POLYTECHNIC UNIVERSITY OF BARI

DEI - Department of Electrical and Information Engineering

Introduction to Simulink

MATLAB

SIMULINK®

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Simulink

- **Simulink** is a graphical programming environment for modeling, simulating and analyzing multidomain dynamical systems.

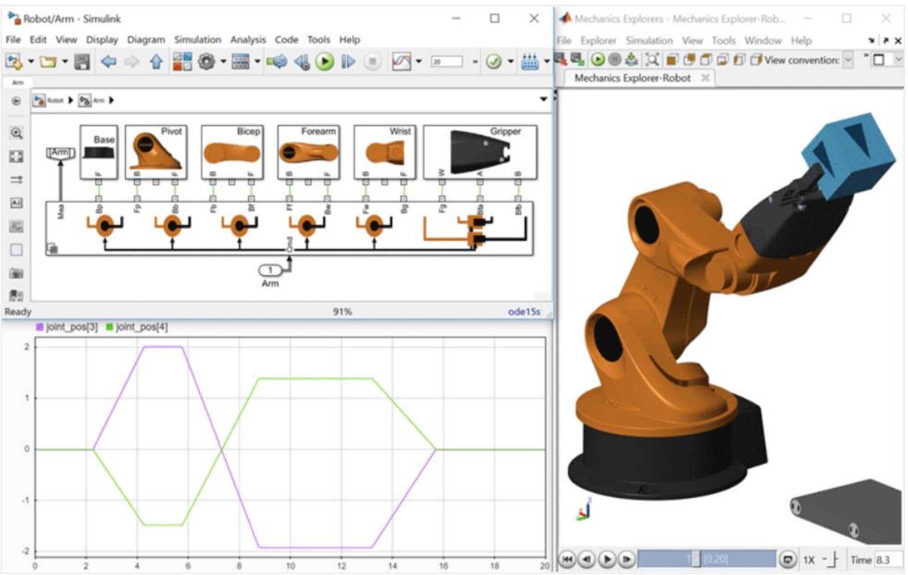
- Its primary interface is a graphical block diagramming tool and a customizable set of block libraries.

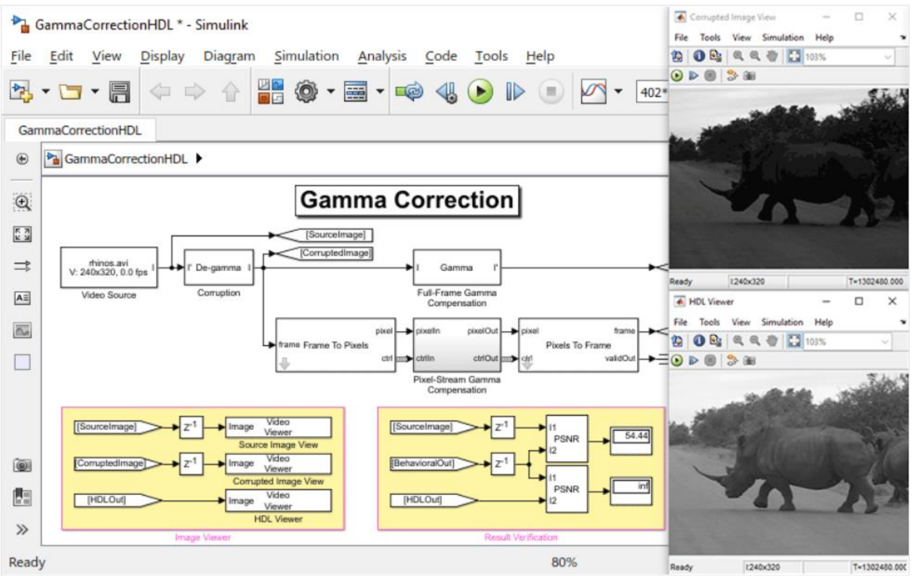
- It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it.

- Simulink is widely used in automatic control and digital signal processing for multidomain simulation and Model-Based Design.

Why Simulink?

- Simulink, makes simulations easier to achieve, by using blocks that correspond to codes you do not see.
- With Simulink, the model of the system you want to simulate is more readable, because it is represented by graphics.
- You can use Matlab to simulate a system, but you have to program your own routines added to the ones that are provided by Matlab.
- Simulink easily allows to simulate hybrid systems that include both continuous and discrete blocks.

