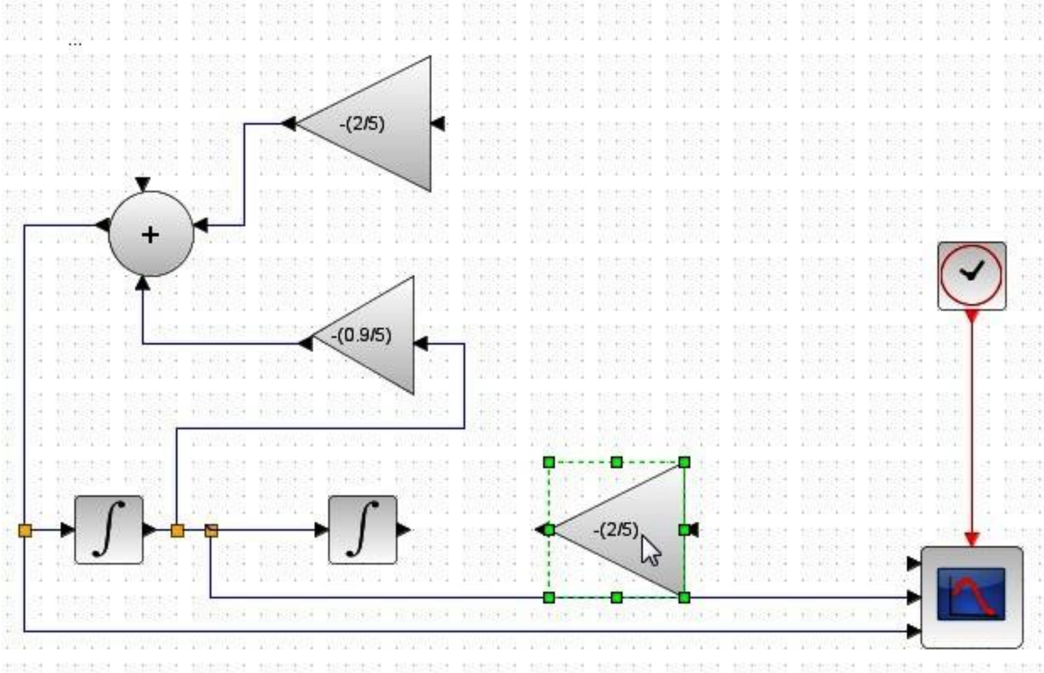
Initial Conditions:

$\chi_0 = 120^\circ$ – initial angle

$\dot{\chi}_0 = 0{,}5\ \frac{rad}{s}$ – initial angular velocity

Let's modify the previous xcos model as it is in the pictures below and save the new model.

