Kom
verder

Using Simulink

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Why using software tools?

- There are only a few DEs, which can be solved analytically:
  - linear one, with constant coefficients
  - simple input functions (polynomials, e-powers and goniometrical)

- Most models from the practice are quickly become complex, so that
  - they are not analytically solvable,
  - an analytical solution does not even exist.

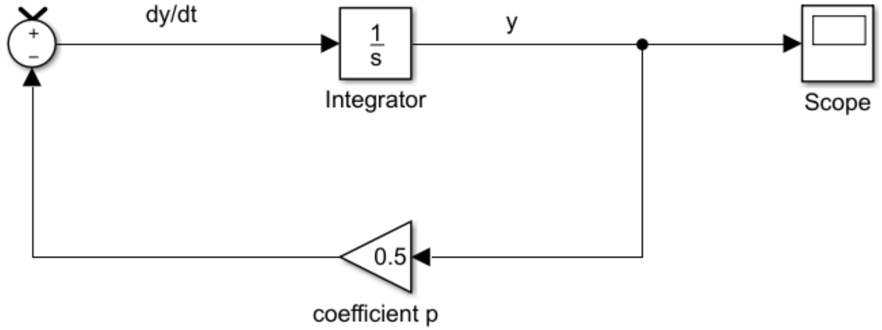
- In these cases, a (very good) approximation of the solution can be found by means of the computer.

- By means of the computer a system can be analysed before it is really built (avoiding costs).

Simulink

- Simulink is a part of Matlab.

- Simulink is good in simulating *dynamical models*, i.e. models of time-dependant systems.

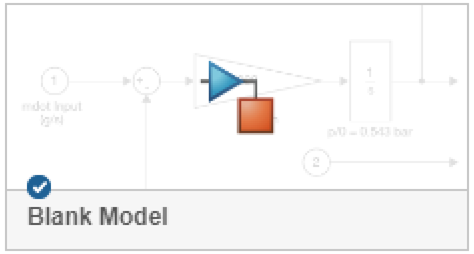


- Simulink is a *graphical programming language*. You work with functions blocks with inputs and outputs.

- You connect these functions blocks together and you can build block schemes.