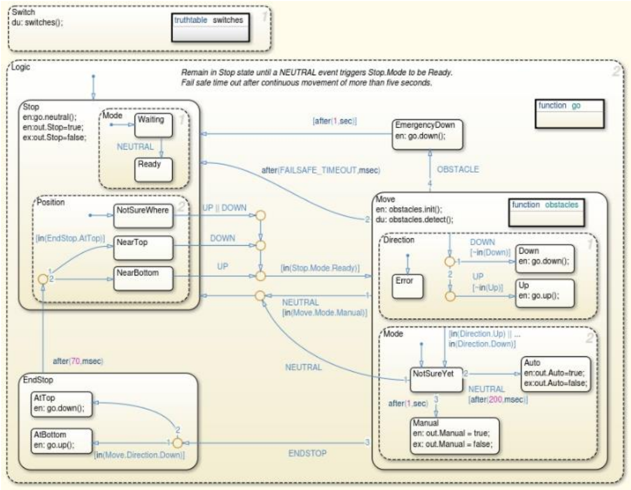




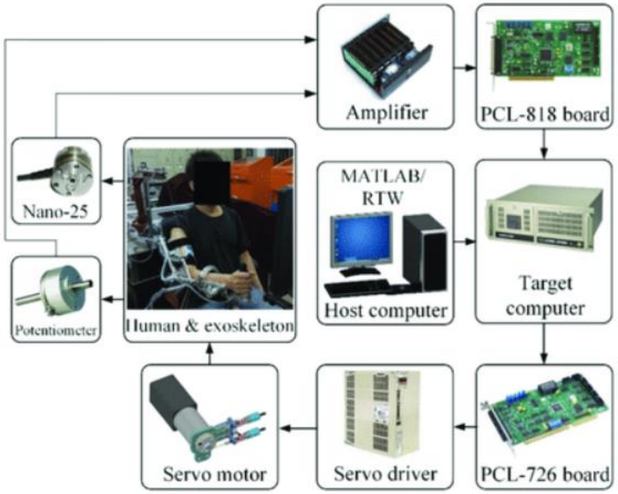
Why Simulink?

- Simulink easily allows to design and simulate complex state machines and flow charts.

- Coupled with another of MathWorks's products, Simulink can automatically generate C source code for real-time implementation of systems.



- Simulink Real-Time (formerly known as xPC Target), together with x86-based real-time systems, is an environment for simulating and testing Simulink and Stateflow models in real-time on the physical system.



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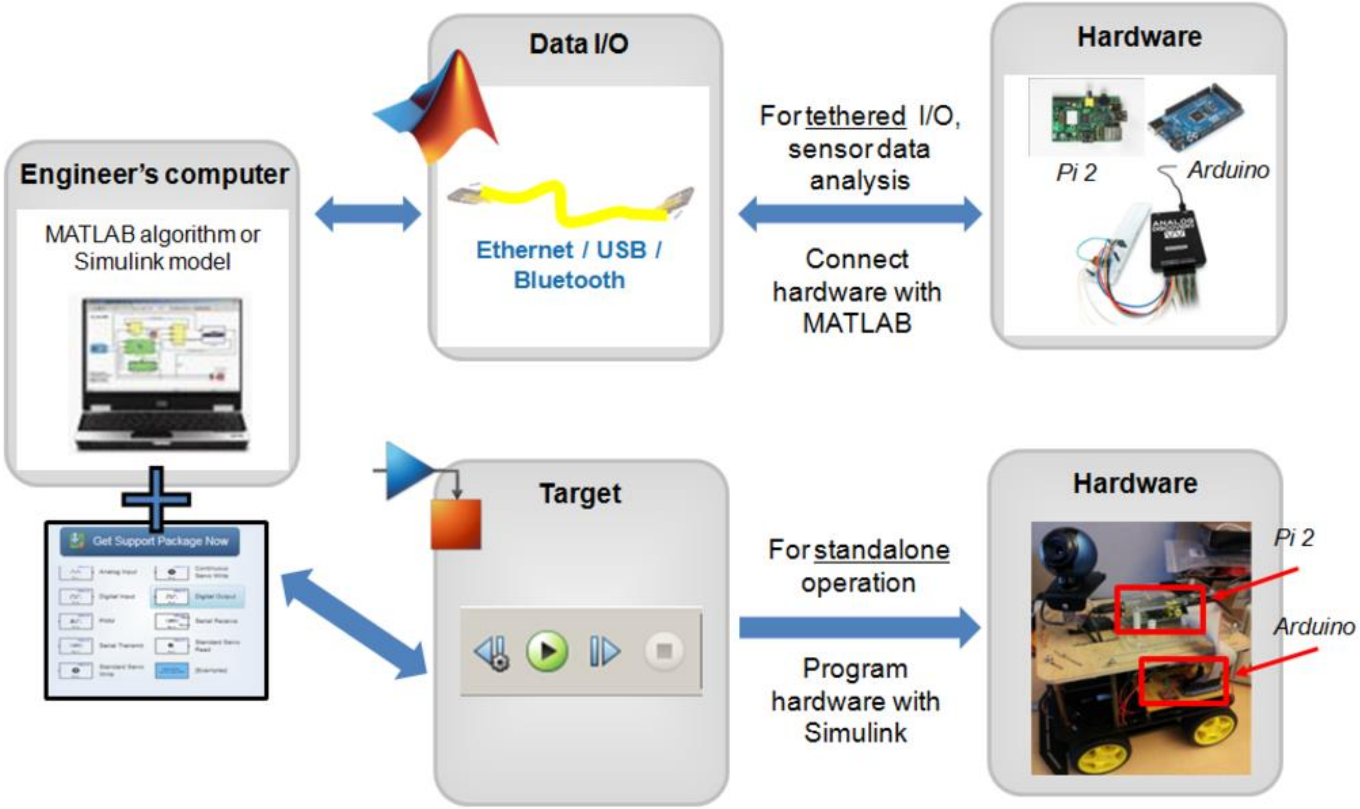
Why Simulink?