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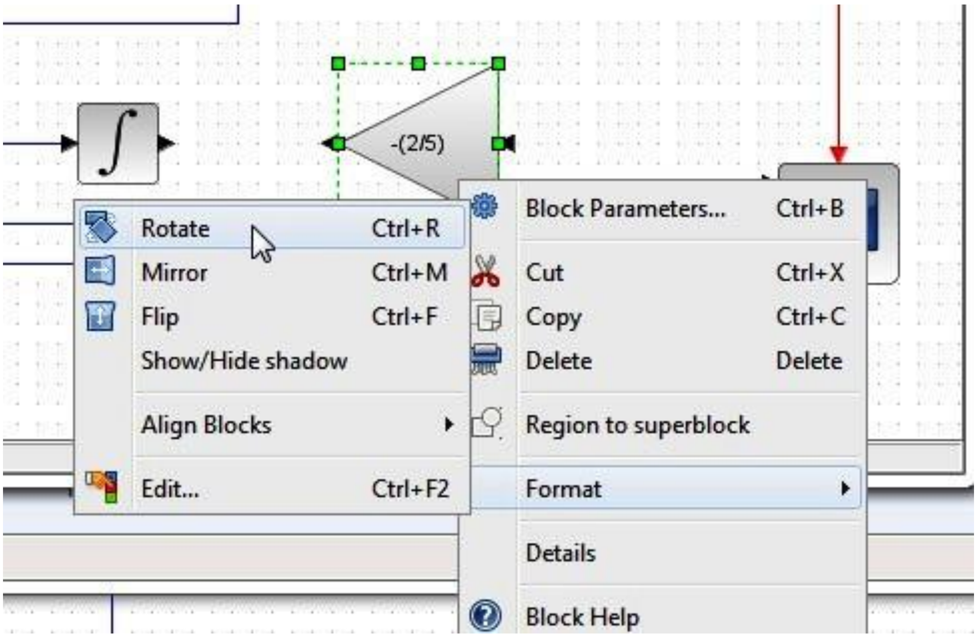
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Rotate Ctrl+R
Mirror Ctrl+M
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Show/Hide shadow
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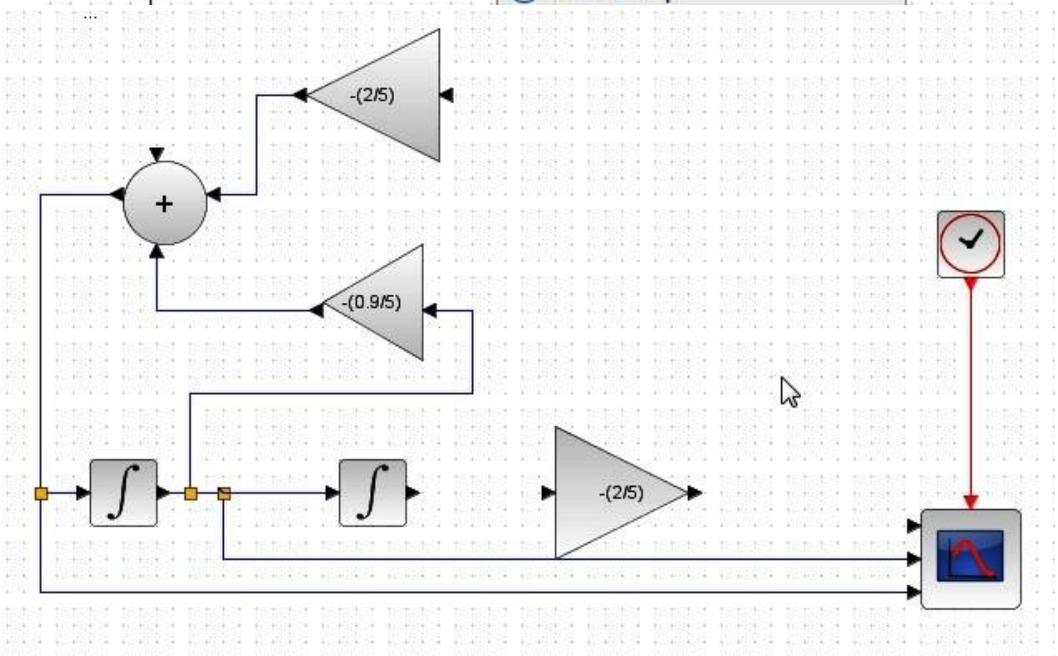
Edit... Ctrl+F2
Block Parameters... Ctrl+B
Cut Ctrl+X
Copy Ctrl+C
Delete Delete
Region to superblock
Format
Details