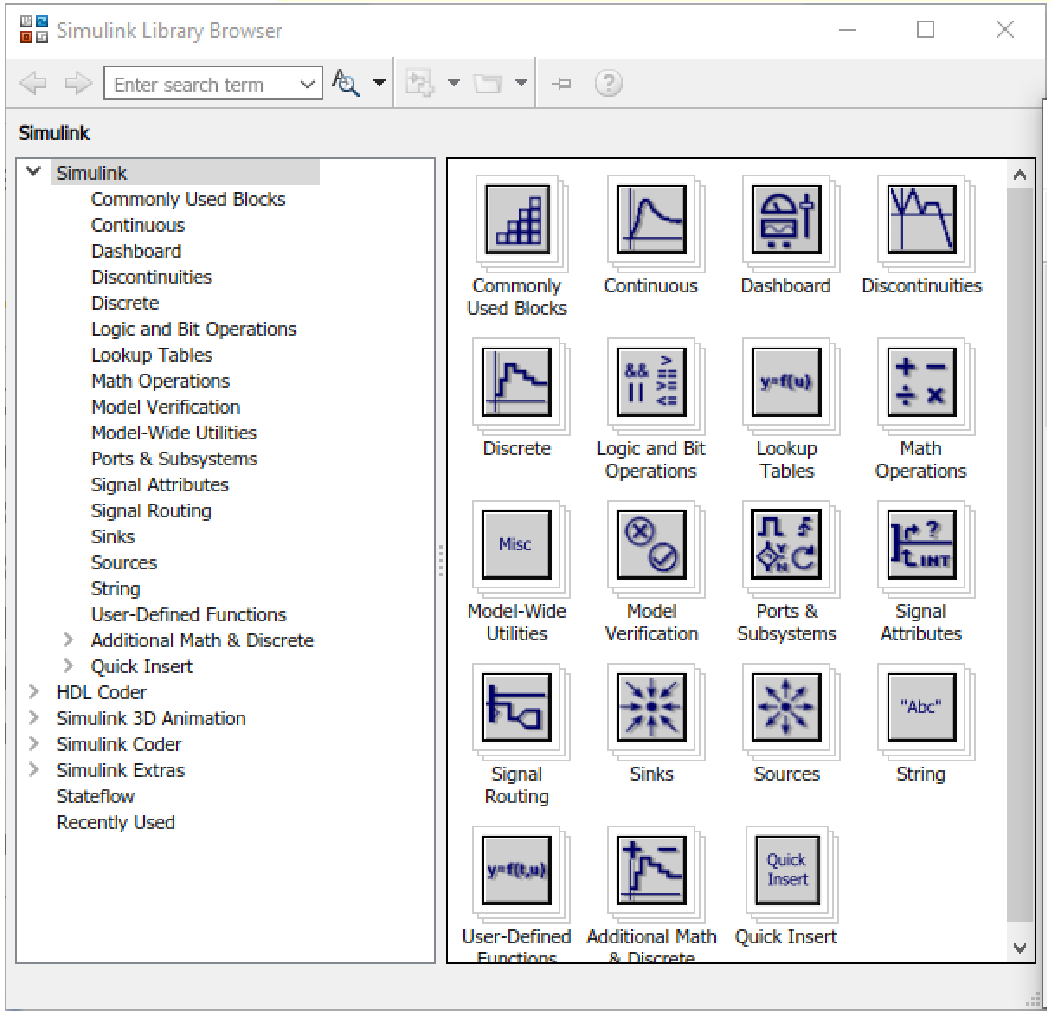
Starting Simulink

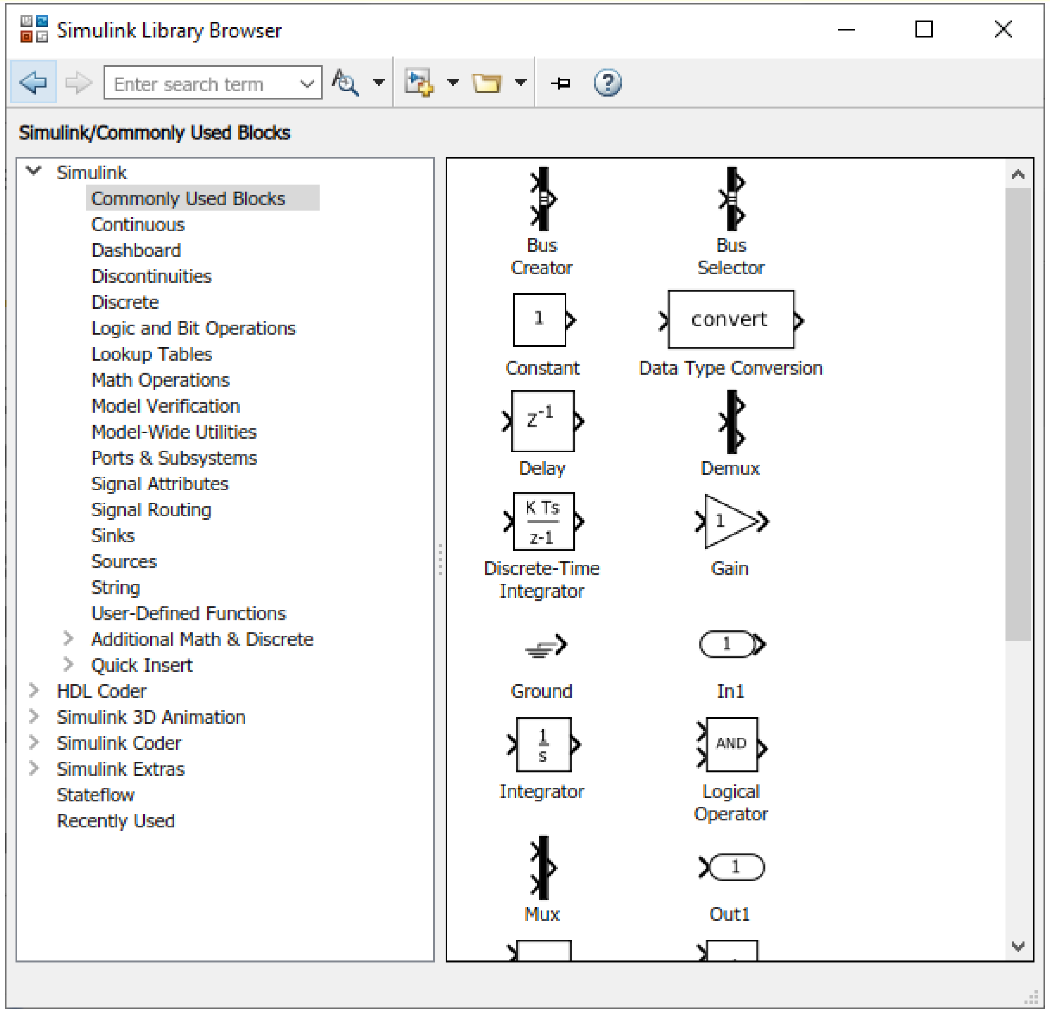
You can start Simulink either by typing the command `simulink` in the command window or by clicking on the Simulink icon in the menu bar 