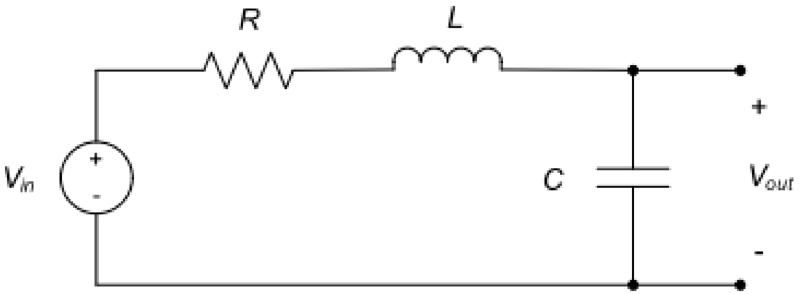
- <u>Simulink also supports specific embedded targets (e.g. Arduino, Raspberry).</u>



RLC Series Circuit: Step Response

$$V_{in}(t) = Ri(t) + L\frac{di(t)}{dt} + V_C(t)$$

$$V_{out}(t) = V_C(t) = \frac{1}{C}\int_0^t i(\tau)d\tau$$



State Variables:

- $X_A(t) = V_c(t)$
- $X_B(t) = i(t)$

Initial state conditions

- $X_A(0) = 0\ V$
- $X_B(0) = 0\ A$

Electrical parameters:

- $V_{in}(t) = 5\ V$
- $R = 2\ \Omega$
- $L = 2\ H$
- $C = 0.5\ F$

RLC Series Circuit: Step Response

$$V_{in}(t) = Ri(t) + L\frac{di(t)}{dt} + V_C(t)$$

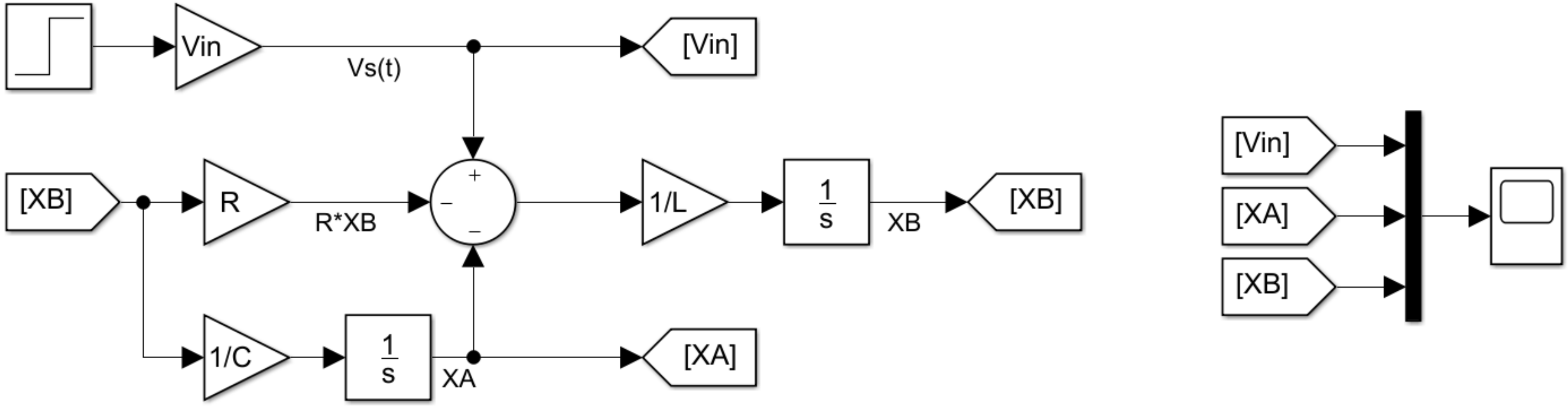
$$V_{out}(t) = V_C(t) = \frac{1}{C}\int_0^t i(\tau)d\tau$$

State Variables:

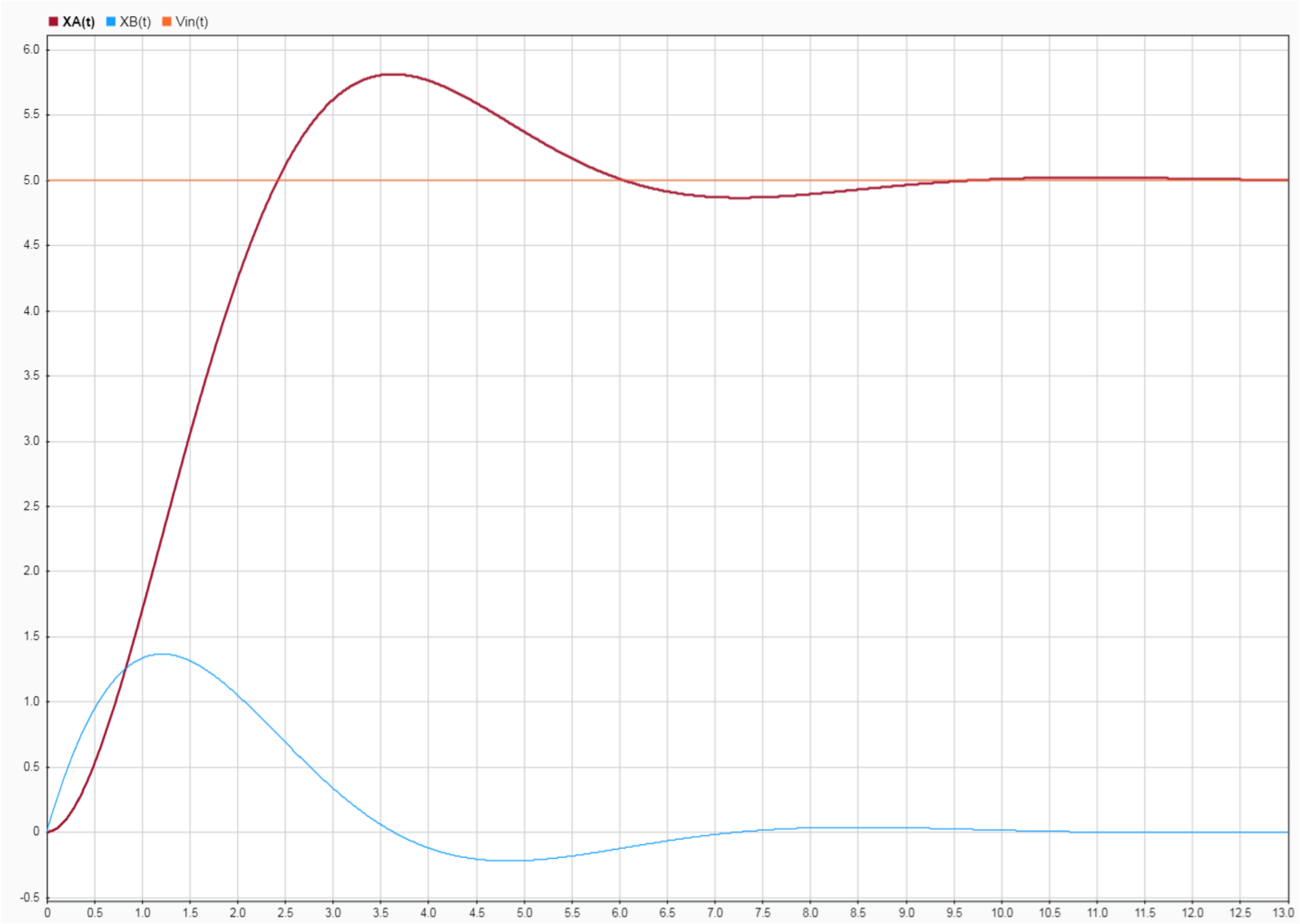
- $X_A(t) = V_c(t)$
- $X_B(t) = i(t)$

$$\dot{X}_A = \frac{1}{C} X_B(t)$$

$$\dot{X}_B(t) = \frac{1}{L}\left(V_{in}(t) - RX_B(t) - X_A(t) \right)$$