Block Help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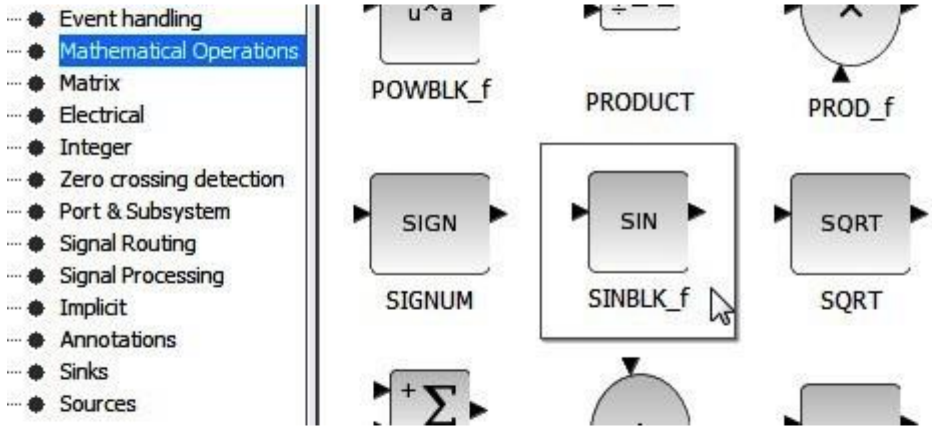
Event handling
Mathematical Operations
Matrix
Electrical
Integer
Zero crossing detection
Port & Subsystem
Signal Routing
Signal Processing
Implicit
Annotations
Sinks
Sources
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POWBLK_f
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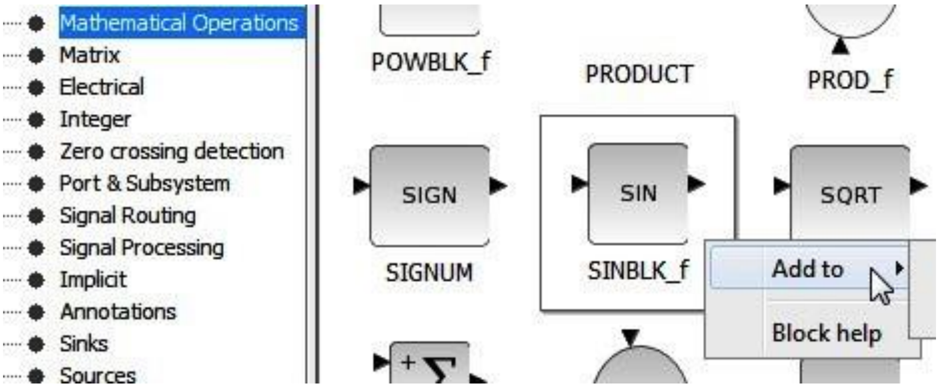
Mathematical Operations