After Simulink has been activated, you should choose a blank model 

After the Blank Model has been activated, you should also activate the Simulink Library Browser, either by typing the key combination Ctrl-Shift-L or by clicking on the Simulink Library Browser icon 

Simulink Library Browser





Simulink

- Suppose we want to solve the following first-order DE by means of Simulink:

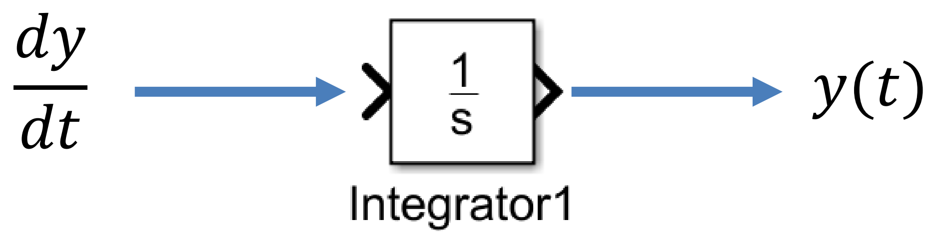
$$\frac{dy(t)}{dt} + p * y(t) = q(t), \quad y(0) = C$$

- **The idea is that the solution can be found by integrating the derivative.**

$$\frac{dy}{dt} \xrightarrow{\text{integrating}} y(t)$$

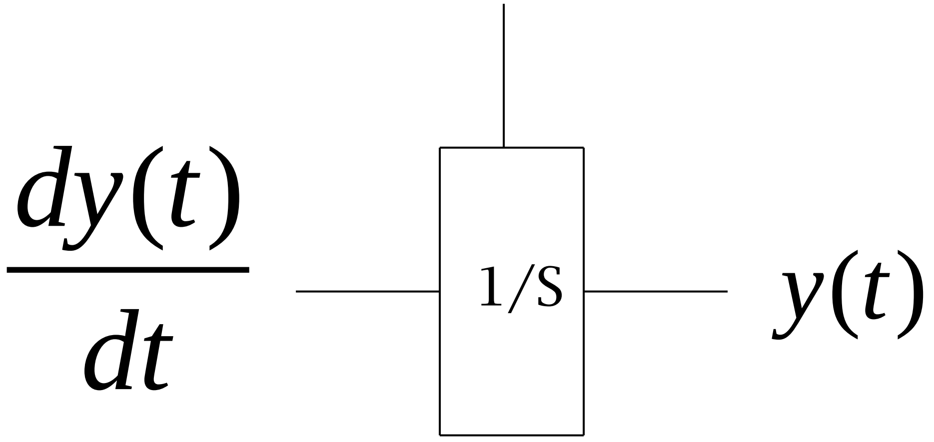
- In the Simulink Library there is a special block (***a very important one***), called the integrator.

  The symbol $\frac{1}{s}$ is obviously related to the Laplace Transform.