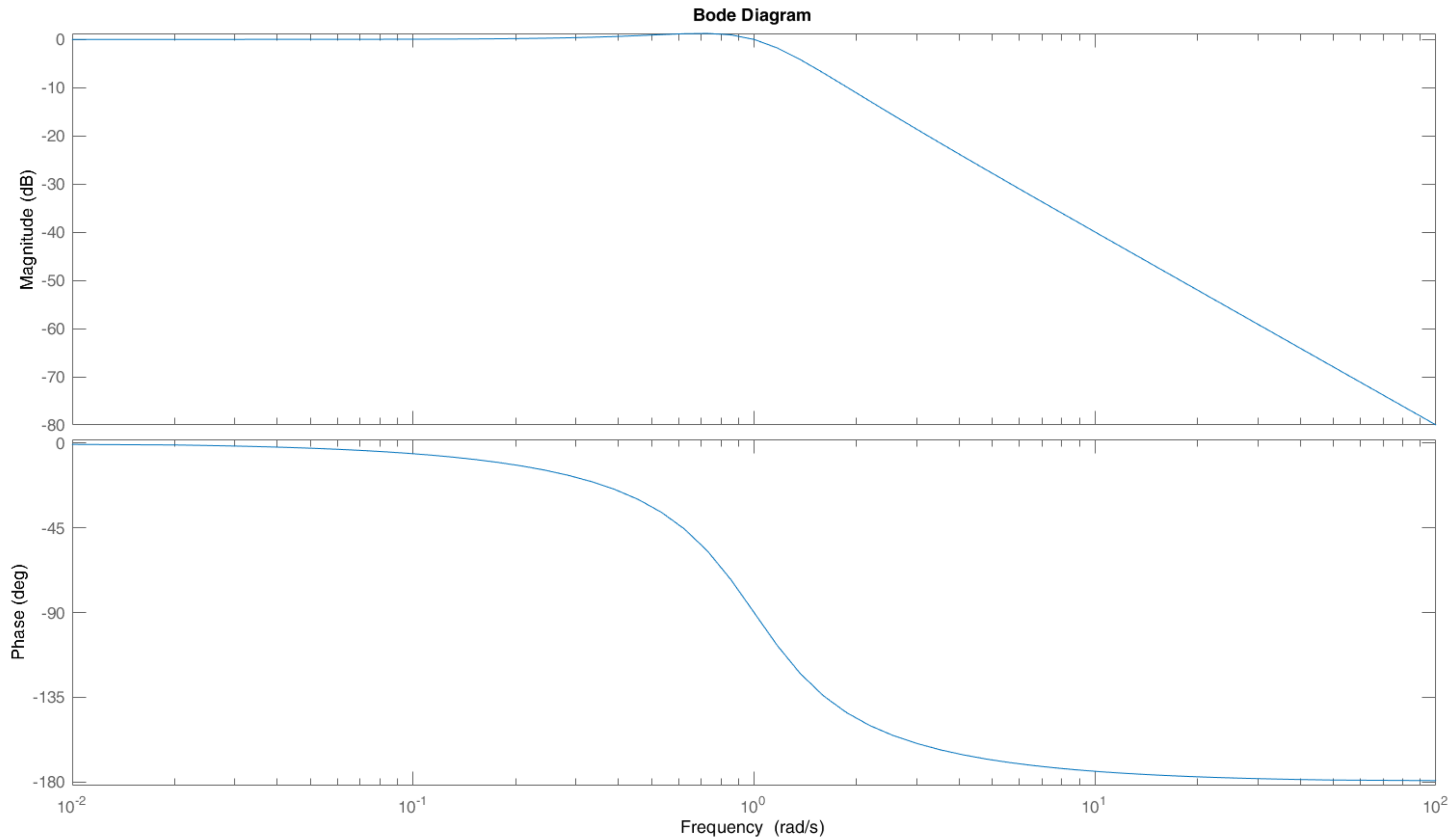
RLC Series Circuit: Step Response



RLC Series Circuit: Bode plot with Matlab

$$G(