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Zero crossing detection
Port & Subsystem
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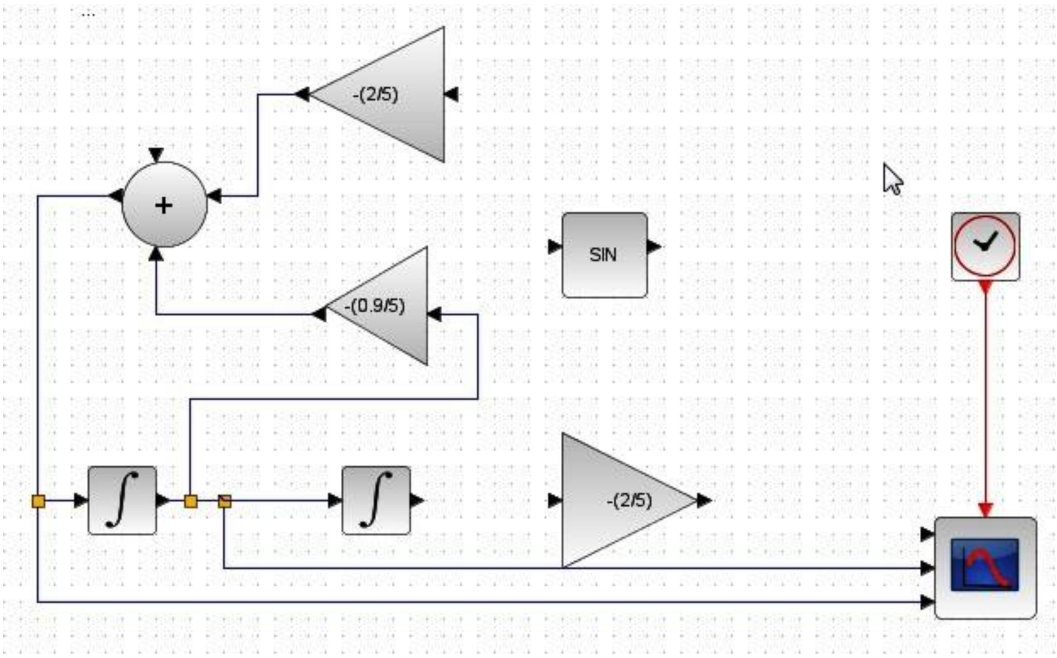
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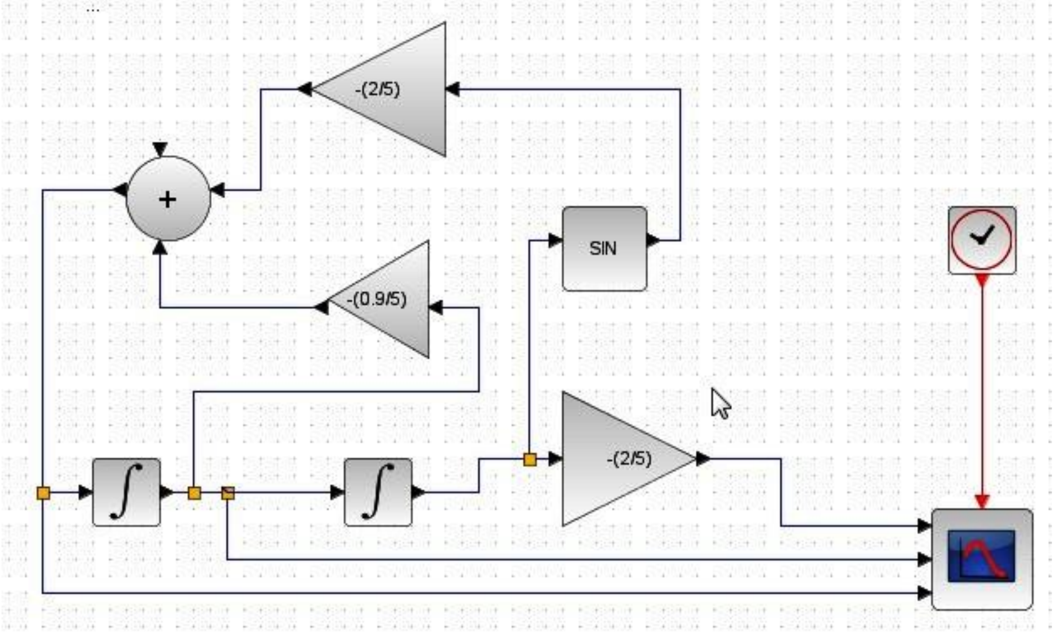
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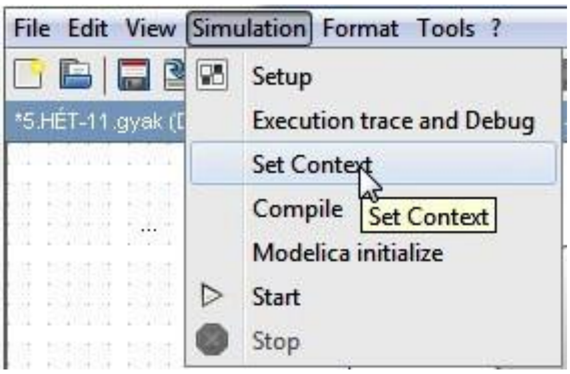
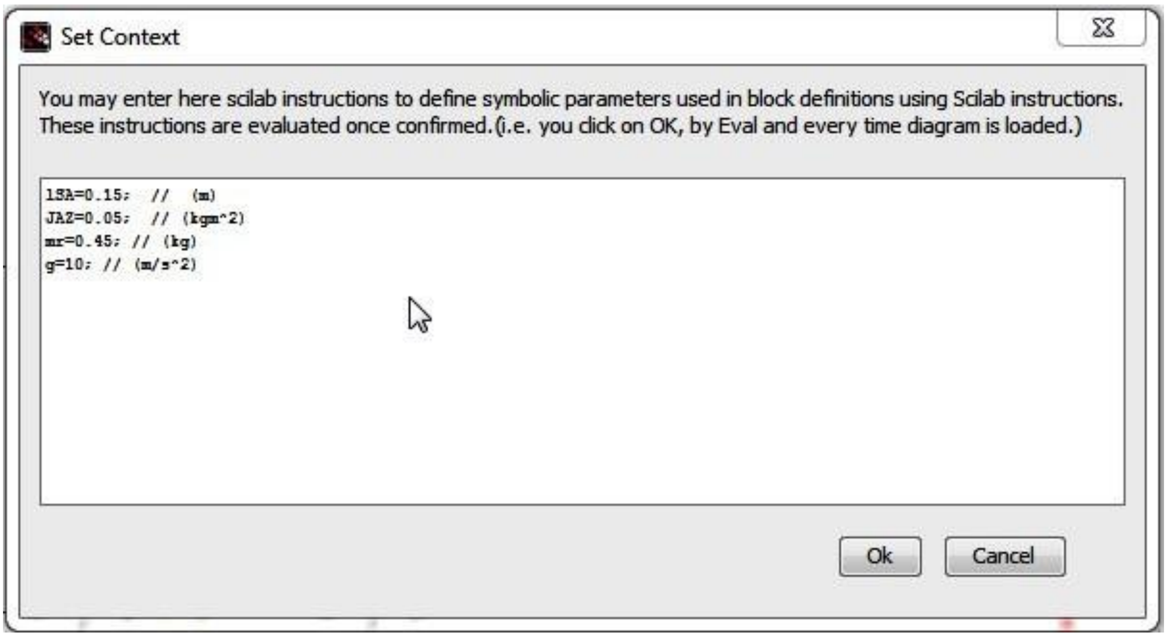
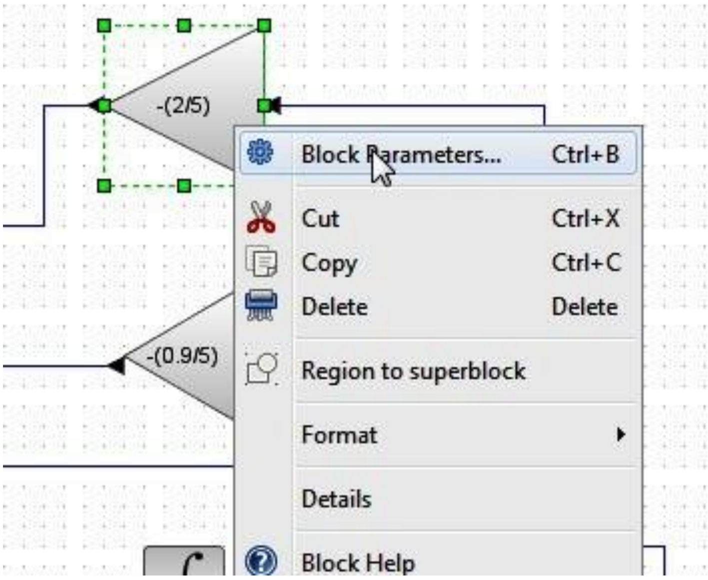