The integrator block

$y(0)$ $\Leftarrow$ *the initial condition (will come back later)*



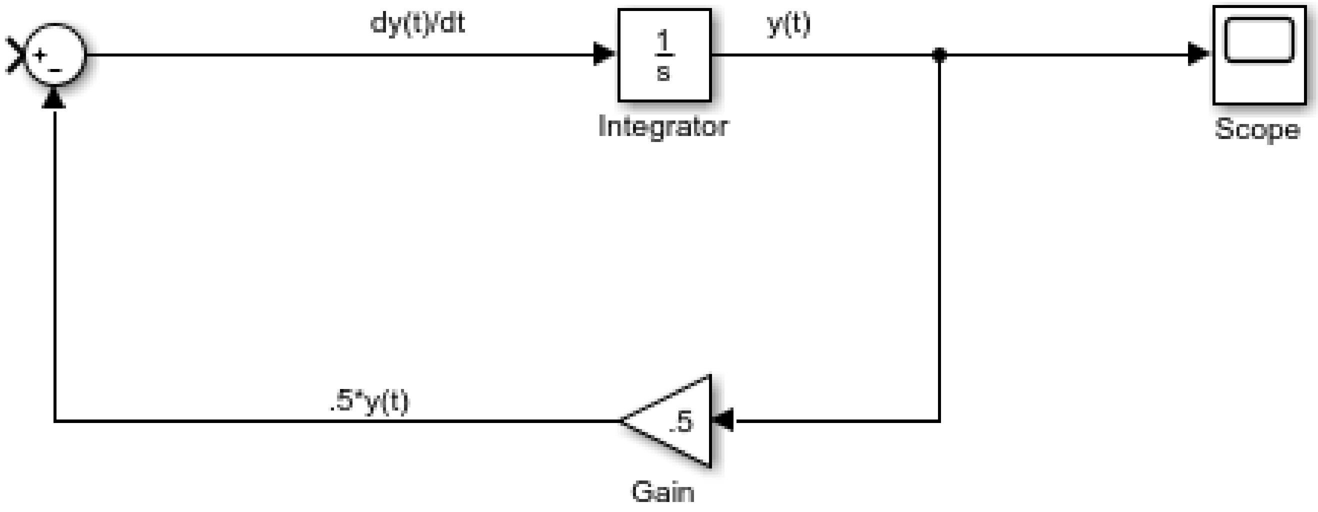
$$y(t) = \int_0^t \frac{dy(\tau)}{d\tau} d\tau + y(0)$$

$$\frac{dy(t)}{dt} + p * y(t) = q(t), \qquad y(0) = C$$

- How do we continue?
- Rewrite the DE so that only the derivative is on the left side of the equation.

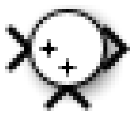
$$\frac{dy(t)}{dt} = q(t) - p * y(t)$$

- Example: $p = 0.5$, $q(t) = 3$ (i.e. a constant input).
- The term $0.5 * y(t)$ can be fed back to define the derivative (the DE).



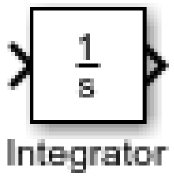
Simulink model: choosing the blocks

Blocks needed from the library:

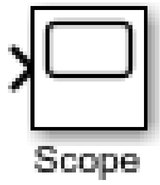


The input signal q(t) and the term p*y(t) enter at the summation block (take care to use the proper sign: + or –)

The output of the summation block is the **derivative of y(t)**



The 1/s block is the integrator. The output will be **y(t)** (take care to use the proper initial condition as input for the integrator).

