# Spring Mass Damper System with Activate

The student is asked to model a dynamical mass-spring-damp system through the block-based graphical approach. For these exercises in class the student needs to install ACTIVATE on his/her laptop.

Theoretical References

For a mass-spring-damper linear system, the second order differential equation which describes the model is $m\ddot{x} + c\dot{x} + kx = F\sin(\omega t)$
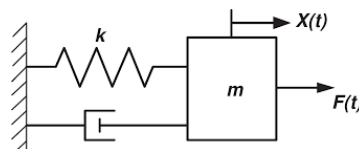

In the graphical approach (usually know as 1D modelling), it's convenient to rewrite the differential equation, in order to solve it for the highest order derivative term. This means:

$$\ddot{x} = \frac{F\sin(\omega t) - c\dot{x} - kx}{m}$$

As it will be shown afterwards, with this approach the system is modeled connecting different blocks, instead of writing a script (as we did in the Euler's method chapter).
The graphical approach is divided in 2 sub-classes: signal-based and physical-based.
In the signal-based modelling the blocks which are connected represent elementary mathematical operations (sum, product, integration...) that allow us to describe the math behind the physics of the system.
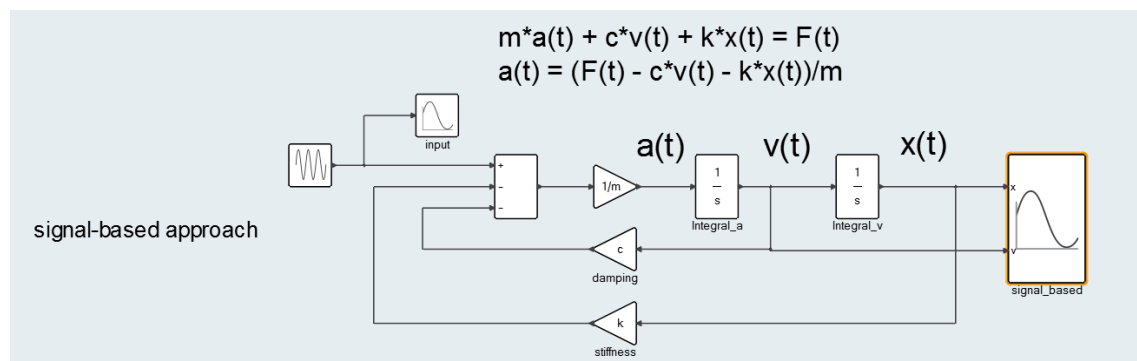
Instead in the physical-based approach, the blocks are called components and they represent real physical components (spring, mass, transducer…) or physical properties (damping, force...). So, with this approach we describe the physics of the system without analyzing the math.

physical-based approach
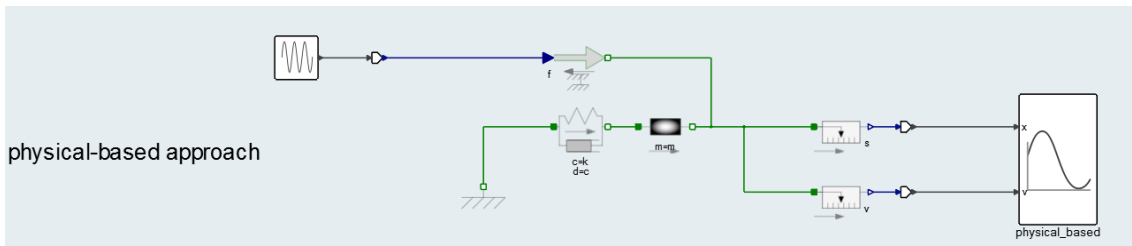
We can freely choose which approach to use (Compose scripts, signal-based blocks or physical-based blocks), because they are all equivalent.

Activate Implementation

Typically, the graphical approach doesn't require to write scripts, but if we want to create **parametric** (and numeric) examples we have to use small scripts to define the variables (parameters) which are then employed inside blocks.
Let's use the same data of the Euler's method for the definition of our variables.

```
% variables initialization
x = 1.0;          %m
v= 0.0;           %m/s
% constants
Tmax= 10.0;       %s
Fo = 50;          %N
m = 10;           %kg
f = 1.6;          %s^(-1)
c = 3.6;          %N/(m/s)
k= 100;           %N/m
```
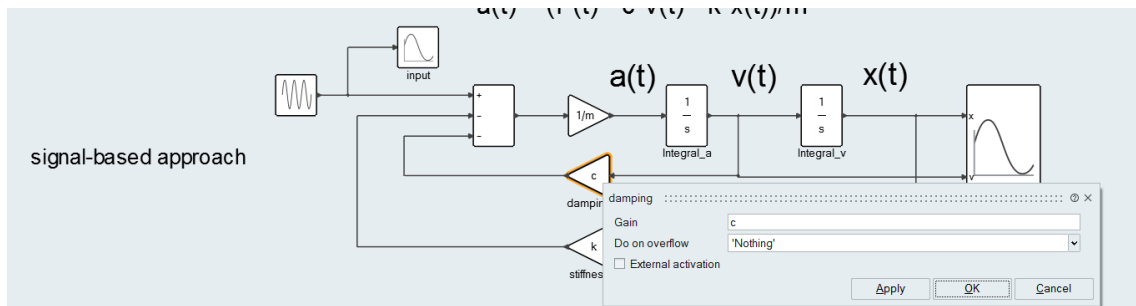
Some notes:

Inputs are defined inside the Editor "Initialization", clicking on model icon:
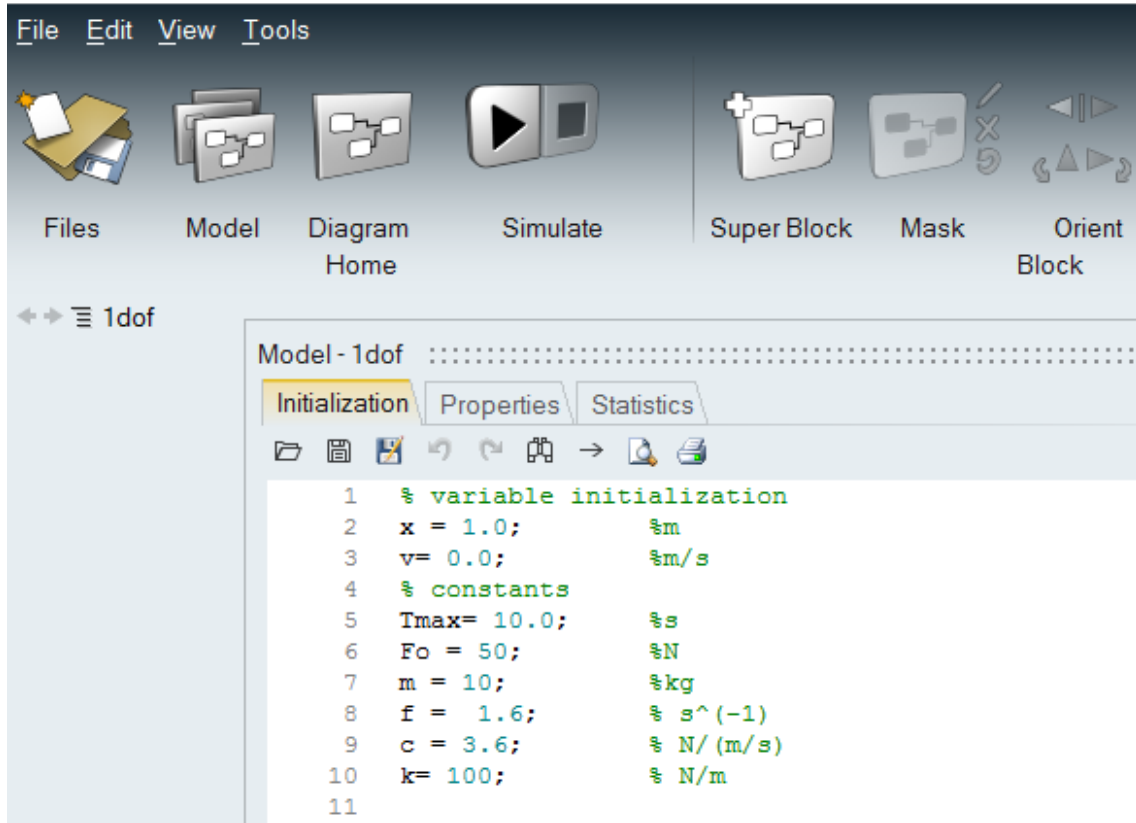
Simulation parameters are defined hovering over the simulate item and clicking on the icon which pops out:
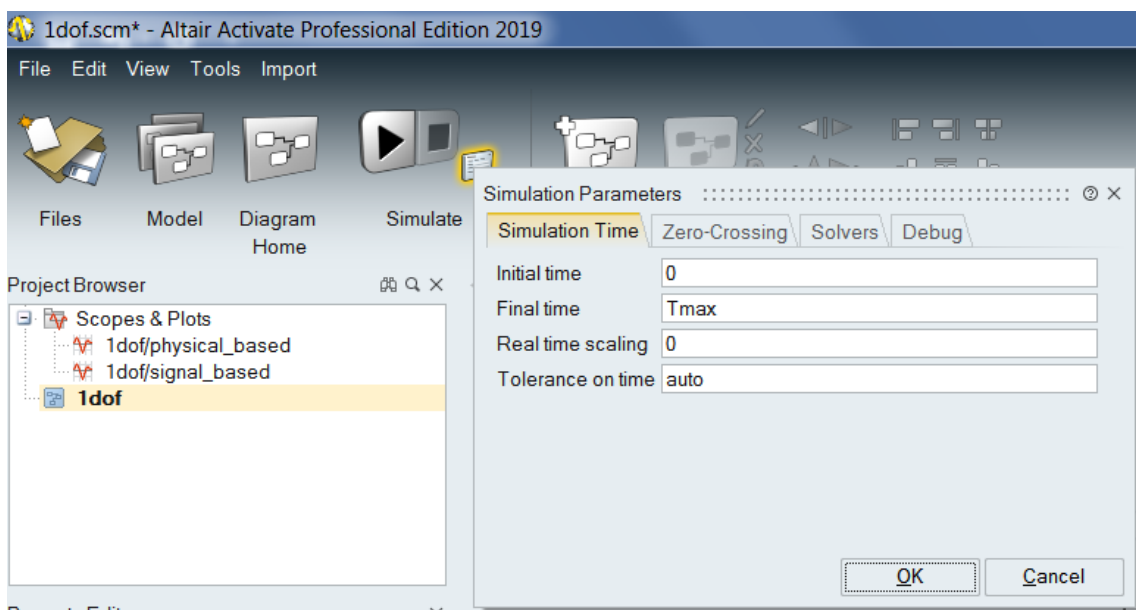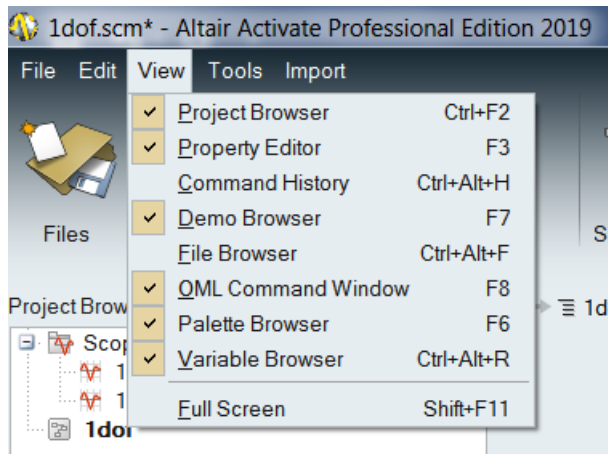
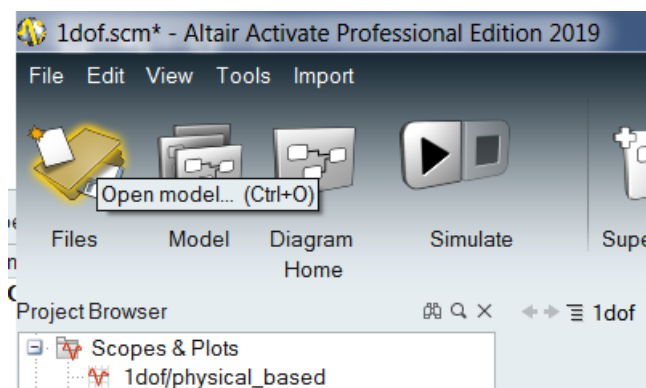Block parameters are defined double clicking on blocks:

To use Activate:

1. Run Activate
2. under tab "View" tick the features we want to enable. Here the most common ones:


3. Open the file 1dof.scm

4. Run the model 1dof.scm (Clicking on the button Start in the Editor toolbar)
5. we should obtain the plots of speed and displacement (as we are considering a forced system the homogeneous reponse evanishes in a certain time and the solution is at

this point only determined by the particular integral.Try to change some parameters value to better see it)

Result:

Double clicking on the Scope block:
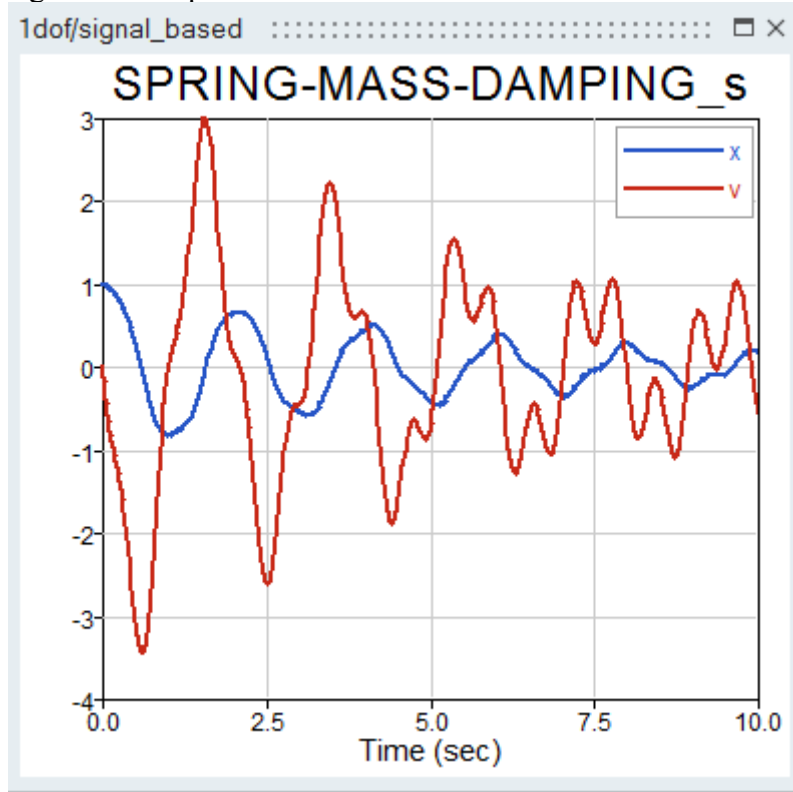
To zoom we can select the interested area keeping the mouse-wheel pressed.

Exercise 1

Modify the model in order to obtain the displacement of the system with these properties:

Initial conditions:
$x_0 = 0.0$ [m]
$v_0 = 2.0$ [m/s]
Harmonic force:
$F_0 = 3$ [N],
Frequency = 4 [Hz]
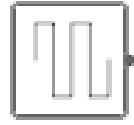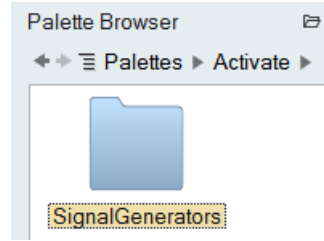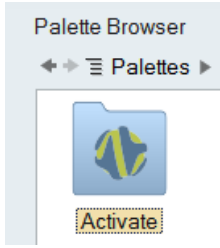System:
damping = 4 [N/(m/s)]
stiffness = 80 [N/m]
mass = 10 [kg]

Exercise 2

Same data of exercise 1 (solved) but this time the external force is a square-wave with amplitude $F_0 = 20$ [N] and frequency = 0.1 [Hz], and the stiffness is 180 [N/m].
Set the simulation time to 20 seconds.
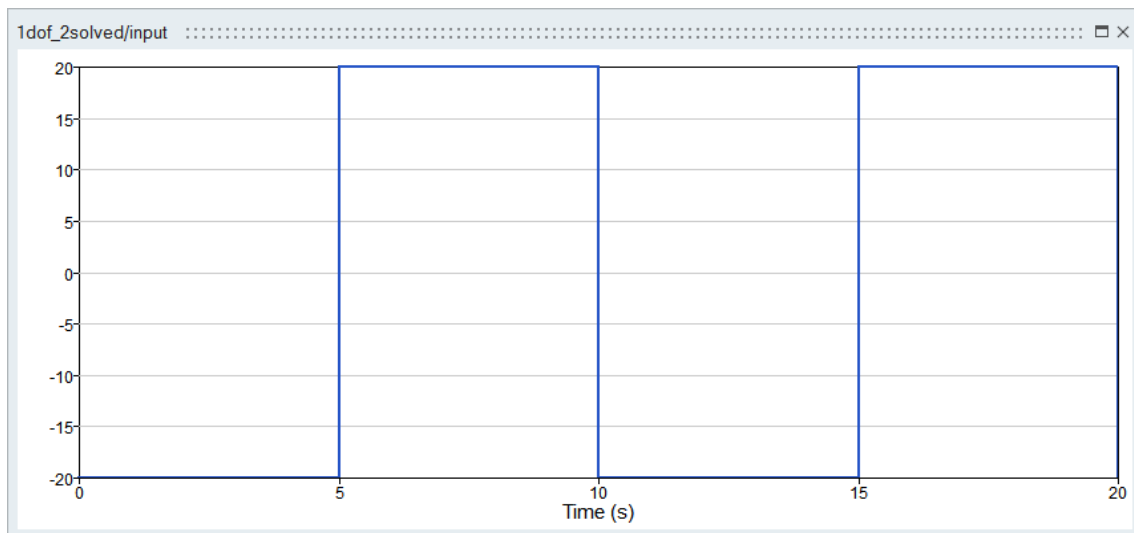
Hint: go to the Palette Browser in folder Activate->SignalGenerators and select the block SquareWaveGenerator:

SquareWaveGenerator