File Edit View Simulation Format Tools ?
*5.HÉT-11.gyak (D
Setup
Execution trace and Debug
Set Context
Compile
Set Context
Modelica initialize
Start
Stop


Set Context
You may enter here scilab instructions to define symbolic parameters used in block definitions using Scilab instructions.
These instructions are evaluated once confirmed.(i.e. you click on OK, by Eval and every time diagram is loaded.)
lSA=0.15; // (m)
JAZ=0.05; // (kgm^2)
mr=0.45; // (kg)
g=10; // (m/s^2)
Ok
Cancel


-(2/5)
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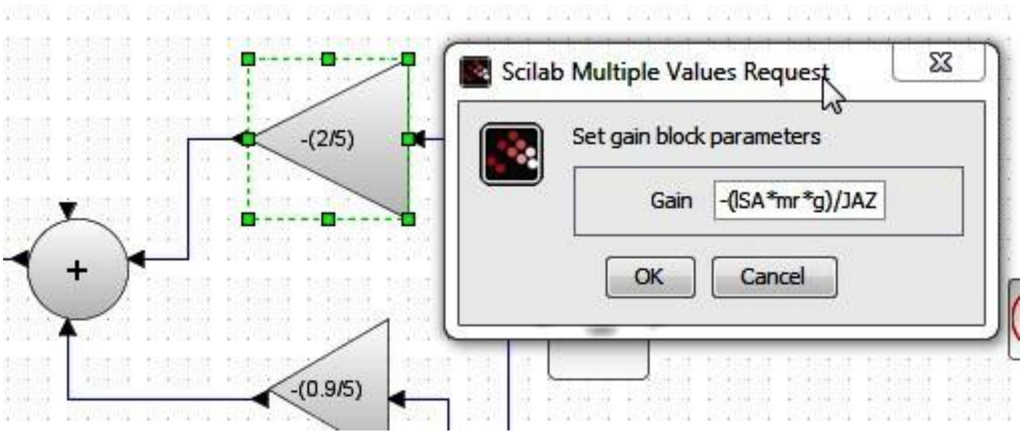
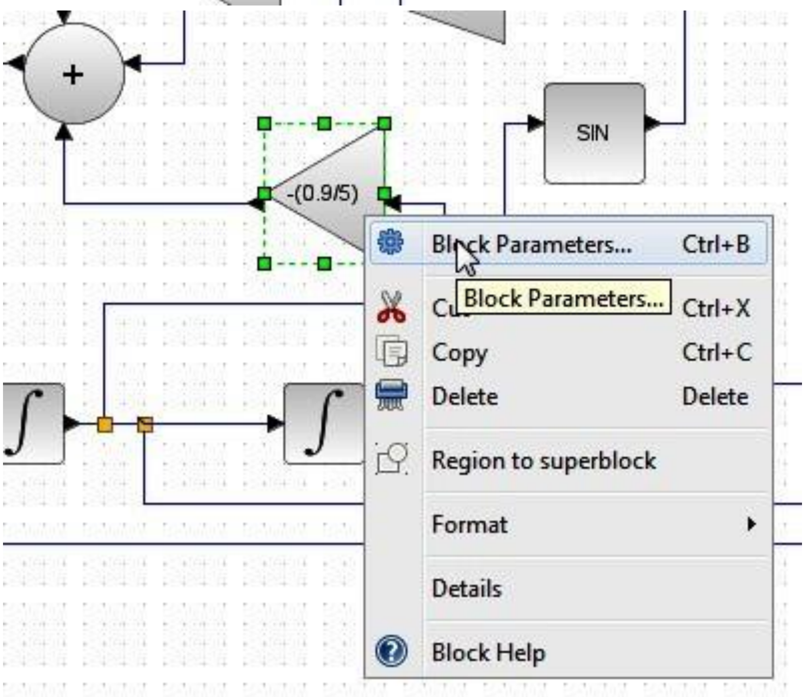
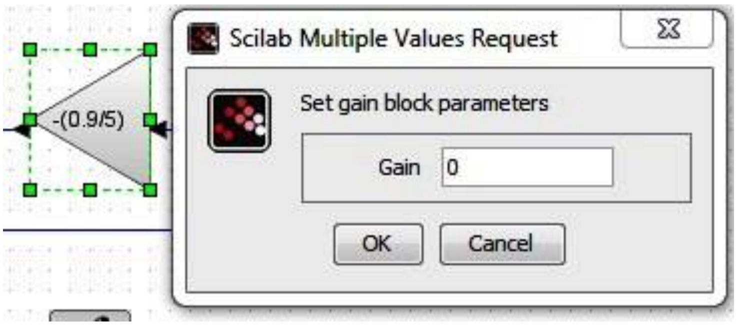
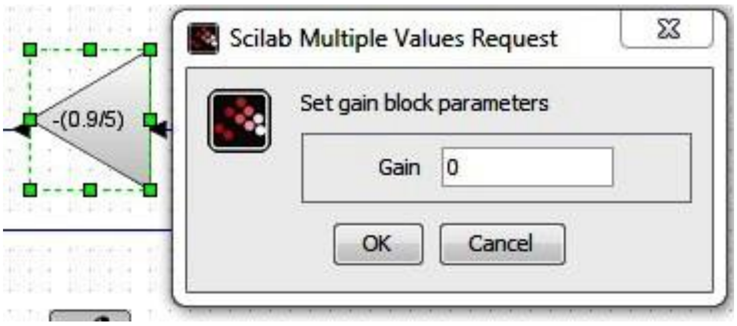
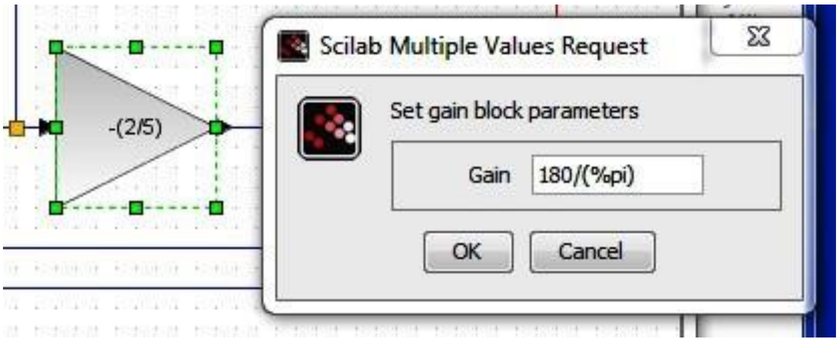
Block Parameters... Ctrl+B
Cut Ctrl+X
Copy Ctrl+C
Delete Delete
Region to superblock
Format
Details
Block Help