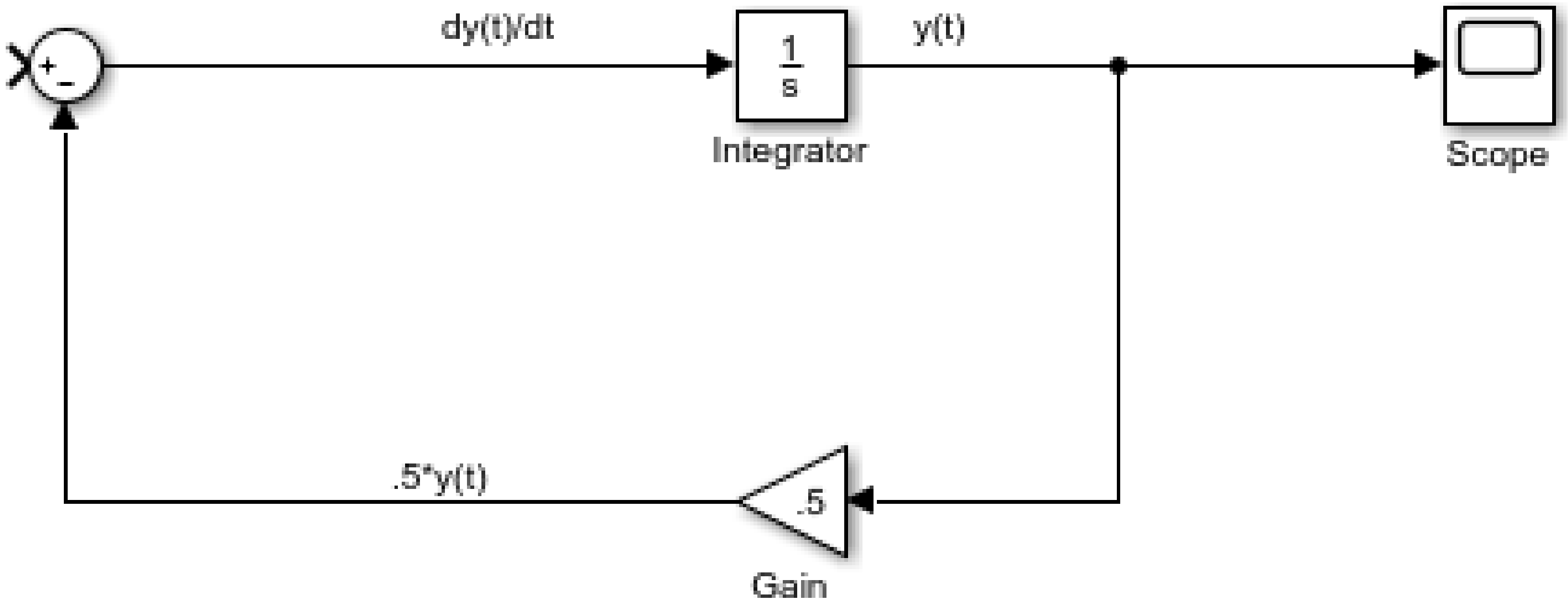


The solution, y(t) will be shown at a scope.

Gain means multiplication factor. Here y(t) is multiplied by the coefficient p.

Simulink model: connecting the blocks

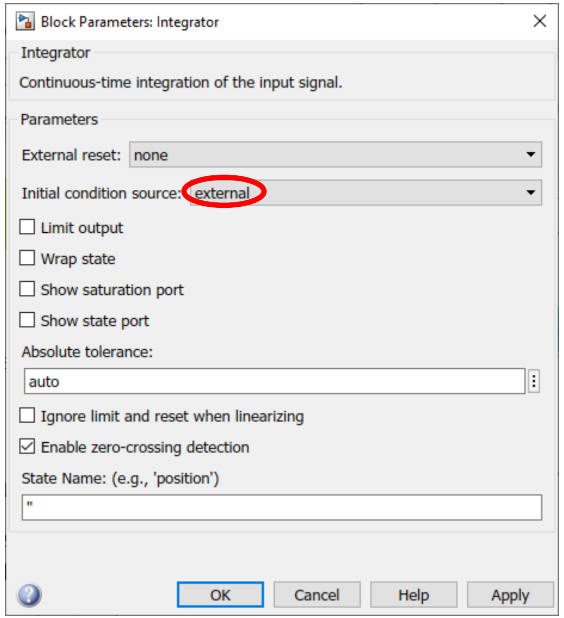
- We connect the blocks an give the gain block the value 0.5.
- The summation block has been edited so that it has one + input and one – input.



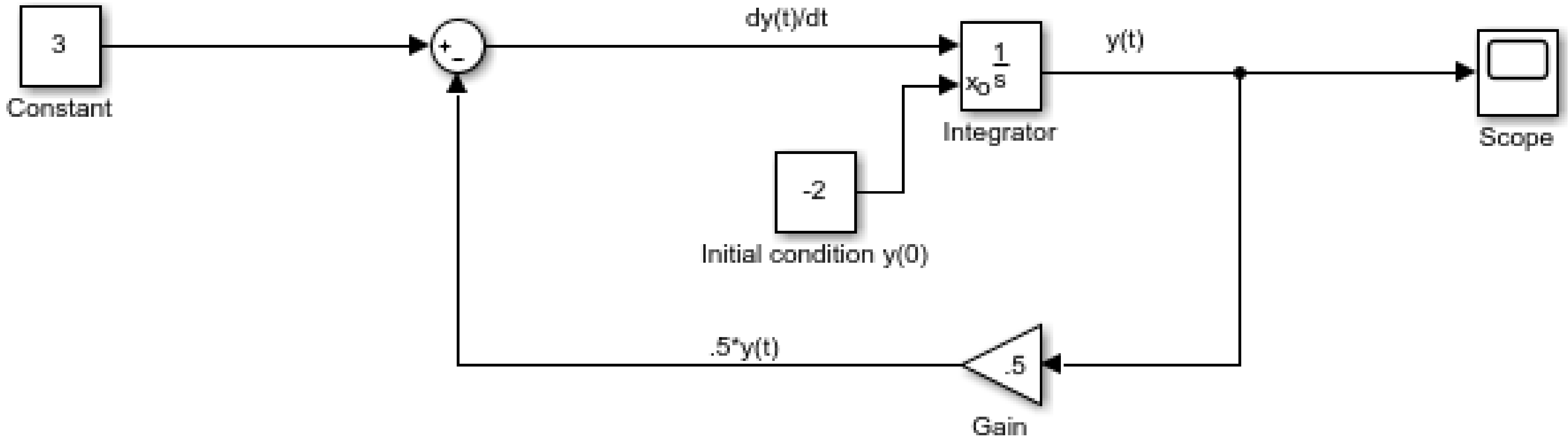
- Now we have to define the input signal and the initial condition.