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{1}{LCs^2 + RCs + 1}$$

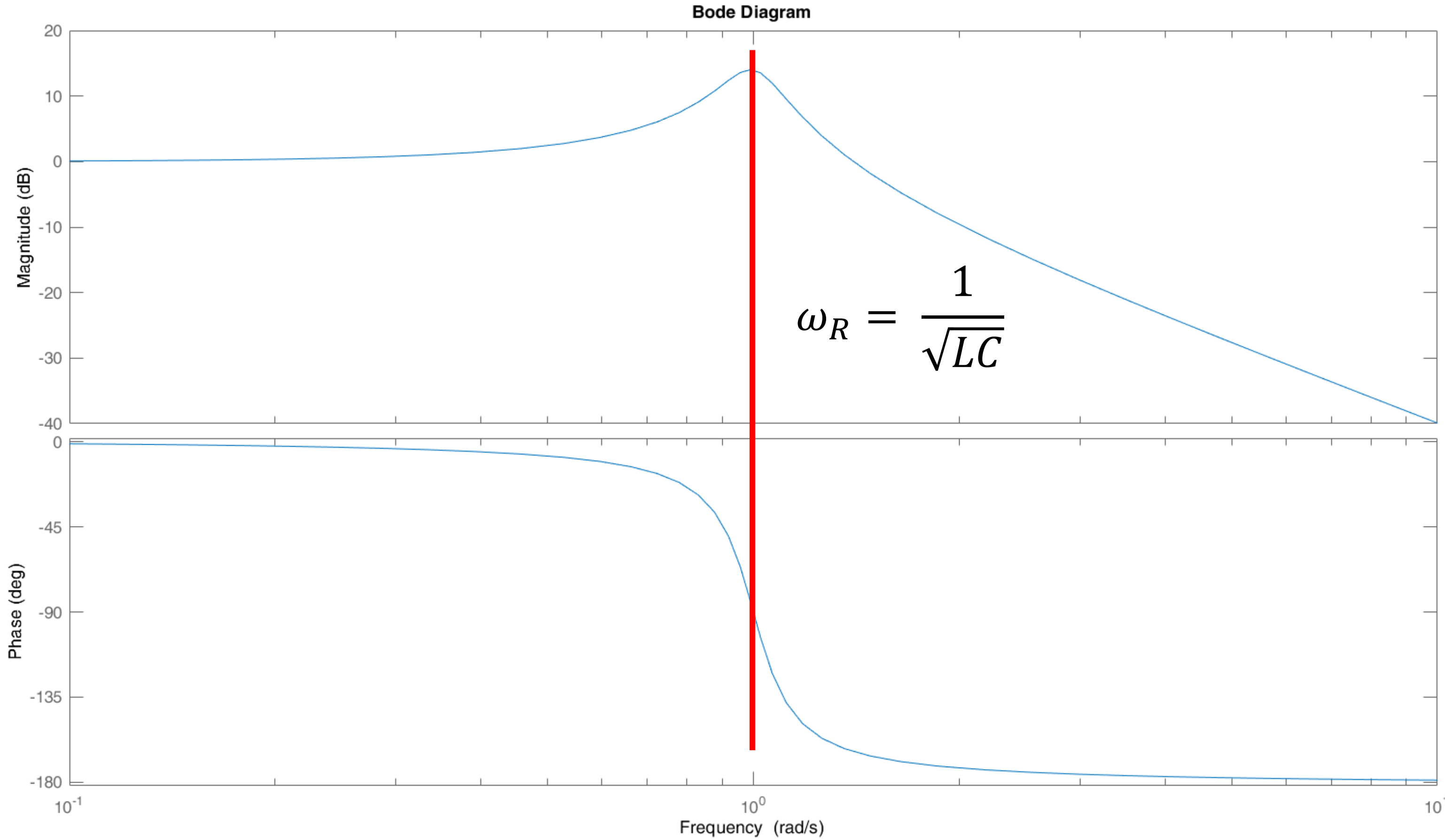
```
>> R = 2; L = 2; C = 0.5;
>> H = tf([1],[L*C R*C 1]);
>> bode(H)
```