-(2/5)
-(0.9/5)
Scilab Multiple Values Request
Set gain block parameters
Gain
-(ISA*mr*g)/JAZ
OK
Cancel

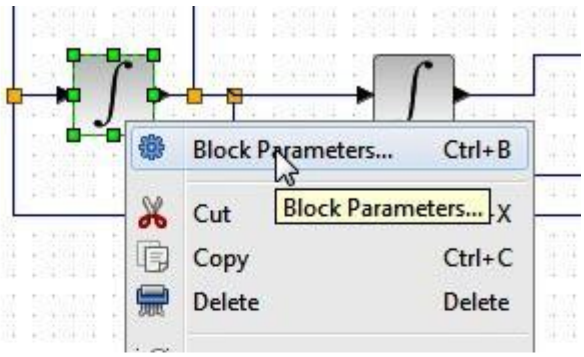

SIN
-(0.9/5)
Block Parameters... Ctrl+B
Block Parameters...
Ctrl+X
Copy Ctrl+C
Delete Delete
Region to superblock
Format
Details
Block Help

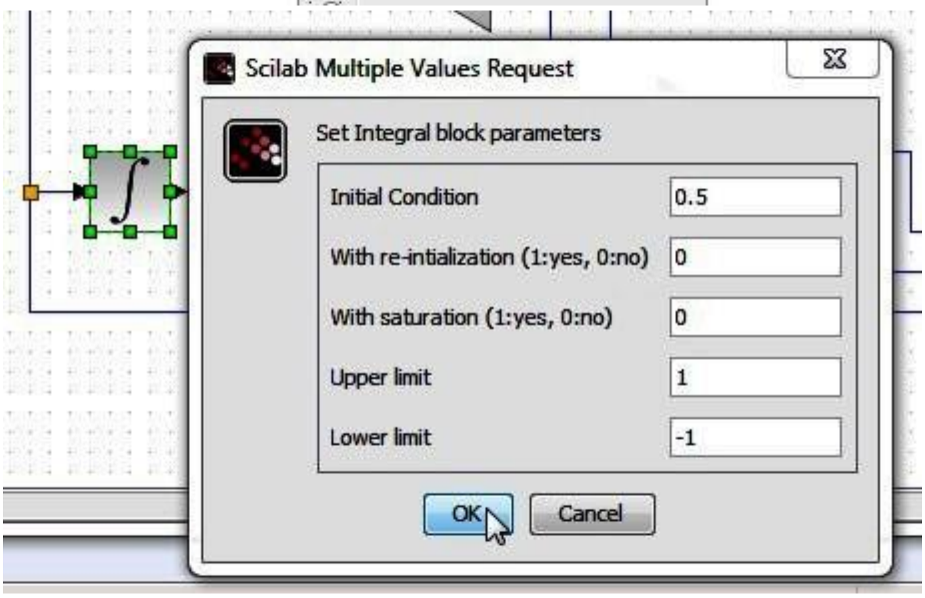




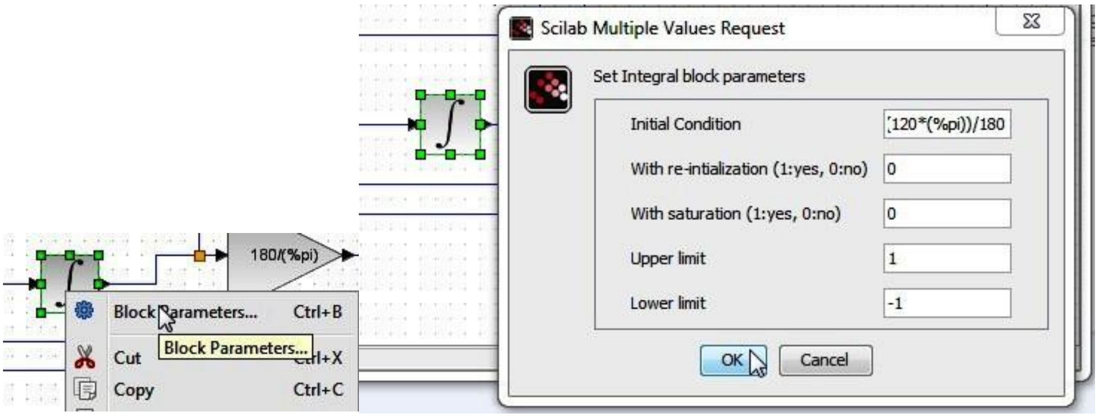


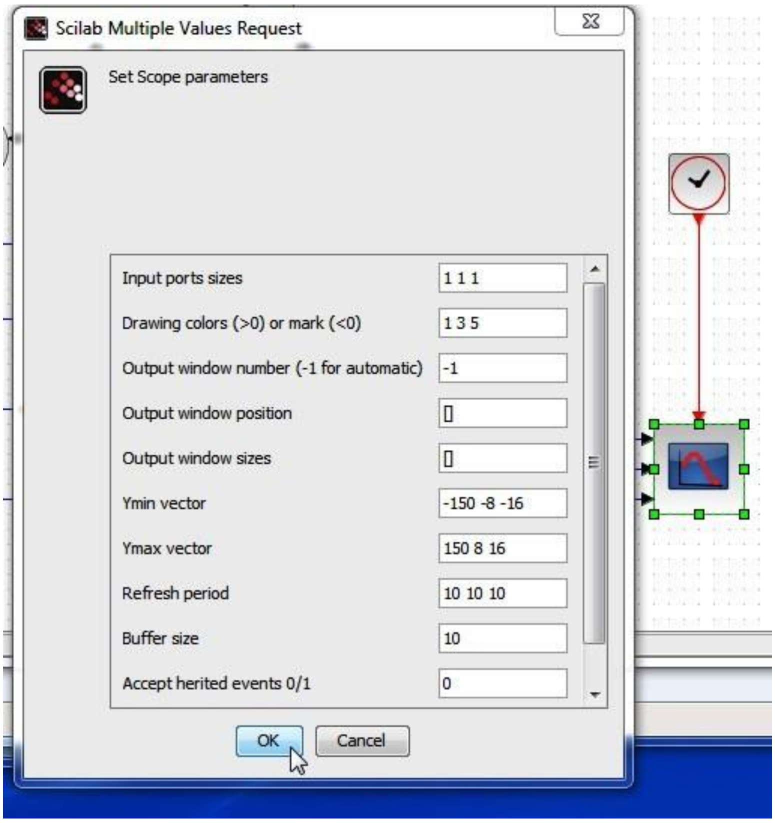
Initial angular velocity: 0.5 (rad/s)

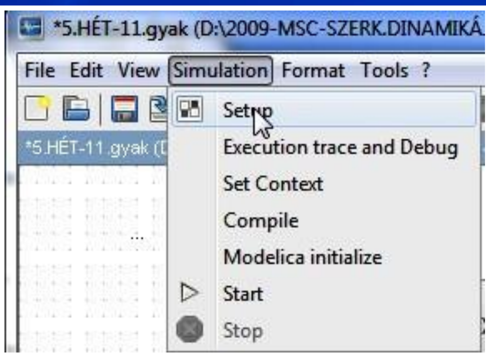




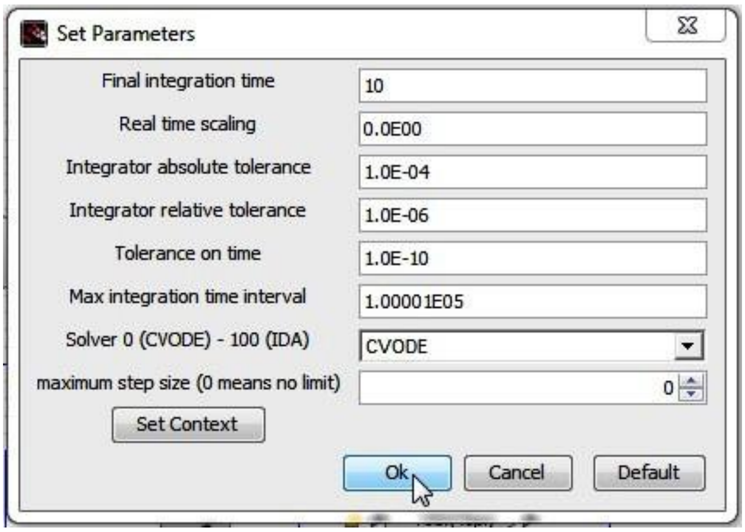
Inital angle: 120 degrees = 120*π/180 rad