Simulink model: finishing it

- As stated before, we take here a constant as input signal $q(t) = 3$
- Furthermore, we have to enter the initial condition: we take $y(0) = -2$
- The ***initial condition*** can be implemented in two different ways:
  1. by double clicking on the integrator, the initial condition can be specified.
  2. by double clicking on the integrator, the initial condition source can be set to external, causing an extra input for the integrator, to which a constant can be connected.



Simulink model: the complete model

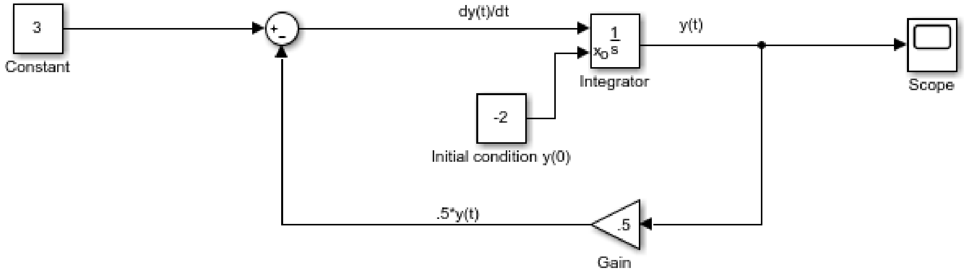


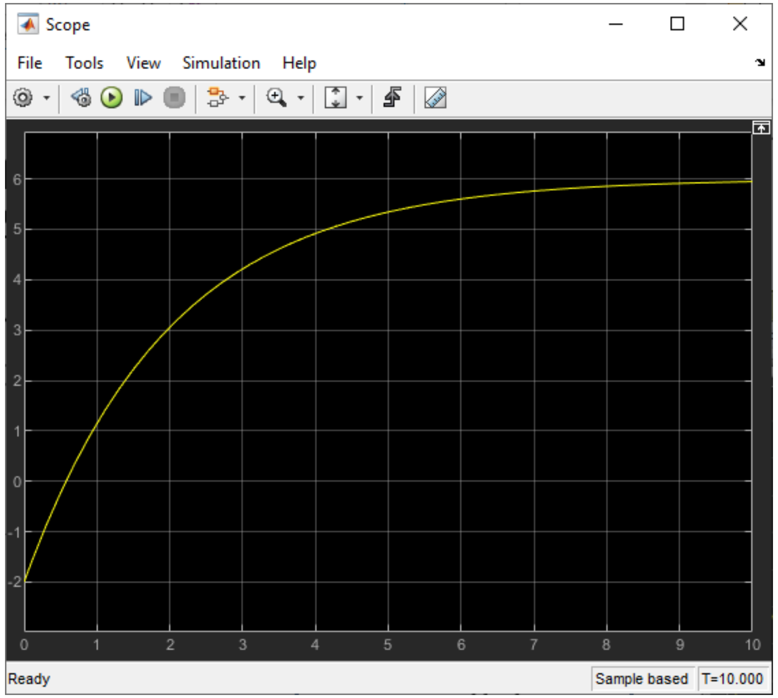
Simulink: checking the results

- A mistake in programming can be made quickly (wrong sign, wrong value filled in, etc …).

- An important step is to check the output.

- You could e.g. check the following points:
  1. is the initial value at t=0 equal to −2?,
  2. is the behaviour "exponential" as might be expected in case of this first-order DE?
  3. is the final value of the solution as expected? In the case of the given example, the final value can be easily calculated manually, since the final value of $\frac{dy(t)}{dt} = 0$ due to the "exponential" shape





$$\frac{dy(t)}{dt} = 3 - 0.5 * y(t) \rightarrow 3 - 0.5 * y_{final} = 0 \rightarrow \boxed{y_{final} = \frac{3}{0.5} = 6}$$

Simulink Onramp Training (1)

- This week you start with the Simulink Onramp Training and should complete it before the next lecture.