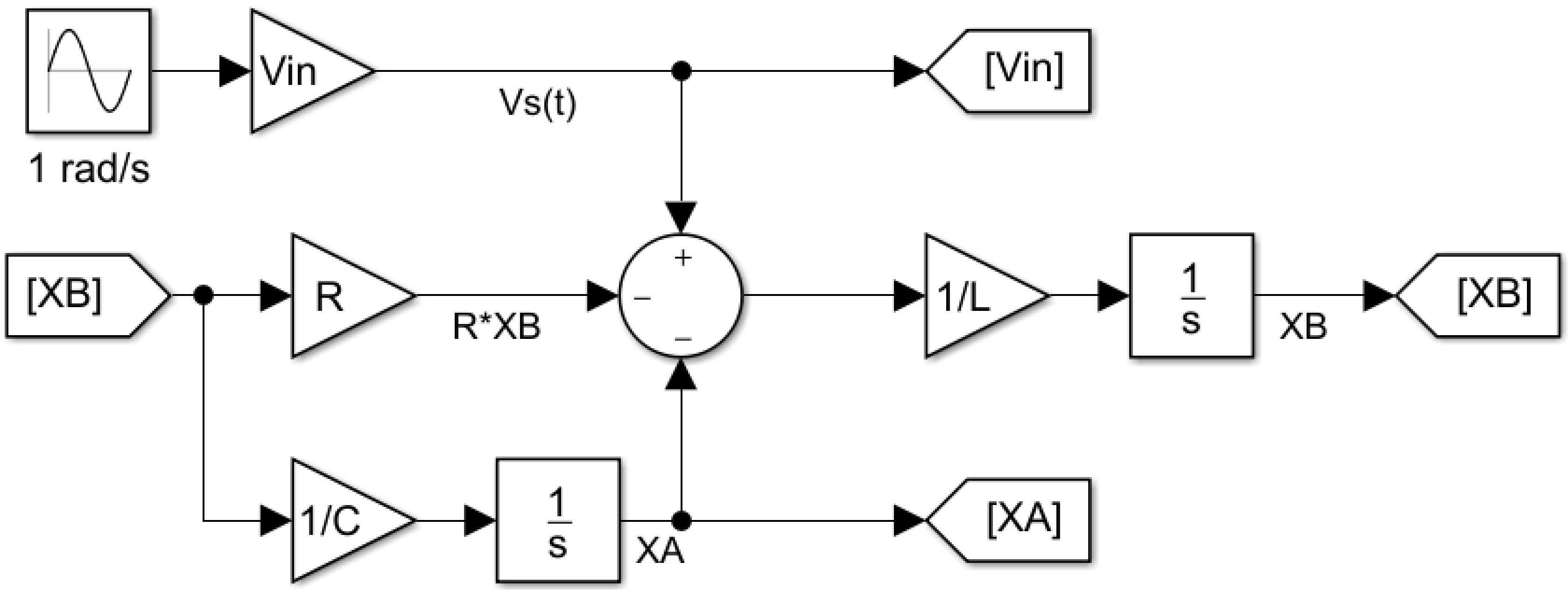
RLC Series Circuit: Resonance

$$G(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{1}{LCs^2 + RCs + 1}$$

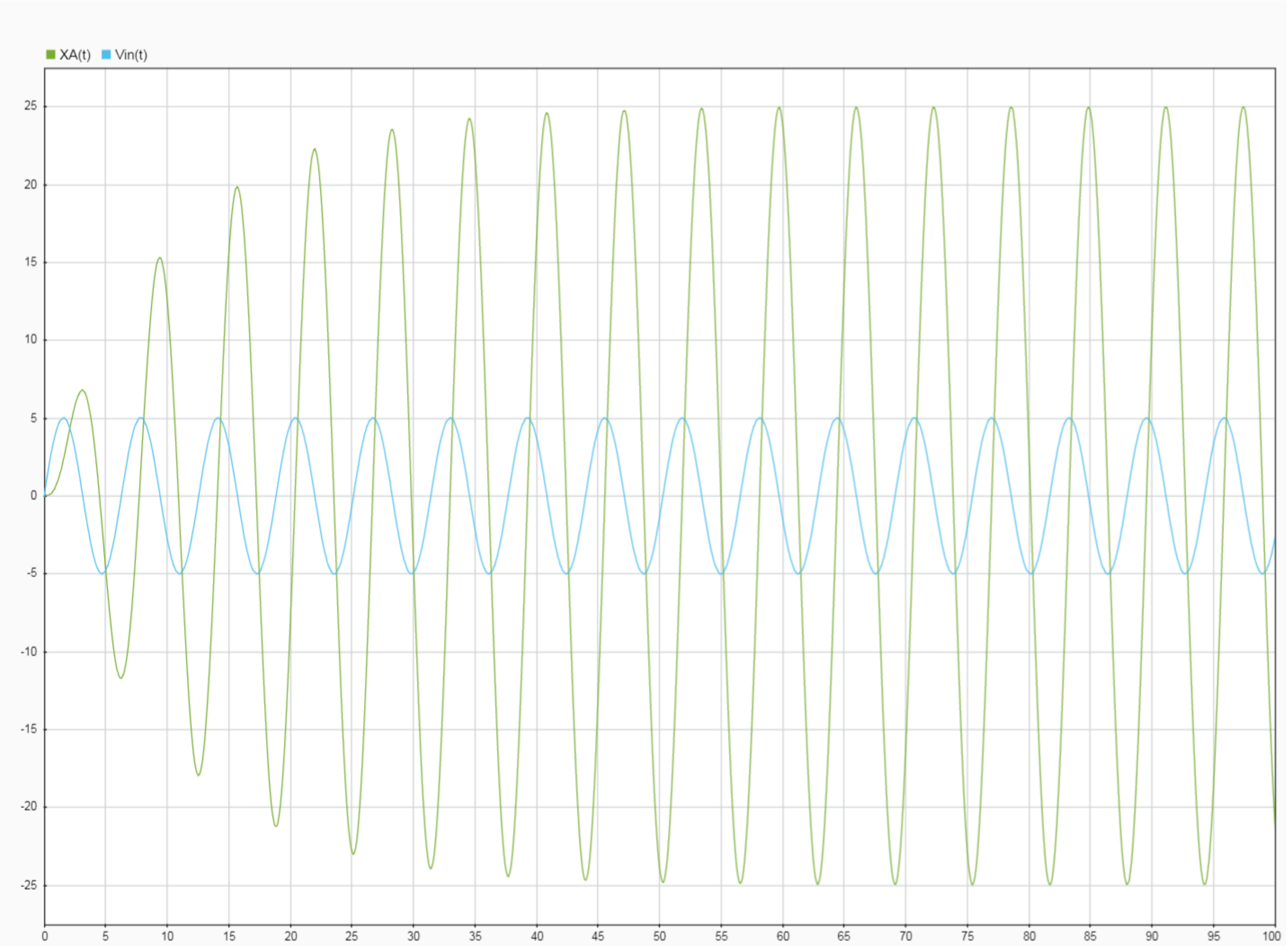
```
>> R = 0.4; L = 2; C = 0.5;
>> H = tf([1],[L*C R*C 1]);
>> bode(H)
```