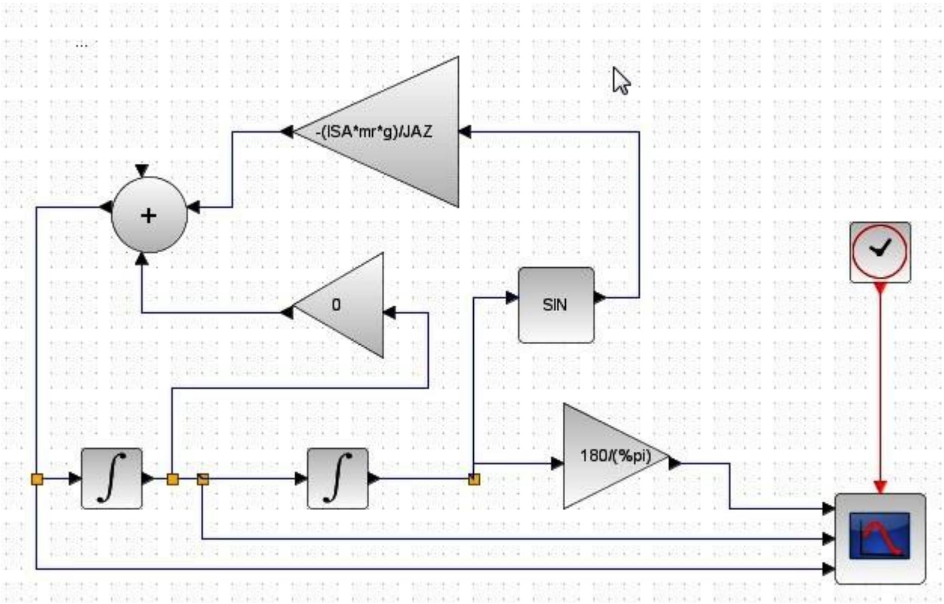




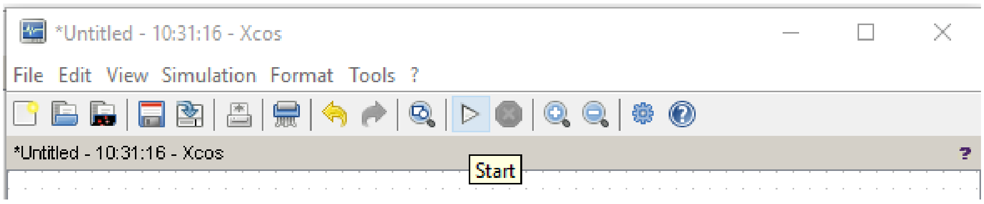


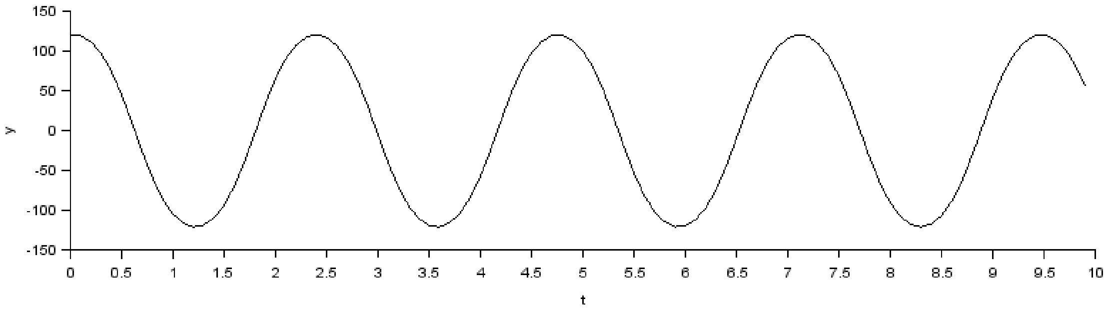
Final integration time: 10 (s)

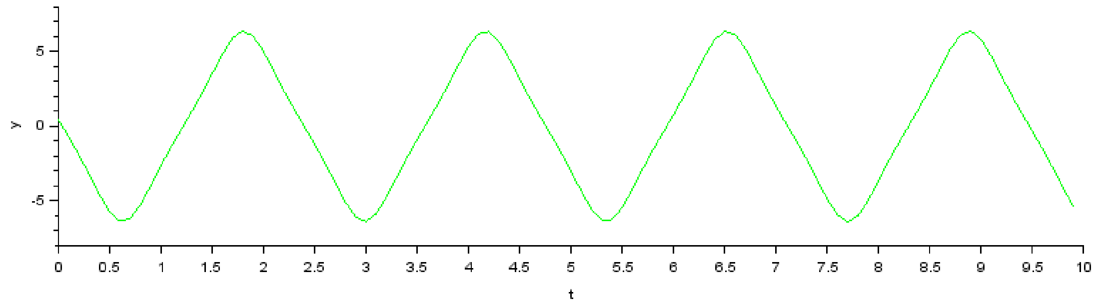


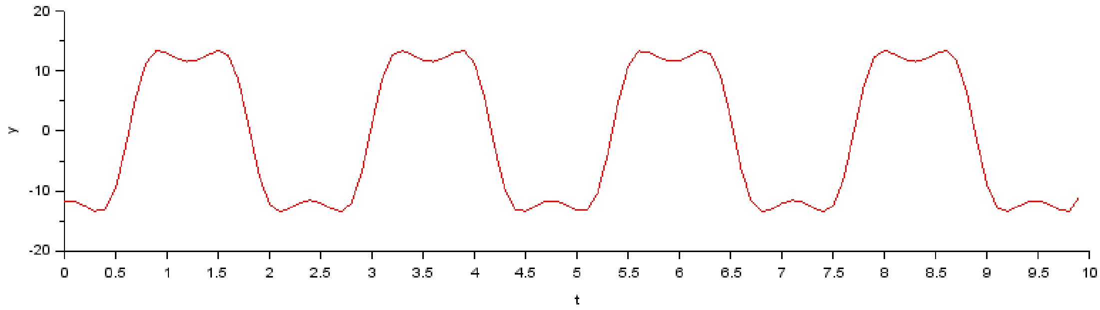


Run the xcos model:




150
100
50
0
-50
-100
-150
y
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
t


5
0
-5
y
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
t


20
10
0
-10
-20
y
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
t