Simulink Onramp

100%

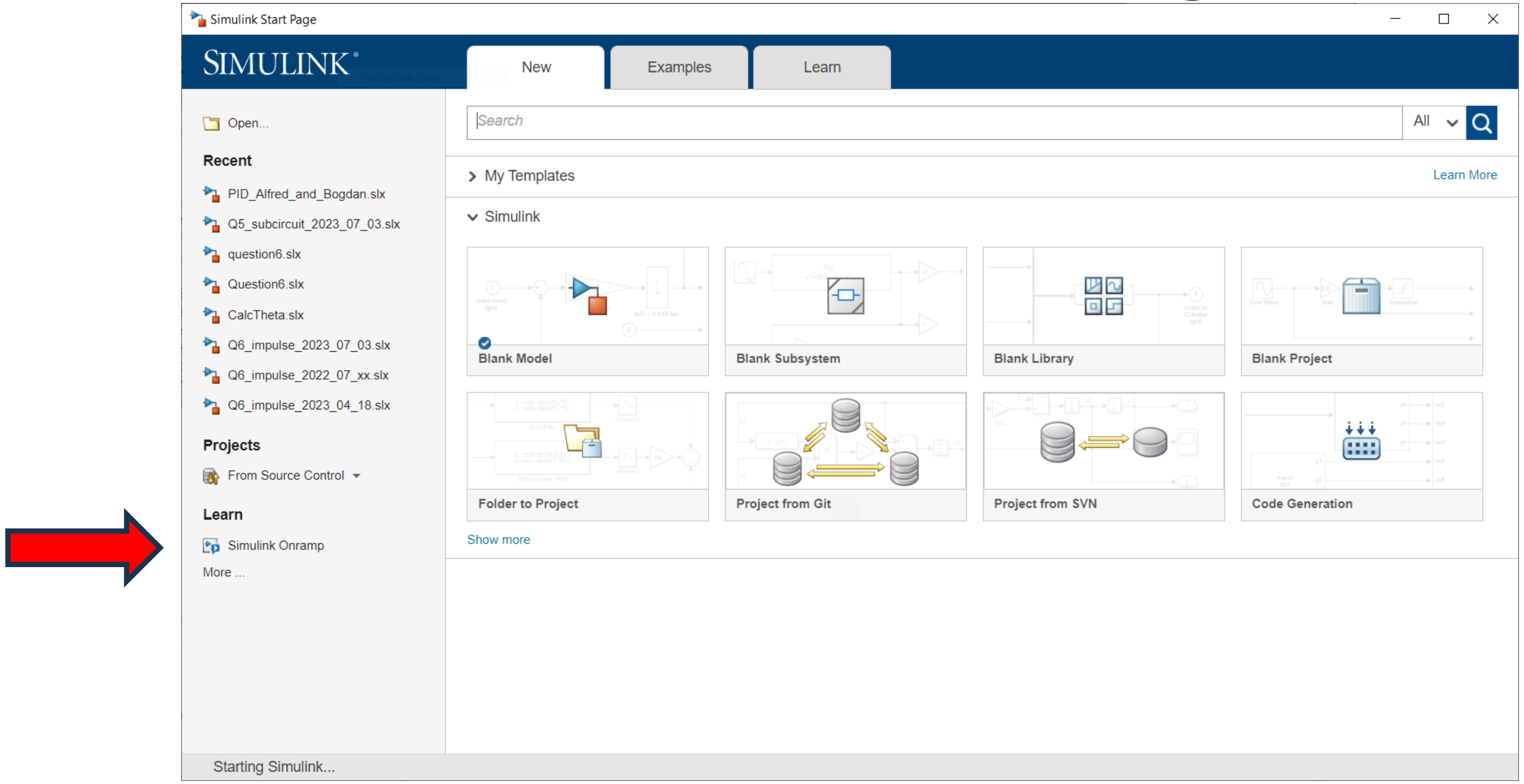
14 modules | 2 hours | Languages

Get started quickly with the basics of Simulink.

- If you finished it successfully, **submit your certificate on blackboard**

Simulink Onramp Training (2)

- Don't use Simulink Onramp **Online** Training but use the **built-in** Simulink Onramp Training



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Questions