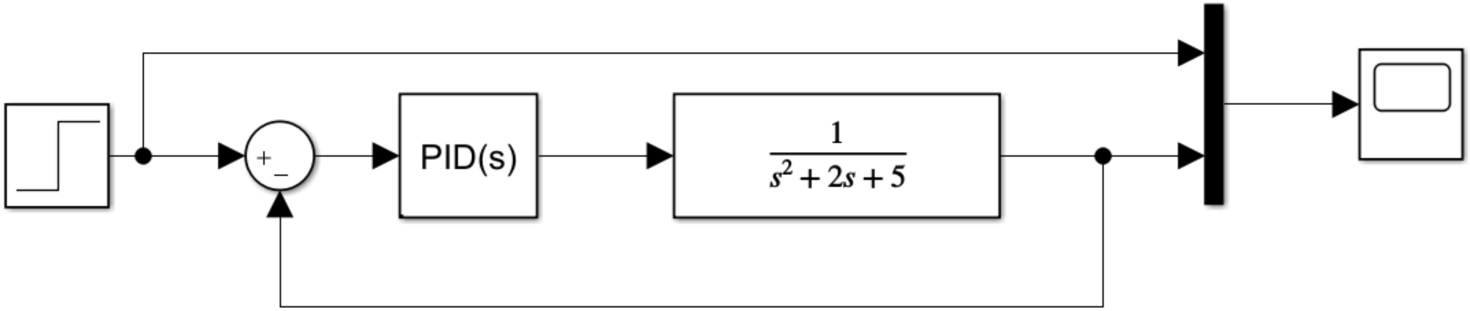
RLC Series Circuit: Resonance

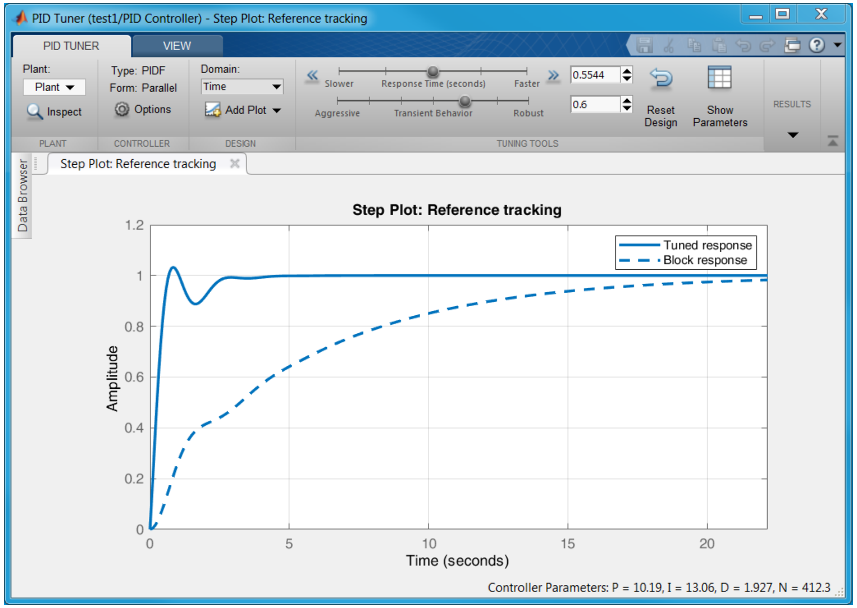


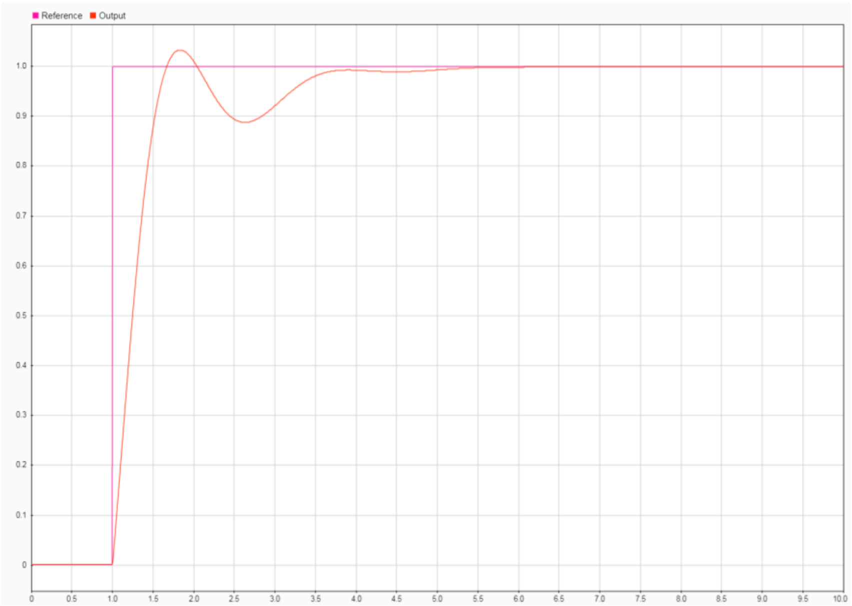
RLC Series Circuit: Resonance



PID Tuning







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thank you!

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